PROCEEDINGS
of the
ENTOMOLOGICAL SOCIETY
of
WASHINGTON

Volume 86

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ENTOMOLOGICAL SOCIETY of WASHINGTON

CENTENNIAL VOLUME

PUBLISHED QUARTERLY

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ARTICLES

(*Continued on back cover*)

THE

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OF WASHINGTON

ORGANIZED MARCH 12, 1884

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All correspondence concerning Society business should be mailed to the appropriate officer at the following address: Entomological Society of Washington, c/o Department of Entomology, NHB 168, Smithsonian Institution, Washington, D.C. 20560.

MEETINGS.—Regular meetings of the Society are held in the Natural History Building, Smithsonian Institution, on the first Thursday of each month from October to June, inclusive, at 8 P.M. Minutes of meetings are published regularly in the *Proceedings.*

MEMBERSHIP.—Members shall be persons who have demonstrated interest in the science of entomology. Annual dues for members are $15.00 (U.S. currency) of which $13.00 is for a subscription to the Proceedings of the Entomological Society of Washington for one year.

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VIGNETTES OF 100 YEARS OF THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

T. J. SPILMAN

Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, Natural History Building—NHB 168, Washington, D.C. 20560.

On March 12, 1984, we celebrate our centennial! The Entomological Society of Washington was conceived on February 29, 1884, at a small informal gathering and was born on March 12th at the first formal meeting at 1700 13th Street, N.W., in Washington. The Society was founded to foster the study of insects and to bring together those interested in the subject. In both of these objectives the Society has been eminently successful.

The history of our Society and its members is in many ways fascinating. I recommend the excellent histories written by the master story-teller, L. O. Howard, who was present at the creation, and by Ashley B. Gurney who brought the history up to date in our Proceedings of 1976 (78: 225–239) and gave references to all past histories.

A society is made up of individuals and each in his or her own way is unique. Some become stars and light up the sky; some plod along and hardly cause a dent in the sand; some are interesting, some dull; some good, some bad. Of some we hardly know a thing, only their names; but of others we know much, even something of their personality, manners, and dealings with others. For our 100th birthday I choose to tell not the larger stories of the Society but the stories of a few individuals. So much has been written of the three principal founders of our Society that I'll not dwell on them: Charles Valentine Riley (1843–1895), Leland Ossian Howard (1857–1950), and Eugene Amandus Schwarz (1844–1928). Nevertheless, I can't resist letting a few words about each of these three important men creep into these stories.

Our Society, from the very beginning, has not been an impersonal organization. On the contrary, it has been very personal, excelling in a mix of amateurism, professionalism, exchange of ideas, and conviviality. The minutes record how important the meetings were and various writers on the history of the Society have described the brotherhood that prevailed. Because some stories concern early meetings of the Society, and because today's meetings are conducted differently, a short explanation is in order. Very early meetings were held in the homes of members, but as meetings became larger, they were switched to various halls, such as the Sängerbund Hall. Members stayed after meetings, for what were called annex meetings, to talk informally about insects and very nearly everything else. It was a time for social intercourse and friendship, with lots of good refreshments. (Today we have a somewhat analogous practice; a few attendees gather before the meeting for dinner at a restaurant on 10th Street near the Natural History Building of the Smithsonian and all attendees take part in a short social period, with refreshments, after the meeting.)

Stories of members are part of the cherished history of our Society. They put living flesh and blood on the names in our Society. We hear and tell these stories over and over, and some stories get better or even worse in the retelling. I have scanned the publications of our Society, especially the minutes, read parts of biographies and autobiographies of a few members, and talked to anyone interested in the subject. Much has been borrowed (a little stolen?) and I thank all, dead or alive, for telling these stories. A few vignettes of perhaps a hundred stories that I have read or heard will serve as examples of how interesting entomologists of the past hundred years were, how they were motivated in their work, and how they were viewed by others. These stories concern members but not necessarily their activities in the Society. You might have other favorite stories. These are mine.

Cockroach Stories

At one of the early "annex" meetings a member spied a cockroach, and this began a round-robin of stories, with several members contributing their favorite roach stories. John B. Smith (1858–1912) relates the following sequence of what was said. Riley said that in his office there was a roach that had become quite tame and familiar. It manifested no fear of him, would watch him at his work and would, when a finger was presented, climb on it, run around on his hand, and make itself very much at home. Howard stated that he also had a tame roach, and this specimen had a fondness for tobacco. He would, when smoking, occasionally lay his cigar on the edge of one of the drawers of his desk and the roach would come to the moist end and feast on nicotine. When taking up the cigar again, he would shake off the roach who would wait until it was again replaced, and then the roach would again resume his feast. Another member, who modestly desired to have his name withheld, thought that insect intelligence had been much underrated. A young lady friend of his had a pet roach that used to frequent her dresser drawers and used to expect and appreciate the little tendernesses and endearments its mistress accorded it. For three years or thereabouts it lived happily, but then, for a short time, its mistress refused to notice it—other matters on her mind probably—and the little pet took it so to heart that it deliberately feasted on 'Pearl Powder,' knowing of its poisonous qualities, and died. Deliberately committing suicide! A marvelous instance of insect intelligence.

That ends Smith's account of the meeting. Several of my colleagues thought Pearl Powder might have been an insecticide, but I couldn't find it mentioned in old books on insect control. At last I found it in a book on the history of cosmetics. It was a pomade and it contained several pernicious ingredients that could kill or, at least, disfigure. The entomologist's lady-friend would have used Pearl Powder on the face, neck, and bosom to produce an enamelled look, "the lily whiteness which so dazzles our eyes." O tempora! O mores!

Theodore Pergande

An early member, Theodore Pergande (1840–1916), was an amateur entomologist in Germany. He came to the United States because the girls in Germany bothered him so much and because he disliked prayer meetings. In the United States he eventually enlisted in the Army and served through the four years of the Civil War, making entomological collections over various battlefields. In St. Louis he met Riley and came to Washington with him. When Howard, just out of college, noted Pergande's difficulties with the English language, he recom-

Fig. 1. Theodore Pergande.

mended that he study the masterpieces of English literature to cultivate a style of writing. Very soon thereafter Pergande, who made practically all the notes for the Bureau of Entomology for many years, began writing those notes in the style of Edmund Spenser's *Fäerie Queene* and similar masterpieces in English literature. It was entomology presented in a classical style.

Pergande was the subject of three items that have become special treasures to a few of us Washington entomologists. Two lovely genre photographs show Pergande as an old man, seated at a desk complete with neighboring spittoon, peering through a fine old compound microscope (at one of his aphids?) and then looking up at the camera. One wonders why he wears a heavy overcoat indoors—did he just come in from the cold and immediately sit down to look at a new specimen, or had he put on the coat to leave and then took one last look at an enigmatic aphid? More likely, his cold old bones needed the warmth of that coat in a drafty museum. Quaint as are the pictures, they are not so strange as a treasure now in my possession. I have a lock of Pergande's hair! It is in an envelope so labeled and dated Apr. 28, '95. How it came to me I cannot recall, but someday I'll pass on that bit of incunabulum to another. Systematists are intrinsically collectors, no matter what the subject.

The Seal of the Society

The origin of our seal has for a long time been a mystery. Jon L. Herring in the Proceedings of 1964 (66: 1) discussed the story of the seal of the Society and

Fig. 2. Theodore Pergande.

its use on the cover of the Proceedings. A 1916 obituary of Otto Heidemann, the engraver of the seal, said that the seal used on the cover of the Proceedings had been adopted as the official seal of the Society. However, Herring could not verify the adoption in a search of pre-1916 minutes of the Society.

Perhaps we will never know the origin of that early action, but I have uncovered a later adoption. At a meeting on 6 October 1932, L. O. Howard reported to our Society on his visit to the Entomological Society of France and told of his disappointment in not having a seal of our Society to put on a portfolio of greetings. In a discussion, after Howard's report, it was stated that the question of a seal had been discussed on a number of previous occasions and that many of the older members had looked upon the cover illustration of the male of *Rheumatobates rileyi* as the seal, "although it had never been officially designated as such." A motion was then duly made and seconded that the Society adopt as its official seal the emblem we now have (redrawn by Herring) on the cover of our Proceedings.

HENRY ULKE

Well before our Society was formed, entomologists in the Washington area met to discuss insects. One of the regulars of those early days was Henry Ulke (1821–1910). He had come to the United States in 1849 after spending time in a prison

Fig. 3. Henry Ulke.

in Germany for political reasons. Eventually he settled in Washington as a photographer and portrait painter. He had previously developed an interest in natural history, especially entomology. Well known for his work as a portraitist of famous people, Ulke became known as "Painter of Presidents." He was a close friend of Abraham Lincoln, and his most famous portrait was of President Grant.

It is ironic that Ulke lived in the Peterson House on 10th Street in 1865. Lincoln died in that house after being carried across the street from Ford's Theatre. What could have been going through Ulke's mind on that terrible night? We might know if the autobiography of Ulke could be found. A few lines of it were quoted in an obituary written by his friends, but the complete work cannot be found today. Just a few weeks ago I had a call from a writer who is doing a study of Ulke, asking about that autobiography. No amount of searching has been successful. If anyone knows of it, please bring it forward so we can learn more about this interesting person who once graced our Society.

Because of his knowledge of beetles and his wonderful collection—he published an annotated list of the beetles of the District of Columbia area—he was sought after by famous entomologists. His stature can perhaps be summed up by the kind and touching words of William H. Dall, the natural history explorer and invertebrate zoologist, in a letter to Ulke, ". . . be sure I shall always think of you when I see a beetle."

At the conclusion of meetings held in the local Sängerbund Hall Ulke would often entertain with a masterful rendition on the piano of the Pilgrim's Chorus from Wagner's Tannhäuser. It was fitting that he was carried to his final resting place as the subdued strains of that fine Chorus was played.

Harrison G. Dyar

Every discipline has its rivalries, and entomology is no exception. Most are friendly, but sometimes the rivalry gets out of hand and develops into envy or jealousy. There has not been a duel with pistols or sabers, but systematists don't need pistols or sabers for dueling—words or names, if used dramatically, can bloody a man's reputation or wound very seriously his pride. The story of such a duel has been told many times by word of mouth and in print, even in the secular press. It is said that early in this century two of our members, both former presidents, developed a mutual dislike that developed into a nomenclatural battle. John B. Smith, the lepidopterist, was a huge man. When his rival Harrison G. Dyar (1866–1929) wanted to antagonize Smith he named an especially fat and ugly moth *smithiformis*. Another version says that he used the specific name of *corpulentis*. It didn't take Smith long to retaliate: he named a genus of moth *Dyaria*. That doesn't seem untoward until one reflects on the double entendre. The pronunciation of that generic name reminds one of a disagreeable and sometimes unmentionable malady. This is indeed a wonderful story, but unfortunately it is pure fiction. No such names were ever proposed by these entomological enemies!

Dyar was one of the most interesting members of our Society. His activities in noctuid and mosquito systematics are well known, but his exploits in his nonprofessional life are almost unbelievable. Dyar was a great digger of tunnels. In 1906–1916, from his first home near Dupont Circle in Washington he dug complex tunnels on various levels that extended approximately 200 or 500 feet and were large enough for a man to stand in. The tunnels were discovered in 1924 when a delivery truck fell through the pavement into one of them. The discoverers, not knowing the origin, thought the tunnels were used by German spies in World War I or by bootleggers during prohibition. Why did Dyar dig? He said he started digging a deep trench for his wife's hollyhocks, became interested in digging, and simply continued. He dug very wide and deep trenches, proceeded to wall and arch them with enameled brick, and finally covered and hid them with earth. In one version of the story he said they were for playrooms for his son but in another said simply that he liked the smell of fresh earth and dug for exercise. The outcome of his other exploits is almost as strange. Dyar, a wealthy man, maintained two homes; in one he had a wife, in the other a mistress. His amorous duplicity was discovered when two children named Dyar met in school and began talking of their fathers. They were surprised when they discovered that their fathers worked at the Smithsonian, then more surprised that they worked in Entomology, and finally astounded that their fathers worked on mosquitoes. The secret was out—their fathers were the same man! The stories are often combined, saying that the tunnels were dug between the two homes, but there is nothing to substantiate that embellishment.

When Dyar died W. T. M. Forbes said in an obituary that "there is no one to take his place." In more ways than he could have imagined, Forbes was right.

HUBBARD'S SCOLYTID BEETLE

Henry G. Hubbard (1850–1899), the coleopterist, was a first-class collector. The cabinets of the National Museum of Natural History are amply blessed with his specimens, many from places that are today ecologically nonexistent. He spent much time in Arizona to help heal his respiratory difficulties, and there he extensively investigated the fauna of the giant *Cereus* cactus. It was an unexplored area and the fauna of the cactus had not been studied. Anything could turn up—and did. Eugene A. Schwarz, his very close friend and scientific colleague, wrote to Hubbard from Washington on January 10, 1897, about the reaction of John B. Smith and A. D. Hopkins to a specimen sent from the cactus. "I must confess that your account of the 'most marvelous Cioid' did not strike me particularly and made up my mind that it was a species of *Ozognathus* (Ptinidae), the males of which have peculiarly-formed horns on the head. On Saturday upon returning from office after 4 o'cl P.M. I found your package and in order to see whether everything was all right I opened the pill boxes. When I came to the box containing the 'Cioid' and looked at the latter I came near being paralyzed and it required a superhuman effort and a swallow of whiskey to recover. Your Cioid turns out to be a most remarkable and entirely new genus of Scolytids!! In fact it is a long time since I put my eyes upon a more odd-looking creature than this species. After recovery I mounted at once a couple of specimens, for it happened that at 5:35 P.M. I had invited Smith, Hopkins and Alwood to dinner at Gerstenberg's with the understanding that they should spend the evening hours in my room, all three of them to leave between 9 and 10 o'cl with the B & O R.R. During dinner (everything as usual fried in cockroach grease) I narrated about that Scolytid and Hopkins could hardly wait for the time to look at it. Upon returning home the specimens were at once exhibited and Hopkins became perfectly wild with excitement and cursed his miserable West Virginia Scolytids because they did not show any distinguishing characters except after most painful scrutiny. One of your Scolytid males happened to be alive and we had an opportunity to watch the movements of this wonderful species. Smith got also excited and in order to prevent further mischief I had Ida at once fetch a pitcher of lager beer. This smoothened the excitement and two subsequent pitchers were drunk to your health, and it was unanimously voted that no one but yourself would have been able to unravel the secrets of the *Cereus* fauna."

Hubbard was to die two years later with his faithful friend at his side.

ALEXANDRE ARSÈNE GIRAULT

If, in the history of our Society, there was no member more important than Howard, no member more strange than Dyar, no member more kindly than Schwarz (though John M. Aldrich might compete, for he often gathered underprivileged children at Christmas time, gave them money, and took them on a shopping spree in his automobile), then there cannot have been a member more paranoid and vitriolic than Alexandre Arsène Girault (1884–1941). No entomologist ever used scientific writing in a more personal way than did he.

He worked for the U.S. Department of Agriculture 1904–1909. He became disillusioned and went to Australia where he worked for the Department of Agriculture and Stock. Then 1914–1917 he was again in the USA working for

Agriculture. Finally he returned to Australia to work again for Agriculture and Stock, never to return to the USA, though he never gave up his American citizenship.

His ideas of how he should do scientific work were definite, no matter that he might have been hired and instructed to do certain tasks not to his liking. Usually he was hired as an economic entomologist, but he felt that the use of entomology for economic purposes was a prostitution of science and learning. The word commerce, used often in his publications, was usually substituted for economic entomology and was meant to be as derogatory as possible.

Hating the economic entomology he had agreed to do, even hating his beloved taxonomic work if it had to be done on species of economic importance, he worked long and hard at home on the kind of taxonomy he loved. Diatribes against economic entomology, his superiors who assigned it, his colleagues who practiced it, and philosophical opinions began to enter his scientific writings. For those reasons and for several other scientific reasons, his superiors and various editors would not accept his manscripts, so he began publishing privately. He was hardly ever devious or cryptic in his statements; he didn't use the rapier—his weapon was the broad-sword and headsman's axe. He could be and often was vicious. He was, if anyone ever was, an embittered man.

He had many prejudices. One of them involved women. He detested what today is called women's liberation, calling it "womanitis . . . a serious disease which doth pock and burn, nay congeal, our very hearts." He even gave a scientific description of such "abnormal females" and proposed the new scientific name *Homo perniciosus* for them. This is not to say that he hated all women—far from it—he evidentally cared very much for his wife and respected other women. It was the new women emerging in the 1920's that vexed him.

After taxonomy, surely his first love was poetry. (He named many species for it.) He composed poems and used them for delivering his opinions of colleagues, both favorable and unfavorable. Perhaps his most famous poem was the one about his earlier USDA superior, another member of our Society: the poem entitled "A Song after the manner of 'Auld Lang Syne,' on some prominent 'Economic Entomologists' (who forsook insects for trade)," begins

Should A. L. Quaintance be forgot
And other childish men?
Who their first love let go to pot
that they might fatten.

He seemed to hate almost everything and everyone in Washington. In an article of 1918 he said "This work was done in Bedlam, that is, the Insect Section, U.S. National Museum at Washington, a place unfit for scholarship." Girault's most vituperative attack, perhaps, was directed at William H. Ashmead, a colleague on the Chalcidae, a president of our Society. He minced no words, saying Ashmead ". . . threw half the chalcid world into convulsions." In poetry he all but drew and quartered Ashmead.

False Captain! Ah! dark Error's pioneer,
Enthusiastic dunce and shamming sneer,

Aching for a day's applause;
Low scholar, ever wishing us laud Ambition's
  wind-blown froth and sandy fraud,
Thus defying Heaven's laws.

Arise! Come, get thee from thy shelt'ring grave
Where, strong walled, e'en thou coulds't dare be brave

With impunity's gaunt grace;
Ah, come, past coward, lily-livered liar,
Fair-tongued sweet-mouthing unctious friar
Let's see what's writ across thy face!

Girault, like so many taxonomists, used scientific names to single out special people. Many of his new generic and specific names are obviously dedicated to the writers, musicians, philosophers, and historians. He touched many social causes with his names: *pattersoni* (1936), "to Haywood Patterson, a persecuted Negro of Alabama;" the timely *judaei* (1937), "to the still persecuted jews;" and his soaring championing of a former boxing champion, *johnsoni* (1922), "to Jack Johnson, American world hero, gentleman and high symbol. . . . delighting Man's world in all perfections. Great in appetite, no man has ever equalled his bicipial girth. A man allied with heaven, pugilistic, fashionable, dissipated, improvident and non-poetical. A true Heaven-born O homo, already acclaimed by thee." Girault's words could soar—no doubt about that.

In Australia Girault evidentally found his superior J. F. Illingworth as guilty of prostituting entomology as his American superiors. His twist of Illingworth's name in a scientific name and his scientific description are insulting, and his dedicatory paragraph is cleverly composed false praise. The genus and species are, of course, fictitious.

> *Shillingsworthia*
>
> Like *Polynema* but petiole, head, abdomen, mandibles absent. *S. shillingsworthi,* blank, vacant, inaneness perfect. Nulliebiety remarkable, visible only from certain points of view. Shadowless. An airy species whose flight cannot be followed except by the winged mind. From a naked chasm on Jupiter, August 5th, 1919.
>
> This so thin genus is consecrated to Doctor Johann Francis Illingworth, in these days remarkable for his selfless devotion to Entomology, not only sacrificing all of the comforts of life, but as well his health and reputation to the uncompromising search for truth and for love of "those filmy people of the air." Honour him!

At times his life was quite harsh, he being once reduced to rock-breaker in a stone quarry. On the 2nd of May of 1941, after fleeing thither and yon, after the death of his wife, after great worry over the support of young children, after being broken in body, after several stretches in asylums, his tortured soul left his body on an island near Brisbane. Dahms recently summed up Girault's life so succinctly, so perfectly—he was a tragic figure whose tragedy came from setting the world against himself.

Plagiarism or Coincidence?

In 1915 all nomenclatural hell broke loose in the Society. It involved two members, taxonomists, who argued over whose presentation of a new genus was first. The Society and its officers were involved because the supposed theft of a new generic concept occurred at a meeting. W. R. Walton read a scientific article at a meeting on February 4th in which he proposed a new genus for a previously described species. Then C. H. Tyler Townsend published a new but different generic name for this same species on February 12th in the *Proceedings of the Biological Society of Washington.* It was charged that Townsend, who was present at the February 4th meeting, had heard Walton discuss the new genus and had rushed into print with his, Townsend's, new and different generic name for the genus. Townsend claimed that he had submitted his manuscript to the Biological Society at 7:00 PM on February 4th, and he presented his typewritten manuscript and the galley proofs to investigators. Charges, countercharges, investigations, resignations, and withdrawal of resignations flew fast and furiously. Walton finally published his article in our *Proceedings* of June 8th but merely said in a footnote on page 96 that he had presented his new genus in a paper that was "read February 4th, but was anticipated" by Townsend in a publication of February 12th. How all this was resolved I do not know. All that I have here related is in the files of our Society, but I could not determine the guilt of either member, not even if there was guilt.

Howard and his Wife

During the first fifty years of our Society L. O. Howard was a great leader of entomology in Washington. His autobiographical *Fighting the Insects* is a delightful and informal account of that period. He was an important man, knowing and associating with many distinguished people, presidents included. He tells the story of when his wife was invited to give a concert of songs in the White House before President Theodore Roosevelt. (She was an accomplished soprano and met Howard at a choral society in Washington; he could sing well in any voice.) Howard, though invited, could not attend because of a trip. He did have a few minutes before leaving, however, and went to the outside of the White House and tried to talk his way past guards to stand under the window to hear his dear wife sing. He tells that story in such a delightful way. (Of all the Society members who went before me, I would like to have known Howard most of all.)

Acknowledgments

My colleagues helped very much: William H. Anderson, J. F. Gates Clarke, Oliver S. Flint Jr., Raymond J. Gagné, Ashley B. Gurney, John M. Kingsolver, Arnold Mallis, Wayne N. Mathis, Arnold S. Menke, Robert W. Poole, Louise M. Russell, Curtis W. Sabrosky, Rose Ella Warner Spilman, Manya B. Stoetzel, Alan Stone, and F. Christian Thompson. Shelly J. Foote of the Department of Cultural History of the Smithsonian, Rosemary Kelly Panzenbeck of the Library of Congress, and Nancy Pierce of the Columbia Historical Society searched for material, Pamela M. Henson of Smithsonian Archives was invaluable in making our Society archives available and in searching beyond her own domain; she is an excellent historian of science. To all these people I give special thanks.

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ESW PAST-PRESIDENTS FOR THE YEARS 1884 THROUGH 1983, PHOTOGRAPHS AND SUPPORT OFFICERS

MANYA B. STOETZEL

Systematic Entomology Laboratory, Agricultural Research Service, USDA, Beltsville, Maryland 20705.

As the Entomological Society of Washington approaches its 100th birthday, March 12, 1984, it seems appropriate to honor those individuals who have served the Society as officers and committee chairmen. Towards that end, photographs of all Past-Presidents and a list of their support officers for the years 1884 through 1983 are presented. The slate of officers is preceded by the names of Past Honorary Presidents and Past Honorary Members and is followed by a list of our current members.

Charles Valentine Riley was the Society's first President; he was elected unanimously for a second term in 1885; but when he was drafted for a third term in 1886, he declined because he felt others should have the opportunity to lead the Society. Later he apparently abandoned this position for he served again in 1892 and 1893. With few exceptions, two-term presidencies were the pattern from 1884 through 1910, from 1916 through 1921, and in 1929–1930. Leland O. Howard, the Society's second President, served in 1886 and 1887 and again in 1923. From 1884 through 1983, a total of 82 different individuals served as President of the Entomological Society of Washington.

Space does not allow for a full discussion of circumstances affecting the terms of some officers. However, special mention is made of two vacancies of the presidency. The death of President H. C. Hubbard in January of 1899 left the Society without a president. At that time 1st Vice-President T. N. Gill chaired the meetings until the May 1899 meeting when the membership finally made Gill President. The Society also had two Presidents in 1973. The details are chronicled in the minutes for the 801st Regular Meeting—December 7, 1972 (1973, Proc. Entomol. Soc. Wash., 75(2): 255–256). Suffice it to say that President A. K. Burditt, Jr. served for "... about 5 minutes ..." (personal communication A. K. Burditt, Jr.) for it took him that long to announce that, with the 1972 ARS reorganization, he had been transferred away from the Washington area and thus would not be able to serve as ESW President during 1973. President Burditt appointed a committee to nominate a new President-Elect and passed the gavel and presidency to the then President-Elect V. E. Adler. President Adler served during all of 1973 with B. D. Burks as the President-Elect.

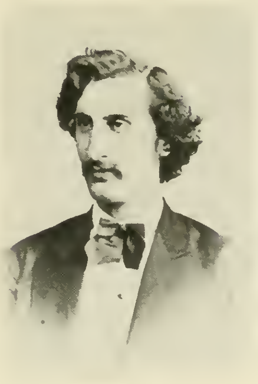
The photographs of the Past-Presidents were obtained from a variety of sources; the individuals themselves or their families, the SEL/SI collection of photographs now under the care of John M. Kingsolver, and the staff of the Entomological Society of America, College Park, Maryland. The copy negatives for all photographs not used "as is" have been turned over to John M. Kingsolver for deposition in the SEL/SI collection of photographs and are thus made available for future projects.

Past Honorary Presidents

E. A. Schwarz	1917–1928
L. O. Howard	1929–1950
C. L. Marlatt	1952–1954
R. E. Snodgrass	1955–1962
T. E. Snyder	1965–1970

Past Honorary Members

H. G. Barber	1957–1959
A. C. Böving	1957
E. N. Cory	1966–1974
A. B. Gahan	1958–1959
A. S. Hoyt	1971–1974
M. D. Leonard	1975
R. A. St. George	1976–1982
T. E. Snyder	1961–1964
L. H. Weld	1961–1964



1884-1885

President	C. V. Riley
1st Vice-Pres.	J. G. Morris
2nd Vice-Pres.	G. Marx
Rec. Secretary	E. A. Schwarz
Corr. Secretary	L. O. Howard
Treasurer	B. P. Mann
Executive Comm.	A. J. Schafhirt
	W. S. Barnard
	P. R. Uhler

1886-1887

President	L. O. Howard
1st Vice-Pres.	J. G. Morris
2nd Vice-Pres.	G. Marx
Rec. Secretary	E. A. Schwarz
Corr. Secretary	J. B. Smith
Treasurer	B. P. Mann
Executive Comm.	C. V. Riley
	O. Lugger
	T. Pergande

1888

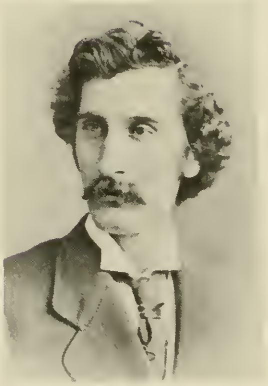
President	E. A. Schwarz
1st Vice-Pres.	C. V. Riley
2nd Vice-Pres.	G. Marx
Rec. Secretary	J. B. Smith
Corr. Secretary	O. Lugger
Treasurer	B. P. Mann
Executive Comm.	L. O. Howard
	T. Pergande
	W. H. Fox

1889

President	E. A. Schwarz
1st Vice-Pres.	C. V. Riley
2nd Vice-Pres.	G. Marx
Rec. Secretary	W. H. Fox
Corr. Secretary	C. H. T. Townsend
Treasurer	B. P. Mann
Executive Comm.	L. O. Howard
	T. Pergande
	C. L. Marlatt

1890-1891

President	G. Marx
1st Vice-Pres.	C. V. Riley
2nd Vice-Pres.	L. O. Howard
Rec. Secretary	C. L. Marlatt
Corr. Secretary	C. H. T. Townsend
Treasurer	B. P. Mann
Executive Comm.	E. A. Schwarz O. Heidemann W. H. Fox



1892

President	C. V. Riley
1st Vice-Pres.	C. L. Marlatt
2nd Vice-Pres.	W. H. Ashmead
Rec. Secretary	N. Banks
Corr. Secretary	L. O. Howard
Treasurer	E. A. Schwarz
Executive Comm.	W. H. Fox G. Marx B. E. Fernow

1893

President	C. V. Riley
1st Vice-Pres.	W. H. Ashmead
2nd Vice-Pres.	C. W. Stiles
Rec. Secretary	C. L. Marlatt
Corr. Secretary	L. O. Howard
Treasurer	E. A. Schwarz
Executive Comm.	W. H. Fox G. Marx B. E. Fernow

1894-1895

President	W. H. Ashmead
1st Vice-Pres.	T. N. Gill
2nd Vice-Pres.	C. L. Marlatt
Rec. Secretary	L. O. Howard
Corr. Secretary	F. H. Chittenden
Treasurer	E. A. Schwarz
Executive Comm.	G. Marx
	B. E. Fernow
	C. V. Riley

1896-1897

President	C. H. Marlatt
1st Vice-Pres.	T. N. Gill
2nd Vice-Pres.	H. G. Hubbard
Rec. Secretary	L. O. Howard
Corr. Secretary	F. Benton
Treasurer	E. A. Schwarz
Executive Comm.	W. H. Ashmead
	D. W. Coquillett
	C. W. Stiles

1898

President	H. G. Hubbard
1st Vice-Pres.	T. N. Gill
2nd Vice-Pres.	H. G. Dyar
Rec. Secretary	L. O. Howard
Corr. Secretary	F. Benton
Treasurer	E. A. Schwarz
Executive Comm.	C. L. Marlatt
	W. H. Ashmead
	F. H. Chittenden

1899-1900

President	T. N. Gill
1st Vice-Pres.	H. G. Dyar
Rec. Secretary	L. O. Howard
Corr. Secretary	F. Benton
Treasurer	E. A. Schwarz
Executive Comm.	C. L. Marlatt
	W. H. Ashmead
	F. H. Chittenden

1901-1902

President	H. G. Dyar
1st Vice-Pres.	W. G. Johnson
2nd Vice-Pres.	E. A. Schwarz
Rec. Secretary	R. P. Currie
Corr. Secretary	F. Benton
Treasurer	J. D. Patten
Executive Comm.	L. O. Howard
	T. N. Gill
	C. L. Marlatt

1903-1904

President	D. W. Coquillett
1st Vice-Pres.	N. Banks
2nd Vice-Pres.	A. D. Hopkins
Rec. Secretary	R. P. Currie
Corr. Secretary	F. Benton
Treasurer	J. D. Patten
Executive Comm.	H. G. Dyar
	L. O. Howard
	C. L. Marlatt

1905

President	N. Banks
1st Vice-Pres.	A. D. Hopkins
2nd Vice-Pres.	O. Heidemann
Rec. Secretary	R. P. Currie
Corr. Secretary	F. Benton
Treasurer	J. D. Patten
Executive Comm.	H. G. Dyar
	L. O. Howard
	C. L. Marlatt

1906

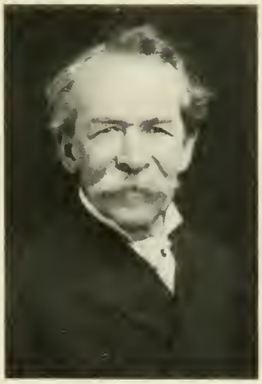
President	N. Banks
1st Vice-Pres.	A. D. Hopkins
2nd Vice-Pres.	O. Heidemann
Rec. Secretary	R. P. Currie
Corr. Secretary	E. S. G. Titus
Treasurer	J. D. Patten
Executive Comm.	H. G. Dyar
	L. O. Howard
	C. L. Marlatt

1907

President	A. D. Hopkins
1st Vice-Pres.	O. Heidemann
2nd Vice-Pres.	E. A. Schwarz
Rec. Secretary	W. F. Fiske
Corr. Secretary	J. G. Sanders
Treasurer	J. D. Patten
Executive Comm.	H. G. Dyar
	L. O. Howard
	C. L. Marlatt

1908

President	A. D. Hopkins
1st Vice-Pres.	O. Heidemann
2nd Vice-Pres.	E. A. Schwarz
Rec. Secretary	H. E. Burke
Corr. Secretary	J. G. Sanders
Treasurer	J. D. Patten
Executive Comm.	H. G. Dyar
	L. O. Howard
	C. L. Marlatt



1909-1910

President	O. Heidemann
1st Vice-Pres.	F. M. Webster
2nd Vice-Pres.	A. L. Quaintance
Rec. Secretary	J. C. Crawford
Corr. Sec.-Treas.	E. F. Phillips
Executive Comm.	L. O. Howard
	C. L. Marlatt
	H. G. Dyar

1911

President	F. M. Webster
1st Vice-Pres.	A. L. Quaintance
2nd Vice-Pres.	E. F. Phillips
Rec. Secretary	H. S. Barber
Corr. Sec.-Treas.	S. A. Rohwer
Executive Comm.	L. O. Howard
	E. A. Schwarz
	H. G. Dyar

1912

President	A. L. Quaintance
1st Vice-Pres.	A. Busck
2nd Vice-Pres.	A. N. Caudell
Rec. Secretary	E. R. Sasscer
Corr. Sec.-Treas.	S. A. Rohwer
Editor	J. C. Crawford
Executive Comm.	N. Banks
	E. A. Schwarz
	H. G. Dyar

1913

President	A. Busck
1st Vice-Pres.	W. D. Hunter
2nd Vice-Pres.	A. N. Caudell
Rec. Secretary	E. R. Sasscer
Corr. Sec.-Treas.	S. A. Rohwer
Editor	W. D. Hunter
Executive Comm.	N. Banks
	E. A. Schwarz
	L. O. Howard

1914

President	W. D. Hunter
1st Vice-Pres.	A. N. Caudell
2nd Vice-Pres.	E. R. Sasscer
Rec. Secretary	W. B. Wood
Corr. Sec.-Treas.	S. A. Rohwer
Editor	W. D. Hunter
Executive Comm.	A. Busck
	E. A. Schwarz
	L. O. Howard

1915

President	A. N. Caudell
1st Vice-Pres.	C. R. Ely
2nd Vice-Pres.	E. R. Sasscer
Rec. Secretary	A. B. Gahan
Corr. Sec.-Treas.	S. A. Rohwer
Editor	J. C. Crawford
Executive Comm.	E. A. Schwarz
	A. L. Quaintance
	C. L. Marlatt

1916-1917

President	C. R. Ely
1st Vice-Pres.	E. R. Sasscer
2nd Vice-Pres.	F. Knab
Rec. Secretary	A. B. Gahan
Corr. Sec.-Treas.	S. A. Rohwer
Editor	J. C. Crawford
Executive Comm.	A. N. Caudell
	A. L. Quaintance
	W. D. Hunter

1918

President	E. R. Sasscer
1st Vice-Pres.	F. Knab
2nd Vice-Pres.	W. R. Walton
Rec. Secretary	A. B. Gahan
Corr. Sec.-Treas.	S. A. Rohwer
Editor	A. C. Baker
Executive Comm.	A. N. Caudell
	A. L. Quaintance
	C. R. Ely

1919

President	E. R. Sasscer
1st Vice-Pres.	W. R. Walton
2nd Vice-Pres.	A. B. Gahan
Rec. Secretary	R. A. Cushman
Corr. Sec.-Treas.	S. A. Rohwer
Editor	A. C. Baker
Executive Comm.	A. N. Caudell
	A. L. Quaintance
	C. R. Ely

1920-1921

President	W. R. Walton
1st Vice-Pres.	A. B. Gahan
2nd Vice-Pres.	A. G. Böving
Rec. Secretary	R. A. Cushman
Corr. Sec.-Treas.	S. A. Rohwer
Editor	A. C. Baker
Executive Comm.	A. N. Caudell
	A. L. Quaintance
	E. R. Sasscer

1922

President	A. B. Gahan
1st Vice-Pres.	A. G. Böving
2nd Vice-Pres.	R. A. Cushman
Rec. Secretary	C. T. Greene
Corr. Sec.-Treas.	S. A. Rohwer
Editor	A. C. Baker
Executive Comm.	A. N. Caudell
	A. L. Quaintance
	J. M. Aldrich

1923

President	L. O. Howard
1st Vice-Pres.	A. G. Böving
2nd Vice-Pres.	R. A. Cushman
Rec. Secretary	C. T. Greene
Corr. Sec.-Treas.	S. A. Rohwer
Editor	A. C. Baker
Executive Comm.	A. N. Caudell
	A. L. Quaintance
	J. M. Aldrich

1924

President	A. G. Böving
1st Vice-Pres.	R. A. Cushman
2nd Vice-Pres.	J. M. Aldrich
Rec. Secretary	C. T. Greene
Corr. Sec.-Treas.	S. A. Rohwer
Editor	C. Heinrich
Executive Comm.	A. N. Caudell
	W. R. Walton
	J. A. Hyslop

1925

President	R. A. Cushman
1st Vice-Pres.	J. M. Aldrich
2nd Vice-Pres.	J. A. Hyslop
Rec. Secretary	C. T. Greene
Corr. Sec.-Treas.	S. A. Rohwer
Editor	C. Heinrich
Executive Comm.	A. N. Caudell
	W. R. Walton
	J. E. Graf

1926

President	J. M. Aldrich
1st Vice-Pres.	J. A. Hyslop
2nd Vice-Pres.	J. E. Graf
Rec. Secretary	C. T. Greene
Corr. Sec.-Treas.	S. A. Rowher
Editor	C. Heinrich
Executive Comm.	W. R. Walton
	A. N. Caudell
	T. E. Snyder

1927

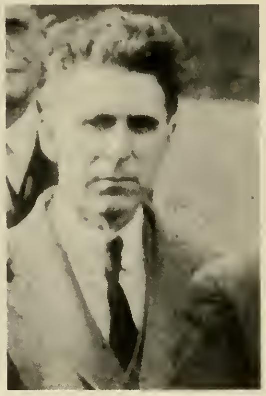
President	J. A. Hyslop
1st Vice-Pres.	J. E. Graf
2nd Vice-Pres.	A. C. Baker
Rec. Secretary	J. S. Wade
Corr. Sec.-Treas.	S. A. Rohwer
Editor	W. R. Walton
Executive Comm.	C. T. Greene
	A. N. Caudell
	T. E. Snyder

1928

President	S. A. Rohwer
1st Vice-Pres.	J. E. Graf
2nd Vice-Pres.	A. C. Baker
Rec. Secretary	J. S. Wade
Corr. Sec.-Treas.	S. A. Rohwer
Editor	W. R. Walton
Executive Comm.	C. T. Greene
	A. N. Caudell
	T. E. Snyder

1929-1930

President	J. E. Graf
1st Vice-Pres.	A. C. Baker
2nd Vice-Pres.	F. C. Bishopp
Rec. Secretary	J. S. Wade
Corr. Sec.-Treas.	S. A. Rohwer
Editor	W. R. Walton
Executive Comm.	C. T. Greene
	A. N. Caudell
	T. E. Snyder



1931

President	A. C. Baker
1st Vice-Pres.	F. C. Bishopp
2nd Vice-Pres.	C. T. Greene
Rec. Secretary	J. S. Wade
Corr. Sec.-Treas.	S. A. Rohwer
Editor	W. R. Walton
Executive Comm.	A. N. Caudell
	T. E. Snyder
	W. H. Larrimer

1932

President	F. C. Bishopp
1st Vice-Pres.	C. T. Greene
2nd Vice-Pres.	J. S. Wade
Rec. Secretary	F. M. Wadley
Corr. Sec.-Treas.	S. A. Rohwer
Editor	W. R. Walton
Executive Comm.	A. N. Caudell
	T. E. Snyder
	W. H. Larrimer

1933

President	C. T. Greene
1st Vice-Pres.	J. S. Wade
2nd Vice-Pres.	B. A. Porter
Rec. Secretary	F. M. Wadley
Corr. Sec.-Treas.	S. A. Rohwer
Editor	W. R. Walton
Executive Comm.	W. H. Larrimer
	S. B. Fracker
	H. E. Ewing

1934

President	J. S. Wade
1st Vice-Pres.	B. A. Porter
2nd Vice-Pres.	S. B. Fracker
Rec. Secretary	F. M. Wadley
Corr. Sec.-Treas.	S. A. Rohwer
Editor	W. R. Walton
Executive Comm.	W. H. Larrimer
	H. E. Ewing
	F. L. Campbell

1935

President	B. A. Porter
1st Vice-Pres.	S. B. Fracker
2nd Vice-Pres.	N. E. McIndoo
Rec. Secretary	P. W. Oman
Corr. Sec.-Treas.	J. E. Graf
Editor	W. R. Walton
Executive Comm.	S. A. Rohwer
	H. E. Ewing
	J. S. Wade

1936

President	S. B. Fracker
1st Vice-Pres.	N. E. McIndoo
2nd Vice-Pres.	H. Morrison
Rec. Secretary	H. H. Richardson
Corr. Sec.-Treas.	J. E. Graf
Editor	W. R. Walton
Executive Comm.	H. E. Ewing
	J. S. Wade
	B. A. Porter

1937

President	N. E. McIndoo
1st Vice-Pres.	E. A. Back
2nd Vice-Pres.	R. E. Snodgrass
Rec. Secretary	C. Ford
Corr. Secretary	D. J. Caffrey
Treasurer	H. E. Ewing
Editor	W. R. Walton
Executive Comm.	J. S. Wade
	B. A. Porter
	S. B. Fracker

1938

President	E. A. Back
1st Vice-Pres.	R. E. Snodgrass
2nd Vice-Pres.	L. A. Strong
Rec. Secretary	A. B. Gurney
Corr. Secretary	D. J. Caffrey
Treasurer	H. E. Ewing
Editor	W. R. Walton
Executive Comm.	B. A. Porter
	S. B. Fracker
	N. E. McIndoo

1939

President	R. E. Snodgrass
1st Vice-Pres.	L. A. Strong
2nd Vice-Pres.	C. F. W. Muesebeck
Rec. Secretary	A. B. Gurney
Corr. Secretary	D. J. Caffrey
Treasurer	H. E. Ewing
Editor	W. R. Walton
Executive Comm.	S. B. Fracker
	N. E. McIndoo
	E. A. Back

1940

President	C. F. W. Muesebeck
1st Vice-Pres.	L. A. Strong
2nd Vice-Pres.	H. E. Ewing
Rec. Secretary	A. B. Gurney
Corr. Secretary	D. J. Caffrey
Treasurer	W. B. Wood
Editor	W. R. Walton
Executive Comm.	S. B. Fracker
	E. A. Back
	R. E. Snodgrass

1941

President	H. E. Ewing
1st Vice-Pres.	E. N. Cory
2nd Vice-Pres.	R. W. Harned
Rec. Secretary	A. B. Gurney
Corr. Secretary	F. W. Poos
Treasurer	W. B. Wood
Editor	W. R. Walton
Executive Comm.	E. A. Back
	R. E. Snodgrass
	C. F. W. Muesebeck

1942

President	E. N. Cory
1st Vice-Pres.	R. W. Harned
2nd Vice-Pres.	P. N. Annand
Rec. Secretary	A. B. Gurney
Corr. Secretary	F. M. Wadley
Treasurer	L. G. Baumhofer
Editor	W. R. Walton
Executive Comm.	R. E. Snodgrass C. F. W. Muesebeck H. E. Ewing

1943

President	R. W. Harned
1st Vice-Pres.	P. N. Annand
2nd Vice-Pres.	F. W. Poos
Rec. Secretary	W. H. Anderson
Corr. Secretary	F. W. Wadley
Treasurer	G. I. Haeussler
Editor	A. Stone
Executive Comm.	C. F. W. Muesebeck H. E. Ewing E. N. Cory

1944

President	P. N. Annand
1st Vice-Pres.	F. W. Poos
2nd Vice-Pres.	C. A. Weigel
Rec. Secretary	I. L. Hawes
Corr. Secretary	F. M. Wadley
Treasurer	G. J. Haeussler
Editor	A. Stone
Executive Comm.	H. E. Ewing E. N. Cory R. W. Harned

1945

President	F. W. Poos
1st Vice-Pres.	C. A. Weigel
2nd Vice-Pres.	A. H. Clark
Rec. Secretary	I. L. Hawes
Corr. Secretary	F. M. Wadley
Treasurer	L. B. Reed
Editor	A. Stone
Executive Comm.	E. N. Cory R. W. Harned P. N. Annand

1946

President	C. A. Weigel
1st Vice-Pres.	A. H. Clark
2nd Vice-Pres.	E. H. Siegler
Rec. Secretary	I. L. Hawes
Corr. Secretary	R. I. Sailer
Treasurer	L. B. Reed
Editor	A. Stone
Executive Comm.	R. W. Harned P. N. Annand F. W. Poos

1947

President	A. H. Clark
1st Vice-Pres.	E. H. Siegler
2nd Vice-Pres.	T. E. Snyder
Rec. Secretary	I. L. Hawes
Corr. Secretary	R. I. Sailer
Treasurer	L. B. Reed
Editor	A. Stone
Executive Comm.	P. N. Annand F. W. Poos C. A. Weigel

1948

President	E. H. Siegler
1st Vice-Pres.	T. E. Snyder
2nd Vice-Pres.	W. B. Wood
Rec. Secretary	I. L. Hawes
Corr. Secretary	R. I. Sailer
Treasurer	H. Baker
Editor	K. V. Krombein
Executive Comm.	F. W. Poos C. A. Weigel A. H. Clark

1949

President	T. E. Snyder
1st Vice-Pres.	W. B. Wood
2nd Vice-Pres.	A. Stone
Rec. Secretary	H. L. Trembley
Corr. Secretary	A. B. Gurney
Treasurer	H. Baker
Editor	K. V. Krombein
Executive Comm.	C. A. Weigel A. H. Clark E. H. Siegler

1950

President	W. B. Wood
1st Vice-Pres.	A. Stone
2nd Vice-Pres.	P. W. Oman
Rec. Secretary	H. L. Trembley
Corr. Secretary	R. W. Sherman
Treasurer	R. H. Nelson
Editor	K. V. Krombein
Custodian	H. Sollers
Executive Comm.	A. H. Clark
	E. H. Siegler
	T. E. Snyder

1951

President	A. Stone
1st Vice-Pres.	P. W. Oman
2nd Vice-Pres.	W. D. Reed
Rec. Secretary	G. B. Vogt
Corr. Secretary	R. W. Sherman
Treasurer	R. H. Nelson
Editor	K. V. Krombein
Custodian	H. Sollers
Executive Comm.	E. H. Siegler
	T. E. Snyder
	W. B. Wood

1952

President	W. D. Reed
1st Vice-Pres.	D. J. Caffrey
2nd Vice-Pres.	W. H. Anderson
Rec. Secretary	K. O'Neill
Corr. Secretary	A. M. Vance
Treasurer	R. H. Nelson
Editor	B. D. Burks
Custodian	H. Sollers
Executive Comm.	T. E. Snyder
	W. B. Wood
	A. Stone

1953

President	W. H. Anderson
1st Vice-Pres.	A. B. Gurney
2nd Vice-Pres.	T. L. Bissell
Rec. Secretary	K. O'Neill
Corr. Secretary	A. M. Vance
Treasurer	E. P. Reagan
Editor	B. D. Burks
Custodian	H. J. Conkle
Executive Comm.	W. B. Wood
	A. Stone
	W. D. Reed

1954

President	A. B. Gurney
1st Vice-Pres.	T. L. Bissell
2nd Vice-Pres.	R. A. St. George
Rec. Secretary	K. O'Neill
Corr. Secretary	L. M. Russell
Treasurer	P. X. Peltier
Editor	B. D. Burks
Custodian	H. J. Conkle
Program Chmn.	K. A. Haines
Executive Comm.	A. Stone
	W. D. Reed
	W. H. Anderson

1955

President	T. L. Bissell
1st Vice-Pres.	R. A. St. George
2nd Vice-Pres.	F. L. Campbell
Rec. Secretary	K. O'Neill
Corr. Secretary	L. M. Russell
Treasurer	P. X. Peltier
Editor	R. H. Foote
Custodian	H. J. Conkle
Program Chmn.	J. F. G. Clarke
Executive Comm.	W. D. Reed
	W. H. Anderson
	A. B. Gurney

1956

President	R. A. St. George
1st Vice-Pres.	F. L. Campbell
2nd Vice-Pres.	R. I. Sailer
Rec. Secretary	K. O'Neill
Corr. Secretary	K. Dorward
Treasurer	P. X. Peltier
Editor	R. H. Foote
Custodian	H. J. Conkle
Program Chmn.	J. F. G. Clarke
Executive Comm.	W. H. Anderson
	A. B. Gurney
	T. L. Bissell

1957

President	F. L. Campbell
1st Vice-Pres.	R. I. Sailer
2nd Vice-Pres.	R. H. Nelson
Rec. Secretary	K. O'Neill
Corr. Secretary	K. Dorward
Treasurer	F. P. Harrison
Editor	A. V. Renk
Custodian	H. J. Conkle
Program Chmn.	J. F. G. Clarke
Executive Comm.	A. B. Gurney
	T. L. Bissell
	R. A. St. George

1958

President	R. I. Sailer
1st Vice-Pres.	R. H. Nelson
2nd Vice-Pres.	P. W. Oman
Rec. Secretary	H. Sollers
Corr. Secretary	P. A. Woke
Treasurer	F. P. Harrison
Editor	R. H. Foote
Custodian	H. J. Conkle
Program Chmn.	J. G. Rozen
Executive Comm.	T. L. Bissell
	R. A. St. George
	F. L. Campbell

1959

President	R. H. Nelson
President-Elect	P. W. Oman
Rec. Secretary	H. Sollers
Corr. Secretary	P. A. Woke
Treasurer	P. Piquette
Editor	R. H. Foote
Custodian	H. J. Conkle
Program Chmn.	J. H. Fales
Membership Chmn.	A. B. Gurney

1960

President	P. W. Oman
President-Elect	J. F. G. Clarke
Rec. Secretary	E. B. Thurman
Corr. Secretary	P. A. Woke
Treasurer	P. Piquette
Editor	R. H. Foote
Custodian	H. J. Conkle
Program Chmn.	C. W. McComb
Membership Chmn.	W. S. Murray

1961

President	J. F. G. Clarke
President-Elect	H. H. Shepard
Rec. Secretary	E. B. Thurman
Corr. Secretary	P. A. Woke
Treasurer	P. Piquette
Editor	R. H. Foote
Custodian	H. J. Conkle
Program Chmn.	T. McIntyre
Membership Chmn.	W. S. Murray

1962

President	H. H. Shepard
President-Elect	W. E. Bickley
Rec. Secretary	O. S. Flint, Jr.
Corr. Secretary	P. A. Woke
Treasurer	C. Blickenstaff
Editor	R. H. Foote
Custodian	H. J. Conkle
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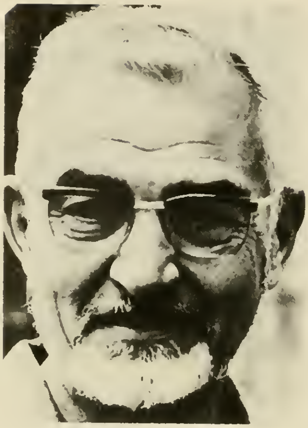

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December 8, 1983

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Aldrich, J. R., 1983	Maryland
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Anderson, D. M., 1954	Dist. Columbia
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Appel, A. G., 1983	California
Armitage, B. J., 1983	Alabama
Arnaud, P. H., 1955	California
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Austin, D. F., 1977	Florida
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Baker, E. W., 1944	Maryland
Ball, G. E., 1948	Canada
Barber, K. N., 1981	Canada
Barker, Z. A., 1964	California
Barnes, J. K., 1979	New York
Barnett, D. E., 1976	Maryland
Barnum, A., 1956	Utah
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Barr, W. F., 1958	Idaho
Barrows, E. M., 1976	Dist. Columbia
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Baumann, R. W., 1973	Utah
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Beaver, O., 1974	Thailand
Bechtel, R. C., 1960	Nevada
Beck, T. R., 1979	Maryland
Becker, E. C., 1951	Canada
Beckham, C., 1983	Maryland
Bell, R. T., 1955	Vermont
Bellinger, R. G., 1972	Virginia
Berg, C. O., 1975	New York
Bergman, P. W., 1966	Virginia
Berner, L., 1949	Florida
Berry, R. L., 1972	Ohio
Beyer, W. N., 1977	Maryland
Bezark, L., 1974	California
Bicha, W., 1981	Illinois
Bickel, D. J., 1981	Massachusetts
Bickley, W. E., 1949* (President 1963)	Maryland
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Blackburn, V. L., 1983	Maryland
Blanchard, A., 1968	Texas
Bodri, M. S., 1979	Pennsylvania
Boese, J. L., 1977	Dist. Columbia
Boesel, M. W., 1973	Ohio
Boettcher, R. A., 1955	Dist. Columbia
Bohart, R. M., 1944	California
Bohnsack, K. K., 1958	California
Borchelt, R., 1979	Maryland
Bouseman, J. K., 1975	Illinois

Bowen, T. W., 1980	North Carolina
Brajkovic, M., 1983	Yugoslavia
Brassard, D. W., 1978	Virginia
Brigham, W. U., 1975	Illinois
Brown, B. V., 1982	Canada
Brown, F. M., 1975	Colorado
Brown, H. P., 1977	Oklahoma
Brown, R. L., 1979	Mississippi
Bryce, G. K., 1977	California
Bueno-Soria, J., 1977	Mexico
Burditt, A. K., Jr., 1965 (President 1973)	Washington
Burger, J. F., 1973	New Hampshire
Burke, H. R., 1981	Texas
Burks, B. D., 1938 (President 1974)	Arizona
Burks, K. O., 1950	Arizona
Burnett, J. A., 1975	California
Burns, J. M., 1975	Dist. Columbia
Bushman, D. W., 1983	Maryland
Butler, L., 1966	West Virginia
Calabrese, D. M., 1980	Pennsylvania
Campbell, J. M., 1966	Canada
Carestia, R. C., 1981	Maryland
Carlson, R. W., 1970*	Korea
Caron, D. M., 1971	Delaware
Carrington, J. H., 1943	Florida
Carroll, J. F., 1977	Maryland
Casdorph, D. G., 1977	California
Cave, R., 1977	Alabama
Chapin, J. B., 1973	Louisiana
Charpentier, P. O., 1962	Connecticut
Chilson, L. M., 1977	Maryland
Chittick, H. A., 1946	New York
Clark, W. E., 1975	Alabama
Clark, S. T., 1981	Texas
Clark, T. B., 1983	Maryland
Clarke, J. F. G., 1936 (President 1961)	Dist. Columbia
Cochran, D. G., 1981	Virginia
Coffman, C. C., 1980	West Virginia
Cohen, N. Y., 1983	Maryland
Cole, A. E., 1977	West Virginia
Cole, F. R., 1963	California
Collins, M. S., 1977 (President 1982)	Dist. Columbia
Connell, J. G., 1974	Indiana
Cook, D. R., 1952	Michigan
Cooper, C. M., 1976	Mississippi
Cooper, K. W., 1955	California
Copeland, T. P., 1977	Tennessee
Corkum, L. D., 1979	Canada
Coulson, J. R., 1961	Maryland
Covell, C. V., 1971	Kentucky
Craig, G. B., 1954	Indiana
Crooks, E. E., 1964	Maryland
Cross, H. F., 1954	Georgia
Curčić, B., 1982	Yugoslavia
Currado, I., 1978	Italy
Curtin, T. J., 1956	Texas
Darling, D. C., 1981	Oregon
Darsie, R. F., 1949	Colorado
Daum, R. J., 1969	Maryland
Davidson, J. A., 1957	Maryland
Davidson, R. L., 1975	Pennsylvania
Davis, D. R., 1961 (President 1979)	Dist. Columbia
Davis, E. J., 1982	Maryland
Davis, L. G., 1952 (President 1967)	California
Davis, M. M., 1979	Maryland
DeBold, K. J., 1981	Maryland
Deeming, J. C., 1974	Wales
Deitz, L. L., 1983	North Carolina
Delgado, H., 1979	Colombia
DeLong, D. M., 1936	Ohio
Denning, D. G., 1966	California
Dennis, S., 1976	Colorado
Deyrup, M. A., 1979	Florida
Dicke, F. F., 1933	Iowa
Donley, D. E., 1955	Ohio
Donnelly, T. W., 1962	New York
Doria, J. J., 1977	Virginia
Dos Passos, C. F., 1947	New Jersey
Downs, W. G., 1981	Connecticut
Doyen, J. T., 1983	California
Dozier, H. L., 1952*	South Carolina
Drummond, R. O., 1954	Texas
Duckworth, W. D., 1961	Dist. Columbia
Duffield, R., 1978	Dist. Columbia
Duret, J. P., 1969	Argentina
Edmunds, G. F., Jr., 1951	Utah
Eikenbary, R. D., 1979	Oklahoma
Elias, B. T., 1983	Maryland
Elias, M. K., 1972	Maryland
Emerson, K. C., 1952	Florida
Emsley, M. G., 1970	Virginia
Enns, W. R., 1960	Missouri
Erwin, T. L., 1972	Dist. Columbia
Evans, H. E., 1948	Colorado
Evans, W. G., 1957	Canada
Evenhuis, N. L., 1980	Hawaii
Fairchild, G. B., 1939	Florida
Fales, J. H., 1944	Maryland
Faran, M. E., 1977	Maryland
Fedde, G., 1962	Georgia
Fedde, V. H., 1977	Georgia
Fee, F. D., 1983	Pennsylvania
Fennah, R. G., 1941	England
Ferguson, D. C., 1969	Dist. Columbia
Field, W. D., 1965	Virginia

Fisher, E. M., 1977	California
Fisk, F. W., 1968	Ohio
Flechtmann, C., 1968	Brazil
Flint, O. S., Jr., 1961	Dist. Columbia
Floore, T. G., 1967	Florida
Fluno, J. A., 1957	Florida
Foote, B. A., 1958	Ohio
Foote, R. H., 1950 (President 1968)	Dist. Columbia
Forattini, O. P., 1956	Brazil
Foster, J. R., 1953	Maryland
Fox, I., 1936	Puerto Rico
Franclemont, J. G., 1947	New York
Freeman, J. V., 1981	Vermont
Freytag, P. H., 1979	Kentucky
Friedburg, A., 1979	Israel
Froeschner, R. C., 1961	Dist. Columbia
Fukuda, A., 1983	Japan
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Gentry, J. W., 1958	Florida
Gerberg, E. J., 1953	Maryland
Gerberich, A. G., 1981	Virginia
Gerdes, C. F., 1976	Missouri
Ghorpade, K. D., 1983	Dist. Columbia
Gibson, L. P., 1982	Ohio
Giles, F. E., 1981	Maryland
Gill, G. D., 1958	Michigan
Gimpel, W. F., Jr., 1970	Maryland
Gingras, S. S., 1980	Maryland
Glick, J. I., 1979	Maryland
Godfrey, G. L., 1971	Illinois
Goeden, R. D., 1982	California
Gonzalez, R. H., 1974	Chile
Gordh, G., 1975	California
Gordon, R. D., 1968	Dist. Columbia
Gorham, J. R., 1974	Dist. Columbia
Gotwald, W. H., Jr., 1977	New York
Grabowski, W. B., 1970	New Mexico
Grant, C. D., 1948	California
Gregg, R. E., 1945	Colorado
Grissell, E. E., 1979	Dist. Columbia
Grogan, W. L., Jr., 1974	Maryland
Grothaus, R. H., 1981	Wisconsin
Gunther, R. G., 1981	Illinois
Habeck, D. H., 1957	Florida
Hacker, J. D., 1971	West Virginia
Hagen, K. S., 1949	California
Haines, K. A., 1952	Virginia
Halstead, J. A., 1983	California
Hamid, A., 1976	Nigeria
Hamilton, S. W., 1982	South Carolina
Hamman, R. E., 1968	Dist. Columbia
Hannemann, H. J., 1979	East Germany
Harbach, R. E., 1972	Dist. Columbia
Harding, W. C., Jr., 1955	Virginia
Hardy, A. R., 1974	California
Harman, D. M., 1966	Maryland
Harmston, F. C., 1940	Utah
Harper, P. P., 1977	Canada
Harris, S. C., 1979	Alabama
Harrison, B. A., 1976	Dist. Columbia
Harrison, F. P., 1954	Maryland
Haskins, C. P., 1945	Dist. Columbia
Hawkins, B. A., 1983	California
Hawkins, L. S., Jr., 1970	California
Hayes, D. K., 1970	Maryland
Heitzman, R. L., 1980	Maryland
Hendrickson, R. M., Jr., 1978	Delaware
Henry, C. S., 1975	Connecticut
Henry, T. J., 1975	Dist. Columbia
Heppner, J. B., 1974	Florida
Herman, L. H., Jr., 1965	New York
Hespenheide, H. A., III, 1981	California
Hevel, G. F., 1970	Dist. Columbia
Higgins, H. G., 1948	Utah
Hodges, R. W., 1960	Dist. Columbia
Hoebeke, E. R., 1980	New York
Hoelscher, S. M., 1980	Arkansas
Hoffmann, C. H., 1945	Maryland
Hoffmann, W. E., 1944	Kansas
Holzbach, J. E., 1983	Ohio
Hoogstraal, H., 1946	New York
Hopla, C. E., 1961	Oklahoma
Hopper, H. P., 1978	Dist. Columbia
Horne, J. E., 1971	Maryland
Howden, H. F., 1948	Canada
Huang, Y.-M., 1968	Dist. Columbia
Hubbard, M. D., 1976	Florida
Hudson, B. N. A., 1980	Canada
Hull, W. B., 1949	Maryland
Hung, A. C. F., 1981	Maryland
Hunter, P. E., 1961	Georgia
Husband, R. W., 1973	Michigan
Imai, E. M., 1980	Maryland
Ingles, R., 1975	Puerto Rico
Irwin, M. E., 1976	Illinois
Ivie, M. A., 1981	Ohio
Jackson, D. L., 1966	Ohio
Jacobs, T. J., 1981	North Dakota
Jakob, W. L., 1977	Colorado
Johnson, M. D., 1973	Indiana
Johnson, N. F., 1980	Ohio
Johnson, P. E., 1983	Illinois
Johnson, P. T., 1951	Maryland
Jones, R. H., 1955	Colorado

Joseph, S. R., 1957	Maryland
Kaster, C. H., 1979	Michigan
Kaufmann, T. Y., 1982	Oklahoma
Kelly, R. W., 1982	South Carolina
Kennedy, J. H., 1977	Pennsylvania
Kethley, J. B., 1974	Illinois
Kim, K. C., 1983	Pennsylvania
King, C. S., 1983	New York
Kingsolver, J. M., 1963	Dist. Columbia
Kirchner, R. F., 1981	West Virginia
Kissinger, D. G., 1955	California
Kitayama, C., 1974	California
Kiteley, E. J., 1971	Canada
Kittle, P., 1975	Missouri
Kliewer, J. W., 1983	Virginia
Knight, K. L., 1944	North Carolina
Knipling, E. F., 1946	Maryland
Kniser, S. G., 1981	Virginia
Knisley, C. B., 1981	Virginia
Knudson, E. C., 1982	Texas
Knutson, L. V., 1963*	Dist. Columbia
Kormilev, N. A., 1941	New York
Korytkowski, C. A., 1982	Panama
Kosztarab, M., 1978	Virginia
Krafsur, E. S., 1968	Iowa
Kramer, J. P., 1957	Dist. Columbia
Krause, C. R., 1983	Ohio
Krombein, K. V., 1941* (President 1970)	Dist. Columbia
Kurczewski, F. E., 1970	New York
Lager, T. M., 1976	Wisconsin
LaGoy, P. K., 1983	Virginia
Lamb, N. J., 1978	APO New York
Lambdin, P. L., 1974	Tennessee
Lampert, L. L., Jr., 1976	North Carolina
Langford, G. S., 1924	Maryland
Larew, H. G., 1982	Maryland
LaSalle, J., 1982	California
Lassmann, G. W., 1946	Mexico
Lavigne, R., 1973	Wyoming
Lewis, P. A., 1974	Ohio
Lewis, R. E., 1958	Iowa
Lewis, S. E., 1974	Minnesota
Lien, J. C., 1967	Taiwan
Linam, J., 1982	Colorado
Linkfield, R. L., 1959	New Jersey
Lipes, J. E., 1974 (President 1981)	Maryland
Louton, C. E., 1982	Dist. Columbia
Louton, J. A., 1982	Dist. Columbia
Lowry, J. E., 1983	Maryland
Ludvik, G. F., 1978	Virginia
Lund, H. O., 1952	Georgia
Lyon, R. J., 1961	California

Mabry, J. E., 1954	Florida
Mackay, W. P., 1982	New Mexico
MacLachlan, W. B., 1980	Arizona
Magner, J. M., 1953	Missouri
Maier, C. T., 1976	Connecticut
Main, A. J., Jr., 1965	Connecticut
Maldonado-Capriles, J., 1947	Puerto Rico
Mallack, J., 1957	Maryland
Mallis, A., 1977	Maryland
Mangan, R. L., 1974	Texas
Manglitz, G. R., 1956	Nebraska
Manuel, K. L., 1983	North Carolina
Mari Mutt, J. A., 1976	Puerto Rico
Marsh, P. M., 1960	Dist. Columbia
Marshall, S., 1982	Canada
Masner, L., 1969	Canada
Mason, T. L., Jr., 1977	West Virginia
Mason, W. R. M., 1970	Canada
Mathien-Veillard, J. J., 1982	Mexico
Mathis, W. N., 1976	Dist. Columbia
Matile, L., 1983	France
Matta, J., 1978	Virginia
Mayor, A. J., 1981	California
McCabe, T. L., 1977	New York
McCafferty, W. P., 1968	Indiana
McComb, C. W., 1976	Maryland
McDaniel, B., 1964	South Dakota
McDonald, F. J. D., 1983	Australia
McFadden, M. W., 1956	Virginia
McGann, D. R., 1979	Maryland
McMurty, J. A., 1981	California
Mead, F. W., 1976	Florida
Mendez, E., 1976	APO Florida
Menke, A. S., 1969	Dist. Columbia
Messersmith, D. H., 1965	Maryland
Miller, C. E., 1981	Maryland
Miller, D. R., 1969	Maryland
Miller, G. L., 1981	Alabama
Miller, R. M., 1974	South Africa
Miller, R. S., 1981	Ohio
Miller, S. E., 1980	Massachusetts
Miller, W. E., 1983	Minnesota
Mockford, E. L., 1955	Illinois
Moore, T. E., 1950	Michigan
Moraes, A. P. A. de, 1978	California
Moran, N., 1982	Michigan
Morgan, N. O., 1969	Maryland
Morse, J. C., 1976	South Carolina
Moser, J. C., 1973	Louisiana
Mullens, B. A., 1979	California

Munte, S. T., 1983	Dist. Columbia
Muraleedharan, D., 1981	India
Murdoch, W. P., 1966	Pennsylvania
Murphy, W. L., 1983	Maryland
Nakahara, S., 1968	Maryland
Neal, J. W., Jr., 1982	Maryland
Neff, S. E., 1969	Kentucky
Nelson, C. H., 1969	Tennessee
Nelson, G. H., 1949	California
Nelson, R. H., 1933 (President 1959)	Pennsylvania
Neunzig, H. H., 1956	North Carolina
Newkirk, R. A., 1968	Maryland
Nickle, D. A., 1980	Dist. Columbia
Nielsen, G. R., 1983	Vermont
Nielson, L. T., 1951	Utah
Norrbom, A. L., 1983	Pennsylvania
Norton, R. A., 1978	New York
Nuhn, T. P., 1981	Virginia
Nutting, W. H., 1973	California
Oatman, E. R., 1980	California
O'Brien, M. F., 1979	Michigan
Oman, P. W., 1930 (President 1960)	Oregon
Orth, R. E., 1981	California
Osgood, E. A., 1977	Maine
Padiou, M., 1982	France
Pakaluk, J., 1981	Kansas
Palacios-Vargas, J. G., 1980	Mexico
Palmer, M. K., 1976	New York
Parker, C. R., 1977	Canada
Parrish, D. W., 1963	Maryland
Parsons, M., 1963	Ohio
Pena-Guzzman, L. E., 1980	Chile
Perkins, E. M., Jr., 1977	California
Perkins, P. D., 1973	Massachusetts
Peters, T. M., 1979	Massachusetts
Peters, W. L., 1971	Florida
Peterson, R. V., 1952	Dist. Columbia
Peterson, J. L., 1981	APO Florida
Peyton, E. L., 1968	Dist. Columbia
Phillips, W. G., 1955	Maryland
Pinto, J. D., 1982	California
Pitkin, B. R., 1977	England
Pogue, M. G., 1980	Minnesota
Polhemus, J. T., 1964	Colorado
Poyner, M. M., 1969	Maryland
Pratt, G. K., 1974	Florida
Pratt, H. D., 1943	Georgia
Preval, S., 1978	New York
Price, R. D., 1963	Minnesota
Pulawski, W. J., 1975	California
Rack, G., 1975	West Germany
Radovic, I., 1981	Yugoslavia
Ramalingam, S., 1970	Malaysia
Ramos, J. A., 1947	Puerto Rico
Ramsay, M. G., 1968 (President 1977)	Maryland
Raupp, M. J., 1982	Maryland
Rawlins, J. E., 1974	Texas
Reed, W. D., 1931 (President 1952)	Dist. Columbia
Reichart, C. V., 1946	Rhode Island
Ribble, D. W., 1981	California
Riegel, G. T., 1952	Illinois
Robbins, R. G., 1979	Dist. Columbia
Roberts, D. R., 1968	Dist. Columbia
Robinson, H., 1963	Dist. Columbia
Robinson, W. H., 1975	Virginia
Rochette, R. A., 1982	New Mexico
Rohwer, G. G., 1964	Dist. Columbia
Rolston, L. H., 1973	Louisiana
Rose, S., 1981	Montana
Ross, E. S., 1983	California
Ross, M. H., 1981	Virginia
Roth, L. M., 1944	Massachusetts
Roth, M., 1968	Dist. Columbia
Rozen, J. G., Jr., 1956	New York
Ruiter, D., 1976	Colorado
Russell, L., 1979	Oregon
Russell, L. M., 1930 (President 1966)	Maryland
Sabrosky, C. W., 1946 (President 1972)	Dist. Columbia
Sailer, R. I., 1943 (President 1958)	Florida
Sakimura, K., 1982	Hawaii
Sands, D. P. A., 1983	Australia
Santana, F. J., 1966	Dist. Columbia
Saugstad, E. S., 1979	Maryland
Scanlon, J. E., 1952	Texas
Scarbrough, A. G., 1971	Maryland
Schaber, B. D., 1980	Canada
Scharf, W. C., 1981	Michigan
Schauff, M. E., 1980	Dist. Columbia
Schmidt, C. H., 1969	North Dakota
Schroder, R. F. W., 1976	Maryland
Schwan, T. G., 1980	California
Sedman, Y., 1951	Illinois
Shaffer, J. C., 1974	Virginia
Shands, W. A., 1940	South Carolina
Shannon, M. H., 1980	Maryland
Shaw, S. R., 1979	Maryland
Shelly, T. E., 1982	California
Shenefelt, R. D., 1946	Wisconsin
Shepard, H. H., 1927 (President 1962)	Virginia

Sherman, R. W., 1947	Maryland
Shewell, G. E., 1949	Canada
Shinohara, A., 1981	Japan
Shockley, C. W., 1955	California
Sholes, O. D. V., 1979	Massachusetts
Shubeck, P. P., 1982	New Jersey
Simpson, K. W., 1976	New York
Singletary, H. M., 1983	North Carolina
Sirivanakarn, S., 1969	Dist. Columbia
Skaptason, J. L., 1979	Virginia
Skiles, D. D., 1978	California
Slater, J. A., 1949	Connecticut
Sleeper, E. L., 1976	California
Sloan, M. J., 1983	Dist. Columbia
Sluss, T. P., 1970	Colorado
Smiley, R. L., 1964	Maryland
Smith, C. F., 1967	North Carolina
Smith, C. L., 1977	Georgia
Smith, D. R., 1965*	Dist. Columbia
Smith, F. F., 1921	Maryland
Snelling, R. R., 1968	California
Sofield, R. K., 1983	New Jersey
Sollers-Riedel, H., 1938* (President 1969)	Dist. Columbia
Sommerman, K. M., 1947	Maine
Southern, P. S., 1977	North Carolina
Spaeth, V. A., 1976	Wisconsin
Spangler, P. J., 1958*	Dist. Columbia
Spencer, C. B., Jr., 1955	Virginia
Spicer, G., 1978	Texas
Spilman, T. J., 1950 (President 1980)	Dist. Columbia
Spinelli, G. R., 1983	Argentina
Staines, C. L., Jr., 1975	Maryland
Stannard, L. J., 1948	Illinois
Steffan, W. A., 1970	Hawaii
Stegmaier, C. E., Jr., 1965	Florida
Steiner, W. E., Jr., 1979	Maryland
Steinhauer, A. L., 1958	Maryland
Steinly, B. A., 1983	Illinois
Stephens, G., 1982	Wyoming
Stewart, K. W., 1981	Texas
Steyskal, G. C., 1947 (President 1976)	Dist. Columbia
Stibick, J. N. L., 1966	Maryland
Stimmel, J. F., 1979	Pennsylvania
Stoetzel, M. B., 1971 (President 1983)	Maryland
Stoltzfuss, W. B., 1967	Iowa
Stone, A., 1931* (President 1951)	Maryland
Stonedahl, G. M., 1982	Oregon
Stribling, J. B., 1983	Ohio
Surdick, R. F., 1979	Virginia
Sutherland, C. M., 1974	New Mexico
Sutherland, D. W. S., 1973 (President 1978)	Maryland
Taft, S. J., 1979	Wisconsin
Taylor, N. J., 1983	APO New York
Teale, S. A., 1983	Kansas
Tena, J. A., 1983	Mexico
Tennessen, K. J., 1982	Alabama
Thomas, D. B., 1983	Nebraska
Thomas, E. A., 1982	Maryland
Thompson, F. C., 1968	Virginia
Thompson, J. V., 1953	New Jersey
Thornburg, M. C., 1961	Maryland
Thorpe, K. W., 1980	Maryland
Threlfall, W., 1977	Canada
Tibbetts, T., 1955	Utah
Tidwell, M. A., 1981	South Carolina
Todd, E. L., 1953	Dist. Columbia
Togashi, I., 1983	Japan
Townes, G. F., 1956	South Carolina
Townes, H. K., 1941	Michigan
Townsend, L. H., Jr., 1977	Kentucky
Trapido, H., 1948	Louisiana
Traub, R., 1947	Maryland
Triplehorn, C. A., 1972	Ohio
Trumble, J. T., 1979	California
Turner, W. J., 1982	Washington
Tyson, W. H., 1970	California
Ulrich, H., 1978*	West Germany
Unzicker, J. D., 1980	Illinois
Utmar, J. A., 1974*	Maryland
Valentine, J. F., 1983	Alabama
Valley, K., 1976	Pennsylvania
Vasquez, A., 1957	Virginia
Venables, B. A., 1983	Maryland
Venables, L., 1983	Maryland
Villegas, B., 1977	California
Vincent, D. L., 1980	Maryland
Viraktamath, C. A., 1981	India
Voegtlin, D., 1981	Illinois
Vogt, G. B., 1947	Mississippi
Voshell, J. R., Jr., 1977	Virginia
Waldbauer, G. P., 1983	Illinois
Walker, H. G., 1941	California
Wallenmaier, T. E., 1979	Maryland

Waller, D., 1983	Virginia
Wallis, R. C., 1948	Connecticut
Walton, M., 1937	Maryland
Ward, R. A., 1975	Dist. Columbia
Weaver, J. S., III, 1980	South Carolina
Webb, D. W., 1982	Illinois
Webb, R. E., 1967	Maryland
Weems, H. V., Jr., 1953	Florida
Weisman, D. M., 1956	Dist. Columbia
Wendleton, D. S., 1965	Pennsylvania
Werner, F., 1948	Arizona
Wharton, R., 1981	Texas
Wheeler, A. G., Jr., 1974	Pennsylvania
Wheeler, G. C., 1949	Texas
Whitcomb, R. F., 1966	Maryland
White, G. B., 1977	Maryland
White, R. E., 1966	Dist. Columbia
White, T. R., 1979	Georgia
Whitehead, D. R., 1974	Dist. Columbia
Whitsel, R. H., 1967	California
Whittemore, F. W., 1974	Virginia
Wieber, A. M., 1983	Maryland
Wiegmann, B. M., 1983	Maryland
Wilder, D. D., 1974	Oregon
Wilkerson, R. C., 1980	Florida
Williams, H. B., 1977	Dist. Columbia
Williams, M. L., 1971	Alabama
Williams, R. W., 1946	New York
Wills, W., 1977	Saudi Arabia
Wilson, G. B., 1982	Tennessee
Wilson, N., 1957	Iowa
Wirth, W. W., 1945	Dist. Columbia
Wojtowicz, J. A., 1981	Tennessee
Wood, F. E., 1968	Maryland
Wood, T. K., 1974	Delaware
Woodley, N. E., 1983	Dist. Columbia
Yonke, T. R., 1971	Missouri
Young, A. M., 1983	Wisconsin
Young, D. K., 1981	Wisconsin
Zack, R., 1982	Washington
Zenner-Polania, I., 1977	Colombia
Zimmerman, E. C., 1965	Australia
Zungoli, P. A., 1978	South Carolina
Zuska, J., 1974	Czechoslovakia

Emeritus Members

Crabill, R. E., Jr. (1968; 1983)	Maryland
Hatch, M. H. (1921; 1975)	Washington
Knowlton, G. F. (1935; 1973)	Utah
Mason, H. C. (1949; 1973)	Maryland
McGovran, E. R. (1937; 1973)	North Carolina
McGuire, J. U., Jr. (1954; 1980)	Nigeria
Mitchell, R. T. (1949; 1978)	Maryland
Munson, S. C. (1938; 1976)	Maryland
Rainwater, C. F. (1954; 1975)	Florida
Rainwater, H. I. (1964; 1983) (President 1975)	Maryland
Richardson, H. H. (1939; 1976)	New Jersey
Spilman, R. E. W. (1950; 1977)	Maryland
Swartzwelder, E. B. (1948; 1974)	Louisiana
Weber, N. A. (1941; 1981)	Florida
Woke, P. A. (1936; 1976) (President 1965)	Maryland
Young, D. A., Jr. (1950; 1983)	North Carolina

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86(1), 1984, pp. 43–52

BIOLOGY AND IMMATURE STAGES OF *DRYOMYZA ANILIS* FALLÉN (DIPTERA: DRYOMYZIDAE)[1]

Jeffrey K. Barnes

Biological Survey, New York State Museum, State Education Department, Albany, New York 12230.

Abstract.—Information is presented on the life cycle of *Dryomyza anilis* Fallén, the saprophagous larvae of which feed on decaying animal matter and decaying fungi. Data on the habitat, behavior, feeding habits, and phenology of adults and immature stages are presented. The egg, three larval instars, and puparium are described in detail. The taxonomy of the species, and the systematics of the Dryomyzidae, are discussed briefly.

Information on the biology and immature stages of the Dryomyzidae is fragmentary and scattered in the literature. Burger et al. (1980) described the second- and third-instar larva and the life history of *Oedoparena glauca* (Coquillett), a predator of barnacles on the west coast of North America. Steyskal (1957) illustrated an egg of *Dryomyza flaveola* (Fabricius) that was dissected from an adult, and Hinton (1960, 1981) described and illustrated eggs of the same species, stating that they were usually laid on the vertical sides of cow pats in shaded areas of fields or woods. Burger et al. (1980) presented previously unpublished rearing records for *D. simplex* Loew, prepared by B. A. Foote, which indicate that this species, as well as *D. anilis* Fallén, can develop from egg to pupa on dead animal matter, but not on decaying plant matter.

The literature dealing with the biology of *D. anilis* was reviewed by Smith (1980). This species has been found in association with rotting fungi, carrion, and excrement. Portschinsky (1910) illustrated the egg and the terminal segment of the larva, and Smith (1980) illustrated and briefly described the mature larva. Foote (in Burger et al., 1980) found that larvae of *D. anilis* fed and pupated on hamburger, dead earthworms, dead crane flies, dead polygyrid snails, a dead milkweed caterpillar, a dead slug, and rotting agaric mushrooms. Larvae did not attain maturity when given rotting grass, decaying pumpkin flesh, decaying lettuce, or cow manure.

The Dryomyzidae were usually considered a part of the Sciomyzidae by earlier authors, but they are now considered a separate family with two subfamilies, the Dryomyzinae and Helcomyzinae (Griffiths, 1972; Mathis and Steyskal, 1980), or, as in this paper, they are considered two separate families, the Dryomyzidae and Helcomyzidae (Barnes, 1981). The Dryomyzidae can be separated from the Helcomyzidae by the closely spaced first antennal segments, protruding oral margin,

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Fig. 1. *Dryomyza anilis*, adult female.

strap-shaped or oval prosternum that is not joined to the propleura, and lack of costal spines. Two genera, *Dryomyza*, with ten species, and *Oedoparena*, with two species, are presently recognized in the Dryomyzidae (Steyskal, 1957, 1958, 1962; Mathis and Steyskal, 1980).

Dryomyza anilis is widely distributed in the Palaearctic and Nearctic Regions. Adults (Fig. 1) are light brown and medium sized, ranging in overall length from about 7 to about 14 mm. It can be separated from other species of Dryomyzidae by the nearly bare arista, covered lunule, and well developed prostigmatic and prescutellar bristles.

Rearing Methods

Laboratory rearings were kept in an incubator at 20°C under a LD 16:8 lighting schedule, unless otherwise indicated. Adults were held in clear plastic vials (5.0 × 8.5 cm) fitted with screen caps. A layer of cotton on the bottom of each vial moistened with a 0.1% aqueous solution of the mold inhibitor Lexgard M®[2] helped to maintain high humidity. A wooden applicator stick provided a resting site for the flies. Adults fed readily on an artificial diet consisting of honey, brewer's yeast, and dehydrated milk.

Eggs were allowed to hatch in the vials in which they were laid, and potential food items were placed on the cotton substrate. Larvae were transferred to fresh rearing vials when the old ones became overgrown with mold. Several larvae were reared together in each vial, so it was not possible to determine the duration of each stadium for individual larvae, but it was possible to determine the number of days after eclosion that molts and pupariation occurred for each group of larvae by observing when cast exuviae and puparia appeared in the vials. Puparia were placed in individual glass vials containing a layer of moist cotton. The vials were plugged with dry cotton and placed in incubators to await emergence of adults.

BIOLOGY

Dryomyza anilis is a common species in Europe and northern North America. The specimens used in this study were collected at Black Creek Swamp, on Koontz Rd., Voorheesville, New York (42°39′57″N, 73°58′05″W). They were collected by sweeping *Aster simplex* Willdenow and *Onoclea sensibilis* Linnaeus, the dominant low vegetation under the thin canopy of *Ulmus rubra* Muhlenberg and *Fraxinus pennsylvanica* Marshall. The locality was frequently flooded after a heavy rain, and it is surrounded by a *Typha* and *Sparganium* marsh.

Laboratory-reared males lived 28–178 days (mean ± SD, 83.0 ± 50.4; n = 13), and females lived 26–167 days (79.2 ± 38.9; n = 20). Field-collected and laboratory-reared adults mated frequently in the laboratory. No courtship behavior was observed. A male mounts a female and, facing in the same direction, persuades her to spread her wings with the assistance of the tip of his abdomen and his hind tarsi. The male's fore tarsi are placed either on the substrate or the female's head, his mid tarsi are placed either on the substrate or the bases of the female's wings, and his hind tarsi usually grasp the female's abdomen near the midlateral line of segment 3 or 4. The male's wings remain in the rest position over the abdomen during mating.

During this investigation eggs were not found in the field, but Portschinsky (1910) found them on the surface of human excrement, and the excrement was often entirely covered by eggs. The eggs were laid singly, and they acquired the coloration of the substrate. In the laboratory, eggs were laid on a variety of materials that were introduced into the breeding vials, including dead insects, chicken liver, hamburger, and the moist cotton substrate. Eggs are rarely deposited on a dry surface. If the surface on which they are laid is liquid, the eggs sink into the material part way, but the upper surface of the eggs and the lateral flanges (Fig. 2) remain exposed to the air. If an egg is forced below the surface of the liquid the lateral flanges fold upward, and a bubble of air is held in contact with the upper surface of the flanges and the dorsal surface of the egg. The lower surface of the egg, including the underside of the flanges, is shiny and sticky. Eggs are

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[2] Inolex Corporation, Philadelphia, Pennsylvania.

usually scattered over a surface one by one, but sometimes they are deposited side by side in rows of 2–5.

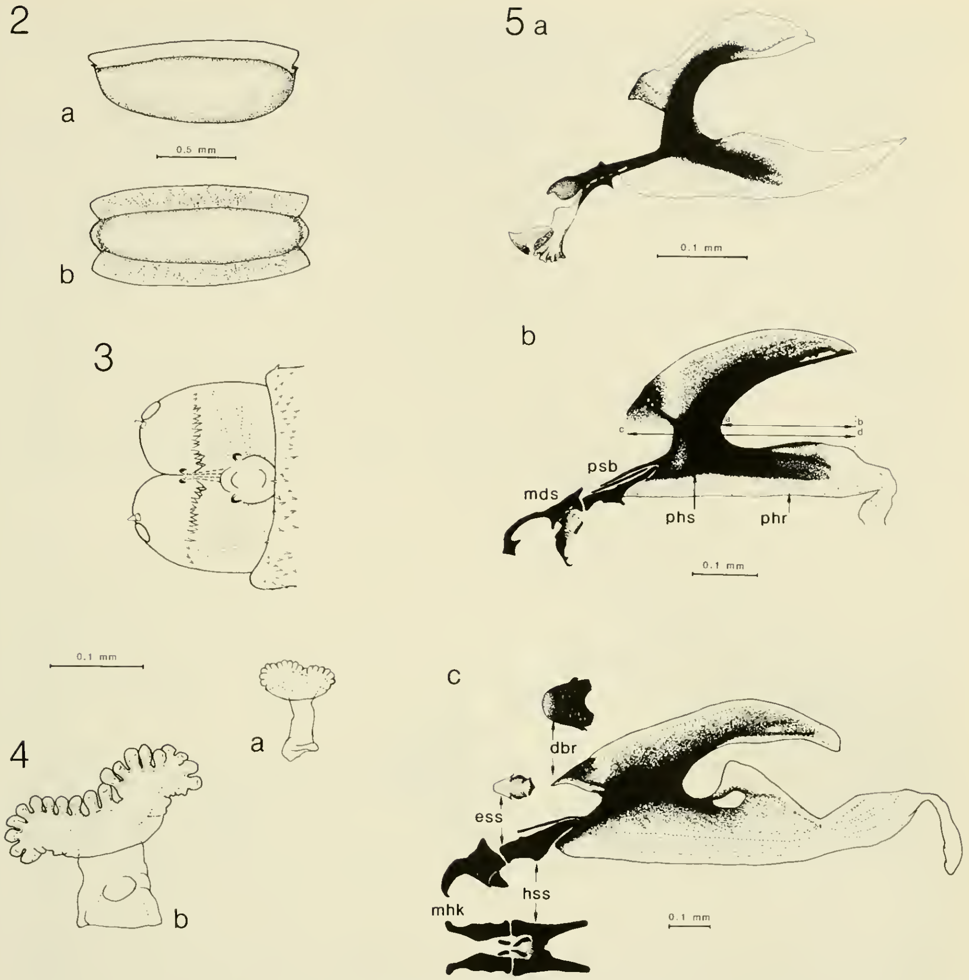
Eggs were laid by field-collected females within a few days after they were taken into the laboratory, regardless of when they were collected. Females were collected between May 26 and September 25, 1981, and all of them produced fertile eggs. They usually oviposited every 2–10 days, depositing as many as 48 eggs in a single day, and as many as 208 eggs altogether. Laboratory-reared females began to lay eggs 30–81 days (49.5 ± 19.8; $n = 11$) after they emerged from puparia. The egg incubation period is short; 29 eggs that were laid between 1:00 and 4:00 PM one day hatched between 3:47 and 4:14 PM the next day, so the minimum incubation period was 23 h 47 m, and the maximum was 27 h 14 m.

At eclosion, the chorion at the anterior end of the egg splits, and the larva escapes. The young larvae search for a soft spot or crevice into which they burrow, leaving only the posterior spiracles exposed. In laboratory rearings the larvae frequently congregated in the moist cotton beneath their food source, and cast exuviae were often found in this area following molting.

Larvae fed readily on a variety of dead, and often putrid, animal matter. Successful laboratory rearings were accomplished using dead, crushed insects, such as June beetles (*Phyllophaga* sp.), carrion beetles (*Nicrophorus* sp.), dytiscid beetles, dobsonflies (*Corydalus cornutus* (Linnaeus)), and calliphorid flies, and rotting chicken liver and hamburger as food sources. In one rearing, 41 newly hatched first-instar larvae were given both chicken liver and June beetles. Some of the larvae fed and molted to the second instar on the chicken liver, but within two days after starting the rearing all larvae were found to be feeding on the June beetles in preference to the liver. Larvae did not feed on dead, crushed gypsy moth larvae or pupae (*Lymantria dispar* (Linnaeus)), nor on a rotting polypore fungus (*Polyporus squamosus* Micheli: Fries). Six larvae that were given only decaying lettuce died within two days, but not before one of them molted to the second instar. One of 33 larvae that were given only decaying spinach formed a puparium seven days after hatching, but the puparium was small (only 4 mm long), and it did not yield an adult fly.

The first molt of the fly larvae occurred within one day after eclosion, the second molt occurred within two days after eclosion, and the larvae formed puparia 6–8 days (7.1 ± 0.7; $n = 39$) after eclosion. Larvae usually burrowed deep into the moist cotton in the rearing vials before forming puparia, but they also frequently pupariated on the surface of the cotton under the food source. Adults emerged 18–27 days (20.4 ± 1.6; $n = 46$) after pupariation. Reared females produced fertile eggs and apparently healthy larvae.

Evidence concerning overwintering stages and diapause in *Dryomyza anilis* is inconclusive. Adults were not found in the field until May 26, but a gravid female was collected as late as September 25. She produced 152 fertile eggs by October 13, then stopped ovipositing, but lived until January 29. Puparia were reared from her eggs at 20°C and LD 16:8, and within 1–7 days after preparation, in early to mid October, they were placed in an incubator that simulated mild winter conditions. The daily temperature range of 10–21°C and the lighting schedule of LD 12.5:11.5 in October were gradually changed to 3–10°C and LD 9:15 in January, where they remained until March, when the trends were reversed. On two occasions, once in late February and once in early April, the incubator malfunctioned, and the temperature dropped to −1.5°C for a short period. From a



Figs. 2–5. *Dryomyza anilis.* 2, Egg, lateral (a) and dorsal (b) views. 3, Segment 1, 1st-instar larva, ventral view. 4, Anterior spiracles of 2nd- (a) and 3rd- (b) instar larvae. 5, Cephalopharyngeal skeletons of 1st- (a), 2nd- (b), and 3rd- (c) instar larvae (shown separately: ess and dbr in dorsal view, mds and hss in ventral view). Indentation index = ab/cd × 100. Abbreviations: dbr, dorsal bridge; ess, epistomal sclerite; hss, hypostomal sclerite; mds, mandibular sclerite; mhk, mouth-hook; phr, pharyngeal ridges; phs, pharyngeal sclerite; psb, parastomal bar.

total of 70 puparia, 31 adults emerged in the incubator from November 5 to January 25. The remaining puparia were warmed to 20°C, and the lighting schedule was adjusted to LD 16:8, on May 5. Adults emerged from seven more puparia between May 20 and June 11. No adults emerged from the remaining 32 puparia, all of which eventually turned moldy.

DESCRIPTIONS OF IMMATURE STAGES

Egg (Fig. 2).—Length 1.22–1.37 mm, greatest width 0.41–0.48 mm. Creamy white, elongate, somewhat tapered anteriorly. Paired, elongate, ribbon-like flanges present dorsolaterally; each flange with anterior end rounded, posterior end more acute; dorsal surface covered with fine, radiating ridges. Small curved flanges present anteriorly and posteriorly. Surface of egg, excluding lateral flanges, wholly covered with fine, honeycomb-like reticulation.

Larva (Figs. 3–7).—*First instar:* Length 1.67–2.96 mm, greatest width 0.41–0.59 mm. Anterior spiracles absent. Posterior spiracular plates (Fig. 6a) pale yellow, each with a B-shaped spiracular opening and 4 sets of peripheral, palmately-branched hair-like processes about ½ as long as diameter of plate.

Cephalopharyngeal skeleton (Fig. 5a) brown to black, 0.28–0.33 mm long; indentation index 67–77. Segment 1 with rows of 3–4 darkly pigmented and 13–14 smaller, colorless spinules extending laterally from each side of midline ventrally (Fig. 3). Paired, lightly pigmented, irregular sclerites, apparently associated with oral grooves, present below rows of spinules. Lateral bars fused anteriorly, forming a small, mouth-hook-like structure; each bar fused posteriorly to anteroventral edge of respective pharyngeal sclerite. Paired, narrow, elongate, weakly fused sclerites present below anterior ends of lateral bars. Pharyngeal sclerites without windows; lightly pigmented bridge present anterodorsally, pharyngeal ridges present between ventral cornua.

Second instar: Similar to 3rd-instar larva. Length 2.74–4.71 mm, greatest width 0.61–0.91 mm. Anterior spiracles (Fig. 4a) pale yellow; reniform apical part bearing 19–20 rudimentary papillae. Posterior spiracular plates (Fig. 6b) pale yellowish brown, each with 2 elongate spiracular slits, a white spiracular scar, and 4 sets of peripheral, palmately branched, hair-like processes about ⅓ as long as diameter of plate; ventral spiracular slit upcurved at both ends.

Cephalopharyngeal skeleton (Fig. 5b) brown to black, 0.57–0.61 mm long; indentation index 60–67. Mandibular sclerites long, narrow; mouth-hooks triangular in lateral view, bearing 3–4 ventral teeth in anteroventral view, connected to mandibular sclerites by long, narrow, curved bars. Dentary sclerites long, narrow, irregularly shaped, pointed ventrally, lightly pigmented posterodorsally. Small, paired, quadrate sclerites present between mandibular sclerites in area of dentary sclerites. Hypostomal sclerite with posterior end free from pharyngeal sclerites. Pharyngeal sclerites with long, narrow windows posteroventrally on dorsal cornua and posterodorsally on ventral cornua; bridge present anterodorsally. Pharyngeal ridges present between ventral cornua.

Third instar (Fig. 7): Length 4.10–9.42 mm; greatest width 0.76–2.13 mm. White; integument translucent. Body elongate, conicocylindrical; anterior end strongly tapered; posterior ⅔ relatively uniform in width; posterior end truncate, strongly sloping. Primary and secondary integumentary folds weak. Tubercles absent from segments 1–11. Segment 1 strongly bilobed apically, each lobe with a short, pale yellowish brown, 2-segmented sensory papilla dorso-apically and a pair of circular sensory plates ventro-apically; oral grooves present. Posterior portion covered with fine, unicuspid, posteriorly-directed spinules. Segment 2 bearing paired, yellowish to yellowish brown, reniform, transverse anterior spiracles posterolaterally (Fig. 4b); spiracles projecting nearly perpendicular to body, each bearing 19–24 papillae. Segments 2–3 with fine, unicuspid, colorless spinules, particularly dense dorsally and anteriorly. Segments 4–11 covered with larger, unicuspid, yellowish brown spinules dorsally and laterally; with spinules denser and stouter at anterior end of each segment ventrally. Segments 5–11 with poorly developed fusiform welts posterolaterally. Segment 12 covered with spinules dorsally, laterally, and ventrally; bearing anal plate, paired anal lobes, minute ven-

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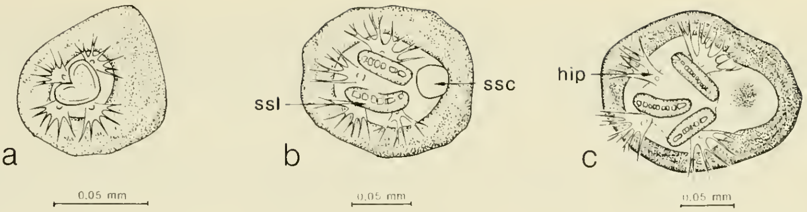

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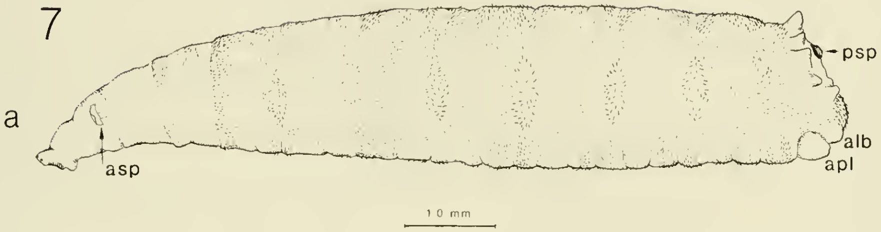

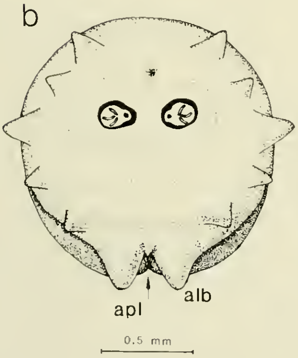

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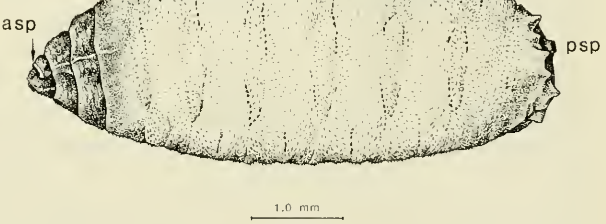

Figs. 6–8. *Dryomyza anilis.* 6, Posterior spiracular plates of 1st- (a), 2nd- (b), and 3rd- (c) instar larvae. 7, 3rd-instar larva, lateral (a) and posterodorsal (b) views. 8, Puparium, lateral view. Abbreviations: alb, anal lobe; apl, anal plate; asp, anterior spiracle; hip, hair-like interspiracular process; psp, posterior spiracle; ssc, spiracular scar; ssl, spiracular slit.

tromedial lobe, and spiracular disc posteriorly. Anal plate white to yellowish brown, strongly wrinkled, transverse, ovoid, lacking spinules; anus invaginated. Anal lobes posterior to anal plate short, stout, covered with spinules. Posterior spiracular disc (Fig. 7b) with spinules peripherally and ventromedially, with 5 pairs of spinule-covered, conical, peripheral lobes and 2 dorsocentral spiracular plates. Dorsal, dorsolateral, lateral, ventrolateral, and ventral lobes about 1.2, 0.6, 1.5, 0.8, and 1.0 times as long as diameter of spiracular plates, respectively. Spiracular plates (Fig. 6c) subcircular, yellowish brown to brown, each with 3 elongate-oval, diverging spiracular slits at 40–45° angle to each other, 1 circular, brown spiracular scar, and 4 colorless, palmately branched, hair-like interspiracular processes about ⅓ as long as diameter of spiracular plates; middle spiracular slit curved upwards at both ends.

Cephalopharyngeal skeleton (Fig. 5c) dark brown to black, 0.93–1.05 mm long; indentation index 50–56. Mandibular sclerites well developed, paired, separate, without accessory teeth below curved mouth-hooks, with 1 small window centrally. Dentary sclerites paired, separate, near posteroventral margin of mandibular sclerites. Epistomal sclerite small, lightly pigmented not fused with parastomal bars, located between anterior rami of hypostomal sclerite, loosely articulated with paired, narrow, strap-like sclerites that nearly reach posterior end of hypostomal sclerite. Parastomal bars narrow, darkly pigmented; posterior ends fused to pharyngeal sclerites. Hypostomal sclerite H-shaped, not fused posteriorly to pharyngeal sclerites; anterior rami about ½ length of posterior rami and wider than posterior rami; hypostomal bridge notched posteriorly. Small, paired sclerites present between anterior rami of hypostomal sclerite and between dentary sclerites. Pharyngeal sclerites with anterodorsal bridge joining anterior ends of dorsal cornua, and with anteroventral projections lying below posterior rami of hypostomal sclerite; anterodorsal bridge lightly pigmented anteriorly, emarginate posteriorly, with several small windows on each side of midline; dorsal cornua narrower than ventral cornua, with elongate window posteroventrally; ventral cornua lightly pigmented posteroventrally and on mid-dorsal lobe, with large window on mid-dorsal lobe. Pharyngeal ridges between ventral cornua well developed.

Puparium (Fig. 8).—Length 4.41–6.23 mm, greatest width 1.75–2.51 mm. Light yellowish brown to reddish brown; segments 2–4 and 12 often darker than remainder. Primary and secondary integumentary folds indistinct. Integument densely wrinkled on segments 2–4 and 12. Puparium elongate, subcylindrical; dorsal surface more convex than ventral surface. Segment 1 invaginated. Segments 2–4 strongly tapered, somewhat flattened dorsoventrally. Anterior spiracles dark reddish brown, sessile, transverse, on anterolateral angles of dorsal cephalic cap, projecting anterolaterally. Spinules arranged as in 3rd-instar larva. Punctiform papilla vestiges distinct, darkly pigmented, arranged in a consistent pattern on segments 5–11—a transverse row posterodorsally, in rows on dorsal and ventral margins of posterolateral fusiform welts, in 2 short, paired rows dorsolaterally and 1 short row mid-dorsally, and in 3 irregular, transverse rows ventrally. Segment 12 truncate, indented mid-dorsally; lobes as in 3rd-instar larva, but usually somewhat reduced. Posterior spiracular plates dark yellowish brown to reddish brown; spiracular slits yellowish brown; spiracular scar dark brown to black. Anal plate dark reddish brown, somewhat invaginated. Cephalopharyngeal skeleton as in 3rd-instar larva, appressed to ventral cephalic cap.

Discussion

Adults of *Dryomyza anilis* have been found in association with human excrement (Portschinsky, 1910; Skidmore, 1978), fox and pheasant carrion (Smith, 1975, 1980), and malodorous stinkhorn fungi (Parmenter, 1951; Smith, 1956). Eggs have been found on human excrement (Portschinsky, 1910), and larvae have been found in pheasant carrion (Smith, 1980). The laboratory rearings described in this paper and in Burger et al. (1980) show that *D. anilis* can be successfully reared on a variety of dead annelids, molluscs, insects, vertebrates, and rotting fungi. The presence of well developed pharyngeal ridges in all three larval stages indicates that the larvae are probably deriving most of their nutrition from particulate material, including micro-organisms that colonize rotting organic material. Pharyngeal ridges are commonly found in saprophagous cyclorrhaphous larvae, and they have been found to effectively separate bacteria and other microorganisms from liquid entering the pharynx, thus preventing the uptake of excess, non-nutritious liquid. Larvae that feed on living tissue lack such ridges (Dowding, 1967, 1968).

The cephalopharyngeal skeleton of the mature larva fits the characterization of the generalized type found in saprophagous cyclorrhaphous Diptera, as given by Miller and Foote (1976). The mandibular sclerites, hypostomal sclerite, and pharyngeal sclerites are not fused to each other. Paired dentary sclerites are present. The narrow parastomal bars are fused to the pharyngeal sclerites, but not to the epistomal sclerite. An anterodorsal bridge joins the pharyngeal sclerites. The hypostomal sclerite is H-shaped. Among the Sciomyzoidea this type of cephalopharyngeal skeleton is also characteristic of the Helosciomyzidae (Steyskal and Knutson, 1978; Barnes, 1980a, b). *D. anilis* lacks the apomorphic ventral arch characteristic of the Sciomyzidae (Knutson et al., 1970; Griffiths, 1972). Comparisons cannot be made with other families of Sciomyzoidea because there are too few thorough descriptions of larvae.

The egg of *D. anilis* seems particularly well adapted to survival on the type of substrate upon which it is laid. Like the eggs of some Anthomyiidae and Muscidae, it bears two dorsolateral flanges. These flanges appear to aid the egg in floating on the surface of a liquid or semiliquid substrate. The chorion quickly takes on the coloration of the substrate, thus affording the egg some camouflage. The short incubation period (about 24 h) reported here and by Portschinsky (1910) might give the species a competitive advantage in exploiting a limited resource, and it might also help prevent parasitism or predation of this vulnerable stage.

In this study, no predators or parasites of *D. anilis* were found, but Portschinsky (1910) reported that several larvae of *Mydaea urbana* (Meigen) (Diptera: Muscidae) destroyed a large population of *D. anilis* larvae on human excrement.

Diagnostic descriptions of larvae exist for less than five percent of the Nearctic species of cyclorrhaphous Diptera (Tesky, 1981). Good descriptions of the mature larvae of Helcomyzidae and Dryomyzidae now exist for only three species worldwide. Comparison of these descriptions reveals that mature larvae of the three species differ significantly in many respects. Larvae of *Helcomyza ustulata* Curtis (Helcomyzidae) have short posterior spiracular tubes and a strong, upwardly directed hook on each posterior spiracular plate, and lack well developed tubercles (Egglishaw, 1960). Those of *Oedoparena glauca* (Dryomyzidae) have elongate posterior spiracular tubes, lack hooks on the posterior spiracular plates, and have well developed tubercles on segments 5–12 (Burger et al., 1980). Those of *D. anilis* have short posterior spiracular tubes, lack hooks on the posterior spiracular plates, and have well developed tubercles on segment 12 only. As larvae of more species of Dryomyzidae, Helcomyzidae, and other species of Cyclorrhapha are described these characters may not prove to be diagnostic, especially at the species level.

Based on adult morphology, the Dryomyzidae, Helcomyzidae, and Helosciomyzidae appear to be more closely related to each other than they are to other Sciomyzoidea (Barnes, 1981). At this time little can be said about these relationships, based on larval morphology. Too few species have been reared, and insufficient information is available on the immature stages.

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REVISION OF THE SPIDER-COMMENSAL PLANT BUG GENUS *RANZOVIUS* DISTANT (HETEROPTERA: MIRIDAE)

THOMAS J. HENRY

Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % National Museum of Natural History, NHB 168, Washington, D.C. 20560.

Abstract.—The spider-commensal plant bug genus *Ranzovius* Reuter (Hemiptera: Miridae) is revised. The species *californicus* Van Duzee and *mexicanus* Van Duzee are resurrected from synonymy, and the new species ***agelenopsis*** and ***contubernalis*** are described from the eastern United States. New distributions are given and records in the literature are clarified. Illustrations of antennal segments and male genitalia and a key are provided to help separate the 7 known species. Possible morphological modifications in the claws of *Ranzovius* and several other heteropteran taxa associated with spider webs are discussed.

The habits of species in the phyline genus *Ranzovius* Distant are among the most interesting in the plant bug family Miridae (Hemiptera: Heteroptera). Carvalho (1954) first reported on the relationship between *R. fennahi* Carvalho and the semi-social spider *Theridion eximius* Keyserling [*Anelosimus eximius* (Keyserling)]. Adults and nymphs of *fennahi* were observed to live in the webs and feed on *A. eximius* eggs. Davis and Russell (1969) recorded similar observations of commensalism between a species identified as *R. moerens* (Reuter) and the funnel-web spider *Hololena curta* (McCook). They noted two differences from Carvalho's report: *H. curta* is a solitary spider, not semi-social; and *R. moerens* is a scavenger in the spider webs, not an egg predator.

My interest in this genus developed because material in the National Museum of Natural History (NMNH) from California differed from specimens recently collected in the eastern United States. Because of this discrepancy and because a name is needed for a paper on the biology and habits of a new eastern species (Wheeler and McCaffrey, 1984—this issue), I attempt to clarify the names and recognize the species now included in the genus *Ranzovius.* I review the species of *Ranzovius,* describe 2 new species from the eastern United States, clarify previous synonymies, figure antennal segments and male genitalia, and provide a key to help distinguish species.

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TAXONOMIC HISTORY

Distant (1893) erected the genus *Ranzovius* to accommodate his new species *crinitus* described from Guerrero and Veracruz, Mexico; Carvalho and Dolling (1976) selected a female from Omilteme, Guerrero as the lectotype. Reuter (1905) described *Nyctella moerens* from Venezuela and (1908) *Nyctella lunifera* from Puebla, Mexico. Carvalho (1954) synonymized *Nyctella* Reuter, transferred both of Reuter's species to *Ranzovius* and placed *lunifera* in synonymy under *crinitus*. Van Duzee (1917) described *Excentricus californicus* from Placer Co., California and (1923) *Excentricus mexicanus* from Francisquita Bay, Lower California. Blatchley (1926) reported *mexicanus* (in *Excentricus*) from Florida, providing the only eastern U. S. record for the genus. Carvalho (1954) described *Ranzovius fennahi* from Trinidad, and later (1955a) transferred both of Van Duzee's species to *Ranzovius*, synonymizing them under *moerens*. Knight (1968) reported *moerens* from Arizona and Texas.

***Ranzovius* Distant**

Ranzovius Distant, 1893: 422. Type-species: *Ranzovius crinitus* Distant, 1893: 422 (Monobasic).

Nyctella Reuter, 1905: 35. Type-species: *Nyctella moerens* Reuter, 1905: 35 (Monobasic) (Synonymized by Carvalho, 1954: 95).

Diagnosis.—Small, length 1.8–2.7 mm, dark colored, clothed with simple setae, intermixed on dorsum and pleural areas of thorax with recumbent, silvery, silky setae; head broader than long, produced in front of eyes; eyes finely pubescent, touching anterior margin of pronotum; rostrum reaching metacoxae or beyond; antennae stout, segment I shortest and thickened, II longest and swollen in both sexes, subequal to or greater than thickness of segment I, slightly greater than, to shorter than, width of head; pronotum trapeziform, scutellum equilateral; hemelytra entire, membrane with 2 closed cells; claws phyline, without fleshy parempodia.

Remarks.—The genus *Ranzovius* can be keyed in Blatchley (1926) [as *Excentricus* Van Duzee not Reuter] or Slater and Baranowski (1978) based on the claws, the silky pubescence, the length of thickened 2nd antennal segments, and by the head that is produced in front of the eyes. Because the silky pubescence was not a known character for the genus, Carvalho's (1955b) key will not work in the final couplet containing *Ranzovius*.

It has been suggested that the claws of certain spider web-inhabiting insects, including members of the genus *Ranzovius*, are specialized for walking on spider webs. Davis and Russell (1969) described that the claws of *R. californicus* [as *R. moerens*—see discussion of *R. californicus*] can be held down, parallel to the tarsus, for walking on top of spider webs or almost perpendicular for hanging under the webs. They also noted a ridge [unguitractor plate] at the base of the claws, suggesting a further adaptation for movement in webs.

Contrary to Davis and Russell's (1969) suggestion that the claws of *R. californicus* are modified for walking in webs, I find that there is little observable morphological difference in *Ranzovius contubernalis* claws (Fig. 16) compared to the claws of other genera or even subfamilies of the Miridae. Scanning electron microscopy shows that while the claws of *Ranzovius* (Fig. 16) are much less curved than in some taxa, they are quite similar to the claw micrographs provided by

Figs. 1–4. 1, *Ranzovius agelenopsis* (paratype ♀). 2, *R. californicus* (holotype ♀). 3, *R. contubernalis* (holotype ♂). 4, *R. crinitus* (paralectotype ♂).

Schuh (1976) of certain plant-inhabiting phylines like *Campylomma* sp. (Fig. 23), *Austropsallus drakensbergensis* Schuh (Fig. 24), and *Tytthus alboornatus* (Knight) (Fig. 25), or even the orthotyline *Ellenia obscuricornis* (Poppius) (Fig. 31). Likewise, the unguitractor plate is not unlike the plates shown by Schuh in these same figures.

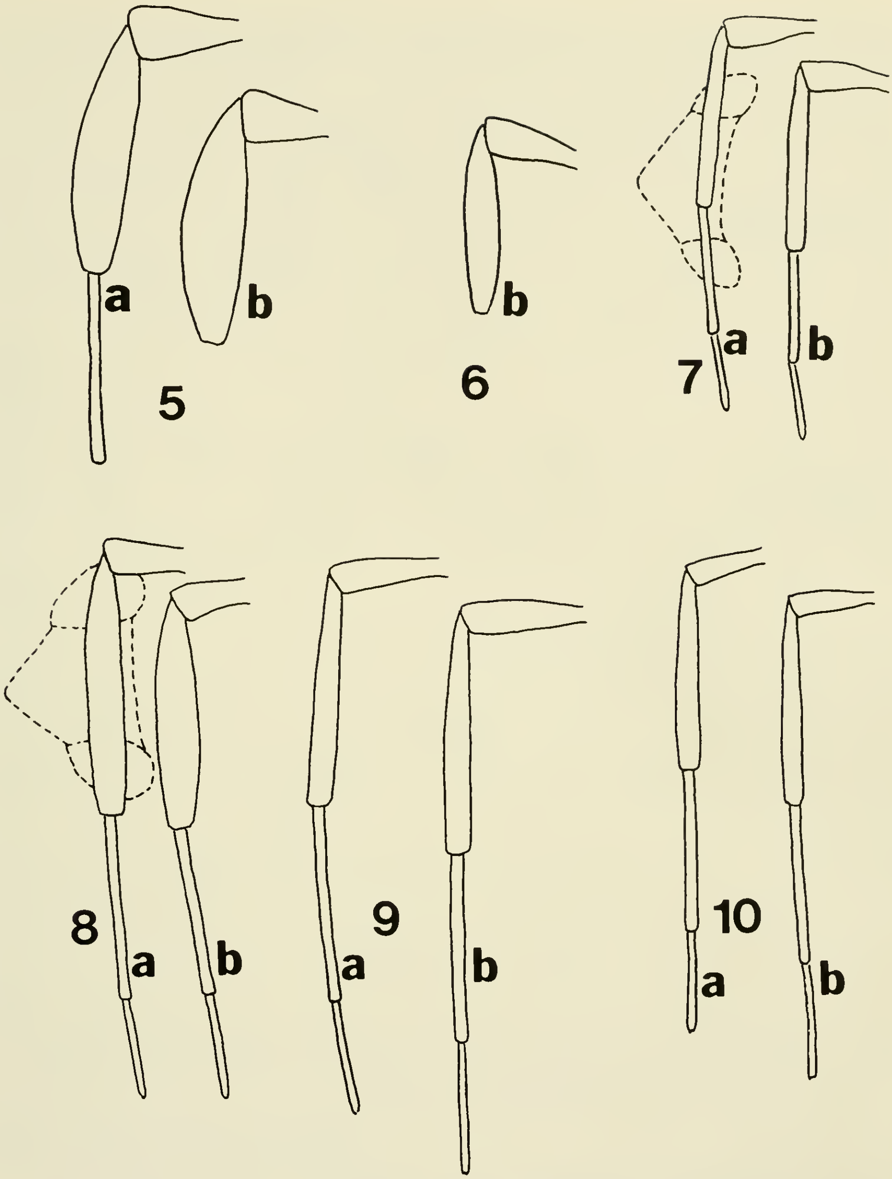
In contrast, an examination of two nabid genera shows that the claws of some heteroptera are morphologically adapted for a spider web existence. Myers (1925) observed that the claws of nabid species in the genus *Arachnocoris* can be appressed to form efficient hooks that enable them to walk suspended upside down in theridiid spider webs. An SEM comparison of the plant-inhabiting *Lasiomerus annulatus* (Reuter) to the spider web-inhabiting *Arachnocoris alboannulatus* Lima illustrates some differences. The claws of *L. annulatus* are long and curved and have three rows of ridges on the unguitractor plate (Fig. 19), whereas in *A. alboannulatus* the claws are straight and very short (Fig. 17) and the middle row on the unguitractor plate is without definite ridges (Fig. 18). The form of the latter claws would imply that Myers' (1925) observation is correct. The smooth middle ridge (Fig. 18) of the unguitractor plate might be a further modification used by this bug when walking on top of webs, assuming that it straddles each strand of the web with the inner and outer part of the claw (as *Ranzovius contubernalis* frequently does (personal observation)). It would seem that this "unquitractor chute" could serve as a slide for the web strand as it is channeled between the claw.

Further observations have been noted in the Reduviidae. Wygodzinsky (1966) described the claws of certain spider web-inhabiting emesines as similar to those of many spiders having ridges or serrate bases on their claws. He notes that the resemblence of certain emesine claws (e.g., Fig. 4E) to many spiders ". . . suggests the hypothesis that the structure of the claws is functionally related to the conquest by the bugs of a unique niche, the spider web." My examination of *Anelosimus studiosus,* which has comblike claws, confirms the strong similarity of the claws of at least one theridiid spider to some emesine claws as described and figured by Wygodzinsky.

From this brief study, it becomes obvious that there is a great deal to be learned about arachnophilous insects. A detailed survey of the diversity of insects that inhabit spider webs is needed to understand the functional morphology of the claws and behavioral adaptions of these interesting arthropods.

KEY TO THE SPECIES OF *RANZOVIUS*

1. Length of antennal segment II equal to or greater than width of head . . 2
– Length of antennal segment II shorter than width of head, not greater than width of vertex and a single eye combined 3
2. Antennal segment II strongly swollen (Fig. 5), greatest diameter ½ or more the width of the vertex; aedeagus (Fig. 11) with 2 sclerotized spiculi . . . . *californicus* (Van Duzee)
– Antennal segment II more slender (Fig. 8), greatest diameter about ⅓ the width of the vertex; aedeagus (Fig. 14) without any apparent spiculi . . . . *agelenopsis* Henry, new species
3. Apex of embolium and base of cuneus with a wide, white, lunate mark, often reaching from outer margin to membrane 4

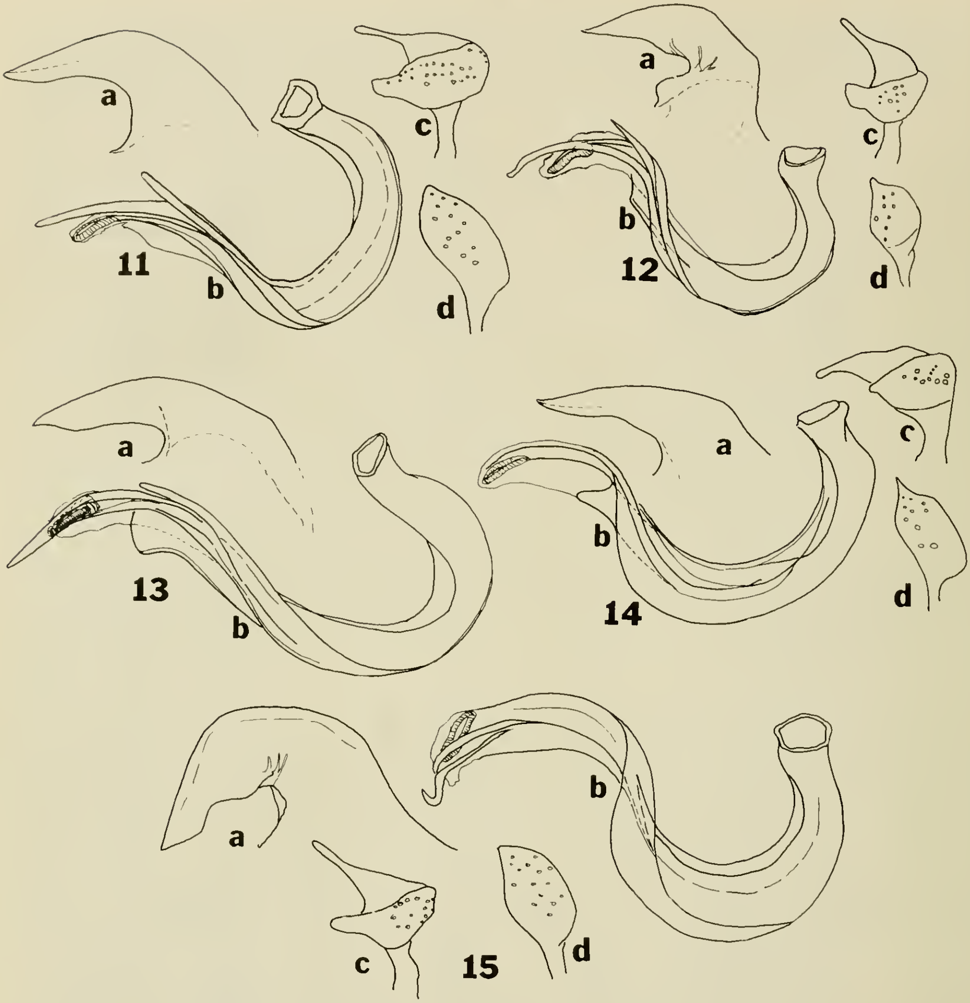


Figs. 5–10. a, Male antenna; b, female antenna. 5, *Ranzovius californicus*. 6, *R. mexicanus*. 7, *R. contubernalis*. 8, *R. agelenopsis*. 9, *R. fennahi*. 10, *B. crinitus*.

– Apex of embolium black or, at most, narrowly whitish, base of cuneus black 5

4. Larger species, length 2.28–2.32 mm in males, length 2.60–2.68 mm in females; length of antennal segment III greater than width of vertex; spiculi of aedeagus (Fig. 13) relatively thickened, secondary spiculum blunt apically . . . . *crinitus* Distant

– Smaller species, length 1.86–2.10 mm in males, length 2.08–2.28 mm in females; length of antennal segment III equal to or less than width of



Figs. 11–15. Male genitalia: a, phallotheca; b, aedeagus; c, left paramere; d, right paramere. 11, *Ranzovius californicus.* 12, *R. contubernalis.* 13, *R. crinitus.* 14, *R. agelenopsis.* 15, *R. fennahi.*

vertex; spiculi of aedeagus (Fig. 12) relatively slender, secondary spiculum acute apically .... *contubernalis* Henry, new species

5. Antennal segment II swollen (Fig. 6), length less than length of head; length of antennal segment III less than width of vertex .... *mexicanus* (Van Duzee)

– Antennal segment II relatively slender (Fig. 9), length distinctly longer than length of head; length of antennal segment III greater than width of vertex .... *fennahi* Carvalho and *moerens* (Reuter)

Ranzovius agelenopsis **Henry, New Species**

Figs. 1, 8, 14

Description.—*Holotype* ♂: Length 2.40 mm (paratype ♂ 2.32 mm), width 1.00 mm (0.88 mm). *Head:* Length 0.40 mm (0.44 mm), width 0.54 mm (0.52 mm), vertex 0.24 mm (0.22 mm). *Rostrum:* Length 1.10 mm (1.10 mm), reaching apices of metacoxae. *Antenna:* Segment I, length 0.22 mm (0.24 mm), apical diameter 0.08 mm (0.08 mm); II, length 0.56 mm (0.56 mm), greatest diameter 0.08 mm (0.08 mm); III, length 0.42 mm (0.42 mm); IV, length 0.26 mm (0.28 mm). *Pronotum:* Length 0.40 mm (0.42 mm), basal width 0.76 mm (0.76 mm). *Genitalia:* Aedeagus (Fig. 14b), left paramere (Fig. 14c), right paramere (Fig. 14d).

Shiny black, apex of corium or embolium and base and apex of cuneus whitish, membrane fumate with a small clear area at middle, veins pale or whitish; antenna black, segments III and IV brownish, base of III whitish; venter shiny black, ventral margin of propleura and ostiolar evaporatum slightly paler; femora black with apices whitish, sometimes tinged with red; tibiae yellowish brown, bases brown or reddish, tibial spines black, metatibial spines with indistinct dark spots at bases.

Females.—Length 2.40–2.56 mm ($\bar{x}$ = 2.46 mm, n = 3), width 1.04–1.12 mm. *Head:* Length 0.40–0.42 mm, width 0.50–0.52 mm, vertex 0.28–0.30 mm. *Rostrum:* Length 1.10–1.12 mm. *Antenna:* Segment I, length 0.22 mm, apical width 0.08 mm; II, length 0.52–0.54 mm, greatest diameter 0.10 mm; III, length 0.40–0.44 mm; IV, length 0.24–0.26 mm. *Pronotum:* Length 0.42–0.44 mm, basal width 0.78–0.80 mm.

Similar to male in color and pubescence.

Type specimens.—*Holotype* ♂: Knox Co., Tennessee, Knoxville, University of Tenn. Campus, 10 Aug. 1981, L. N. Sorkin and D. Faber, taken in web of *Agelenopsis pennsylvanica* (C. L. Koch), on tree trunk covered with two species of ivy (AMNH). *Paratypes:* 2 ♂, 6 ♀ (2 5th-instar nymphs), same data as for holotype (AMNH; 1 ♂ and 1 ♀ in USNM); 8 ♂, 1 ♀, Tennessee, Knox Co., Univ. Tenn. Agric. Campus, 15–17 Jul. 1982, A. G. Wheeler, Jr., taken in webs of *Agelenopsis pennsylvanicus* on tree trunk covered with ivy and on boxwood (PDA, USNM).

Remarks.—*Ranzovius agelenopsis* is most similar to *californicus* in having the 2nd antennal segment thickened, especially in the female, and the relatively long 2nd antennal segments that are equal to or greater than the width of the head, but can be separated as given in the key by the lack of apparent spiculi on the aedeagus and by the more slender 2nd antennal segment that has a diameter about ⅓ the width of the vertex.

The type specimens of *agelenopsis* were taken in the webs of the agelenid *Agelenopsis pennsylvanicus* (C. L. Koch). According to Kaston (1981), this is one of our most common spiders that ranges from New England to Tennessee, and west to Oregon and Washington.

It is interesting that *contubernalis* n. sp. was taken on the same boxwood bush in Tennessee as was *agelenopsis* n. sp., only apparently in the web of *Anelosimus studiosus* (A. G. Wheeler, Jr., personal communication). In one case, the webs of the two spiders actually were touching and it was assumed that *contubernalis* was specific to *Anelosimus studiosus* webs and *agelenopsis* was specific to *Agelenopsis pennsylvanicus* webs. Since this collection, however, Dr. Wheeler has found *contubernalis* in the webs of *Agelenopsis pennsylvanicus* in North Carolina and Virginia (see discussion under *contubernalis*).

The specific name *agelenopsis* is taken from the generic name of its spider associate, *A. pennsylvanicus.*

Ranzovius californicus **(Van Duzee), REVISED STATUS**

Figs. 2, 5, 11

Excentricus californicus Van Duzee, 1917: 284.

Ranzovius californicus: Carvalho, 1955a: 224 (as synonym of *moerens*); Carvalho, 1958: 136 (as synonym of *moerens*).

Ranzovius moerens: Knight, 1968: 35 (in part); Davis and Russell, 1969: 262.

Description.—*Holotype* ♀: Length 2.52 mm (range, including holotype 2.44–2.52 mm, *n* = 4), width 1.16 mm (1.04–1.20 mm). *Head:* Length 0.46 mm (0.46–0.52 mm), width 0.50 mm (0.50–0.52 mm), vertex 0.30 mm (0.30 mm). *Rostrum:* Length ca. 0.98 mm (partially bent and imbedded in glue) (ca. 0.98–1.12 mm). *Antenna:* Segment I, length 0.28 mm (0.28 mm), apical width 0.12 mm (0.12 mm); II, length 0.50 mm (0.50–0.54 mm), greatest diameter 0.16 mm (0.16–0.18 mm); III, length ca. 0.34 mm (curled) (ca. 0.34–0.40 mm); IV, length 0.20 mm (0.20–0.30 mm). *Pronotum:* Length 0.44 mm (0.44–0.46 mm), basal width 0.84 mm (0.84–0.88 mm).

General coloration dark brown or fuscous (almost black); head strongly produced with anterior ½ in front of eyes; rostrum reaching just beyond metacoxae; antennal segments I–II black and strongly thickened, III–IV whitish to yellowish brown, slender; hemelytra blackish except for narrow pale or whitish areas at apex of cuneus and along cuneal fracture; membrane smoky black, middle and area near apex of cuneus clear; femora fuscous, apices white; tibiae pallid or yellowish white, bases and occasional large spots at bases of tibial spines dark brown or black.

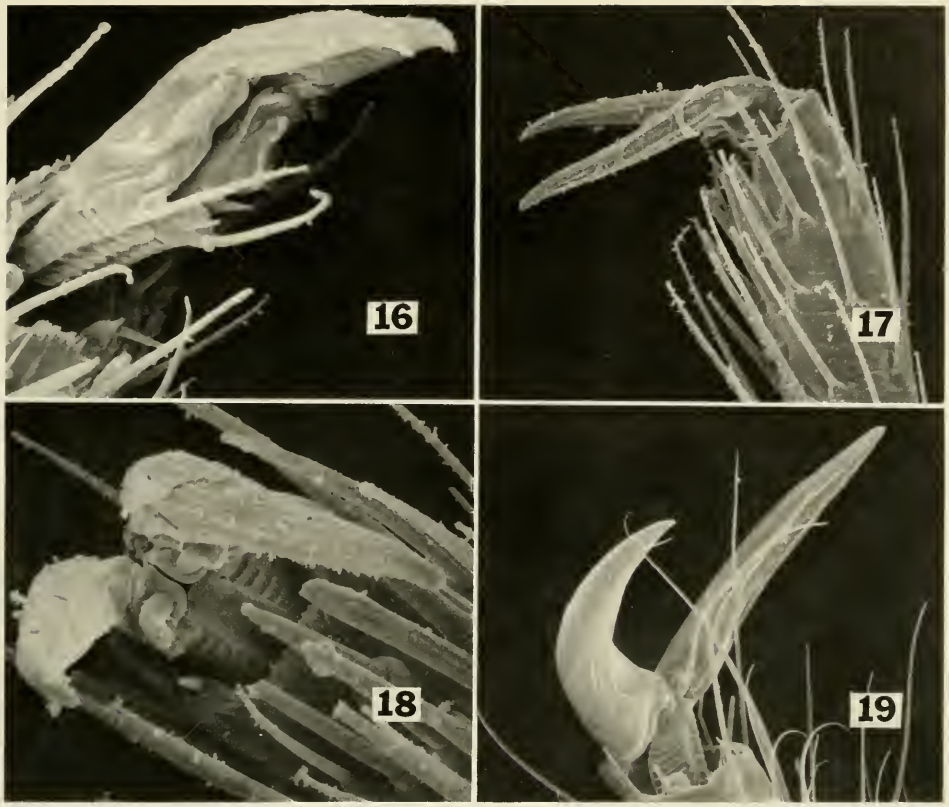
Male (*n* = 4).—Length 2.32–2.60 mm, width 1.00–1.04 mm. *Head:* Length 0.42–0.48 mm, width 0.46–0.50 mm, vertex 0.24–0.30 mm. *Rostrum:* Length 1.04–1.12 mm, reaching 3rd or 4th abdominal segment. *Antenna:* Segment I, length 0.24–0.26 mm, apical width 0.12 mm: II, length 0.52–0.54 mm, greatest diameter 0.12–0.14 mm; III, length 0.40–0.42 mm; IV, length 0.30–0.32 mm. *Genitalia:* Aedeagus (Fig. 11b), left paramere (Fig. 11c), right paramere (Fig. 11d).

Male very similar to female in color and pubescence.

Specimens examined.—*Holotype* ♀: Placer Co., California, 20 August 1916, 4500 ft., W. M. Giffard (CAS); 1 ♀, Lake Co., Cal., Lucerne, 10 Aug. 1957, H. B. Leech (CAS); 3 ♀, Los Angeles Co., San Marino, C. Goodpasture (USNM); 1 ♂ and 1 ♀, San Marino, 3–5 Aug. 1982, M. P. Russell (USNM); 1 ♀, Marin Co., Cal., Mill Valley, 3 Aug. 1957, H. B. Leech (CAS); 1 ♂, Sonoma Co., Santa Rosa, Cal., 1 July 1968, ex. corn, D. A. Moore (USNM); 1 ♂, Sisson, Cal., 24 July 1918, E. P. Van Duzee (CAS).

Remarks.—Carvalho (1955a) synonymized this species and *Excentricus mexicanus* under *moerens,* stating that *californicus* and *mexicanus* were only the male and female of *moerens,* respectively. This statement, however, is in error because both of Van Duzee's species descriptions are based on unique female types. I have examined the holotype of *californicus* and find it distinct from other known species of the genus.

Judging from the distribution, I suspected that Davis and Russell's (1969) study was based on *californicus,* not *moerens.* Although the original material from their study has been lost, Dr. Russell kindly returned to and collected 2 specimens from the same locality. These specimens are *californicus. Hololena curta,* the spider



Figs. 16–19. Pretarsi of Heteroptera. 16, *Ranzovius contubernalis* (1720×). 17, *Arachnocoris alboannulatus* (740×). 18, *Arachnocoris alboannulatus* (1650×). 19, *Lasiomerus annulatus* (414×).

associate for this species, also is known only from California (Chamberlin and Ivie, 1942).

Ranzovius californicus can be recognized by the proportionately long 2nd antennal segment that is subequal to the width of the head, and by the strongly thickened 2nd antennal segment (Fig. 5) that is at least ½ as wide as the width of the vertex.

Ranzovius contubernalis **Henry, New Species**

Figs. 3, 7, 12, 17

Excentricus mexicanus: Blatchley, 1926: 962 (in part).
Ranzovius moerens: Knight, 1968: 35 (in part); Carvalho, 1958: 136 (in part).

Description.—*Holotype* ♂: Length 2.04 mm (range of 10 paratypes 1.86–2.10 mm, $\bar{x}$ = 1.98 mm), width 0.90 mm (0.82–0.90 mm). *Head:* Length 0.36 mm (0.34–0.40 mm), width 0.50 mm (0.48–0.50 mm), vertex 0.28 mm (0.26–0.28 mm). *Rostrum:* Length 1.00 mm (0.92–1.00 mm), reaching 7th or 8th abdominal segment. *Antenna:* Segment I, length 0.18 mm (0.18–0.20 mm), apical width 0.06 mm (0.06 mm, or less); II, length 0.40 mm (0.38–0.40 mm): greatest diameter 0.06 mm (0.06 mm, or less); III, length 0.26 mm (0.26 mm); IV, length 0.18 mm

(0.18–0.20 mm). *Pronotum:* Length 0.38 mm (0.34–0.38 mm); basal width 0.76 mm (0.68–0.76 mm). *Genitalia:* Aedeagus (Fig. 12b); left paramere (Fig. 12c); right paramere (Fig. 12d).

Generally brownish black to black, clothed with semierect, brown, simple setae, intermixed with patches of silvery scalelike setae on dorsum and thoracic pleura; head, pronotum, and venter shiny black; hemelytra dark, shiny, brownish black, apex of embolium and apex of cuneus whitish, base of cuneus from outer margin to membrane clear to translucent; membrane smoky black with a clear spot at center; veins reddish; antennal segments I and II black, segment III pale tinged with brown, segment IV brownish; femora black with apices yellow; tibiae brownish yellow with bases somewhat darker, basal ½ of metatibia with large black spots at bases of spines.

Females.—Length 2.08–2.28 mm ($\bar{x}$ = 2.19 mm), width 0.96–1.00 mm. *Head:* Length 0.38–0.40 mm, width 0.50–0.52 mm, vertex 0.28–0.30 mm. *Rostrum:* Length 0.98–1.04 mm. *Antenna:* Segment I, length 0.20 mm, apical width 0.06 mm, or less: II, length 0.30–0.40 mm, greatest diameter 0.60 mm, or less; III, length 0.28 mm; IV, length 0.20 mm. *Pronotum:* Length 0.36–0.40 mm, basal width 0.78–0.80 mm.

Very similar to males in color and pubescence, differing only in their slightly greater length and broader form.

Type specimens.—Holotype ♂: Washington, D.C., National Arboretum, 14–15 June 1981, T. J. Henry and A. G. Wheeler, Jr., taken in web of *Anelosimus studiosus* (Hentz) on azalea bushes (USNM type no. 73730). Paratypes: 20 ♂, 12 ♀, same data as for holotype (AMNH, BM, TAM, PDA, USNM); 3 ♂, 2 ♀, same locality as for holotype, 1 Aug. 1981, T. J. Henry (USNM); 28 ♂, 33 ♀, same locality as for holotype, 17 Aug. 1982, R. C. Froeschner, T. J. Henry, J. T. Polhemus, in webs of *A. studiosus* on ornamental azalea, *Hedera helix* L. '*arborescens,*' and *Quercus prinus* L. (AMNH, NHMP, TAM, USNM; J. T. Polhemus colln., Englewood, CO); 1 ♀, Westport, Connecticut, 15 July 1976, M. McClure, taken on hemlock (UCN); 1 ♀, Dade Co., Florida, Rt. 41, "Shark Valley," 10 April 1981. T. J. Henry and A. G. Wheeler, Jr. (USNM); 1 ♀, Patuxent R[iver], Maryland, 27 June 1926, H. H. Knight (USNM); 3 ♂, 2 ♀, Mecklenburg Co., North Carolina, nr. Matthews, 4–5 Nov. 1979, A. G. Wheeler, Jr., taken on *Juniperus virginiana* L. (PDA); 2 ♂, 1 ♀, Steeles Tavern, Virginia, 15 Sept. 1979, J. P. McCaffrey, associated with *Anelosimus studiosus* (Hentz) (PDA, USNM); 3 ♂, 5 ♀, Virginia, Fairfax Co., Alexandria, 22 Aug. 1982, T. J. Henry and K. Weisberg, in webs of *A. studiosus* on *Hedera helix* L., *Berberis* sp., *Rosa* sp., and ornamental azalea (USNM).

I also have examined material of this species from the following localities: 1 specimen, Santa Rita Mts., Arizona, 26 June 1920, A. A. Nichol (USNM); 10, Baton Rouge, Louisiana, 20 June and 10 Aug. 1935, T. McGregor (PDA, TAM); 1, Starkville, Mississippi, 13 June 1929, H. G. Johnston (TAM); 3, Brazos Co., Texas, 8 Oct. 1965, (AMNH, PDA, TAM); 10, Montgomery Co., Texas, Monroe, 16 July 1964, on *Pinus* sp. (AMNH, PDA, TAM); 1, Nacogdoches Co., Texas, 5 mi. s. of Martinsville, Oct. 1970, H. Burke and J. C. Schaffner (TAM).

Remarks.—*Ranzovius contubernalis* is closely related to *crinitus* but can be separated by the smaller size and the proportionately shorter 3rd antennal segment.

Also the spiculi of the aedeagus (Fig. 12b) are more slender than in *crinitus* (Fig. 13b). I have examined male genitalia of specimens from Arizona, North Carolina, Texas, and Washington, D.C. and find that the form of the aedeagus is consistent throughout the entire range.

The spider most often associated with *contubernalis, A. studiosus* (Hentz), ranges from New England south into Argentina (Levi, 1963). Since the discovery of this mirid it has been taken (Wheeler, PDA) in the webs of *Agelenopsis pennsylvanicus* in North Carolina, Tennessee, and Virginia. These finds disturb my original conclusion that species of *Ranzovius* are specific to the webs of certain species of spiders. Further research is needed on the biology of these bugs to study their degree in spider specificity.

The Latin name *contubernalis,* meaning tent companion, is provided for J. McCaffrey and A. G. Wheeler, Jr., who are publishing on the life history and habits of this species (this issue).

Ranzovius crinitus **Distant**

Figs. 4, 10, 13

Ranzovius crinitus Distant, 1893: 423; Carvalho 1954: 96.
Nyctella lunifera Reuter, 1908: 175 (Synonymized by Carvalho, 1954: 96).

Description.—*Lectotype* ♀: Length ca. 2.60 mm, apex of membrane folded (for paralectotype 2.68 mm), width 1.04 mm (1.08 mm). *Head:* Length 0.40 mm (0.38), width 0.54 mm (0.54 mm), vertex 0.32 mm, distorted (0.36 mm). *Rostrum:* Length 1.10 mm (venter obscured in glue). *Antenna:* Segment I, length 0.22 mm (0.22 mm), apical width 0.06 mm (0.06 mm); II, length 0.46 mm (0.46 mm), greatest diameter 0.06 mm (0.06 mm); III, length 0.36 mm (0.40 mm); IV, length 0.26 mm (0.26 mm). *Pronotum:* Length 0.42 mm (0.44 mm), basal width 0.90 mm.

General coloration dark brown to fuscous, except for pale or whitish apex of cuneus, and a distinct band encircling base of cuneus from embolium to membrane; membrane smoky black or fumate with an apparent pale area near apex of cuneus (membrane curled and distorted); antennal segments I and II dark, III pale or whitish; IV, brown with base and apex pallid; venter dark brown or black; femora dark brown or black with apices whitish; tibiae whitish or yellowish brown with fuscous spots at bases of tibial spines.

Males (2 paralectotypes).—Length 2.32 mm (2nd specimen with wing membrane distorted, length ca. 2.28 mm), width 1.04–1.08 mm. *Head:* Length 0.38 mm, width 0.46–0.50 mm, vertex 0.30–0.32 mm. *Rostrum:* Embedded in glue. *Antenna:* Segment I, length 0.22 mm, apical width 0.06 mm; III, length 0.42–0.44 mm, greatest diameter 0.06 mm; III, length 0.36 mm; IV, length 0.26 mm. *Pronotum:* Length 0.40–0.44 mm, basal width 0.76–0.80 mm. *Genitalia:* Aedeagus (Fig. 13b).

Specimens examined.—Mexico: Lectotype ♀, 1 paralectotype ♂, Omilteme, Guerrero, 8000 ft., H. H. Smith (BM); 1 paralectotype ♂ and ♀, Orizaba, Veracruz, H. H. Smith (BM).

Remarks.—*Ranzovius crinitus* is most similar to *contubernalis* in the pale markings at the apex of the corium and base of the cuneus, but *crinitus* is consistently larger in overall body length and has the 3rd antennal segment (Fig. 10) longer in proportion to segment II (0.08 or more the length of II) than does *contubernalis* (0.71 or less the length of II). As discussed under *contubernalis* and in the key, the male genitalia also differ.

Ranzovius crinitus has not been associated with any spiders.

Ranzovius fennahi **Carvalho**

Figs. 9, 15

Ranzovius fennahi Carvalho, 1954: 93; Carvalho, 1958: 136.

Description.—♂ (*n* = 4): Length 2.32–2.64 mm, width 1.00–1.12 mm. *Head:* Length 0.40–0.44 mm, width 0.54 mm, vertex 0.32–0.34 mm. *Rostrum:* Length 1.18–1.20 mm, reaching near base of genital segment. *Antenna:* Segment I, length 0.24–0.26 mm, apical width 0.06–0.08 mm; II, length 0.44–0.48 mm, greatest diameter 0.06–0.08 mm; III, length 0.38–0.40 mm; IV, length 0.28–0.30 mm. *Pronotum:* Length 0.44–0.46 mm, basal width 0.76–0.80 mm. *Genitalia:* Aedeagus (Fig. 15b), left paramere (Fig. 15c), right paramere (Fig. 15d).

General coloration dark brown or black; antenna black, segment III and IV brown with bases and apices whitish; hemelytra uniformly blackish, except for an occasional indistinct, very narrow, pale line at apex of embolium along cuneal francture; venter dark, ventral margin of propleura and anterior lobe of ostiolar evaporatum pale or whitish; femora black with apices pale; tibiae pale or whitish with indistinct dark spots at bases of metatibial spines.

Female (*n* = 2).—Length 2.64–2.68 mm, width 1.12–1.32 mm. *Head:* Length 0.44–0.48 mm, width 0.52–0.54 mm, vertex 0.32–0.40 mm. *Rostrum:* Length 1.32–1.38 mm, reaching 6th abdominal segment. *Antenna:* Segment I, 0.26–0.30 mm, apical width 0.10 mm; II, length 0.46–0.48 mm, greatest diameter 0.06–0.08 mm; III, length 0.40–0.44 mm; IV, length 0.28–0.30 mm. *Pronotum:* Length 0.50–0.52 mm, basal width 0.92–0.98 mm.

Female very similar to male in color and pubescence.

Specimens examined.—1 paratype ♀, Santa Cruz, Trinidad, 19 Mar. 1949, R. G. Fennah coll. (USNM); 1 ♂, Panama, Cerro Jefe, 11 Oct. 1974, D. Quintero, ex.: spider web of *Anelosimus eximius* (USNM); 10 ♂, 5 ♀, and nymphs, Touenke Island, French Guiana, 20 Nov. 1975, M. Boulard, taken in webs of *Anelosimus eximius* (MNHP; 3 in USNM); 4 ♂ and nymphs, Suriname, Saramacca Prov., along Coppename River, Voltzberg-Raleighvallin Reserve, Feb. 1982, Deborah R. Smith (USNM).

Remarks.—Boulard (1979) observed a phyline mirid from South America in webs of social spiders ". . . in the manner of the African Plokiophilidae." I have examined his specimens and find them to be the species *fennahi. Razovius fennahi,* described from Trinidad and Brazil, and now known from French Guiana and Panama, probably will be found wherever its spider-associate *A. eximius* occurs. According to Levi (1963), this theridiid ranges from Panama into southern Brazil.

Ranzovius fennahi can be recognized by the totally dark dorsum without white markings at the apex of the corium and cuneus, and by the long 2nd antennal segment that is subequal to or longer than the width of the head. A few of the Boulard specimens (in alcohol) have narrow, indistinct, white markings at the apex of the cuneus and embolium. This is the only species having a hooked spiculum on the aedeagus.

I have not been able to separate *fennahi* from *moerens*. Reuter's (1905) description closely fits that of *fennahi*. Judging from the description and distribution, I am reasonably certain that these two species will prove to be the same. Because I have not been able to locate Reuter's holotype and the original description lacks specific measurements and other details, I feel that it is best at this time to maintain the name until the type of *moerens* or additional specimens from the region are examined.

Ranzovius mexicanus **(Van Duzee), REVISED STATUS**

Fig. 4, 6

Excentricus mexicanus Van Duzee, 1923: 163; Blatchley, 1926: 962 (in part).
Ranzovius moerens Carvalho, 1954: 95 (in part); Knight, 1968: 35 (in part).
Ranzovius mexicanus: Carvalho, 1955a: 224 (as synonym of *moerens*).

Description.—*Holotype* ♀: Length 2.28 mm, width ca. 1.04 mm (1 hemelytron missing). *Head:* Length 0.42 mm, width 0.54 mm, vertex 0.32 mm. *Rostrum:* Missing. *Antenna:* Segment I, length 0.22 mm, apical width 0.08 mm; II, length 0.38 mm, greatest diameter 0.08 mm; III and IV missing. *Pronotum:* Length 0.38 mm, basal width ca. 0.80 mm, posterior angles broken and missing.

General coloration dark brown to almost black; hemelytra dark, except for apex of cuneus, arrow pale area at apex of embolium along cuneal fracture, and a small area at inner angle of corium near apex of clavus; venter fuscous or black; membrane smoky black, paler around middle, veins pale becoming reddish posteriorly; femora fuscous with apices pale or whitish; tibiae pale yellowish brown or whitish with base and 4 or 5 fuscous spots at bases of tibial spines.

Specimens examined.—*Holotype* ♀: San Francisquito Bay, Gulf of California, Mexico, 10 May 1921, E. P. Van Duzee (CAS); 2 ♀, intercepted at Brownsville, Texas, from Mexico, 23 Mar. 1937, on gardenias (USNM).

Remarks.—Carvalho (1955a) synonymized *mexicanus* and *californicus* under *moerens* Reuter. Now that more specimens of the genus have become available for study, I can place more weight on the antennal characters. Comparison of both sexes of several species shows that the thickness of the 2nd antennal segment is consistent within the genus. For this reason, I recognize *mexicanus* because of the short and rather stout 2nd antennal segment. The thickened 2nd segment (Fig. 6) and the narrow white mark at the apex of the embolium (Fig. 4) will separate *mexicanus* from other species of *Ranzovius*.

Carvalho (1954) based his concept of *moerens*, at least in part, on 2 females from Mexico [intercepted at Brownsville, Tx.] in the USNM collection. These specimens, although in poor condition, have been restudied and are considered to represent the species *mexicanus*. As Carvalho noted, the 2nd antennal segment is stouter than in *crinitus* and *fennahi* and there are only narrow pale markings at the apex of the corium and cuneus. Blatchley's (1926) record of *mexicanus* from Florida should be referred to the species *contubernalis*. *Ranzovius mexicanus* has not been associated with any spider.

Ranzovius moerens **(Reuter)**

Nyctella moerens Reuter, 1905: 36.
Ranzovius moerens: Carvalho, 1954: 95 (in part); Carvalho, 1958: 136 (in part); Knight, 1968: 35 (in part).

I have been unable to locate Reuter's holotype of *moerens,* collected at Caracas, Venezuela. The following is a translation from Latin of Reuter's description.

Dull black, smooth dorsally; antennae black, segments III and IV missing; 2nd segment 2× the length of I and subequal to the width of an eye and vertex combined, subcylindrical, slightly thinner than segment I, constricted at the base; apical margin of corium and narrow apical margin [outer apex] of cuneus pale golden yellow; tibiae golden yellow, spines on metatibiae with black spots at bases, bases of metatibiae somewhat fuscous at bases; tarsi fuscous, paler at bases; rostrum darkly testaceous, 1st segement black at apex, apex reaching posterior coxae; length of pronotum about $^2/_5$ the basal width, anterior margin ½ as wide as base; membrane black with a glass-green spot at apex of cuneus. Length 2⅓ mm.

Remarks.—As indicated in the discussion under *fennahi,* I cannot separate *moerens* from *fennahi.* These species may prove to be synonymous.

Acknowledgments

I am grateful to all of the curators who lent specimens of *Ranzovius*; to M. P. Russell (California State University, Los Angeles) for collecting specimens of *californicus* specifically for this study; to A. G. Wheeler, Jr. (PDA) for sharing his notes on *agelenopsis* and *contubernalis*; to L. H. Kassianoff (USNM) for translating Reuter's description of *moerens*; N. T. Platnick (AMNH) for identifying the spider from French Guiana; and to R. C. Froeschner (USNM) for commenting on the manuscript.

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RANZOVIUS CONTUBERNALIS: SEASONAL HISTORY, HABITS, AND DESCRIPTION OF FIFTH INSTAR, WITH SPECULATION ON THE ORIGIN OF SPIDER COMMENSALISM IN THE GENUS *RANZOVIUS* (HEMIPTERA: MIRIDAE)[1]

A. G. Wheeler, Jr. and Joseph P. McCaffrey

(AGW) Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania 17110; (JPM) Department of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, Idaho 83843.

Abstract.—Plant bugs of the genus *Ranzovius* are unique among Miridae in their obligate association with web-building spiders. *Ranzovius* spp. may be commensals, kleptoparasites, or predators of spider egg sacs. Two species of *Ranzovius* are known to occur in the eastern United States. *R. contubernalis* Henry lives mainly as a commensal in the webs of the subsocial theridiid *Anelosimus studiosus* (Hentz) and also, probably secondarily, in webs of the agelenid *Agelenopsis pennsylvanica* (C. L. Koch). Seasonal history, behavior, and feeding habits are summarized for populations of *R. contubernalis* studied in North Carolina, Virginia, and Washington, D.C. during 1979–83. The fifth-instar nymph is described and illustrated. In addition, notes on *R. agelenopsis* Henry, which inhabits the webs of *A. pennsylvanica*, are given for a population that co-occurs with *R. contubernalis* at Knoxville, Tennessee. The evolutionary steps that may have led to spider commensalism in *Ranzovius* are discussed.

Plant bugs or mirids, members of the largest family of Hemiptera-Heteroptera, are well known as pests of field and fruit crops and as predators of various soft-bodied arthropods and their eggs (Kullenberg, 1944; Wheeler, 1976). Most mirids live on the foliage, stems, or inflorescences of living herbs, shrubs, and trees but a few, mainly predaceous, species occur in other habitats. For example, isometopines (Wheeler and Henry, 1978) and *Phytocoris* spp. (Knight, 1923a) live on tree trunks; *Cylapus tenuicornis* Say (Heidemann, 1891; Banks, 1893) and *Fulvius* and *Peritropis* spp. (Knight, 1923b; Knight and McAtee, 1929) live among fallen logs or on tree stumps; *Trynocoris lawrencei* Herring has been taken in shelf fungi (Herring, 1976); and *Schaffneria* spp. inhabit the ground layer (Knight, 1966). The genus *Ranzovius* Distant exhibits one of the most remarkable habits recorded for the Miridae—an obligate relationship with web-building spiders.

The first species of the genus reported in association with spiders was *R. fennahi* Carvalho. Based on R. G. Fennah's observation in the West Indies, Carvalho (1954) recorded it as predaceous on egg sacs of the theridiid *Anelosimus eximius*

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[1] Contribution no. 83730 from the Idaho Agricultural Experiment Station.

(Keyserling). In southern California, Davis and Russell (1969) reported commensalism between *R. californicus* (Van Duzee) [cited as *R. moerens* (Reuter)—see Henry, 1984] and a solitary funnel-web or agelenid spider, *Hololena curta* (McCook). The bugs were observed feeding on entrapped insects or on plant material in the webs. Until Henry's (1984) revision of *Ranzovius*, all North American records of this presumed Neotropical group (Slater, 1974) were referred to *moerens*, and in the U.S. the genus was thought to occur only in Arizona, California, Florida, and Texas (e.g., Knight, 1968; Slater and Baranowski, 1978).

In 1979 the collection of *Ranzovius* from webs of *Anelosimus studiosus* (Hentz) in central Virginia (by JPM) prompted additional collecting in the eastern U.S. and observations on life history. In 1981, L. N. Sorkin (American Museum of Natural History, New York) and D. Faber (University of Wisconsin, Madison) collected what proved to be a different species from webs of an agelenid spider at Knoxville, Tennessee. Specimens from theridiid and agelenid webs were sent to T. J. Henry, mirid specialist with the Systematic Entomology Laboratory, USDA, Washington, D.C. His discovery that material from the eastern U.S. was not conspecific with that from California led to a revision of the genus (Henry, 1984). Described as new were *R. contubernalis* Henry, a species recorded from Connecticut south to Florida and west to Arizona, and *R. agelenopsis* Henry from Tennessee.

We summarize here our observations on seasonal history and habits of *R. contubernalis* in the eastern U.S. and describe the fifth-instar nymph. The habits of *R. agelenopsis* are briefly noted. We also speculate on the ecological and behavioral conditions that may have led to the evolution of spider commensalism in *Ranzovius*.

METHODS

Biological information was obtained from populations of *Ranzovius contubernalis* studied in ornamental plantings during 1979–80 at Steeles Tavern, Virginia (by JPM); 1981–83 at the U.S. National Arboretum, Washington, D.C. (by AGW and T. J. Henry); and 1982–83 at Staunton, Virginia and Charlotte, North Carolina (by AGW). The seasonal history reported for *R. contubernalis* thus is a composite based on the periodic sampling of populations at Washington from late May through October, Steeles Tavern from early June to mid-September, Staunton from late May to early September, and Charlotte from early April to early November. On each sample date, either the relative proportion of nymphs to adults was estimated in the field and the nymphal populations "rough-sorted" into early and late instars, or a sample (usually at least 5 individuals) was collected and the stages recorded after examination under a binocular microscope. Feeding habits and behavior were observed at all study sites and, to a limited extent, in the laboratory (mainly by JPM). The field notes on *R. agelenopsis* are based on collections at Knoxville, Tennessee, in early August 1981 (by D. Faber and L. N. Sorkin), mid-July 1982 (by AGW), and late July 1983 (by R. E. Kelly and G. L. Miller).

HABITAT PREFERENCES

Plant associations.—With the exception of a collection from native red-cedar, *Juniperus virginiana* L., we found *Ranzovius contubernalis* only in ornamental plantings: shrubs and hedges in the home landscape, in landscaped plantings of

Figs. 1–2. Webs of the subsocial theridiid *Anelosimus studiosus.* 1, New web on Chinese holly, *Ilex cornuta.* 2, Old web on stems of glossy abelia, *Abelia* × *grandiflora,* filled with arthropod exoskeletons, plant material, and other debris.

commercial establishments, on college campuses, and in an arboretum. Small, compact shrubs like boxwood (*Buxus*), certain hollies (*Ilex*) (Fig. 1), and yews (*Taxus*) seemed to be favored sites for web construction by *Anelosimus studiosus,* the most common host spider of *R. contubernalis* in the eastern United States. The mirid also was abundant in hedges of glossy abelia (*Abelia* × *grandiflora* (André) Rehd.) and azalea (*Rhododendron* spp.) and developed in webs on tree trunks covered by English ivy (*Hedera helix* L.). In areas where the spider was abundant, webs could be found on nearly all available shrubs and occasionally at heights of 2 m on the lowest branches of trees. The apparent scarcity of *R. contubernalis* outside landscape plantings may be an artifact of our collecting efforts. In Florida, the theridiid is known to construct its webs in a variety of habitats (Brach, 1977), and the mirid may well occur more frequently in natural areas than is indicated by our sampling.

Host spiders.—The theridiid *Anelosimus studiosus* ranges from Connecticut to Florida, west to eastern Texas, through Mexico and Central America, and south to Argentina (Levi, 1956, 1963). The webs of *A. studiosus* have been described as "unsightly masses of dead leaves tied together with silk," having a sheetlike extension somewhat like the silken sheets of agelenid spiders (Comstock, 1913) or superficially resembling the silken nests of webworms (Brach, 1977). In Florida, Brach described web formation by a founding female. Criss-crossed support strands are attached to branch terminals of a shrub, reinforced and branched to form a dense maze or mesh, and then a sheet is constructed on this scaffolding. The resulting web, about 60 × 60 mm, consists of a sheetlike platform having above a "space-filling meshwork of silk" that serves as a "labyrinthine snare"; at the edges of the platform are retreats constructed around dead leaves to which the spiders usually retire by day (Brach, 1977). According to Brach, the spiders tend to be more active at night, patrolling the webs and feeding on small Diptera and other entrapped insects. Theridiid webs are "selectively sticky," that is, they contain trapping threads studded with glue droplets (see Foelix, 1982). Plant material, excreta, and other debris often accumulate in the webs (Fig. 2) and, in Florida, Brach (1977) recorded other spiders, ants, cockroaches, and pyralid larvae as web inhabitants.

Anelosimus studiosus displays several elements of subsocial behavior: the persistence of colonies of up to 50 young in the web, regurgitation feeding of spiderlings by the mother, and cooperative prey capture, feeding, and web maintenance. However, tolerance among colony members is not permanent; when the founding female dies, the first-maturing sibling female becomes aggressive toward other adult females. In contrast, indiscriminant brood care is found in the Neotropical *A. eximius,* allowing the formation of large, placid colonies of as many as 1000 individuals (Brach, 1975, 1977; Foelix, 1982). Brach (1977) suggests that the development of tactile or specific-surface recognition of web mates and tolerance between females was important in the evolution of large, perennial colonies and quasisociality in *A. eximius* and a few other spiders.

After the first two seasons of observations, we thought that *Ranzovius contubernalis* might be restricted to webs of *Anelosimus studiosus.* But the mirid also occurs in webs of *Agelenopsis pennsylvanica* (C. L. Koch), a common North American agelenid known from Maine south to Mississippi and west to Oregon and Washington (Chamberlin and Ivie, 1941). Mirids also were collected in webs of agelenids too immature to identify with certainty, and it is possible that *R. contubernalis* is associated with other *Agelenopsis* spp. or other agelenid genera.

Webs of *Agelenopsis* spp. are horizontal, slightly concave, flat sheets having an open tube or funnel extending from one side, in which the spider waits for prey to strike the web. The nonviscid sheet simply impairs the movement of prey on its surface. Agelenids detect vibrations of insects that strike the web, whereupon the spider rushes from its retreat to seize the prey and carry it back to the tube (Turnbull, 1965; Kaston, 1981).

In North Carolina, Tennessee, and Virginia we have encountered webs of both spider species in the same shrub or hedge, often directly above one another, or side by side with the periphery of the webs in contact or nearly so. On Chinese holly (*Ilex cornuta* Lindl. & Paxt.) in Charlotte, N.C., agelenid and theridiid webs formed a nearly continuous "superstructure" extending for several meters along the lower half of the hedge, allowing mirids to move from web to web. In its association with agelenids, which we consider secondary, *R. contubernalis* was most common in late summer and early fall in expanded sheet webs of mature *A. pennsylvanica.* It appears that first generation *Ranzovius* develop mainly in webs of *Anelosimus* rather than in the inconspicuous webs constructed by young *Agelenopsis.*

Even though webs of certain other spiders, e.g., the linyphiid *Frontinella pyramitela* (Walckenaer) and various araneids, were constructed near those of *Agelenopsis* and *Anelosimus,* their webs did not support populations of *Ranzovius contubernalis.* We cannot agree with Knight's (1968) comment that "spider webs everywhere are much the same . . . ." Not only are there differences in the webs of various spiders, but the species also display behavioral differences.

Fig. 3. Egg of *Ranzovius contubernalis* inserted in stem of yew, *Taxus* sp.

SEASONAL HISTORY

Eggs of *Ranzovius contubernalis* are deposited in stems of plants harboring host spiders (Fig. 3) and are inserted in branches that support (or are near) the webs. The hatching of overwintering eggs seems to occur soon after *Anelosimus studiosus* becomes active in spring and begins to expand its webs. At Charlotte the overwintered eggs had hatched by early April (first and second instars were present on 10 April), and by late May populations in webs of *Agelenopsis pennsylvanica* and *Anelosimus studiosus* on Chinese holly consisted mainly of fourth and fifth with a few third instars present. Webs often contained 5–10 nymphs and occasionally as many as 20. Adults were observed during the first week of June. This duration between the appearance of nymphs in early spring and the first appearance of adults agrees with that observed for *R. californicus* in webs of *Hololena curta* in southern California: 70 days in the first year of study, 46 days in the second year (Davis and Russell, 1969).

By early July nearly all first generation adults had died, and first and second instars of a second generation were present. Late instars and adults of this generation were collected in early August. A third generation was produced during mid-August–September; third to fifth instars and teneral adults were found from early to mid-September. Adults and a fifth instar were taken as late as 5 November.

In central Virginia and in the Washington area the overwintering eggs hatched approximately 4–5 weeks later than in southern North Carolina, based on the collection of third instars in late May. The adults began to appear in mid- to late June. Second generation adults were present by late July to mid-August. A third generation developed during late August and September.

In contrast, Davis and Russell (1969) reported that the population of *R. californicus* studied in southern California was univoltine. Nymphs appeared in mid-March, with egg hatch believed to continue until June. Adults, however, were present until late August or mid-September, a period longer than what might be expected for most adult mirids. With a recorded average nymphal period of 26.3 days, based on laboratory rearing at 30°C, multiple generations would seem possible for *R. californicus*.

BEHAVIOR AND FEEDING HABITS

By day, nymphs and adults of *Ranzovius contubernalis* are found in the webs of host spiders or on the underside of leaves at the periphery of the webs. Brief observations suggested that the bugs were less active on webs at night, perhaps because the host spiders were more active then. Davis and Russell (1969) suggested that the observed inactivity of *R. californicus* at night might be due to the host agelenid's presence on the web platform.

The mirids walk upside down along the bottom of webs (Fig. 4) or upright on the top. Although Davis and Russell (1969) commented that the claws of *R. californicus* "can be either held straight down, parallel to the tarsus, for walking on the web or turned in, almost perpendicular to the tarsus, for hanging under the web," the claws of *Ranzovius* actually are similar to those of other phyline Miridae and may not be highly modified (see Henry, 1984). In contrast, spider commensals of the nabid genus *Arachnocoris* (Myers, 1925) and certain higher emesine Reduviidae that inhabit spider webs (Wygodzinsky, 1966) do have specialized claws.

Ranzovius contubernalis often rest in webs, their motionlessness and posture (antennae outstretched) rendering them easily mistaken for dead adults. When walking in webs, nymphs and adults move slowly with their antennae in constant motion, moving alternately up and down or weaving a rapid figure-eight. The bugs stop frequently to clean their antennae with the tarsi. When disturbed, the bugs run quickly across webs and usually hide among foliage at the webs' periphery.

Fig. 4. Adult *Ranzovius contubernalis* hanging from bottom of web of *Anelosimus studiosus.*

Even though *Ranzovius* is fully capable of flight, the bugs do not fly when disturbed. In fact, a web and its supporting stems can be cut from a plant and transported to the laboratory without the adults escaping.

The movements of *R. contubernalis* in webs did not appear to elicit responses from host spiders, possibly because their small size and manner of walking do not produce vibrations similar to those of potential prey that strike the webs. Intruders in the webs of *Anelosimus studiosus* usually induce convergence by colony members, although the presence of another spider (Mimetidae) was not detected under experimental conditions (Brach, 1977). On one occasion we observed a nymph of *R. contubernalis* walking on a web directly beneath a subadult or mature *Agelenopsis pennsylvanica* without eliciting a response from the spider. Davis and Russell (1969) reported that *R. californicus* also "did not try to avoid the spiders," and they observed a nymph walking within a centimeter of a mature spider; however, when caged with immature *Hololena curta,* first- and second-instar mirids were killed after an average of 4.4 days (11 trials).

The food sources most readily available to *Ranzovius contubernalis* tend to fluctuate throughout the season and may depend on the plant species supporting webs of host spiders. The mirid appears to scavenge mainly on insects ignored by host spiders or that are too small to have triggered a feeding response. For example, in the agelenid *Agelenopsis potteri* (Blackwall) prey capture does not exceed a certain level, with no individual catching all available prey (Turnbull, 1965), and in *Anelosimus eximius* the efficiency of prey capture decreases with prey size so that mosquito-sized or small insects often are ignored (Brach, 1975). In North Carolina large numbers of black citrus aphid, *Toxoptera aurantii* (Fonscolombe), which infested new growth of Chinese holly, became entrapped in webs of *Anelosimus studiosus* and at times furnished an abundant food source for the bugs. On boxwood, the large numbers of boxwood psyllid, *Psylla buxi* (L.), trapped in webs during peak adult activity provided the mirids a ready supply of food. In webs of *A. studiosus* and *A. pennsylvanica, Ranzovius contubernalis* also fed on small Diptera, a winged ant, a moth, the flatid *Anormenis septentrionalis* (Spinola), the cicadellid *Orientus ishidae* (Matsumura), the cercopid *Prosapia bicincta* (Say), and an adult psocid.

Several large insects fed on by *Ranzovius contubernalis* obviously were not fresh. However, even nutrients in these rather dry cadavers may be accessible to the bugs. The saliva of mirids appears to allow nutrients to be extracted from fungus-killed anthomyiid flies, with the bugs often concentrating on the eyes (Wheeler, 1971). The haustellate mouthparts and saliva of plant-feeding Heteroptera facilitate opportunistic feeding on dried bird droppings, dung, and carrion (Adler and Wheeler, 1984).

The relationship of *Ranzovius contubernalis* to its spider hosts appears to represent primarily a benign commensalism, i.e., the fitness of its hosts is not lowered (see Wise, 1982). Although Davis and Russell (1969) referred to *R. californicus* as a commensal in webs of *Hololena curta* (which of course applies in the broad sense), some of its behavior might be termed kleptoparasitic, i.e., involving a stealing of prey items. This species sometimes fed on insects that the host agelenid had tied to its web. When small Diptera were thrown on a web, a nymph attacked one of the struggling flies, but the spider soon emerged from its retreat to claim the fly.

In one web we also observed *Ranzovius contubernalis* on a staminate oak catkin, the nymph apparently feeding on pollen. Davis and Russell (1969) noted that *R. californicus* fed on honeysuckle stamens that had dropped onto webs of *Hololena curta.* On one occasion we observed predation on molting spiderlings of *Anelosimus studiosus,* but *R. contubernalis* was not seen to feed on eggs of its host spiders. In the field when JPM disturbed an egg sac of *A. studiosus,* the female spider quickly grasped it in her chelicerae.

In the laboratory adult *Ranzovius* fed on eggs of cabbage looper, *Trichoplusia* *ni* (Hübner) (Lepidoptera: Noctuidae), and on a dead adult of their species. When confined in rearing containers, the mirids showed some cannibalism.

DESCRIPTION OF FIFTH INSTAR

Fig. 5

Length 1.60 mm. Elongate oval, general coloration red, pronotum darker red, wing pads fusco-reddish, legs and antennal segment IV paler, segment III white; rostral segments III–IV, tarsi, and apex of hind tibia tinged with fuscous. Dorsum sparsely clothed with pale, recumbent setae, lateral margin of pronotum and abdomen fringed with darker setae, antennal segment I incrassate, with dark, bristlelike setae, 2 longer erect setae at apical ⅓ of dorsal surface; II incrassate, with rows of dark bristlelike setae, length less than width of head across eyes; III–IV slender, with finer setae. Antenna: I, length, 0.22 mm; II, 0.40 mm; III, 0.30 mm; IV, 0.26 mm. Rostrum: length 1.06 mm, reaching just beyond bases of metacoxae. Wing pads reaching base of 5th abdominal segment; dorsal abdominal scent gland opening distinct (but secondary doubling barely visible), a sclerotized bar above. Hind tibia with row of 4–5 faint, dark spots or bands, 2 stout spines at base on outer face.

Description based on nymph (in alcohol), taken in theridiid spider web with adults of *Ranzovius contubernalis*, near Matthews, N.C., 5 Nov. 1979.

NOTES ON *RANZOVIUS AGELENOPSIS*

Collected only on the University of Tennessee campus at Knoxville, this mirid undoubtedly has a much wider distribution. In 1981 and 1982 it was common in webs of *Agelenopsis pennsylvanica* among English ivy on tree trunks and, although webs were abundant in ivy growing on the ground, the mirid was not found in such situations (1982 observations). We note that *Anelosimus studiosus* was common among ivy trees at the National Arboretum in Washington, but this spider was not observed on ivy-covered trunks at Knoxville. The theridiid, however, was present on the University of Tennessee campus. In 1982, collections from webs of *Agelenopsis* and *Anelosimus* on two boxwood plants yielded both *R. agelenopsis* and *R. contubernalis* but, because only the former mirid was presumed present, bugs from the various webs were not kept separate. In 1983 when a web of each spider species was examined, the webs yielded only *R. contubernalis*. Thus, we know that at the type-locality of *R. agelenopsis* this species lives in agelenid webs occurring among ivy on tree trunks and that on boxwood at Knoxville, *R. contubernalis* develops in agelenid and theridiid webs, as is typical in other areas of the eastern U.S. On boxwood where the two mirids co-occurred, *R. agelenopsis* may be confined to agelenid webs, but detailed experimental work is needed to clarify the ecological relationships of these bugs in the only known area of sympatry. Whether agelenids are the sole host spiders for *R. agelenopsis* or not, it does appear that these spiders are at least the primary hosts for this mirid, whereas they seem to be secondary hosts for *R. contubernalis*.

We observed *Ranzovius agelenopsis* feeding on dead invertebrates, including ants and a sowbug (Isopoda), in webs of *Agelenopsis pennsylvanica* on tree trunks. In the laboratory L. N. Sorkin (pers. comm.) observed feeding on dead *Drosophila*, the bugs often penetrating the flies' eyes.

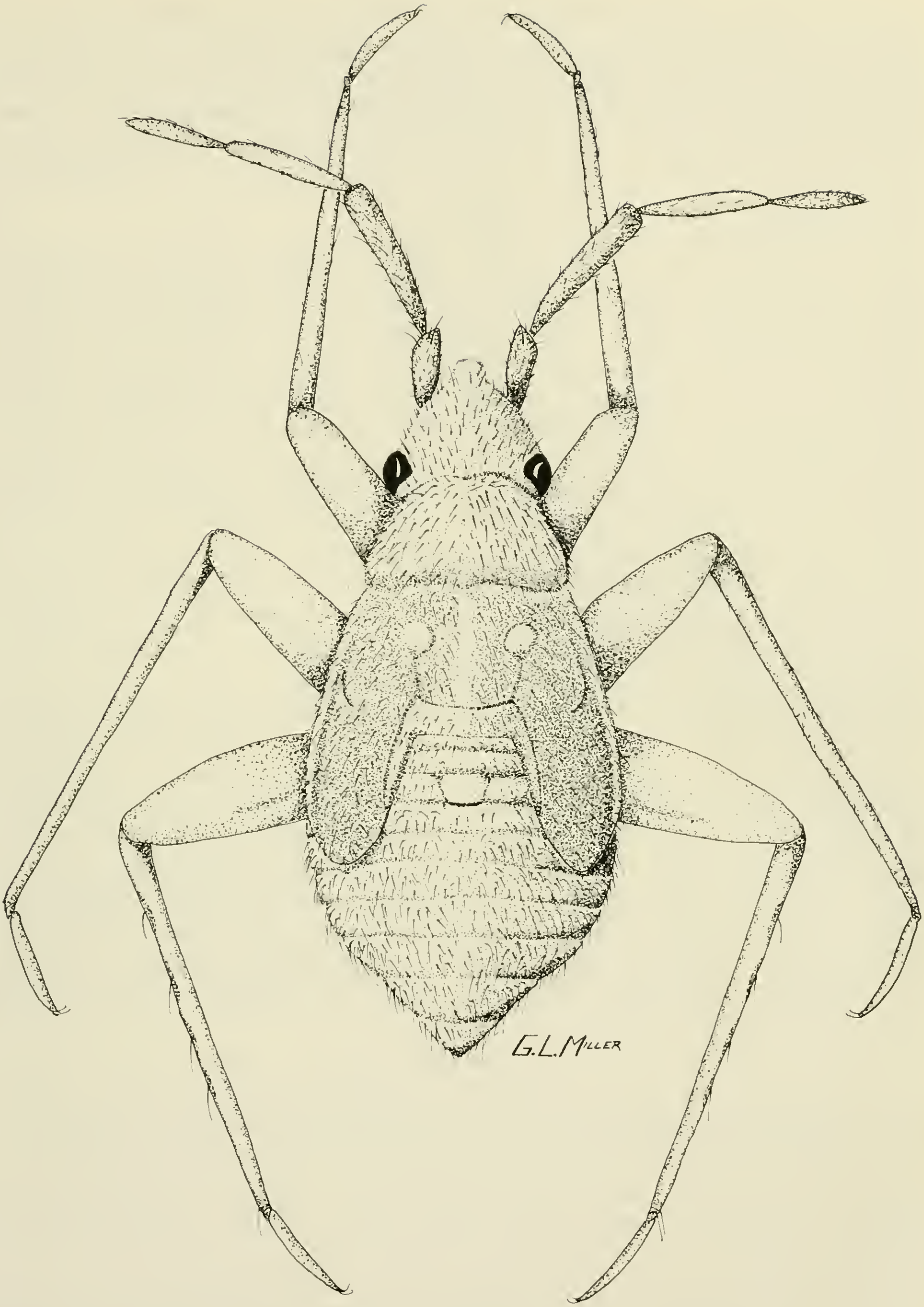

Fig. 5. *Ranzovius contubernalis*, fifth-instar nymph.

PROBABLE ORIGIN OF FEEDING HABITS IN *RANZOVIUS*

Ranzovius species share an apparent obligate association with spiders that also has evolved in several predatory heteropterans: species of the nabid genus *Arachnocoris* (Myers, 1925), certain emesine reduviids (Wygodzinsky, 1966), and the plokiophilid subfamily Plokiophilinae (Carayon, 1974). In addition, a predaceous bug of the family Anthocoridae inhabits the webs of a colonial spider in South Australia (China and Myers, 1929).

The mirid genus *Ranzovius* probably originated in the Neotropics, with the ancestral bug inhabiting shrubs and trees. Like many phyline mirids, it most likely was a "mixed feeder," that is, both phytophagous and zoophagous (Kullenberg, 1944). Phylines, as well as certain other groups of Miridae, feed opportunistically on readily available nitrogen-rich food sources. They will attack small-bodied arthropods (aphids, mites, etc.) and will exploit stationary food sources like arthropod eggs (e.g., Kullenberg, 1944; Butler, 1965; Wheeler, 1976), mummified aphids (Wheeler et al., 1968), and cadavers of flies killed by phycomycosis (Wheeler, 1971). We speculate that *Ranzovius* began to feed fortuitously as a timid carnivore or scavenger at the periphery of spider webs built on the bugs' host plants. The large, communal, perennial webs of the Neotropical *Anelosimus eximius* (Brach, 1975) would have offered an abundance of food in the form of entrapped arthropods and plant debris. Because the ready food supply would have made a more intimate association with spiders a profitable way of life, the bugs eventually may have ventured onto webs for feeding.

Their small size—adults range from slightly less than 2.00 mm long to slightly more than 2.50 mm and are among the smallest Miridae—might have preadapted them for walking on nonadhesive strands of silk and made them less likely to trigger vibrations eliciting response from colony members. Fennah, quoted in Carvalho (1954), suggests that in spider webs *Ranzovius* may "not give the necessary stimulus for attack by pulling on the threads." Although *A. eximius* is "quite aggressive" (Brach, 1975), this subsocial spider, whose webs probably were inhabited by a variety of commensals and kleptoparasites, may be somewhat more tolerant of *Ranzovius* than solitary spiders. Also, these spiders presumably had developed a "sensory screen" or adaptation for filtering vibrations so that conspecifics would not elicit predatory responses.

A predictable food source in communal webs would have made commensalism (in the broad sense) an inexpensive strategy in terms of time and energy expended and brought about a specialization of the web-living habit. Selection would have favored behavioral modifications (or perhaps slight modifications in tarsal structure) allowing webs to be traversed more easily or setting up vibrations more similar to those of its subsocial host than to those of potential prey organisms striking the web.

We hypothesize that the ancestral *Ranzovius* and its presumed spider host possessed certain attributes that facilitated the evolution of commensalism: sharing of the same habitat, the bugs' opportunistic feeding habits, and a concentration of communal hosts in perennial webs harboring a predictable food supply. Brockman and Barnard (1979) identified these and other ecological conditions and behavioral patterns that have led to kleptoparasitism in birds. In *Ranzovius*, the various feeding strategies possible—carnivory on spider egg sacs or molting spiderlings, kleptoparasitism, or scavenging—apparently all occur, just as they do in commensal spiders of the theridiid genus *Argyrodes* (see Wise, 1982). For an apparent opportunist like *Ranzovius* the habits of egg predation and scavenging would be behaviorally and physiologically similar. A species, depending on the particular set of ecological conditions, could function as a predator, kleptoparasite, or scavenger.

Discussion

All *Ranzovius* species whose habits are known live in spider webs. *R. contubernalis* is found mainly in webs of the subsocial *Anelosimus studiosus* (Theridiidae) and, to a lesser extent, in webs of the solitary *Agelenopsis pennsylvanica* (Agelenidae) and perhaps other agelenids. The relationship to host spiders appears mainly commensal rather than kleptoparasitic or predatory.

More common in the southern United States, *Ranzovius contubernalis* has been recorded as far north as Connecticut (Henry, 1984) (which also is the northernmost record for *A. studiosus*), although this is the only record north of the Washington, D.C. area. The mirid is known to occur as far west as the Santa Rita Mountains in southeastern Arizona (Henry, 1984), but *Anelosimus studiosus* is known only as far west as eastern Texas (Levi, 1956). The spider associations of *R. contubernalis* in the westernmost area of its range need to be established.

Additional field and laboratory research is needed to clarify basic life history phenomena of *Ranzovius* species in temperate and tropical regions. Experimental work would reveal interesting facts about the nature of the relationship between *Ranzovius* spp. and their spider hosts, including possible impact on mirid and host fitness.

The sympatry of *R. agelenopsis* and *R. contubernalis* in Tennessee raises several questions. Do the mirid-spider relationships indicate ecological partitioning by the two *Ranzovius* species, and is the apparent rareness of *R. agelenopsis* a result of competition with *R. contubernalis*? Is their sympatry at Knoxville the result of secondary overlap in the range of *agelenopsis*? Crucial to a better understanding of the relationship between these species is a critical study of their Tennessee populations and particularly extensive collecting to determine the range of *R. agelenopsis.*

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A SYNOPSIS OF THE EMBIIDINA OF THE UNITED STATES

Edward S. Ross

California Academy of Sciences, San Francisco, California 94118.

Abstract.—The ordinal name Embiidina Hagen, 1862, is used in preference to the more recent, less appropriate name, Embioptera, Shipley, 1904. All embiids occurring in the continental United States and Hawaii are briefly treated and assigned to proper taxa. The fossil, *Embia florissantensis* Cockerell, is assigned to ***Lithembia*** new genus. The subgenus *Dactylocerca* Ross, 1940, of *Chelicerca* Ross, 1940, is elevated to generic status and a new species ***D. ashworthi*** from Arizona is described. The subgenus *Dilobocerca* Ross, 1944, of *Oligembia* Davis, 1939, is treated as a synonym of *Diradius* Friederichs, 1934, and one of its species, *caribbeanus* Ross, 1944, described from Cuba, is newly recorded from the Florida Keys. The bisexual form of *Haploembia solieri* (Rambur) is reported as a new introduction to the New World.

Although suprafamilial names of animals are not regulated by international rules, I have at last decided to follow priority and use Embiidina (Embidina *sic*) Hagen, 1862 and 1885, as the ordinal name for embiids instead of Embioptera Shipley, 1904. It should be noted that Embiidina was also used by Krauss, 1911, and Enderlein, 1912, in their world monographs. Embiidina, although not referred to as an ordinal name by Hagen, was the first suprafamilial name applied exclusively to embiids. The inappropriate name Embioptera was perhaps proposed to foster uniform ptera endings on insect ordinal names but this objective is needless and impossible to attain. In German-speaking cultures the name Embiodea Kusnezow, 1903, is in current use and thus there is no consensus on the use of the name Embioptera.

The embiids (web-spinners, or better, foot-spinners) are poorly represented in the United States and constitute only a feeble northern extension of the Order's rich Neotropical fauna. A few weed species of the Mediterranean and Asian family Oligotomidae have been introduced in human commerce.

Key to Families and Genera of U.S. Embiidina

1. Tertiary fossil from Florissant shales (Embiidae) .... Genus *Lithembia*
– Recent species 2
2. All instars with two papillae ("bladders") on ventral surface of hind basitarsi (Oligotomidae, part) .... Genus *Haploembia*
– All instars with only one hind basitarsal papilla 3
3. Adult males without apical mandibular dentation; segments of left cercus fused, bearing a few peg-setae (echinulations) on inner apex (Anisembiidae) 4

– Adult males with mandibles apically dentate; left cercus two segmented, inner surface of basal segment lacking peg-setae 5

4\. All instars with intersegmental membranes of thorax pale, body otherwise tan or golden-brown. Mid and hind coxae of nymphs and females pale. Adult males apterous or alate, head golden; left cercus straight, with an acute, inner-apical lobe. South-central states and NE Mexico .... Genus *Anisembia*

– Nymphs and females uniformly reddish-brown to brick-red, mid and hind coxae as dark as other leg segments. Adult males always alate, head jet-black, body extensively reddish; left cercus C-shaped, without a distinct inner lobe. Southwestern States and Mexico .... Genus *Dactylocerca*

5\. MA vein of wings (R4+5 of Comstock-Needham) forked (Teratembiidae) 6

– MA unforked (Oligotomidae, part) 7

6\. Adult males with left cercus-base (left cercus-basipodite) bearing two, prominent, inner lobes; the ventral one either finger-shaped or conate .... Genus *Diradius*

– Cercus-base with only the dorsal lobe; as in *Diradius*, this terminates in a minute bifurcation .... Genus *Oligembia*

7\. Adult males with cercus-base a complete ring bearing a prominent inner lobe. Widespread; including mainland U.S.A. and Hawaii .... Genus *Oligotoma*

– Cercus-base obsolete except for an outer basal flange; inner lobe thus absent. Hawaii and other Pacific islands .... Genus *Aposthonia*

FAMILY EMBIIDAE

Lithembia Ross, New Genus

Type-species.—*Embia florissantensis* Cockerell, by present designation.

Distribution.—Tertiary (Miocene?) fossil in volcanic ash shale, Florissant, Colorado.

Diagnosis.—The type is a large adult male with well preserved wings displaying typical embiid venation (MA forked). Abdominal terminalia represented by only a dark blotch.

Discussion.—This species is certainly not an *Embia*—a genus restricted to Africa and adjacent regions and belonging to a subfamily not represented in the New World. Its large size rules out an assignment to Teratembiidae and the wing venation is not of the anisembiid type (MA simple). Its northerly occurrence and slender body suggest that it is not a clothodid, a family confined to South America and the eastern Isthmus of Panama. It therefore seems advisable to assign it to the Embiidae which today has representation as far north as Nayarit in NW Mexico.

Lithembia florissantensis **(Cockerell) New Combination**

Embia florissantensis Cockerell, 1908: 230, fig. 4. Handlirsch, 1906–08: 1357.—Enderlein, 1912: 53.

Oligotoma florissantensis (Cockerell), Krauss, 1911: 48.

Clothoda florissantensis (Cockerell), Davis, 1939d: 379.—Ross, 1944: 406.

Holotype.—Alate male on rock slab in Riker Mount, Univ. of Colorado Museum, Denver. *Type data.*—Florissant Colorado Station 14, 1907 (W. P. Cockerell). Miocene.

Discussion.—All above references are based on Cockerell's original publication. To date no additional specimens have been found. The writer has studied the type and cannot add new details to the description or improve on the original published photograph.

Even if additional specimens are collected, it is doubtful if they would reveal terminalia details sufficient to add significant information concerning the systematic placement of the species.

Family Anisembiidae

Distribution.—Neotropical with limited extension into south-central and southwestern U.S.A.

In spite of the great evolutionary diversity within the family, males of all anisembiids have in common non-dentate mandibles, an unforked MA wing vein and a lack of a second basitarsal papilla.

Species of the two subfamily groups represented in the United States are able to withstand extremely cold climatic conditions—perhaps by wintering deep in soil crevices.

Genus *Anisembia* Krauss

Anisembia Krauss, 1911: 74.—Enderlein, 1912: 109 (in error as a syn. of *Oligotoma* Westwood and *Haploembia* Verhoeff).—Chamberlin, 1923: 346.—Davis, 1940: 531.—Ross, 1940: 649; 1944: 445.

Type-species.—*Embia texana* Melander, 1902, by original designation.

Distribution.—Lower Mississippi Valley, western Oklahoma, southward through eastern Texas to Victoria, Mexico.

This genus is here restricted to its type-species and one or more closely related species or subspecies occurring in NE Mexico at least as far south as Victoria.

Anisembia texana (Melander)

Embia texana Melander, 1902: 99, figs. 1, 2.—Friederichs, 1906: 238.

Anisembia texana (Melander) Krauss, 1911: 74, fig. F.—Chamberlin, 1923: 345.—Davis, 1940: 532.—Sanderson, 1941: 60 (record).—Shetlar, 1973: 205 (parasitoid).

Oligotoma texana (Melander) Enderlein, 1912: 92, 109, fig. 62.—Mills, 1932: 648, figs. 1–4.

Anisembia (*Anisembia*) *texana* (Melander) Ross, 1940: 650, figs. 20–22, 28; 1944: 445.

Diagnosis.—All nymphal stages and adults can be distinguished from other U.S. embiids by the pale intersegmental thoracic membranes. These are more evident as other body surfaces darken with maturity. Nymphs and adult females have pale coxae. Males have many distinctive features and in some regions may be invariably winged, in others winged or apterous, and in still others always apterous. Apterism appears to be more frequent, even universal, in more arid regions.

Anisembia texana was described from specimens collected under stones at

Austin, Texas in 1902. Since that time additional collecting indicates extensive habitat and geographic ranges. The species has been recorded from as far south as the Rio Grande River whence it extends south into Mexico, and as far north as southwestern Oklahoma and southern Arkansas and east to Vicksburg, Mississippi. In the more arid, hot, southwestern extremes of range, the species evades heat and dryness under stones and in soil cracks or under loose bark in shaded areas. Progressing northeast with the increasing rains of shaded hardwood forests, it adopts the less protected surface of the bark of trees and uses only superficial bark cracks as retreats.

It was thus collected at Texarkana, Texas, and at Monroe, Louisiana. In the latter locality, it was found to be very common on the shaded side of the larger shade trees (mostly oaks) bordering the city streets. As many as 50 separate colonies were observed on a single tree extending from the base to a considerable height. During mid-August each colony contained a single female and her brood of first and second instar young. No males were observed. Usually the only retreat was a slightly deeper bark crack from which radiated outward a system of galleries among the moss and lichens which comprise the food supply. Only alate males developed from these broods.

In the Wichita Mountains of SW Oklahoma, *texana* is very abundant on arid, south-facing slopes. Extensive galleries extend up the sides of stones from subterranean retreats. Only apterous males occur at this locality.

Genus *Dactylocerca* Ross, New Status

Anisembia (*Dactylocerca*) Ross, 1940b: 659.
Chelicerca (*Dactylocerca*) Ross, 1944: 454; 1957: 52.

Type-species.—*Anisembia* (*Dactylocerca*) *rubra* Ross, 1940, by original designation.

Distribution.—Mexican highlands northward into southwestern United States.

Diagnosis.—Males small, alate; jet-black to brown, but with prothorax and subterminal abdominal segments reddish. Head and mandibles small. Wings always present; small, slender. Terminalia exceptionally large—much larger than head; right hemitergite (10R) broadly-rounded caudally, bearing only an indefinite process represented only as a small, acute point (10RP) on right caudal arc; epiproct (EP) complex, heavily sclerotized, usually armed with basad-recurved spicules; hypandrium process (HP) expanded and arcuated caudally, its dorsal surface specially sclerotized, its membranous areas coarsely spiculate; left cercus without trace of a terminal segment, greatly elongated, tubular in shape, strongly arcuated or almost straight, inner apex bearing a few peg-setae.

Females small, slender; uniformly reddish in color.

Remarks.—*Dactylocerca* represents the greatest degree of anatomical complexity on the *Chelicerca* line. *Dactylocerca rubra* (Ross) is one of the most north-ranging, cold-enduring species of the order. It ranges over a wide area from central Utah and New Mexico to northwestern Baja California without apparent subspeciation. Its preferred habitat is juniper piñon pine zones. I have recently decided that populations occurring in southwestern Arizona and adjacent regions of northern Mexico represent a new species. Several undescribed additional species occur on the Mexican Plateau, at least as far south as the Lago Chapala region.

Dactylocerca rubra (Ross) New Combination
(Figs. 1–2)

Anisembia (*Dactylocerca*) *rubra* Ross, 1940: 659, figs. 35–37.
Chelicerca (*Dactylocerca*) *rubra* (Ross), 1944: 454; 1957: 52, fig. 3.

Distribution.—Mexico: NW Baja California, from coast to foothills of Sierra San Pedro Martir. California: from SW coast throughout S California mountains up to approximately 5000 ft level as far north as Tehachapi Mountains. Nevada: Yucca Flats, Nye Co. Utah: Dugway, Filmore and La Verkin. Arizona: Oracle (N side Santa Catalina Mts.); White Mts., 50 mi. S of Alpine in juniper zone. New Mexico: Winter Park, just W of Cloudcroft, Sacramento Mts., juniper-piñon zone.

This distinctive species may be recognized by reference to the accompanying figures. Its colonies occur under stones but these may actually be more generally distributed in the sod of grassy habitats. Rubra's rich pigmentation, and that of the following new species, suggest that males disperse diurnally.

Dactylocerca ashworthi Ross, New Species
Figs. 3–4

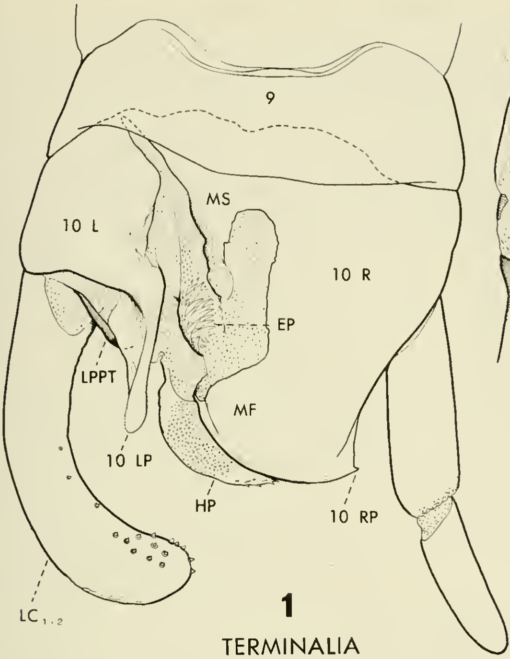
Holotype.—Male, on slide, deposited in the California Academy of Sciences, San Francisco. *Type data:* Arizona: Ridge S of Parker Cyn., W side of Huachuca Mts., Santa Cruz Co., 5600 ft, matured in culture May 3, 1977 (E. S. Ross).

Description.—Appearance: Similar to *rubra* but slightly darker overall; small, alate, black to dark brown except in the membranous and weakly sclerotized areas which are salmon-red. Color details (in alcohol): Cranium uniformly black, shining in spite of alutaceous surface. Eyes pink, lacking dark facet-interstices. Antennae blackish basally, brown distad, all membranes pink; 17-segmented, complete. Mouthparts dark brown. Thorax largely salmon-red except for dark brown scuta, pleurites and sternites of pterothorax; prothoracic and cervical sclerites dark brown; pronotum dark brown medially, blending to salmon-red laterally and in caudal angles. Legs uniformly dark brown except for pink membranes of basitarsus of forelegs. Wing bands medium brown; hyaline stripes narrow, sharply defined; costa and radius borders pink, the latter merging with costa well before wing apex. Abdomen salmon-red except for black terminalia sclerites. Dimensions (on slide): body length 6.5 mm; forewing length 3.5 mm, breadth 0.7 mm.

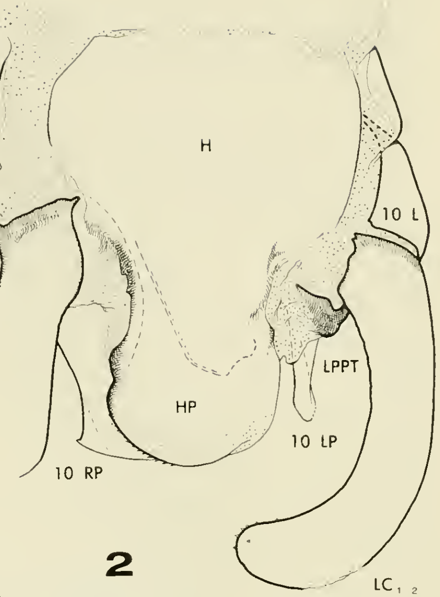
Important anatomical features: very similar to *rubra* except for terminalia, as follows: caudal arc of right hemitergite only half as long as in *rubra*; right process (10RP) larger than in *rubra*—a definite arcuated hook. Hypandrium process (HP) much narrower than in *rubra*. Left cercus (LC1+2) abruptly curved inward, instead of being evenly arcuated as in *rubra*; its apex bulbous.

⟶

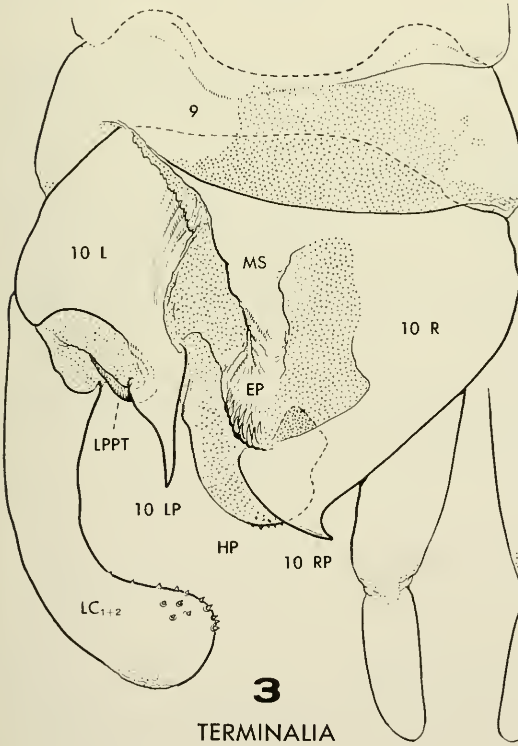
Figs. 1–4. Figs. 1–2. Abdominal terminalia of *Dactylocerca rubra* holotype. Figs. 3–4. Same for *Dactylocerca ashworthi* holotype. Not to scale, stippling represents membranous areas; setae omitted, except for peg-setae (echinulations) of left cercus. Explanation of symbols: 9 = ninth abdominal tergite, 10L and 10R = hemitergites of tenth segment, 10LP and 10RP = processes of these hemitergites; MS = medial sclerite of 10; EP = epiproct (segment 11); H = hypandrium (sternite 9), HP = process of H; LPPT = left paraproct; LC1+2 = composite left cercus.



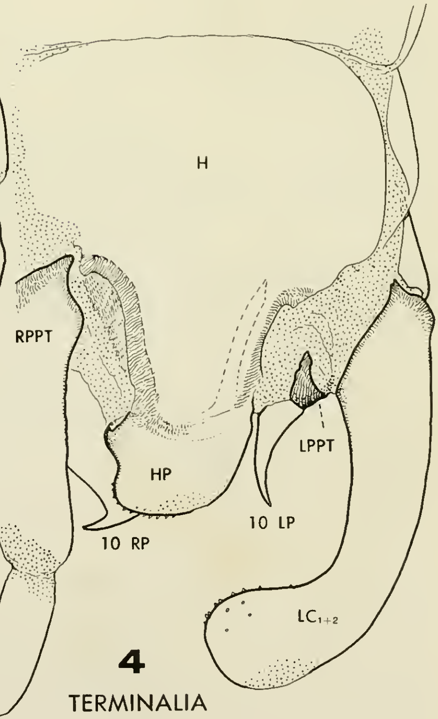
1
TERMINALIA
DORSAL



2
TERMINALIA
VENTRAL



3
TERMINALIA
DORSAL



4
TERMINALIA
VENTRAL

Allotype.—Female with type data and disposition. Uniformly reddish in color. Without apparent specific characters.

Paratypes.—Numerous topotypic adults to be deposited in major entomological museums.

Other specimens studied (except as indicated, all are in writer's collection, C.A.S.).—Arizona: Patagonia, Santa Cruz Co., matured in cultures during I, II, V, VIII, and IX, 1976 (E. S. Ross); Nogales, Santa Cruz Co., VIII-30-27 (J. C. Bradley); 6 mi NW of Nogales, VIII-16-50 (R. S. Beal); Pena Blanca, Atacosa Mts., Santa Cruz Co., 4000 ft, matured in cultures IX and X, 1976 (E. S. Ross); Santa Rita Mts., VI-21-36 (R. A. Flock). Mexico: 17 mi E Imuris, Sonora, 3800 ft, matured in culture XII-28-76, I-26-77 and VI-77 (E. S. Ross).

In addition to the above samples which are very similar to those of the type series, I have specimens from the southeastern portion of Cochise County, Arizona which are somewhat distinct, as follows: the caudal arc of 10R is longer; the hypandrium process (HP) is broader and has a small, fleshy, microspiculate lobe on the dorso-caudal angle and the left process (LC1+2) is less bulbous yet more abruptly curved inward than in *rubra*. Records of this variant are: Chiricahua R.R. Station (now abandoned), Cochise Co., open, grassy hillside, under stones after rains, males matured in culture III-65 (E. S. Ross, also P. H. Arnaud); 5 mi SW of Apache, Cochise Co., 4400 ft, males matured XII-15-60 (E. S. Ross); Cave Creek, Chiricahua Mts. (W of Portal), VII-4-40 (R. H. Beamer) (U. of Kansas); SW Research Station (W of Portal), IX-29-58 (H. V. Weems) (State Plant Board of Florida).

Discussion.—*Dactylocerca ashworthi* apparently is confined to mountainous habitats just north of the Mexican boundary in SE Arizona and thence occurs southward into Sonora. Strangely, *rubra* occurs in the nearby Santa Catalina and White Mountains, as well as far to the east in the Sacramento Mts. of New Mexico, in addition to its widespread occurrence in other regions of southwestern U.S.A.

Its habits are similar to those of *rubra*, colonies being most readily encountered beneath the edges of stones. Each colony consists of a single female and her brood with reproductive activity stimulated by the first rains of the summer season. Males, which mature mostly during September and October, disperse diurnally and thus may be collected by sweeping. They never fly to light.

Very often colonies are found under stones resting on litter beneath trees but at the type locality, and in the Apache region, the species occurs in treeless habitats—open grasslands with an abundance of stones.

This species named after Clifford Ashworth in recognition of his important support of scientific research.

Family Teratembiidae

This large family of delicate, small species is primarily Neotropical and Afrotropical, with a small representation in tropical Asia. The name is based on *Teratembia geniculata* Krauss, 1911, which was long known only from its unique, poorly-described type collected in Tucuman, Argentina. The writer has collected additional specimens and determined (1952) that the family name Oligembiidae, Davis 1940, is synonymous.

Five species of the widespread genera *Oligembia* Davis, and *Diradius* Friederichs occur within the United States and are keyed as follows:

KEY TO U.S. GENERA AND SPECIES OF TERATEMBIIDAE (MALES)

1. Left cercus-basipodite (LCB) with two, prominent inner lobes, or processes; the upper minutely furcated, the lower acutely pointed, or finely tapered. Right hemitergite (10R) with outer margin long, as long as tergal length; without furrow representing line of fusion with composite left hemitergite and medial sclerite (10L + MS). *Diradius* 3
– Left cercus-basipodite with only the upper, furcated lobe. Right hemitergite very small, short-sided; weakly defined by a shallow, diagonal furrow. *Oligembia* 2
2. Color pale, head golden, Florida, Bimini and Bahamas .... *hubbardi*
– Uniformly blackish. S Louisiana, SE Texas, NE Mexico .... *melanura*
3. Submentum with a lobe at each anterior angle; incisor arc of right mandible with a small but distinct, acute tooth. SE U.S.A. .... *vandykei*
– Anterior angles of submentum unlobed; incisor arc without a tooth 4
4. Lower lobe of left cercus-basipodite short, blunt. SE Texas, NE Mexico .... *lobatus*
– Lower lobe of left cercus-basipodite long, narrowly tapered to a fine point. S Florida, Cuba .... *caribbeanus*

Genus *Oligembia* Davis

Oligembia Davis, 1939: 217.—Ross, 1940: 636; 1944: 459; 1952: 226.

Type-species.—*Oligotoma hubbardi* Hagen, by original designation.

Distribution.—SE United States, southward throughout the Neotropical region. Absent in Old World.

Oligembia hubbardi (Hagen)

Oligotoma hubbardi Hagen, 1885: 152.—Schwarz, 1888: 94 (biol.).—Krauss, 1911: 44.—Enderlein, 1912: 91.

Embia (*Oligotoma*) *hubbardi* (Hagen) Melander, 1902: 21.

Oligembia hubbardi (Hagen) Davis, 1939: 218.—Ross, 1940: 637, figs. 5–7; 1944: 462, figs. 98–100.

Holotype.—Male, on slide, Museum of Comparative Zoology, Cambridge, Mass. *Type data:* Enterprise, Fla., May 24 (H. G. Hubbard).

Distribution.—Florida, including the Keys, S Bimini, and Bahamas.

This species occurs in bark flakes and crevices in many Florida localities and the pale males frequently fly to lights. Males of similar-appearing *Diradius vandykei* may easily be distinguished by the anterior lobes of the submentum, the attenuated second (lower) inner lobe of the left cercus-basipodite. *Diradius caribbeanus* also has the latter distinction.

Oligembia melanura Ross

Oligembia melanura Ross, 1944: 470, figs. 118–120: 499.

Holotype.—Male, on slide, deposited in the National Museum of Natural History, Washington, D.C. *Type data:* New Braunfels, Texas, Aug. 20, 1942 (E. S. Ross).

Distribution.—Probably throughout the Gulf Coast lowlands from New Orleans through post oak zone of Texas and southward into Mexico.

Adults of *melanura* are readily recognized by their blackish appearance. Colonies are found beneath bark flakes of many types of trees in very distinct habitats. Just north of New Orleans the writer frequently found colonies in bald cypress bark in swamps and that of oaks bordering streets within the city of New Orleans. It is doubtful if the species occurs in mesquite-cactus habitats of Texas. It, and close relatives, are found in many Mexican localities. In the central highlands, colonies are encountered beneath stones.

Genus *Diradius* Friederichs

Diradius Friederichs, 1934: 419.—Davis, 1940: 528.—Ross, 1944: 493.

Oligembia (*Dilobocerca*) Ross, 1944: 476 (type species: *Oligembia* (*Dilobocerca*) *lobata* Ross, by orig. designation). New Synonym.

Type-species.—*Diradius pusillus* Friederichs.

Distribution.—Neotropical and West African.

During 1964 the writer collected and studied topotypic specimens of the type species in SE Brazil and determined that the holotype of *pusillus* has anomalous wing venation and that the subgenus *Dilobocerca* Ross, of *Oligembia*, is synonymous. Based on knowledge of many new species, it is now concluded that *Diradius* deserves full generic status.

Diradius lobatus (Ross), New Combination

Oligembia (*Dilobocerca*) *lobata* Ross, 1944: 477, figs. 127–129.

Holotype.—Male, on slide, deposited in the National Museum of Natural History, Washington, D.C. *Type data:* Texas: Palm Grove, Brownsville, Sept. 29, 1942 (E. S. Ross).

Males of this species are readily distinguished from the two other U.S. *Diradius* by the shorter and blunter lower lobe of the left cercus-basipodite, as well as numerous other characters. It is the most northerly of a large, difficult complex of species and/or races which occur throughout lowland Mexico, Central America, and N South America. Its colonies were found in bark crevices of trees and dead stumps. Perhaps its U.S. occurrence is limited to the "tropical" habitats near the mouth of the Rio Grande.

Diradius caribbeanus (Ross) New Combination

Oligembia (*Dilobocerca*) *caribbeana* Ross, 1944: 492, figs. 154–156.

Holotype.—Male, on slide, deposited in the National Museum of Natural History, Washington, D.C. *Type data:* Cuba: Cayamas, Santa Clara, on dead vines, March 11, 1911 (E. A. Schwarz).

This species has recently been collected on the Florida Keys (Crane Keys, Johnston Key, Galdin Key, Mud Keys, Squirrel Key, Whiting Key, Rattlesnake Lumps and Inner Narrows) during June–August, 1969–70 by Drs. E. O. Wilson, D. Simberloff and S. Peck. Mixed in the various lots were specimens of *Oligembia hubbardi* and *Diradius vandykei*. It is likely that these species are blown about in hurricanes in silk-secured colonies in crevices of small dead branches and other debris.

From *vandykei,* which also has an attenuated lower left cercus-basipodite lobe, *caribbeanus* is easily distinguished by an absence of lobes on the anterior angles of the submentum of adult males.

Diradius vandykei **(Ross), New Combination**

Oligembia (*Dilobocerca*) *vandykei* Ross, 1944, p. 488, figs. 151–153.

Holotype.—Male, on slide, deposited in the National Museum of Natural History, Washington, D.C. *Type data.*—Florida: 5 mi. NE Pensacola, shores of Escambia Bay, matured in culture III-10-43 (E. S. Ross).

Distribution.—Gulf Coast Plain (prob. from S Mississippi to Florida): Florida, incl. Keys; coastal plains and lower Piedmont of Georgia, S. Carolina, N. Carolina and SE Virginia.

Males of this very distinct species are readily distinguished by the presence of a medial tooth in the incisor arc of the right mandible, and the broad submentum with a lobe at each anterior angle. There are other distinctions in the mandibles and terminalia.

Colonies are obscure, but common, in bark flakes of trees—most noticeably on the trunks of shade trees in small towns. Specimens from the Florida Keys are smaller and paler than those from northern localities which tend to have a two-tone cranium—the caudal half brown, the anterior golden-brown. It is possible that future studies will reveal the existence of races.

FAMILY OLIGOTOMIDAE

Except for the genus *Haploembia* of the Mediterranean region, oligotomids are endemic to Asia and Australia. Several species, however, even within the family's region of endemicity, are "weeds" distributed in human commerce. Four species of the family are now established within the United States.

Oligotoma saundersii **(Westwood)**

This is the most widespread species of the order and is likely to be found in any warm region of the world, especially in and around human settlements. Males frequently are attracted to light. It is very common in Florida and Texas and may occur, particularly near port cities, along the entire Gulf coast. It should eventually establish itself in other warm habitats, such as California. It is the most common species in Hawaii.

Males are readily recognized by their oligotomid wing venation (MA unforked), dentate mandibles, sclerotic submentum; the broad spatulate left tergal process (10LP), and the sickle-shaped horizontal hook beneath the apex of the hypandrium lobe (HP).

Oligotoma nigra **(Hagen)**

Oligotoma nigra is very common in the Middle East, Pakistan and northern India (the endemic center of *Oligotoma*). Perhaps during the 1880's it was accidentally introduced into the USA in date palm cuttings and has since become very common in southern California, southern Utah (Zion Natl. Pk.), Arizona, perhaps New Mexico, and it has recently appeared in the San Antonio region of Texas. Like *saundersii, nigra* should steadily increase its range, especially in semi-arid regions. Males commonly fly to lights.

Males are very similar to those of *saundersii* but distinguished by the slender left tergal process and talon-like ventrally directed hook on the left side of the apex of the hypandrium process.

Aposthonia oceania (Ross)

Oligotoma (*Aposthonia*) *oceania* Ross, 1951, p. 307, fig. 1. (Holotype, Bishop Mus., Fatu Hiva, Marquesas Islands).

This species, which is related to SE Asian species, apparently was brought to many islands of the Pacific, including Easter Island and New Caledonia during the ancient movements of Polynesians. It perhaps occurs on all of the Hawaiian islands, including the small, remnant islands of the northwest. The writer found the species exceptionally common in rather dry trail bank crevices in Oahu's Aeia Heights (State Park) above Pearl Harbor. D. E. Hardy collected the species at Kainalu, Molokai, 1500–2000 ft, under lichens and moss on scrubby ohia lehua (*Metrosideros collina*) IV-9-63. It should be noted, however, that embiids never have specific associations with host plants.

From the only other Hawaiian embiid, *O. saundersii*, males of *oceania* can be distinguished by the lack of a complete, ring-like, left cercus-basipodite and absence of large, horizontal, sickle-shaped process beneath the apex of the hypandrium lobe.

Haploembia solieri (Rambur)

This Mediterranean species, more fully treated in Ross (1957, 1966), was long ago introduced into California where it is now exceedingly common under stones, particularly in oak-grass habitats. It has spread into southern Oregon (Grants Pass), southern Utah (St. George), Arizona, and Texas (Kimble Co. and Alpine). All such populations are parthenogenetic, as are those of North Africa and many adjacent European regions.

Recently, however, a bisexual population (typical *solieri*) was discovered in Redwood City, California and its spread has not yet been determined. I believe that this is a new introduction from the Mediterranean region. It is possible that the parthenogenetic form is a distinct species for it is more lightly pigmented, has egg-form distinctions, and no sexual relationships with males of typical *solieri*.

All instars of *Haploembia* can be distinguished from all other U.S. embiids by the presence of a second (medial) ventral papilla on the hind basitarsus.

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A TAXONOMIC STUDY OF THE ARMORED SCALE *PSEUDISCHNASPIS* HEMPEL (HOMOPTERA: COCCOIDEA: DIASPIDIDAE)[1]

DOUGLASS R. MILLER, JOHN A. DAVIDSON, AND MANYA B. STOETZEL

(DRM,MBS) Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, Beltsville, Maryland 20705; (JAD) Department of Entomology, University of Maryland, College Park, Maryland 20742.

Abstract.—The genus *Pseudischnaspis* includes two species, *P. acephala* Ferris and *P. bowreyi* (Cockerell). *Pseudischnaspis longissima* (Cockerell) is treated as a junior, subjective synonym of *P. bowreyi* for the first time. Lectotypes are designated where necessary. Descriptions and illustrations are given of the adult females of each species and of the first instar and adult male of *P. bowreyi.*

While preparing a description of *Pseudischnaspis bowreyi* (Cockerell) as part of a study on the economic scale insects of the United States, we discovered some conflicts between the current concepts of species in *Pseudischnaspis* and the actual identity of type specimens. The purpose of this paper is to redescribe each of the two known species (*P. acephala* Ferris and *P. bowreyi*), to place *P. longissima* (Cockerell) as a junior, subjective synonym of *P. bowreyi,* and to provide a key for the identification of the two species in the genus.

METHODS

Terminology used in the description of the first instar is that of Stoetzel and Davidson (1974b) and Howell and Tippins (1977). We have adhered to the usage of Ghauri (1962) in the male description. In the adult female we have used the terms "first space," "second space," and "third space" to refer to the interlobular area between the median lobe and lobe 2, lobe 2 and lobe 3, and lobe 3 and projections representing lobe 4, respectively.

Descriptions are based on 10 specimens from as many localities and hosts as possible. If fewer specimens were studied, we have so stated at the end of the description. We arrived at conclusions on the morphology of adult males of *Melanaspis aliena* (Newstead) based on two poor specimens, and of *M. obscura* (Comstock), *M. smilacis* (Comstock), and *M. tenebricosa* (Comstock), each based on 10 excellent specimens. Descriptions of first instars of *Pseudischnaspis bowreyi* and *Melanaspis aliena* are based on embryos; comparisons with the crawlers of *M. obscura, M. smilacis,* and *M. tenebricosa* are based on at least 10 excellent

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specimens collected outside of the body of the female. Numerical values are given as a range followed by an average in parentheses (rounded off to the nearest whole number). Statistical significance was determined by use of the student's t-test. Descriptions and illustrations were made using a Zeiss, Phase-Contrast Microscope with 10× eyepieces and 16×, 40×, and 100× objectives. The adult male was drawn using a zoom camera lucida attachment on a Wild, Phase-Contrast Microscope with 15× eyepieces and 10× and 20× objectives.

RESULTS

Pseudischnaspis **Hempel**

Pseudischnaspis Hempel, 1900: 506.

Type species.—*Pseudischnaspis linearis* Hempel, 1900 (= *P. bowreyi* (Cockerell 1893)) by original designation and monotypy.

Slide mounted characters.—The following characters occur in each species of *Pseudischnaspis* and are unique or unusual to *Pseudischnaspis* or to *Pseudischnaspis* and closely related genera.

Adult female with 3 pairs of definite lobes, area anterior of lobe 3 with series of lobelike projections; paraphysis formula usually 2-2-1, some specimens with small paraphysis attached to medial margin of lobe 3 making formula 2-3-1. Median lobe without basal sclerosis or yoke, medial margin axes parallel, lateral margins rounded, with distinct paraphysis attached to medial margin; second and third lobe simple; second lobe wider than median lobe, third lobe slightly wider than second lobe. Plates often difficult to see, with orifice of microduct at apex, posterior plate in third space represented by single narrow tine, with simple plates interspersed among projections on lateral margin of segment 5, with 2 simple plates between median lobes ½ to equal to length of lobe. Macroducts of 2 distinct sizes, larger size located posterior of anal opening, becoming slightly smaller anteriorly, smaller size located near to or attached to narrow sclerotized area laterad of anal opening and on lateral margin of segment 4. Microducts on venter elongate, in marginal or submarginal areas of head and in submedial areas near mouthparts; microducts on dorsum shorter than those on venter. Perivulvar pores in 4 or 5 loose clusters. Perispiracular pores absent.

Dorsal seta laterad of median lobes ½–¾ length of lobe. Eyes absent. Head usually with 1 or 2 tubercles in form of low dome or with apical point. Body oval in newly matured adult females, elongate in older adult females. Antenna with 1 long seta and 1 sensillum.

We have not discussed generic characters of adult males and first instars because sufficient data and specimens were unavailable.

Discussion.—Species of *Pseudischnaspis* are very similar to some species of *Melanaspis* Cockerell and very probably these species should be considered as congeneric. The only consistent difference in the adult female is the shape of the body; old adult females of species of *Pseudischnaspis* are noticeably elongate with the lateral body margins nearly parallel; old adult females of species of *Melanaspis* are round or oval with the body margins convex. Specimens of *Melanaspis aliena* and *Pseudischnaspis bowreyi* are indistinguishable except for the body shape in old adult females. These species seem to differ also in the distribution and abundance of the ventral microducts, but these differences are overlapping and have a large variance.

Table 1. Comparison of 5 characters between *Pseudischnaspis acephala* Ferris and *P. bowreyi* (Cockerell). For each character, differences between species were detected with a student's *t*-test. For each species significant differences were found for number of perivulvar pores, number of macrotubular ducts, number of macrotubular ducts in subunits of the second space, and the distance between the anal opening and the median lobes.

Character	Species	Mean	±Standard error	n	*t*-test value	Level of significance
No. perivulvar pores	acep.	10.55	0.48	40	22.25	$P < .001$
	bow.	23.14	0.73	50		
No. macroducts on pygidium	acep.	22.47	0.23	40	12.62	$P < .001$
	bow.	29.26	0.44	50		
No. macroducts between lobe 3 and interlobular paraphysis	acep.	4.32	0.06	80	16.92	$P < .001$
	bow.	6.31	0.09	100		
No. macroducts as above and anterior of paraphysis apices	acep.	2.25	0.06	80	14.48	$P < .001$
	bow.	4.04	0.10	100		
Distance between anal opening and median lobes	acep.	90.03	1.04	40	12.99	$P < .001$
	bow.	121.82	1.12	50		

We could find no morphological differences in the first instar of *Melanaspis aliena* and *Pseudischnaspis bowreyi.* We note an unusual amount of similarity among the crawlers of the above mentioned species and *Melanaspis smilacis.* These similarities are not shared by *M. obscura* and *M. tenebricosa* (for details see the discussion section of the first instar of *Pseudischnaspis bowreyi*).

In the adult male there is one noticeable difference between *M. aliena* and *Pseudischnaspis bowreyi.* It is interesting that like the first instars, the adult males of *Melanaspis smilacis* share several apparently apomorphic features with *M. aliena* and *Pseudischnaspis bowreyi* (for details see the discussion section of the adult male of *P. bowreyi*).

KEY TO SPECIES OF *PSEUDISCHNASPIS* (ADULT FEMALES)

1. With 8–13(11) perivulvar pores; usually with 4 or 5(4), rarely 6, macroduct orifices in row beginning between medial margin of third lobe and interlobular paraphysis in second space (Fig. 1B); distance between posterior apex of anal opening and base of median lobes 59–123(90) μ, rarely over 101 μ .... *acephala* Ferris
– With 13–31(23) perivulvar pores; usually with 5–7(6), rarely 4, 8, or 9, macroducts orifices in row beginning between medial margin of third lobe and interlobular paraphysis in second space (Fig. 2B); distance between posterior apex of anal opening and base of median lobes 91–143(122) μ, rarely under 103 μ .... *bowreyi* (Cockerell)

Pseudischnaspis acephala Ferris

Pseudischnaspis acephala Ferris 1941: 382.

Suggested common name.—Flatheaded scale.

Type material.—Through the courtesy of Raymond J. Gill, Department of Food and Agriculture, Sacramento, California, and Robert O. Schuster, Department of Entomology, University of California, Davis, (UCD), we have examined the syntype series of this species. We have selected an adult female mounted on a slide with another adult female labeled as follows: Right label "Pseudischnaspis/*acephala* Ferris/On Cavendishia/Type/Boquete/Chiriqui Province,/Panama/Ferris 1938 no. 62"; left label "LECTOTYPE/Pseudischnaspis/acephala Ferris/PARALECTOTYPE/desig. Miller, Davidson, & Stoetzel, 1984." The specimen on the right is the lectotype and a map is given on the slide showing the position of the primary type; it is deposited at UCD. In addition to the 2 specimens mentioned above there are 3 additional slides containing the following paralectotypes: 6 adult females, 4 second instar exuviae, 4 first instar exuviae, and 1 first instar; all are deposited at UCD. A single slide containing 2 adult female paralectotypes is deposited in the U.S. National Museum of Natural History Collection, Beltsville, Maryland (USNM).

Field characters.—Adult female cover black, elongate, and narrow; exuviae terminal, black. Ventral cover thick, well developed. Male cover similar in texture and color to female cover but shorter. Occurring on underside of leaves and on fruit (Ferris 1941).

Adult Female

Fig. 1

Description.—Lectotype with area anterior of lobe 3 with 5 lobelike projections (other specimens with 4–6(5) projections). Median lobes separated by space 0.5 × width of median lobe (other specimens 0.4–0.7(0.5) ×), with 1 or 2 lateral notches, without medial notch (other specimens with or without 1 medial notch); second lobe with 2 and 3 lateral notches (other specimens 2–3(2) notches), without medial notch; third lobe with 4 and 5 lateral notches (other specimens 2–5(4) notches), without medial notch. Plate formula 2-3-4 (other specimens usually 2-3-3, sometimes 2-2-3 or 2-2-2). Macroduct between median lobes 1.0 × as long as distance between base of median lobe and posterior apex of anal opening (other specimens 0.9–1.4(1.1) ×); macroduct in first space 105 μ long (other specimens 85–132(109) μ), with 22 large macroduct orifices on pygidium (other specimens 19–26(23) orifices), with 4 macroduct orifices in row beginning between median margin of lobe 3 and interlobular paraphysis in 2nd space (other specimens with 4–6(4) orifices) (Fig. 1B), with 2 macroduct orifices in same row of macroducts anterior of imaginary line drawn between anterior apex of paraphysis attached to lateral margin of lobe 3 and anterior apex of interlobular paraphysis in 2nd space (Fig. 1C) (other specimens with 1–3(2) orifices). Pygidial microducts in clusters on venter of segment 5 with 7 ducts in each cluster posterior of seta marking segment 4 (other specimens with 5–9(7) ducts); prepygidial microducts on venter in marginal or submarginal areas of head (other specimens on head or head and prothorax) and on segments 3 and 4 (rarely with 1 or 2 on segment 2), in submedial areas around mouthparts, anterior of anterior spiracle, and on metathorax (other specimens with microducts also anterior of anterior spiracle and in submedial areas of metathorax, segments 1–2); prepygidial microducts on dorsum in submarginal areas of prothorax to segment 2 (other specimens with dorsal microducts on prothorax or mesothorax to segment 1, 2, or 3). Perivulvar pores total 13 (other specimens 8–13(11) pores). Anal opening located 97 μ from posterior apex of anal opening to base of median lobes (other specimens 59–123(90), anal opening located 9 × length of anal opening from posterior apex of anal opening to base of

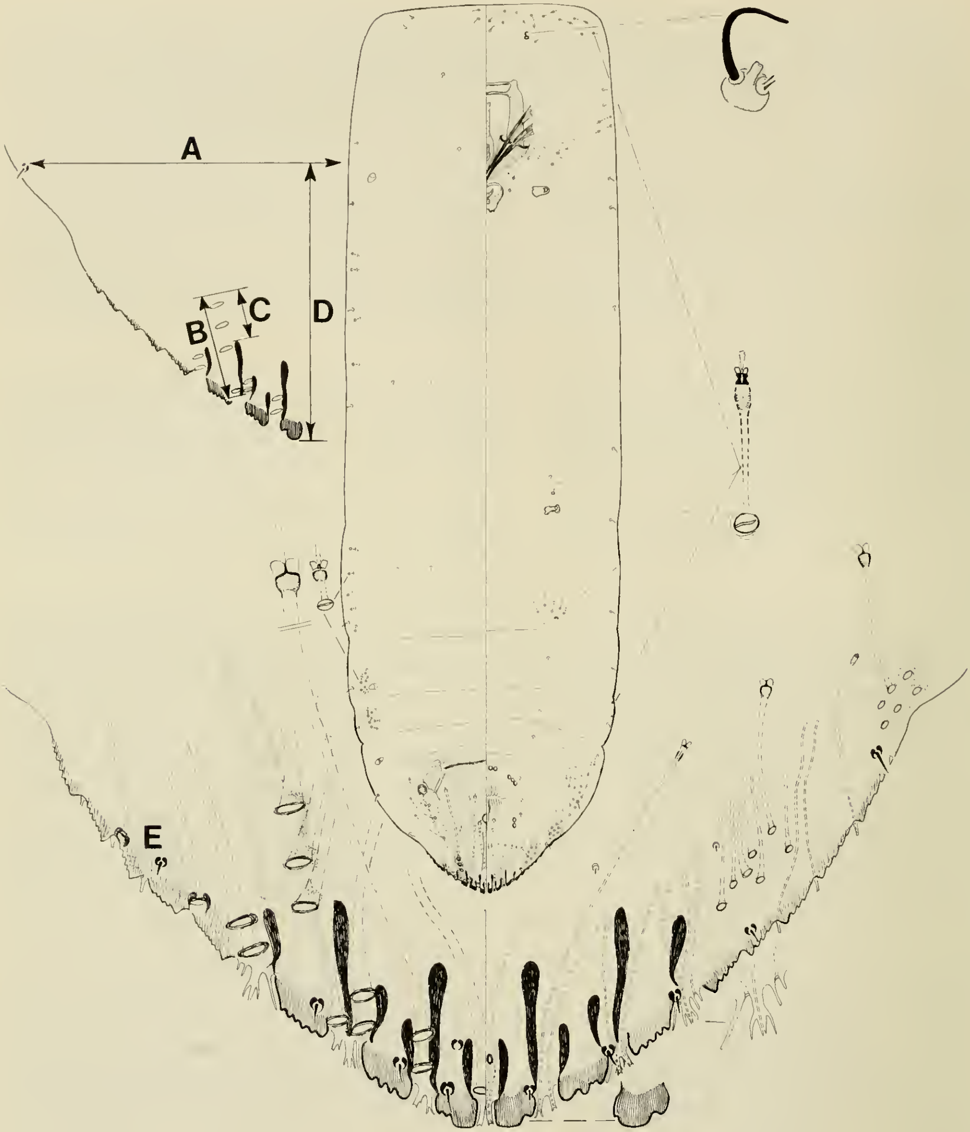

Fig. 1. A to E, *Pseudischnaspis acephala* adult female, 1938, Panama, Chiriqui Prov., ex. *Cavendishia* (Lectotype).

median lobes (other specimens 6–15(8) ×), anal opening 11 μ long (other specimens 7–17(13) μ). Marginal area of each side of segment 5 with 2 clusters of ventral microducts on sclerotized areas (other specimens with or without these areas). Pygidium usually relatively broad, ratio of distance of imaginary line drawn between bases of dorsal setae on lateral margin of segment 4 (Fig. 1A) divided by line drawn from midpoint of same imaginary line to posterior apex of median lobes (Fig. 1D) 2.4 units (other specimens 1.8–2.6(2.4) units). Apex of head rectangular with rounded lateral angles (some other specimens with nearly 90° angles). Dorsal sclerotized area adjacent to lobelike projections on segment 5 relatively small.

FIRST INSTAR

Description.—We have examined 4 embryos of this species and could find no differences compared with the crawler of *P. bowreyi* (see "First Instar" in the treatment of *P. bowreyi*).

Discussion.—*Pseudischnaspis acephala* is separated from *P. bowreyi* by having: 8–13(11) perivulvar pores; 4–6(4), macroduct orifices in row beginning between medial margin of 3rd lobe and interlobular paraphysis in 2nd space (Fig. 1B); 1–3(2) macroduct orifices in same row located anterior of imaginary line drawn between anterior apex of paraphysis attached to lateral margin of 3rd lobe and anterior apex of interlobular paraphysis in 2nd space (Fig. 1C); 19–26(23) large macroducts on pygidium; elongate, ventral microducts usually on submarginal areas of segments 3 and 4 only, rarely with 1 or 2 ducts on segment 2; distance from posterior apex of anal opening to base of median lobes 59–123(90) μ; relatively small sclerotized area adjacent of lobelike projections on segment 5 (Fig. 1E); 5–9(7) microducts in each cluster on sublateral area of segment 5 posterior of ventral seta marking segment 4; *P. bowreyi* has 13–31(23) perivulvar pores; 4–9(6), usually 5–7, macroducts in row mentioned above (Fig. 2B); 2–7(4) macroducts anterior of imaginary line described above (Fig. 2C); 25–36(29) large macroducts on pygidium; elongate, ventral microducts in band on submarginal areas of mesothorax, metathorax, segment 1, or segment 2 to segment 4; distance from posterior apex of anal opening to base of median lobes 91–143(122) μ; relatively large sclerotized area adjacent of lobelike projections on segment 5 (Fig. 2E); 6–14(9) microducts in each cluster on sublateral area of segment 5 posterior of ventral seta marking segment 4. See Table 1 for a statistical analysis of the above numerical data.

Specimens examined.—In addition to the 19 type specimens mentioned earlier, we examined 48 specimens on 22 slides as follows—MEXICO: On *Chamaedorea* sp., VII-19-1976, R. Park; on *Citrus aurantifolia*, XI-2-1956, Gondeck, CENTRAL AMERICA: Canal Zone-Frijoles, on *Persea* sp. (avocado); V-23-1919, H. F. Dietz, J. Zetek, I. Molino. El Salvador—on *Mangifera indica*, VII-20-1946, Cranford. Nicaragua-Managua, on *Anacardium* sp. (cashew) and *Citrus* sp., IV-28-1959, T. Sequeira; Managua, on palm and *Narcissus* sp., V-5-1959, F. Perez; La Calera, on *Coffea* sp. (coffee), VI-1-1959, R. Bodan. Panama-Anton, on *Cocos* sp. (coconut), IV-1924, J. Zetek. SOUTH AMERICA: Columbia-Espinal, on *Mangifera indica*, II-8-1972, H. E. Martin and F. Mosquera; Fusagasuga, on ornamental palm and ornamental plant, VIII-17-1971, F. Mosquera. Peru-Uchumayo, on *Citrus medica*, VI-18-1919, Bwes.

***Pseudischnaspis bowreyi* (Cockerell)**

Aspidiotus bowreyi Cockerell 1893: 383.
Aspidiotus (*Chrysomphalus*) *bowreyi* Cockerell 1897: 23.
Chrysomphalus bowreyi (Cockerell): Leonardi 1899: 220.
Pseudischnaspis bowreyi (Cockerell): Cockerell 1901: 64.
Aspidiotus (*Chrysomphalus*) *longissima* Cockerell 1898: 439. NEW SYNONYMY.
Chrysomphalus longissimus (Cockerell): Leonardi 1900: 342.
Pseudischnaspis longissima (Cockerell): Cockerell 1901: 64.
Aspidiotus longissima Cockerell: Cockerell 1905: 45.

Pseudischnaspis linearis Hempel 1900: 506.
Aspidiotus linearis (Hempel): Ferris 1941: 45.

Suggested common name.—Bowrey scale.

Type material.—We have examined the syntype series of *Aspidiotus bowreyi* and here designate as lectotype an adult female mounted alone on a slide labeled as follows: Left label "*Aspidiotus* bowreyi/Ckll./ON *Agave rigida*/Hope, Jamaica/Bowrey, Coll. Ckll. Coll./#7831/from Type Material."; right label "LECTOTYPE/Aspidiotus/bowreyi (Ckll.)/desig. by/Miller/Davidson & Stoetzel 1984." The paralectotypes include 1 adult male on 1 slide, 3 second instars and 2 adult females on 1 slide, 2 second instars and 2 adult females on 1 slide, 1 adult female on 1 slide, and 3 adult females on 1 slide. There is a single slide from the type series that contains a scale cover.

We also have examined the syntype series of *Pseudischnaspis longissima* and here designate as lectotype an adult female mounted singly on a slide labeled as follows: Left label "7973./A. longissimus Ckll/(*Type*)/Mango./Frontera, Tab. Mex./June 28 '97."; right label "LECTOTYPE/Aspidiotus/longissima/Cockerell/desig. by/Miller/Davidson & Stoetzel 1984." The paralectotypes include 1 first instar on 1 slide, 1 second instar on 1 slide, 1 adult female and 1 second instar female on 1 slide, and 3 adult females on 3 slides. In addition 3 slides contain 12 scale covers that were collected at the same time as the type series. We also have examined specimens labeled as "cotype material" of *Pseudischnaspis linearis* Hempel and here designate as lectotype an adult female mounted singly on a slide labeled as follows: "*Pseudischnaspis/linearis* Hempel/Cotype/Ypiranga, Brazil/A. Hempel,/let. Apr. 28, 1900/Hempel # 79"; right label "LECTOTYPE/Pseudischnaspis/linearis/Hempel/desig. by/Miller/Davidson &/Stoetzel 1984." The original description gives the host as *Myrcia.* The paralectotypes include 1 2nd instar on 1 slide. All material in this section is in the USNM.

Field characters.—Adult female cover black with blue or purple tinge; cover of newly molted adult female nearly circular; cover of more mature adult female elongate oval with approximately parallel sides. Ventral cover well developed. Male cover similar in texture to female cover except smaller and narrower. Infestations occur on bark and leaves (Ferris 1941).

Adult Female

Figs. 2–3

Description.—Lectotype adult female of *Pseudischnaspis bowreyi* with area anterior of lobe 3 with 5 lobelike projections (other specimens with 4 or 5 projections). Median lobes separated by space 0.6× width of median lobes (other specimens 0.3–0.7(0.5)×), with 1 lateral notch on specimens without worn lobes, without medial notch; second lobe with 2 lateral notches (other specimens 2–3(2) notches), without medial notch; third lobe with 4 lateral notches on 1 side, 5 on other (other specimens 3–5(4) notches), without medial notch (other specimens rarely with 1 medial notch). Plate formula not clear on lectotype (other specimens usually 2-3-3, sometimes 2-2-3 or 2-2-2). Macroduct between median lobes unclear on lectotype (other specimens with macroduct between median lobes unclear on lectotype (other specimens with macroduct between median lobes 1.0–1.2(1.0) times as long as distance between base of median lobe and posterior apex of anal opening); macroduct in first space unclear on lectotype (other specimens with this

Fig. 2. A to E, *Pseudischnaspis bowreyi* adult female, VIII-19-1976, Guatemala, ex. bromeliad.

macroduct 107–170(149) μ long), with 31 large macroduct orifices on pygidium (other specimens 25–36(29) orifices), with 7 macroduct orifices in row beginning between medial margin of lobe 3 and interlobular paraphysis in second space (other specimens with 4–9(6) orifices) (Fig. 2B), with 5 macroduct orifices in same row of macroducts anterior of imaginary line drawn between anterior apex of paraphysis attached to lateral margin of lobe 3 and anterior apex of interlobular paraphysis in second space (Fig. 2C) (other specimens 2–7(4) orifices). Pygidial microducts in cluster on venter of segment 5, with 7 and 9 ducts in each cluster posterior of seta marking segment 4 (other specimens with 6–14(9) ducts); pre-

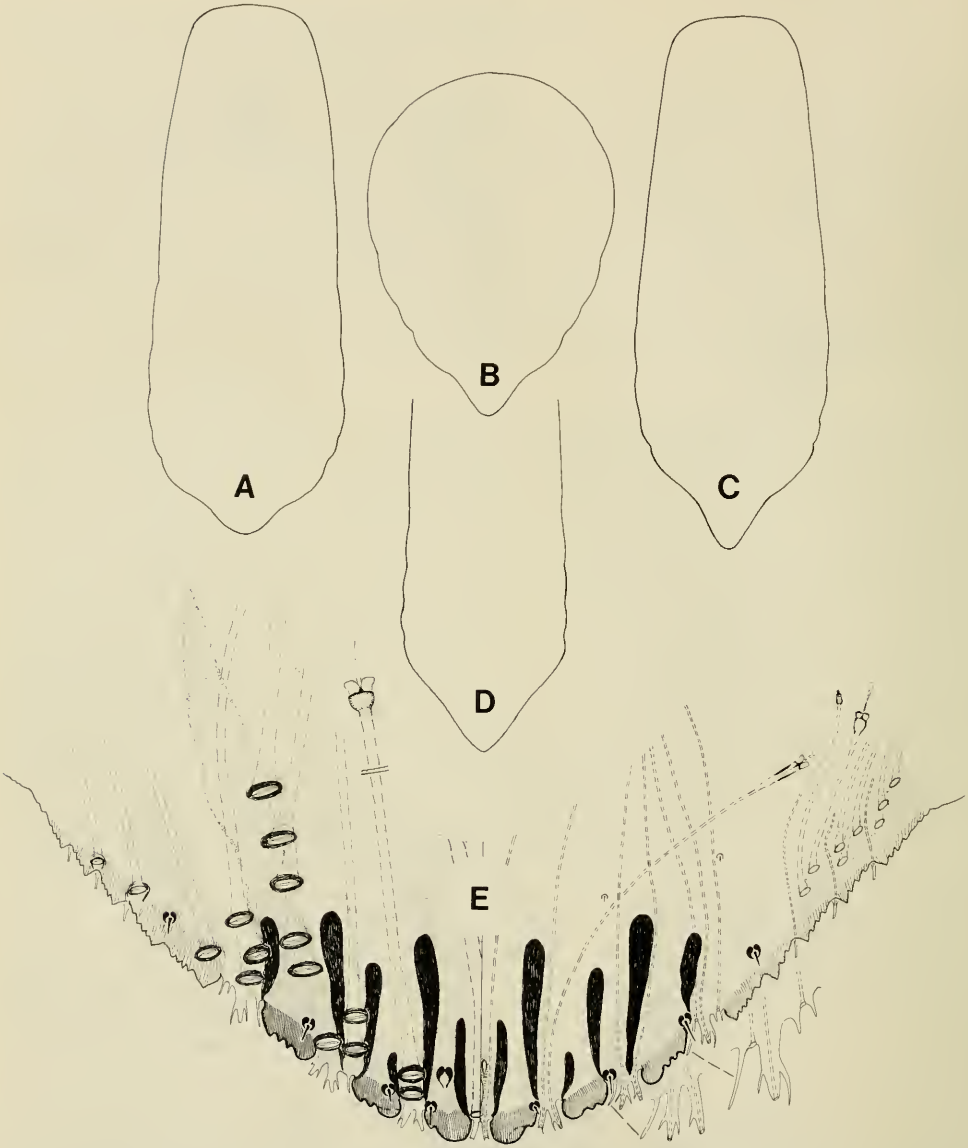

Fig. 3. A and E, *Pseudischnaspis bowreyi* adult female, VI-28-1897, Mexico, Frontera, Tab., ex. *Mangifera*. B, Adult female, I-24-1945, Peru, Lima, ex. "long green plum." C, Adult female, IV-20-79, Mexico, ex. Orchidaceae. D, Adult female, V-15-1973, Colombia, Cachipay Cund., ex. *Pyrus*.

pygidial microducts on venter in marginal or submarginal areas of head (some other specimens with microducts on head and prothorax) and on submarginal areas of metathorax to segment 4 (other specimens with microducts on mesothorax, metathorax, segment 1, or segment 2 to segment 4), in submedial areas around mouthparts, anterior of anterior spiracle, anterior of posterior spiracle and on metathorax (other specimens with submedial ducts on metathorax, segment 1 and sometimes on segments 2 and 3); prepygidial microducts on dorsum in submarginal areas of prothorax to segment 2 (other specimens with dorsal microducts on prothorax or mesothorax to segment 1, 2, or 3). Perivulvar pores total 26 (other specimens 13–31(23) pores). Anal opening located 110 μ from posterior apex of anal opening to base of median lobes (other specimens 91–143(122) μ), anal opening located 6× length of anal opening from posterior apex of anal opening to base of median lobes (other specimens 6–11(9)×), anal opening 18 μ long (other specimens 11–20(15) μ). Marginal area of each side of segment 5 usually with only single cluster of ventral microducts, ducts on sclerotized area (other specimens with or without sclerotized area). Pygidium usually relatively narrow, ratio of distance of imaginary line drawn between bases of dorsal setae on lateral margin of segment 4 (Fig. 2A) divided by line drawn from midpoint of same imaginary line to posterior apex of median lobes (Fig. 2D) 2.2 units (other specimens 1.4–2.4(1.9) units). Apex of head usually broadly rounded. Dorsal sclerotized area adjacent to lobelike projections on segment 5 relatively large (Fig. 2E).

Discussion.—*Pseudischnaspis bowreyi* is morphologically diverse, particularly in body and pygidial shape (Fig. 3, A–D), but seems to be a single variable species. We were somewhat dismayed when we examined the type series of *P. longissima*, because specimens in the series have a very broad pygidium (Fig. 3, A and E) and 2 distinct clusters of ventral microducts on the submarginal areas of segment 5. These states are quite different from their homologues in the type series of *P. bowreyi*. However, after studying more than 250 specimens of *P. bowreyi* and "*P. longissima*" we could find no consistent difference. Further, we were unable to find any combination of characters that might be used to distinguish these 2 hypothesized taxa. For a comparison of *P. bowreyi* with *P. acephala* see the discussion section of *P. acephala*. The specimen illustrated is not part of the type series of *P. bowreyi* but has been compared with the type and is conspecific with *P. bowreyi*.

First Instar

Fig. 4

Description.—Mounted, 0.2–0.3(0.2) mm long, 0.1–0.3(0.2) mm wide. Dorsum with setae and ducts as illustrated. Pygidium with 2 large lobes and 2–3(3) additional fringed, lobelike structures associated with marginal ducts; 2nd lobe with 2–3(3) notches; 3rd lobe with 2–5(3) notches. Plates between median lobes relatively conspicuous, with 5–6(5) tines; 2 plates between lobes 2 and 3 each with 2–4(3) tines. Posterior marginal ducts conspicuously larger than others, duct between 2nd lobes 25–30(28) μ long, duct anterior of 3rd lobe 11–15(12) μ long. Anal opening 5–7(6) μ long, distance from posterior apex of anal opening to base of 2nd lobes 20–30(25) μ, distance from anal opening to base of 2nd lobes/length of anal opening 3.3–5.0(4.2).

Venter with long apical seta 35–70(48) μ long. Area between antennae with 0–2(1) sclerotized tubercles. Legs with hind trochanter + femur 25–43(33) μ long, tibia + tarsus (excluding claw) 18–28(22) μ long; trochanter + femur/tibia + tarsus 1.4–1.9(1.5); tarsi of male with sensillum; each tarsus and claw with 2 capitate setae extending to or beyond claw apex. Antenna 5-segmented, 70–90(78) μ long, apical segment 45–58(53) μ long; antennal length/apical segment 1.3–1.6(1.5); distance from apex of antenna to distal sensory seta 15–30(24) μ; apical antennal segment with 2 sensilla, 1 usually located near base of distal sensory seta occa-

Fig. 4. *Pseudischnaspis bowreyi* female crawler, VII-17-25, Brazil, ex. bromeliad. A, Composite third lobe of *Melanaspis obscura* and *M. tenebricosa.*

sionally more proximal (Fig. 4), other near base of next proximal seta on same side of antenna.

Description based on 8 embryos from 8 localities.

Discussion.—We have been unable to distinguish between the first instars of *P. bowreyi* and *Melanaspis aliena.* Comparisons with 3 other species of *Melanaspis* have provided some interesting results. The first instars of *Pseudischnaspis bowreyi, Melanaspis aliena,* and *M. smilacis* share several unusual characters. All have large, fringed plates between the second lobes; 2 fringed plates in the space between lobes 2 and 3; trapezoidal-shaped 3rd lobes; fringed, lobelike processes anterior of lobe 3; usually have mediolateral setae absent from abdominal segments 1 and 2 on the female; usually have mediolateral setae absent from abdominal segment 1 and present on abdominal segment 2 on the male. The first instars of *M. obscura* and *M. tenebricosa* have small plates that are simple or consist of only 2 or 3 tines between the 2nd lobes; 1 simple plate or no plate in the space between lobes 2 and 3; triangular-shaped 3rd lobes (Fig. 4A); simple, lobelike processes anterior of lobe 3; usually have mediolateral setae absent from abdominal segment 1 and present on segment 2 on the female; usually have mediolateral setae present on segments 1 and 2 on the male. Males of all species examined have a tarsal sensillum, while females lack this structure. Chaetotactic sexual dimorphism was first demonstrated by Stoetzel and Davidson (1974a); sensilla sexual dimorphism was first suggested by Howell and Tippins (1977).

The first instar of *P. bowreyi* and *Melanaspis aliena* differs from that of *M. smilacis* by having notches on the 2nd lobes restricted to the lateral margin, the sensilla on the apical antennal segment in the central and proximal portion of the segment, length of trochanter + femur/tibia + tarsus (excluding claw) 1.1–1.9(1.5), usually having 1 or 2 tubercles between the antennae; *M. smilacis* usually has notches on the medial and lateral margins, has the sensilla on the apical antennal segment in the central and distal portion of the segment, length of trochanter + femur/tibia + tarsus (excluding claw) 1.2–1.4(1.3), without tubercles between antennae.

ADULT MALE
Fig. 5

Description.—Mounted, 0.8–0.9(0.9) mm long, 0.2–0.3(0.3) mm wide.

Dorsum with setae as illustrated except on abdomen where variable; marginal, and submarginal setae as follows: Segment 1 with 0–1(1) on each side of body, segment 2 with 0–1(1), segment 3 with 0–1(1), segment 4 with 0–2(1), segment 5 with 2, segment 6 with 2, segment 7 with 2–3(3), segment 8 with 2–4(4); mediolateral setae usually restricted to segment 2 (on 1 side of 1 specimen 1 seta also on segments 1 and 4, other side of same specimen normal). Abdominal sclerotization weakly indicated. Metathorax with postnotum not sclerotized. Mesothorax with postnotal membranous area with longitudinal striation, scutellum 143–150(147) μ wide, foramen 7–10(8) μ wide, scutellum/foramen 15–20(18). Prothorax with posttergite inconspicuous, pronotal sclerite absent. Head occasionally with weak extension of midcranial ridge, posterior angle of postoccipital ridge 105–126(114) degrees, transverse median body of ridge 35–37(37) μ wide, anterior arms weakly developed forming triangular angle. Dorsal eye 25–37(32) μ in diameter.

Penial sheath apically acute, 237–270(259) μ long; greatest width/length 0.21–0.22(0.21); aedeagus from distal end of basal rod to apex 227–253(239) μ long; anal opening inconspicuous.

Venter with setae as illustrated except mediolateral setae variable as follows: Segment 3 with 0–1(0) on each side of body, segment 4 with 0–1(0), segment 5 with 1–2(1), segment 6 with 1–2(2), segment 7 with 2. Abdominal sclerotization weakly indicated. Metathorax with conspicuous precoxal ridge, metasternum weakly developed. Mesothorax with basisternum partially divided medially. Prothorax with prosternum well developed medially, transverse ridges slightly produced, posterior sclerotic area represented by dermal reticulation only. Head with narrow midcranial ridge terminating posteriorly in weakly sclerotized plate, postocular ridge separate from preoral ridge, without noticeable ventral plates, cranial

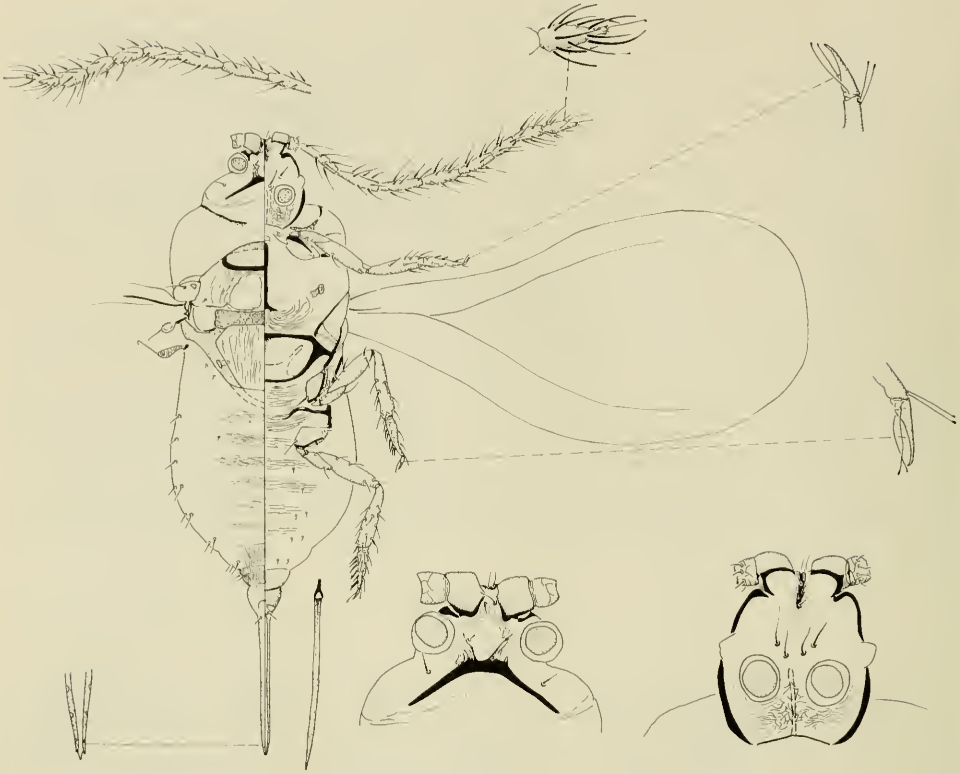

Fig. 5. *Pseudischnaspis bowreyi* adult male, III-1970, Puerto Rico, San Juan, ex. *Agave*.

apophysis not divided apically, 43–60(51) μ long. Ventral eye 25–35(30) μ in diameter. Ocelli conspicuous.

Front legs 310–355(337) μ long, middle legs 313–353(338) μ long, hind legs 340–373(354) μ long; length of hind tibia/tarsus 1.4–1.5(1.4); setae hairlike, bifurcate on inner margin of tarsus, spurs absent; trochanter with 4 sensilla, tarsus with 1; tarsus 2-segmented; digitules similar on each pair of legs, tarsal pair capitate, not reaching tip of claw, claw digitules capitate, extending beyond tip of claw. Antennae 434–460(446) μ long, body 1.9–2.0(2.0) times length of antennae, 10-segmented, 3rd segment 1.3–1.5(1.4) × longer than apical segment; setae absent from segment 1; proximal seta on 3rd segment 40–53(45) μ long, sensillum not seen on segment 2; with 15–16(15) setae on segment 10 counting capitate seta, excluding sensillum; segment 10 with apical capitate seta and at least 1 more capitate seta. Wing 564–682(612) μ long, 279–316(296) μ wide, wing length/width 2.0–2.2(2.1).

Description based on 5 specimens from 2 localities including a paralectotype.

Discussion.—Of the adult males described by Ghauri (1962), *Aspidiotus destructor* (Signoret) seems to be most similar to the male of *Pseudischnaspis bowreyi*. The former can be separated by having: The anterior arms of the postoccipital ridge nearly parallel forming a rectangle; the legs each with the tarsal and claw digitules represented by a short setiform digitule and a long capitate digitule; 1 mediolateral seta on each side of the dorsum of segments 1 and 2; the prosternum narrow, with no lateral development of the transverse processes; the mesosternum with a complete median ridge; and by usually having no mediolateral, ventral setae on segment 5, 1 on segment 6, and 2 on segment 7. *Pseudischnaspis bowreyi* has: The anterior arms of the postoccipital ridge diverging anteriorly forming a triangle; the legs each with 2 elongate, capitate tarsal digitules and 2 elongate, capitate claw digitules; 1 mediolateral seta on each side of the dorsum on segment 2 only; the prosternum relatively broad, with a slight lateral development of the transverse processes; the mesosternum with an incomplete median ridge; and by usually having 1 mediolateral, ventral seta on segment 5, 2 on segment 6, and 2 on segment 7.

Males of *Melanaspis* are similar to males of *Pseudischnaspis*. Differences are found in overall size and in setal patterns, but obvious differences have not been observed in reticulate patterns, sizes and shapes of sclerites, or presence or absence of ridges. The male of *Melanaspis obscura* differs by having relatively short antennal setae (proximal seta on third segment 20–33(25) μ long), 3–5(4) clubbed setae on tenth segment of antenna excluding apical seta, 1–3(2) setae in the membranous area near the tegula, penial sheath 415–487(452) μ long, 2–3(3) marginal or submarginal setae on each side of segments 5 and 6, 1 mediolateral seta on the dorsum of segment 1, hind legs over 480 μ long, antennal segments broad (3rd segment 2.5–3.7(3.3)× as long as wide). In comparison *Pseudischnaspis bowreyi* has long antennal setae (proximal seta on 3rd segment 40–53(45) μ long), 0–1(1) clubbed setae on tenth segment of antennae excluding apical seta, 1 seta in the membranous area near the tegula, penial sheath 237–270(259) μ long, 2 marginal or submarginal setae on each side of segment 5 and 6, usually without a mediolateral seta on the dorsum of segment 1, hind legs less than 400 μ long, antennal segments narrow (third segment 4.0–4.8(4.3)× as long as wide).

The male of *Melanaspis tenebricosa* has the apex of the penial sheath bluntly rounded, 2–3(2) clubbed setae on the tenth segment of the antenna excluding the apical seta, penial sheath 275–307(293) μ long, 1–2(2) genal setae, 1–2(2) submedial setae on each side of venter of segment 5, and 2 marginal or submarginal setae on each side of segment 4. *Pseudischnaspis bowreyi* has the apex of the penial sheath apically acute, 0–1(1) clubbed seta on the tenth segment of the antenna excluding the apical seta, penial sheath 237–270(259) μ long, 1 genal seta, 1–2(1) submedial setae on each side of venter of segment 5, and 0–2(1) marginal or submarginal setae on each side of segment 4.

The male of *Melanaspis smilacis* is remarkably similar to the male of *Pseudischnaspis bowreyi*. Both usually lack the mediolateral setae on segment 2; both have the tenth antennal segment without capitate setae (excluding apical seta) or with 1 such seta with the club so small that it is nearly impossible to see; and both have the same setal patterns. *Melanaspis smilacis* usually has a definite dorsal extension of the midcranial ridge, the length of the body/length of the antenna 1.4–1.8(1.6), and the length of the antenna 471–639(573) μ. *Pseudischnaspis bowreyi* has the dorsal extension of the midcranial ridge absent or weakly indicated, the length of the body/length of the antenna 1.9–2.0(2.0), and the length of the antenna 434–460(446) μ.

Comparison of adult males of *Melanaspis aliena* with those of *Pseudischnaspis bowreyi* supports the conclusion of a close relationship demonstrated by other instars. The male of the former differs by having much longer setae on the antennae (proximal seta on 3rd segment about 70 μ long), body about 1.1 mm long, and penial sheath about 325 μ long. The latter has shorter setae on the antennae (proximal seta on 3rd segment 40–53(45) μ long, body 0.8–0.9(0.9) mm long, and penial sheath 237–270(259) μ long.

Specimens examined.—We have examined about 250 specimens on 170 slides. A synopsis of pertinent collection data is as follows: UNITED STATES: Florida—Homestead (on *Lagerstroemia lanceolata,* 1977); Key West (on *Rosa* sp. and *Vitis* sp., 1890 to 1921); Miami (on *Coccoloba uvifera, Persea* sp., and *Psidium guajava,* 1909–1980). Missouri—Shaw Botanic Garden, St. Louis (on *Agave* spp. and *Yucca aloifolia,* 1921). New York—New York Botanic Garden, New York (on *Agave decipients* and *Yucca aloifolia,* 1921 to 1934). MEXICO:—(on *Beaucarnea,* cactus, *Citrus, Dracaena Ficus, Hylocerus,* Orchidaceae, *Mangifera, Persea, Yucca,* 1897 to 1977). CENTRAL AMERICA: Belize—(on *Tillandsia,* 1976). Costa Rica—(on *Carya, Persea, Prunus, Rosa,* 1932 to 1951). Guatemala—(on "bromeliad," *Tillandsia,* 1976 to 1979). Honduras—("bromeliad," *Tillandsia,* 1976). Nicaragua—(on *Citrus, Pyrus, Theobroma,* 1959). Panama—(on *Tillandsia,* 1951). SOUTH AMERICA: Brazil—(on *Bromelia,* "bromeliads," "*Holocalyx,*" 1946 to 1978). Colombia—(on *Eucalyptus, Pyrus,* 1973 to 1977). Ecuador—(on *Persea,* 1925). Peru—(on "bromeliad," *Hibiscus,* "long green plum," *Musa, Nerium,* "orchid," *Passiflora, Rosa,* 1910 to 1979). Venezuela—(on *Cattleya,* 1943). WEST INDIES: Barbados—(on *Rosa,* 1935). Bermuda—(on *Agave,* 1921 to 1936). Cuba—(on *Agave, Aloe, Annona, Ciba, Hibiscus, Hylocereus, Jasminum, Mangifera, Phoenix, Psidium, Rosa,* 1917 to 1955). Jamaica—(*Agave,* 1893–1974). Puerto Rico—(on *Agave, Annona, Coccoloba, Rosa, Spondias*). St. Croix—("bromeliad," 1976. St. Thomas—(on *Agave, Poinciana, Psidium,* 1924–1975). Trinidad—(*Euphorbia,* 1975).

Summary and Discussion

Several conclusions merit special attention.

(1). *Pseudischnaspis* now includes two species. *Pseudischnaspis longissima* is believed to be a broad-pygidium extreme of *P. bowreyi* and is synonymized for the first time. *Melanaspis aliena* virtually is inseparable from *Pseudischnaspis bowreyi* in the first instar, is difficult to separate in the adult female except with old mature specimens, and apparently is easily distinguished in the adult male by the length of the antennal setae.

(2). An unusual amount of intraspecific variation was detected in both *Pseudischnaspis acephala* and *P. bowreyi.* In the former the median lobes either have a medial notch or lack it. In several paralectotypes a single specimen has one median lobe with the medial notch, whereas the other lobe completely lacks this notch. In *P. bowreyi* the shape of the pygidium varies from the broad form described as *P. longissima,* to the narrow form typical of the traditional concept of *P. bowreyi.* In several long series of specimens we found both pygidial forms with numerous intergrades. No correlation was found between the degree of body elongation and pygidial shape.

(3). Chaetotactic sexual dimorphism in *Pseudischnaspis bowreyi* is different from what has been reported in other aspidiotine armored scales. The usual aspidiotine setal arrangement is for the female to be without dorsal setae mediolaterally on the dorsum of segments 1 and 2 and for the male to have these setae.

In *P. bowreyi* the female lacks mediolateral setae, typical of other aspidiotines, but the male has mediolateral setae on segment 2 and lacks them on segment 1. The same setal patterns were found in *Melanaspis aliena* and *M. smilacis.*

Chaetotactic sexual dimorphism in *M. obscura* and *M. tenebricosa* was quite different. The female usually has mediolateral setae absent from segment 1 and present on segment 2. The male usually has mediolateral setae present on segments 1 and 2.

(4). Based on our examination of just a few species of *Melanaspis,* it is evident that generic concepts of *Pseudischnaspis* and *Melanaspis* need to be reexamined. Our hypothesis, based on characteristics of first instars and adult males, is that *M. aliena, M. smilacis,* and *Pseudischnaspis bowreyi* form a group of species and that *Melanaspis obscura* and *M. tenebricosa* form another group. It is evident that further study is needed.

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ETHOLOGY OF *ANOPLIUS TENEBROSUS* (CRESSON) (HYMENOPTERA: POMPILIDAE)

STEVEN R. ALM AND FRANK E. KURCZEWSKI

(SRA) Department of Entomology, OARDC, Wooster, Ohio 44691; (FEK) Dept. of Environmental and Forest Biology, SUNY College of Environmental Science and Forestry, Syracuse, New York 13210.

Abstract.—*Anoplius tenebrosus* (Cresson) has one generation per year. Females and males emerge in mid-summer in upstate NY. The males die within a few weeks of mating. The females, after mating, feed on flowers, especially goldenrod, and dig overwintering burrows in the ground in late summer and fall. They reappear during the first warm days of spring, and nest in sandy areas bordered by woodlands. Females of *A. tenebrosus* hunt and capture a variety of errant spiders, especially Lycosidae, and store one spider in a shallow, single-celled nest. The prey is cached either on a low plant or on the ground during burrow construction. Transport of the spider to the nest is always backwards on the ground, the wasp usually holding the base of the prey's hind leg with the mandibles. The spider is pulled into the nest by its spinnerets. The wasp's egg is placed obliquely on the venter of the spider's abdomen. *A. viaticus* (L.), a related Palearctic species, has almost identical nesting behavior as *A. tenebrosus.*

Knowledge of the nesting behavior of pompilids is limited, especially in the subgenus *Pompilinus.* There are few particulars for the 17 Nearctic species in this group. Prey preferences of some of the species are narrow, whereas those of others are broad (Evans, 1951). *Anoplius tenebrosus* (Cresson) is one of the commonest pompilids in this subgenus in the Canadian and Transition Zones. The species "occurs in sandy places, particularly in the vicinity of woods; the nest is a short tunnel in the earth with an enlarged terminal cell" (Evans, 1951). Prey spiders comprise Thomisidae and Lycosidae (Evans, 1951; Evans and Yoshimoto, 1962; Wasbauer and Powell, 1962).

Evans (1970) observed *Anoplius tenebrosus* at Jackson Hole, Wyoming from July 4 to August 26. He indicated that females may overwinter because they appear early in the season and that males and fresh females emerged about July 20 after which mating took place. Records of *A. tenebrosus* occurring in the Northwest Territories and the Yukon, Canada were published by Steiner (1970). Kurczewski and Kurczewski (1973) reported Gnaphosidae as a new prey family, described burrow construction, prey transport, nest structure and dimensions, and indicated that females may overwinter.

Our paper describes the ethology of *A. tenebrosus.* The behavior of this species is compared with that of the related Palearctic *Anoplius viaticus* (L.).

Location of nests.—Natural nesting sites comprised sand bordered by woodlands. Data were collected at three sand pits near Mallory, one near Fulton, and

Fig. 1. Sandy road, Boonville, N.Y., in which *Anoplius tenebrosus* nested. (Photograph by R. A. Norton).

one in Selkirk Shores State Park, all in Oswego Co., NY. Other wasps were observed on Camp Road, Boonville. Oneida Co. (Fig. 1), and along a truck trail on the State Campus at Wanakena, St. Lawrence Co., NY.

Females nested in open sand, never under tree canopy. The Mallory, Fulton and Selkirk Shores areas contained sparse mosses, grasses and the remains of the previous years' growth. Deciduous trees and scattered white pine (*Pinus strobus* L.) surrounded these sites; the Wanakena site was bordered by conifers. The soil was moist and firm in the spring when nesting was at its peak (late April or May). Nests were always dug from nearly level ground, even where banks comprised a major component of the sand pit. In 1977 females nested in the central area of a sand pit near Mallory, whereas in 1978 almost all nests occupied a 3 × 8 m area on the northern periphery of the pit.

Associated species.—Early in the spring the bees *Sphecodes persimilis* Lovell and Cockerell, *S. confertus* Say (Halictidae), *Andrena milwaukeensis* Viereck (Andrenidae) and *Colletes inaequalis* Say (Colletidae) occurred in the same soils as *A. tenebrosus.* The only sphecids found nesting early in the spring were the cricket-hunting *Liris argentata* (P-B) (O'Brien and Kurczewski, 1982a) and a caterpillar

Table 1. Prey records for *Anoplius tenebrosus*.

	Species of spider	No. of records	Locality	Reference
Lycosidae				
	Trochosa terricola Thorell imm., ♀	21	Mallory, Boonville, NY	
	Trochosa avara Keys. imm., ♀	16	Mallory, Boonville, NY; Mich	Evans & Yoshimoto, 1962
	Tarentula kochi Keys. ♀	1	Calif.	Wasbauer & Powell, 1962
	Lycosa frondicola Em. ♂	4	Mallory, Boonville, NY; Mich	Evans & Yoshimoto, 1962
	Lycosa gulosa Walck. ♀	1	Boonville, NY	
	Lycosa baltimoriana (Keys.) imm.	1	Mich.	Evans, 1970
	Pardosa moesta Banks ♀	1	Mallory, NY	
	Schizocosa crassipalpata Roewer ♂	1	Mallory, NY	
	Schizocosa saltatrix Hentz	1	NJ NY	Evans, 1951 Kurczewski & Kurczewski, 1973
	Schizocosa avida (Walck.)	1		
	Schizocosa sp. (probably *avida*)	1	Boonville, NY	
Thomisidae				
	Xysticus gulosus Keys.	1	Wash.	Evans, 1951
	Xysticus ferox (Hentz) imm., ♀ & ♂	5	Mallory, Fulton, NY; Mich.	Evans & Yoshimoto, 1962
	Xysticus ampullatus Turnbull et al. ♀	1	Selkirk Shores St. Park, NY	
	Xysticus elegans Keys. ♀	3	Mallory, Boonville, NY	
	Xysticus sp. imm.	1	Boonville, NY	
	Thanatus formicinus (Oliv.) ♀	2	MA; NY	Evans, 1970; Kurczewski & Kurczewski, 1973
	Misumena vatia (Clerck) ♀	1	Wanakena, NY	
	Ozyptila distans Dondale & Redner ♀	1	Wanakena, NY	
Agelenidae				
	Wadotes hybridus Em. ♀	2	Boonville, NY	
	Wadotes sp. imm.	1	Boonville, NY	
	Tegenaria domestica (Clerck) imm. ♂	1	Boonville, NY	
Gnaphosidae				
	Haplodrassus signifer (Koch) ♀	1	NY	Kurczewski & Kurczewski, 1973
	Zelotes subterraneous (Koch) ♂	1	Wanakena, NY	
	Drassulus sp. ♂	1	Wanakena, NY	
Salticidae				
	Pellenes sp. imm.	1	Boonville, NY	

Table 1. Continued

	Species of spider	No. of records	Locality	Reference
Amaurobiidae				
	Callobius bennetti (Blackwall) ♀	1	Wanakena, NY	
Clubionidae				
	Agroeca ornata Banks ♀	1	Boonville, NY	

hunter, *Podalonia luctuosa* (Smith) (O'Brien and Kurczewski, 1982b). Another pompilid that nested at this time was *Priocnemis* (*Priocnemissus*) *minorata* Banks. *P. minorata* nested in the wooded edges of the sandy roads near Boonville, NY.

Parasites.—At Boonville, a female of *Metopia argyrocephala* (Mg.) (Sarcophagidae: Miltogramminae) entered a nest of *Anoplius tenebrosus* when the wasp was out retrieving her prey. Upon excavation of the nest, the wasp's egg was found to be destroyed and a small maggot was located on the spider. The maggot, which was reared to an adult *M. argyrocephala*, had been deposited before the prey or egg of *A. tenebrosus* had been placed in the nest. Another nest contained three unidentified maggots on a spider, and the egg of *A. tenebrosus* had been destroyed.

Predators.—*Anoplius tenebrosus* females were attacked unsuccessfully by the cicindelids *Cicindela scutellaris lecontei* Haldeman, *C. repanda* Dejean, and *C. formosa generosa* Dejean. However, the beetles fed upon the spiders captured by *A. tenebrosus*. One cicindelid punctured the spider's abdomen which caused the wasp to release the prey and attack the beetle. The wasp was successful in driving off the beetle but the damaged prey was unsuitable for provisioning and was abandoned after the female fed on its body fluids. This wasp was then "offered" another, paralyzed spider which had been abandoned by a female. It was readily accepted and used for provisioning.

Prey.—*A. tenebrosus* preys on at least 25 species of spiders belonging to seven families. The majority are errant spiders, but some are funnel-web spinners (Agelenidae) or those which spin loose, irregular webs (Amaurobiidae). The prey consist primarily of Lycosidae of which *Trochosa terricola* Thorell is the predominant species (Table 1).

The average weight of a paralyzed prey was 92.39 mg (16.1–210.2, $n = 91$), while that of a recently killed wasp was 40.16 mg (11.0–72.0, $n = 48$). An average prey to wasp ratio in this species approximated 2.3 to 1 which coincides with other pompilid prey to wasp ratios (Iwata 1942). Since only one prey was stored for the larva, it must be of sufficient size to permit larval development. One larva did not complete development on a small spider (16.1 mg).

Activity conditions.—Nesting began the last week of April and ended during the second week of June in upstate New York. Little or no activity was observed on cold, cloudy days, during periods of drought or high temperatures. One female was observed digging as it began to rain. The temperature had dropped to 17°C, she was moving slowly and managed to bring her prey into the nest, but never

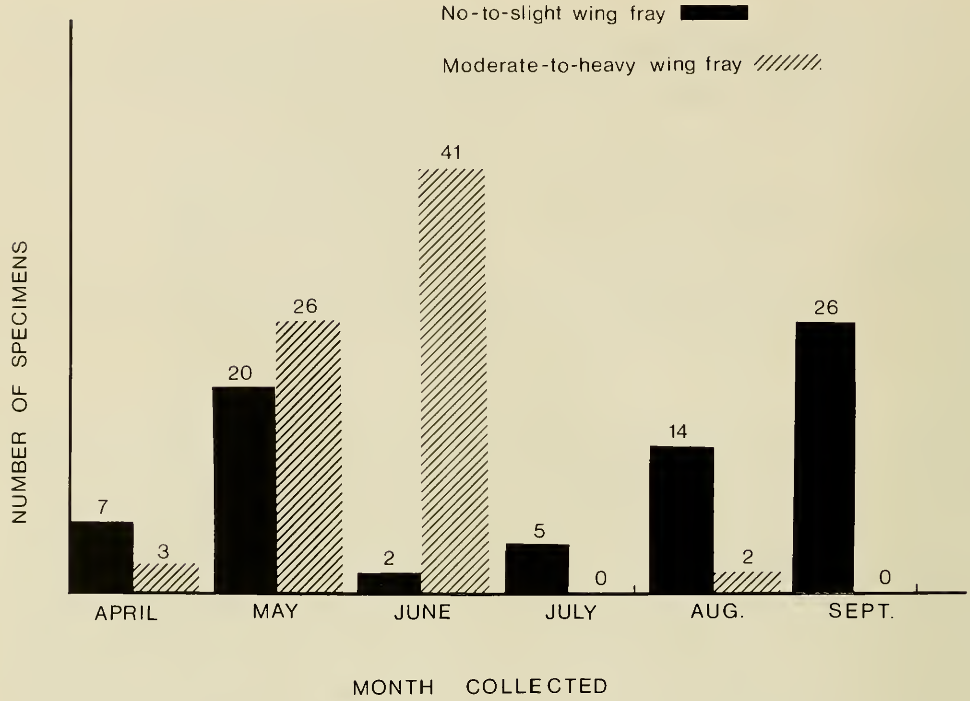

Fig. 2. Number of ♀ *Anoplius tenebrosus* with no-to-slight and moderate-to-heavy wing fray in relation to the month of collection.

came out. The nest was still open the next day and, upon excavating it, we found the female in a small cell off the main tunnel above the provisioning cell.

Females nested continuously throughout the day from when the ambient temperature exceeded 15°C up to 32°C or until the temperature dropped below 16°C late in the afternoon or at twilight. Females then either dug shallow overnight burrows in the sand or burrowed into moss and spent the night. Some wasps used what appeared to be abandoned tiger beetle or bee tunnels, but usually examined several holes before settling on a site.

No hunting or nesting occurred in the fall; rather, females spent much time feeding on goldenrod, *Solidago* spp. They walked to the blossoms if the temperature was low (ca. 17°C) or flew if the temperature was higher. This activity continued until the goldenrod had finished blooming in October.

Overwintering.—In the fall of 1977 seven females were marked with vital paint at Mallory, NY. One female was recaptured in the spring, proving that some wasps overwinter. On October 5, 1978 one female was dug out of a burrow, 21 cm deep. She had entered the burrow on October 3rd and may have overwintered there.

Circumstantial evidence supports a univoltine existence and overwintering of females. Based upon wing condition, there were two appearances of the females (Fig. 2). Field studies demonstrated that wasps found during late summer and early fall were mating, feeding on nectar, and building overwintering burrows, whereas those observed during spring were nesting. Males were present only in summer (July–September).

Activity of males.—Males of *Anoplius tenebrosus* flew erratically above the sand, searching for females. They were collected on the flowers of *Daucus carota* L.

Prey capture.—Hunting took place in the spring in the fields or woodlots surrounding the nesting area. Females ran on and through vegetation and periodically made short flights. They flicked their wings continuously and tapped their antennae constantly on the substrate.

Two females were observed fighting over a small gnaphosid, lapping up body fluids from a hole in its abdomen. This spider, not used for nesting, was abandoned by both wasps. Another female was seen sucking body fluids from a spider's cephalothorax, after stinging it.

Females were observed moving excitedly through clumps of grass which harbored spiders. Wasps captured errant spiders by pouncing on their dorsum and curving the abdomen underneath in order to insert the sting in the cephalothorax.

At Mallory *A. tenebrosus* almost invariably placed the spider in a clump of grass, moss or dried fern before digging the nest. At Boonville approximately half of the females left their prey on the sand. Some wasps moved their prey closer to the nest after burrow construction had begun and they examined it several times during the construction. If the prey had fallen from its cachement the wasp repositioned it before returning to her nest.

Nesting behavior.—Females dug burrows at angles of approximately 70–90° to the sand surface (Fig. 3). Each burrow ended in an enlarged, terminal cell. The average entrance diameter was 5.6 mm (5–7, $n = 15$). The mean distance from the soil surface to the bottom of the cell was 3.8 cm (1.8–6.8, $n = 45$). The cell averaged 9.1 (6–13, $n = 47$) × 7.5 mm (5.5–10, $n = 35$).

Digging was initiated in depressions in the sand, frequently hoof- or footprints. Some females dug down a few millimeters but abandoned these excavations and dug elsewhere. Females began digging by spreading the legs and biting the sand with the mandibles. The mandibles loosened the sand while the forelegs alternately swept it back under the abdomen. The mesothoracic legs were used to pass loads of sand from the forelegs to the hindlegs which would then push the sand up the burrow. When several loads had been deposited behind the wasp, she would back up the burrow while pushing the sand into the entrance with the hindlegs. At the entrance the female would back out, using the meso- and metathoracic legs, while the forelegs swept the sand back under the abdomen. After several such backings, a low, fan-shaped tumulus extended approximately 6 cm from the entrance.

One female started to dig, abandoned the burrow and started another within a few centimeters of the first. She continually confused the two locations and, after checking on her prey, returned to one nest one time and the other the next. This continued until both nests were nearly completed and culminated with the completion and provisioning of one nest.

The female coming out of the nest head first signified the completion of the burrow and cell. The entrance was left open as the wasp retrieved her spider. Females averaged 36 (16–70, $n = 14$) minutes to dig a nest, the time varying with soil texture, moisture content, wasp's age, ambient temperature, and size of prey. The maximum duration was for a female digging in dry, hard-packed sand.

Prey transport and provisioning.—Prey transport involved pulling the spider backwards, usually by the base of a hind or other leg, with the mandibles. A few wasps grasped prey by a foreleg and held the spider upside down while walking

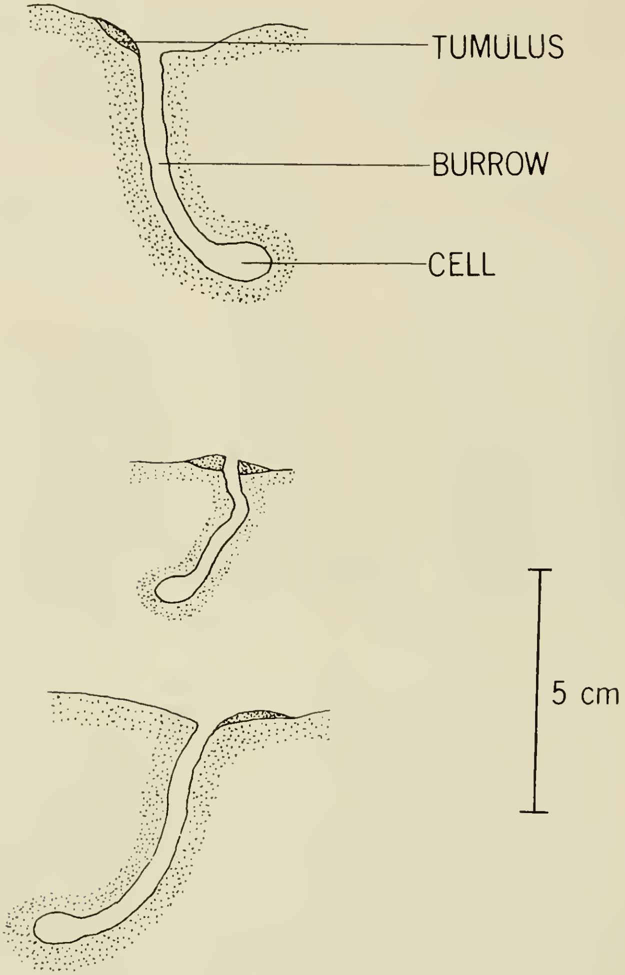

Fig. 3. Side views of nests of *Anoplius tenebrosus,* showing burrows, terminal cells and tumuli.

backwards. During transport, a female usually dropped her spider before reaching the entrance. If the spider had been cached some distance from the nest, females released their prey several times and reoriented. After a wasp had dropped her prey near the entrance, she grasped it by the base of a hind coxa, a pedipalp, or the distal part of a leg and positioned it, dorsum up, spinnerets toward the entrance. Females then entered head first, turned around inside and came out head first. They grasped the spider by the spinnerets with the mandibles and pulled it into the nest, except in one case when a large thomisid was pulled in by the base of a hind leg. The spider was often positioned in the cell dorsum upward and head outward. The legs formed a plug at the proximal end of the cell for the sand closure.

Closure.—Closure of the nest began after the egg had been laid, based upon wasps observed between glass partitions. The female broke in the sides of the burrow with the mandibles and tamped the sand with the tip of the abdomen as

Fig. 4. *Trochosa terricola* with egg of *Anoplius tenebrosus* on venter of abdomen. (Photograph by R. A. Norton).

she moved up the burrow. When she neared the entrance she used the forelegs alternately to scrape in the loose sand on the surface that had been removed during digging. The tip of the abdomen packed the sand in the burrow and smoothed it flush with the surrounding sand. The female then alternately swept sand under her body with the forelegs in the direction of the filled entrance. Some females placed small pebbles, grass, or twigs on the filled entrance. The wasp then usually cleaned herself and flew off.

Eclosion, larval and pupal development.—Seven eggs averaged 2.4 × 1.0 mm in size and were placed rather obliquely on the venter of the spider's abdomen (Fig. 4). Variability in egg placement was due to variation in the size and species of prey. In the laboratory, 23 eggs from Mallory and Boonville eclosed in 2–3 days at ambient temperatures of 21°–26°C. Larval and pupal development lasted 31 days for one male; 35, 46 and 64 days for three females.

DISCUSSION

Anoplius tenebrosus is nearly identical to the Palearctic *A. viaticus* in its nesting behavior (Table 2). Both species mate during the summer after which the males die. The females of both *A. tenebrosus* and *A. viaticus* do not hunt during the late summer or fall but feed on nectar, overwinter in relatively deep burrows, reemerge in the spring and provision short, shallow nests with paralyzed wandering spiders.

Females of *A. viaticus* dig overwintering burrows, 15–30 cm deep (Adlerz, 1903; Schütze, 1921–24; Nielsen, 1932; Grandi, 1961; Wolf, 1971). But Soyer (1963), working in France, found overwintering burrows of this species to be only 5–6 cm deep—perhaps a reflection of a shallower substrate freeze line at this latitude. We found one female of *A. tenebrosus* overwintering in a burrow, 21 cm deep. Schütze (1921–1924) found as many as 50 overwintering burrows of *A. viaticus*

Table 2. Ethological comparison of *Anoplius tenebrosus* and *A. viaticus.*

Anoplius (*Pompilinus*) *tenebrosus* (Cresson)	*Anoplius* (*Pompilinus*) *viaticus* (Linnaeus)
Overwintering stage: adult	Overwintering stage: adult
Generations per year: one	Generations per year: one
Depth of overwintering burrow: 21 cm	Depth of overwintering burrow: 15 cm (Schütze, 1921–24); 15–20 cm (Nielsen, 1932); 30 cm (Adlerz, 1903); 5–6 cm (Soyer, 1963)
Cell depth (surface to bottom): $\bar{x}$ = 3.8 cm (range 1.8–6.8)	Cell depth (surface to bottom): (2–6 cm)
Cell length: $\bar{x}$= 9.1 mm (range 6–13)	Cell length: 12 mm
Prey cache: in plant or on ground	Prey cache: in plant or on ground
Prey transportation: backwards by the base of a hind leg; pulled into nest by spinnerets	Prey transportation: backwards by the base of a hind leg; pulled into nest by spinnerets
Egg placement: obliquely on the abdomen	Egg placement: obliquely on the abdomen
Nest closure: first by breaking in the sides of the burrow, then sweeping in sand with the forelegs, which is pressed down with the tip of the abdomen	Nest closure: first by breaking in the sides of the burrow, then sweeping in sand with the forelegs, which is pressed down with the tip of the abdomen
Prey: primarily Lycosidae	Prey: primarily Lycosidae
Ethological type: VPTIOC	Ethological type: VPTIOC

in a single area. Wolf (1971) noted that overwintering burrows of this species always faced southward as did those of *A. tenebrosus.*

Four other European pompilids, *Priocnemis perturbator* (Harris), *P. coriacea* (Dahlbom), *P. propinqua* (Lepeletier) and *Dipogon intermedius* (Dahlbom) overwinter as adult females, according to Richards and Hamm (1939). Additional Nearctic species of Pompilidae with northern ranges of distribution may also overwinter as adults but it remains to mark and recapture the females in order to ascertain this. One explanation of female overwintering and spring provisioning in *A. tenebrosus* may involve lessening egg and larval predation by miltogrammine flies (Sarcophagidae) and other summer cleptoparasites.

Burrow construction and final closing behavior are similar in *A. tenebrosus* and *A. viaticus.* Soyer (1963) found females of the latter taking 15–65 ($\bar{x}$, 28) min. to construct a burrow, and we recorded females of *A. tenebrosus* taking 16–70 ($\bar{x}$, 36) min. for this behavior. The nests of the two species are equivalent in form and dimensions (see Soyer, 1963; Bonelli, 1966; Wolf, 1971; for *A. viaticus*). Ferton (1897) noted a female of *A. viaticus* that constructed more than one cell from a single burrow. Bonelli (1966) reported that several burrows of *A. viaticus* were built and visited before each was stored with a spider. Both of these observations need confirmation.

The prey species found in the nests of the two species of *Anoplius* are similar, with a preponderance of one lycosid, *Trochosa terricola.* Five families of prey are identical, emphasizing the selection of wandering spiders of similar ecological requirements and suggesting similar hunting behaviors for the two species of wasps (see Picard, 1903; Adlerz, 1903; Bristowe, 1928; for *A. viaticus*).

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PREY SELECTION BY THE NEOTROPICAL ROBBER FLY, *ATRACTIA MARGINATA* (DIPTERA: ASILIDAE)

TODD E. SHELLY

Department of Biology, University of California, Los Angeles, California 90024.

Abstract.—Actual prey of *Atractia marginata* Osten Sacken were compared to sticky trap samples of available prey. Individuals did not feed randomly on available prey. Coleoptera were overrepresented in the diet in comparison to their contribution to the sticky trap sample, while the opposite was true for Isoptera and non-nematocerous Diptera. In addition, foraging rate was found to vary directly with prey abundance. In a comparison of two adjacent microhabitats, both total prey abundance and foraging rate of *A. marginata* were approximately three times greater in one area than in the other.

Many researchers have recorded prey of adult robber flies. These reports range from anecdotal accounts in which only one or several prey are recorded (Wallis, 1913; Balduf, 1943; Hardy, 1953; Bouseman and Maier, 1977) to intensive studies in which hundreds or even thousands of prey are listed for individual asilid species (Adamovic, 1963, 1968; Dennis and Lavigne, 1975; Scarbrough, 1979; Scarbrough and Sraver, 1979). Despite this variation, these studies all share a common feature, i.e., actual prey were collected without regard to the availability of prey in the habitat. Thus, while investigators have made inferences concerning apparent preferences for particular prey types and sizes, the actual extent to which any asilid species selectively feeds upon particular prey remains unknown. The use of lures of varying dimensions and colors may help identify those prey characteristics most likely to elicit an asilid attack response (Lavigne and Holland, 1969; Dennis et al., 1975; Shelly and Pearson. 1978, 1980), but clearly a comparison of actual prey vs. available prey constitutes the most direct analysis of prey selection.

In this paper I compare the actual prey of a Neotropical robber fly species with samples of available prey obtained using sticky traps. *Atractia marginata* Osten Sacken is a small (8 mm–10 mm) robber fly recorded from forests in Panama, Costa Rica, and Nicaragua (E. Fisher, personal communication). Like most robber flies, *A. marginata* is a sit-and-wait predator. Individuals usually perch on the sides of fallen trees and attempt aerial capture of flying insects. Upon successful capture, the asilid returns to its perch and sucks the contents of its prey. Collection of prey from feeding individuals thus permits direct assessment of the dietary composition.

Preliminary observations also suggested that *A. marginata* individuals within meters of one another foraged at greatly different rates. By identifying sites of "high" and "low" foraging activity and measuring prey abundance within each, it was possible to test the hypothesis that foraging rate is directly proportional to the encounter rate with available prey. This relationship has been observed for other predaceous insects (Hassell et al., 1976) but has never been documented for robber flies.

Materials and Methods

The study was conducted between February 26 and March 11, 1979, on Barro Colorado Island (BCI), Panama. This time interval coincided approximately with the mid-point of the dry season, which annually extends from late December to early May (Croat, 1978). No rain fell during the course of the study, and days were generally sunny. BCI is covered by a lowland tropical moist forest (Holdridge et al., 1971) portions of which range in age from approximately 60–130 years (Croat, 1978; Knight, 1975).

All observations and collections were made at one fallen tree within the forest. The tree was approximately 20 m long and 1.5 m in circumference. A bend in the trunk resulted in the fallen tree having the shape of an inverted V with its apex off the ground and its arms sloping downward until they were lying on the ground. Preliminary observations indicated that *A. marginata* perched near the apex were foraging less frequently than were individuals perched along the arms and hence closer to the ground. To investigate this difference, I first established a high and a low trunk section and then (1) measured foraging rates of *A. marginata* and (2) sampled actual and available prey in each section.

The trunk sections were established as follows. The "high" section included the apex of the fall (tree underside 91 cm above ground) and a 1.75 m length immediately to the left of the apex (tree underside 71 cm above ground at the lowest point) and a 1.0 m length immediately to the right of the apex (tree underside 84 cm above ground at the lowest point). The low section was a 3.0 m portion of the right arm of the fall that rested directly on the ground. Only 5.1 m separated the high and low sections. No low section was established on the left arm owing to the presence there of an active nest of *Trigona* sp. (Hymenoptera: Apidae). Although no capture attempts were observed, individuals of *A. marginata* in the nest's vicinity were observed chasing bees. The *Trigona*-induced flights thus precluded valid comparisons with *A. marginata* individuals in nest free portions of the trunk.

All foraging observations were made between 1200–1600 hrs between February 26–March 2 and March 8–March 11. In general, 3–5 females were observed each day in both sections. During the entire study, 30 females were observed in each section. These observations consisted of watching a female for 5 minutes and recording the number of foraging flights. Only females were observed since (1) females were much more abundant than males and (2) I wished to avoid potential complications arising from sexual differences in behavior. Foraging flights were easily distinguished from other flights (e.g. relocation flights), since (1) the prey eliciting the attack could often be seen and (2) they were characteristically rapid, straight flights to points 15 cm–45 cm from the log surface. In addition, after a foraging flight, the individual generally returned to a site very close to its original position. If, however, an individual moved out of the study section (through either a foraging or relocation flight), observation ceased. In addition to flight activity, foraging efficiency (no. successful captures/no. foraging flights) was noted. Observation did not stop following a successful capture, since feeding individuals usually continued to search for prey.

Actual prey were collected during the same time intervals in which foraging observations were made. *Atractia marginata* females with prey were captured by a quick "cupping" action of a wide-mouthed jar over the asilid. After the asilid dropped its prey, the prey was collected, and the asilid was released. Prey were identified to order except for Diptera which were further categorized as nematocerans or non-nematocerans. Body lengths were measured to the nearest 0.1 mm using a dissecting microscope equipped with a disc micrometer.

Available prey were sampled at both trunk sections from March 3–March 7. Ideally, samples of available and actual prey would be taken simultaneously. Over several hours, however, my movements would possibly affect insect distribution near the fallen tree. Consequently, after setting the traps, I avoided the area. I must assume, then, that these samples of available prey were typical of the entire study period. Two tangle-foot coated, white paper discs (diameter 11.5 cm) were placed at each section at 1200 hrs and removed at 1600 hrs. Each disc was fastened to the top of a wooden rod which in turn was driven into the ground immediately adjacent to the log with its plane perpendicular to the log's long axis. The discs in the high and low sections were positioned with their centers 115 cm and 95 cm above ground and 20 cm and 25 cm above ground, respectively. As with actual prey, sampled insects were identified to order except for Diptera which were further categorized as nematocerans or non-nematocerans. Body lengths were measured to the nearest 1 mm with a ruler. Entrapment in the tanglefoot precluded more accurate measurement of the sampled items.

Actual prey of *A. marginata* females were compared with the sticky trap sample in two ways. Differences in the taxonomic and size compositions of the actual and available prey were first tested using a G-statistic (Sokal and Rohlf, 1969: 575). Ivlev's (1961) index of electivity (E) was also used as a measure of prey selectivity: $E = (r_i - p_i)/(r_i + p_i)$ where r_i is the proportion of the predator's diet composed of prey type (or size) category i, and p_i is the proportion of the available prey composed of prey type (or size) category i. Values of E range from +1.0 (complete preference) to −1.0 (complete avoidance).

RESULTS

Atractia marginata females within the high trunk section foraged less frequently than did females in the low section. For the 30 females observed within each section, the mean foraging rates were 0.42 (SD = 0.28) and 1.29 (SD = 0.55) flights/minute for the high and low sections, respectively ($t = 7.64$, $P < .001$). Although flight activity varied, foraging efficiencies did not differ significantly between females in the two sections ($t = 0.12$, $P < .9$; arc sine transformation, Sokal and Rohlf, 1969: 608). The foraging efficiencies for the high and low sections were 6.0% (4/67) and 6.6% (13/196), respectively.

Prey abundance also differed greatly between the high and low trunk sections (Table 1). Nearly 3 times as many insects were collected at the low section (mean number/disc = 31.2, SD = 6.5) than at the high section (mean number/disc = 12.4, SD = 2.5). These means were significantly different ($t = 8.6$, $P < .001$). Despite this numerical difference, taxonomic composition of the samples did not

Table 1. Taxonomic composition of available and actual prey of *Atractia marginata* females. Available prey values for each section represent total number of individuals of each category collected on 10 sampling discs over a 5 day period.

	Available prey								
	Low trunk section		High trunk section		Total		Actual prey		
Prey taxa	No.	(%)	No.	(%)	No.	(%)	No.	(%)	Electivity
Coleoptera	148	(47.4)	64	(51.6)	212	(48.6)	75	(69.4)	+0.18
Diptera									
Nematocera	43	(13.8)	16	(12.9)	59	(13.5)	13	(12.0)	−0.06
Non-Nematocera	61	(19.5)	22	(17.7)	83	(19.0)	8	(7.4)	−0.44
Isoptera	26	(8.3)	17	(13.7)	43	(9.9)	6	(5.5)	−0.28
Other	34[1]	(10.9)	5[2]	(4.0)	39	(8.9)	6[3]	(5.5)	—
Total	312		124		436		108		

[1] Other includes: 20 Hymenoptera, 7 Thysanoptera, 5 Homoptera, 1 Hemiptera, 1 Lepidoptera.
[2] Other includes: 3 Hymenoptera, 1 Homoptera, 1 Strepsiptera.
[3] Other includes: 3 Hymenoptera, 1 Homoptera, 2 Psocoptera.

differ significantly between the 2 sections (G = 8.2, $P < .1$, df = 4). In both sections, Coleoptera (primarily Platypodidae and Scolytidae) and Diptera represented approximately 50% and 30% of the sampled prey, respectively. Among the Diptera, approximately 40% were nematocerans (primarily Sciaridae and Cecidomyiidae) and 60% were non-nematocerans (primarily Phoridae and Stratiomyidae) in both sections. Similarly, Isoptera comprised approximately 10% of the trapped insects in both sections. In addition to this taxonomic similarity, size frequency distributions of Coleoptera (G = 3.2, $P < .5$, df = 5) and Diptera (G = 2.4, $P < .1$, df = 3 for nematocerans and non-nematocerans combined) did not differ significantly between the high and low sections. Given these similarities in available prey in the 2 sections, the following comparisons between actual and available prey were made using combined data from both sections.

The recorded prey of *A. marginata* females did not represent a random sample of the available prey (G = 18.0, $P < .001$, df = 4, Table 1). Coleoptera comprised a much greater proportion of the diet (69.4%) than of the sampled prey (48.6%). Consequently, the electivity value for Coleoptera was positive. As in the sticky trap sample, the majority (approximately 75%) of beetle prey were scolytids and platypodids. In contrast, both non-nematocerous Diptera and Isoptera were underrepresented in the diet relative to their contributions to the sample of available prey. As a result, electivity values for these prey were negative. Nematocerous Diptera, on the other hand, were consumed in approximately the same proportion as their relative abundance in the environment, and the corresponding electivity value was near zero.

Only Diptera and Coleoptera were preyed upon in sufficient numbers to permit a valid comparison between actual and available prey size distributions (Table 2). These distributions differed significantly for both dipteran prey (G = 16.4, $P < .001$, df = 3 for nematocerans and non-nematocerans combined) and beetles (G = 17.6, $P < .005$, df = 5). For both taxa, the smaller size classes were overrepresented in the diet relative to their contributions to the sticky trap sample. Electivity values were positive for flies less than 2 mm but negative for larger

Table 2. Size distributions of available and actual prey. Numbers of available prey represent total numbers of each size class collected on 20 sampling discs over a 5 day period. Nematocera and non-Nematocera are combined in Diptera figures.

		Available		Actual		
Prey	Size (mm)	No.	(%)	No.	(%)	Electivity
Diptera	0–1	18	(12.7)	4	(19.0)	+0.20
	1–2	55	(38.7)	12	(57.1)	+0.19
	2–3	46	(32.4)	5	(23.8)	−0.15
	>3	23	(16.3)	0	(0.0)	−1.00
Coleoptera	0–1	15	(7.1)	6	(8.0)	+0.06
	1–2	50	(23.6)	18	(24.0)	+0.01
	2–3	92	(43.3)	40	(53.3)	+0.10
	3–4	20	(9.4)	10	(13.3)	+0.17
	4–5	21	(9.9)	1	(1.3)	−0.77
	>5	14	(6.6)	0	(0.0)	−1.00

flies. Similarly, electivity values were positive for beetles less than 4 mm but negative for the larger size classes. Among beetle prey, a sharp decrease in electivity was noted between the 3 mm–4 mm and 4 mm–5 mm size classes. Both classes comprised approximately 9% of the available beetle prey, but 3 mm–4 mm and 4 mm–5 mm individuals comprised 13.3% and 1.3% of the actual beetle prey, respectively.

Discussion

Field studies of prey selection invariably rely upon sampling methods which yield biased estimates of both actual and available prey. Sticky traps, for example, have an inherent bias resulting from the fact that different insects have different abilities to detect and avoid a trap (examples in Robinson and Robinson, 1973). In addition, Olive (1980) suggested that very small insects may be passively carried around traps by air currents and hence be underrepresented in the sample. The sampling of actual prey is subject to a "handling time" bias. That is, small prey that are rapidly consumed are less likely to be sampled than are larger items that require longer processing times. Since the effect of any of these biases is unknown in the present study, the following interpretations must be considered preliminary. More definitive statements may require correction for these biases through simultaneous use of several sampling methods (e.g. Taylor, 1962).

The present results suggest that *A. marginata* females did not feed randomly upon available prey. Two explanations may account for this finding. First, *A. marginata* females may have restricted attacks to those prey offering a "reasonable" chance of capture, but, within this subset, attempted capture of every prey encountered. Dietary composition may thus have reflected only differential capture probabilities for different types and sizes of "catchable" prey. Second, within the "catchable" subset of available prey, *A. marginata* females may have further restricted attacks to those prey yielding maximum rates of net energy intake. The foraging behavior of several insect predators (Charnov, 1976; Townsend and Hildrew, 1980) appears consistent with the predictions of optimal diet theory (review in Pyke et al., 1977). Consequently, dietary composition may have reflected not only differential capture probabilities, but also active discrimination within the subset of "catchable" prey.

While a rigorous assessment of these explanations is not possible, several observations suggest that differential prey vulnerability is a primary determinant of dietary composition. *Atractia marginata* females did not attempt capture of all sighted prey, e.g. large, fast flying prey such as euglossine bees and butterflies occasionally flew near an asilid but usually failed to elicit an attack response. Such prey were presumably ignored, since they offered only minimal chance of successful capture. The positive electivity found for Coleoptera and the difference in the electivity values noted between nematocerous and non-nematocerous Diptera are consistent with my subjective assessment of the relative vulnerability of these groups. A combination of slow and relatively straight flight may have rendered beetles more susceptible to predation. Most Diptera, if not faster fliers, appeared to have erratic flight paths and consequently may have been more difficult to capture. However, the slow flying nematocerans may have been more easily captured than the non-nematocerans (e.g. phorids and stratiomyids), which are probably more rapid fliers. Finally, the negative electivity values found for the larger beetles and flies are consistent with the assumption (Hocking, 1953) that, within a prey taxon, larger individuals are more rapid fliers and hence more difficult to capture and subdue than smaller individuals.

Prey density has often been considered an important determinant of robber fly foraging activity (Lavigne and Holland, 1969; Dennis and Lavigne, 1975; Scarbrough and Norden, 1977). However, quantitative evidence has been lacking. The present results indicate that the foraging rate of *A. marginata* females varied directly with prey abundance. Total prey abundance and foraging rate were approximately 3 times greater in the low section than in the high section. Interestingly, despite higher prey abundance in the low section, females did not exhibit an "aggregative response" (Hassell et al., 1976). That is, females did not appear to concentrate their foraging efforts in the area with greater prey density. Females could always be found in both sections, and no clustering of individuals in the low section was ever apparent. While air temperature and light levels appeared identical in both sections, it is possible that factors unrelated to prey density (e.g. aggressive encounters among females) affected the distribution of females along the log.

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A TAXONOMIC REVIEW OF *CYSTEODEMUS* LeCONTE, *PHODAGA* LeCONTE AND *PLEUROPASTA* WELLMAN (COLEOPTERA: MELOIDAE: EUPOMPHINA) WITH A NEW GENERIC SYNONYMY

John D. Pinto

Department of Entomology, University of California, Riverside, California 92521.

Abstract.—Three small genera of southwestern North American Meloidae, *Cysteodemus, Phodaga* and *Pleuropasta*, are reviewed. *Negalius* Casey is treated as a synonym of *Phodaga* (New Synonymy). Included are generic and species synonymies, species diagnoses, and a summary of the seasonal and geographic distribution of all species.

The subtribe Eupomphina includes seven small but highly distinctive genera of meloid beetles from the arid regions of southwestern North America. Four of these, *Megetra* LeC., *Cordylospasta* Horn, *Tegrodera* LeC. and *Eupompha* LeC. have recently been revised (Selander, 1965; Pinto, 1972a, 1975, 1979). In preparation for a generic classification of the subtribe, a review of the remaining genera, *Cysteodemus, Phodaga* and *Pleuropasta*, is presented here. There are no particular difficulties with these genera and the only taxonomic modification proposed is the synonymy of *Phodaga* and *Negalius*. However, this paper does provide the first opportunity to summarize the geographic and seasonal distribution of all species, and to present generic and species synonymies as well as pertinent diagnoses. Comments on intergeneric relationships will be deferred.

The genera treated here each contain two species. All are confined to desert areas. *Cysteodemus* and *Pleuropasta* both have an eastern (Chihuahuan) and a western (Mojave and Sonoran) representative. Congeners are dichopatric (see Figs. 13, 15). In *Pleuropasta* and *Cysteodemus*, adult activity is correlated with the period of maximum precipitation. Thus, western desert species (*Cysteodemus armatus* and *Pleuropasta mirabilis*) occur primarily in spring or early summer; eastern representatives (*C. wislizeni* and *P. reticulata*) are most common from mid-summer to early autumn (see Tables 1–4). *Phodaga* differs in that its species overlap geographically (Fig. 14). The geographic and seasonal distribution of *Phodaga alticeps* is similar to that of *Pleuropasta mirabilis*, and the two are frequently collected together feeding on species of *Coldenia* (Boraginaceae). *Phodaga marmorata*, however, is unique within the Eupomphina in that it ranges continuously from the Chihuahuan to the Sonoran and Mojave deserts. Although wide ranging, its seasonal distribution throughout is typical of Chihuahuan Desert eupomphines (i.e. primarily summer and autumn).

Phodaga alticeps, Pleuropasta mirabilis and *Cysteodemus armatus* do not occur throughout the Sonoran Desert. They are primarily localized in the lower and drier western section, referred to as the Colorado Desert or Lower Colorado Valley. *P. mirabilis* and *C. armatus* are thus separated from their Chihuahuan Desert congener by ca. 400 km.

Collection data reported below are based on literature records and material examined in numerous museums and private collections. The collections of the California Academy of Sciences, California Department of Food and Agriculture, University of Arizona, and University of California (Berkeley, Davis and Riverside) provided the majority of records.

Cysteodemus LeConte

Cysteodemus LeConte, 1851: 158 (type-species *Cysteodemus armatus* LeConte, herein designated; Wellman (1910b) erroneously listed *C. armatus* as the type-species of *Cysteodemus* by original designation); 1853: 329; 1858: 11; 1859: 126; 1862: 269. LeConte and Horn, 1883: 416. Champion, 1892: 369. Beauregard, 1890: 409, 411. Wellman, 1910a: 215–221, *passim*; 1910b: 391. Van Dyke, 1928: 458. Bradley, 1930: 114. Denier, 1935: 146, 176. Vaurie, 1950: 6, 60. MacSwain, 1956: 21, 24, 35. Kaszab, 1959: 80, 99; 1969: 243. Arnett, 1963: 623–624. Gupta, 1965: 468; 1971: 27. Erickson, 1973: 785. Pinto, 1977a: 389; 1977b: 947–950, *passim*.

Robust, wingless, subglabrous, elytra inflated and connate along suture. Body length varying from 7–18 mm, breadth across elytra ⅔–⅘ body length.

Head with antennal sockets directly above base of lateral margin of clypeus. Eyes broadly emarginate anteriorly, with longitudinal axis directed toward front of head (Fig. 3). Labrum shallowly emarginate. Antennae 11-segmented, subfiliform, uniformly setate, relatively short, only slightly longer than protibiae. Pronotum transverse, much broader than long, angulate or spinose laterally (Figs. 10–12). Elytra strongly reticulate. Legs slender; two subequal spiniform spurs at apex of all tibiae, spurs brown except those of middle and hind legs usually yellowish at apex; tarsal claws with relatively small ventral tooth at base. Abdomen with anterior four terga distinctly less sclerotized than others. Aedeagus with 1 or 2 ventral spines and 1 dorsal spine; posterior ventral spine near apex (Fig. 8).

Remarks.—The inflated and connate elytra separate *Cysteodemus* from all other North American meloids.

Cysteodemus was described by LeConte (1851) for the two species currently included. In 1853 LeConte treated another wingless species, *Meloe cancellatus* Brandt and Erichson, as a *Cysteodemus*, but eventually removed it, placing it in its own genus, *Megetra* (LeConte, 1859).

Adults of *Cysteodemus* were redescribed by Van Dyke (1928). The first instar larvae of both species were described by MacSwain (1956).

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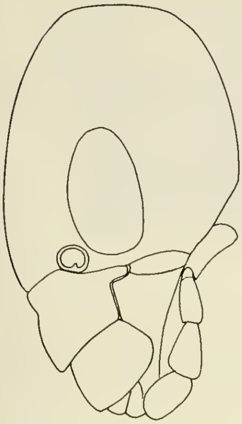
Figs. 1–9. Figs. 1–3. Head (lateral view) of eupomphine genera showing position of eye relative to front. 1, *Phodaga marmorata*. 2, *Pleuropasta mirabilis*. 3, *Cysteodemus armatus*. Figs. 4–5. Head (anterior view) of eupomphine genera showing structure of clypeus and position of antennal sockets relative to lateral clypeal margins. 4, *Phodaga marmorata*. 5, *Cysteodemus armatus*. Figs. 6–9. Aedeagus (lateral view) of eupomphine species. 6, *Pleuropasta reticulata*. 7, *Pleuropasta mirabilis*. 8, *Cysteodemus armatus*. 9, *Phodaga alticeps*.



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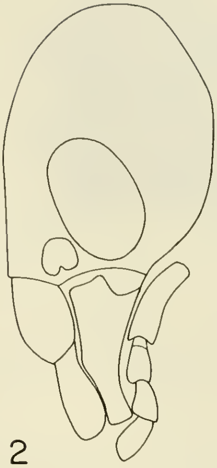

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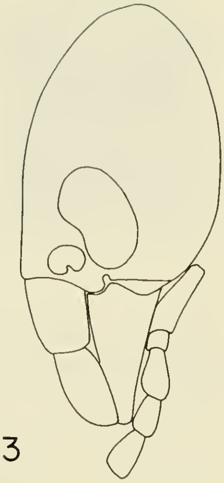

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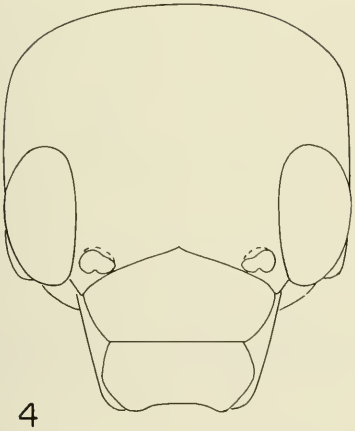

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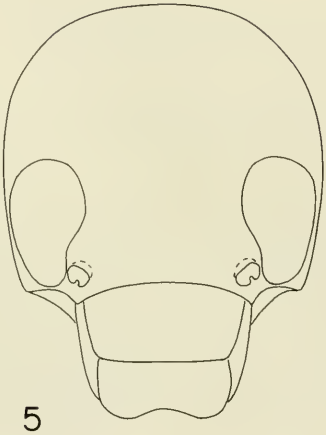

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Figs. 10–12. Pronotum of *Cysteodemus* illustrating inter- and intraspecific variation. 10, *C. wislizeni*. 11, *C. armatus* (from Wilsona, Los Angeles Co., CA), an example of poorest development of lateral spines in species. 12, *C. armatus* (from 3.5 mi. NW Glamis, Imperial Co., CA) an example of highest development of lateral spines in species.

SPECIES DIAGNOSES

Cysteodemus armatus LeConte: Pronotum distinctly spinose laterally (Figs. 11, 12), disc abruptly declivous posteriorly; elytra with relatively large reticula (a line drawn over longest aspect of elytra traverses ca. 20 reticula); legs of both sexes lacking tarsal pads; head moderately coarsely punctate, punctures moderately dense and ill-defined; dorsal coloration black, often with a slight metallic blue, green or violet tint; commonly with white, yellow or yellow-brown incrustation on head, pronotum and elytra. Inhabiting the Colorado and Mojave deserts.

Cysteodemus wislizeni LeConte: Pronotum angulate or, at most, tuberculate laterally, never spinose (Fig. 10), disc only slightly declivous posteriorly; elytra with smaller, more numerous reticula (a line drawn over longest aspect of elytra traverses ca. 30 reticula); legs of male with heavy tarsal pads on segments I and II of pro- and mesotarsi; head with coarse, distinct and dense punctures; dorsal coloration deep metallic blue, green or violet; cuticle shining, lacking an incrustation. Inhabiting the Chihuahuan Desert.

***Cysteodemus armatus* LeConte**

Cysteodemus armatus LeConte, 1851: 158; 1853: 330; 1859: 126. Wellman, 1910b: 391. Van Dyke, 1928: 459. La Rivers, 1938: 124. Gupta, 1965: 451; 1971: 11. Werner et al., 1966: 8, 29. Leppla, 1976: 49. Pinto, 1977a: 389. Cohen and Pinto, 1977: 741. Cohen et al., 1981: 179.

Types.—From California, desert near the Colorado River, in the Museum of Comparative Zoology, Harvard University.

Geographic distribution.—Figure 13. Confined to the Colorado and Mojave deserts. Typically associated with creosote scrub vegetation. *C. armatus* is not known further north than the Panamint and Death valleys in California. Saline and Eureka valleys to the immediate north present a similar habitat, but the species has never been taken there in spite of heavy collecting in both areas in recent years.

Seasonal distribution.—Table 1. 1 February (Seeley, Imperial Co., CA)–29 June (Victorville, San Bernardino Co., CA). Although overlap is considerable, populations in the Colorado Desert (S of 34°N) are significantly earlier than those to the north in the Mojave Desert (N of 34°N) (see Table 1). Unlike *Phodaga alticeps*

Table 1. Seasonal distribution and its geographic variation in *Cysteodemus armatus* with frequencies expressed as semi-monthly percentages of total records.

Area	Semi-monthly intervals[1,3]										Total records[2]
	Feb-A	Feb-B	Mar-A	Mar-B	Apr-A	Apr-B	May-A	May-B	Jun-A	Jun-B	
I. S of 34°N	1	1	6.1	30.6	37.4	16.3	4.8	0	2.0	1	147
II. N of 34°N	0	0	0	8.3	17.9	39.3	25.0	7.1	1.2	1.2	84

[1] (A) following the month refers to records from the 1st to the 15th—(B) to records after the 15th.
[2] A record consists of one or more specimens collected at a locale on a particular date.
[3] In Area I (Colorado Desert) the majority of the records are prior to 15 April; in Area II (Mojave Desert) most are after this date ($\chi^2 = 56.86$; $P < .001$).

and *Pleuropasta mirabilis* (see below), *C. armatus* has never been taken in late summer or in autumn.

Adult hosts.—Adults of *C. armatus* are most commonly found feeding on flowers of creosote (*Larrea tridentata* Cov.; Zygophyllaceae), but frequently eat blooms of other desert plants as well. Other food plants recorded are: *Acamptopappus sphaerocephalum* Gray, *Chaenactis* spp., *Geraea canescens* T. & G., *Palafoxia linearis* (Cav.) (Asteraceae); *Gilia* spp., *Langloisia matthewsii* (Gray) (Polemoniaceae); and *Coldenia* spp. (Boraginaceae).

Creosote bush is a predictable food source for *C. armatus* even in the driest of years. Quantitative data are lacking, but it is my impression that, when available, plants other than creosote are preferred.

Remarks.—The structure of the pronotum is variable in *C. armatus.* Although typically abruptly declivous posteriorly, it is barely so in some. The expression of the pronotal spines also varies (Figs. 11, 12). At an extreme, most common in the southern portion of the range, each spine is elongate, strongly curved apically and accompanied by a smaller spine at its base.

The color of the incrustation covering the dorsal surface of most *C. armatus* varies continuously from white to yellow-brown. All forms are known from all geographic regions. However, the frequency of the color classes may vary geographically. In the Colorado Desert (S of 34°N), 42.6% of the series examined with an incrustation were white to very light yellow (n = 68). Mojave Desert populations (N of 34°N) are more commonly yellow or yellow-brown; only 24.2% of the series examined were white or light yellow (n = 33). A chi-square test on these limited data was not significant at the 5% level. Although this incrustation has not been completely analyzed, preliminary study indicates that it is a nitrogenous secretion (Cohen and Pinto, unpubl.).

Gupta (1971) erroneously characterized this species as having 2 dorsal and 2 ventral spines on the aedeagus. All specimens that I have examined possess but 1 of each.

Records.—MEXICO. BAJA CALIFORNIA NORTE: Cocopah Mts.; Laguna Salada, N end; Los Medanos, 10.3 mi. SW; Palacio, 15 & 20 mi. S; Rio del Mayor, 35 mi. S; San Felipe, & 3, 25, 35, 50 mi. N, and 14, 18 mi. S. SONORA: El Golfo, 6 mi. N & 36 mi. NE. UNITED STATES. ARIZONA: *Pinal Co.* Sacaton. *Maricopa Co.* Gila Bend, 18 mi. S. *Mojave Co.* Alamo Crossing; Bullhead City; Oatman; Topock. *Yuma Co.* Aztec, 2 mi. E; Dateland, 6 mi. N & 20 mi. E; Ehrenberg, & 5 mi. N; Ligurta; Martinez Lake, 1 mi. SE; Mohawk; Parker, & 8 mi. SE; Quartzsite; San Luis; Tinaja Atlas Mts.; Wellton, & 4 mi. E, 15 mi. S;

Yuma, 21 mi. N. CALIFORNIA: *Imperial Co.* Brawley, 15 mi. W; Chocolate Mts.; Fig Tree John's; Glamis, & 7 mi. W, 2 mi. N, 3.5 mi. NW (Algodones Dunes), 10 mi. N; Grays Well; Harpers Well; Holtville, & 5 mi. W; Kane Springs; Niland; Ocotillo, 5 mi. N; Ogilby Rd., 3 mi. S Jct. Hwy. 78; Palo Verde; Plaster City, 15 mi. N; Pinto Wash; Potholes; Seeley, S of; Signal Mtn., at base of; Superstition Mtn.; Winterhaven, 12 & 31 mi. W; Westermoreland, 15 mi. NW. *Inyo Co.* Argus Mts.; Death Valley Jct., 10 mi. S; Death Valley National Monument (Ashford Mill, Furnace Ck., Confidence Mill, Jct. Hwy. 178 & Saratoga Spgs. Rd.); Darwin; Darwin Falls; Little Lake, & 10 mi. S; Panamint Springs, 2 mi. E; Panamint Valley, Jct. Trona & Ballarat Rds.; Shoshone, 15 mi. S; Trona, 14 mi. N, 17 mi. NE; Valley Wells. *Kern Co.* Brown, 5 mi. E; China Lake; El Paso Mts. (Iron Cyn.); Inyokern, & 7 mi. NE; Mojave; Searles Station; Short Cyn.; Ridgecrest; Rosamond. *Los Angeles Co.* Acton; Lancaster; Llano, & 7 mi. S; Lovejoy Buttes; Valyermo, 2 mi. NW; Wilsona. *Riverside Co.* Blythe, & 18 mi. W, 22 mi. W, 8 mi. N; Box Cyn.; Coachella; Cottonwood Spgs.; Desert Center, 5 mi. N, 18 mi. E; Desert Hot Springs; Dos Palmas; Edom, 4 mi. E; Hopkins Well; Indio, & 3 mi. E, 20 mi. E, 22 mi. S; Joshua Tree National Monument (Cholla Gardens, Hidden Valley, SE entrance); Mecca, & 7 mi. E, 10 mi. E, 10 mi. S; McCoy Spgs.; Oasis, 2 mi. S; Painted Cyn.; Palm Cyn.; Palm Desert, 3.5 mi. S (Boyd Desert Reserve); Palm Springs; Rancho Mirage; Shavers Well; Taquitz Cyn.; Thermal; Thousand Palms, & 6 mi. NE; Whitewater. *San Bernardino Co.* Afton; Amboy, 3 mi. E; Amboy Crater; Amboy Lava Flow; Baker; Barstow, & 3 mi. W; Cronise Valley; Daggett; Essex, 18 mi. E; Goffs; Joshua Tree; Jolly's Corner, 4 mi. E (nr. Hesperia); Kelso, 2.5 mi. S; Kramer Hills; Kramer Jct., 2 mi. S; Lobecks Pass; Lucerne Valley; Ludlow; Manix; Morongo Valley, 1 mi. N; Needles; Old Dale, 5.4 mi. NW; Old Woman Springs; Parker Dam; Phelan, 10 mi. E; Providence Mts. (Bonanza Mine); Rice, 3 mi. N; Salt Wells, 7 mi. W; Saratoga Springs; Tecopa, 12 mi. ESE; Twentynine Palms, & 3 mi. N; Victorville; Vidal Junction, 7 mi. N; Westend; Yermo; Yucca Valley, 10 mi. N; Zzyzx Springs, dunes S of. *San Diego Co.* Agua Caliente (Springs); Borrego Valley; Borrego Springs, & 3 mi. E; Coyote Ck., Anza Borrego State Park; Jacumba, 5 mi. E; Ocotillo Wells; Split Mtn. Rd. (nr. Ocotillo Wells); Sweeney Pass; NEVADA: *Clark Co.* Dead Mts.; Glendale, 1.6 mi. E; Logandale; Stump Spring.

Cysteodemus wislizeni **LeConte**

Cysteodemus wislizeni LeConte, 1851: 158; 1853: 330; 1859: 126; Dugès, 1889: 40. Champion, 1892: 369 (as *wizlizeni*, in error). Van Dyke, 1928: 460. Vaurie, 1950: 60. Selander, 1954: 85. Dillon, 1952: 368. MacSwain, 1956: 36. Pinto, 1977a: 389.

Types.—From New Mexico, in the collection of the Museum of Comparative Zoology, Harvard University.

Geographic distribution.—Figure 13. Within and peripheral to the Chihuahuan Desert, from northern Durango and southern Coahuila, north to northern New Mexico. A single Arizona record from Pima Co., AZ (Oct. 1928), cited by Werner et al. (1966) is the only report of this species west of the Continental Divide. The locale is ca. 200 km from the continuous range of *C. wislizeni*. The record is not mapped in Fig. 13; it should be confirmed by additional collections.

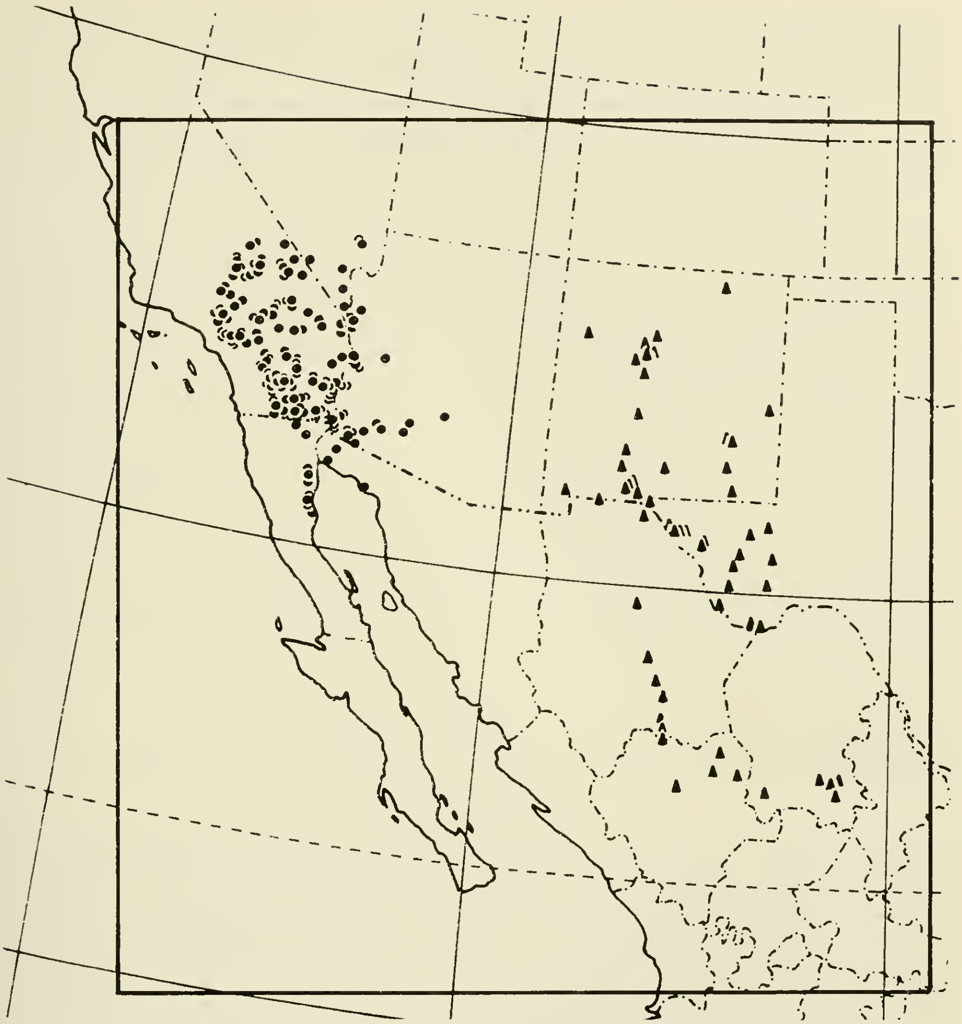

Fig. 13. Geographic distribution of *Cysteodemus armatus* (dots), and *C. wislizeni* (triangles).

Seasonal distribution.—Table 2. 10 March (Presidio, TX)–8 November (70 km. N Saltillo, Coahuila). The records available do not suggest geographic variation in season of adult activity. Adults have been most commonly taken in August in all areas. Collection dates approaching the two extremes of the seasonal range are known from the same locale in different years (e.g. 16 June & 11 September at Fort Hancock, TX; 25 May & 16 August at Loving, NM).

Adult hosts.—Selander (1954) records adults of *C. wislizeni* feeding on *Aster* sp. (Asteraceae), *Tidestromia lanuginosa* (Nutt.) (Amaranthaceae) and *Kallstroemia parviflora* Norton (Zygophyllaceae). Werner et al. record *Solanum eleagnifolium* Cav. (Solanaceae) as a common host, and Pinto (1977a) recorded numerous specimens feeding on flowers of *Gilia longiflora* (Polemoniaceae) and foliage of *Tribulus terrestris* L. (Zygophyllaceae).

Table 2. Seasonal distribution of *Cysteodemus wislizeni* with frequencies expressed as monthly percentages of total records.

Total records	Month								
	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.
65	1.5	4.6	6.2	10.8	13.8	36.9	16.9	7.7	1.5

Records.—MEXICO. CHIHUAHUA: Chihuahua, 30 & 25 mi. S; Ciudad Camargo, 10 mi. N, 42 mi. SW; Delicias; Hidalgo del Parral, 27 mi. E; Samalayuca, 29 km. N; Sueco. COAHUILA: Guadelupe; Saltillo, 70 km. N; San Pedro de las Colonias. DURANGO: Bermejillo, 16 mi. N; Ceballos; La Zarca, 2 mi. SE; Villa Lerdo; Yermo. UNITED STATES. NEW MEXICO: *Bernalillo Co.* Rio Puerco; Albuquerque, 7 mi. NE. *Chaves Co.* Bottomless Lake State Park; Pecos River (near Roswell). *Colfax Co.* Koehler. *Dona Ana Co.* Las Cruces, & 4 mi. E; Mesilla Dam; Mesilla Park, 3 mi. E, 3 mi. S; Jornada Range Reserve (S entrance); Rincon, 6 mi. N. *Eddy Co.* Artesia, S of; Loving. *Grant Co.* County record only. *Luna Co.* Columbus, 1 mi. W. *McKinley Co.* Coolidge. *Otero Co.* Alamogordo, 36 mi. SE. *Roosevelt Co.* Portales. *Sandoval Co.* Bernalillo, 4 mi. N; Coronado; Domingo. *Sierra Co.* Truth or Consequences, 17 km. S. *Socorro Co.* San Antonio, 2 mi. E. *Valencia Co.* Los Lunas. TEXAS: *Brewster Co.* Big Bend National Park (Santa Elena); Castolon; Chisos Mts.; Marathon. *Culberson Co.* Van Horn, & 6 mi. N. *El Paso Co.* El Paso. *Jeff Davis Co.* Davis Mts. *Hudspeth Co.* Finley; Fort Hancock; McNary, 3 mi. SE; Sierra Blanca. *Presidio Co.* Presidio; San Estaban. *Reeves Co.* Balmorhea; Pecos; Toyahvale, 3 mi. S. *Ward Co.* Peyote, 6 mi. N.

Phodaga **LeConte**

Phodaga LeConte, 1858: 76 (type species, *Phodaga alticeps* LeConte, by monotypy). LeConte and Horn, 1883: 420, 422. Beauregard, 1890: 433. Wellman, 1910a: 215, 221; 1910b: 394. Van Dyke, 1928: 405. Bradley, 1930: 113. Dillon, 1952: 374. MacSwain, 1956: 21, 28. Kaszab, 1959: 80, 99; 1969: 243. Arnett, 1963: 623, 624. Gupta, 1965: 468; 1971: 27. Pinto, 1972b: 459; 1972c: 577; 1977b: 949.

Negalius Casey, 1891: 175 (type species, *Negalius marmoratus* Casey, by monotypy). Wellman, 1910a: 221; 1910b: 394. Van Dyke, 1928: 405. Bradley, 1930: 113. Dillon, 1952: 374, 376. MacSwain, 1956: 21, 29. Kaszab, 1959: 80, 99; 1969: 243. Arnett, 1963: 623, 624. Gupta, 1965: 468; 1971: 27. Pinto, 1972b: 459; 1977b: 949. NEW SYNONYMY.

Elongate to moderately robust, holelytrous, fully winged, cuticle entirely black. Body length varying from 6–25 mm.

Head with antennal sockets dorsomedial to lateral margin of clypeus (Fig. 4). Eyes not noticeably emarginate anteriorly, with long axis subparallel to front of head (Fig. 1). Clypeus with basal suture arcuate or angulate (Fig. 4). Labrum slightly but distinctly concave, emarginate or not. Mandibles usually tridentate at apex. Antennae short, subequal in length to protibia, 11-segmented, segments subquadrate, laterally compressed. Pronotum subquadrate, slightly wider than long, sides subparallel, disc more distinctly convex at basal ½, abruptly declivous to basal margin, bilobed basally. Elytra not strongly reticulate. Legs slender, elongate, each with 2 spurs at apex of tibia, anterior (outer) spur typically shorter, metatibial spurs yellowish in color. Fore and middle legs sexually dimorphic. Protarsi with segment I flanged in male. Aedeagus with 2 small ventral spines, and 1 dorsal spine; posterior ventral spine distinctly subapical (Fig. 9).

Remarks.—Synonymizing *Negalius* with *Phodaga* is clearly justified on phenetic and cladistic grounds (Pinto, MS). As indicated in an earlier paper (Pinto, 1977b), it is primarily the anatomical correlates of courtship behavior that separate the two. Differences in elytral sculpturing, setal coloration and distribution, head shape, and claw structure, also used for separation, are superficial. Considering the apparent recent origin of distinctive courtship displays in the Eupomphina (Pinto, 1977b), the numerous similarities between the two argue convincingly for synonymy at the generic level. The first instar larvae of both are almost identical (MacSwain, 1956), and adults share several derived traits unique within the subtribe. These include the flanged first protarsal segment in males, the more medial position of the antennal sockets (cf. Figs. 4, 5), the typically tridentate mandibles, eye structure (cf. Figs. 1–3), the concave labrum, and the shortened, laterally compressed antennae. Although courtship behavior is different, the use of the middle legs in male display is an additional shared derived trait unique within the Eupomphina (Pinto, 1972, 1977b). According to Gupta (1965) the two species are also distinguishable from other eupomphine genera on the basis of stomodeal anatomy.

SPECIES DIAGNOSES

Phodaga marmorata (Casey): Elytra obsolescently reticulate with a variegated pattern of cinereous pubescence at floor of reticula; occiput evenly convex; protarsal segment I of male with a ventral flange, lacking a basal fovea; pro- and mesotibia of male normal, not enlarged; mesotarsi of male slightly inflated, subglabrous; mesotibial spurs strongly unequal, length of posterior spur ca. ½ that of anterior spur; antennae not sexually dimorphic; body broadly tumid posteriorly, elytra only moderately declivent laterally, width across elytra increasing posteriorly.

Phodaga alticeps LeConte: Elytra relatively smooth, subglabrous; occiput distinctly acuminate; protarsal segment I of male with both a ventral flange and a deep basal fovea; mesotibia of male inflated, with a deep ventral furrow; mesotarsi of male not inflated; length of posterior mesotibial spur greater than ½ length of anterior spur; antennae sexually dimorphic, segments III–V of male wider and subglabrous anteriorly; body linear, elytra distinctly declivent laterally, width across elytra not increasing posteriorly.

Phodaga marmorata (Casey), NEW COMBINATION

Negalius marmoratus Casey, 1891: 175. Dillon, 1952: 377. MacSwain, 1956: 29. Gupta, 1965: 453; 1971: 12. Werner et al., 1966: 7, 26. Pinto, 1972b: 459; 1977b: 949. Cohen and Pinto, 1977: 742.

Type information.—2 males, from western Texas, in the collection of the United States National Museum, Washington, D.C.

Geographic distribution.—Fig. 14. Occurs in the Rio Grande Valley from near Albuquerque, NM, south to the Big Bend region of Texas and then west through

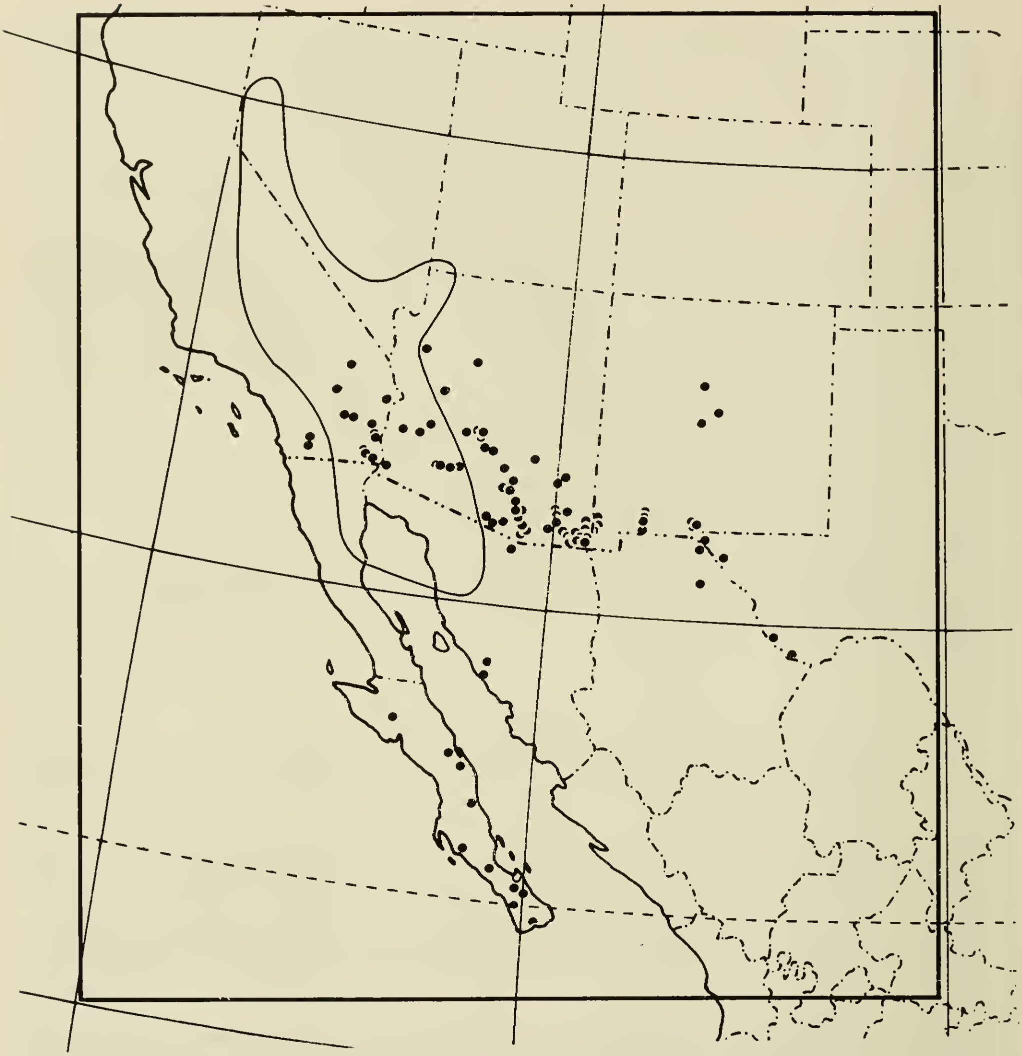

Fig. 14. Geographic distribution of *Phodaga marmorata* (dots), and *P. alticeps* (solid, irregular outline). See Pinto, 1972c for detailed distribution map.

southern Arizona and Sonora to the Colorado and Mojave deserts of California. Also occurring in Baja California Sur; currently unknown from Baja California Norte.

P. marmorata is not as commonly taken in the western portion of its range. This is probably attributable to the less frequent summer rainfall in these regions.

Seasonal distribution.—Table 3. 28 June (El Paso, TX)—17 October (Blythe, CA). Occurs most commonly prior to September in Chihuahuan Desert locales, and in September or later in the Sonoran and Mojave deserts (see Table 3). The seasonal distribution in Baja California Sur is similar to that of populations to the northwest (primarily September).

Adult hosts.—Recorded feeding on flowers and foliage of *Pectis papposa* Harv.

Table 3. Seasonal distribution and its geographic variation in *Phodaga marmorata* with frequencies expressed as monthly percentages of total records.

Area	Month[3] June	Jul.	Aug.	Sept.	Oct.	Total records
Chihuahuan Desert[1]	2.4	9.5	73.8	14.3	0	42
Mojave & Sonoran deserts[2]	0	2.0	28.0	58.0	12.0	50

[1] Locales in New Mexico, Texas, Cochise Co., Arizona, and Chihuahua.

[2] Locales in California, Arizona (except Cochise Co.), Sonora, and Baja California Sur.

[3] More commonly taken before 1 September in the eastern portion of the range; more common after 1 September in the west ($\chi^2 = 28.68$; $P < .001$).

& Gray (Asteraceae), *Kallstroemia grandiflora* Torr. and *Tribulus terrestris* L. (Zygophyllaceae). I have observed large populations of *P. marmorata* feeding on all three species.

Records.—MEXICO: BAJA CALIFORNIA SUR. Guerrero Negro, 57 km SE; La Paz, & 51 km W; Loreto, ca. 35 mi. N, 48 km S; Mulege, 26 km SSE (El Coyote); Pescadero; San Antonio, 7 mi. S; Santa Rita, 9 km SE. CHIHUAHUA. Ojo del Lucero, 5 mi. N; Samalayuca, 29 km N. SONORA. Empalme; Guaymas, 51 km N; Santa Ana, 3 mi. N. UNITED STATES: ARIZONA. *Cochise Co.* Apache, 3.3 mi. S, 5 mi. SE; Douglas, & 10 mi. NW, 17 mi. E; Dos Cabezas; Elfrida; Kansas Settlement; McNeal; Pinery Cyn.; Pearce; Portal, & 2 mi. SE, 4 mi. E; Tex Cyn.; Willcox, & 3 mi. S. *Gila Co.* Globe. *Graham Co.* Bonita; Safford. *Maricopa Co.* Aguila, 12.7 mi. W; Gila Bend, & 1 mi. W, 11 & 20 mi. E; Litchfield Park; Mesa, near; Phoenix; Salt River Indian Reservation; Sentinel, & 5 mi. E. *Mojave Co.* Kingman, 10 mi. E. *Pima Co.* Baboquivari Mts.; Continental, 5 mi. E; Madera Cyn.; Robles Jct., 6 mi. S; Sabino Cyn.; Sells, 5 mi. NW; Tucson, & 2 mi. E, 7 mi. N, 10 mi. S. *Pinal Co.* Florence, & 20 mi. S; Higley; Picacho Pass; Redrock. *Santa Cruz Co.* Atascosa Mts.; Nogales, 12 mi. N. *Yavapai Co.* Ashfork; Santa Maria River, 4 mi. N on Hwy. 93. *Yuma Co.* Quartzsite, 10 mi. E; Salome; Wenden, 2 mi. E; Yuma, 3 mi. N. CALIFORNIA. *Imperial Co.* Indian Wash (on Ogilby Rd.); Glamis, & 3 mi. NW; Palo Verde, & 2 mi. S. *Riverside Co.* Blythe, 20 mi. W; Chiriaco Summit, 5 mi. E; Desert Center. *San Bernardino Co.* Kelso, 20 mi. S (Granite Mts.); Twentynine Palms; Vidal Jct. *San Diego Co.* Anza Borrego State Park, Box Cyn. (ambiguous); San Felipe, W of; Scissors Crossing, & 3 mi. W. NEW MEXICO. *Bernalillo Co.* Albuquerque, 7 mi. NE. *Dona Ana Co.* La Mesa; Las Cruces, 4 & 5 mi. E; Mesilla Park, 3 mi. N; Mesquite. *Grant Co.* Hachita, 17 mi. N. *Luna Co.* Columbus, 1 mi. W; Deming, 20 mi. E, 8 & 14 mi. S. *Hidalgo Co.* Lordsburg; Peloncillo Mts. (Granite Pass); Rodeo, 1, 15, & 18 mi. N. *Socorro Co.* Bernardo, near (as 31 mi. W Mountainair, Torrence Co.). TEXAS. *El Paso Co.* El Paso. *Brewster Co.* Big Bend National Park (Santa Elena Cyn.). *Hudspeth Co.* Finlay. *Presidio Co.* Presidio.

***Phodaga alticeps* LeConte**

Phodaga alticeps LeConte, 1858: 76. Hubbard, 1901: 186. Varley, 1939: 101. Werner et al., 1966: 7, 28. Pinto, 1972b: 459; 1972c: 577; 1977c: 204. Cohen and Pinto, 1977: 741.

The bionomics of *P. alticeps* was covered in earlier papers (Pinto, 1972b, c, 1977c). The species is primarily vernal and occurs in the Colorado Desert, and north through the Mojave Desert to the periphery of the Great Basin. Species of *Coldenia* serve as primary host plants. On one occasion I also found a few individuals feeding on flowers of another Boraginaceae, *Cryptantha micrantha* (Torr.).

P. alticeps is sympatric with *P. marmorata* in the Mojave and Colorado deserts. Since *P. marmorata* occurs in late summer or early autumn in these areas, it is primarily asynchronous to its vernal congener. However, adults of *P. alticeps* do occasionally occur in autumn (Pinto, 1977c), and I am currently aware of one record of both species being collected together at the same locale (20 mi. S Kelso, Granite Mts., San Bernardino, CA; 10 Oct. 1977).

***Pleuropasta* Wellman**

Pleuropasta Wellman, 1909: 20 (type species, *Calospasta mirabilis* Horn, original designation); 1910a: 221; 1910b: 392. Dillon, 1952: 374, 376. Pinto, 1977b: 949.

Pleurospasta: Van Dyke, 1928: 401, 405. Bradley, 1930: 114. Vaurie, 1950: 6, 56. MacSwain, 1956: 21, 25, 30. Kaszab, 1959: 80, 99; 1969: 244. Arnett, 1963: 623, 625. Gupta, 1965: 468; 1971: 27. *Incorrect Subsequent Spelling.*

Small to moderate size, elongate, holelytrous, fully winged, cuticle yellow and brown with black coloration confined to small portions of elytra at most. Body length 6–13 mm.

Head with antennal sockets directly above base of lateral margin of clypeus. Eyes very slightly emarginate anteriorly, with longitudinal axis not quite subparallel to front of head (Fig. 2). Clypeus with basal margin slightly to distinctly arcuate. Labrum shallowly emarginate or not. Antennae 11-segmented, subfiliform, moderately long (ca. 50% longer than the protibiae). Pronotum distinctly constricted at apical ¼, bilobed basally. Elytra with 4 distinct longitudinal costae on disc, yellow with brown to black apical and postmedian bands, each elytron with 1 or more basal spots. Legs elongate, slender, not sexually dimorphic except for degree of tarsal pad development, each with 2 spurs at apex of tibia, anterior (outer) spur slightly but distinctly shorter, metatibial spurs yellowish in color. Aedeagus with 2 small ventral spines, and 1 dorsal spine; posterior ventral spine distinctly subapical (Figs. 6, 7).

Species Diagnoses

Differences between *P. mirabilis* and *P. reticulata* were detailed by Vaurie (1950).

Pleuropasta mirabilis (Horn): Elytral costae distinct to apex, connected by relatively few transverse ribs which are weaker than the longitudinal costae themselves; frons and base of clypeus distinctly convex; basal margin of clypeus arched; male with antennal segment III slightly excavated basally; gonoforceps with lateral lobes straight, subparallel, lobes not noticeably setate apically; aedeagus with dorsal spine slender, elongate (Fig. 7).

Pleuropasta reticulata Van Dyke: Elytral costae anastomosing at postmedial fascia, transverse ribs in area of fascia as strongly developed as longitudinal costae; frons and base of clypeus not distinctly convex; basal margin of clypeus feebly arcuate; male with antennal segment III normal, without basal excavation; gonoforceps with lateral lobes bowed outward at apex, distinctly setate apically; aedeagus, with dorsal spine short, robust (Fig. 6).

Pleuropasta mirabilis **(Horn)**

Calospasta mirabilis Horn, 1870: 93; 1891: 100. Champion, 1892: 393 (in part, not incl. Coahuila rec. & Fig.).

Pleuropasta mirabilis: Wellman, 1909: 21; 1910b: 392. Dillon, 1952: 376 (in part, not incl. TX & Mex. recs.). Pinto, 1977b: 939, 949; 1977c: 204.

Pleurospasta mirabilis mirabilis: Van Dyke, 1947: 157.

Pleurospasta mirabilis: Vaurie, 1950: 57. MacSwain, 1956: 31. Kaszab, 1959: 81. Gupta, 1965: 451; 1971: 12. Werner et al., 1966: 27.

Type information.—Holotype from southern Arizona, in the collection of the Museum of Comparative Zoology.

Geographic distribution.—Figure 15. From NW Nevada, south along the western edge of the Great Basin through the Mojave and Colorado deserts to near Mulege in Baja California Sur. The distribution of *P. mirabilis* is similar to that of *Phodaga alticeps,* but the former is more common in the northern portion of the range and extends more than 500 km further south in Baja California.

Seasonal distribution.—Table 4. 13 March (10 mi. W Glamis, CA)–18 November (12 mi. W Glamis, CA). The range of *P. mirabilis* is divided into northern, central and southern portions. Although overlap is substantial, adult activity is generally delayed from south to north. Adults are active more commonly prior to May in the Sonoran Desert (S of 34°N). North of 34°N activity is most common in May or later. It is latest north of the Mojave Desert (N of 30°N) where most of the records are from June and July.

Although primarily a vernal species in the Mojave and Colorado deserts, adults of *P. mirabilis* are infrequently found here during early autumn apparently when summer rains are sufficiently heavy. This asynchrony is also characteristic of *Phodaga alticeps* (Pinto, 1977c).

Adult hosts.—Species of Boraginaceae. Most commonly collected feeding on flowers of *Coldenia palmeri* Gray and *C. plicata* (Torr.). Also taken by P. H. Timberlake on three occasions on species of *Cryptantha* [*C. angustifolia* (Torr.) and *C. barbigera* (Gray)].

Remarks.—Two of the characters listed by Vaurie (1950) as distinguishing *Pleuropasta* species are inadequate. *P. mirabilis* is characterized by lacking all black coloration, and having a pad on foretarsal segment I of males restricted to the apex only. Specimens examined from Baja California Sur are exceptions for both traits. In material from near Mulege and near San Ignacio, the elytra is black rather than brown at the postmedian and apical fascia. The only male from these locales (nr. Mulege) has a wide, complete pad on protarsal segment I. Since the species has not been collected commonly in Baja California, the form of this variation is unknown.

Records.—MEXICO: BAJA CALIFORNIA NORTE. Meling Ranch, 1 mi. E; Rancho Ines, 9 km NW (29°, 46′N, 114°, 46′W); San Felipe, & 14 mi. S. BAJA CALIFORNIA SUR. Mulege, 19 km. NW; San Ignacio, 39 km W. SONORA. El Golfo, 36 mi. SE. UNITED STATES: ARIZONA. *Maricopa Co.* Gila Bend, & 17 mi. S; Paradise Valley; Phoenix. *Mojave Co.* Oatman. *Pima.* Ajo; Tucson (Pantano Wash); Tucson, 8–12 mi. N. *Pinal Co.* Florence Jct.; Picacho. *Yuma*

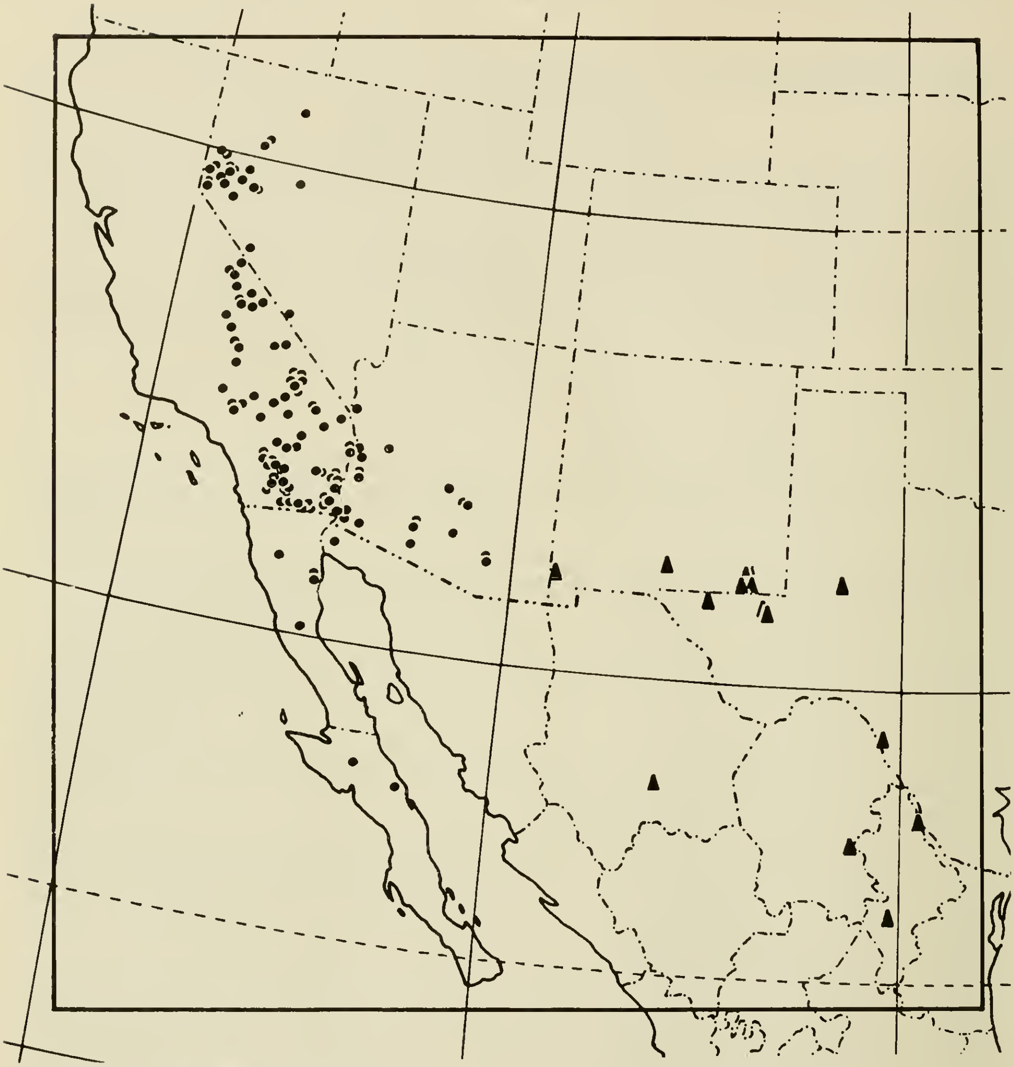

Fig. 15. Geographic distribution of *Pleuropasta mirabilis* (dots) and *P. reticulata* (triangles).

Co. Alamo Lake State Park; Ligurta; Martinez Lake, 1 mi. SE; Parker, 8 mi. SE; Quartzsite, & 9 mi. S; Wellton; Yuma. CALIFORNIA. *Imperial Co.* Bard; Bonds Corner, 4.7 mi. E; Calexico, 14 mi. E; Glamis, 3.5, 17 mi. NW, 10, 12.2 mi. W; Gordons Well; Harpers Well; Holtville; Holtville Airstrip; Kane Springs, & 2 mi. N; Palo Verde, & 3 mi. N; Plaster City, 2.5 mi. N; Seeley; Signal Mtn., at base of; Superstition Mtn.; Truckhaven. *Inyo Co.* Big Pine, & 4, 12 mi. S, 2 mi. E; Bishop; Death Valley National Monument (Jct. Hwy. 178 & Saratoga Springs Rd.); Deep Springs; Deep Springs College, 5 mi. S; Eureka Valley; Eureka Valley Dunes; Little Lake; Lone Pine, & 11 mi. W; Olancha; Solsberry Pass. *Kern Co.* China Lake; Indian Wells; Mojave. *Los Angeles Co.* Alpine Buttes; Black Butte; Lovejoy Buttes; Palmdale; Pearblossom, 5 mi. NNE. *Mono Co.* Benton Hot Springs; Paradise Camp; Toms Place. *Riverside Co.* Blythe, 15, 19, 40 mi. W; Cathedral City; Desert Center, 3 mi. NE, 33 mi. E; Desert Hot Springs; Hopkins

Table 4. Seasonal distribution and its geographic variation in *Pleuropasta mirabilis* with frequencies expressed as monthly percentages of total records.

Area	Month[1]									Total records
	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	
I. S of 34°N	13.4	62.2	18.3	1.2	0	0	0	3.7	1.2	82
II. 34°N–36°N	5.3	36.8	47.4	5.3	0	0	5.3	0	0	38
III. N of 36°N	0	0	19.6	45.1	29.4	3.9	2.0	0	0	51

[1] Populations in Area I more common prior to 1 May; those in Area II more common after this date ($\chi^2 = 12.81$; $P < .005$). Populations in Area III more common after 1 June; those in Area II more common before this date ($\chi^2 = 42.52$; $P < .001$).

Well; Indian Wells; Indio, & 6 mi. W; Mecca, 6 mi. W; Morongo Wash; Mule Mts. (Hodgkins Mine); Oasis; Painted Cyn.; Palm Springs, & 2 mi. N, 2 mi. W; Palm Springs Station; Pushwalla Palms; Ripley, 7 mi.; San Andreas Cyn.; Thousand Palms Oasis; Whitewater. *San Bernardino Co.* Amboy Lava Flow; Apple Valley; Baker, 5 mi. N, 23 mi. SW; Cronise Lake, & 2 mi. S; Essex; Goffs, 2.3 mi. N; Kelso, & 2.5 mi. S; Kramer Hills; Ludlow; Manix, 22 mi. N; Morongo Valley; Sheep Creek; Silverlake; Twentynine Palms; Victorville; Vidal Jct., & 5 mi. N; Yermo; Zzyzx Springs, dunes S of. *San Diego Co.* Blair Valley; Borrego Springs, 3 mi. E; Borrego Valley; Ocotillo. NEVADA. *Churchill Co.* Fallon, 23 mi. E; Frenchman, 9 mi. W (Sand Mtn.); Stillwater, 12 mi. NE. *Humboldt Co.* Golconda, 3 mi. N; Soldier Meadows (not located). *Lander Co.* Austin. *Lyon Co.* Dayton, 16 mi. NE; Fernley, & 5 mi. E; Fort Churchill; Yerington. *Mineral Co.* Basalt. *Nye Co.* Lathrop Wells, 9.4 mi. NW. *Ormsby Co.* Carson City. *Pershing Co.* Lovelock; Woolsey. *Storey Co.* Reno. *Washoe Co.* Mustang; Nixon; Patrick; Pyramid Lake; Wadsworth, & 2.8 mi. W; Washoe Lake, 1 mi. E.

Pleuropasta reticulata Van Dyke

Calospasta mirabilis: Champion, 1892: 393 (in part, incl. Coahuila rec. & Fig.).
Pleurospasta mirabilis reticulata Van Dyke, 1947: 158.
Pleurospasta reticulata: Vaurie, 1950: 56. Werner et al., 1966: 27.
Pleuropasta mirabilis: Dillon, 1952: 376 (in part, incl. TX rec.).
Pleuropasta reticulata: Cohen and Pinto, 1977: 742.

Type information.—Holotype, from Loving, New Mexico, in the collection of the California Academy of Sciences.

Geographic distribution.—Figure 15. Occurs in the Chihuahuan Desert from southern New Mexico to southern Chihuahua, Coahuila and Nuevo Leon.

Seasonal distribution.—15 April (Pecos, TX)—21 September (5 mi. N Carlsbad, NM). Frequency by month for 20 records as follows: April—1, May—3, June—4, July—2, August—8, September—2. Seasonal extremes are known from the same general area; no geographic variation in season of adult activity is yet apparent.

Adult host.—Collected on *Coldenia canescens* DC. and *Coldenia* sp. at several sites. I observed a large population feeding on flowers of *C. canescens* in Hidalgo Co., NM.

Records.—MEXICO: CHIHUAHUA: Hidalgo de Parral, 33 mi. N. *Coahuila.* Cuesta La Muralla (on Hwy. 57). NUEVO LEON. Villa de Garcia, 8 km. SE.

TAMAULIPAS. Nuevo Laredo. UNITED STATES: NEW MEXICO. *Eddy Co.* Carlsbad, 1, 5 mi. N; Loving; Whites City. *Hidalgo Co.* Granite Gap, 1 mi. N; Rodeo, 18 mi. N. *Otero Co.* Valmont, 9 mi. S. TEXAS. *Howard Co.* Big Spring. *Hudspeth Co.* Salt Flat, 5 mi. N. *Maverick Co.* Eagle Pass. *Reeves Co.* Pecos, & 11 mi. N.

Acknowledgments

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86(1), 1984, pp. 144–146

A NEW *PARUZELIA* FROM SRI LANKA (HOMOPTERA: FULGOROIDEA: TROPIDUCHIDAE)

R. G. Fennah

℅ Commonwealth Institute of Entomology, ℅ British Museum (Natural History), London SW7 5BD, United Kingdom.

Abstract.—A new species of Tropiduchidae, *Paruzelia salome,* is described from a male taken in Sri Lanka and compared with *P. psyllomorpha* Melichar, its only other known congener.

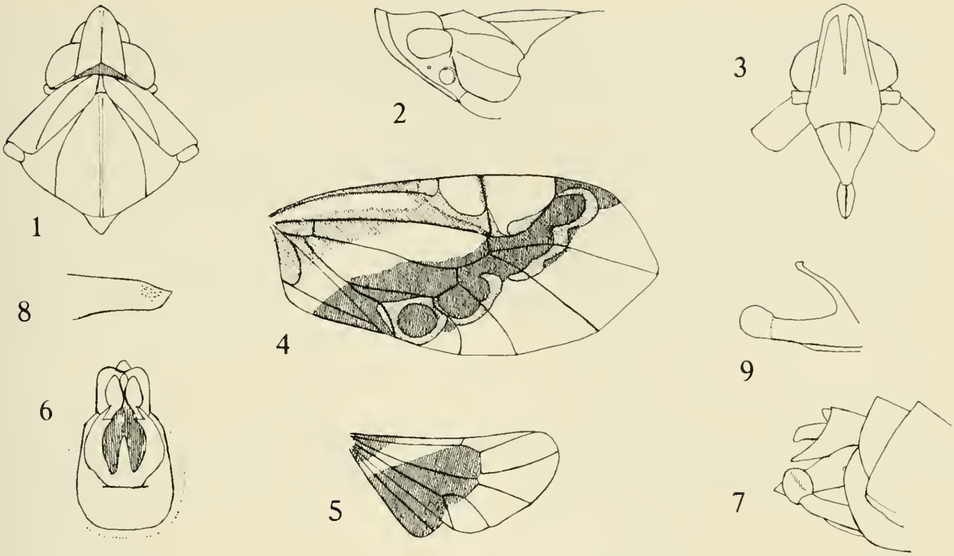
The genus *Paruzelia* has hitherto been known only from the material examined by Melichar when erecting the species *psyllomorpha* (Melichar 1903: 223). A specimen of a tropiduchid fulgoroid sent to the writer by Dr. K. V. Krombein that had been taken by him in Sri Lanka proved to represent a second and very distinct species of this genus, and this is described below.

Paruzelia salome Fennah, New Species

Figs. 1–9

Holotype male.—Head with eyes narrower than pronotum (1:1.9). Vertex about as long in middle line as broad at base, in profile slightly ascending distad of eye, anterior margin deeply convex, not callussed; posterior margin obtusely angulately excavate; median carina narrow, absent near apex of vertex. Frons longer than broad (about 1.5:1), wider at widest part than at base (about 1.2:1) and at apex (about 1.9:1); lateral margins diverging to below level of antennae, callussed; median carina present at least in basal half, moderately callussed basally and narrowing distad. Rostrum not attaining mesotrochanters; basal segment as long as apical segment and about as long as broad anteriorly. Pronotum broader than long in middle (12:1), posterior margin subrectangulately excavate; median carina shorter than lateral discal carinae (1:4.8); a single carina between eye and tegula. Mesonotum slightly broader than long to basal transverse line (about 1.3:1), lateral carinae curving mesad throughout and almost meeting median carina apically. Post-tibia longer than broad at middle (14:1), with 2 spines laterally, 5 apically. Basal metatarsal segment dorsally longer than wide between outer apical teeth (1.7:1), and than second segment dorsally (2:1), and with 5 apical teeth. Post-coxal process papery. Tegmen longer than broad (about 2.0:1); costal and commissural margins diverging to level of apex of Cu_1; corium smooth between veins; Sc+R forking at level of node, nodal line oblique stepwise, 8 apical cells between node and apex of clavus; no subapical cells present; clavus short, cell PCu subovate, claval veins uniting close to basal margin of clavus; wing-tucking lobe stout, triangular. Wing as figured.

Body fuscous; frons in distal third, clypeus, rostrum and legs except post-femora basally, pygofer posterolaterally and genital styles, pale brownish yellow; frons



Figs. 1–9. *Paruzelia salome*. 1, Head and thorax, dorsal view. 2, Head, pronotum and mesonotum, lateral view. 3, Head and lateral lobes of pronotum, anterior view. 4, Tegmen. 5, Wing. 6, Male genitalia, posterior view. 7, Male genitalia, right side. 8, Aedeagus, left side. 9, Genital style, right side.

pale green across middle and dull red in basal third; genae dull red. Pronotum (except lateral lobes) and mesonotum orange; carinae, margins and mesoscutellum, abdomen dorsally in middle line and anal style, green. Genital styles at apex and anal segment on distal margins, red. Tegmen hyaline; a band parallel to costa from base to nodal line, and clavus basally, dull greenish yellow; margin of tegmen and veins and a broad oblique band overlying distal third of clavus and extending to anterior margin near apical angle, fuscous; vein Sc_1 and a broadly scalloped callus along distal border of fuscous band, looping in posterior apical cell to form a complete circle, pink or cerise. Wing hyaline, a suffusion at base and a broad suffusion covering most of wing basad of transverse line, and across anal area, fuscous.

Anal segment short, with ventral margin about twice as long as dorsal margin; anal foramen at middle; anal style scarcely reaching apical margin. Pygofer moderately short, with lateral margins shallowly convex and ventral margin transverse. Aedeagus unarmed, moderately long and deep, strongly laterally compressed and slightly narrowing to bluntly pointed apex. Genital styles in posterior view arcuately convex from base and with a process, twice as long as broad, arising mesally at base and lying in middle line; each style moderately narrow in lateral view and slightly expanded apically into a circular lobe; an elongate narrow process, abruptly curving laterad at its apex, arising on dorsal margin near base of style and extending dorsocephalad. Length, 3.5 mm; tegmen, 4.3 mm.

Holotype ♂.—SRI LANKA: Mon. District, Angunakolapelessa, 100 m. 22.i.1979 (K. V. Krombein), USNM Type No. 100384, in National Museum of Natural History, Washington, D.C.

This species differs strongly from *Paruzelia psyllomorpha* Melichar, the only other member of the genus, in the shape and venation of the tegmen and from all known Tropiduchidae in the coloration of the tegmen. The specimen was collected while being carried as prey by the wasp *Bembecinus proximus* (Handlirsch). The name *salome* is a noun in apposition.

ACKNOWLEDGMENT

I am greatly indebted to Dr. K. V. Krombein for sending this rare and informative material for study.

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TWO NEW SPECIES OF STONEFLIES (PLECOPTERA) FROM NEW MEXICO

Richard W. Baumann and Gerald Z. Jacobi

(RWB) Monte L. Bean Life Science Museum, Department of Zoology, Brigham Young University, Provo, Utah 84602; (GZJ) Environmental Improvement Division, Water Pollution Control Bureau, P.O. Box 968, Santa Fe, New Mexico 87503.

Abstract.—Two new species of Plecoptera, *Taeniopteryx* ***pecos*** male, female and nymph and *Sweltsa* ***hondo*** male and female, are described from New Mexico. Descriptions are enhanced by original drawings. Ecological notes are included for both species.

While conducting water quality studies for the state of New Mexico, the junior author collected two undescribed stonefly species. Since both represented interesting morphological and distributional conditions, it was decided to make this information available to aquatic biologists.

The 1968 revision by Ricker and Ross of the North American species of *Taeniopteryx* listed eight valid species. Stewart and Szczytko (1974) added another species from Texas. In 1980, Fullington and Stewart described the nymphs of all nine species. Then a tenth species was described from Virginia, including both the nymphal and adult stages (Kondratieff and Kirchner, 1982). However, the single *Taeniopteryx* nymph collected from the Pecos River at Santa Rosa in 1971 by Stewart, Baumann and Stark (Stewart et al., 1974) still remained an enigma. Although *T. nivalis* was listed as the only species confirmed from the Rocky Mountains (Baumann et al., 1977), it was noted that this New Mexico specimen could represent another species.

Taeniopteryx pecos **Baumann and Jacobi, New Species**
Figs. 1–6

Male.—Macropterous. Length of forewings 5–6 mm; length of body 4–6 mm. General body color dark brown; legs light brown; antennae brown. Head wide as prothorax, ocellar triangle equilateral, posterior ocelli closer to eyes than to each other. Pronotum slightly wider than long. Wings fumose, veins light brown, venation typical for genus. Abdominal segments uniformly dark brown; ninth sternum enlarged, extending posteriorly to cover base of paraprocts, tip covered with posteriorly directed medium length hairs, vesicle absent; tenth tergum with large basal shield, truncate apically, extending to epiproctal base. Epiproct large; lateral aspect curved upward perpendicular to long axis, base broad, constricted below apex, tip broadly rounded posteriorly (Fig. 4); dorsal aspect well rounded, base broad, becoming narrowed below apex, tip abruptly rounded into expanded bean-

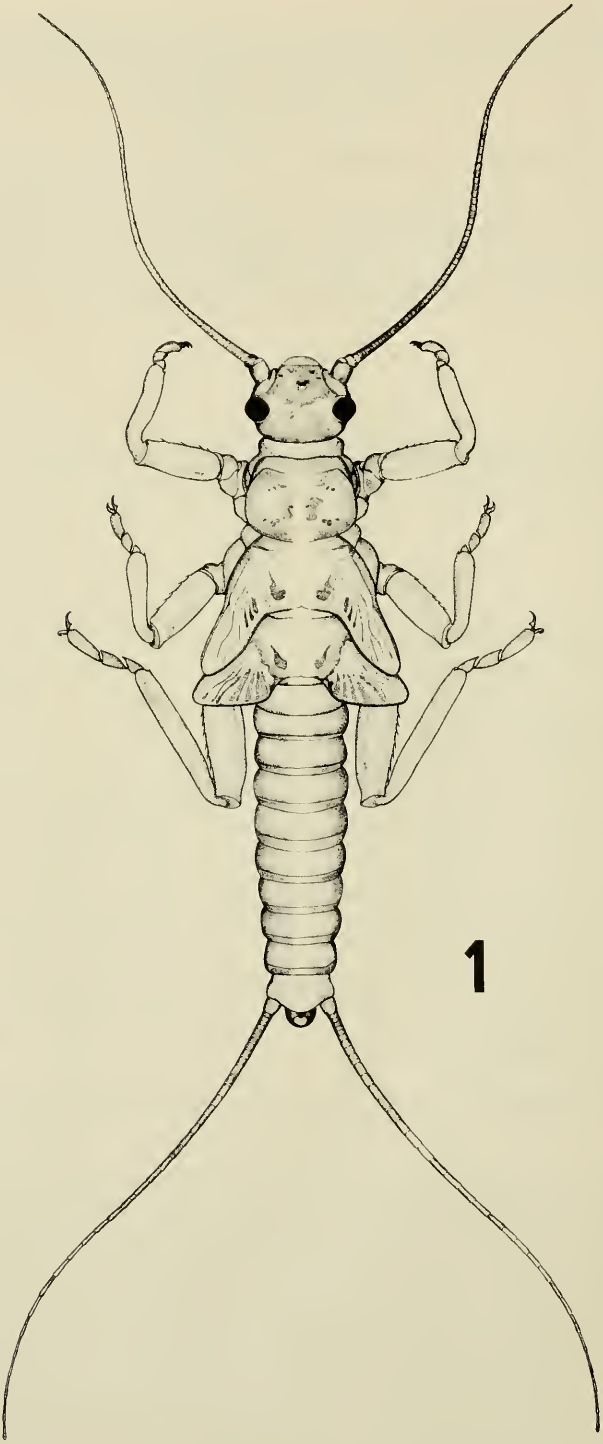
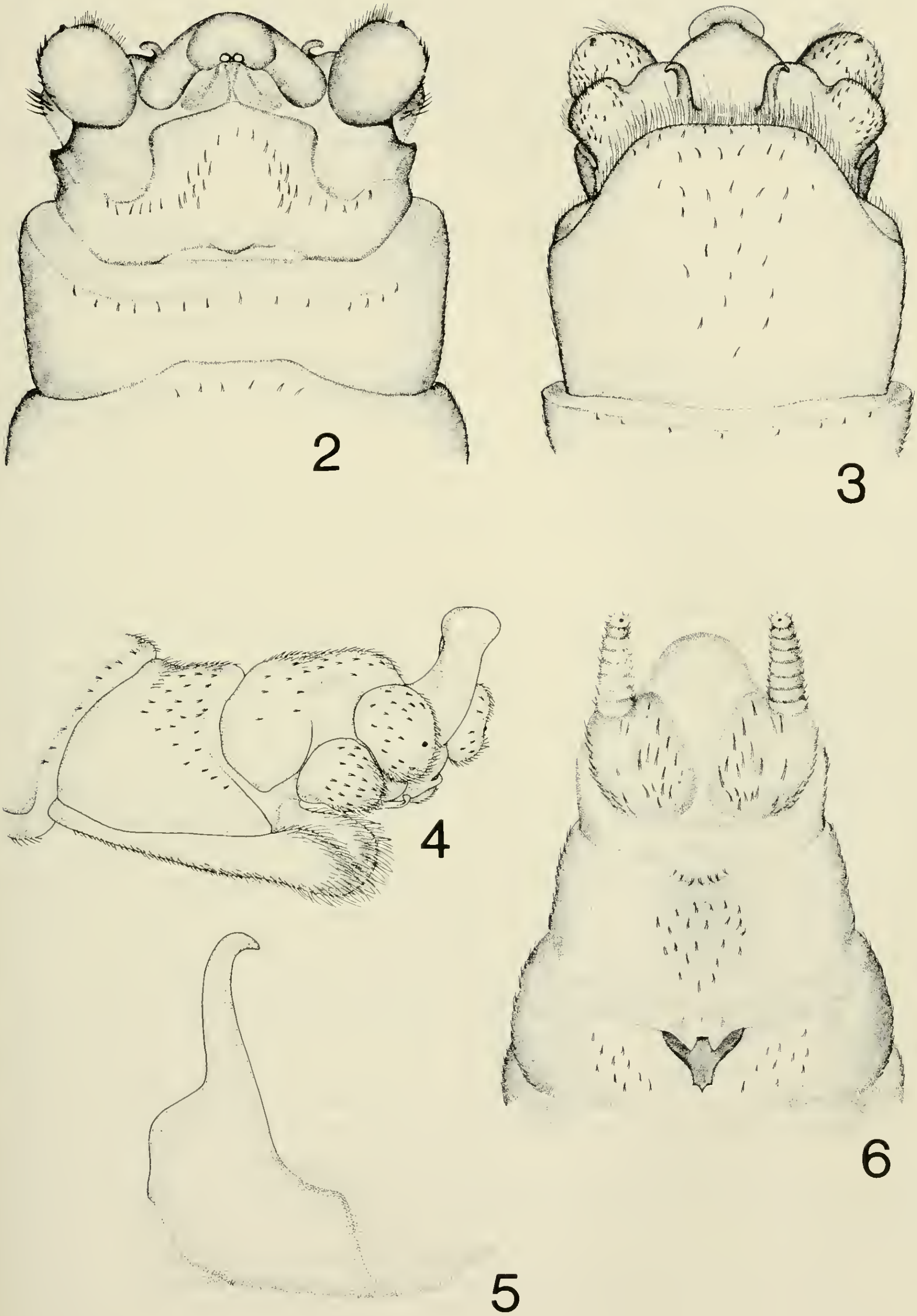


Fig. 1. *Taeniopteryx pecos,* mature nymphal habitus.



Figs. 2–6. *Taeniopteryx pecos*. 2, Male terminalia, dorsal. 3, Male terminalia, ventral. 4, Male terminalia, lateral. 5, Male paraproct, right. 6, Female terminalia, ventral.

shaped structure apically, paired filaments visable at indented margin (Fig. 2). Paraprocts broad at base and very narrow at apex, tips acute, hooked and bent outward (Figs. 3, 5). Cerci large and globular, not longer than broad, membranous, bearing straight medium length hairs (Figs. 2–4).

Female.—Macropterous. Length of forewings 9–10 mm; length of body 7–9 mm. Color and general morphology similar to male. Eight sternum sclerotized at posterior median notch, sclerotized portion somewhat "w" shaped, outer prongs bent slightly downward, median prong broad and truncate at tip, base single and forming triangular point (Fig. 6).

Nymph.—Length 7–10 mm. Color light brown; narrow light median dorsal stripe extending from tip of abdomen to anterior margin of prothorax, but not to head. Occipital portion of head divided from anterior portion by ecdysal line running posterior to ocelli, occipital area covered with small dark rugose markings, anterior portion evenly darkly pigmented. Pronotum nearly as long as wide, mostly light brown, with few scattered dark rugosities. Paired teloscopic coxal gills present on thoracic sterna. Abdominal segments mostly light brown, with 8–10 dark spots forming bead-like ring at middle of each tergum, abdominal terga covered with scattered short spines, posterior margin with fringe of small spines, median and lateral fringes of long hairs running length of abdomen. Cerci with whorl of short spines at posterior margin, with double fringe of long swimming hairs throughout most of length (Fig. 1).

Diagnosis.—*Taeniopteryx pecos* is very close to *T. parvula* Banks, a common species of large eastern rivers. It keys out to *T. parvula* in Ricker and Ross (1968) because both species lack a vesicle on the ninth sternum and have pointed hooked paraprocts. However, the hook on the paraprocts of *T. pecos* is small and diverges only slightly from the plane of the point while in *T. parvula* the hook is large and broadly curved. *Taeniopteryx ugola* Ricker and Ross also has hooked paraprocts but bears a vesicle on sternum nine. The epiproct is larger proportionally to the size of the insect in *T. pecos,* where the width of the apex is ⅓ the width of the base, while in *T. parvula* the width of the apex is only ¼ the width of the base.

Taeniopteryx pecos nymphs exhibit a definite median dorsal stripe which runs from the base of the head to the tip of the abdomen, while those of *T. parvula* lack a distinct median dorsal stripe. The nymph of *T. pecos* is smaller and less robust when compared to the other species which possess a dorsal stripe.

Types.—Holotype ♂ (100861), allotype and 8 ♂ and 6 ♀ paratypes, Pecos River, Hwy. 119, Tecolotito, 1615 m, San Miguel Co., New Mexico, 27-II-1979, G. Z. Jacobi. *Additional specimens:* Guadalupe Co.: Pecos River, Santa Rosa, 27-XI-1971, R. W. Baumann, B. P. Stark and K. W. Stewart, 1 nymph (NTSU); Pecos River, Hwy. 119, Anton Chico, 1585 m, 5-I-1980, G. Z. Jacobi, 10 nymphs (BYU) (GZJ). San Miguel Co.: same data as holotype except 5-I-1980, 10 nymphs (BYU) (GZJ). Types deposited in National Museum of Natural History, Washington, D.C.

Etymology.—The specific name is a noun in apposition based on the Pecos River where all specimens of this species have been collected.

Ecological notes.—The Pecos River at Tecolotito (1615 m) runs through the eastern edge of the Glorieta Mesa. Upstream the 1% gradient has carved a 60 m deep gorge through a quartzite cap. Below Tecolotito, towards Anton Chico (1585 m), the valley widens considerably and the gradient drops to less than 0.5%. At

Tecolotito the habitat consists of a riffle area with a substrate of pea-sized gravel and scattered smooth stones 7–20 cm diameter. The substrate at Anton Chico contains pea-sized gravel, silt and leaf litter. However, irrigation diversions near Anton Chico reduce stream flow during the summer.

The Tecolotito site corresponds roughly to the physiographic boundary between the northern mountains and southeastern plains in New Mexico. It is perhaps more indicative of the preferred habitat of *T. pecos* than the downstream sites at Anton Chico and Santa Rosa.

Additional stoneflies collected along with *T. pecos* include members of the families Capniidae, Nemouridae, Perlodidae and Perlidae. In fact, the collection of *Acroneuria abnormis* (Newman) represents a new state record for New Mexico.

Sweltsa hondo **Baumann and Jacobi, New Species**

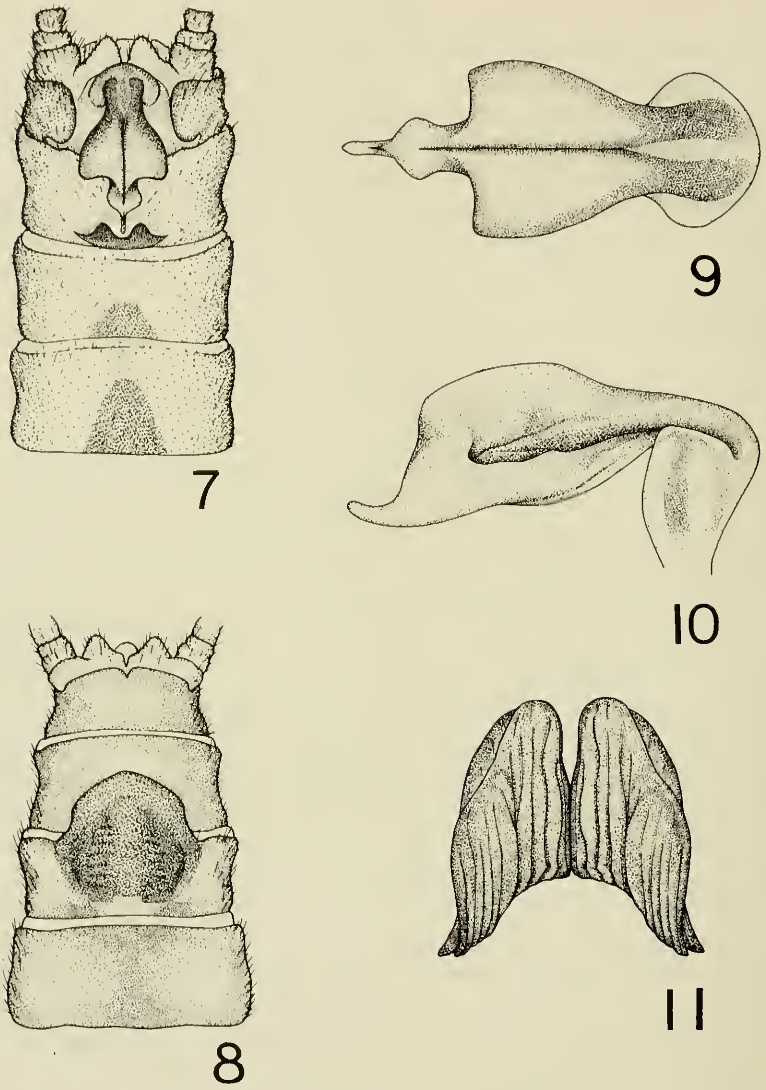
Figs. 7–11

Male.—Macropterous. Length of forewings 7–8 mm; length of body 6–8 mm. General color yellow with brown markings, abdomen more brown in mature specimens; legs yellow, with brown stripes along margins of femur; antennae yellow at base, brown near apex; cerci yellow. Head slightly narrower than prothorax, ocellar triangle equilateral, posterior ocelli the same distance from each other as from eyes, dark reticulate markings around ocelli and on anterior rugosites. Pronotum wider than long, completely enclosed by brown border, which is incomplete both anterior and posterior near midline, median stripe faint, lateral rugosites distinctively marked with brown coloration, anterior and posterior borders broad. Wings hyaline, veins brown, venation typical for genus. Abdominal segments yellow, terga bearing brown triangular patches, larger near thorax, becoming progressively smaller toward apex; ninth tergum with sclerotized, U-shaped process at anterior margin, deeply excavated at posterior margin to accommodate epiproct; tenth tergum completely bisected, with sclerotized ventral plate and lateral sclerotized bars (Fig. 7). Epiproct sclerotized; dorsal aspect broad and angular, base narrow, expanding laterally to anterior third, then becoming abruptly narrow toward apex, median carina extending to base of apex, base wide and nearly square behind narrow pointed tip; lateral aspect shaped like head of a duck, with narrow area near base, dorsolateral ridges running from base to apical third, broadest portion near narrow apex, with small ventral apical tip (Figs. 9, 10). Aedeagus with sclerotized leaf-like appendage, D-shaped, with deep median incision, dorsolateral margins with rounded edges, entire structure with longitudinal grooves (Fig. 11).

Female.—Macropterous. Length of forewings 9–10 mm; length of body 8–10 mm. Color and general morphology similar to male. Subgenital plate formed by seventh sternum; base located near anterior margin, width at base one-third as wide as segment, plate becoming gradually wider to posterior margin of seventh sternum, then reversing and becoming narrow again in apical half, apex broadly triangular, often slightly pointed at tip, entire plate becoming darkly sclerotized in mature specimens (Fig. 8).

Nymph.—Unknown.

Diagnosis.—*Sweltsa hondo* is most similar to *S. lamba* (Needham and Claassen), *S. albertensis* (Needham and Claassen) and *S. gaufini* Baumann. All four species possess a leaf-like appendage on the aedeagus. This process is much longer



Figs. 7–11. *Sweltsa hondo*. 7, Male terminalia, dorsal. 8, Female terminalia, ventral. 9, Epiproct, dorsal. 10, Epiproct, lateral. 11, Leaf-like appendage on aedeagus.

than broad in *S. albertensis* and *S. gaufini*. It is short and broad in *S. lamba* and *S. hondo*. However, in *S. hondo* the apex is broadly rounded, while in *S. lamba*, the apex is almost square with only slightly rounded corners. Figures of the leaf-like appendages on the other three *Sweltsa* species are found in Baumann (1973).

The dorsal aspect of the male epiproct of *S. hondo* is very broad and angular much like *S. coloradensis* (Banks), which lacks the leaf-like appendage of the aedeagus. The dorsal aspect of the epiproct in the three related species noted above is quite narrow, especially near the apex. The epiproct of *S. hondo* is, however, very broad adjacent to the apex before it becomes abruptly narrow.

The females of all four *Sweltsa* species, which possess a leaf-like appendage, are very similar, making them difficult to separate consistently without associated males. This means the *S. lamba* records listed in Baumann et al. (1977) are questionable until the specimens can be examined. However, the female subgenital plate in *S. hondo* is rather distinctively pointed apically, where it extends over sternum eight.

Types.—Holotype ♂ (100862), allotype and 4 ♂ and 7 ♀ paratypes, Lake Fork, Rio Hondo, at the beaver pond above Taos Ski Valley, 3000 m, Taos Co., New Mexico, 31-VII-1980, G. Z. Jacobi. *Additional paratypes:* Sandoval Co.: Las Huertas Creek, Las Huertas Campground, 2315 m, 7-VIII-1980, G. Z. Jacobi and L. R. Smolka, 7 ♀ (BYU) (GZJ). Santa Fe Co.: Rio En Medio, Aspen Ranch, 2805 m, 3-VIII-1980, G. Z. and M. D. Jacobi, 1 ♀ (GZJ). San Miguel Co.: 3 miles NNW Terrero, 20-VI-1978, J. D. Hansen, 1 ♂ (NMSU). Taos Co.: Rio Hondo, above Taos Ski Valley, 22-VII-1980, G. Z. Jacobi and A. M. Young, 1 ♀ (GZJ); same data as holotype except 22-VII-1980, 1 ♂ (BYU). Types deposited at the Smithsonian Institution, Washington, D.C.

Etymology.—The specific name is a noun in apposition taken from the Rio Hondo where the specimens were collected that led to the recognition that this was a previously undescribed species.

Ecology.—*Sweltsa hondo* is known only from streams characterized by relatively pristine conditions. Water quality data from December 1974 through July 1975, at the Lake Fork beaver pond are indicative of an unperturbed, cold water habitat (NMEID, 1975).

A related species, *Sweltsa borealis* (Banks) was found emerging at the same time as *S. hondo* in the headwater area (3000 m) of the Rio Hondo drainage. *Sweltsa coloradensis* occurs at lower elevations (below 1900 m) in the Rio Hondo proper.

Unlike *Taeniopteryx pecos,* which has been found only in one isolated river reach, this previously undescribed *Sweltsa* species, has been collected at elevations ranging from 3000 m to 1900 m at four separate locations. The three northern sites lie within 100 km of each other in the Sangre de Christo Mountains, while the fourth site is in the isolated Sandia Mountains 150 km south.

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We are grateful to James R. Zimmerman, New Mexico State University (NMSU), Kenneth W. Stewart, North Texas State University (NTSU) and John F. Flannagan, Freshwater Institute, Winnipeg, Manitoba for making specimens available for study and comparison. Special thanks are given to the personnel of the Water Pollution Control Bureau of the New Mexico Environmental Improvement Division in Santa Fe for their support with this research project and for the aid of the staff at the Department of Zoology, Brigham Young University (BYU). The drawings were made by Connie A. Bevan, Diane E. Mellor and Jean A. Stanger.

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THE NORTH AMERICAN PREDACEOUS MIDGES OF THE *BEZZIA ANNULIPES* GROUP (DIPTERA: CERATOPOGONIDAE)

WILLIS W. WIRTH, SUSAN M. PALCHICK, AND LEO FORSTER

(WWW) Systematic Entomology Laboratory, IIBIII, Agric. Res. Serv., USDA, % U.S. National Museum, Washington, D.C. 20560; (SMP) Department of Entomology, University of Wisconsin, Madison, Wisconsin 53706 (Present address: Department of Entomology, University of California, Davis, California 95616); (LF) Biosystematics Research Institute, Agriculture Canada, Ottawa, Ontario K1A 0C6, Canada.

Abstract.—The *annulipes* Group of the subgenus *Homobezzia* Macfie, genus *Bezzia* Kieffer, is comprised in North America of six species: three known previously only from Eurasia, *Bezzia annulipes* (Meigen), *B. japonica* Tokunaga, and *B. solstitialis* (Winnertz); *B. varicolor* (Coquillett), under which name the three previously listed species were confused in North America; *B. fascispinosa* Clastrier known previously only from Europe; and *B. pseudobscura* Wirth, a rare species known only from Virginia and Florida. Two recently described North American species are junior synonyms: *B. longiradia* Dow and Turner, a NEW SYNONYM of *B. fascispinosa*, and *B. suffusa* Dow and Turner, a NEW SYNONYM of *B. japonica*. Diagnoses are given of all taxa, a key is presented, and illustrations are given, especially of the pupal characters.

The predaceous midge *Bezzia varicolor* (Coquillett) was thought to be one of the commonest and most widespread species of this genus in North America. Wirth (1965) gave the distribution of the species as "Alaska to Mass., s. to Calif. and Md." Dow and Turner (1976), in their revision of the North American *Bezzia*, listed 15 states and provinces under the distribution of *B. varicolor*, from Alaska to California and Ontario to Florida. Material keying to *B. varicolor*, reared by Palchick in Wisconsin, was found to have two distinct kinds of pupae in addition to variation in color markings. A review was therefore made of the material identified as *B. varicolor* in the U.S. National Museum of Natural History and Canadian National Collection, and four distinct species were found: *B. varicolor* and three species known initially only from Eurasia, *B. annulipes* (Meigen), *B. japonica* Tokunaga (syn. *B. suffusa* Dow and Turner), and *B. solstitialis* (Winnertz). Moreover, the closely related species *B. longiradia* Dow and Turner from Ontario was found to be more widely distributed and was determined to be a junior synonym of *B. fascispinosa* Clastrier, formerly known only from the northern Palaearctic. A sixth species, *B. pseudobscura* Wirth, is rare and known only from Virginia and Florida.

The group of species discussed in this paper may be designated as the *Bezzia annulipes* Group of the subgenus *Homobezzia* Macfie, taking its name from the earliest described species, *Bezzia annulipes* (Meigen 1830). Diagnoses are given of all taxa, a key is presented for the North American species, and illustrations are given, especially of the pupal characters.

To help resolve the taxonomic difficulties, special effort was made to collect and rear pupae. The immature stages of species of this group are often numerous at the margins of shallow lakes, ponds, or streams, or in mats of algae or sphagnum in these locations. Pupae were collected by sampling debris floating at the margins of these habitats or by shaking the mats of vegetation in pans of water. The pupae were pipetted into ¼-dram vials partially filled with distilled water or with water from the habitat, onto a layer of cotton tightly packed into the bottom 0.8 cm of the vials; the vials were plugged with cotton. After emergence, the adult flies were given time to sclerotize and then pupal exuviae and associated adults were stored in 70% alcohol. Slide-mounted specimens were cleared in 10% KOH, dehydrated, and mounted in diaphane (Euparal), Canada balsam, or phenol-balsam.

Taxonomic characters employed for identification of the adults were described by Wirth (1952), Dow and Turner (1976), and Wirth et al. (1977). Wing length is measured from the basal arculus to the wing tip and costal length from the basal arculus to the costal apex. Costal ratio is the costal length divided by the wing length. Antennal ratio of the female is the sum of the lengths of the elongated distal five flagellar segments divided by the sum of the lengths of the preceding eight; male antennal ratio is obtained similarly as the sum of the lengths of the distal four elongated segments divided by the sum of the lengths of the preceding nine. Palpal ratio is the length of the third palpal segment divided by its greatest breadth. Tarsal ratio is the length of the basitarsus divided by the length of the second tarsomere. Femoral ratio is the femoral length divided by its greatest breadth.

SYNOPTIC KEY TO SUBGENERA AND GROUPS OF NEARCTIC *BEZZIA*

1. Male antennal segment 12 no longer than 13, antennal plume weakly developed (mesonotum dull, occasionally weakly shiny, brownish or grayish with or without vittae; tibiae pale or with a dark medial or basal ring; spines of fore femur stout when present; female with 0–5 pairs of gland rods; males considerably smaller than females; male aedeagus triangular with minute spinules or hairs) (Subgenus *Homobezzia* Macfie) 2

– Male antennal segment 12 longest; antennal plume well developed, extending at least to apex of 13th segment (mesonotum black, shiny or dull or with silvery hairs, if grayish brown with dark vittae, the hind tibia is yellow in midportion, apex broadly black, and all femora bear spines; tibiae often black; fore femur with spines slender when present; female abdomen with 1–2 pairs of gland rods; males about same size as female; male aedeagus variable but not as above) (Subgenus *Bezzia* Meigen, *s. str.* 5

2. Larger species, female wing 1.3–3.4 mm long; mesonotum without bristly setae on disc (fore femur without spines or with 1–4 stout to slender spines of similar lengths, with or without strong basal tubercles; pupal respiratory horn with numerous (25–60) spiracular openings, apex more or less flared, abdominal tubercles well developed) 3

– Small species, female wing 1.2–1.3 mm long; mesonotum with 2 rows of strong bristly setae on disc (fore femur with 5–7 stout ventral spines of alternating uneven lengths arising from distinct elevations; pupal respiratory horn with only 7–12 spiracular openings, abdominal tubercles small) .... *dorsasetula* Group

3. Fore femure unarmed ventrally .... *bicolor* Group
– Fore femur armed ventrally with one or more short black spines 4
4. Fore and mid femora entirely dark brown or with dark bands apical ... . *cockerelli* Group
– Fore and mid femora with subapical dark bands .... *annulipes* Group
5. Fore femur usually unarmed ventrally; legs brown to black; femora and tibiae usually with narrow pale rings, rarely femora pale at base or tibiae pale .... *bivittata* Group
– Fore femur armed ventrally with one or more slender black spines; legs brown to black, or if banded the pale bands broad 6
6. Legs broadly yellow or with broad yellow median bands on fore femora and tibiae .... *nobilis* Group
– Legs primarily dark brown to black, at most one pair of legs with broad yellowish bands .... *expolita* Group

Bezzia Kieffer, subgenus *Homobezzia* Macfie

Homobezzia Macfie, 1932: 496. Type-species, *Homobezzia nyasae* Macfie (monotypic). *Bezzia,* subgenus *Homobezzia* Macfie; Remm, 1974: 137 (status; diagnosis).

Diagnosis (from Remm, 1974).—"Scutum dull, occasionally weakly shiny, brownish or grayish, with or without vittae. Tibiae light or with a dark ring in the middle or basally; spines of fore femur stout. Anteromarginal spine of scutum present or absent. Twelfth segment of male antenna no longer than 13th; antennal plume weakly developed, extending to base of the 13th segment. Aedeagus of male triangular, with spinules or hairs. Tergites of female with 0–5 pairs of gland rods; claws frequently with a denticle on inner face. Males considerably smaller than females. Gonostyli of male well developed, of practically the same length as the gonocoxites, pilose. Mandibles of female with 8–15 teeth, basal teeth smaller than distal ones. Legs frequently with dark rings or entirely yellow."

Bezzia annulipes Group

The species of the *annulipes* Group may be distinguished from those of other North American groups of the subgenus *Homobezzia* by the characters given in the key. Within the *annulipes* Group there also appears to be a good separation between two groups of species. *Bezzia annulipes* and *japonica* have the fore femoral spines short and subconical, borne on prominent elevations, the distal antennal segments are shorter, and the ducts of the spermathecae are longer than in *B. solstitialis* and the remaining species of the group.

The male genitalia of species of this group (Fig. 1f) are remarkably uniform in structure and do not offer good characters for species determination. The ninth tergum is elongate, the ninth sternum a narrow band with shallow caudomedian excavation; the basistyles and dististyles are moderately long and tapering; the aedeagus is a nearly equilateral, triangular sclerite with low basal arch and slender, slightly spiculose tip; the parameres are fused distally in a long spatulate process. Males of *B. japonica* and *varicolor* usually have a rather well developed basal swelling on the mesal side of the basistyle bearing several larger setae arising from distinct tubercles, but on some preparations this swelling is difficult to see. Occasionally *B. solstitialis* males with a fairly definite apical band on the hind femur appear to have a well developed basal swelling on the basistyle.

As a rule, male specimens may be keyed out fairly accurately by means of the shapes of the distal antennal segments and the shapes of the fore femoral spines, since these are quite similar to those of the females of the species. The legs of the males usually have more extensive but less distinct dark markings than do those of the females.

KEY TO THE NORTH AMERICAN SPECIES OF THE *BEZZIA ANNULIPES* GROUP

1. Female wing (Fig. 2c) with costa extending nearly to wing tip (costal ratio 0.90–0.98); fore femur (Fig. 2f) with 8–12 spines in a group on distal half, not in one row; female abdomen (Fig. 2d) with prominent pair of round smooth areas on eighth sternum; pupal respiratory horn (Fig. 2g) with 50–60 spiracular openings . . . . *fascispinosa* Clastrier

– Female wing with costa not extending nearly to wing tip (costal ratio about 0.80); fore femur with 2–5 spines in one row; female abdomen without prominent smooth areas on eighth sternum; pupal respiratory horn with 18–50 spiracular openings 2

2. Fore femur with spines stout and subconical, each borne on a prominent elevation (Fig. 1g); antenna (Fig. 1a) with five distal segments shorter, ratio of 11/10 is 2.0–2.6; ducts of spermathecae (Fig. 1d) long (0.020–0.040 mm), about as long as diameter of spermatheca 3

– Fore femur with spines longer and more slender, not borne on prominences (Fig. 5d); antenna (Fig. 5a) with five distal segments longer, ratio of 11/10 about 3.0; ducts of spermathecae (Fig. 5e) shorter (0.010–0.012 mm) 4

3. Hind femur pale with subapical dark ring (Fig. 1h); dark rings on legs indistinct, especially on fore legs, often absent in male; mesonotum brownish with indistinct dark vittae; pupal respiratory horn with about 40 spiracular openings . . . . *annulipes* (Meigen)

– Hind femur almost entirely dark, fore and middle femora each with a dark subapical ring (Fig. 3g); mesonotum ashen gray with four dark vittae; pupal respiratory horn with 18–23 spiracular openings . *japonica* Tokunaga

4. Hind tibia pale except extreme apex dark (Fig. 4g) . . . . . *pseudobscura* Wirth

– Hind tibia with subbasal dark band and narrow apex dark (Fig. 5g) 5

5. Mid tibia pale except extreme apex dark (Fig. 6l); pupal respiratory horn with 40–50 spiracular openings (Fig. 6h) . . . . *varicolor* (Coquillett)

– Mid tibia with broad median dark band and narrow apex dark (Fig. 5g); pupal respiratory horn with 18–36 spiracular openings (Fig. 5h) . . . . *solstitialis* (Winnertz)

***Bezzia annulipes* (Meigen)**

Fig. 1

Ceratopogon annulipes Meigen, 1830: 264 (female: Europe).
Palpomyia annulipes (Meigen); Kieffer, 1906: 62 (combination).

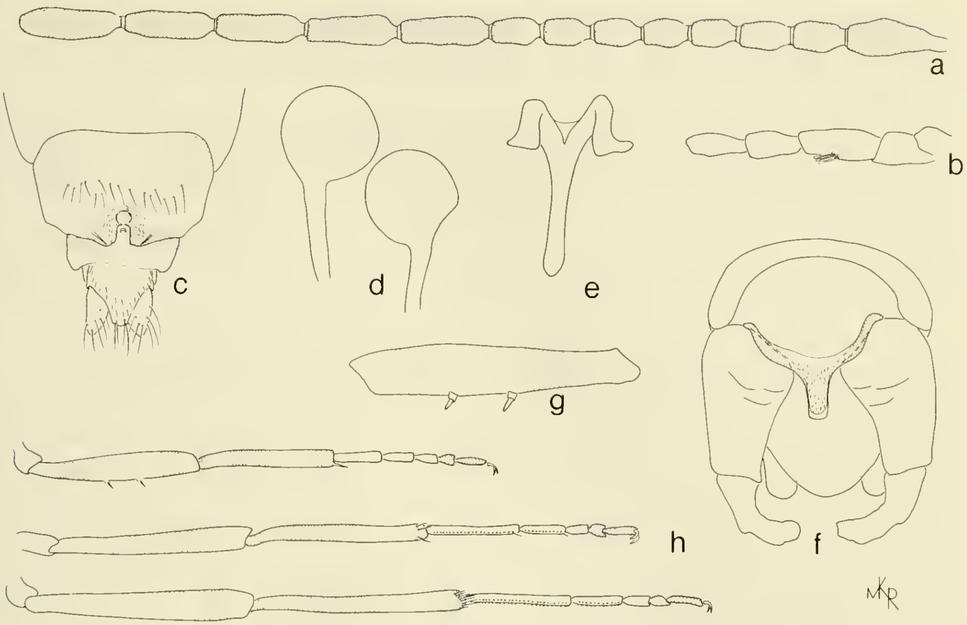

Fig. 1. *Bezzia annulipes* from Luss, Scotland; a–d, g–h, female; e–f, male: a, antenna; b, palpus; c, genital sclerotization; d, spermathecae; e, parameres; f, genitalia, parameres omitted; g, fore femoral spines; h, fore, mid, and hind legs (top to bottom).

Bezzia annulipes (Meigen); Kieffer, 1925: 130 (combination); Edwards, 1926: 130 (Britain; diagnosis); Remm, 1974: 440 (in key; descriptive notes; USSR records; syns.: *bidentata* Kieffer, *fossicola* Kieffer, *kyotoensis* Tokunaga, *media* Kieffer, *phragmites* Kieffer, *ploenensis* Kieffer, *sicarti* Clastrier); Glukhova, 1979: 133 (larva; USSR).

Bezzia solstitialis (Winnertz); Downes, 1978: 4 (misdet.; Scottish prey records).

Diagnosis.—Wing length 2.4–2.8 in female, 1.7–2.0 in male. General color dull dark brown; scutum with indistinct dark vittae; antenna (Fig. 1a) with bases of flagellar segments indistinctly pale; legs (Fig. 1h) relatively stout, mainly yellow; coxae, trochanters, and two distal tarsomeres brown, femora of all legs with dark preapical ring, tibiae with both ends dark and a broad dark sub-basal to median band; leg bands indistinct, especially on fore leg, often absent in male; wing faintly brown, anterior veins pale brown; halter dark brown; abdomen dark brown above, pale below. Female antennal ratio 1.10–1.14; lengths of flagellar segments in proportion of 22-17-17-17-17-17-18-18-36-38-37-37-45; palpus as in Fig. 1b; fore femur (Fig. 1g) with 2–3 short, very stout, well separated black spines arising from distinct prominences; spermathecae (Fig. 1d) with genital sclerotization as in Fig. 1c; spermathecae (Fig. 1d) with long necks (0.020–0.040 mm), as long as diameter of spermatheca. Male genitalia (Fig. 1f) short and stout, structure typical of the group; basistyle without prominent basal hump; parameres as in Fig. 1e.

Distribution.—A Boreal species; northern Eurasia, Japan, Alaska, Manitoba, Idaho.

Specimens examined.—ALASKA: Fairbanks, College, 14.20.vi.1948, Lienk and Esselbaugh, emergence trap, 1 ♂, 3 ♀; Fairbanks, vi–vii.1967, K. M. Sommerman, jeep trap, 6 ♀.

ALBERTA: Brooks, 30.v–9.vi.1955, J. A. Downes, 1 ♂, 3 ♀.

BELGIUM: Dostelbergen, 13.v.1936, M. Goetghebuer, 3 ♂, 3 ♀.

FRANCE: Haute-Garonne, Tournefeuille, 2.iv.1959, M. Sicart, 1 ♀ (paratype of *sicarti* Clastrier).

GERMANY: Tübingen, 13.viii.1960, J. A. Downes, 5 ♀. Kühkopf, 25.vii.1977, leg. Fritz, 2 ♂, 1 ♀ (det. Havelka).

GREAT BRITAIN: Bucks., Black Park, 21.v–7.vi.1934, reared from nest of coot, 2 ♂, 2 ♀. Glamorgan, Porthcawl, 10.vi.1906, A. H. Verrall, 3 ♂. Herts., Knebworth, vi.1922, F. W. Edwards, 1 ♀; Letchworth, iv–vi.1918, Edwards, 4 ♂, 1 ♀, pupal exuviae; Radwell, vi.1918, Edwards, 2 ♂, 4 ♀ (1 ♀ with *Tanytarsus* prey); 12.ix.1920, 1 ♀ with ♂ *Cricotopus* prey; v.1924, 1 ♂, 1 ♀ (in copula). Huddersfield, v.1904, C. Waterhouse, 1 ♀, pupal exuviae. Inverness, Aviemore, vi.1931, Edwards, 4 ♀; Loch Garten, 21.vi.1933, R. L. Coe, 1 ♀. Lake District, Hawkshead, Calife Heights, Three Dubs Tarn, 5.vi.1947, T. T. Macan, 3 ♀. Luss, 21.vi–3.vii.1960, J. A. Downes, 7 ♂, 19 ♀. Middlesex, Ruislip, 7.ix.1914, Edwards, 1 ♀. Notts., Strelley, 21.ix.1922, Edwards, 1 ♀. Perthshire, Glen Lyon, Cashlie, 15.vi.1932, Edwards, 1 ♀. S. Devon, Slapton, 9.ix.1889, A. H. Verrall, 1 ♀. Surrey, Wimbledon, 3.ix.1920, Edwards, 2 ♀, pupal exuviae. Westmorland, Staveley, vi. 1929, Edwards, 1 ♀; Witherslack, vi.1929, Edwards, 1 ♀.

IDAHO: Latah Co., Trails End, 22.vii.1969. J. Gillespie, reared from algal mat, 1 ♀.

MANITOBA: Churchill, 9.viii.1953, J. A. Downes, 1 ♀.

USSR: Estonia, Kingissepp, 3.vi.1967, H. Remm, 1 ♂; Misso, 25.vi.1964, Remm, 2 ♀; Picasilla, 28.vii.1969, Remm, 3 ♀. Moscow, 27.v.1967, 2 ♂, 1 ♀ (all det. as *annulipes* by Remm).

Remarks.—This species is recognizable by its relatively stout legs, the fore femur with short, stout, well separated spines on distinct prominences; its short antenna, with segment eleven 2.0× as long as ten; its pale legs with indistinct dark bands, the hind femur with only a narrow subapical dark band; and its spermathecae with exceptionally long necks, about as long as the main body of the spermatheca.

According to Mayer (1934), the pupal respiratory horn (of the synonym *ploenensis*) is similar to that of *varicolor* (Coquillett), with about 40 spiracular openings in a convoluted row.

Our identification of this species is based on the excellent diagnosis and figures by Remm (1974), on the examination of 65 specimens from Britain determined by Edwards, six from Belgium determined by Goetghebuer, and a paratype of *sicarti* Clastrier from France (all USNM collection), and on the series from the USSR determined by Remm. In our Alaskan material we found females with the hind femur more broadly infuscated than in European specimens, approaching that of *B. japonica,* but with the apex pale; the long spermathecal necks confirmed the identification.

The specimens from Luss, Loch Lomand, Scotland (recorded in error by Downes, 1978, as *B. solstitialis*) were feeding on *Chironomus* sp. and *Tanytarsus* spp. which they captured by flying into the male swarms of the prey species.

Bezzia fascispinosa Clastrier
Fig. 2

Bezzia sp. indet.; Edwards, 1926: 424 (male; England; notes).

Bezzia fascispinosa Clastrier, 1962; 91 (male, female; France; figs.); Remm, 1974: 440 (in key; figs.; Lithuania, Maritime Terr., USSR; syn. *sexstrigata* Remm).

Bezzia sexstrigata Remm, 1971: 213 (female; Maritime Terr., USSR; figs.; compared *solstitialis*).

Bezzia longiradia Dow and Turner, 1976: 97 (female; Ontario; figs.); Palchick, 1981: 9 (Wisconsin; pupa described; figs.). New Synonymy.

Diagnosis.—Wing length 2.3–3.4 mm in female; 1.6–2.0 in male. General color dull dark brown, mesonotum with reddish tinge and with dark brown vittae; legs (Fig. 2f) yellowish with distinct subapical brown bands on all femora and median brown bands on all tibiae, a dark knee spot on fore leg, apices of mid and hind tibiae narrowly brown; tarsi yellowish, fifth tarsomere brown; wing grayish, veins brownish; halter brown; abdomen brownish, often yellowish brown. Female antenna (Fig. 2a) with lengths of flagellar segments in proportion of 18-13-13-13-14-15-15-14-53-57-53-54-55, antennal ratio 1.9–2.4; palpal segments (Fig. 2b) with lengths in proportion of 9-15-31-20-21, third segment short; wing (Fig. 2c) with costa long, costal ratio 0.90–0.98; fore femur with 9–11 stout ventral spines in a group (not in one row) on distal half in female, 2–8 ventral spines in male; female eighth sternum (Fig. 2d) with two smooth depressions bordered by setae; spermathecae (Fig. 2d) with long necks nearly as long as main body of spermatheca; one pair of long gland rods arising from seventh tergum and extending to base of third segment. Male genitalia (Fig. 2e) of the usual structure for the group, longer and more slender than usual, basistyle relatively slender at base without basal hump.

Pupa: Length 6.0 mm; general color pale yellow. Respiratory horn (Fig. 2g) moderately long (0.450 mm), slightly curved and expanded distally, bearing 55–60 spiracular openings in an undulating line around apex and down ⅓ way on each side. Operculum (Fig. 2h) with longitudinal striations on posterior margin, face bare; wider (0.378 mm) than long (0.276 mm), with three poorly developed *am* tubercles, anteromost with moderately long seta. Cephalothoracic chaetotaxy: Two *dl* tubercles (Fig. 2k), each with a moderately long fine seta; two *vm* tubercles (Fig. 2l), each with a strong spine, one short and the other moderately long; *vl* tubercle (Fig. 2i) with one short stout spine; dorsal tubercles *d*4 and *d*5 without spines, other dorsal spines (Fig. 2j) as follows: *d*1 and *d*2 close together with *d*2 longer than *d*1, *d*3 long and thin, *d*5 tubercle posterior to *d*3 and *d*4. Abdomen with caudal segment (Fig. 2p) denticulate, longer (0.247 mm) than wide (0.200 mm); posterolateral processes denticulate and almost twice as long as segment (0.408 mm); abdominal spines long, *dasm* tubercles (Fig. 2m) truncate and bearing a long thick seta, *dasm*1 seta longer than *dasm*2 seta; *dpm*1 tubercle (Fig. 2h) cuspidate, bearing a long thin seta, *dpm*2 tubercle rounded and bearing a medium-length strong seta, *dpm*4 tubercle not well developed, bearing a short stout spinule, *dpm*2 tubercle not apparent; *vpm*3 tubercle (Fig. 2o) well developed with long strong seta, *vpm*2 tubercle close to *vpm*3, poorly developed, but with medium length strong seta; *vpm*1 tubercle not apparent.

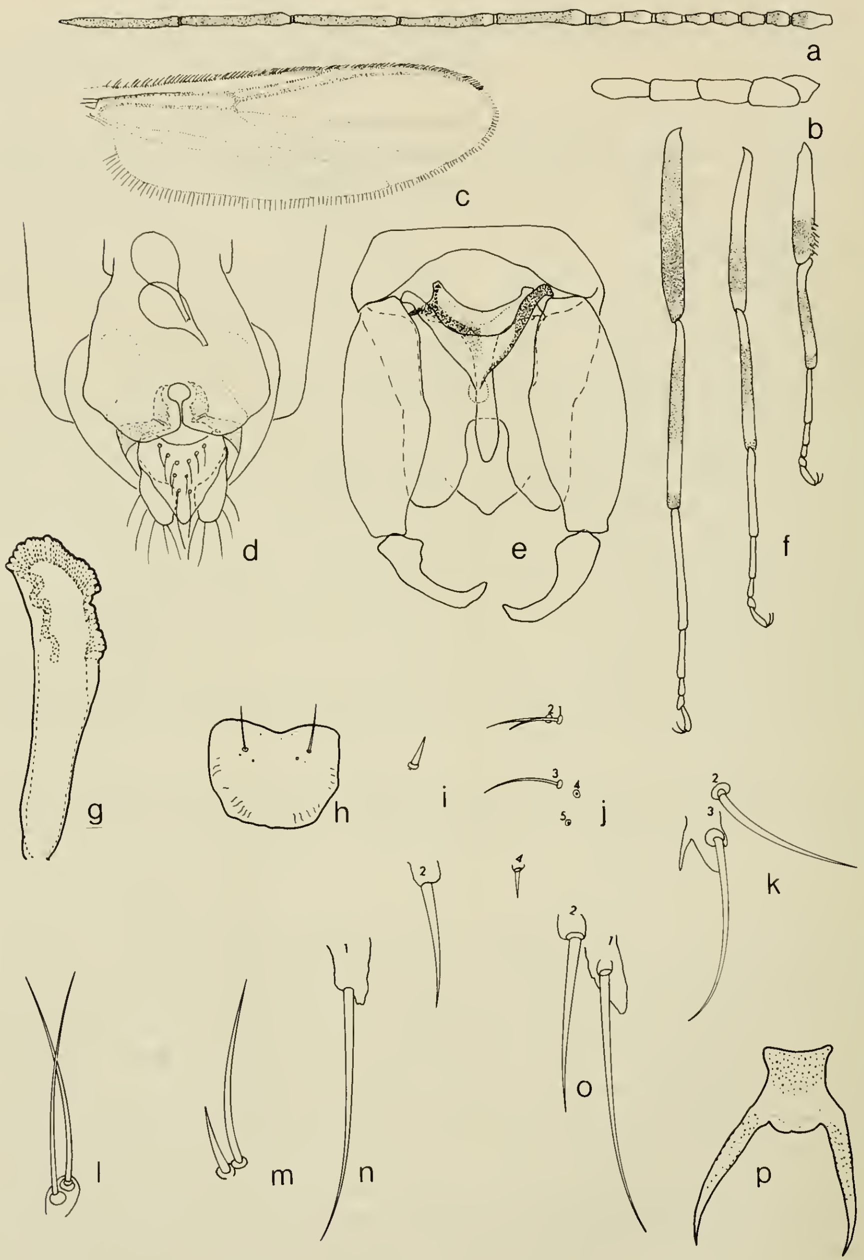

Fig. 2. *Bezzia fascispinosa* from Beltsville, Maryland; a–d, f, female; e, male; g–p, pupa (from Burnett Co., Wis.): a, antenna; b, palpus; c, wing; d, genital sclerotization and spermathecae; e, genitalia; f, hind, mid, and fore legs (left to right); g, respiratory horn; h, female operculum; i, *vl* tubercles; j, dorsal tubercles; k, *dl* tubercles; l, *vm* tubercles; m, *dasm* tubercles; n, *dpm* tubercles; o, *vpm* tubercles; p, female caudal segment.

Distribution.—Northern Palaeractic; Florida, Maine, Maryland, Michigan, Newfoundland, Ontario, Wisconsin.

Specimens examined.—FLORIDA: Alachua Co., Gainesville, Chantilly Acres, v.1967, F. S. Blanton, light trap, 6 ♀. Leon Co., 3 mi N Tallahassee, v.1970, Blanton, light trap, 1 ♂, 9 ♀; Tall Timbers Res. Sta., 29.v.1973, W. W. Wirth, light trap, 1 ♀. Wakulla Co., Ochlockonee River St. Park, 29.iv.1970, Wirth, light trap, 2 ♀.

FRANCE: Moselle, Hasselfurth, 12.vii.1956, J. Clastrier, 5 ♂, 5 ♀ (paratypes).

GREAT BRITAIN: Inverness, Nethy Bridge, vi.1906, C. G. Lamb, 1 ♀. Yorks., Castle Howard, 3.vii.1926, F. W. Edwards, 1 ♀ (all from BMNH).

MAINE: Old Town, Lake Pushaw, 1.viii.1966, Wirth, light trap, 1 ♀.

MARYLAND: Prince George's Co., College Park, Lakeland Pond, 26–30.v.1975, W. L. Grogan, Jr., reared, 1 ♂, 1 ♀, with pupal exuviae; Patuxent Wildlife Res. Center, 22–29.iv.1976, Grogan, malaise trap, 1 ♂; 3.viii.1976, Grogan, reared from pond weeds, 1 ♂ with pupal exuviae; v,vii,viii.1978, v,vii.1979, Wirth, malaise trap, 3 ♂, 4 ♀.

MICHIGAN: Manistee Co., Manistee, 15.vii.1942, C. W. Sabrosky, 1 ♀. Otsego Co., 24.vii.1955, R. R. Dreisbach, 1 ♀.

NEWFOUNDLAND: Little River, 18.vii.1905, C. W. Johnson, 1 ♀ (MCZ).

ONTARIO: Black Lake, N. Burgess Twp., 4.vi.1967, J. A. Downes, 2 ♀ (CNC); Grand Bend, 14.vii.1939, G. E. Shewell, 1 ♀ (CNC); London, 28.v.1958, 9–21.vii.1958, 28.v.1960, 26.vii.1960, W. W. Judd, 7 ♀ (type series of *longiradia* Dow and Turner).

WISCONSIN: Burnett Co., Pine Lake, 19.vii.1979, S. Palchick, 1 ♀ (Palchick, 1981). Washburn Co., 28–30.vii.1951, 13.vii.1952, R. H. Jones, light trap, 1 ♂, 7 ♀.

Remarks.—This species is set apart from the others in the *annulipes* group by the unusually long costa, which nearly reaches the wing tip in the female and is much longer than normal in the male.

Bezzia japonica **Tokunaga**
Fig. 3

Bezzia japonica Tokunaga, 1939: 280 (female; Japan; fig. wing, abdomen); Tokunaga, 1960; 75 (male; Japan; fig. genitalia); Tokunaga, 1963: 47 (larva, pupa; Japan; fig. operculum); Remm, 1974: 438 (USSR; diagnosis, in key; figs.).
Bezzia suffusa Dow and Turner, 1976: 110 (male; Manitoba; figs.). NEW SYNONYMY.
Bezzia varicolor (Coquillett): Downes, 1978: 4 (misdet.; prey records).

Diagnosis.—Wing length 2.1–3.1 in female; 1.5–2.2 in male. General color dull grayish brown; mesonotum with four dark brown vittae, scutellum brown; head brown; antenna (Fig. 3a) with bases of flagellar segments pale; legs (Fig. 3g) mainly yellow, fore and mid femora with subapical brown ring, often incomplete, hind femur dark brown except narrowly at base, fore and mid knees dark; all tibiae with broad subbasal brown band and narrow dark brown apices, distal ends of proximal three tarsomeres and all of tarsomeres 4 and 5 brown; wing hyaline but anterior veins and their marginal areas brown; halter pale brown; abdomen shining dark brown dorsally, sides and venter yellowish brown.

Female antenna (Fig. 3a) with lengths of flagellar segments in proportion of 22-17-17-17-17-17-17-17-35-38-32-35-53, antennal ratio 1.22–1.30; female palpus

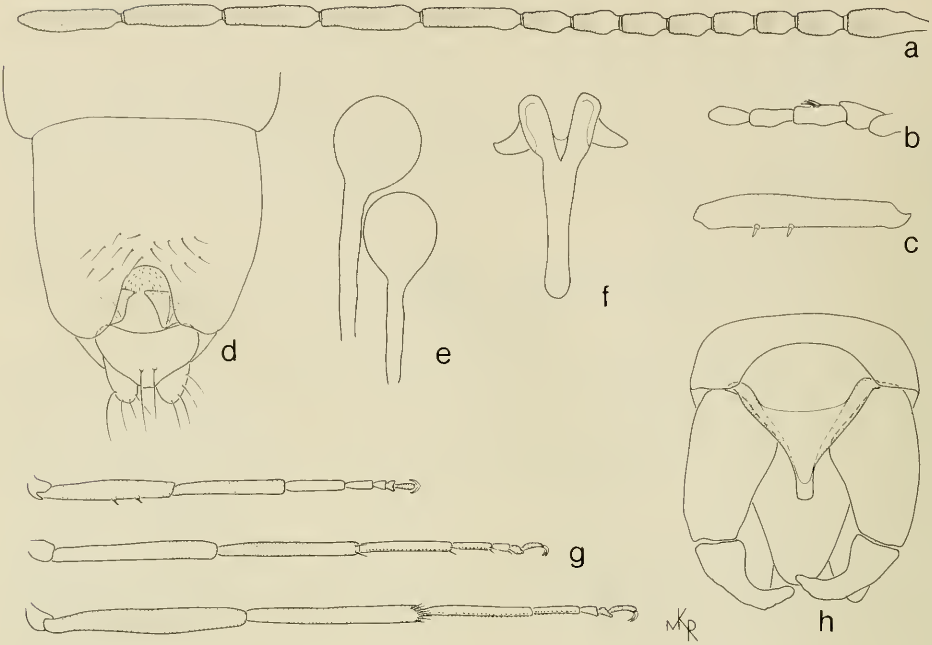

Fig. 3. *Bezzia japonica* from Kyoto, Japan; a–e, g, female; f, h, male: a, antenna; b, palpus; c, fore femoral spines; d, genital sclerotization; e, spermathecae; f, parameres; g, fore, mid, and hind legs (top to bottom); h, genitalia, parameres omitted.

as in Fig. 3b; fore femur (Fig. 3c) with two strong ventral spines; hind tarsal ratio 2.5; costal ratio 0.82; female abdomen with four pairs of gland rods, the first pair hyaline, the others blackish; genital sclerotization as in Fig. 3d; spermathecae (Fig. 3e) with long (0.024–0.032 mm) necks. Male genitalia (Fig. 3h) of the usual structure for the group, shorter and broader than in other species, basistyle usually with a prominent basal hump on mesal side; parameres as in Fig. 3f.

Pupa (from Tokunaga 1963): Length 5.5 mm. Integument brownish. Operculum weakly granulate, with sharp-pointed tip, four pairs of *am* tubercles, foremost with delicate hair, next two with pore only, fourth with short delicate hair. Respiratory horn dark brown, slightly dilated apically, length 0.20 mm, basal width 0.020 mm, subapical width 0.030 mm; bearing 18–23 spiracular openings in a horseshoe shape apically. Caudal segment with posterolateral processes imbricated almost entirely, tips sharp-pointed, dark apically, more or less incurved at tips; processes longer than caudal segment (ratio 180:141 in male, 168:147 in female).

Distribution.—Northern Palaearctic; Japan; Alaska south to California, east to Manitoba and New Brunswick.

Specimens examined.—ALASKA: Anchorage-Seward Highway, 6.viii.1964, K. M. Sommerman, jeep trap, 1 ♂, 1 ♀. Fairbanks, 22.vi.1948, Lienk and Esselbaugh, emergence trap, 11 ♂, 2 ♀. Palmer, vii.1964, Sommerman, jeep trap, 2 ♂, 11 ♀.

CALIFORNIA: Monterey Co., Plaskett Creek Camp, 7.viii.1963, E. I. Schlinger, at light, 1 ♀.

JAPAN: Honshu, Kyoto Prefect., Midoro Pond, iv–vi.1955, P. H. Arnaud, light trap, 21 ♂, 2 ♀. Otsu, Shiga Prefect., xi.1954, P. H. Arnaud, light, 1 ♀.

MANITOBA: Churchill, 12–31.vii, 9.viii.1953, J. A. Downes, 13 ♂, 18 ♀, 1 intersex, including holotype, 9 paratype ♂ of *suffusa* Dow and Turner.

NEW BRUNSWICK: Kouchibouguac National Park, 8.vii.1978, L. Forster, 2 ♂ (CNC).

OREGON: Lane Co., Waldo Lake, 23.vii.1969, K. Goeden, light trap, 1 ♀.

USSR: Sakhalin, Gorki, 2.vii.1975, Leg. Vilbaste, 1 ♀ (det. Remm).

Remarks.—*Bezzia suffusa* Dow and Turner is a synonym of this species. The specimens Dow and Turner described were taken at Churchill, Manitoba, among the other specimens recorded above, and prove to be identical.

Bezzia japonica resembles *B. annulipes* in its short, stout, fore femoral spines arising from distinct prominences, its short antenna, and long spermathecal necks, but it is readily distinguished by the dark hind femur and the small number of spiracular openings (18–23) on the pupal respiratory horn.

At Churchill, Manitoba, the females of this species (recorded in error as *B. varicolor* by Downes, 1978) feed on the small mayfly *Baetis hudsonicus* Ide which they capture in the mating swarm.

Bezzia pseudobscura Wirth

Fig. 4

Bezzia pseudobscura Wirth, 1951: 324 (female; Virginia); Dow and Turner, 1976: 101 (redescribed; figs.).

Female diagnosis.—Wing length 2.19 mm; breadth 0.74 mm. General color dark brown, thorax with very dense pearly gray pollen, scutellum yellowish brown; legs (Fig. 4g) yellow, coxae, broad subapical bands on fore and mid femora, all except extreme base of hind femur, dark brown; fore tibia with broad subbasal brown band; narrow apices of all tibiae blackish; wing grayish, veins yellowish; halter pale; abdomen whitish above, venter and last tergum brownish. Eye separation as in fig. 4e. Antenna (Fig. 4a) with lengths of flagellar segments in proportion of 15-10-10-10-10-10-10-10-45-40-40-40-40, antennal ratio 2.4. Palpal segments (Fig. 4b) with lengths in proportion of 4-10-15-10-8, third segment slender. Costal ratio 0.80. Fore femur (Fig. 4d) with 2–3 black ventral spines at distal third. Abdomen with 2 pairs of long hyaline gland rods; genital sclerotization as in Fig. 4f; spermathecae (Fig. 4f) with necks about ¼ as long as diameter of spermatheca. Male and immature stages unknown.

Distribution.—Florida, Maryland, Virginia.

Specimens examined.—FLORIDA: Alachua Co., Gainesville, Chantilly Acres, 8.v.1967, F. S. Blanton, light trap, 1 ♀. MARYLAND: Wicomico Co., Wango, Beech Island Cedar Swamp, 19–24.vi.1982, W. L. Grogan, Jr., Malaise trap, 1 ♀. VIRGINIA: Fairfax Co., Falls Church, vii–viii.1960, W. W. Wirth, holotype ♀, 3 ♀ paratypes pinned, 2 ♀ paratypes on slides (Type no. 60976, USNM).

Bezzia solstitialis (Winnertz)

Fig. 5

Ceratopogon solstitialis Winnertz, 1852: 78 (male, female; Germany; figs.).

Bezzia solstitialis (Winnertz); Kieffer, 1901: 153 (combination; in key); Goetghebuer, 1914: 197 (larva, pupa; figs.; Belgium); Edwards, 1926: 130 (diagnosis; Britain); Remm, 1974: 439 (in key; descriptive notes; figs.; USSR records; syns.:

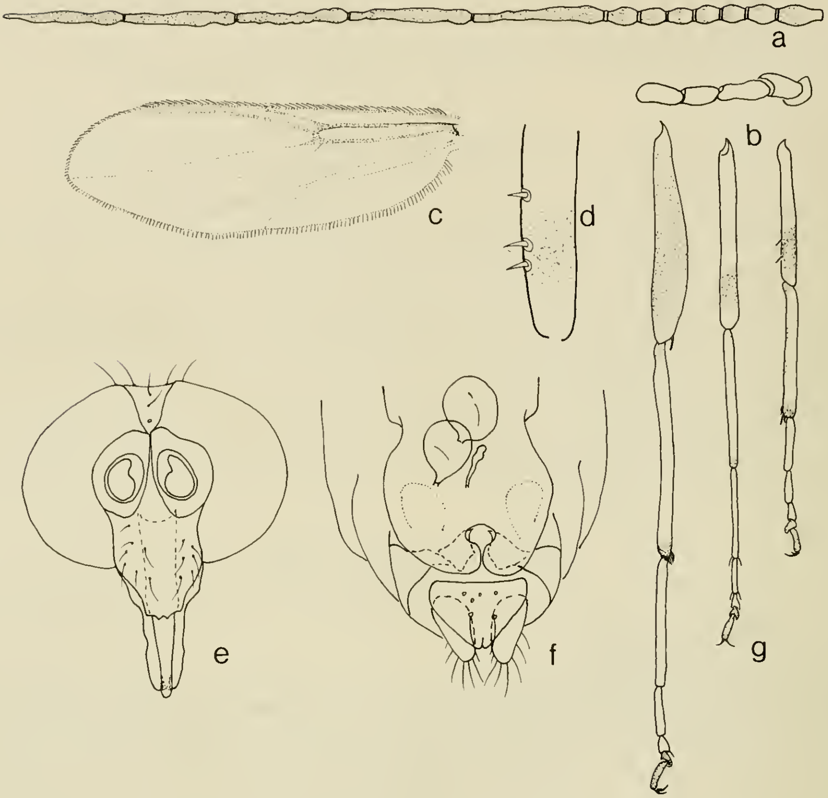

Fig. 4. *Bezzia pseudobscura* female paratypes (from Falls Church, Virginia): a, antenna; b, palpus; c, wing; d, fore femoral spines; e, head, anterior view; f, genital sclerotization and spermathecae; g, hind, mid, and fore legs (left to right).

circumdata Staeger, *hydrophila* Kieffer, *sieberti* Kieffer, *aquatilis* Goetghebuer); Glukhova, 1979: 135 (larva; USSR); Havelka, 1981: 9 (synonymy; Germany; figs. female).

Bezzia varicolor (Coquillett), in part; Dow and Turner, 1976: 117 (misdet.; key, diagnosis, figs.); in part, Downes, 1978: 709 (misdet.; prey records).

Diagnosis.—Wing length 2.4–2.8 mm in female, 1.6–2.0 mm in male. General color dark brown; scutum with gray pollen and distinct dark vittae; head brown; antenna with bases of flagellar segments pale; legs (Fig. 5g) mainly yellow, fore and mid femora with subapical brown ring, hind femur variably brown on distal fourth to third, dark to tip; all tibiae with subbasal brown band, broader on hind leg, and narrow apices dark brown; dark leg bands more extensive but not as distinct in male; wing (Fig. 5c) faintly brown, anterior veins pale brown; halter brown; abdomen brown.

Antennal ratio 1.40–1.70 in female; 0.98 in male; distal segments long and slender, in female segment 11 about 3.0 times as long as 10 (Fig. 5a); third palpal segment (Fig. 5b) slender, palpal ratio in female 3.4; mandible with about 13 teeth. Fore femur (Fig. 5d) with 2–5 relatively long and slender black spines; hind femur often with one strong ventral spine near apex; hind femoral ratio 8.2; hind

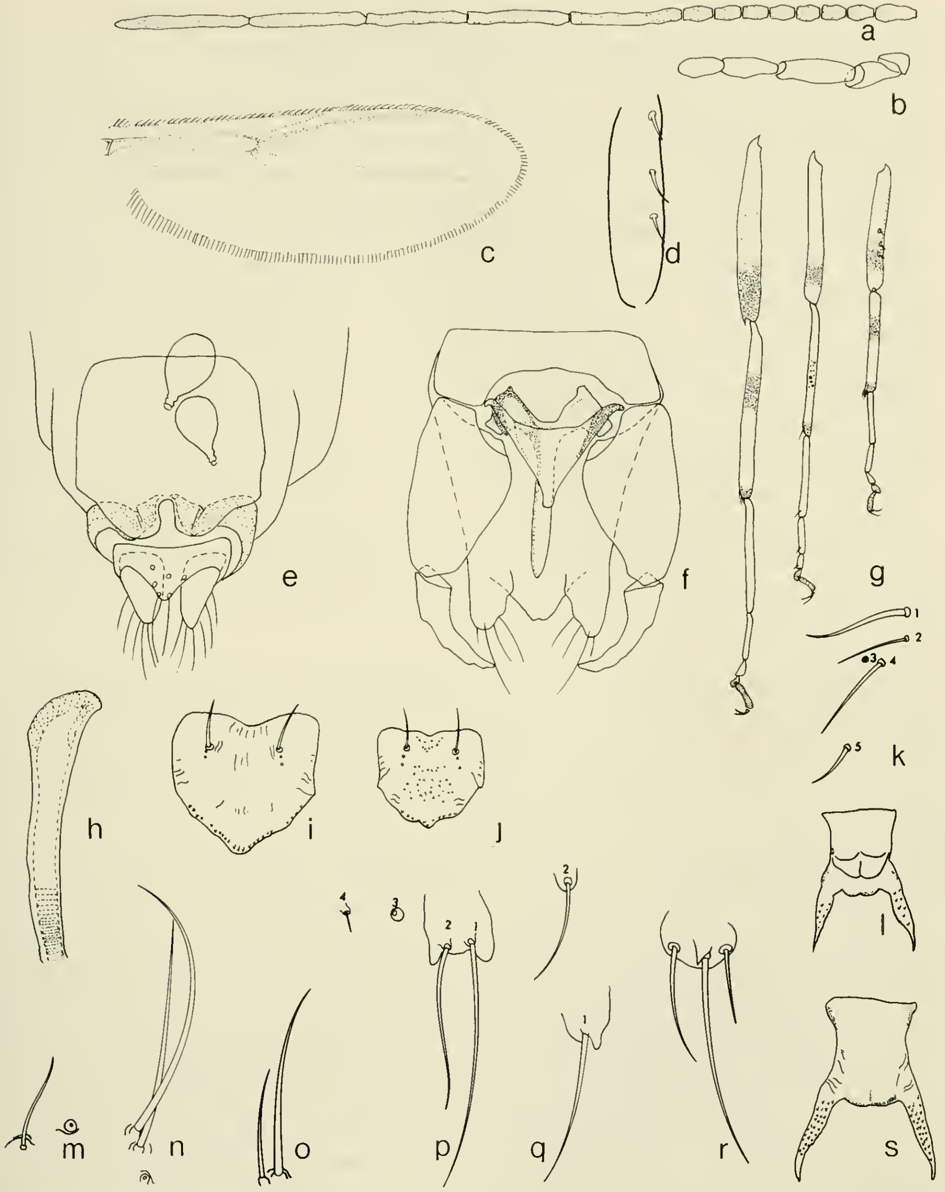

Fig. 5. *Bezzia solstitialis* (from Douglas Lake, Michigan); a–d, g, female; f, male; h–s, pupa (from Oneida Co., Wis.): a, antenna; b, palpus; c, wing; d, fore femoral spines; e, genital sclerotization and spermathecae; f, genitalia; g, hind, mid, and fore legs (left to right); h, respiratory horn; i, female operculum; j, male operculum; k, dorsal tubercles; l, male caudal segment; m, *vl* tubercles; n, *dl* tubercles; o, *vm* tubercles; p, *dpm* tubercles; q, *dasm* tubercles; r, *vpm* tubercles; s, female caudal segment.

tarsal ratio 2.5; wing with costal ratio 0.77; abdomen with 2 pairs of sclerotized gland rods extending over three segments; genital sclerotization as in Fig. 5e; spermathecae subequal, with relatively short necks (0.010 mm), these no longer than a third the diameter of spermatheca. Male genitalia (Fig. 5f) typical of the *annulipes* group; basistyle without prominent basal hump.

Pupa: Length 5–6 mm; color of exuviae brown overall. Respiratory horn (Fig. 5h) clavate, length 0.30 mm, darker in color than operculum; with 18–26 (21) spiracular openings confined to apical portion. Operculum (Fig. 5i,j) pentagonal in shape, light yellow in color, wider than long; denticulate along posterior margin in female, denticulate overall in male; three *am* tubercles, anteromost with moderately stout seta 0.095 mm long. Cephalothoracic chaetotaxy: Three *dl* tubercles (Fig. 5n), two with setae of approximately equal lengths; two *vm* tubercles (Fig. 5o) with unequal setae of medium thickness; two *vl* tubercles (Fig. 5m), one with delicate seta; tubercle *d*3 without seta but other dorsal setae (Fig. 5k) with lengths *d*1 0.110 mm, *d*2 0.106 mm, *d*4 0.147 mm; and *d*5 0.070 mm. Abdomen: Female caudal segment (Fig. 5s) denticulate, as long (0.207 mm) as wide (0.205 mm); male caudal segment (Fig. 5l) denticulate, longer (0.192 mm) than wide (0.179 mm); posterolateral processes denticulate, tips sclerotized, as long as segment. Four *dpm* tubercles (Fig. 5p), *dpm*4 with a short delicate seta, *dpm*2 without seta, *dpm*1 and *dpm*2 blend together bearing two delicate setae; two *dasm* tubercles (Fig. 5q), *dasm*2 tubercle not developed but bearing medium-length thin seta; three *vpm* tubercles (Fig. 5r) fused together bearing three setae with middle one longest.

Distribution.—Europe, North America.

Specimens examined.—ALASKA: Anchorage-Girdwood Highway, 9–14.vii.1964, K. M. Sommerman, jeep trap, 1 ♀. Eklutna, 6.vii.1950, W. C. Frohne, reared, 2 ♀ with pupal exuviae. Fairbanks, vi–viii.1967, Sommerman, jeep trap, 5 ♀. Kenai Peninsula, Johnson Lake to Kasilof, 19.vii.1965, Sommerman, jeep trap, 1 ♀. Palmer, vii–viii.1963, 1964, Sommerman, jeep trap, 5 ♀. Talkeetna, 18.vii.1965, Sommerman, jeep trap, 1 ♀.

BELGIUM: Heusden, 8.vi.1933, M. Goetghebuer, 1 ♂, 1 ♀.

CALIFORNIA: Tulare Co., Sequoia Nat. Park, Heather Lake, 9.viii.1947, W. W. Wirth, 9 ♂, 1 ♀, with pupal exuviae.

FLORIDA: Alachua Co., Gainesville, Chantilly Acres, v.1967, F. S. Blanton, 1 ♂, 26 ♀. Jackson Co., Florida Caverns St. Park, 26.v.1973, W. W. Wirth, light trap, 2 ♀. Levy Co., 13.iii.1954, F. W. Mead, 1 ♀. Marion Co., Juniper Springs, 28.iv.1970, Wirth, light trap, 2 ♀. Santa Rosa Co., Blackwater River St. Park, 25.vi.1973, Wirth, light trap, 2 ♀. Walton Co., Santa Rosa, 11.iv.1950, Peterson, light trap, 1 ♀.

GERMANY: Holstein, 1922–470, #26, A. Thienemann, 1 ♂, 1 ♀, 15 larvae, 6 pupae (BMNH).

GREAT BRITAIN: Carnarvon, Llandwrog, 8.vii.1914, F. W. Edwards, 2 ♀. Essex, Epping Forest, 20.vii.1920, 1 ♂, 1 ♀; vi.1929, 1 ♂, 2 ♀, Edwards coll. Herts., Radwell, vi.1918, Edwards, 1 ♂. Inverness, Aviemore, vi.1931, Edwards, 3 ♂, 2 ♀. N. Lancs., Holker Moss, 11–13.vii.1923, Edwards, 3 ♀. Yorks., Castle Howard, 3.vii.1926, Edwards, 4 ♂, 4 ♀ (all BMNH).

MAINE: Piscataquis Co., Mt. Katahdin, 30.vi.1968, D. R. Oliver, 1 ♀. Penobscot Co., Old Town, Lake Pushaw, 1.viii.1966, W. W. Wirth, light trap, 1 ♀.

MANITOBA: Churchill, 12–19.vii.1953, J. A. Downes, 2 ♂, 5 ♀ (CNC).

MARYLAND: Cecil Co., Elk Neck St. Park, 22–26.v.1979, R. L. Tatman, Malaise trap, 1 ♂. Garrett Co., Cranesville Swamp, 6.v.1960, W. W. Wirth, reared from sphagnum, 11 ♂, 6 ♀ with pupal exuviae. Montgomery Co., Fairland, 27.v.1959, A. A. Hubert, reared, 1 ♂ with pupal exuviae. Prince George's Co., College Park, Calvert Road Park, 26.v.1975, W. L. Grogan, Jr., reared from small slow stream, 1 ♀; Patuxent Wildlife Res. Center, iv–v.1976, Grogan, Malaise trap, 5 ♂, 3 ♀; 27.iv.1977, Shaheen Navai, reared from pond margin, 1 ♀. Wicomico Co., Wango, Beech Island Cedar Swamp, 7–17.vi.1982, Grogan, Malaise trap, 3 ♀.

MASSACHUSETTS: Hampshire Co., Amherst, 1.vi.1943, M. E. Smith, 1 ♂, 1 ♀. Middlesex Co., Concord, 27.vii.1961, W. W. Wirth, marshy pond, 1 ♀.

MICHIGAN: Cheboygan Co., Douglas Lake Biol. Station, vii–viii.1954, R. W. Williams, 2 ♂, 2 ♀; Bryants Bog, 17.vii.1961, D. H. Messersmith, emergence trap, 1 ♀. Clinton Co., Rose Lake, 24.v.1941, C. W. Sabrosky, 2 ♀. Gladwin Co., 14.vi.1958, R. R. Dreisbach, 1 ♀. Isabella Co., 7.vi.1958, Dreisbach, 2 ♀. Livingston Co., George Reserve, v,vi.1943, Sabrosky, 1 ♀. Manistee Co., 22.vi.1957, Dreisbach, 1 ♀. Otsego Co., 9.vii.1959, Dreisbach, 2 ♀. Roscommon Co., 28.vi.1952, 20.vi.1953, Dreisbach, 2 ♀. St. Joseph Co., Nottawa, 28.v.1938, Sabrosky, 1 ♂. Wexford Co., 20.vii.1957, Dreisbach, 1 ♀.

MINNESOTA: St. Louis Co., Work Farm, 25.v.1934, D. G. Denning, 1 ♀.

MONTANA: Big Timber, 14.vii.1917, H. G. Dyar, 1 ♀.

NEBRASKA: Cherry Co., Pelican Lake, 2.vi.1969, W. W. Wirth, light trap, 5 ♀.

NEW BRUNSWICK: Kouchibouguac, 11–17.vii.1977, I. Smith, 1 ♀; 5–8.vii.1978, L. Forster, 1 ♂, 3 ♀.

NEW HAMPSHIRE: Grafton Co., White Mts., Stinson Lake, 23.vii.1961, W. W. Wirth, 1 ♀.

NEW YORK: Chautauqua Co., S. Dayton, 1.vi.1963, W. W. Wirth, marsh area, 2 ♂, 2 ♀. Erie Co., E. Concord Bog, 1.vi.1963, Wirth, maple swamp, 1 ♀. Lewis Co., Brantingham Lake, 22.vi.1963, Wirth, lake margin, 3 ♀. Hamilton Co., Blue Mountain Lake, swamp beyond Salmon River, 14.v.1959, H. A. Jamnback, 2 ♂, 1 ♀ with pupal exuviae. Monroe Co., Braddock Bay, 12.vi.1963, Wirth, near marsh, 14 ♂, 22 ♀. Schuyler Co., Kayutah Lake, 17.vi.1963, Wirth, lake margin, 3 ♀. St. Lawrence Co., Cranberry Lake, 25.vi.1963, Wirth, swamp, 2 ♂, 7 ♀; Wanakena, 25.vi.1963, Wirth, reared, lake margin, 1 ♂, 1 ♀ with pupal exuviae. Tompkins Co., Ringwood Reserve, 16.vi.1963, Wirth, swamp, 2 ♀. Wyoming Co., Portageville, Genesee River, 13.vi.1963, Wirth, 1 ♀.

NEWFOUNDLAND: Avalon, Brigus Jctn., 1.vii.1961, C. P. Alexander, 1 ♀.

NEW HAMPSHIRE: Squam Lake, 10.vii, C. H. Paige, 1 ♀ (MCZ).

NOVA SCOTIA: Baddeck, Victoria, vii,ix.1971, G. B. Fairchild, light trap, 2 ♀.

ONTARIO: Algonquin Park, Bat Lake, 7.vi.1960, W. W. Wirth, reared from sphagnum, 12 ♂, 13 ♀, with pupal exuviae. Black Lake, N. Burgess Twp., 4.vi.1967, J. A. Downes, 9 ♂, 14 ♀ (3 with pupal exuviae; 25.vi–15.vii.1971, J. A. Downes, 14 ♀. Ottawa, 17.vi.1946, G. E. Shewell, 1 ♀; 10.vi.1956, J. R. Vockeroth, 1 ♀. Ottawa, Mer Bleue, 27.v.1960, W. W. Wirth, reared from sphagnum, 4 ♂, 10 ♀ with pupal exuviae. White Lake, 29.v.1967, D. R. Oliver, 1 ♂ with pupal exuviae. Kemptville, v.vi.1960, Wirth, 1 ♂, 27 ♀. Black Lake, N. Burgess Twp., 24.vi.1975, W. L. Grogan, reared, 6 ♂, 2 ♀ with pupal exuviae.

QUEBEC: Aylmer, 2.vi.1960, J. A. Downes, 7 ♂, 4 ♀; same, C. W. Twinn, light trap, 1 ♀. Meach Lake, 6.vi.1960, W. W. Wirth, 2 ♀. Old Chelsea, Summit King Mt., 1150 ft, viii.1965, malaise trap, 1 ♀.

USSR: Estonia, Kingissepp, 10.vi.1967, H. Remm, 1 ♂; Pikasilla, 7.vii.1969, Remm, 2 ♀; Tartu, 9.ix.1967, Remm, 1 ♀. Lithuania, Pajuris, 30.vi.1963, Remm, 2 ♀; Silute, 1.vii.1962, Remm, 1 ♂, 4 ♀ (all det. Remm).

VIRGINIA: Alexandria, Dyke Marsh, 3.vi.1975, W. L. Grogan and W. W. Wirth, 1 ♀. Augusta Co., Mount Solon, 13.vii.1950, Wirth, light trap, 1 ♀. Fairfax Co., Falls Church, 10.viii.1958, Wirth, light trap, 1 ♀.

WISCONSIN: Burnett Co., Banach Lake, 19.vii.1979, S. Palchick, 2 ♂, 1 ♀ with pupal exuviae. Dane Co., Madison, 11.vi.1979, Palchick, 1 ♂, 1 ♀; Oregon, 25.vi.1962, Wirth, light trap, 1 ♂. Marathon Co., Stratford, Kanns Brookview Terrace, Hwy 97, pond, 15.viii.1978, K. A. Kann, 2 ♂, 1 ♀ with pupal exuviae. Oneida Co., Big Carr Lake, 19.vii.1978, W. R. Atchley, 7 ♂, 3 ♀, with pupal exuviae; Tomahawk Lake, off Hwy 47 bridge, 21.vii.1979, Kann, 1 ♂, 1 ♀ with pupal exuviae. Vilas Co., Little John Jr. Lake, 8.vi.1978, Atchley, 8 ♂, 3 ♀ with pupal exuviae; Rudolph Lake, 8.vi.1978, Atchley, 16 ♂, 11 ♀, with pupal exuviae. Washburn Co., 29.vii.1951, 13.vii.1952, R. H. Jones, light trap, 4 ♂, 2 ♀; 2.vii.1952, reared from pool, 2 ♂, 3 ♀. Saweno, vi.1968, R. Habeck, light trap, 1 ♀.

Remarks.—We have compared our Nearctic material of *B. solstitialis* with two specimens from Belgium determined by Goetghebuer, 22 specimens from Great Britain determined by Edwards, and 11 specimens from the USSR determined by Remm.

The hind femur of an occasional male or female specimen of *B. solstitialis* may bear a stout black ventral spine near the apex on one or both legs. No other species in this group has been seen to exhibit this unusual variation.

We have had considerable difficulty in characterizing this species on the basis of our North American material because it exhibited considerable variation in antennal proportions, the development of the fore femoral spines, and in the extent of the dark markings on the hind femur. In cases where confusion might occur with *japonica*, we were forced to rely to a great extent on the shape of the female spermathecae, which tapered more gradually toward the necks and always had shorter necks than in *japonica*.

Bezzia solstitialis is the commonest and most widespread species of the group in North America, as seems to be the case in Europe. In North America its main distribution is somewhat more southerly than in *B. annulipes*, which it resembles in color markings and with which it has been confused in Europe. The material we have seen from Florida has consistently more extensive dark leg markings than others in North America and these individuals might be confused with those of *japonica* or *varicolor* except that in the Florida *solstitialis* the hind femur is often dark at the base and the apex, and broadly, more or less pale in midportion. Structurally the Florida specimens agree perfectly with typical *solstitialis*.

In Ontario, the females of this species (recorded in error as *B. varicolor* (Coquillett)) feed on *Chaoborus* spp. and a variety of medium-sized chironomids, which they capture in the mating swarms of the prey species (Downes, 1978).

***Bezzia varicolor* (Coquillett)**

Fig. 6

Ceratopogon varicolor Coquillett, 1902: 84 (female; New York); Dyar, 1903: 38 (pupa; fig. pupa of holotype).

Fig. 6. *Bezzia varicolor* (from Noyack, New York); a–d, f, l, female; e, k, male; h–j, m–r, pupa (from Oneida Co., Wis.): a, antenna; b, palpus; c, genital sclerotization; d, spermathecae; e, parameres; f, fore femoral spines; g, female operculum; h, respiratory horn; i, *vl* tubercles; j, dorsal tubercles; k, genitalia, parameres ommitted; l, fore, mid, and hind legs (left to right); m, *dl* tubercles; n, *vm* tubercles; o, *dasm* tubercles; p, *dpm* tubercles; q, *vpm* tubercles; r, female caudal segment.

Bezzia varicolor (Coquillett); Kieffer, 1906: 59 (combination); Malloch, 1914: 282 (in key); Malloch, 1915: 348 (mention); Thomsen, 1937: 77 (immature stages; New York; biology; figs.); Wirth, 1952: 234 (in part; California; figs.; pupa); Dow and Turner, 1976: 117 (in part; diagnosis; figs.); Downes, 1978: 7–8 (in part; prey records; figs.).

Diagnosis.—Female wing length 3.0 mm. Color dull brown with dense grayish pollen; mesonotum with dark brown vittae; legs (Fig. 6l) yellowish, fore and mid femora with narrow subapical brown rings; fore and mid knee spots dark brown, hind femur brown nearly to base, fore and hind tibiae with broad brown subbasal bands, all tibiae with apices narrowly dark brown; last three tarsomeres dark; wing grayish hyaline, anterior veins yellowish; halter pale brownish; abdomen grayish brown.

Female antenna (Fig. 6a) with lengths of flagellar segments in proportion of 20-12-10-10-10-10-10-12-35-35-35-35-38, antennal ratio 1.90–2.00; palpal segments (Fig. 6b) with lengths in proportion of 5-10-20-10-15, third segment short and slender; mandible with 11–12 teeth. Costal ratio 0.80. Fore femur (Fig. 6f) with 2–4 rather long, slender, ventral spines in the area of the subapial brown ring; hind tarsal ratio 2.4. Female abdomen with one pair of unpigmented gland rods; genital sclerotization as in Fig. 6c; spermathecae (Fig. 6d) unequal, measuring 0.080 by 0.051 mm and 0.058 by 0.043 mm including the short, slender necks. Male genitalia (Fig. 6k) of the usual structure for the group, moderately broad, basistyle with pronounced basal hump on mesal side; parameres as in Fig. 6e.

Pupa: Length 5.5 mm; color pale brown. Respiratory horn (Fig. 6h) four times as long as greatest breadth, slightly curved and expanded subapically and bearing 40–50 spiracular openings in a slightly undulating row around apex and a third way down both sides. Operculum (Fig. 6g) light brown, somewhat pentagonal in shape, about 1.3 times as wide as long, denticulate in midportion, with three *am* tubercles, foremost with a seta 0.113 mm long. Cephalothoracic chaetotaxy: Three *dl* tubercles (Fig. 6m), two with setae 0.119 mm and 0.082 mm long; two *vm* tubercles (Fig. 6n) with medium-size spines; two *vl* tubercles (Fig. 6i), one with seta 0.066 mm long; tubercle for *d*3 without spine, other dorsal spines (Fig. 6j) with lengths *d*1 0.126 mm, *d*2 0.119 mm, *d*4 0.150 mm, and *d*5 0.095 mm. Abdomen denticulate at posterior margin of each segment; caudal segment (Fig. 6r) as wide (female 0.236 mm, male 0.202 mm) as long (female 0.216 mm, male 0.207 mm); posterolateral processes spinulose with length 0.245 mm (female) and 0.216 mm (male); three *dpm* tubercles (Fig. 6p) with *dpm*1 and *dpm*2 close together and bearing very long, thin setae, *dpm*3 with short thin spines; *dasm*1 (Fig. 6o) with truncate tubercle and long thin seta, *dasm*2 tubercle pointed and bearing shorter seta; three *vpm* tubercles (Fig. 6q) fused together and bearing a medium-long seta and a short seta.

Distribution.—California, Florida, Maryland, Massachusetts, New York, Ontario, Quebec, Texas, Virginia, and Wisconsin.

Specimens examined.—CALIFORNIA: Alameda Co., Berkeley, Lake Temescal, 1.v.1948, W. W. Wirth, reared from pupae floating at lake margin, 11 ♂, 18 ♀, with pupal exuviae.

FLORIDA: Orange Co., Rock Springs, 21.iv.1970, Wirth, light trap, 4 ♀.

MARYLAND: Montgomery Co., Plummers Island, 29.v.1914, R. C. Shannon, at light, 1 ♀.

MASSACHUSETTS: Brookline, 2.vi. (collector ?), 1 ♀ (MCZ).

NEW YORK: Suffolk Co., Long Island, Bellport, v,ix, H. G. Dyar, ♀ holotype; Noyack, Mill Creek Brook, 6.v.1957, H. A. Jannback, 1 ♀ with pupal exuviae. Tompkins Co., Ithaca, 23.vii–11.viii.1931, O. A. Johannsen, 3 ♂, 4 ♀ (CORNELL); iii,v.1933, L. C. Thomsen, 2 ♂, 4 ♀, 1 larva, 4 pupae; Brooktondale, vi.1933, Thomsen, 1 ♂, 2 ♀, 2 pupae; McLean, iii–vii.1933, Thomsen, 7 ♂, 13 ♀, 4 larvae, 12 pupae; Slaterville, 8.v.1933, Thomsen, 3 ♂, 4 ♀, 10 larvae; Ringwood, v.1933, Thomsen, 1 ♂, 1 ♀ (all CORNELL).

ONTARIO: Black Lake, N. Burgess Twp., 4,25.vi.1967, 26,28.vi,2.vii.1971, 27.v.1973, J. A. Downes, 3 ♂, 7 ♀. London, 30.viii.1956, v–viii.1958–60, W. W.

Judd, 7 ♂, 15 ♀. Ottawa, vi.1960, J. A. Downes, 1 ♀; Rideau River, 29.v.1960, W. W. Wirth, reared from river margin, 1 ♂, 3 ♀, with pupal exuviae. Stanleyville, Black Lake, 26.vi.1975, W. L. Grogan, reared, 1 ♂, 1 ♀, with pupal exuviae. Pakenham, 12.vi.1974, Downes and Forster, 1 ♂, 1 ♀. Simcoe, 28.v, 13,26.vi.1939, G. E. Shewell, 4 ♀.

QUEBEC: Pinks Lake, Gatineau Park, 15.vii.1967, L. Forster, 1 ♂, 1 ♀. St. Pierre de Wakefield, 19.vi, 10.vii.1974, 3.vi.1975, L. Forster, 2 ♂, 5 ♀.

TEXAS: Kerr Co., Hunt, Guadalupe River, 12.vi.1953, W. W. Wirth, 2 ♂, 6 ♀, with pupal exuviae; Kerrville, 13.vi.1953, iii–iv.1954, L. J. Bottimer, light trap, 1 ♂, 4 ♀; Kerrville, Henkes Pond, 7.iv.1955, Wirth, pond margin, 1 ♂ with pupal exuviae. Llano Co., Enchanted Rock, 15.vi.1953, Wirth, 1 ♂. Real Co., Rio Frio 5 mi NW Leakey, 23.v.1972, Wirth, reared, 1 ♀ with pupal exuviae.

VIRGINIA: Montgomery Co., Blacksburg, vi.1960, D. H. Messersmith, light trap, 1 ♀.

WISCONSIN: Chippewa Co., Lake Wissota at St. Park, 22.vii.1979, S. Palchick, 1 ♂ with pupal exuviae. Dane Co., Madison, Vilas Zoo, 11.vii.1978, K. A. Kann, 1 ♂ with pupal exuviae; Nevin Fish Hatchery, 14.vii.1978, Kann, 9 ♂, 3 ♀ with pupal exuviae. Lafayette Co., Yellowstone Lake at St. Park, 23.vi.1979, Palchick, 3 ♂, 3 ♀ with pupal exuviae. Marathon Co., N of Stratford, Panzigraus Farm, 13–15.viii.1978, Kann, reared from stream through cow yard, 1 ♂, 14 ♀, with pupal exuviae. Oneida Co., Lake Minocqua, 19.vii.1978, W. R. Atchley, 2 ♂ with pupal exuviae; Lake Tomahawk, Kemp Biol. Station, 20.vii.1978, Kann, 17 ♂, 12 ♀ with pupal exuviae. Sauk Co., Mirror Lake at St. Park, 18.viii.1979, Palchick, 5 ♂, 4 ♀, with pupal exuviae. Waupaca Co., Bear Lake, 8.viii.1979, Palchick, 3 ♂, 3 ♀, with pupal exuviae. Washburn Co., 13.vii.1952, R. H. Jones, light trap, 1 ♂, 1 ♀.

Remarks.—Wirth (1952) confused two species in the California material that he reported as *B. varicolor*; the series from Lake Temescal, Alameda Co., which he described and whose pupa he figured, is *varicolor*; the series reared from Heather Lake, Tulare Co., from which the male genitalia figure was prepared, is actually *B. solstitialis.* Dow and Turner (1976) had a mixture of *varicolor* and *solstitialis* in the series which they described as *varicolor.*

In Ontario the females of this species feed on *Chaoborus* spp. and various chironomids, which they capture in the mating swarms of the prey species (Downes, 1978).

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MATING AND NESTING BEHAVIOR OF *TACHYTES INTERMEDIUS* (VIERECK) (HYMENOPTERA: SPHECIDAE)

Frank E. Kurczewski and Edmund J. Kurczewski

(FEK) Department of Environmental and Forest Biology, S.U.N.Y. College of Environmental Science and Forestry, Syracuse, New York 13210; (EJK) 2921 Reed Street, Erie, Pennsylvania 16504.

Abstract.—The mating and nesting behavior of *Tachytes intermedius* (Viereck) were studied during 1980–1982 in a gravel pit in Erie County, Pennsylvania. Male activity and the copulatory positions of the male and female are described and compared with those of *Tachysphex similis* (Rohwer) and *T. terminatus* (Smith). Descriptions of the hunting components and the unearthment of the pygmy mole-cricket are given and are essentially identical to those of *Tachytes mergus* Fox. Details of prey transport and the unique method of entry into the open nest are presented. Prey stealing by conspecific females and worker *Formica subsericea* Say (Formicidae) was prevalent, but cleptoparasitism by satellite-flies (Sarcophagidae) was absent. The 1–3-celled nests of *T. intermedius* extended deeper into sandy-gravelly soil than into clayey soil. The burrows entered the soil less vertically than those of other species of *Tachytes*, and the cells were often found at right angles to the burrow termini. Fully-provisioned cells of *T. intermedius* in July 1981 held 2–4 larger adult *Neotridactylus apicialis* (Say) (Tridactylidae), whereas such cells in August 1981 contained 4–6 smaller nymphs of this species. All prey were lightly paralyzed. The wasp's egg was placed between the fore- and midcoxae of the cricket in a position similar to that of other species of Larrinae that use orthopterous, non-mantid prey.

One of the most unusual behavior patterns exhibited by the larrine wasps is that involving the unearthment, capture and provisionment of pygmy mole-crickets (Tridactylidae). In North America only two species of *Tachytes, T. mergus* Fox and *T. intermedius* (Viereck), are known to practice this behavior (Krombein, 1963; Krombein and Kurczewski, 1963; Kurczewski, 1966a; Kurczewski and Kurczewski, 1971; Williams, 1928). *T. mergus* is unique among the Nearctic *Tachytes* in its unusual manner of burrow construction and temporary nest closure. *T. intermedius* is a more "typical" *Tachytes,* based upon its digging behavior and lack of temporary closure.

Despite the fact that some particulars for the nesting behavior of *T. intermedius* have been reported, the full spectrum of its ethology has yet to be presented. Krombein and Kurczewski (1963) noted a few females that were collected with tridactylid prey in Maryland, Florida and New York. Krombein (1963) observed females hunting Tridactylidae in mud along the Potomac River in Maryland. Kurczewski (1966a) detailed the hunting, capture, transport, nest entry and species of prey of *T. intermedius,* but his presentation of the nest architecture, dimensions and contents left several questions unanswered. Kurczewski and Kurczewski (1971) added one tridactylid host record each from Pennsylvania and Kansas.

In 1980–1982 we studied this species in more detail than had been previously reported, particularly with regard to male activity, nest construction, nest architecture, dimensions and contents. In 1980 about 20 males and 12 females, some of which were captured with prey, were observed 2 mi SE of Erie, Erie Co., PA during 9 July–20 August. This area comprised nearly 30 acres of sandy banks, hills of mixed gravel, sand and clay, and flat areas of recently bulldozed gravel, interspersed with two large and several small ponds. *T. intermedius* occupied an area of approximately 1 × 1 m of gravelly hills adjacent to one of the ponds (Fig. 1).

In 1981 in this area eight males were observed perching on pebbles and making low flights during 26–28 June. Females emerged on 3–4 July after several days of rainfall and by 5 July, 23 wasps were digging and occupying nests in the 1 × 1 m area (Fig. 2). Twenty-one of the 23 nests were in the hill *per se,* whereas two females had nests in the flat soil at the base of the hill. During the last half of July the numbers of males and females in this area diminished considerably, but during the second week of August the number of such wasps with unfrayed wings increased noticeably—suggestive of a second generation. During 17–20 August, more than 50 females and 20 males occupied a 2 × 2 m area incorporating the area in which these wasps were found in June and July. The females nested there until 13 September.

In 1982 this area had become overgrown with vegetation. Many males and females emerged between 28 June and 5 July. On 17 July at 0945 hrs (EDT) more than 100 males were flying and landing in a 3 × 6 m area amidst 25 nesting females. The number of males gradually declined throughout late July as the number of nesting females increased to about 75. A much smaller, presumed second generation of wasps occupied this area in late August and early September 1982.

Male activity.—In June 1981 males of *T. intermedius* emerged from five to eight days before the females, the female emergence delayed because of several days of rainfall. The number of males in the 1 × 1 m area increased from 8 on 28 June to about 30 on 5 July. In August 1981 males appeared only two or three days before the females, this duration probably representing the more typical emergence pattern in this species. The number of males doubled between 12 and 17 August.

After their emergences the males made rapid, low flights back and forth above the soil. They landed periodically on pebbles, vegetation and other elevated objects, rested for a few or several seconds, sometimes cleaned their antennae, and then flew elsewhere. Upon landing the male lowered his wings flat on the dorsum, moved the antennae or held them straight, and kept the legs outstretched. Males rested for longer periods during cloud cover than during periods of sunshine.

Certain males returned periodically to the same pebble, plant or elevated object and perched thereon. Such continued maintenance of a particular perch or station may represent a form of territorial behavior. In late June 1981 males flew at and chased one another, but occasionally two males took turns using a common perch or station. Later, after the females began nesting, much male activity was focused on chasing and attempting to mate with the provisioning females. Provisioning females were reluctant to mate with such males and usually turned the abdomen

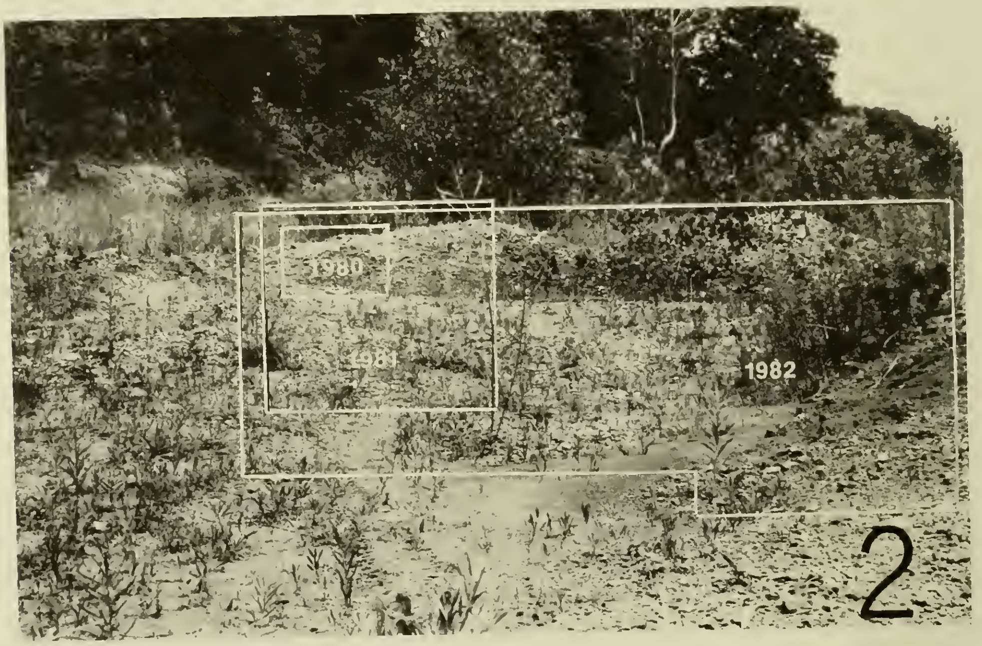

Fig. 1. Small pond (lower left) and surrounding mud in which females of *Tachytes intermedius* hunted. Males patrolled and females nested in hill to right.

Fig. 2. *Tachytes intermedius* nesting areas in 1980, 1981 and 1982.

to one side. Some females were pounced upon so vigorously by males that they temporarily lost possession of their prey and had to recover, reposition and groom the pygmy mole-cricket prior to resuming transport.

Copulation involved the male pouncing upon the female's dorsum and holding her wings flat. The female's abdomen twisted about 45° to the side in order to receive the twisted and underturned male genitalia. Although the pair remained more or less motionless, the male's abdominal segments moved rhythmically. After about one-half minute the pair disengaged. The male usually flew away, landed and cleaned, while the female cleaned her antennae with the strigili and rubbed her abdomen with the hindlegs prior to taking flight.

Nest building.—Females began digging nests by using the mandibles to loosen pieces of soil and remove gravel. After the mandibles loosened the soil, the forelegs were used in unison to rake the soil backward beneath the body. The hindlegs and the end of the abdomen, especially the pygidium, were used later to shove the soil up the burrow and out of the entrance. The wasp did not immediately remove this soil from around the entrance, resulting in a rim of moistened sand and gravel. Later females came out of their entrances and distributed some of the soil to distances of a few or several millimeters from the opening, but much of the surrounding rim remained in place. As burrow construction progressed, females appeared in their entrances, removing sand, at increasingly longer intervals. Three wasps took from 55 to 90 ($\bar{x} = 67$) minutes to complete a burrow (and cell?). A rather extensive orientation flight followed the construction of the burrow.

The construction of a second cell was signalled by the female staying inside the nest for many minutes after bringing in prey. This was followed by the wasp plugging her entrance with loosened, moistened sand and gravel and periodically transferring this soil to the rim of the tumulus. Such a manner of soil removal was repeated a few or several times prior to the female's exiting head first and going in search of prey.

Hunting and prey capture.—Details of hunting and the unearthment of the pygmy mole-cricket were essentially as described by Kurczewski (1966a). Females searched for prey by walking rapidly on the ground in a zigzag manner with the wings held flat on the dorsum and the antennal tips tapping the soil. Wasps paused on certain areas of soil, especially moistened sand and mud, tapped the soil alternately with the antennal apices, and then dug rapidly downward with the mandibles. If unsuccessful in their search for prey, females walked or flew elsewhere and repeated this behavior. But, if the wasp received the appropriate stimuli, she continued to dig downward rapidly with the mandibles and forelegs, repeatedly shoved her head into the opening, circled, dug, thrust the head into the excavation and circled. Then the female flew rapidly upward, grasping the tridactylid by its neck with the mandibles, landed on the ground, and bent the abdomen underneath the pygmy mole-cricket while stinging it in the underside of the thorax near the legs. The prey was stung one or a few times. Regardless of the number of stings, the paralysis was slight as indicated by the noticeable, rhythmic movements of the cricket's appendages and abdominal segments. Two wasps captured consecutive prey 2–28 ($\bar{x}$, 9; $n = 32$) minutes apart.

Prey transport and nest entry.—Provisioning females were seen as early as 1005 hrs (EDT). They repositioned their prey, after stinging it, and, maintaining the cricket either dorsal or ventral side upward, grasped its antennae with the mandibles and its body with the legs and made a low, rapid flight toward the nest. Some flights were over 1 m in length. Wasps with large prey made several, shorter flights. At the open entrance some prey were shifted backward and held by their neck with the wasp's hindlegs as the female went inside. In such cases, the cricket extended well beyond the wasp's abdominal apex. Large prey were frequently released on the soil while the wasp entered her nest and turned around inside. Such females came partly out of the entrance and, grasping the prey's antennae with the mandibles, backed into the nest. Following either manner of entry, the provisioning wasp reappeared in the entrance several seconds or minutes later, paused in the opening, looked around and took flight.

Some provisioning wasps were interrupted in flight by males attempting to copulate and many such females released their prey on the ground. These wasps often lost the cricket for several seconds or minutes and this diversion encouraged prey stealing by other females and ants. Prey stealing by workers of the ant, *Formica subsericea* Say, sometimes followed conspecific female interference and prevailed when provisioning females had difficulty in finding their nest entrances. Workers of another species of ant, *Tetramorium caespitum* (L.), invaded open nests of *T. intermedius* and took prey from the cells.

Prey stealing by conspecific females was facilitated when the wasps nested in close proximity, such as in the case of the 23 nests in the 1 × 1 m area in 1981. In each observed case of brigandage the cricket was restung by the thieving female before it was taken into her nest. Two females each entered nests with other provisioning wasps inside. Whether or not this was a case of mistaken nest identity related to the proximity of the entrances, some being only a few cm apart, is unknown.

Nest architecture and dimensions.—The burrows of *T. intermedius* penetrated the sand mixed with gravel but did not extend far into an underlying layer of clay. Five cells in clayey soil were, with one exception, shallower (3.5–6.5 cm) than 23 cells in sandy-gravelly soil (4.7–9.0 cm). Nest entrances averaged nearly 4 mm in diameter. Thirty-four of 51 entrances were concealed beneath overhanging, flat rocks or between sizeable pebbles. About one-fourth of the tumuli surrounding the entrances had been eliminated entirely by weathering. Those that remained varied in size from 1.9 × 2.8 to 4.0 × 5.5 cm. Nests on slopes had asymmetrical tumuli, whereas those in flat areas were, more or less, symmetrical.

None of the nests that we excavated had been finished by the wasps. The burrows entered the sand at 40°–70° angles with the horizon and plunged downward for 3.0–7.5 cm; then, some of them coursed horizontally for 6.3–12.7 cm and terminated in 1–3 cells (Fig. 3). We found no storage chambers in these nests, but the cells were often located at right angles to the termini of the burrows. Five nests in clayey soil did not course horizontally but terminated abruptly after the burrows plunged downward; the dimensions of another nest were delimited by the outline of a large, subterranean rock (Fig. 3). Burrows (15) ranged in total length from 5.2 to 15.7 ($\bar{x} = 11.8$) cm. Rearing cells (28) were unearthed from 3.5 to 9.0 ($\bar{x} = 5.6$) cm beneath the surface. The shallowest and deepest nests were excavated in August 1981. Cells (28) averaged 6.1 (5–7) mm wide and 11.1 (9–12) mm long.

Provisions.—Fifteen fully-provisioned cells of *T. intermedius* in July 1981 contained 2–4 ($\bar{x} = 3.1$) pygmy mole-crickets, whereas six such cells in August 1981

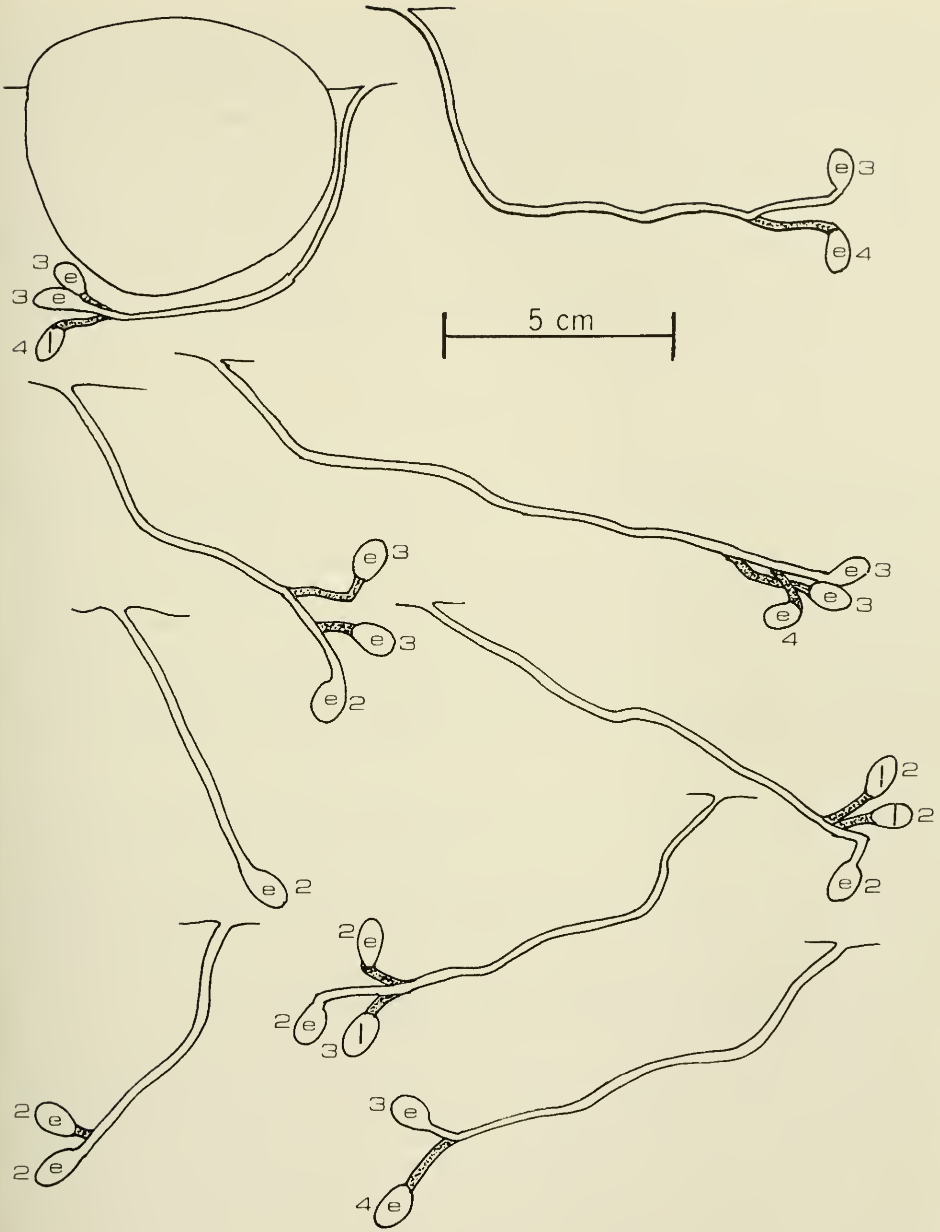

Fig. 3. Nests of *Tachytes intermedius* as viewed from the side. Stippling indicates burrow filled with soil; (e), egg; (l), larva. Scale refers to all nests. Numbers beside cells refer to number of prey per cell.

held 4–6 ($\bar{x} = 5.0$) prey. The species provisioned exclusively with *Neotridactylus apicialis* (Say), utilizing 61 adults during 3–5 July 1981 and 7–17 July 1982; 6 adults and 1 immature during 18–24 July 1982; 38 immatures during 13–16 August 1981; 2 immatures and 1 adult on 20 August 1981; and 3 adults on 13 September 1981. Crickets from cells in July 1981 averaged 22.4 (13–27) mg in body weight, whereas those from cells in August 1981 averaged 17.8 (8–23) mg. Eight female wasps were more equivalent in size: July, $\bar{x} = 10$ mg; August, $\bar{x} = 9$ mg. The crickets were placed in the cells head inward with any side upward. As indicated, recently captured prey were lightly paralyzed and moved their antennae, mouthparts and legs considerably. Some crickets leapt several cm when unearthed from the cells.

Egg.—The egg of *T. intermedius* was attached to a cricket in a ventral-side-upward and head-inward position at the bottom of the cell. The eggs, averaging 1.7 × 0.4 mm, were white, sausage-shaped, and were attached to either the right or left forecoxal corium of the prey. Such eggs were placed transversely between the bases of the fore- and midlegs of the cricket.

Discussion

Tachytes intermedius usually nests in sandy or gravelly soil near water. Its prey—species of Tridactylidae—prefers soil with a relatively high water table. In the northeastern United States *T. intermedius* may have two generations per year with peak emergences in late June–early July and mid-August. Krombein (1963) reported that this species is "probably univoltine" in Maryland, but we have collected females in Pennsylvania and New York a month later than Krombein collected his wasps. *T. intermedius* has been collected from March (Krombein and Evans, 1955) to July (Kurczewski, 1966a) in southern Florida, suggesting more than two generations per year in this region. Our data indicate a 1:1 sex ratio for this species, based upon the observation of about 170 males and 160 females during 1980–1982.

Male activity and behavior were nearly identical to those of *Tachysphex similis* Rohwer and *T. terminatus* (Smith) (Kurczewski, 1966b). Males of *T. intermedius* emerged before the females, made low rapid flights above the soil, landed on elevated objects, and returned periodically to the same perches. They pursued recently emerged and nesting females, but were successful in mating only with the former. The copulatory positions of the male and female were similar to those of male and female *Tachysphex terminatus* (Kurczewski, 1966b).

In constructing a burrow *T. intermedius*, belonging to the *abdominalis* group, resembles *T. validus* Cresson, a member of the *aurulentus* group (Evans and Kurczewski, 1966; Kurczewski and Ginsburg, 1971). Females of both species use the mandibles to loosen soil and the forelegs to rake the soil backward beneath the body. The hindlegs and the abdominal apex are then used to shove the soil up the burrow, resulting in a rim of moistened soil around the entrance. *T. mergus*, belonging to the *mergus* group, on the other hand, forms a pellet of sand between the mandibles and forelegs, walks backward several centimeters, and deposits the sand pellet away from the entrance (Krombein and Kurczewski, 1963). Both *T. intermedius* and *T. validus* leave the nest entrance open during provisioning, whereas *T. mergus* maintains a temporary nest closure.

Females of *T. intermedius* and *T. mergus* exhibit essentially identical hunting behavior. Both species extract pygmy mole-crickets from the soil, using the mandibles, fly upward, land, and sting the prey one or a few times in the thorax (Krombein and Kurczewski, 1963; Kurczewski, 1966a). In both species the paralysis of the prey is slight, with the pygmy mole-crickets leaping vigorously from the cells when unearthed.

Unlike many larger species of *Tachytes* which carry their prey in long, rather high flights and produce a loud, buzzing sound (Williams, 1914; Parker, 1921; Evans and Kurczewski, 1966), *T. intermedius* makes short, low, silent provisioning flights. *T. intermedius* thus resembles some other species in the *abdominalis* group such as *T. obductus* Fox. Unlike *Tachytes mergus* which must remove a temporary sand closure before entering its nest (Krombein and Kurczewski, 1963) or species in the *aurulentus* group which plunge directly downward into their open nests with prey (Evans and Kurczewski, 1966), *T. intermedius* often releases the pygmy mole-cricket in the entrance before pulling it inside or shifts the prey backward and holds it by the neck with the hindlegs during entry.

Prey stealing, a seemingly unknown phenomenon among other species of *Tachytes,* was prevalent in *T. intermedius.* The high incidence of brigandage by both conspecifics and worker ants was undoubtedly related to male interference and to the proximity in which the females nested. The lack of satellite-fly attacks on the prey of *T. intermedius* may be related to the gravelly habitat in which the females nested with entrances concealed beneath over-hanging rocks and between pebbles. Other pompilids and sphecids nesting in this area were also less afflicted with miltogrammine cleptoparasites than similar species nesting in bare sand.

Nests of species in the *aurulentus* group contain long, vertical main burrows and rather long, almost horizontal side burrows leading to elongate rearing cells (Evans and Kurczewski, 1966; Kurczewski and Ginsburg, 1971). *T. mergus,* on the other hand, has a proximal main burrow with a slight slope—obviously related to its temporary nest closure—which grades into a vertical main burrow and much shorter side burrows leading to a few, ovoidal rearing cells (Krombein and Kurczewski, 1963). The nests of species in the *abdominalis* group, including *T. intermedius* and *T. obductus,* are somewhat variable in architecture depending upon the substrate in which they are constructed (Kurczewski, 1966a, 1976; Kurczewski and Kurczewski, 1971). The main burrows tend to be more angular than those of species of the other groups with short side burrows leading to a few or several ovoidal rearing cells. Cell depth in the genus seems to be related to the sizes of the adult wasps, with larger species building deeper nests. *T. intermedius* is the only *Tachytes* that has been studied throughout an entire summer, and there was no noticeable change in cell depth during these months. Although temporary storage chambers have been described for *T. validus* (Evans and Kurczewski, 1966) and *T. intermedius* (Kurczewski, 1966a), such chambers were not found in later studies on these species (Kurczewski and Ginsburg, 1971). In the latter species the rearing cells are often constructed at right angles to the burrow termini.

Tachytes intermedius and *T. mergus* are the only sphecids in North America that provision with Tridactylidae. Nymphal and adult *Neotridactylus* comprise the prey of another larrine, *Gastrosericus rothneyi* Cameron, in Thailand (Iwata and Yoshikawa 1964). In *T. intermedius* there was a shift from using larger adult *Neotridactylus apicialis* and therefore fewer prey per cell in July to storing smaller nymphs of this species and thus more prey per cell in August back to larger adults in September.

The egg of *T. intermedius* is placed transversely between the fore- and midcoxae of the prey and is attached on or near a forecoxal corium. Such a placement is a diagnostic behavioral feature in most *Tachytes* and *Tachysphex* and many other larrine wasps (Iwata, 1976), and seems related to the use of non-mantid, orthopterous prey.

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ECOLOGICAL NOTES ON CACAO-ASSOCIATED MIDGES (DIPTERA: CERATOPOGONIDAE) IN THE "CATONGO" CACAO PLANTATION AT TURRIALBA, COSTA RICA

Allen M. Young

Invertebrate Zoology Section, Milwaukee Public Museum, Milwaukee, Wisconsin 53233.

Abstract.—A comparison of larvae and pupae of cacao-associated midges (Diptera: Ceratopogonidae) in various breeding substrates was made between successive rainy and dry seasons in the "Catongo" cacao plantation at Turrialba, Costa Rica. One collection of adult midges on cacao flowers was also made in the rainy season. One cluster of 25 larvae of *Forcipomyia fuliginosa* (Meigen) was found in one of 22 leaf litter-filled plastic cups in cacao trees in the rainy season, and several pupae of *F. cinctipes* group were collected from rotten slices of banana tree trunk at this time. A total of five adults of *F. genualis* (Loew) emerged from about 25% of the leaf litter collected in the rainy season. During the dry season, a few slices of banana tree trunks yielded pupae belonging to *F. genualis* and *F. cinctipes* group. Adult midges collected from cacao flowers in the rainy season included *Dasyhelea soriai* Wirth and Waugh. Although only small portions of available breeding substrate materials were occupied by midges in both seasons, immature stages appeared to be more concentrated in the rotting slices of banana tree trunks during the dry season, a time when flowering in cacao is quite low at this locality. Midge populations appear to be more evenly dispersed within the plantation during the rainy season, a time of peak flowering in cacao. These data, while limited, may reflect general patterns of response to tropical seasonal conditions by cacao-associated midges, some of which might be effective pollinators of cacao. The midge species studied deserve further attention in terms of their possible roles as effective pollinators of *T. cacao.*

A complete understanding of the relationship between flowering patterns in *Theobroma cacao* L. (Sterculiaceae), "cocoa," and the abundance of pollinating midges in the family Ceratopogonidae (Diptera), includes a consideration of how prevailing patterns of tropical seasonality influence both abundance of flowers and pollinators. It is generally believed that *T. cacao,* in its cultivated state, is pollinated chiefly by ceratopogonid midges, and most notably those of a few genera such as *Forcipomyia, Euprojoannisia,* and *Dasyhelea* (e.g. Soetardi, 1950; Saunders, 1959; Hernandez, 1965; Soria et al., 1980; Soria et al., 1981, and many other references). Abundance within adult populations of these tiny midges varies considerably throughout the year in plantations, with greatest numbers retrieved from cacao flowers during the rainy season (e.g. De la Cruz and Soria, 1973; Soria and Abreu, 1976; Winder and Silva, 1975). In lowland tropical rain forest with an erratic annual dry season, highest densities of immature stages (larvae and pupae) of some species of ceratopogonids occur in slices of rotting banana tree trunks during the dry season, such substrates or microhabitats acting as ecological "refugia" for these insects (Young, 1982, 1983). The purpose of this paper is to present some limited data on the abundance of primarily ceratopogonid larvae and pupae in various life cycle substrates in a cacao plantation in the highlands of Costa Rica.

Locality and Methods

The locality is the cacao plantation complex of the Inter-American Institute for Agricultural Sciences (also known as CATIE) at Turrialba (9°55'N, 83°41'W), Turrialba Province, Costa Rica. The area is essentially lower montane rain forest (about 600 m elev.). Because only less than 10% of the days each year have daily temperatures above 28°C and rainfall is high every month, it is not ideal for *T. cacao* plantations, even though harvests of mature pods are fairly constant all year long. I studied ceratopogonid midge species associated with a mature planting of about 70 trees of the "Catongo" self-compatible variety or clone of *T. cacao*. The "Catongo" *T. cacao* originated at Bahia, Brazil and it is readily recognized by its uniformly white flowers and seeds (Dr. G. Enriquez, personal communication). The area of the plantation selected for study has a broken canopy of various legume trees, creating a patchwork of both shaded and sunny places within the *T. cacao*.

Beginning in late June 1980, I tagged 52 randomly selected *T. cacao* trees within this plantation, and obtained monthly data on abundance of flowers and new fruits, information to be interpreted in terms of monthly rainfall and temperature patterns. At the time these studies were initiated, I established an experiment designed to examine the breeding or life-cycle substrate associations of ceratopogonid midges within this plantation. To accomplish this, I distributed in random fashion 22 large, debris-filled plastic cups (Fig. 1), suspended individually from different *T. cacao* trees, with approximately half in shaded places and the others in sunny places. I also set up ten ground plots, each about 2 × 2 meters, of freshly sliced cross-sections of recently-felled banana (plantain) trees (*Musa* sp.) available in the area. Each of these plots was positioned beneath a *T. cacao* tree and contained about 30 slices of the trunks (Fig. 1). The trunk slices are allowed to decompose naturally, making them attractive as breeding micro-habitats for the midges. I also established a set of eight 2 × 2 meter wooden frames piled generously with rotting leaves from *T. cacao* trees, and distributed these randomly in the same plantation (Fig. 2). All of the substrates were left undisturbed until the following November (late rainy season) at which time the debris was collected from them and examined for larvae and pupae of midges. The substrates were replenished at this time and a second census taken the following February (1981), or mid-dry season. During June 1980 I also made a limited collection of adult midges from *T. cacao* flowers in the plantation. Records were kept on the condition

Fig. 1. Experimental breeding microhabitats for ceratopogonid midges studied in the "Catongo" cacao plantation at Turrialba, Costa Rica. Above: litter-filled plastic cup; note standard laboratory forceps for scale; each cup outfitted with drainage holes in bottom and suspended by sturdy wires from branches of *T. cacao* trees. Cups courtesy of the Sweetheart Corporation, Chicago, Illinois. Below: slices of banana tree trunks rotting on the ground beneath *T. cacao* trees. Slices are prepared by cutting a freshly fallen banana tree trunk with a machete.

Fig. 2. Experimental ground box of cacao leaf litter. The box is actually a wooden square frame set on the ground and filled with rotting *T. cacao* leaves. Note shaded place in foreground and sunny place behind.

of the ground leaf litter in the plantation, particularly in terms of general depth, dryness, and the height of weedy plants growing in the sunny places. In a few instances I confined portions of test substrates in large, clear plastic bags to capture any freshly-eclosed midges coming from them.

Collections from the cups, designed to simulate bromeliads, were done by collecting all of the litter in them. For the rotting banana trunk slices, I only collected those individual pieces sufficiently decomposed and moist to have midges in them; otherwise, the remaining ones were left behind. I collected about ¼ of the total leaf litter in each box to make a census of the ground box litter. All collected samples were taken into the laboratory and insects sorted from the debris with use of a powerful hand lens and binocular dissecting microscope. Voucher specimens were retained for generic and specific determinations.

Meteorological data was provided by CATIE.

RESULTS

A marked decline in monthly rainfall in January through March each year at Turrialba coincides with very pronounced declines in the amount of flowering in *T. cacao* (Fig. 3). Peak flowering in *T. cacao* at this locality is largely confined to the early-to-middle rainy season (Fig. 3). During the late rainy season census of potential ceratopogonid midge breeding sites, I collected a total of three species,

Fig. 3. Phenological patterns of the "Catongo" *T. cacao* at CATIE, Turrialba. Data for flowering recorded from 52 tagged trees. Meteorological data courtesy of CATIE.

Forcipomyia fuliginosa (Meigen), *F.* (*F.*) *genualis* (Loew), and *F.* (*F.*) *cinctipes* group. One aggregated group of 25 larvae of *F. fuliginosa* were collected from a dry leaf (Fig. 4) in one of the arboreal litter-filled cups, and all other cups were completely devoid of midges. All but four slices of the banana trunks were completely decomposed and thus not censused, and the four collected and censused yielded seven pupae of *F.* (*F.*) *cinctipes* (all from one piece). One composite bag of box leaf litter yielded a total of five adults of *F. genualis* in about 24 hours (13–14 November 1980).

The dry season census (16–18 February 1981) gave somewhat different results. No midges were collected from the arboreal simulated bromeliads, even though most of these containers had a considerably thick (range 20–90 mm) layer of rotting leaf litter. But most of the litter in the cups at this time, unlike in the late rainy season census, was extremely dry and brittle. The ground leaf litter was much drier now than in the late rainy season, and most of the thick weed cover found previously, gone. The box litter samples yielded no midges at this time. Only two plots of the rotting banana trunk slices had pieces moist enough to have midges. The slices in the other plots were very hard and mummified as a result of the intense dryness of this period. Such pieces generally do not have midge larvae and pupae. The two *T. cacao* trees with trunk slices still moist enough for midges were located in shaded parts of the plantation. One plot of 18 moist slices yielded two pupae of *F. genualis*, and a second set of 19 slices from the other tree produced 13 pupae of *F. cinctipes* group. An additional set of six banana trunk slices collected from several different plots at this time produced a total of 10 *F. genualis* adults in 24 hours.

Thus the census program produced a total of 22 individuals (larvae and pupae) of three species of ceratopogonid midges in the late rainy season, and a total of 25 individuals belonging to two species in the following dry season. These samples are very small and most likely represent less than 20% of the total midge fauna of the plantation. An initial survey of midges in open *T. cacao* flowers during June 1980 (early rainy season) yielded three *F. genualis* (one female, two males), *Forcipomyia* (*F.*) sp. (one male), *F.* (*Euprojoannisia*) sp. (one male), and *Dasyhelea soriai* Wirth & Waugh (one female). Thus several additional ceratopogonid species associated with *T. cacao* were not accounted for by the limited census program for immature stages in rotting organic debris.

The dry season data suggest possible contraction of midge populations: a total of 43 banana tree trunk slices produced 25 larvae and pupae during the dry season, while only four pieces produced seven individuals during the late rainy season.

During the rainy season, the ground leaf litter, as well as that in the simulated bromeliads, contained several species of ants, as well as spiders and roaches. Other typical litter inhabitants in this cacao plantation include at least one unidentified species of carabid beetle, a millipede, and a centipede. The late rainy season cup litter, for example, yielded one individual of the salticid spider *Chapoda festiva* Peckhams, a form which I have observed successfully capturing adult *Forcipomyia* midges in *T. cacao* trees at "Finca La Lola," near Siquirres, Limon Province, Costa Rica (Young, 1983). At least one other salticid, *Metacyrba* sp., also occurs in the cup litter at Turrialba. During the dry season, however, such arthropods are generally absent from the same litter substrates. During the rainy season, both leaf litter and banana tree trunk slices decompose in *T. cacao* plantations more quickly than they do in the dry season.

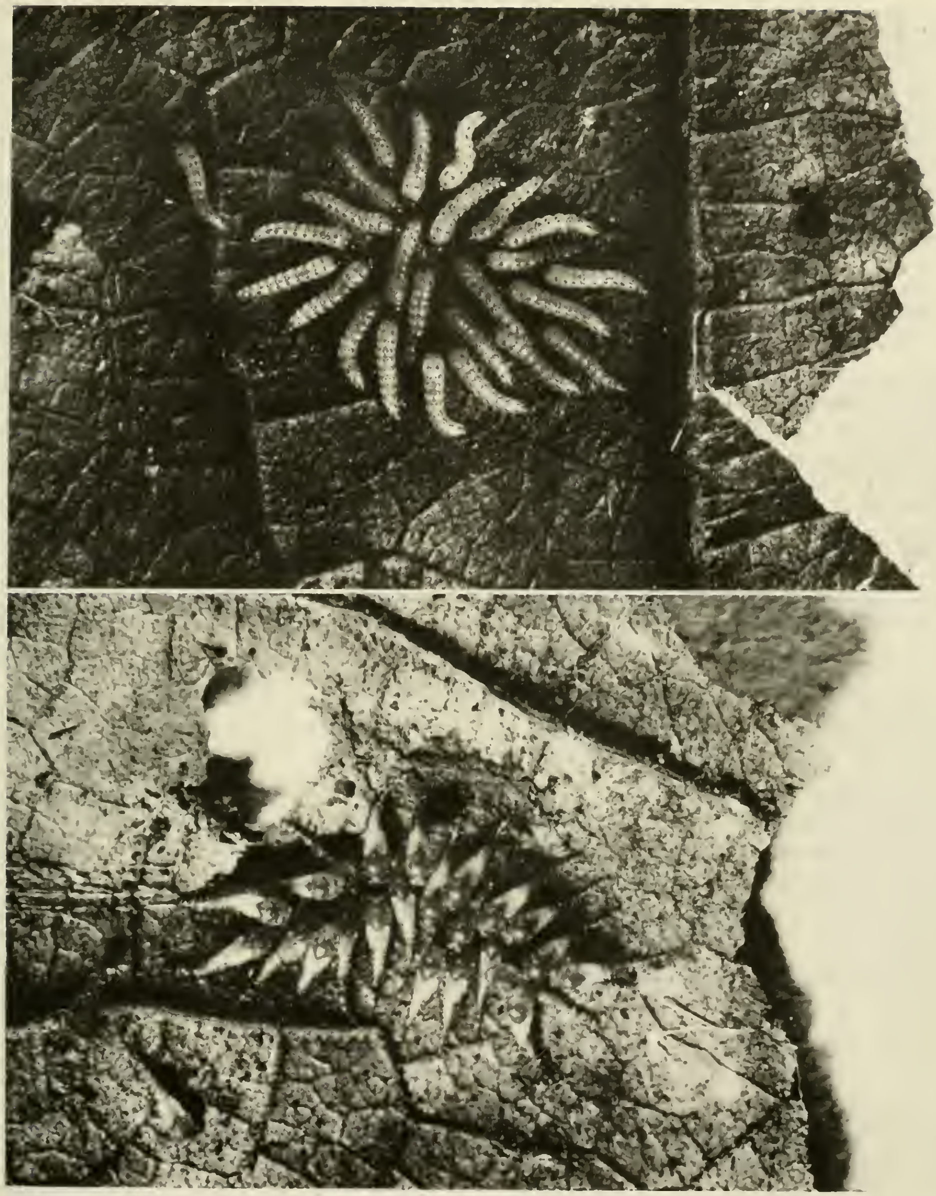

Fig. 4. Immature stages of *Forcipomyia fuliginosa.* Above: aggregate of larvae; below: pupae. Larvae and pupae attached to rotting *T. cacao* leaf in arboreal plastic cup (simulated bromeliad).

DISCUSSION

Although ceratopogonid midges are active in *T. cacao* plantations throughout the year, the spatial distribution of breeding populations may change considerably between rainy and dry seasons, as suggested by the limited data gathered in the present study. Young (1982, 1983) noted considerable increases in the densities of larvae and pupae in rotting banana tree trunk slices during the dry season in the lowlands of Costa Rica's Caribbean coastal floodplain. During the lengthy rainy season, densities in such a substrate are lowered considerably, a response to increased availability of other suitable breeding sites during this season. In *T. cacao* plantations, various groups of insects associated with this tree species cycle through the year in terms of abundance which is an adaptive response to changes in the availability of food supplies (Leston, 1969; Gibbs and Leston, 1970). For ceratopogonid midges, the life cycle requires very moist conditions, places where suspected larval food supplies such as bacteria, fungi, and mold thrive (Saunders, 1959). The high abundance of adult midges in *T. cacao* flowers commonly seen for the rainy season (e.g. Soria and Abreu, 1976) reflects the increased size of the immature populations during this period. During the dry season, many preferred breeding sites may dry up in cacao plantations, generating very low numbers of adult midges at this time (e.g. Winder and Silva, 1975). Even the daily activity of adult cacao-pollinating ceratopogonids is governed largely by prevailing weather conditions (Soetardi, 1950).

Saunders (1959) reared *F. genualis* from rotting cacao pod husks, and Wirth and Soria (1975) reared the closely related *F. harpegonata* Wirth & Soria from rotting banana trunks and other substrates. Young (1982, 1983) reared *F. genualis* and *D. soriai* from rotting banana tree trunk slices in Costa Rica. This species has also been reared from the debris in an epiphytic bromeliad, and both *Dasyhelea* and *F. cinctipes* group have been reared from this substrate as well as rotting cacao pod husks (Winder, 1977). *Forcipomyia fuliginosa* has been reared from rotting jackfruit and epiphytic bromeliads, but not from rotting banana tree trunk sections, although at least one species of *Dasyhelea* has also been reared from the latter substrate at Bahia (Winder, 1977). Young (1982, 1983) reared several genera and species of ceratopogonids from rotting banana trunk slices in Costa Rica, including *F. genualis* and *D. soriai*. Soria et al. (1978) reared *F. fuliginosa* from rotten cacao pods at Bahia. Wirth and Waugh (1976) noted that several species of *Dasyhelea* completed their life cycles in rotten cacao pods in the American tropics. *Dasyhelea* species, considered to be major pollinators of *T. cacao* (e.g. Soria and Wirth, 1979; Wirth and Waugh, 1976), appear to have broad breeding site preferences, having been reared from a variety of rotten organic materials in Turrialba (CATIE) cacao plantations (Soria et al., 1981).

Adult *Forcipomyia* are limited in terms of activity related to breeding and pollination by moisture conditions. Oviposition requires moist substrates and adults generally require liquid food for survival (Saunders, 1959; Kaufmann, 1975; Soria and Wirth, 1975). During the rainy season, adults of individual species are fairly evenly distributed in cacao plantations, with actual densities over small parcels of the habitat determined largely by sunlight and moisture conditions (e.g. Soria and Abreu, 1976). During the same period, populations of larvae and pupae are generally more diffuse than in the dry season (Young, 1982, 1983). Rotting banana tree trunk slices provide a major breeding microhabitat for ceratopogonids in both seasons (Young, 1982, 1983; and the present study), but during the dry season, they become the major breeding site exclusive of most others. During the dry season, leaf litter becomes very dry in the cacao plantation, a condition that concentrates breeding in those substrates that remain moist. While densities of larvae and pupae are higher in banana tree trunk slices in the dry season as a result of such effects, a bias is introduced by the very high rate of decomposition of these substrates in the rainy season. The highly scattered census program used in the present study undoubtedly misses many ceratopogonids that thrived in banana tree trunks, and ones never recorded because the substrates disappeared.

Soria et al. (1980) consider *F. fuliginosa* not to be an important pollinator of *T. cacao* relative to other species, even though it is usually one of the more abundant species encountered. These authors list eight genera and species of ceratopogonids from *T. cacao* flowers in Turrialba (CATIE) cacao plantations. Clearly many species were missed by the census program in the present study. Soria and Wirth (1979) suggest that ceratopogonids such as *F. genualis* and *F. cinctipes* group require further study to determine their effectiveness as *T. cacao* pollinators. *Forcipomyia genualis* might be a pollinator of *T. cacao* in lowland cacao plantations in Costa Rica (Young, 1982, 1983), although direct descriptions of pollinating behavior are lacking.

Behavioral patterns associated with immature stages may have marked influence on the distribution of ceratopogonid species in cacao plantations, and requires further study. The aggregative behavior of forms such as *F. fuliginosa,* in which both the larvae and pupae occur in organized clusters or groupings in litter, suggests a very different spatial arrangement of breeding populations from others such as *D. soriai,* in which larvae and pupae generally occur singly. Such behavior may also be related to the ability of species to occupy different kinds of moist microhabitats. *Dasyhelea* species, for example, exhibit different strategies of colonizing various kinds of aquatic microhabitats (McLachlan and Cantrell, 1980).

Although limited, I propose that the data presented here are fairly representative of the general patterns of adaptive response of cacao-associated ceratopogonids to tropical seasonality in cacao plantations. The tropical dry season is a period of environmental stress to small, relatively soft-bodied insects (Janzen and Schoener, 1968), resulting in a decline of their populations in the dry season (same reference). The apparent "synchronization" of peak flowering in *T. cacao* within the rainy season at Turrialba allows for maximal pollinating activity by small-bodied insects, including ceratopogonid midges. What is needed, however, is further delineation of those ecological factors limiting abundance of pollinator populations throughout the year, and such patterns of limitation are related to levels of pollination in *T. cacao.*

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REARING OF *TABANUS NIGROVITTATUS* (DIPTERA: TABANIDAE)[1,2]

Roy K. Sofield and Elton J. Hansens

Department of Entomology and Economic Zoology, Cook College, New Jersey Agricultural Experiment Station, Rutgers University, New Brunswick, New Jersey 08903; (RKS present address) Science Department, Tennessee Temple University, Chattanooga, Tennessee 37404.

Abstract.—*Tabanus nigrovittatus* Macquart was reared from egg to adult in 78–155 days, at 27°C and 16:8 LD cycle. Larval mortality was 94.5% in 1978 and 70.3% in 1979. Seven to ten instars were observed. The length of the head capsule increased by a factor of 1.37 in successive instars. The duration of the instars decreased from 15.6 days for the second instar to 10.1 days for the sixth, then increased to 18.5 days for the ninth. Reared flies did not mate in the laboratory, but some of the virgin females oviposited and then blood-fed from a human host.

In 1906, Hine reported the rearing of a single adult *Hybomitra lasiophthalma* (Macquart) from the egg stage. Within a few years three other species were reared from egg to adult: *Tabanus biguttatus* Wied. (King, 1908); *T. par* Walker (King, 1910); and *T. striatus* Fabricius (= *T. partitus* Walker) (Mitzmain, 1913). The greatest number of specimens reared from egg to adult was 401 for *Tabanus taeniola* Palisot de Beauvois (Hafez et al., 1970b).

Thompson et al. (1979) reared 212 adult *T. nigrovittatus* Macquart from eggs. They reared the flies in "1-gal plastic ice cream pails" with up to eight adults emerging from each pail. They did not report the number or duration of instars, and all of the larvae entered diapause.

In this study, we reared *T. nigrovittatus* individually to determine the number and duration of larval instars. The temperature and light cycle were controlled to prevent diapause.

Materials and Methods

Eggs of *T. nigrovittatus* were obtained from field collected females, using the method of Stoffolano (1979), however the flies fed through Baudrauche membrane (Joseph Long, Inc., Bellville, NJ) instead of Parafilm.

We reared adult flies from 15 egg masses laid between July 19 and September 21. Each egg mass was placed on wet filter paper in a petri dish until hatching.

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Larvae were reared individually in 32 ml vials containing filter paper and 3 ml 0.8–1.4% salt water, incubated at 27°C and 16:8 LD cycle. Every 2–5 days, we fed house fly maggots to the tabanid larvae and replaced the water and filter paper in each vial.

We determined instars by the number of black bodies in Graber's organ up to the fourth instar, and thereafter by observation of exuviae. In addition, all exuviae from the larvae of one egg mass (number 51) were mounted on slides in Hoyer's medium and the head capsules measured. The method of Cameron (1934) was used to determine missed exuviae.

Pupae were rolled in a piece of filter paper and placed in a vial with 3 ml salt water until emergence of the adults. We maintained reared adult flies in 473 ml cardboard containers with marquisette stretched over the top and offered female flies a human host from which to blood-feed. To permit mating, male and female adults were placed together in cages or tethered on thread, allowing a limited amount of flight. Induced mating, as is achieved with mosquitoes (McDaniel and Horsfall, 1957), was also attempted.

RESULTS

Twenty-eight of 506 neonate larvae were reared to the pupal stage in 1978 (94.5% mortality). In 1979, the mortality decreased to 70.3% (99 pupae from 333 neonate larvae). Mortality was greatest during the first 40 days of development with 87.4% in 1978 and 62.8% in 1979.

Larvae molted to the second instar within a day after hatching. This molt was indicated by exuviae on the filter paper. We observed two pairs of black bodies in Graber's organ during the first and second instars, three pairs during the third, and four pairs during the fourth. Subsequent instars, however, had a variable number of black bodies in Graber's organ. Seven to ten instars were found (Table 1) for 42 larvae from 6 egg masses. The instars were determined by the increase in number of black bodies in Graber's organ up to the fourth instar and thereafter by recovery of exuviae. The length of the head capsule increased by an average factor of 1.37 in successive instars. Corrections for missed exuviae, using head capsule length, increased the recorded number of instars for 14 of the 45 larvae (31%) of egg mass number 51 (Table 1). The duration of each instar and head capsule lengths are shown in Table 2.

T. nigrovittatus larvae reared at 27°C in 16:8 LD cycle did not diapause, but pupated after 78–155 days. Whether diapause is initiated by light, temperature, or the interaction of these parameters has not been determined.

The pupal stage lasted 6 to 12 days with a mean of 8.4 days. Seventeen of 127 pupae (13.4%) died before adult emergence. The duration was not significantly different between the sexes ($P < 0.05$).

Efforts to mate *T. nigrovittatus* in the laboratory were unsuccessful. Of the 13 adult females reared in 1978, 7 oviposited a mass of eggs; 3 of these flies then took a blood meal and one fly laid a second egg mass.

DISCUSSION

A laboratory colony of a tabanid has never been established, mainly because of the inability to achieve mating in the laboratory. Hafez et al. (1970a) attempted to induce copulation in *T. taeniola* using a technique similar to that used by Baker

Table 1. Number of larval instars observed with and without correction for missed exuviae.

Number of instars	Uncorrected				Corrected	
	6 egg masses		mass 51		mass 51	
	n	%	n	%	n	%
6			1	2.2		
7	10	23.8	8	17.8	1	2.2
8	18	42.9	20	44.4	23	51.1
9	13	31.0	16	35.6	21	46.7
10	1	2.4				

et al. (1962) with *Anopheles* mosquitoes but without success. Adult *T. nigrovittatus* were placed in a large cage by Thompson et al. (1979), but no sexual activity was observed and no eggs were laid.

Horse fly larvae are frequently reared individually because they are cannibalistic (Mitzmain, 1913; Webb and Wells, 1924; Schwardt, 1936; Roberts and Dicke, 1964; Singh, 1968; Burger, 1977; Yagi, 1978). Mitzmain (1913) attributed 85% of the larval mortality of *T. striatus* (= *T. partitus*) to cannibalism and 5% to other causes, when larvae were reared together in a common container. Thompson et al. (1979), however, found no evidence for cannibalism when *T. nigrovittatus* were reared in common containers.

In our study, larval mortality was reduced from 95% to 70% due to careful handling of larvae and reduction in the amount of food given to small larvae.

Cameron (1934) applied Dyar's (1890) method of using head capsule measurements of a reared tabanid, *Haematopota pluvialis* L., to detect missed exuviae. The average factor of increase from one instar to the next was 1.29, slightly less than that which we found for *T. nigrovittatus*. Saito (1967) and Orminati (1969) measured the head capsules from each instar of *T. trigonus* Coquillett and *T. lineola lineola* Fabricius, respectively, but they did not use these measurements to reveal missed exuviae. This procedure along with the recovery of all exuviae should be used to determine the number and duration of larval instars.

Table 2. Length of the larval head capsules and duration of each instar of mass 51 after correction for missed exuviae. Measurements were made from the posterior end of the tentorial rods to the tip of the labrum.

Instar	Head capsule length (mm)		Duration (days)	
	n	Mean ± SD	n	Mean ± SD
2	12	0.476 ± 0.015	36	15.6 ± 6.4
3	32	0.630 ± 0.039	30	14.1 ± 4.5
4	40	0.830 ± 0.063	28	11.6 ± 4.0
5	40	1.114 ± 0.098	30	11.2 ± 2.9
6	44	1.525 ± 0.155	33	10.1 ± 3.3
7	44	2.056 ± 0.191	36	12.8 ± 4.0
8	27	2.617 ± 0.178	35	17.9 ± 6.2
9	2	3.222 ± 0.129	16	18.5 ± 2.4

In our studies, *T. nigrovittatus* larvae pupated in an average of 103 days when reared at 27°C and 16:8 LD cycle. Further research is needed to fully define the effects of temperature and photoperiod on the development of *T. nigrovittatus*. It may be possible to expedite or postpone pupation in the laboratory by manipulation of these parameters.

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LABORATORY AND FIELD OBSERVATIONS ON THE LIFE HISTORY OF *EPINOTIA KASLOANA* MCDUNNOUGH (LEPIDOPTERA: TORTRICIDAE: OLETHREUTINAE), A MOTH FEEDING ON JOJOBA (*SIMMONDSIA CHINENSIS* (LINK) SCHNEIDER)

JOHN D. PINTO AND SAUL I. FROMMER

Department of Entomology, University of California, Riverside, California 92521.

Abstract.—The olethreutine moth *Epinotia kasloana* McDunnough is known to utilize jojoba (*Simmondsia chinensis*) and species of *Ceanothus* as host plants. Included here are observations on the life history of this moth on sylvatic jojoba in southern California and Arizona. Larvae feed on male flowers, developing fruits and leaves during spring. There are five larval instars. After feeding, fifth instar larvae drop to the ground and construct a hibernaculum in which they remain throughout the summer months. Pupation occurs in fall and adults are active in late fall and early winter. Oviposition occurs primarily on leaves, and is more common on male plants.

An earlier paper listed 50 species of phytophagous arthropods on native jojoba, a dioecious shrub growing in southwestern North America (Pinto and Frommer, 1980). Because of numerous industrial applications for the unique liquid wax in jojoba seeds (Yermanos, 1979), arthropods damaging developing fruit are of particular interest. In this paper we report on basic features of the life history of one of these, the olethreutine moth, *Epinotia kasloana* McDunnough, a species known to feed on male flowers and leaves of jojoba as well as fruit. Provided are data on phenology, laboratory rearings, and parasite associates. Notes on other Lepidoptera known to damage jojoba fruit are included. Several species of *Epinotia* are known as enemies of forests and parklands (e.g., Felt, 1906; Baker, 1972; Furniss and Carolin, 1977; Yarger and Brewer, 1977); however, there is virtually no information on *E. kasloana* except for the original description by McDunnough (1925), and a recent treatment of its taxonomy and geographic range in an unpublished thesis by Brown (1980).[1] The species occurs from British Columbia, south to San Diego County in southern California, and east to southern Arizona. In the southern portion of its range, both jojoba, *Simmondsia chinensis* (Link) Schneider (Simmondsiaceae) and species of *Ceanothus* (Rhamnaceae) are known hosts. Outside of the range of jojoba (N and W of Riverside Co., CA), *Ceanothus* is the only recorded host.

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[1] Jojoba populations treated as specifically distinct from *E. kasloana* (Brown 1980), but now considered conspecific (Brown, pers. comm.).

Materials and Methods

This report is based on collections and observations of *E. kasloana* from natural jojoba stands. The primary study area was located in Riverside County, California, ca. 8 km N Radec on Hwy. R3 (Radec site). Much of the data from Radec resulted from an initial 2-year (1976–78) survey of jojoba arthropods (Pinto and Frommer, 1980). Additionally, Radec was utilized for egg censusing (11 March 1980 and 19 January 1981), and phenology studies (1978–80). Laboratory rearings also utilized specimens from this locale. An additional study site was in Pinal County, Arizona, 6–14 km W Superior, at ca. 750 m elev. (Superior site). *Ceanothus* spp., the alternate hosts for *E. kasloana,* do not occur in the immediate vicinity of either study area.

To determine the frequency of eggs of *E. kasloana* on male vs. female jojoba, and their location on the plant, 25 ♂ and 25 ♀ shrubs were selected at random. Plants contiguous with one of the opposite sex were avoided. One peripheral, multibranched sprig (ca. 35 cm in length) was clipped at 1–1.5 m height from each of 4 quadrants around each plant. Samples included stems, leaves, and at least one male flower cluster or female flower. Since male flowers are more numerous than female flowers, they were more heavily sampled.

Samples were tagged and placed in plastic sacks in the field. In the laboratory a portion of each sample was carefully examined for eggs and egg chorions. This subsample consisted of 25 randomly selected leaves, the longest stem, and either 10 randomly selected flower clusters (if male) or all flowers (if female).

Laboratory rearings utilized larvae hatching from eggs collected at Radec from 14 January–12 March 1981. Individuals were isolated in plastic dishes (35 × 10 mm) within a day of eclosion. Fresh male flowers were utilized as food. Larvae were maintained throughout the rearing in a constant temperature cabinet held at 28 ± 1°C and ca. 50% R.H. Rearing dishes were examined daily to monitor moulting, retrieve cast exuviae, and provide fresh food.

Adult emergence data (Table 2) stem from the two individuals successfully reared from eggs, late instar larvae beaten from male jojoba plants at Radec (spring, 1978) and Superior (spring, 1980), and hibernacula sifted from soil beneath male plants at Radec (1978). Individuals were maintained in the laboratory at ambient temperature (23–27°C) and at ca. 70% R.H., and held for adult emergence. Larvae beaten from plants were allowed to feed to repletion in the laboratory on male flowers.

Head capsule widths (Table 5) were measured with an ocular micrometer and are based on both intact larvae and cast exuviae. Quantitative data reported include the mean ± standard deviation, and the range.

Life History

General characteristics and phenology.—Adults of *E. kasloana* are dark grey to brownish-grey in color with a forewing length of ca. 9 mm (Fig. 10). The phenology of the species at Radec is summarized in Fig. 1. Females oviposit on both male and female jojoba in winter. Larvae feed on male flowers, developing fruit, and, less commonly, young leaves, during spring. Leaves and flowers are tied with silk (Fig. 4). Damage to developing fruit is characterized by a feeding hole in the side with the interior partially or totally consumed (as in Fig. 9).

Larvae of *E. kasloana* are light yellow except for the brown head and base of

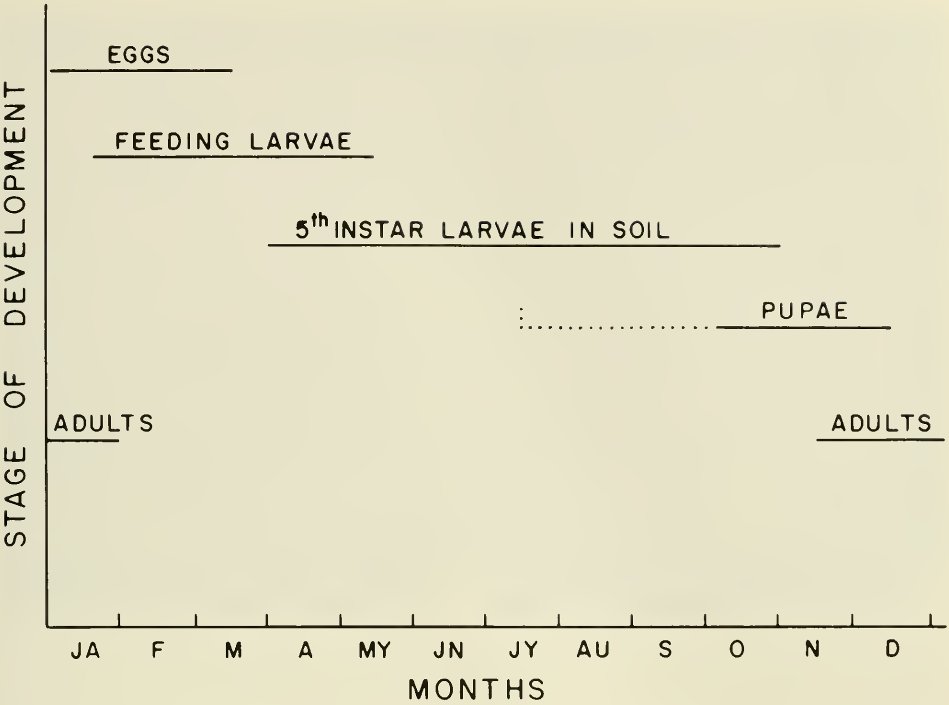


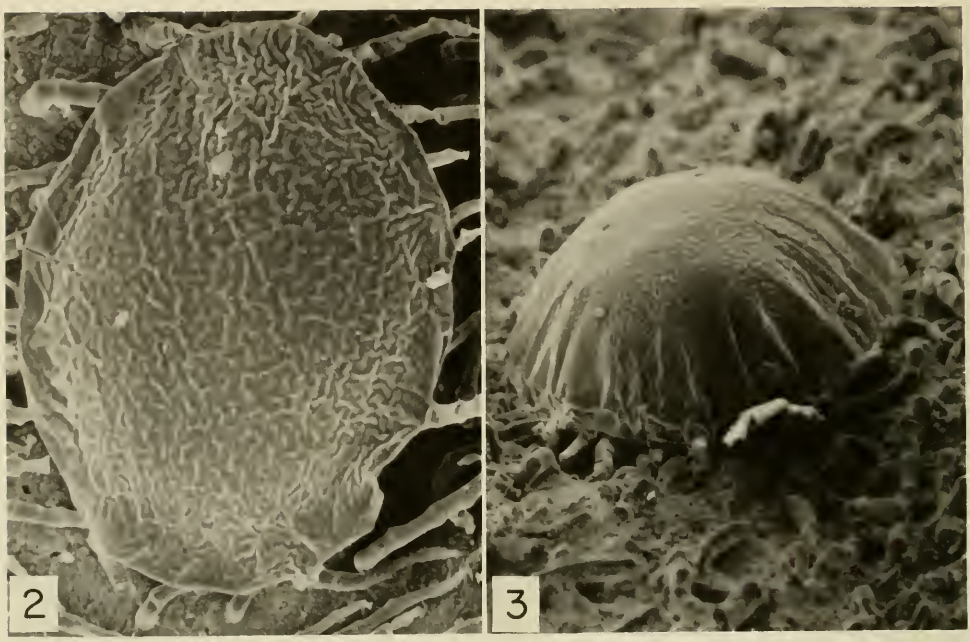
Fig. 1. Phenology of *Epinotia kasloana* primarily as determined from a population associated with jojoba near Radec, CA. Period of adult activity also based on records of adults from other areas in southern California. Dotted line for pupae refers to apparently infrequent early pupation (see text).

the pronotum (Fig. 5). Mature larvae attain a length of ca. 12 mm and often have light red coloration dorsally. The larva of *E. kasloana* is undescribed. However, larvae of other members of the genus are treated by Mackay (1959).

Fifth instar larvae drop to the ground after feeding to repletion, dig several cm. into the soil and construct a hibernaculum. Larvae remain in these hibernacula throughout the summer. Pupation, also within the hibernaculum, normally occurs in mid- to late fall, and adults emerge shortly thereafter. Just before adult emergence, the pupa (Figs. 6, 7) breaks through the hibernacula and becomes partially exerted from it. Life histories with components similar to that of *E. kasloana* have also been reported for other species of *Epinotia* (e.g. Bradley, et al., 1979).

Egg.—The singly laid eggs of *E. kasloana* are squamous and subelliptical in shape, and have a rugulose surface (Fig. 2). They measure 0.60 ± 0.04 mm in length, 0.46 ± 0.04 mm in width ($n = 10$) and are ca. 0.3 mm in height. Eggs are essentially colorless at first, turning a light orange as maturation proceeds. Rarely was more than a single egg found per leaf. Larvae exit at the interface of the chorion and the attachment substrate, leaving the chorion more or less intact. There is no evidence that larvae consume the chorion upon emergence.

Egg surveys on both male and female plants of jojoba are summarized in Table 1. They show that eggs are most abundant on leaves, and are rarely laid on stems or male flowers. They were never found on female flowers. Although oviposition occurs on both male and female plants, males are preferred. Larvae also are more



Figs. 2–3. Egg of *Epinotia kasloana* on leaf of jojoba. 2, Normal egg viewed from above, 100×. 3, Egg parasitized by *Trichogramma* sp., characterized by abnormal swelling, 160×.

common on male plants (Pinto and Frommer, 1980). Egg frequency on leaves of male jojoba in 1980 and 1981 was 5.0% and 3.3%, respectively. The lower frequency during 1981 may simply have been due to the earlier sampling date. The occurrence of eggs on stems and male flowers was insignificant both years.

Larvae–adult.—We are unable to give precise limits to the period of larval activity at the Radec site. However, observations of eclosed eggs during the census of 19 January 1981 (Table 1) indicates activity had begun by that date. Larvae are commonly collected on jojoba from February–April, and disappear by the middle of May. Upon completion of feeding, mature larvae drop to the ground, dig several cm. into the soil beneath their host plant, and spin a silk hibernaculum which incorporates soil particles and a variety of debris (Fig. 8).

The soil beneath numerous jojoba at Radec was sifted on 16 occasions from 22 June–13 December 1978 to determine the approximate time of pupation. Hibernacula were inhabited almost exclusively by mature larvae until mid-October (9 sampling dates, ca. 100 hibernacula examined). This prolonged period of inactivity of the 5th instar larva was paralleled in our laboratory studies of adult emergence (Table 2). The only exceptions were 3 pupae encountered during July. On the third week of October, hibernacula with pupae became common. Of the 42 hibernacula sampled on 4 dates between 22 October–10 November, 32 (76%) contained pupae. The pupal instar apparently lasts no more than 2–3 weeks, as almost all of the hibernacula found after 15 November were empty. This date coincides closely with the beginning date of adult activity of *E. kasloana* in southern California reported by Brown (1980), and time of adult emergence in the laboratory.

Table 1. Frequency of eggs of *E. kasloana* on jojoba vegetation.[1,2]

Sex of Plant & Sampling Date	No. Plants Sampled	Leaves	Stems		Flowers	
		$\bar{x}$ (± SD) no. Eggs/ 100 Leaf Sample Plant; (Range)	Sq. m Stem Sampled[4]	Total no. Eggs	No. Sampled	No. Eggs
Male						
11 March 1980	25	4.96 ± 3.5[3] (1–16)	0.095	3	ca. 1000[5]	1
Female						
11 March 1980	25	1.40 ± 1.5[3] (0–5)	0.217	0	>100	0
Male						
19 January 1981	25	3.28 ± 2.2 (1–10)	0.062	4	ca. 1000[5]	2

[1] See Materials and Methods for sampling method.

[2] Based on counts of hatched and unhatched eggs.

[3] Eggs significantly more abundant on leaves of male plants ($P < .001$; $t = 4.672$).

[4] Sq. m. of stem surface was approximated by: Π·(estimated diameter of stem)·(length of stem).

[5] Refers to clusters of flowers.

Adult emergence data are summarized in Table 2. The vast majority of individuals from Radec emerged from the last half of November to the middle of December (range, 31 October–10 January). The range of emergence for the few individuals from Superior was similar (20 October–17 January), although the majority emerged somewhat earlier than did the Radec material.

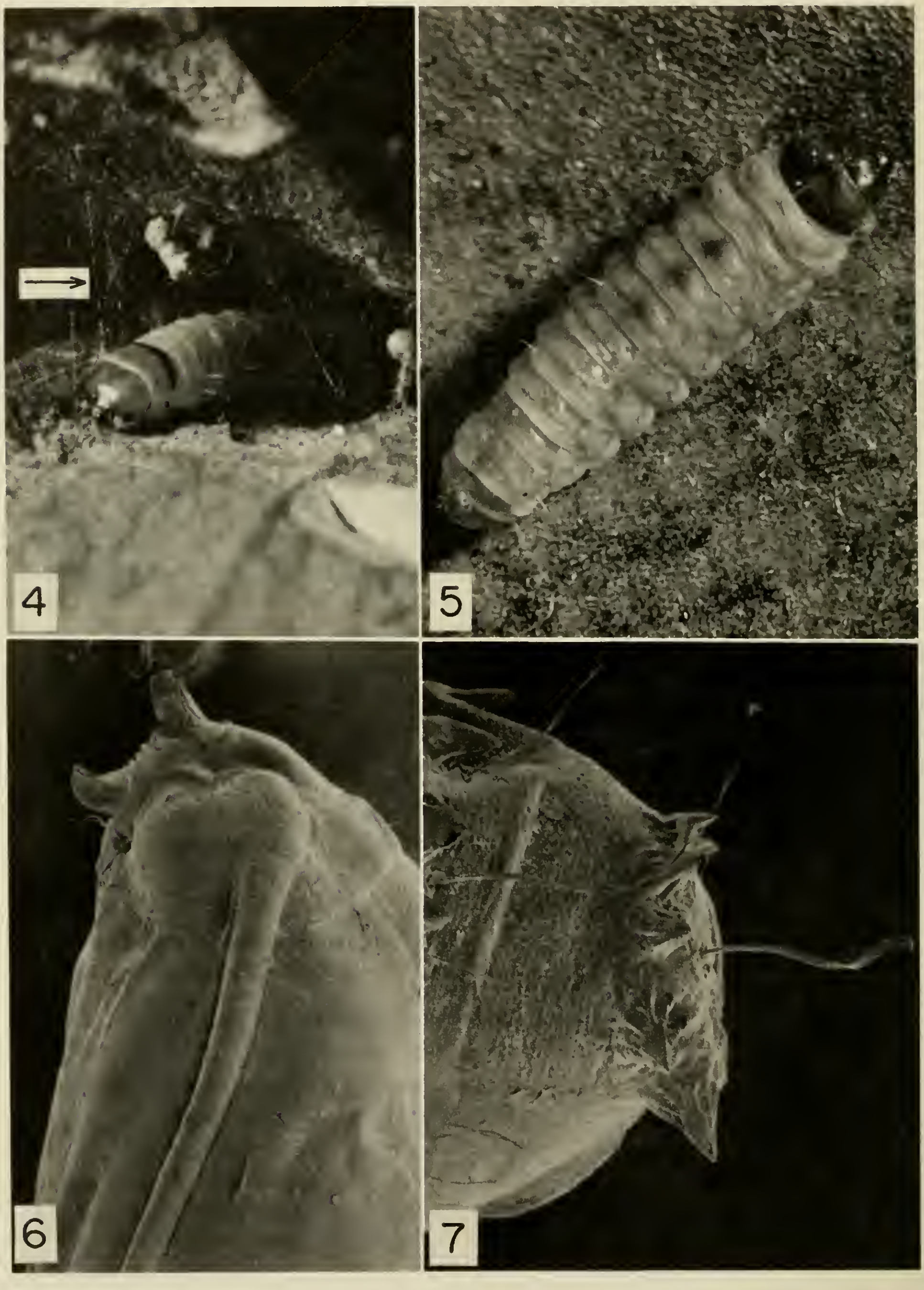
We never collected adults of *E. kasloana* on the wing at Radec. However, 2 live adults were sifted from soil beneath a jojoba on 13 December 1978. We assume these individuals were working their way to the surface from their pupation site.

The end of adult activity in southern California appears to be late January

Table 2. Time of adult emergence of *E. kasloana* in the laboratory.

Source	Stage Collected	Mo(s). & Yr(s). of Collection	Time (in 2-wk. Intervals) of Adult Emergence as % of n[1]							
			Jn	O-II	N-I	N-II	D-I	D-II	Ja-I	n
CA, Radec	Instars 4 & 5 on jojoba	Mar.–May 1976–80	0	0	8.7	39.1	43.5	4.3	4.3	46
CA, Radec	Instar 5 &/or 6 (pupae) in hibernacula	May & Sept.–Nov. 1978	–	1.6	11.5	55.7	26.2	4.9	0	61
CA, Radec	Eggs on jojoba	Jan. 1981	100	....						2
AZ, Superior	Instars 4 & 5 on jojoba	Mar.–May 1981	–	25.0	33.3	33.3	0	0	8.3	12

[1] Jn, O, N, D, and Ja = June, October, November, December and January, respectively. I = from first to 15th of month; II = from 16th to end of month.



Figs. 4–7. Immature stages of *Epinotia kasloana.* 4, Larva feeding between leaves tied together with silk (leaves separated to expose larva; arrow pointing to silk strands). 5, Late instar larva. 6, Pupa (lateral view of anterior section showing cephalic horns), 40×. 7, Pupa (lateral view of cremaster), 130×.

Fig. 8. Hibernacula of *Epinotia kasloana* sifted from soil beneath jojoba plants near Radec, CA, illustrating variety of materials often used in their construction including soil particles, pebbles, twigs, and leaves.

Fig. 9. Total destruction of developing fruit of jojoba as produced by feeding larvae of *Epinotia kasloana* and *Xylomyges curialis.*

Fig. 10. Adult of *Epinotia kasloana* (5.6 mi S Sage, Riverside Co., CA). Length of photographed specimen = 9.4 mm.

Table 3. Duration (in days) of instars in a laboratory rearing of *E. kasloana.*

Instar(s)	Mean	SD	Range	*n*
1	5.2	1.6	3–10	28
2	4.0	1.2	3–7	16
3	3.5	1.3	1–5	10
4	5.3	2.1	3–7	3
5 & 6[1]	98.0	5.8	93–103	2

[1] Instar 5 and 6 (pupa) combined due to inability to determine time of molt (see text for approximate duration of each instar).

(Brown, 1980). As noted, oviposition at Radec was well along if not complete by mid-January 1981.

The discovery of 3 pupae at Radec in July 1978 occurred about 4 months before pupae were commonly collected. It is unknown whether these represent individuals that failed to pupate the previous fall, or 1978 individuals that pupated early. The latter is more likely in light of the early pupation of reared individuals (see below).

Laboratory Rearings

Rearings of individual larvae indicate that development normally consists of 5 larval instars. The duration of each of the first 4 larval instars is given in Table 3. We were unable to determine the duration of the 5th since its molt to the pupa occurs within the hibernaculum. Thus, only the combined duration of the 5th and pupal instars is reported. It is clear from field studies that the 5th instar is the longest phase of development (see above), normally lasting ca. 5–6 months. The pupa lasts only a few weeks.

Although we normally encountered 5 larval skins in rearings, occasionally a 6th skin was found. This may represent a supernumerary instar or merely contamination. Although the male flowers provided as larval food were carefully examined before placing them in the rearing chamber, the possibility of introducing a foreign exuviae or larva remains. These questionable records were not included in the summarization of rearing data.

The two individuals reared from egg to adult spent a mean of only 98 days (range, 93–103) as 5th instar larvae and pupae. Both emerged as adults in June, or 4–5 months earlier than normal. Although numbers are few, this suggests that the laboratory conditions experienced by the first 3 larval instars was responsible for early pupation, because the numerous field collected 4th and 5th instars brought into the laboratory all became adult at the normal time (Table 2). Yet the fact that 3 pupae were sifted from soil at Radec in July 1978 indicates that early adult emergence occasionally occurs in the field.

Mortality during rearings was high for all periods of development (Table 4). From a starting group of 70 1st instars, only two continued to adult. The causes of death to larvae were not determined.

The size of instars 1–5 as indicated by head capsule width is reported in Table 5. These data are based totally on reared material where instar identification was unequivocal. Data on two groups of reared 5th instar larvae are given in Table 5. One consisted of individuals dying in the 5th instar. Head capsule width was

Table 4. Mortality among larvae in a laboratory rearing of *E. kasloana*.

Instar(s)	*n* Larvae Entering Instar(s)	Mortality (%)
1	70	45.7
2–4	38	34.2
5	25	76.0
6 (Pupa)	6	67.0

significantly smaller for these ($\bar{x}$ = 0.86 mm, n = 10) than those successfully completing this instar ($\bar{x}$ = 1.10 mm, n = 4) (see Table 5). The latter group was not significantly different from the size of putative 5ths collected in the field ($\bar{x}$ = 1.05 ± 0.12) (range, 0.8–1.4 mm) (n = 233).

Ceanothus spp. are the only hosts other than jojoba recorded for *E. kasloana*. The species has been reared from *C. thyrsiflorus* Eschsch. in Marin Co., CA, by J. A. Powell (University of Calif., Berkeley; pers. comm.). Also, we have collected a few larvae of *E. kasloana* on *C. crassifolius* Torr. at two locales in Riverside Co., CA, which lack jojoba (Menifee Valley, and 11 mi. E Temecula). Early instar larvae from *C. crassifolius* fed readily on male flowers of jojoba and attained the 5th instar before dying. Eleven early instars originating on jojoba at Radec also fed on flowers of *C. crassifolius*, and 2 individuals were reared to adult on this alternate host.

PARASITES

The parasite associates of *E. kasloana* are listed in Table 6. Twelve species of parasites (8 Hymenoptera, 4 Diptera) have been retrieved from eggs (Fig. 3), feeding larvae, and inactive 5th instar larvae within hibernacula.

OTHER LEPIDOPTERA

Our initial survey of jojoba arthropods (Pinto and Frommer, 1980) implicated only *E. kasloana* as a potential pest of developing fruit. However, this moth is only one of three Lepidoptera now believed to cause similar damage. The citrus cutworm, *Xylomyges curialis* Grote (Noctuidae), originally cited in our survey as feeding on leaves and male flowers was found in large numbers on 30 March 1981 at Superior. Although larvae were not observed feeding, they readily devoured

Table 5. Maximum head capsule width (mm) of laboratory reared larvae of *E. kasloana*.

Instar(s)	Mean	Range	SD	*n*
1	.17	.15–.19	.01	79
2	.28	.25–.35	.03	30
3	.43	.32–.52	.05	20
4	.63	.40–.75	.08	16
5[1]	.86	.80–.94	.06	10
5[2]	1.10	1.05–1.15	.09	4

[1] Larvae dying in the 5th instar.

[2] Larvae successfully completing the 5th instar. Two of these died as pupae, two became adult; these individuals were significantly larger than individuals dying in fifth instar ($P < .01$; $t = 4.909$).

Table 6. Parasitic associates of *Epinotia kasloana.*

Taxon of Parasite	Association
Diptera	
Bombyliidae	
Phthiria similis Coquillett	larva in hibernaculum
Phthiria sp.[1]	larva in hibernaculum
Tachinidae	
Genus, sp. unknown	larva in hibernaculum
Nemorilla pyste Walker	larva in hibernaculum
Hymenoptera	
Braconidae	
Agathis sp.	larva feeding on plant
Apanteles aristoteliae Viereck	larva feeding on plant
Apanteles sp. C	larva feeding on plant
Ascogaster sp.	larva in hibernaculum
Ichneumonidae	
Glypta rufiscutellaris Cresson	larva feeding on plant
Mastrus sp.	larva in hibernaculum
Trichogrammatidae	
Trichogramma sp. near *pretiosum* Riley	egg
Trichogramma sp.	egg

[1] Based on pupa collected from a hibernaculum on 7 September 1978. This is later than the period of adult activity for *P. similis,* and may represent a different species of *Phthiria.*

jojoba fruit in the laboratory and were the only Lepidoptera collected on that date. A survey of damage to fruit at a locale 14 km W Superior on 30 March indicated ca. 30% fruit destruction. Feeding damage is similar to that described for *E. kasloana* (as in Fig. 9).

Also in spring of 1981, Dr. H. Flint (USDA, Phoenix, AZ) informed us of the almost total destruction of jojoba fruit at Usery Pass, Maricopa Co., AZ (pers. comm.). The described damage was similar to that caused by *Xylomyges* and *Epinotia*; however, the discovery was too late to determine the primary pest. The single larva and adult sent for identification represented the omnivorous leaf roller, *Platynota stultana* Walsingham (Tortricidae). It is questionable whether *P. stultana* was the sole or even the primary cause of fruit damage at Usery Pass in light of the abundance of citrus cutworm at Superior. *P. stultana* was not collected in our 1980 survey, but it was implicated as a pest of young cultivated jojoba by Johnson (1978).[2] One or more of the 3 species of Lepidoptera discussed here probably were responsible for the 75–80% destruction of jojoba fruit in the Pinal Mts., AZ, during 1957–58 cited by Gentry (1958). With the exception of Johnson's (1978) record, we are unaware of lepidopterous damage to cultivated jojoba.

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[2] Johnson's record of *Platynota stultana* is based on a tentative identification (T. Eichlin, Calif. Dept. Agric., pers. comm.).

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PROC. ENTOMOL. SOC. WASH.
86(1), 1984, pp. 210–213

TWO NEW SPECIES OF ORIENTAL BITING MIDGES (DIPTERA: CERATOPOGONIDAE)

Francis E. Giles and Willis W. Wirth

(FEG) Professor of Biology, Loyola College in Maryland, Baltimore, Maryland 21210; (WWW) Systematic Entomology Laboratory IIBIII, Agric. Res. Serv., USDA, % U.S. National Museum of Natural History, Washington, D.C. 20560.

Abstract.—Two new species of oriental biting midges (Diptera: Ceratopogonidae) are described and illustrated: *Atrichopogon daleyae* from Malaysia, Philippines, and Vietnam, and *Alluaudomyia delfinadoae* from Malaysia.

Recently we published a description of an unusual species of *Atrichopogon* from Sri Lanka (Giles and Wirth, 1982). Further study of material from the Oriental Region has brought to light a similar species which we describe here. In addition we address ourselves to the problem of a Malaysian species, *Alluaudomyia infuscata,* described by Wirth and Delfinado (1964). The holotype male (Type no. 67241), allotype female, paratype female, and 2 paratype males were deposited in the NMNH. While studying this type series we found that the two paratype males were not *A. infuscata* but a different species that we describe as new in this paper.

The senior author thanks Wayne N. Mathis, Chairman of the Department of Entomology, Smithsonian Institution for use of the Museum's facilities, and both authors acknowledge Ms. Molly Ryan for her illustrations used in this paper.

For explanation of measurements and ratios see Giles et al. (1981), Wirth (1980), and Wirth and Delfinado (1964). NMNH indicates the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Atrichopogon daleyae **Giles and Wirth, New Species**

Fig. 1

Female.—Wing length 0.84 (0.79–0.89, $n = 5$) mm; breadth 0.36 (0.34–0.38, $n = 5$) mm.

Head: Brown. Eyes finely pubescent above, bare below; narrowly separated by a distance equal to 1 ommatidial facet. Antenna (Fig. 1a) light brown with well-developed verticils on all segments; flagellar segments in proportion of 24-14-16-19-20-20-20-22-54-54-58-60-86; antennal ratio 2.01 (1.81–2.01, $n = 6$); segment 15 with terminal papilla; segments 3–10 ovoid and not appressed. Palpus (Fig. 1b) light brown; segments in proportion of 15-29-38-22-22; 3rd segment moderately swollen from base with sensory pit both moderately large and deep; palpal ratio 2.71 (2.13–2.71, $n = 6$). Proboscis brown, long, sections A-B-C (see Wirth, 1980) in proportion of 46-32-30; mandible (Fig. 1d) with 16 (15–18, $n = 6$) large teeth becoming smaller proximad.

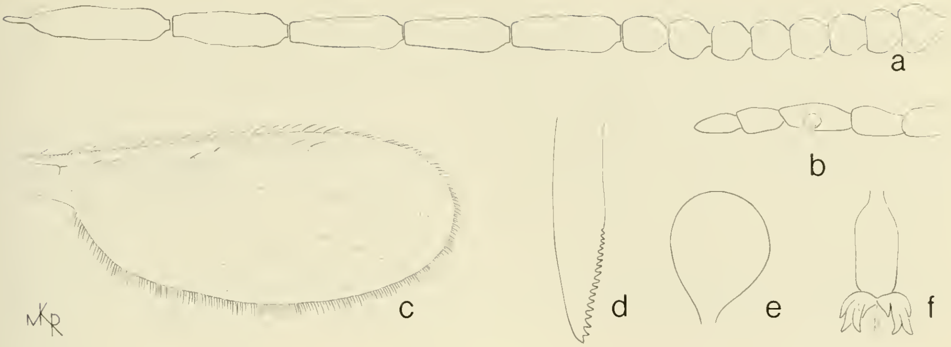

Fig. 1. *Atrichopogon daleyae*, female: a, antenna; b, palpus; c, wing; d, mandible; e, spermatheca; f, claws of midleg.

Thorax: Brown, pleura lighter. Legs with coxae brown, trochanters light brown; femora and tibiae light brown becoming paler proximally; hindtibial comb with 5 (5–7, $n = 6$) spines; hindtarsal ratio 2.92 (2.59–2.95, $n = 6$). Paired claws (Fig. 1f) of each leg trifid, the midtooth longest.

Wing (Fig. 1c): Light brown, veins darker; macrotrichia few on anterior veins, none on membrane. Costal ratio 0.70 (0.68–0.71, $n = 6$); 2nd radial cell 2.6 (2.4–3.3, $n = 6$) × length of 1st. Halter but lightly infuscated.

Abdomen: Light brown, darkening toward tip. Spermatheca (Fig. 1e) measuring 0.044 by 0.062 mm including neck; ovoid, sparsely punctate basally, with long tapering neck.

Male.—Unknown.

Distribution.—Malaysia, Philippines, Vietnam.

Types.—On slides in phenol balsam. Holotype female, Vietnam, Chu Lai, January 1969, B. L. Trap, Coll. J. E. Tisdale (Type no. 76599, USNM). Paratypes, 2 females, same data as holotype; 1 female, Malaya, Selangor, Kuala Lumpur, IMR Grazing Ground, vii.1958, light, coll. R. Traub; 1 female, Malaya, Selangor, Subang For. Res., 1959–60, trap, coll. H. E. McClure; 1 female, Philippine Islands, Mindanao, Mt. Apo School, 15 km SW Davao, 500 m, 22–31.x.1965, coll. D. Davis. Holotype and paratypes deposited in NMNH.

Etymology.—This species is named for Ms. Margaret Daley in appreciation of her humor and patience in typing our manuscripts.

Discussion.—*Atrichopogon schizonyx* Giles and Wirth (1982) from Sri Lanka is closely related but can be distinguished from *A. daleyae* by the following characters: proximal antennal segments are shorter and disciform, antennal ratio 2.49 (2.01 in *daleyae*); 3rd palpal segment is more swollen, with palpal ratio 2.1 (2.71 in *daleyae*) and in the wing the 2nd radial cell is 4× length of the 1st (2.6 in *daleyae*). The spermatheca is larger (0.106 × 0.074 mm) and oval, not tapering to the neck (0.044 by 0.062 mm with tapering neck in *daleyae*).

***Alluaudomyia delfinadoae* Giles and Wirth, New Species**

Fig. 2

Alluaudomyia infuscata Wirth and Delfinado, 1964: 621 (in part; 2 paratype males from Kuala Singgora, Malaysia).

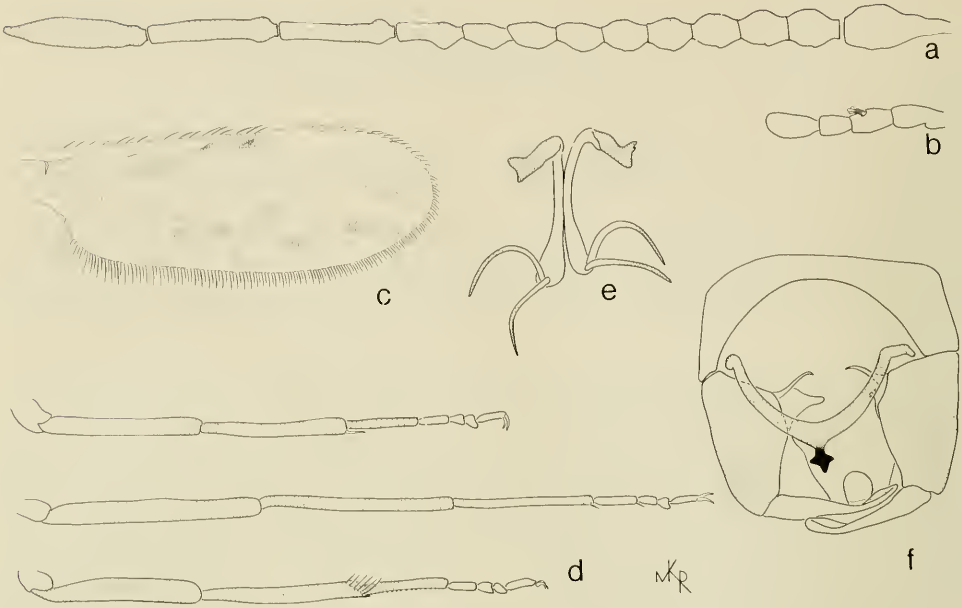

Fig. 2. *Alluaudomyia delfinadoae*, male: a, antenna; b, palpus; c, wing; d, fore-, mid-, and hindlegs (top to bottom); e, parameres; f, genitalia, parameres omitted.

Male.—Wing length 0.88 mm (0.85–0.88, $n = 2$).

Head: Brown. Eyes narrowly separated by a distance equal to 1 ommatidial facet. Antenna (Fig. 2a) stramineus with well-developed plume; flagellar segments dark at apical half of 3, tip of 12, base of 13, basal ⅔ of 14 and all of 15; verticils large on segments 13 and 14, weakly developed on 15; segment 15 lanceolate. Palpus (Fig. 2b) dark brown, segment 3 with moderately large, irregular, shallow, sensory area; palpal ratio 1.86 (1.69–1.86, $n = 2$).

Thorax: Brown with dark brown mottling dorsad; pleura with dark brown vittae. Legs (Fig. 2d) yellowish, coxae and trochanters brown; femora dark at base, forefemur with weak dark bands at ½ and ¾ the length and a subapical dark band; midfemur with weak subapical and apical dark bands and variable dark mottling on dorsal surface; hindfemur with weak dark bands apically, and at midlength wide dark markings varying from indistinct bands to mottling. Knee spots pale. Tibiae with basal and apical dark bands, 3 to 4 dark markings along the length varying from indistinct bands to mottling. Hindtibial comb with 6 spines ($n = 2$). Tarsi pale; fore- and hindbasitarsi, tip and base of mid basitarsus dark; hindtarsal ratio 3.42 (3.33–3.42, $n = 2$).

Wing (Fig. 2c): Light brown. Costal cell grayish; veins M_{1+2}, M_1, M_{3+4}, Cu_1, Cu_2 and A_1 with grayish streaks basally; dark spot over r-m crossvein extending from vein M_{1+2} and covering vein R_1, small dark spot at junction of veins R_1 and R_{4+5}; large dark spot covering veins R_{4+5} at end of second radial cell and a lighter poststigmatic spot extending laterally; distal end of vein R_{4+5} with 2 punctures; submarginal dark spots on veins M_1 and M_2 with a dark spot on vein M_1 approximately ⅓ the distance from the medial fork; a submarginal dark spot on vein M_{3+4} and Cu_1 with a dark spot filling the base of the mediocubital fork; apex of vein A_1 with dark spot and 2 small dark areas in base of anal cell; costal ratio 0.56 ($n = 2$). Halter lightly infuscated with dark dorsal streak on knob.

Genitalia (Fig. 2e, f): Sternum 9 with broad, deep, caudomedian excavation, ventral membrane lightly spiculate; tergum 9 long, strongly tapering, with long, stout, moderately separated, convergent, apicolateral processes; basistyle short; dististyle elongate, tip tapering and moderately hooked; aedeagus with a high round basal arch, ending caudally in a heavily sclerotized cruciform tip; parameres moderately stout, basal arms acutely bent and ending in foot-shaped apodemes, midportions strongly curving to meet mesally, the swollen distal ends flaring and each bearing a pair of sclerotized, sharply pointed processes curving posterad.

Female.—Unknown.

Distribution.—Malaysia.

Types.—On slides in phenol balsam. Holotype male, 1 male paratype, Malaya, Pahang, Kuala Singgora, 10.vii.1958, light trap, coll. R. H. Wharton (Type no. 76600, NMNH).

Etymology.—This species is named for Dr. Mercedes Delfinado Baker in recognition of her work on Oriental Ceratopogonidae.

Discussion.—The wing pattern and the leg bands and mottling place this species in the *Alluaudomyia annulata* Group. The species appears to be closely related to *A. bifurcata* Wirth and Delfinado and *A. griffithi* Wirth and Delfinado. *A. delfinadoae* is readily separated from *A. bifurcata* by obvious genitalic differences, and from both *A. bifurcata* and *A. griffithi* by the wing pattern, as the latter two species have many more black spots along the radial sector.

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TAXONOMIC NOTES ON *ANAPHES DIANA* (GIRAULT), AN IMPORTED MYMARID (HYMENOPTERA: MYMARIDAE) EGG PARASITE OF *SITONA* WEEVILS (COLEOPTERA: CURCULIONIDAE)

Michael E. Schauff

Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % National Museum of Natural History, Washington, D.C. 20560.

Abstract.—Anaphes (Patasson) lameerei Debauche, imported from Europe to control *Sitona* weevils, is a junior synonym of *Anaphes diana* (Girault), new combination. A lectotype is designated for *A. diana* and a diagnosis is provided to separate it from other North American species of *Anaphes.*

During the past few years, several laboratories in the United States have been actively engaged in research designed to control weevils of the genus *Sitona.* Part of that research has focused on the importation of a mymarid egg parasite from various localities in Europe. The parasite has been released in several localities in eastern U.S. and recent field collections indicate that it may have become established.

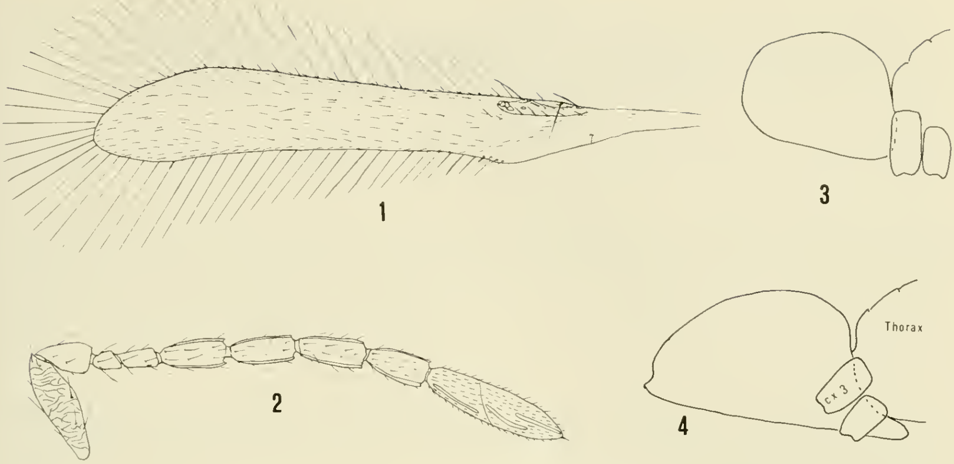
While pursuing research on mymarid genera, I discovered that nomenclatural problems existed regarding the species in question. In addition, it has come to my attention that workers in the field are without any identification aid that would enable them to distinguish this parasite from others in the genus. Therefore, I have taken this opportunity to resolve the nomenclatural problem and provide a diagnosis.

***Anaphes diana* (Girault), New Combination**

Anaphoidea diana Girault, 1911: 215.
Anaphes (Patasson) lameerei Debauche, 1948: 182. New Synonym.

Specimens identified as *Patasson lameerei* Debauche have been imported and released in the U.S. Examination of the types of *A. (P.) lameerei* confirm that the imported specimens agree with the type material. However, I have also discovered that the types of *Anaphoidea diana* Girault are indistinguishable from *Anaphes lameerei.* Since *diana* has priority over *lameerei,* I propose the above synonymy.

Anaphes diana was described by Girault (1911) from specimens collected in England by Fred Enock and apparently donated to the U.S. National Museum of Natural History. Debauche (1948) in his study of the mymarid fauna of Belgium described *A. (P.) lameerei* from a number of specimens taken at various localities around that country. Debauche probably was unaware of the earlier description of *diana* because he made no mention of that species in his paper. Furthermore, his work was limited to Belgium and he might easily have missed or ignored Girault's description of an English species.



Figs. 1–4. 1–3, *Anaphes diana* female. 1, Forewing. 2, Antenna. 3, Thorax and abdomen (lateral view). 4, *Anaphes* sp. Thorax and abdomen (lateral view).

Debauche was the first to recognize that the species of *Patasson* Walker were best placed as part of the genus *Anaphes* Haliday. Previous workers had separated the two genera on the basis of the difference in number of antennal club segments (1 in *Anaphes* and 2 in *Patasson*). Several subsequent workers (e.g. Annecke and Doutt, 1961; Burks, 1979) did not agree with Debauche's views and continued to recognize *Patasson* as a valid genus. Consequently, when an egg parasite of *Sitona* weevils was found, it was identified as *Patasson lameerei* Debauche by European authorities.

Girault described *A. diana* from 2 specimens (1 male and 1 female) but did not designate a holotype. Therefore, I have designated the female specimen as the lectotype. The specimen is mounted in balsam with the following data: "A Fairy Fly, spot lens, 2 inch to ½ inch, *Anaphoidea diana* Gir., Type 13,663, Fred Enock preparer, Order Hymenoptera, Family Mymaridae, Genus *Eustochus,* species *atripennis.*" No locality is given on the slide, but Girault gave it as "London or vicinity?" in his original paper. The paralectotype male is also slide mounted and has the same data.

DIAGNOSIS

Genus *Anaphes*: tarsi 4-segmented; abdomen subsessile (abdomen tapered slightly at point of attachment to thorax, with no visible petiole), phragma not projecting into gaster; antennal funicle 6-segmented, club 1 or 2 segmented (Fig. 2); forewing with a line of setae extending from under venation across membrane to the hindmargin (Fig. 1); propodeum divided medially by a sulcus.

Anaphes diana (female): antennal club 2-segmented; ovipositor not extended forward between hind or midcoxae (Fig. 3); funicle (abbreviated F) 2 only about 2× as long as F1, ½ length of F3, F3–6 each longer than wide.

This species belongs to the "Patasson" group in which the females possess a 2-segmented antennal club. Of the nine other species of this group known from North America (i.e. *Patasson* of Burks, 1979), *diana* is the only one which shows no forward extension of the abdominal sterna and ovipositor between the coxae and under the thoracic venter (Fig. 3). In most of the other species the forward projection of the ovipositor is quite marked (Fig. 4), often reaching beyond the middle of the thorax ventrally. Occasionally, in alcohol preserved specimens, the ovipositor of *diana* protrudes slightly from the antero-ventral portion of the abdomen, but it does not reach forward to the hindcoxae. Only *A. longiclava* Doutt and *A. conferta* Doutt are somewhat similar in this respect. In the few specimens of *longiclava* available for study, the ovipositor reaches just between the hindcoxae. However, *longiclava* is smaller than *diana* (0.4 vs. 0.6 mm) and is light brown or yellowish in color while *diana* is uniformly dark brown. In addition, F2 and F3 are subequal (30:36) in *longiclava,* while in *diana* F2 is only ½ as long as F3. In *conferta* the funicle segments are all quadrate or slightly wider than long (*diana* has F3–6 each at least 2× as long as wide).

Unfortunately, a thorough revision will be necessary before we will be able to distinguish males of most species of *Anaphes.* As a result, the above diagnosis only refers to females.

Specimens examined.—Lectotype (by present designation) and paralectotype of *A. diana* (Girault) (USNM); holotype and paratypes of *A. lameerei* Debauche (Brussels); holotypes or syntypes of all other North American species.

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DESCRIPTION OF FOUR NEW WEST AFRICAN CIXIIDAE (HOMOPTERA, FULGOROIDEA)

J. VAN STALLE AND H. SYNAVE

(JVS) Schoolmuseum M. Thiery, Sint-Pietersplein 14, 9000 Gent, Belgium; (HS, deceased) Koninklijk Belgisch Instituut voor Natuurwetenschappen, Vautierstraat 29, 1040 Brussels, Belgium.

Abstract.—Four Cixiidae species from West Africa are described as new to science: ***Andes africanus***, ***Brixidia variabilis***, ***Oliarus wazae***, and ***Oliarus flavinervis.***

This paper describes four new Cixiidae captured in Liberia, Ivory Coast, Nigeria and Cameroon, and submitted to the late Dr. Synave for identification. The major part of the figures were already drawn by him, but were left unfinished after his sudden death in September 1980. The first author thanks J. P. Kramer (Systematic Entomology Laboratory, USDA) and Dr. P. Dessart (Koninklijk Belgisch Instituut voor Natuurwetenschappen) for the privilege of describing this material. The types are in the U.S. National Museum of Natural History, Washington, D.C., unless otherwise stated.

Andes africanus Van Stalle and Synave, New Species

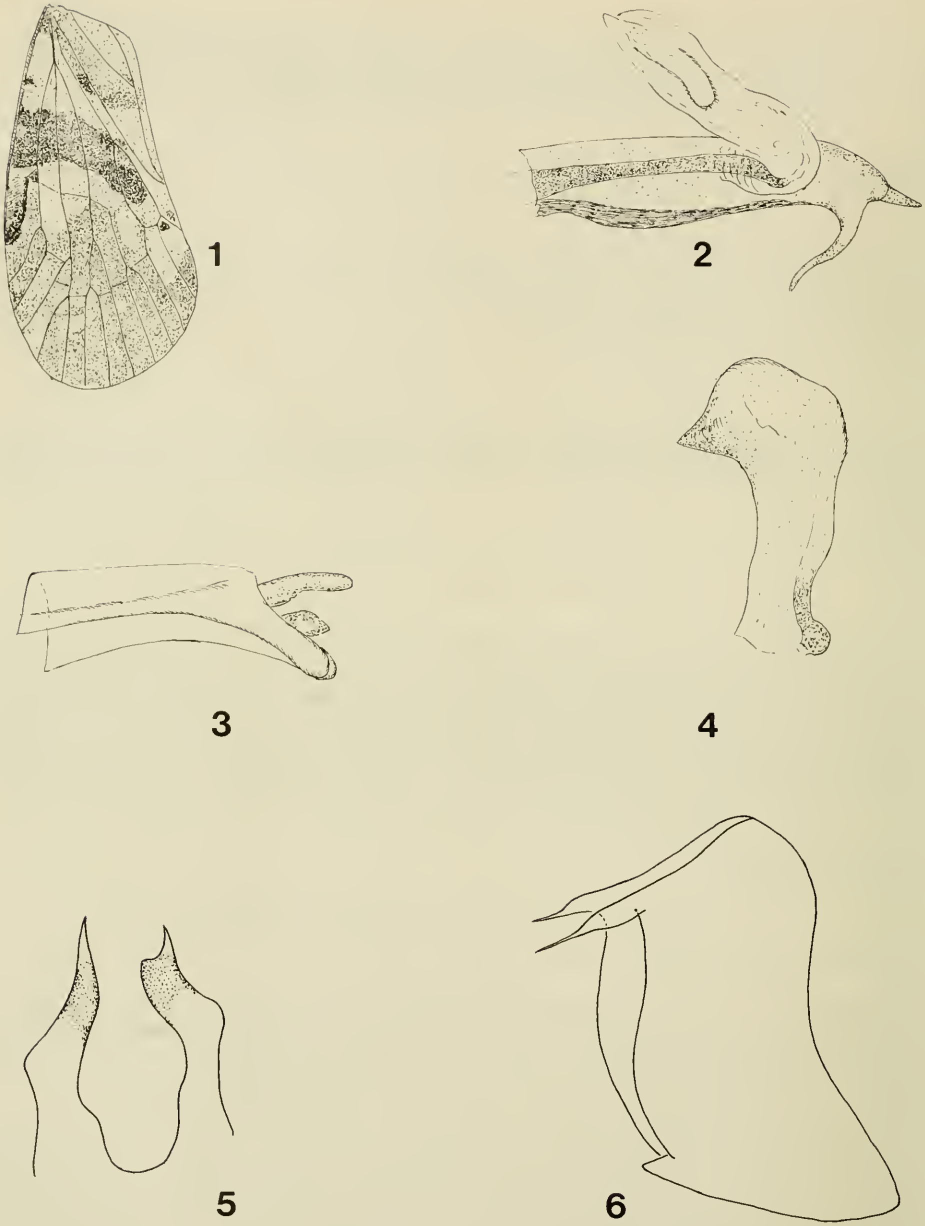
Figs. 1–6

Description.—Color variable; specimens from Liberia yellowish brown, pronotum and legs somewhat paler; specimens from Nigeria darker, vertex and dorsal part of pronotum dark brown. Tegmina fumated with brown, as in Fig. 1, with a dark transverse band in the proximal half. *Total length:* 6 mm.

Male genitalia: anal segment (Fig. 3) moderately long. Posterior lateral margins of pygofer (Fig. 6) slightly convex, with two unequal spinose processes (Fig. 5) dorsally. Genital styles short (Fig. 4). Aedeagus (Fig. 2) with two short spines apically, one directed ventrally, the other running caudally.

Diagnosis.—*Andes africanus* n. sp. is closely related to *Andes schoutedeni* Synave, 1959 and *A. bilineatus* Synave, 1960 in the color pattern of the tegmina and in the general structure of the aedeagus. However, it is well defined from these two species by the presence of two spines on the pygofer, the different shape of the genital styles, and the orientation and implantation of the aedeagal spines.

Material examined.—*Holotype* ♂: Liberia, Grand Gedeh. Co. 25 km N. Zwedru, 11-VII-1971, J. A. Gruwell. *Paratypes:* 1 ♂, 4 ♀, same locality; 1 ♂, Nigeria, W. State, Ikoga, I-1975 (Coll. KBIN).

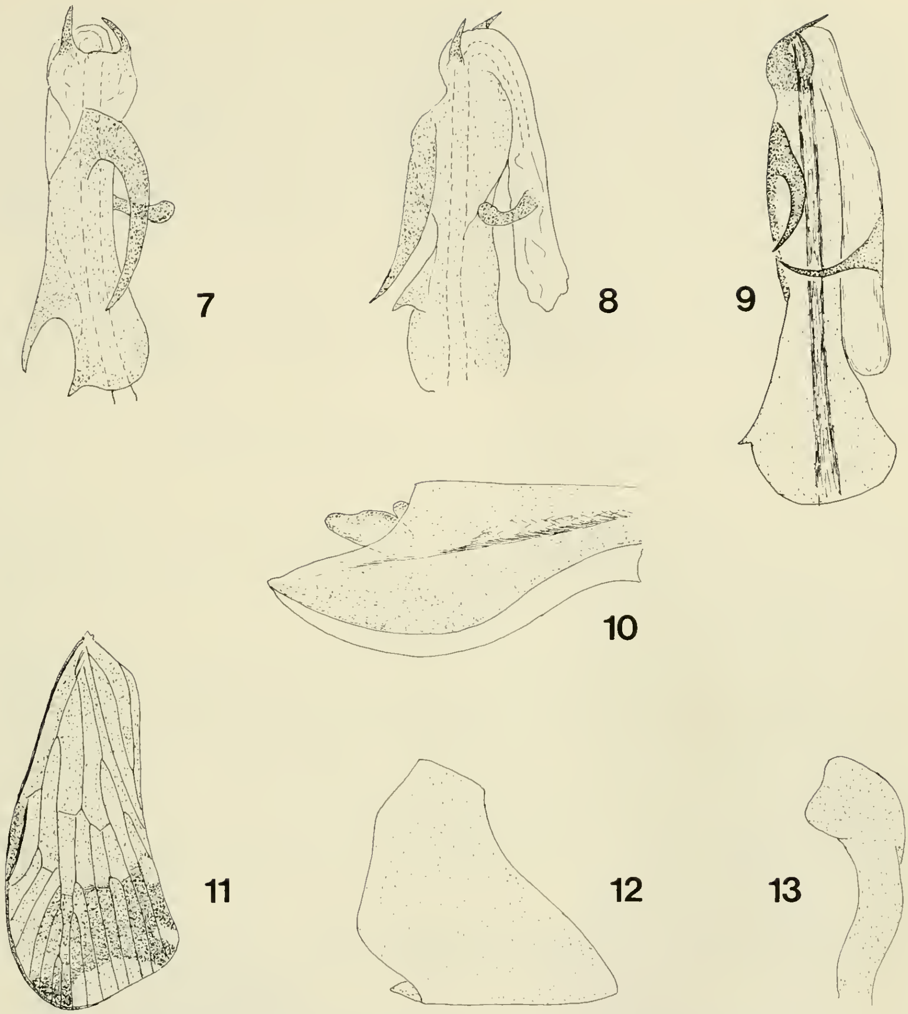


Figs. 1–6. *Andes africanus.* 1, Left tegmen. 2, Aedeagus. 3, Anal segment. 4, Genital style. 5, Processes of pygofer, dorsal view. 6, Pygofer.

Brixidia variabilis **Van Stalle and Synave, New Species**
Figs. 7–13

Description.—Color pale yellowish throughout. Tegmina milky hyaline, veins pale yellowish, slightly fumated with brown in distal part. *Total length:* 9–10 mm.

Male genitalia: anal segment (Fig. 10) and genital styles (Fig. 13) as illustrated. Lateral margins of pygofer (Fig. 12) only slightly produced distally. Aedeagus



Figs. 7–13. *Brixidia variabilis.* 7, Aedeagus, ventral view, holotype. 8, Aedeagus, dorsal view, holotype. 9, Aedeagus, dorsal view, paratype Mt. Tonkoui. 10; Anal segment. 11, Left tegmen. 12, Pygofer. 13, Genital style.

(Figs. 7, 8) with six spinose processes divided as follows: two short spines apically, a spine ventrally near base directed inwards and a small tooth-like spine just above it. Finally, two dorsal spines, one inserted along left side on one third of apex and directed cephalically, and another arising from flagellum and directed to right side. The latter is blunt in the holotype (or possibly broken off), and tapering in the paratypes from Mt. Tonkoui (Fig. 9).

Variability: while the specimens of Liberia are pale yellowish, the paratypes of Mt. Tonkoui are brown; the tegmina (Fig. 11) are fumated with brown and are dark brown in the apical area, with three paler spots along the apical and inner margin, as illustrated in Fig. 11. The aedeagus is basically the same in all males, but the aedeagus of the paratype is longer, and the two dorsal spines are otherwise shaped: in one male, the right one is shorter, and the transverse spine is tapering

(Fig. 9). In another male, the right spine is still shorter, and the transverse spine is blunt like that of the holotype.

Diagnosis.—The genus *Brixidia* Haglund was recently revised by Synave 1980. Till now, eight species are referred to this genus, all recorded on the African continent, and mainly distinguished by the shape of the male genitalia, which were illustrated by the author. *Brixidia variabilis* n. sp. differs from these species by the different shape of the pygofer, and the different form and implantation of the aedeagal spines. As already mentioned above, the color pattern of the tegmina is not a useful character to identify this species.

Material examined.—*Holotype* ♂: Liberia, Grand Gehed. Co., 25 km N. Zwedru, 11-VII-1971, J. A. Gruwell. *Paratypes:* 3 ♀, same locality; 2 ♂, 3 ♀, Ivory Coast, Mt. Tonkoui, 15/22-X-1973 (Coll. Linnavuori, 1 ♂ in Coll. KBIN).

Oliarus wazae **Van Stalle and Synave, New Species**

Figs. 14–20

Description.—Frons, clypeus, pronotum and legs yellowish. Vertex (Fig. 19) ochreous, posterior part and carinae paler, longer than broad (27:20), narrower than an eye (20:27). Mesonotum and abdomen ochreous. Tegmina hyaline (Fig. 16), veins and stigma yellow. *Total length:* 7 mm.

Male genitalia: anal segment (Fig. 18) asymmetrical, dorsal margin straight, ventral margin convex, left lateroapical angle broader than right one. Pygofer (Fig. 20) subsymmetrical, with two caudal finger-like appendages, left one broader than right one. Genital styles (Fig. 17) as illustrated. Aedeagus (Fig. 14 & 15) with two spinose processes, one directed caudally and curved apically to right side, the other subcircular, recurved inwards along left side.

Diagnosis.—The species is characterized by its yellow color, the two-colored vertex, the shape of the pygofer and the form of the aedeagus, which separate it from all other *Oliarus* species.

Material examined.—*Holotype* ♂: Cameroon, Waza, 19-III-1972, filtered black light, J. A. Gruwell. *Paratypes:* 1 ♂, 1 ♀, same locality (♂ in Coll. KBIN).

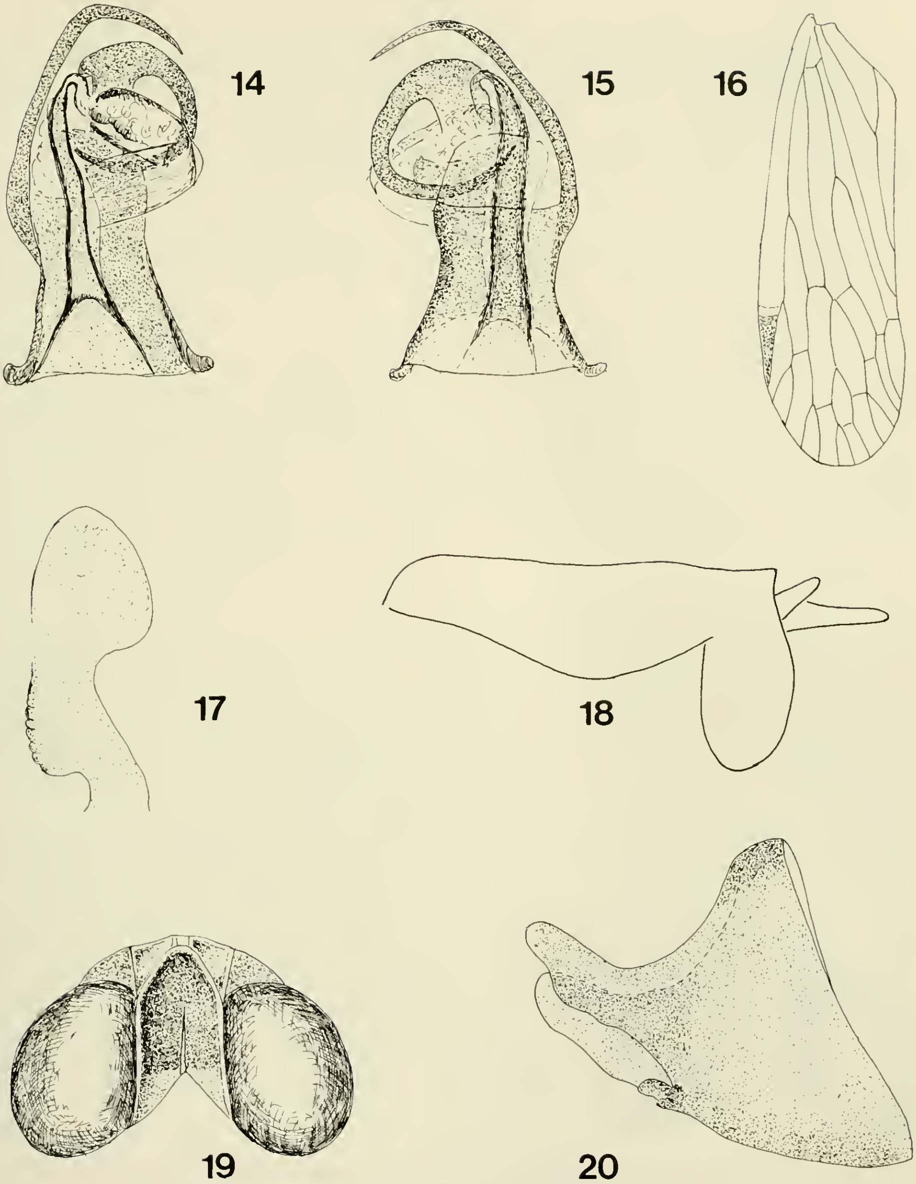
Oliarus flavinervis **Van Stalle and Synave, New Species**

Figs. 21–27

Description.—Color yellowish throughout, vertex (Fig. 22) and mesonotum yellowish brown, carinae paler. Tegmina hyaline (Fig. 23), veins yellow. Vertex as long as broad, as wide as an eye. *Total length:* 5 mm.

Male genitalia: anal segment (Fig. 24) asymmetrical, left ventral margin deflexed into a large triangular lateroapical angle, right ventral margin strongly sinuated proximally, lateroapical angle almost non-existent. Pygofer (Fig. 25) asymmetrical, left lateral margin produced into a large lobe, right lateral margin caudally produced into a narrower process. Genital styles as illustrated (Fig. 27). Aedeagus (Figs. 21, 22) with six spines: a long one and two short subequal ones visible in dorsal view; a short curved process visible from both sides and two others visible in ventral view.

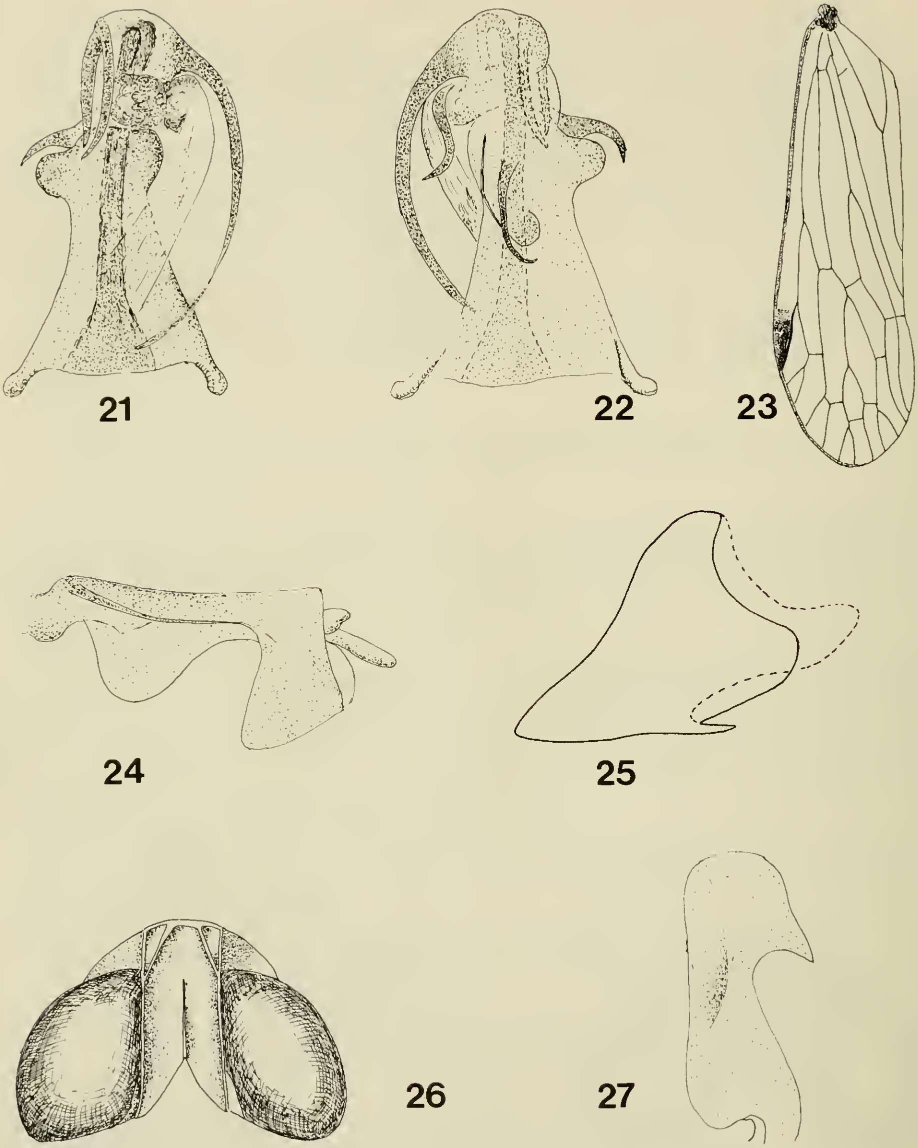
Diagnosis.—Structurally, *Oliarus flavinervis* n. sp. belongs to the group of *O.*



Figs. 14–20. *Oliarus wazae.* 14, Aedeagus, dorsal view. 15, Aedeagus, ventral view. 16, Left tegmen. 17, Genital style. 18, Anal segment. 19, Head. 20, Pygofer.

frontalis Melichar. It is easily characterized by the asymmetrical shape of the pygofer, and anal segment, and the particular shape of the aedeagus, namely the number, implantation and shape of the aedeagal spines, which easily separate this species from all known *Oliarus* species.

Material examined.—*Holotype* ♂; Cameroon, Waza, 19-III-1972, filtered black light, J. A. Gruwell. *Paratypes:* 2 ♂, same locality (1 ♂ in Coll. KBIN).



Figs. 21–27. *Oliarus flavinervis.* 21, Aedeagus, dorsal view. 22, Aedeagus, ventral view. 23, Left tegmen. 24, Anal segment. 25, Pygofer. 26, Head. 27, Genital style.

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THE TRUE NYMPH OF *GOMPHUS (GOMPHURUS) CRASSUS* HAGEN (ODONATA: GOMPHIDAE), WITH NOTES ON ADULTS

K. J. Tennessen and J. A. Louton

(KJT) 1949 Hickory Ave., Florence, Alabama 35630; (JAL) Department of Zoology, University of Tennessee, Knoxville, Tennessee 37916.

Abstract.—Reared nymphs of *Gomphus (Gomphurus) crassus* Hagen from Tennessee are described and diagnostic characters are illustrated. A previous description, based on supposition, was in error, leading to incorrect identifications. The nymphs of *G. crassus,* unique in the subgenus as far as is known, possesses strongly hooked palpal lobes and lateral spines of abdominal segment 9 that are subequal to the middorsal length of segment 10.

Broughton (1928) briefly described unassociated *Gomphus* nymphs from Timonton Lake, Indiana, as *Gomphus crassus* Hagen based on supposition by J. G. Needham. The characters given were subsequently used by Needham and Heywood (1929) and Needham and Westfall (1955) to separate *G. crassus* from the other species of the subgenus *Gomphurus.* Specimens of *G. crassus* that we reared from three localities on the Duck River in Tennessee differ markedly in the form of the labium and the lateral abdominal spines from Broughton's description. We believe the earlier association was in error and that the nymph of *G. crassus* has remained unknown until the present. The nymphs described by Broughton (1928) as *G. crassus* were probably *G. externus* Hagen, judging from the straight line of eight to nine teeth on the palpal lobes, the convex anterior margin of the prementum, and the long lateral spines on abdominal segment nine ("almost twice as long as segment ten"). Also, *G. externus* has been recorded from lakes (Needham and Hart, 1901; Walker, 1958), whereas *G. crassus* has not.

METHODS

Exuviae of reared adults and syntopically collected nymphs were used for descriptive purposes. The lengths of the lateral spines on abdominal segments six to nine were measured dorsally from the posterior margin of the segment to the tip of the spine. The length and width of abdominal segment nine are maximum values, measured ventrally. Because exuviae tend to be laterally compressed to varying degrees, measurements of width may be slightly different than in nymphs. Abdominal segment ten was measured middorsally. Caution must be taken in determining how far the lateral spines on segment nine extend posteriorly compared to segment ten, especially in exuviae, because of the extent of telescoping of segment ten within segment nine. In life, the tip of the blunt dorsal hook on segment nine overhangs the basal one-fourth of segment ten.

Description of *Gomphus crassus* Nymph

Total length 29–33 mm; length abdomen 17.8–21.8 mm; length hind femur 4.5–5.7 mm; width head 5.4–6.0 mm; width abdomen 7.6–8.6 mm. Exuviae and nymphs unpatterned and with a coarse, granular surface. Third antennal segment 2× length of proximal 2 segments together. Prementum constricted proximally, widest just distal to constriction; 1.17–1.23× longer than wide; ligula straight, without median tooth. Palpal lobes with 4 or 5 (rarely 3) teeth arranged in a line curving sharply toward large apical tooth (end hook) (Fig. 1). Legs short compared to other species of subgenus, body 5.6–6.5× as long as hind femur.

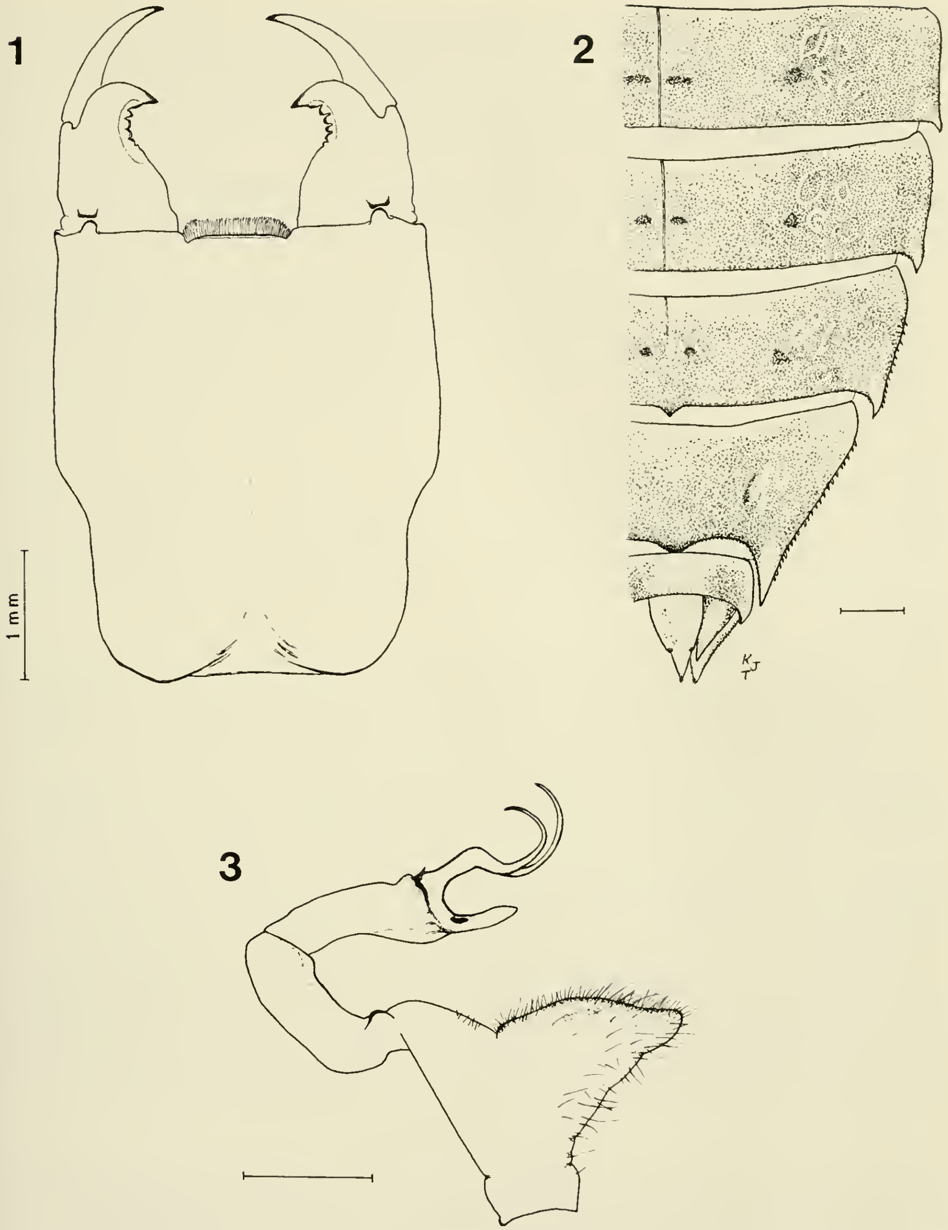
Lateral spines on abdominal segments 6 to 9; small, sharp dorsal hook on segment 8, a rounded hook segment 9. Lateral margins of segments 8 and 9 serrated, segment 8 with 10–16 denticles, segment 9 with 19–25. Segment 9 1.92–2.22× wider than long; lateral spines 1.00–1.35 (typically 1.20) × the middorsal length of segment 10; tips of spines do not extend to posterior margin of segment 10 (Fig. 2). Epiproct (superior anal appendage) 1.5–1.8× middorsal length of segment 10, 1.13–1.27× the length of cerci (lateral appendages). Paraprocts extend slightly beyond tip of epiproct.

Material examined.—TENNESSEE: Bedford Co., Duck River, Anchor Mill, V-20-1978, JAL, 2 reared males, 1 reared ♀ (emerged V-24), 8 nymphs, 5 exuviae; Coffee Co., Duck River, confluence Bashaw Creek, III-23-1978, JAL, 2 nymphs; Marshall Co., Duck River, 2.5 mi SE Chapel Hill, III-24-1978, JAL, 2 nymphs; same location, IV-1-1978, JAL, 1 reared ♀ (emerged V-17), 1 nymph; Maury Co., Duck River at Sowell Ford, V-21-1979, KJT, 6 exuviae; Duck River below Hardison Mill, Hwy. 431, V-14-1980, KJT, 1 reared ♂, 1 reared ♀; same location, V-5-1981, KJT, 5 reared ♂, 3 reared ♀, 3 nymphs, 3 exuviae; Rutherford Co., Stones River, US Hwy. 231, IV-1-1978, JAL, 1 nymph.

Discussion

The nymph of *G. crassus* belongs to the group of *Gomphurus* species with strongly hooked palpal lobes (Fig. 1), which includes five others known in the nymphal stage: *G. modestus* Needham, *G. dilatatus* Rambur, *G. lineatifrons* Calvert, *G. vastus* Walsh, and *G. ozarkensis* Westfall (Louton, 1982). The nymph of *G. ozarkensis* has been reared but is undescribed; it is most similar to *G. crassus*. In the nymphs of the other 4 species, the lateral spines of segment nine are 1.3 to 2.0 times as long as the middorsal length of segment ten, whereas in *G. crassus* the spines are approximately equal in length to segment ten. A key for separating nymphs of *Gomphurus* appeared in Louton (1982).

Nymphs of *G. crassus* were collected from sand-silt deposits near the river bank where flow was relatively swift. Although sympatric over much of its range with *G. vastus*, nymphs of the two species were not usually collected syntopically, except for one collection at Hardison Mill where both were taken in the same microhabitat. Other species of Gomphidae collected at the same localities with *G. crassus* were: *Dromogomphus spinosus* Selys, *D. spoliatus* (Hagen), *Erpetogomphus designatus* Hagen, *Gomphus (Gomphus) quadricolor* Walsh, *Gomphus(Gomphurus) fraternus* (Say), *Gomphus (Gomphurus) hybridus* Williamson, *Gomphus (Gomphurus) vastus*, *Gomphus (Stylurus) plagiatus* (Selys), *Gomphus (Stylurus) spiniceps* (Walsh), *Hagenius brevistylus* Selys, *Ophiogomphus rupinsulensis* (Walsh), *Progomphus obscurus* (Rambur), and *Stylogomphus albistylus* (Hagen).



Figs. 1–3. *Gomphus crassus.* 1, Ventral view of labium of nymph. 2, Right half of abdominal segments six to ten of nymph. 3, Penis.

The emergence period of *G. crassus* appears to begin in mid-May in Tennessee. Our latest collection of adults on the Duck River was July 9; none was seen on trips made in middle and late July. Needham and Westfall (1955) gave the flight dates as May 11 to July 31 (based on Williamson, 1917). The presently known distribution of this species is along the margin of the Wisconsin glacial maximum, southward into the Interior Low Plateaus (Louton, 1982), and a population near the southern end of the Cumberland Plateau in northeastern Alabama (several specimens have been taken also in northwestern Alabama). Several possibilities are indicated by this distribution: 1) the unglaciated portion of the Interior Low Plateaus served as a glacial refuge; 2) if *G. crassus* was displaced southward during the Pleistocene, it was unable to subsequently recolonize the glaciated part of its range; 3) the population in northeastern Alabama may be relict.

Williamson (1919) examined a series of adult *G. crassus* from Indiana for variation in color pattern of abdominal segments eight to ten. He established nine color groups for males and three groups for females, ranging from a minimum to a maximum amount of yellow. Examination of 139 males and 38 females we collected in Tennessee and Alabama from 1979 to 1981 also showed a high degree of variability. Placing our specimens in Williamson's groups showed that the specimens from Tennessee and Alabama have more yellow on the terminal segments than those from Indiana. The extent of variation in color patterns such as these may render them useless as diagnostic characters. However, within the subgenus *Gomphurus,* the penis has been shown to be a useful character for distinguishing the species (Westfall, 1956, 1974, 1975). As the penis of *G. crassus* has not been previously figured, we present a drawing made from a male collected at Halls Mill on the Duck River, Bedford Co., TN, 3 June 1980, KJT (Fig. 3). It is very similar to the penis of *G. ozarkensis,* the major difference being the longer flagella.

Adult records.—ALABAMA: Jackson Co., Estill Fork, Co. Hwy. 9, VI-5-1980, KJT, 11 ♂; Paint Rock River, Hwy. 65, 1 mi ENE of Princeton, VI-5-1980, KJT, 1 ♀. Lauderdale Co., Shoal Creek, Co. Hwy. 8, VI-2-1981, T. Goldsby & T. Sessler, 1 ♂; VI-5-1982, KJT, 1 ♂; Butler Creek, Co. Hwy. 11, VI-12-1982, J. J. Daigle, 1 ♂. TENNESSEE: Bedford Co., Duck River, Halls Mill, VI-3-1980, KJT, 5 ♂, 1 ♀; VII-9-1981, A. H. Price, III, 1 ♂; Fall Creek, Ben Williams Rd., VI-3-1980, KJT, 1 ♀; VI-11-1980, KJT 1 ♂. Giles Co., Richland Creek, Co. Rd. 4209, VI-7-1982, JAL 2 ♂. Lewis Co., Buffalo River, 6 mi S. of Hohenwald, VI-7-1982, KJT, 5 ♂. Marshall Co., Duck River, Lillard Mill, VI-12-1979, KJT, 14 ♂, 12 ♀, 1 pr.; VI-11-1980, KJT, 4 ♂, 4 ♀, 1 pr.; VI-3-1981, 10 ♂, 3 ♀, 2 pr.; VI-18-1981, KJT, 20 ♂, 4 ♀. Maury Co., Duck River at Sowell Ford, V-18-1979, C. H. Gooch, 4 ♂; V-21-1979, KJT, 16 ♂; VI-18-1979, C. H. Gooch, 4 ♂; VI-25-1979, KJT 12 ♂; Duck River below Hardison Mill, Hwy. 431, V-27-1980, KJT 4 ♂, 1 ♀, 1 pr.; VI-16-1980, KJT, 6 ♂, 5 ♀; VI-3-1981, KJT, 2 ♂, 1 ♀; Duck River, Brench Island, VI-7-1982, JAL, 2 ♂; Fountain Creek, Hwy. 50, VI-6-1982, JAL, 8 ♂.

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COMPARISON OF STRIDULATORY STRUCTURES IN NORTH AMERICAN *PISSODES* SPP. (COLEOPTERA: CURCULIONIDAE)

DAN M. HARMAN AND AMY L. HARMAN

(DMH) University of Maryland, Center for Environmental and Estuarine Studies, Appalachian Environmental Laboratory, Frostburg State College Campus, Frostburg, Maryland 21532; (ALH) Department of Biology, Frostburg State College, Frostburg, Maryland 21532.

Abstract.—The stridulatory apparatus was studied in 26 species of North American *Pissodes*. Gross dimensions of the pars stridens, or file, and numbers and spacing of striae were compared. Average width of the pars stridens was greater in males than females, although striae were more numerous and concentrated in females. Proportions of length in relation to width (L/W) of the pars stridens appeared to be a potentially useful means for taxonomic comparisons in *Pissodes* spp. The L/W ratio indicated similarities in some synonym associations, including *P. approximatus* + *canadensis*; *P. rotundatus* + *nigrae*; *P. schwarzi* + *yosemite*; and *P. strobi* + *sitchensis* + *englemanni*. Dissimilarities were exhibited in some other associations. A supplemental examination of 100 *P. strobi* showed a positive correlation between pars stridens dimension and total body length.

The genus *Pissodes* in North America has presented challenging taxonomic problems. Whereas Hopkins (1911) recognized 30 species of *Pissodes*, recent research based on cytology (Manna and Smith, 1959; Smith, 1970) and cytogenetics (Smith and Takenouchi, 1962; Drouin et al., 1963) have greatly reduced the number of *Pissodes* taxa recognized as valid species. Smith and Sugden (1969) listed 11 species, with their synonymy among the formerly recognized species. However, O'Brien and Wibmer (1982) listed 22 *Pissodes* species, accepting most of the synonymy proposed by Smith and Sugden.

Among the problems encountered with *Pissodes* are morphological uniformity within taxa exhibiting marked behavioral differences in some sub-groups. An example is seen in *Pissodes strobi* (Peck), which now includes the former *Pissodes sitchensis* Hopkins and *Pissodes englemanni* Hopkins. Various workers in the past found it difficult to distinguish *P. strobi* from *Pissodes approximatus* Hopkins (Plummer and Pillsbury, 1929), and the 2 groups have been successfully interbred in the laboratory (Godwin and Odell, 1967). Using serological comparisons, Peckham (1969) did not find sufficient evidence to support separation of *P. approximatus* and *P. strobi*. In contrast to this are the "marked behavioral differences" described by Hopkins (1911), and the cytological and cytogenetic differences (Manna and Smith, 1959; Smith, 1970; Smith and Takenouchi, 1969). The likelihood of similar problems exist for other *Pissodes* spp. that have received little study.

Sound production and related morphological structures represent an additional set of criteria useful in determining taxonomic and behavioral status. According to Frings and Frings (1958) differences in acoustical behavior between different species of insects are as specific as the more usual morphological features that distinguish species. Since acoustical behavior in insects is known to be species specific, the sound-making instrument should also have specific features. Differences in dimensions and striation patterns likely relate to the specific acoustical signature. Ideally, numerous living representatives of each taxon should be available for comparison on a population basis.

Within *Pissodes,* an analysis of sound produced by two species, *P. strobi* and *P. approximatus,* was conducted by Harman and Kranzler (1969). They used a cathode ray oscilloscope to determine wave form, duration, and interval of the sounds produced. Significant differences in chirp repetition rates were observed between sexes in both species but not between the species. Stridulation appeared to be composed of two-part diplosyllabic chirps, apparently utilizing both the forward and backward movements of the stridulation mechanism.

An initial reference to the stridulatory apparatus in *P. strobi* was made by Hopkins (1911), who briefly described the position of the stridulatory rasp, the overall ventral elytral surface, and the position of the scraper (plectrum or stridulator) on the dorsal surface of the abdominal tergite. Dumortier (1963) discussed sound- making structures in various insect groups, including the elytro-abdominal method found in *Pissodes.* Further study of the stridulatory apparatus in *P. strobi* was conducted by Harman and Harman (1972). The ventral surface of the elytra, in the vicinity of the stridulatory rasp, was found to consist of at least 4 distinct zones, one of which was considered to be the pars stridens. Spacing and total numbers of ridges on the pars stridens were compared for a few male and female *P. strobi.* Distinct differences in spacing and total numbers of ridges on the pars stridens were observed between the sexes.

An undetermined degree of variability in the plectral teeth probably occurs among the *Pissodes.* Hopkins (1911) described and illustrated the pygal tergites, showing the arrangement of plectral teeth, for *P. englemanni, P. strobi, P. approximatus, Pissodes fraseri, Pissodes affinis,* and *Pissodes curriei.* Differences occurring among the above 6 taxa were substantial. Although the elytral undersurface containing the pars stridens was well preserved, the posterior abdominal segments carrying the plectral teeth were shriveled and partially disintegrated in most of the specimens, eliminating any opportunity for accurate study of these structures in the present study.

Since the significant difference in chirp rate between the sexes in *P. strobi* and *P. approximatus* could easily be verified through visual measurement with magnification, it appeared that similar measurements on other *Pissodes* could be of value, both for sexual and systematic differentiation. In the present study, comparisons were made of the stridulatory apparatus of most species of North American *Pissodes.*

METHODS AND MATERIALS

This study included examination of 26 taxa of *Pissodes* contained in the U.S. National Museum of Natural History, principally from original Hopkins material. Many are now considered to be ecotypes or geographic races because of the work of Smith and Sugden (1969). The taxonomic designations of the present study follow those of Smith and Sugden, except that taxa not treated by Smith and Sugden are listed as found in the collection. The taxa contained in the Smithsonian Institution collection included the following: *Pissodes affinis* Randall (= *curriei* of Hopkins), *P. approximatus* Hopkins (= *canadensis* of Hopkins), *P. burkei* Hopkins, *P. coloradensis* Hopkins, *P. costatus* Mannerheim, *P. dubius* Randall (= *piperi* and *fraseri* of Hopkins), *P. deodarae* Hopkins, *P. fasciatus* LeConte, *P. nemorensis* Germar, *P. puncticollis* Hopkins, *P. radiatae* Hopkins, *P. rotundatus* LeConte (= *nigrae* of Hopkins), *P. schwarzi* Hopkins (= *yosemite* of Hopkins), *P. similis* Hopkins (= *utahensis* of Hopkins), *P. strobi* (Peck) (= *sitchensis* and *englemanni* of Hopkins), *P. terminalis* Hopkins, and *P. webbi* Hopkins. The above list follows that of O'Brien and Wibmer (1982), except that the latter authors listed *P. costatus* as a synonym of *P. schwarzi.*

Comparisons of the pars stridens and the surrounding portions of the undersurface were made by means of general descriptions and diagrammatic drawings, and by microscope measurement to determine spacing of ridges across the pars stridens. Measurements were made using 0.024 mm subdivisions diagonally across the pars stridens, and ridges were counted in each 0.024 mm subdivision. Measurements were taken at 43× with a compound microscope equipped with a micrometer disc. Striation counts were taken proceeding from the distal to the proximal edge across the pars stridens. At this magnification, each 10 spaces on the microscope grid covered 0.024 mm. The method of Van Tassel (1965) was used to obtain a transparent and accurate view of the zone and ridge patterns of the elytral undersurface including the pars stridens. This method consisted of spreading a thin coat of Elmer's Glu-All across the undersurface of the elytra, allowing it to dry, and then lifting it off. Observations and measurements were made on one specimen each of both sexes of each taxon if available specimens existed in the collection.

Additional measurements of 100 specimens of *P. strobi,* which were easily obtainable, were taken to provide insight into individual variation within one representative species of *Pissodes*. The 100 *P. strobi* specimens used for the study were selected from among several thousand which were reared from over 200 trees, at several disjunct locations in Allegany County, Maryland. In selecting the 100 insects, ⅓ were taken which appeared "small," ⅓ "medium," and ⅓ "large." They were then measured and segregated into three size categories which roughly corresponded to the above: <5 mm, 5–6 mm, and >6 mm. Sex was then determined for each insect. Measurements were taken of total body length and width, length and width of the pars stridens, and spacing and numbers of ridges on the pars stridens. The objective of this was to determine whether the width of the pars stridens in representative species of *Pissodes* varied with overall body length.

Results

Examination of the pars stridens and the ventral elytral surface around it affirmed the presence of four distinct zones in *Pissodes* spp. in an arrangement similar to that previously reported for *strobi* (Harman and Harman, 1972). The relative position of the zones is shown in Fig. 1, and the typical sculpturing for *strobi* is shown in Figs. 2 and 3. Variation in sculpturing was pronounced for some taxa, one of which is shown in Fig. 3.

Table 1. Dimensions of the pars stridens elytral zone A and the adjacent striated zone B in North America *Pissodes* (left elytron).[1]

	Pars stridens Elytral zone A				Elytral zone B			
	Female		Male		Female		Male	
Pissodes spp.	Width (mm)	Length (mm)	Width (mm)	Length (mm)	Width (mm)	Length (mm)	Width (mm)	Length (mm)
affinis	.301	.540	.284	.441	.499	.768	.432	.816
(= *currieri*)	.240	.480	.384+	.816	.480	.960	.480	1.008
approximatus	.284	.451	.307+	.499	.505	.676	.220	.407
(= *canadensis*)	.298	.451	.366+	.432	.470	.816	.480	.768
burkei	.113	.299	.294+	.495	.563	.862	.495	.505
coloradensis	.147	.333	—	—	.436	.853	—	—
costatus	.220	.348	.358+	.416	.495	.563	.465	.637
dubius	.192	.480	.336+	.547	.336	.960	.413	1.150
(= *piperi*)	.103	.338	.382+	.612	.588	.603	—	—
(= *fraseri*)	.235	.480	.103	.171	.451	.882	.514	.808
deodarae	.250	.480	.250	.384	.480	.770	.380	.480
fasciatus	.245	.309	.225	.372	.392	.612	.490	.451
nemorensis	.225	.318	.397+	.588	.451	.691	.299	.843
puncticollis	.083	.206	—	—	.167	.593	—	—
radiatae	.384	.403	.461+	.614	.576	.835	.672	.768
rotundatus	.240	.576	—	—	.528	.768	—	—
(= *nigrae*)	.182	.451	no striae	on casts	.403	.768	.402	.612
schwarzi	.259	.432	.249	.413	.480	.768	.499	.672
(= *yosemite*)	.259	.480	.384+	.643	.672	.835	.576	.768
similis	.137	.294	.142+	.201	.318	.451	.318	.343
(= *utahensis*)	.134	.192	—	—	.240	.480	—	—
strobi[2]	.240	.370	.230	.380	.380	.660	.340	.620
(= *sitchensis*)	.196	.304	.240+	.397	.397	.499	.416	.514
(= *englemanni*)	.206	.299	.245+	.402	.505	.554	.402	.612
terminalis	.288	.480	.211	.317	.432	.672	.384	.605
webbi	.314	.539	.318+	.514	.465	.593	.465	.691
Average	.22	.39	.29	.45	.45	.71	.43	.67

[1] Blank spaces indicate specimens unavailable.

[2] Data from 5 *P. strobi* males and 5 females, randomly selected.

Widths of the pars stridens for the 26 taxa are shown in Table 1. Except for *strobi*, the data presented in Table 1 are not averages, but are measurements from a single specimen of each sex from each taxon. Numbers of specimens per taxon in the national collection were not plentiful, often being limited to only one of each sex. Therefore there was no opportunity to obtain multiple measurements and averages for the taxa.

Data for elytral zone B are included because they contain organized striations, similar to those of zone A, and could actually be a portion of the sound-making apparatus. However, zone B has boundaries distinct from zone A, and has not been considered part of the pars stridens.

For females, the width of the pars stridens (zone A) ranged from 0.083 mm in *puncticollis* to 0.384 in *radiatae*. Average width of the pars stridens was greater in males than in females (0.29 mm versus 0.22 mm, respectively). It was wider

Table 2. Length/width ratios of the pars stridens (zone A) and adjacent zone B in North American *Pissodes* spp.

	Ratio of length/width			
	Zone A—pars stridens		Zone B	
Pissodes spp.	Female	Male	Female	Male
affinis	1.8	1.6	1.5	1.9
= *curriei*	2.0	2.1	2.0	2.1
approximatus	1.6	1.6	1.3	1.8
= *canadensis*	1.5	1.3	1.7	1.6
burkei	2.7	1.7	1.5	1.0
coloradensis	2.3	—	1.9	—
costatus	1.6	1.2	1.1	1.4
dubius	2.5	1.6	2.8	2.8
= *piperi*	3.3	1.6	1.0	—
= *fraseri*	2.0	1.7	1.9	1.6
deodarae	1.9	1.5	1.6	1.3
fasciatus	1.3	1.6	1.6	0.9
nemorensis	1.4	1.5	1.5	2.8
puncticollis	2.5	—	3.5	—
radiatae	1.0	1.3	1.4	1.1
rotundatus	2.4	—	1.4	—
= *nigrae*	2.5	—	1.9	1.5
schwarzi	1.7	1.6	1.6	1.3
= *yosemite*	1.8	1.7	1.2	1.3
similis	2.1	1.4	1.4	1.1
= *utahensis*	1.4	—	2.0	—
strobi	1.5	1.6	1.7	1.8
= *sitchensis*	1.5	1.6	1.2	1.2
= *englemanni*	1.5	1.6	1.1	1.5
terminalis	1.7	1.5	1.5	1.6
webbi	1.7	1.6	1.3	1.5

for males in 14 of the 20 taxa for which comparisons were possible. Among the remaining seven taxa, widths were equal in *deodarae* and smaller in males of *affinis, fraseri, fasciatus, schwarzi, strobi, and terminalis.* The rough dimensions of the pars stridens, as presented in Table 1, gave little insight into associations between the taxa, and probably vary with body size of the specimen. However, proportions of length in relation to width (L/W) of the pars stridens appeared to be less influenced by body size, and possibly more useful taxonomically (Table 2). The range in L/W ratio was noticeably less for males (1.2–2.1 mm) than for females (1.0–3.3 mm). The high and low extremes in L/W ratio for females occurred in *piperi* and *radiatae,* respectively, and for males, in *P. currieri* and *P. costatus,* respectively. Among the four above extremes, the first three appeared to be exaggerated in comparison with data for all taxa as a whole. The low extreme for males, *costatus,* (1.2 mm), appeared to be more in line with the data. The pars stridens L/W ratios indicated similarities among some of the *Pissodes* synonyms, such as *approximatus* + *canadensis, rotundatus* + *nigrae, schwarzi* + *yosemite,* and *strobi* + *sitchensis* + *englemanni.* Dissimilarities were exhibited in *dubius* + *piperi* + *fraseri,* in *similis* + *utahensis,* and in *affinis* + *curriei.* The data suggest the need for additional work on some of the synonym associations. Ratios of L/W for zone B were more erratic than for zone A, and appeared to have less indicative value for taxonomic purposes. In females, zone B L/W ratios ranged from 1.0 mm in *dubius* = *piperi* to 3.5 in *puncticollis*, whereas in males zone B ratios ranged from 0.9 mm (*fasciatus*) to 2.8 mm *dubius* and *nemorensis*).

Striations per 0.024 mm interval are shown in Tables 3 and 4, for females and males respectively, of all *Pissodes* taxa examined in the study. Striations were more numerous and more concentrated per interval in females than in males of all taxa examined. Total numbers of striations on the pars stridens ranged from 36 to 106 in females, and from 17 to 55 in males. Notably high total striation counts in females were recorded for *radiatae* and *costatus*. In males, *curriei* had an unusually large number of striations compared to other taxa.

A comparison of total striations for the sexes (male/female ratio) is shown in Table 4. Females generally had twice as many striations as males, except for the male of *curriei* (1.3) and the female of *piperi* (1.5). The possibility exists that the specimens in these 2 taxa are unusual representatives of their groups.

Discernment of patterns of striation concentrations across the pars stridens should be based upon examination of multiple specimens in each taxon, a feature not possible in this study. Therefore, the data herein are intended to provide only a precursory indication. Averaging striations per interval across the entire pars stridens as a unit, we found that means in females were particularly high for *puncticollis* (13.2), followed by *similis*, *coloradensis*, *dubius*, and *utahensis* in descending order. The above taxa exceeded 10 striations per interval. Of the remaining taxa, only one, *schwarzi*, averaged fewer than 6 striations per interval on the total pars stridens.

Striation concentrations on distal, medial, and proximal portions of the pars stridens were compared by segregating striation counts for these regions as shown in Table 5. For the purpose of this comparison, the first and last 3 intervals (0.024 mm each; 0.072 total span) of the pars stridens (proceeding from distal to proximal) for each taxon were considered the distal and proximal edges, respectively. The medial portion for each taxon was defined as the second 3 intervals (intervals 4–6) of the pars stridens, for each taxon. Among females, 6 taxa, *coloradensis*, *costatus*, *dubius*, *puncticollis*, *similis*, and *utahensis* contained more than 30 striations on the distal portion. These are designated "high" in Table 5, indicating a relatively high concentration of striations. Females in the remaining taxa had between 20 and 30 striations (med), except for *canadensis* and *schwarzi*, each of which had 18 striations (low). In the 4–6 interval span (medial portion) an increase over the distal span was observed in *affinis*, *fraseri*, *radiatae*, *yosemite*, and *similis*. Equal numbers were observed in *approximatus*, *canadensis*, *costatus*, *fasciatus*, *rotundatus*, *strobi*, and *webbi*. A decrease in numbers was observed in the remaining taxa. Between the medial and proximal portions in females, decreases in the numbers of striations occurred in each taxon except *approximatus* = *canadensis*. In some of the taxa, intervals 4–6 constituted the medial extent of the pars stridens.

On the distal portion of the pars stridens, males of *curriei*, *fasciatus*, *similis*, and *terminalis* had high relative numbers of striations (10 or more). Accordingly, *affinis*, *fraseri*, *nemorensis*, *radiatae*, and *englemanni* had intermediate numbers (8–9 striations). The remaining taxa were considered low. In all males compared, striations per portion of pars stridens decreased from distal to medial. However,

Table 3. Striation spacing across the pars stridens in female *Pissodes*, left elytron.

	Interval across par stridens (.024 mm) from distal to medial margin																
	Number of striations															Aver-age/inter-val	
Pissodes spp.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		Total
affinis	8	8	7	8	8	9	7	6	5	7	5	6	—	—	—	7.0	84
(= *curriei*)	10	8	8	8	7	7	6	7	7	5	—					7.3	73
approximatus	6	6	8	6	8	6	7	6	6	7	6	5	5	—		6.3	82
(= *canadensis*)	5	6	7	6	6	6	6	8	7	6	—					6.3	63
burkei	10	9	9	8	7	6	4	1	—							6.7	54
coloradensis	11	12	13	13	7	6	—									10.3	62
costatus	11	11	11	11	11	11	11	8	8	2	—					9.5	95
dubius	11	11	11	11	7	—										10.2	51
(= *piperi*)	7	8	7	6	4	4	—									6.0	36
(= *fraseri*)	7	6	7	7	7	9	7	6	5	5	3	—				6.3	69
deodrae	10	7	7	6	7	7	7	7	6	7	5	—				6.9	76
fasciatus	8	8	8	9	9	6	6	6	5	4	—					6.9	69
nemorensis	9	8	8	8	8	7	7	7	7	6	—					7.5	75
puncticollis	12	16	15	12	11	—										13.2	66
radiatae	6	6	8	8	10	10	11	10	9	8	7	6	4	3	—	7.6	106
rotundatus	9	10	9	9	10	9	6	5	—							8.4	67
(=*nigrae*)	8	10	11	11	9	6	—									9.2	55
schwarzi	6	6	6	6	6	5	7	5	3	3	—					5.3	53
(= *yosemite*)	6	8	7	7	8	7	8	7	7	5	4	—				6.7	74
similis	10	12	13	12	13	11	5	—								10.8	76
(= *utahensis*)	11	13	12	11	11	3	—									10.1	61
strobi[1]	7.5	7.5	8.0	7.8	7.9	7.5	7.0	7.1	6.4	4.7	2.5	—				6.7	74
(= *sitchensis*)	8	9	10	8	8	7	7	6	3	—						7.3	66
(= *englemanni*)	7	9	9	8	7	6	6	6	6	3	—					6.7	67
terminalis	8	8	7	7	8	7	8	6	3	—						6.9	62
webbi	9	9	8	9	8	9	8	7	9	8	6	—				8.2	90

[1] Averages from 15 randomly selected specimens.

Table 4. Striations/unit area (.024 mm) across pars stridens in male *Pissodes*, expressed in actual numbers of striations (striae).

Pissodes spp.	Number of striations																Average interval	Total	Ratio of total ♀/♂
	Interval across pars stridens (.024 mm each), from distal to medial margin																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
affinis	4	2	2	2	2	1	2	2	1	2	—						2.0	20	4.2
(= *curriei*)	9	8	7	6	5	4	2	2	1	1	2	1	2	1	2	2	3.4	55	1.3
approximatus	3	2	2	2	1	1	2	1	1	2	1	3	—				1.7	21	3.9
(= *canadensis*)	3	2	2	1	2	1	1	2	1	2	2	2	2	—			1.8	23	2.7
burkei	4	2	1	2	1	2	1	2	1	2	2	2					1.8	22	2.4
coloradensis	no male specimen																—	—	—
costatus	2	2	2	2	2	1	1	1	1	1	1	1	2	1	2	—	1.5	22	4.3
dubius	3	2	2	1	2	2	1	2	1	2	2	2	2	—			1.8	24	2.1
(= *piperi*)	3	2	2	1	1	1	1	1	1	1	1	2	1	2	2	2	1.5	24	1.5
(= *fraseri*)	3	2	3	2	2	2	2	2	2	1	—						2.1	21	3.3
deodarae	3	2	2	2	2	2	1	2	2	—							2.0	18	4.2
fasciatus	4	4	3	3	3	3	3	3	3	3	—						3.2	32	2.1
nemorensis	3	2	3	2	1	1	2	1	1	1	—						1.7	17	4.4
puncticollis	no male specimen																—	—	—
radiatae	3	3	3	2	1	1	1	1	1	1	1	1	1	2	1	—	1.5	23	4.6
rotundatus	no male specimen																—	—	—
(= *nigrae*)	no male specimen																—	—	—
schwarzi	3	2	2	2	2	1	2	1	2	3	—						2.0	20	2.6
(= *yosemite*)	2	2	2	1	1	1	1	1	1	1	1	1	2	1	3	4	1.6	25	2.9
similis	6	4	3	4	3	2	4	—									3.7	26	2.9
(= *utahensis*	no male specimen																—	—	—
strobi[1]	2.8	2.3	2.0	1.9	1.7	1.7	1.6	1.9	2.1	2.8	3.0						2.2	24	3.1
(= *sitchensis*)	3	2	2	2	2	1	2	2	2	2	—						2.2	20	3.3
(= *englemanni*)	4	2	2	1	2	2	1	2	2	4	—						2.2	22	3.0
terminalis	5	2	3	2	2	2	1	2	2	2	2	5	—				2.5	30	2.1
webbi	3	2	1	2	1	1	2	2	2	3	1	—					1.8	20	4.5

[1] Averages from 15 randomly selected specimens.

Table 5. Comparison of striation concentrations on approximate distal, medial, and proximal portions of the pars stridens in North American *Pissodes*.

	Striations[1]											
	Females						Males					
	Portion of pars stridens						Portion of pars stridens					
	Distal		Medial		Proximal		Distal		Medial		Proximal	
Pissodes spp.	No.	Ave/ interval	No.	Ave/ interval	No.	Ave/ interval	No.	Ave/ interval	No.	Ave/ interval	No.	Ave/ interval
affinis	23-M	7.6	25	8.3	18	6.0	8-M	2.7	5	1.7	5	1.7
curriei	26-M	8.7	22	7.3	19	6.3	24-H	8.0	15	5.0	5	1.7
approximatus	20-M	6.7	20	6.7	16	5.3	7-L	2.3	4	1.3	6	2.0
=*canadensis*	18-L	6.0	18	6.0	21	7.0	7-L	2.3	4	1.3	6	2.0
burkei	28-M	9.3	21	7.0	*	2.5	7-L	2.3	5	1.7	6	2.0
coloradensis	36-H	12.0	26	8.7	—	—	—	—	—	—	—	—
costatus	33-H	11.0	33	11.0	18	6.0	6-L	2.0	5	1.7	5	1.7
dubius	33-H	11.0	*	9.0	—	—	7-L	2.3	5	1.7	6	2.0
=*piperi*	22-M	7.3	14	4.7	—	—	7-L	2.3	3	1.0	6	2.0
=*fraseri*	20-M	6.7	23	7.7	13	4.3	8-M	2.7	6	2.0	5	1.7
deodarae	24-M	8.0	20	6.7	18	6.0	7-L	2.3	6	2.0	5	1.7
fasciatus	24-M	8.0	24	8.0	15	5.0	11-H	3.7	9	3.0	9	3.0
nemorensis	25-M	8.3	23	7.7	20	6.7	8-M	2.7	4	1.3	3	1.0
puncticollis	43-H	14.3	*	11.5	—	—	—	—	—	—	—	—
radiatae	20-M	6.7	28	9.3	13	4.3	9-M	3.0	4	1.3	4	1.3
rotundatus	28-M	9.3	28	9.3	*	5.5	—	—	—	—	—	—
=*nigrae*	29-M	9.7	26	8.7	—	—	—	—	—	—	—	—
schwarzi	18-L	6.0	17	5.7	11	3.7	7-L	2.3	5	1.7	6	2.0
=*yosemite*	21-M	7.0	22	7.3	16	5.3	6-L	2.0	3	1.0	8	2.7
similis	35-H	11.7	36	12.0	—	5.0	13-H	4.3	9	3.0	*	4.0
utahensis	36-H	12.0	25	8.3	—	—	—	—	—	—	—	—
strobi	23-M	7.7	23	7.7	14	4.7	7-L	2.3	5	1.7	8	2.3
=*sitchensis*	27-M	9.0	23	7.7	16	5.3	7-L	2.3	5	1.7	6	2.0
=*englemanni*	25-M	8.3	21	7.0	15	5.0	8-M	2.7	5	1.7	8	2.7
terminalis	23-M	7.7	22	7.3	17	5.7	10-H	3.3	6	2.0	9	3.0
webbi	26-M	8.7	26	8.7	23	7.7	6-L	2.0	4	1.3	6	2.0

[1] H, M, L = relatively high, moderate, and low numbers of striations, respectively.

* Pars stridens present through less than 3 intervals (.024 mm)

only 4 taxa, *curriei, fraseri, deodarae,* and *nemorensis,* incurred a decrease between medial and proximal portions. Four taxa, *affinis, costatus, fasciatus,* and *radiatae,* retained equal numbers between medial and proximal portions.

Analysis of measurements on 100 *P. strobi* indicated that a number of body dimensions, including the length and width of the pars stridens, were positively correlated with body length. A comparison of pars stridens dimension in relation to body length in *P. strobi* is provided in Table 6. Increased width and length of the pars stridens accompanied increased total body length of the insects. A Pearson correlation test verified that the trends were significant ($P < .05$). Body length was also significantly correlated with sex in *P. strobi* ($P < .05$) with greater percentages of females than males being more than 6 mm long.

Scarcity of specimens prevented any assessment of size ranges in most of the taxa in this study. However, the data from multiple specimens of *P. strobi* indicated that differences in body size occur, that they relate to sex of adult insects, and that they bear relationship to gross dimensions of the pars stridens. It was

Table 6. Comparison of pars stridens width by overall body length in *Pissodes strobi.*

					Pars stridens (Zone A)							
					Left elytron				Right elytron			
Sex	No.	Body length category	Mean body length (mm)	St. dev.	Mean width (mm)	St. dev.	Mean length (mm)	St. dev.	Mean width (mm)	St. dev.	Mean length (mm)	St. dev.
Male	12	small (5 mm)	4.49	.39	.21	.04	.33	.07	.22	.03	.32	.05
	24	medium (5–6 mm)	5.29	.20	.25	.03	.37	.06	.26	.02	.38	.06
	7	large (6 mm)	6.32	.18	.27	.04	.46	.07	.30	.04	.42	.08
Female	9	small (5 mm)	4.78	.15	.19	.03	.34	.07	.23	.06	.32	.05
	13	medium (5–6 mm)	5.45	.35	.24	.02	.37	.05	.25	.03	.37	.06
	33	large (6 mm)	6.35	.53	.24	.02	.38	.05	.26	.03	.37	.06

deemed unlikely that within-species variation based on body size affects the accoustical signature of the taxon.

ACKNOWLEDGMENTS

We are indebted to the personnel of the Systematic Entomology Laboratory, USDA, and the facilities and collection of the U.S. National Museum of Natural History. Special thanks are extended to Rose Ella Warner for her cooperation and for many helpful comments.

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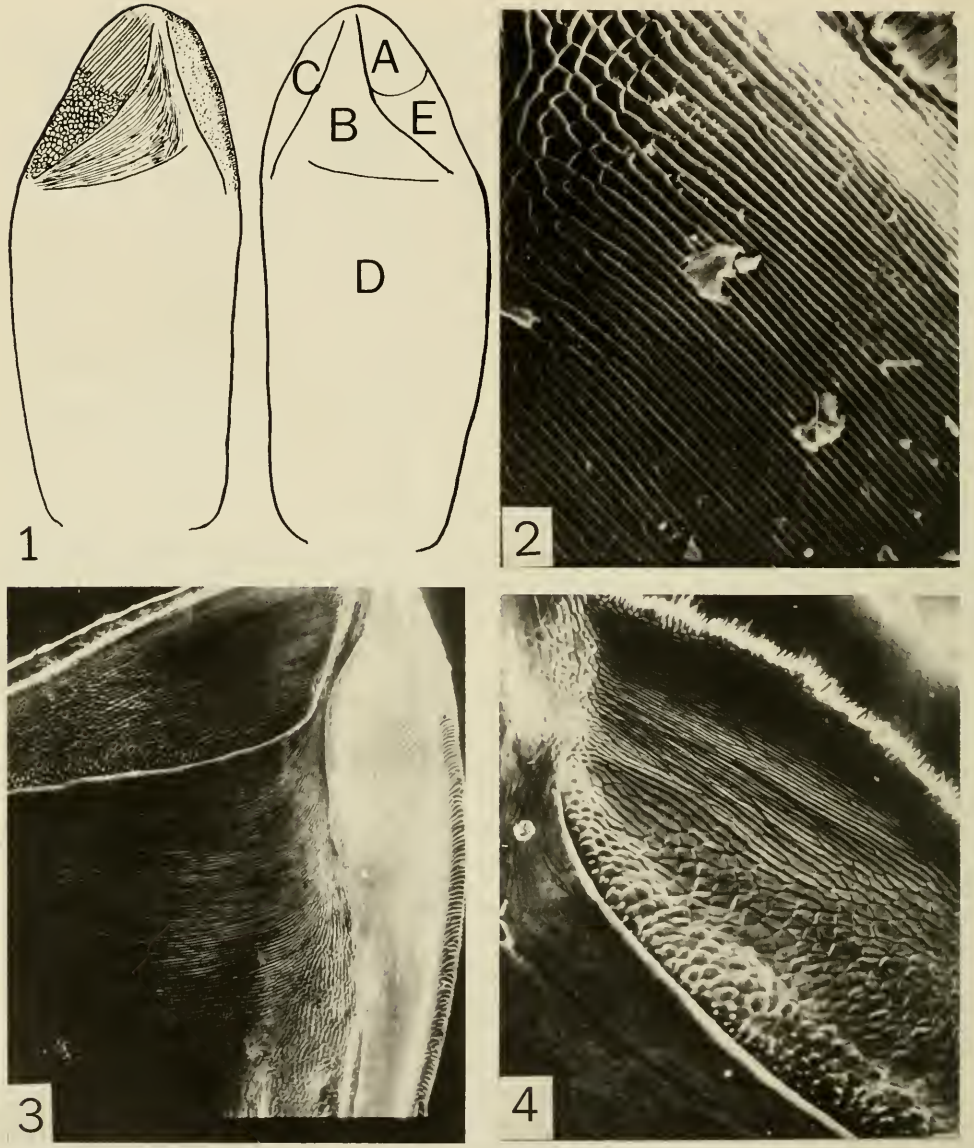

Figs. 1–4. 1, Diagrammatic view of general elytral zones, showing regions of ridges on left elytron and of sculpturing on right elytron (Zone A is the pars stridens; zone C is region of overlap); 2, Electron micrograph of a portion of the pars stridens and adjacent zone E of a female *P. strobi* showing ridge structure, 2000×; 3, Electron micrograph of pars stridens and adjacent zones of a female *P. curreyi*, 100×; 4, Electron micrograph of pars stridens and adjacent zone on a female *P. burkeyi*, 200×.

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NOTE

Records of *Diradius vandykei* (Ross) in North Carolina and Virginia (Embiidina: Teratembiidae)[1]

E. S. Ross (1944. Proc. U.S. Natl. Mus. 94: 401–504) described *Diradius vandykei* (Ross) from Florida material, and listed additional records from Louisiana, Mississippi, and South Carolina. Later, Kethley, Sherberger, and Sikora (1971. J. Ga. Entomol. Soc. 6: 190–192), recorded the species from Georgia. The records below confirm Ross' (1944) prediction that this arboreal webspinner may occur "up the Atlantic Coastal Plain probably as far as southeastern Virginia."

In North Carolina *D. vandykei* was found throughout the Coastal Plain where sought (Fig. 1). Many records are from the trunks of isolated, lichen-encrusted hardwoods, especially oaks, and from pines. Depending on the light, the insects' telltale webs may resemble the trail of a slug or may be smoke-like in appearance. A fine artist's brush and AGA killing solution are useful for collecting. D. L. Stephan identified the recent material consisting of three winged males (see below) and many females and immatures. The specimens are deposited (as noted in parentheses) in the North Carolina Department of Agriculture (NCDA), Raleigh; the North Carolina State University Insect Collection (NCSU), Raleigh; and the United States National Museum of Natural History (USNM), Washington, D.C. We are grateful to K. R. Ahlstrom, J. F. Cornell, and J. E. Hunter, III, who furnished records, and to the many graduate students who donated specimens to NCSU. We also thank E. S. Ross for helpful suggestions.

NORTH CAROLINA: BLADEN CO., 5.5 km SW of Ammon, Co. Road 1325, on *Quercus laevis* Walter, 19-IX-1981, A. B. Bass, R. W. Etzel, M. K. Hennessey, D. H. Landis, D. M. McCorkle, M. L. Rogerson, C. E. Sorenson—18-IX-1982, L. L. Deitz—Bladen Lakes State Forest, on bark, 19-IX-1981, A. Ben Alya—10 air miles ESE of White Lake, on *Pinus palustris* Miller, 29-V-1982, D. L. Stephan (1 male)—on oak, 15-V-1983, D. L. Stephan (1 male) (all NCSU); BRUNSWICK CO., Smith Island, on oak and pine bark, 23-IX-1981, K. R. Ahlstrom and J. E. Hunter—Southport, Howe Street, Carla's Cafe, on pine, 23-IX-1981, K. R. Ahlstrom, J. E. Hunter (all NCDA); CARTERET CO., Beaufort, on oak, 13-III-1982, M. K. Hennessey—8.1 air mi. E of Cape Carteret, Emerald Isle, on *Q. virginiana* Miller, 13-XI-1982, D. L. Stephan (all NCSU); CRAVEN CO., 7.7 air miles NW of Havelock, off US 70 at jct. Co. Road 1103, on *Q. phellos* L., 17-X-1982, H. H. Neunzig, D. L. Stephan (NCSU); DARE CO., Cape Hatteras, 0.5 air mile ESE of Buxton, on pine, 29-X-1981, 5-V-1982, D. L. Stephan—Roanoke Island, 2.5 air miles NW of Manteo, on pine, 30-X-1981, A. L. Braswell, D. L. Stephan (all NCSU); DUPLIN CO., near Calypso, Virginia-Johnson Farm, ex oak and pine litter, 2-I-1965, J. F. Cornell (det. E. S. Ross; specimens which should be at NCSU cannot be located); EDGECOMBE CO., 0.6 air miles SE of Conetoe, off US 64, on *Liquidambar styraciflua* L., 12-IX-1982, D. L. Stephan—3.3 air miles W of

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[1] Paper No. 8603 of the Journal Series of the North Carolina Agricultural Research Service, Raleigh, NC 27650.

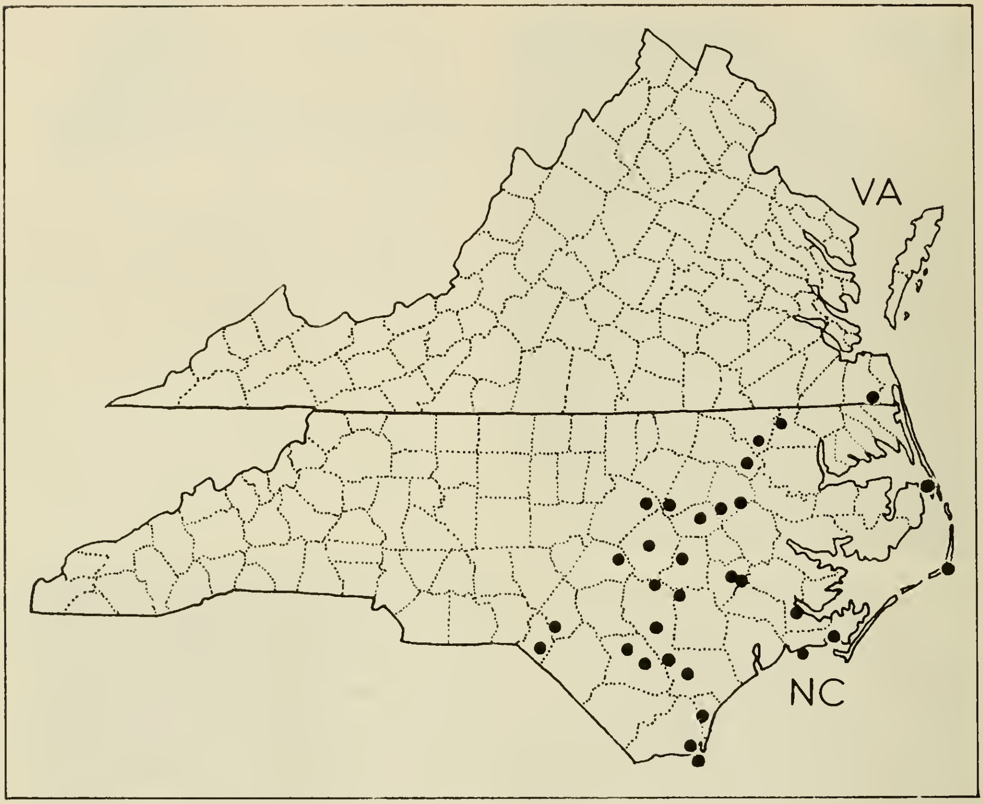

Fig. 1. Known distribution of *Diradius vandykei* in Virginia and North Carolina.

Pinetops, off NC 42 at jct. Co. Road 1109, on *Q. falcata* Michaux and *Q. stellata* Wang., 12-IX-1982, D. L. Stephen (all NCSU); HALIFAX CO., Scotland Neck, on *Acer rubrum* L., 8-V-1983, M. K. Hennessey, P. T. Hertl, D. L. Stephan (NCSU); HARNETT CO., Coats, jct. Co. Roads 1705 & 1558, on oak, 19-XI-1981, J. E. Hunter (NCDA); HERTFORD CO., Murfreesboro, on *Melia azedarach* L., 8-V-1983, M. K. Hennessey, D. L. Stephan (NCSU); HOKE CO., 6 miles SW of Raeford, jct. US 401 & Co. Road 1201, on tree trunk, 29-VIII-1981, R. W. Etzel (NCSU); JOHNSTON CO., Smithfield, Holts Lake, US 301, on oak, 24-IX-1981, K. R. Ahlstrom, J. E. Hunter (NCDA); JONES CO., 12.9 air miles NW of Trenton, off US 70, on *Q. phellos* L., 17-X-1982, H. H. Neunzig, D. L. Stephan (NCSU); LENOIR CO., 3.5 air miles SE of Kinston, off US 70 at Southwest Creek, on *Q. nigra* L., 17-X-1982, H. H. Neunzig, D. L. Stephan (NCSU); NASH CO., 1.5 air miles WNW of Bailey, off US 264, on *Juglans nigra* L. and *Q. stellata* Wang., 10-IX-1982, D. L. Stephan (NCSU); NEW HANOVER CO., Wilmington, Greenfield Park, west parking area, on oak, 24-IX-1981, K. R. Ahlstrom, J. E. Hunter (NCDA)—Wilmington, on *Taxodium distichum* (L.), 4-IX-1982, M. K. Hennessey (NCSU); NORTHAMPTON CO., Rich Square, on *Ulmus* sp., 8-V-1983, M. K. Hennessey, D. L. Stephan (NCSU); PENDER CO., Ward's Corner, US 421, 0.8 miles N of NC 53, on oak, 24-IX-1981, K. R. Ahlstrom, J.

E. Hunter (NCDA); SAMPSON CO., 11 air miles SSE of Clinton, US 421, rest area, on oak, 24-IX-1981, K. R. Ahlstrom, J. E. Hunter—Newton's Crossroads, US 421, 0.3 miles S of Co. Road 1114, Roseville Baptist Church, on oak, 24-IX-1981, K. R. Ahlstrom, J. E. Hunter—Newton Grove, Clinton, & Sunset Streets, on oak, 24-IX-1981, K. R. Ahlstrom, J. E. Hunter (all NCDA); SCOTLAND CO., East Laurinburg, McKay & Eighth Streets, on *Q. nigra* L., 23-VII-1981, J. Mintz, C. J. Cameron—26-VII-1981, L. L. Deitz, M. K. Hennessey—15-VIII-1981, N. A. Leidy, S. P. Whitney—29-VIII-1981, R. W. Etzel—7-IX-1981, K. H. Kendall, M. E. McGiffen, O. C. Umeozor—26-IX-1981, J. C. Killian (1 male) (all NCSU); WAKE CO., 2.5 air miles NW of Wendell, off US 64 at Buffalo Creek, on *Liriodendron tulipifera* L., *Q. alba* L., *Q. falcata* Michaux, and *Q. stellata* Wang., 10-IX-1982, D. L. Stephan—4.6 air miles NNW of Zebulon, off Co. Road 2308, Hopkins community, on *Q. stellata* Wang., 25-XI-1982, D. L. Stephan (all NCSU); WAYNE CO., 2.3 air miles NW of Goldsboro, off US 70, on *Q. alba* L. and *Q.* sp. prob. *velutina* Lam., 19-IX-1982, H. H. Neunzig, D. L. Stephan (NCSU); WILSON CO., 1.7 air miles NE of Wilson, off NC 42 at jct. Co. Road 1327, on *Q. alba* L., *Q. phellos* L., and *Ulmus* sp., 12-IX-1982, D. L. Stephan (NCSU).

VIRGINIA: NORFOLK CO., Northwest, Ballahack Road, 1 mile W of US 168, Northwest Baptist Church, on oak, 7-VIII-1982, L. L. Deitz, M. K. Hennessey (NCSU, USNM).

Lewis L. Deitz and David L. Stephan, *Department of Entomology, North Carolina State University, Raleigh, North Carolina 27650.*

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NOTE

Lectotype designation for *Tabanus vicarius* Walker and comments on *Tabanus simulans* Walker (Diptera: Tabanidae)[1]

In 1981, I had the opportunity to examine the types of species in the British Museum (Natural History) related to *Tabanus nigrovittatus* Macquart and *Tabanus quinquevittatus* Wiedemann.

Walker (1848. List of specimens of Dipterous Insects in the Collection of the British Museum, Part I, p. 187) described *Tabanus vicarius* Walker from 3 syntype females from Honduras (a), Massachusetts (b) and North America (c). Only 2 specimens labelled as types were found (b and c). Of these, the specimen labelled "N. America ex coll. Children 40.4.3.924" agrees best with Walker's original description, particularly in the details of vestiture of the head and thorax, and

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[1] Scientific Contribution No. 1256 from the New Hampshire Agricultural Experiment Station.

wing coloration. I am hereby designating this female specimen as the lectotype of *Tabanus vicarius* Walker. This specimen is synonymous with *Tabanus quinquevittatus* Wiedemann.

Osten Sacken (1876. Mem. Boston Soc. Nat. Hist. Vol. II, Part IV, No. IV, p. 450) listed *T. vicarius* as a synonym of *Tabanus costalis* Wiedemann (= *T. quinquevittatus*) and it was so listed by Hine (1903. Ohio State Acad. Sci. Special Papers No. 5:25) and Kertesz (1908. Catalogus Dipterorum. Vol. III, Mus. Nat. Hung., p. 292) in subsequent catalogs. Philip (1947. Amer. Midl. Nat. 37:313; 1965. U.S. Dept. Agric. Handbook No. 276:335), however, incorrectly listed *vicarius* as a synonym of *Tabanus nigrovittatus* Macquart.

The other syntype ♀ labelled "U.S.A. Massachusetts, ex coll. Prof. Sheppard 39.10.12.354" does not agree well with Walker's description of *vicarius* and is conspecific with *Tabanus similis* Macquart.

Tabanus simulans Walker was described from a single female from Nova Scotia. Osten Sacken (1876. Mem. Boston Soc. Nat. Hist. Vol. II, Part IV, No. IV, p. 448) synonymized it with *Tabanus lineola* Fabricius. This synonymy was followed by Hine (1903. Ohio State Acad. Sci. Special Papers No. 5:26) and Kertesz (1908. Catalogus Dipterorum, Vol. III, Mus. Nat. Hung., p. 279). Philip (1947. Amer. Midl. Nat. 37:311; 1965. U.S. Dept. Agric. Handbook No. 276:335) synonymized it with *T. nigrovittatus* where it has since remained.

Stone (1938. U.S. Dept. Agric. Misc. Pub. No. 305:121), in his discussion of *T. nigrovittatus,* stated that Hine recognized *Tabanus conterminus* Walker as a valid species distinct from *nigrovittatus* by its greater length, grayer mesonotum not tinged by yellow and a greater extension of the large eye facets of the male. Stone, however, believed *conterminus* and *simulans* to be conspecific. Stone did not see the types of *simulans* or *conterminus* but examined specimens compared with the types by Hine. He concluded there was too much variation within *nigrovittatus* to separate either *conterminus* or *simulans* from it.

Pechuman (1981. Search:Agriculture No. 18:31) stated that "a larger form of *nigrovittatus,* with a grayer mesonotum" was *T. simulans (conterminus)* but because of intergrades with *nigrovittatus,* it was not usually considered distinct. Since Pechuman did not examine the types of either *simulans* or *conterminus,* his statement probably is based on Stone's interpretation of Hine's notes.

Recently, several authors have accumulated electrophoretic (Jacobson et al., 1981. Ann. Entomol. Soc. Amer. 74: 602–605) and behavioral (Graham and Stoffolano, 1983. Ann. Entomol. Soc. Amer. 76: 699–702; 703–706) data strongly suggesting that there are 2 distinct species presently called *T. nigrovittatus.* One of these species (Group II of Jacobson et al.) is somewhat larger than the other but there is some overlap in size. Otherwise, these entities are considered to be morphologically indistinguishable.

Graham and Stoffolano have used the name *simulans* for larger flies depositing tan/shingled egg masses and *nigrovittatus* for smaller flies depositing gray/tiered egg masses. Use of the name *simulans* for the larger flies is apparently based on statements by Stone and Pechuman mentioned above, but since flies considered to be *simulans* have not been compared with the types of either *simulans* or *conterminus,* and because size data alone are not sufficient to separate the entities in question, use of the name *simulans* at this time is inadvisable.

In 1981, I examined the holotype of *T. simulans* and the syntypes of *T. con-*

terminus in the BM (NH). Although they are superficially similar, it is by no means clear that they are conspecific, as stated by Stone. I also examined large females (> 14 mm) of *T. nigrovittatus* from Wellfleet, Massachusetts, all of which should be what Graham and Stoffolano call *simulans.* Although they agreed in some respects with the *simulans* holotype, there were differences in the wing coloration, vestiture of the head and thorax, shape of the third antennal segment and palpi, and in the vestiture of the abdomen.

Because specimens in the *T. nigrovittatus* group exhibit considerable variation in color, size and other characteristics, I believe it is premature to conclude that *simulans* and *nigrovittatus* are morphologically indistinguishable or to use the name *simulans* for an entity presumably distinct from *nigrovittatus,* based on behavioral and physiological studies, until purported *simulans* from these studies can be critically compared with the types of *conterminus* and *simulans.* I suggest that if the name *simulans* is to be used in biological studies, it be qualified until further work on the type material is completed.

I also attempted to compare the type specimen of *T. nigrovittatus* in the BM (NH) with *conterminus* and *simulans,* however the specimen labelled as the type is not conspecific with what is called *nigrovittatus* in North America. It appears to be a Neotropical species possibly related to *Tabanus trivittatus* Fabricius, and bears a Panama label. Philip (1947. Amer. Midl. Nat. 37:311) refers to this specimen as a cotype, but all other authors who have discussed it, including Macquart in his original description, refer only to one female. If only a single type specimen for *nigrovittatus* exists and if it is correctly labelled, then *nigrovittatus* is not the correct name for the common saltmarsh "greenhead" horse fly. This will be investigated further when type material is re-examined, and in consultation with interested specialists.

John F. Burger, *Department of Entomology, University of New Hampshire, Durham, New Hampshire 03824.*

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86(1), 1984, p. 244

BOOK REVIEW

New Zealand Butterflies, Identification and Natural History. By G. W. Gibbs. Collins, Auckland. 207 pp., 197 color plates, 16 SEMs, 51 figures, 1980. Cost: $45.00.

The butterfly fauna of New Zealand is relatively depauperate (23 species including introductions and casual migrants), so G. W. Gibbs has stressed the biology and biogeographical affinities of New Zealand's species. The result is excellent. For resident species, Gibbs illustrates their life stages, habitats, and parasitoids with superb color photographs, most from nature. The book is liberally sprinkled with SEMs (photographs taken with a scanning electron microscope) of immature and adult structures, the first time I have seen SEMs in a popular book on butterflies. Gibbs knows the butterfly biology literature worldwide, and uses it masterfully to discuss his handful of species. In an attempt to "explain" its depaupaerate fauna, the first two chapters deal with the geological and climatological history of New Zealand, the potential origin of its species by dipsersal, and the extinction of species over evolutionary time.

There are a few errors in the book, most involving the structures which define butterfly families. Gibbs writes that the double tarsal claws of Pieridae distinguish them from Lycaenidae, but many lycaenids, particularly aphnaeines, have "double tarsal claws." The Pieridae are said to be most closely related to the Papilionidae, but many lepidopterists (e.g., Kristensen) would dispute it. Gibbs' concept of Nymphalidae includes all butterflies with non-functional forelegs, but male Riodinidae share this character. Gibbs attributes a single claw to the unsegmented male forestarsus of lycaenids, but such a claw (as defined in books on insect morphology) does not exist. A specialist on butterflies would not find these mistakes surprising. Virtually every recent popular book on butterflies shares some of them.

One need not live or collect in New Zealand to be interested in buying this book. The excellent color photographs of immature stages and parasitoids are alone sufficient for me to recommend it for the bookshelves of lepidopterists everywhere.

Robert K. Robbins, *Entomology, NHB 127, Smithsonian Institution, Washington, D.C. 20560.*

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BOOK REVIEW

The Australian Crickets (Orthoptera: Gryllidae). By Otte, Daniel and Richard D. Alexander. Monograph 22. The Academy of Natural Sciences of Philadelphia. 19th & the Parkway, Philadelphia, Pennsylvania 19103. 477 pp., 357 figures, 1983. Cost: $45.00.

The Orthoptera of Australia have interested specialists of that group for several generations. Y. Sjostedt's revision of the Australian grasshoppers (K. Sven. Vetenskaps Akad. Handl. 15: 1–191. 1935) followed by J. A. G. Rehn's 3-volume revision of the grasshoppers of Australia (CSIRO, 1952, 1953, 1957) attest to the richness and diversity of the Australasian fauna. With N. B. Tindale's "Australasian mole-crickets of the family Gryllotalpidae" (Rec. S. Aust. Mus. 4: 1–42. 1928) and L. Chopard's "Revision of the Australian Grylloidea" (Rec. S. Aust. Mus. 9: 397–564. 1951), in which about 150 species were listed, we did not expect many additions to the cricket fauna for that region. How wrong we were!

By their own admission, Otte and Alexander also had not expected to find more than 50 new species in their field research, which was to have been primarily a study of the singing behavior of Australian crickets. But their research developed into a taxonomic revision of the Grylloidea of Australia, resulting in the addition of 376 new species to the list, including 41 new genera, more than 3 times the number of species previously known from Australia.

Daniel Otte and Richard D. Alexander are well equipped to handle such a monumental task as a faunistic-systematic revision of the crickets of Australia. Alexander is a pioneer in modern cricket taxonomy and one of the first to use pair-formation behavior and calling songs to correctly identify complexes of sibling species. This approach has resulted in a proliferation of identifications of new species in the United States that were previously unrecognized on the basis of morphological differences alone. Otte is one of the world's leading systematists of Orthoptera and has recently published *The Grasshoppers of North America,* vol. 1 (1981).

Between June 1968 and June 1969, Otte and Alexander travelled extensively throughout Australia, covering 46,000 miles and collecting at more than 900 localities. Their collecting methods included visually searching for specimens by raking leaf litter, sweeping vegetation with nets, bending tree limbs and visually examining the branches, laying oatmeal bait trails and checking them repeatedly, and employing light traps. But their greatest contribution to the knowledge of the fauna of the region rests with their primary method of collecting crickets. This method involved listening for the species-specific calling songs of male crickets. Most species of singing crickets have only one kind of calling song, which differs from the calling songs of all other sympatric, synchronic species and thereby uniquely characterizes that species. The method of collecting singing crickets after tape recording their songs facilitates rapid evaluation of the number of species present (or at least sexually active) at any particular site. The association of song with the singer also becomes a valuable tool for the taxonomist. In cases in which one is uncertain of the taxonomic status of two populations which differ in only minor aspects of their morphology, the problem is often resolved quickly when the calling songs are compared.

Most of the monograph deals with the systematics of all Australian species of crickets and includes descriptions of 41 new genera and 376 new species. For each genus either morphological keys or tables are presented to identify species. Wherever possible, the songs are also described. Variation in both morphology and song is chronicled, and habitat or other behavioral data is presented. Distribution maps are available for each species. Very helpful are the 357 figures expertly rendered by Otte, many of which are the first figures to be presented for some previously described species. There are 118 habitus figures of representative species depicting nearly one-fourth of the known species.

Considering the wealth of information available regarding all the species of crickets of Australia, there are few problems involved in this text. The authors could have elaborated more regarding some of the systematic decisions of their classification. For example, in the subfamily Gryllinae, they divide Australian members into 6 tribes and refer the reader to Table 1 for the definition of these tribes. Six characters are used. But except for the number of harp veins (which seems to define the Modicogryllini) and the presence of spines above the spurs on femur III (which separate the Landrevini and Gryllomorphini from the other tribes), the characters in the Table do not adequately define the tribes. Based on the Table alone, *Gymnogryllus* could just as easily be placed in the Gryllini. Another problem is the uneven handling of information. Some of the above tribes, for example, are discussed in detail; others are not even mentioned. The authors do not discuss characteristics of the 2 tribes of Trigonidiinae at all, possibly because all Australian species belong to the Trigonidiini, but this was not made clear in the text.

I had misgivings about the occurrence of several song patterns of some species and hoped to find more explanation or discussion about such intraspecific variation. One example involves *Stenocephalus australicus,* in which differences in song across its range are striking. The lack of morphological differences among cryptic species is not uncommon; in fact, it is the norm. So I would presume several species may be involved. On the other hand, the authors have identified several species with more than one calling song (see *Comidogryllus adina*), a phenomenon unknown until now for crickets (although it occurs frequently among phaneropterine katydids). Identifying several calling songs may have paved the way for research on more elaborate behavioral studies of cricket pair formation.

Another criticism is in the authors' treatment of 2 species of crickets inhabiting ant nests, *Myrmecophilus mjobergi* and *M. longitarsus.* The authors say on pg. 463 that "*mjobergi* seems best considered a synonym of *longitarsus,*" but they fail to follow their conclusion on pp. 30 and 464–5, treating them as separate species.

Strangely, both the strongest and weakest aspects of this otherwise excellent revision are the figures. In reviewing the figures, I counted no less than 75 errors. There are at least 58 omissions, in which figures are not listed in the text. In addition, I counted at least 12 cases in which the text makes an incorrect reference to a figure. Finally, there are several regretable cases in which figures are neither listed in the text nor otherwise identifiable to species (see Figs. 137G, 259Q, 317W, 340N, O, P, Q, R).

It is not clear why the male genitalia of *Buangina bogabilla* should be figured with those of *Birubia* species (Fig. 71) rather than with *Buangina* species (Fig. 75). It appears as Fig. 71E (which incidentally is not listed in the text).

On pg. 175 under *Pteronemobius garrotis,* Fig. 131F is erroneously referred to as Fig. 132F, while 132F refers instead to *P. ornaticeps.* Figures 198K and 199M depict features of *Endacusta angulifrons.* These figures are placed among figures of species of *Tathra.* Presumably the authors believe this species to belong to *Tathra,* but, apparently because it is not an Australian species, they chose not to elaborate on the new combination. No mention of its appears in their table of changes in nomenclature on pg. 30.

Finally, I was hoping for an explanation regarding the unusual labial palps of *Apterogryllus pedestris,* but alas there was none.

Notwithstanding these problems, *The Australian Crickets* is a model for the kind of systematic research needed for the sound-producing Orthoptera. The incorporation of biological information with morphological features that can be used to identify species is valuable to anyone who needs to know the exact nature of cricket species. Otte and Alexander have paved the way for workers who wish now to study behavior, ecology, cytogenetics, population dynamics, and other biological phenomena of Australian crickets.

David A. Nickle, *Systematic Entomology Laboratory, USDA, % National Museum of Natural History, NHB 168, Washington, D.C. 20560.*

NOTICE OF A NEW PUBLICATION

The Holarctic Genera of Mymaridae (Hymenoptera: Chalcidoidea). By Michael E. Schauff, Maryland Center for Systematic Entomology, Department of Entomology, University of Maryland, College Park, Maryland 20742 (present address: Systematic Entomology Laboratory, % National Museum of Natural History, NHB 168, Washington, D.C. 20560). Memoirs of the Entomological Society of Washington, Number 12, 67 pp. Cost, $5.00.

Twenty-two valid genera of Mymaridae, all egg parasites, are recognized from the Holarctic Region. Each genus is discussed and generic synonymy, differential diagnosis, summary of phylogeny, distribution, hosts, and other notes are given for each genus. A key to genera and illustrations provide a means for recognition of these genera. An overview of the external morphology of the family is presented. Wagner analysis was conducted using 67 morphological characters in order to determine the phylogenetic relationships of the genera and arrive at a generic classification.

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THE WINTER CRANE FLIES OF THE EASTERN UNITED STATES (DIPTERA: TRICHOCERIDAE)

HARRY D. PRATT AND GEORGE K. PRATT[1]

(HDP) 879 Glen Arden Way NE, Atlanta, Georgia 30306; (GKP) Major, USAF, BSC, Headquarters Air Force Engineering and Services Center, Tyndall AFB, Florida 32403.

Abstract.—Ten species of winter crane flies in the family Trichoceridae are found in the eastern United States: *Diazosma hirtipennis* (Siebke), *Trichocera annulata* Meigen, *T. bimacula* Walker, *T. bituberculata* Alexander, *T. brevicornis* Alexander, *T. fattigiana* Alexander, *T. garretti* Alexander, *T. hiemalis* (De Geer), *T. regelationis* (L.), and *T. salmani* Alexander. Keys to species, diagnoses, notes on biology, distribution, and capture in light, molasses, and Malaise traps, and figures of wings and male and female terminalia are provided.

Winter crane flies of the genus *Trichocera* are often found on warm, sunny afternoons during fall, winter and spring from New England to Florida. Swarms of males are seen dancing in the late afternoon sunlight, sometimes thousands of individuals in hundreds of swarms over many acres of lawns and open woodlands. Biologists have also noticed these coldhardy insects swarming above the snow, or individuals crawling on the snow, when temperatures are between 0°C and 10°C.

In Atlanta, Georgia *Trichocera* were collected most easily about an hour before sundown on warm sunny afternoons with clear skies and little or no wind when temperatures ranged from 7° to 20°C. Little or no activity was observed when temperatures were below 7°C. However, Byers and May (1978) reported collecting *T. bimacula, garretti,* and *salmani* in Kansas when the temperature was about 0°C. Swarms of males were seen in the slanting, late-afternoon sunshine, or individuals were observed in their characteristic "bouncing" flight. In Atlanta, Georgia this time was from 3:30 to 5 PM in November and December and from 5 to 6 PM in March. When temperatures were favorable, males and females were collected by sweeping low vegetation with insect nets at any hour of the daytime and throughout the night in light traps. On cold damp afternoons, with the sun completely hidden by clouds, small swarms of two or three to a dozen or more were sometimes seen late in the afternoon, even in a slight drizzly rain.

In the area from Maryland to Georgia, several species of *Trichocera* were collected in weedy, overgrown areas with a ground cover of Japanese honeysuckle

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[1] The contents of this paper reflect the personal view of the authors and are not to be construed as a statement of official Air Force policy.

(*Lonicera japonicum* Thunberg), ivy (*Hedera helix* L.) and low shrubs such as privet (*Ligustrum japonicum* Thunberg). We found no larvae or pupae, but adults were usually collected near low shrubs which offered shelter from the wind, and near a stream or swampy place, where the larvae might occur on damp, rotting leaves similar to the habitats of European species studied by Dahl (1966, 1969). No substantive contributions have been made on the larval habits of Nearctic trichocerids since that by Alexander (1920).

In eastern United States collecting records indicate that adult emergence in the fall begins as early as September in Vermont, October in the area from Massachusetts to the Carolinas, and November in Georgia. We collected five species of *Trichocera* in Georgia from 1971 to 1983. The first adults are usually on the wing during the first half of November and continue active in December and January. Adults of *T. garretti* were collected in February and March, and a few as late as April 5, 1973. Collecting records suggest that five species have only a single generation each 12-month period in Atlanta, Georgia, since adults were found as noted below:

T. bimacula—November 4 to February 4, with population peaks of 115 on December 15, 1976 and 128 on December 21, 1976.

T. brevicornis—November 7 to February 10, with population peaks of 100 or more on November 22, 1974 and December 23, 1972.

T. fattigiana—November 4 to January 23, with peak populations of 100 or more in November and December.

T. garretti—November 4 to April 5, with peak populations of about 100 males swarming on February 10, 1974.

T. hiemalis—November 8 to January 17, never abundant, with only one or two males a day occasionally from early November to mid-January.

In northern United States and Canada collecting records indicate activity in the fall and spring, which may mean two generations a year, or emergence in the fall and hibernation in the winter with swarming when temperatures are favorable in late afternoon.

Three types of male swarms were observed: (1) widespread random flights of thousands of individuals, over acres of residential property, with individual swarms of several dozen males in dancing columns 1 to 5 m high over open lawns or gardens with no obvious swarm marker in the form of a bush or post, as with *T. brevicornis*; (2) swarming over a swarm marker, as a privet bush or post, with *T. brevicornis, T. bimacula,* and *T. garretti* on November 25, 1971; and (3) swarming under the branches of a hemlock tree (*Tsuga canadensis* Carr.) or a Norway spruce (*Picea abies* L.) with branches one to two meters from the ground.

We have collected males from hundreds of swarms over a 12-year period and collected females in such swarms only occasionally. One pair was collected *in copula* from a swarm of *T. brevicornis* two to three meters high, over an open lawn, on a clear, sunny afternoon at 3:45 PM on December 15, 1974.

All ten species of Trichoceridae included in this paper were collected with insect nets. In addition five species, *T. bimacula, T. brevicornis, T. fattigiana, T. garretti,* and *T. hiemalis,* were collected with New Jersey light traps and molasses baited traps. Both types of collections contained males and females of the first four species and males of *T. hiemalis.*

The molasses traps (Pratt and Pratt, 1980) consisted of a 4-liter plastic container with two sides partially cut away containing bait consisting of one part of molasses and four parts of water. Large collections of *T. bimacula* were made with molasses traps, as 20 females and 95 males on December 15, 1976, and 15 females and 113 males on December 21, 1976. The large number of males in molasses traps suggests that they were seeking sugar somewhat as male mosquitoes seek nectar from flowers (Grimstad and DeFoliart, 1974; Haeger, 1955). In Atlanta in December, frosts had killed the flowers, so the molasses traps were the most readily available source of sugar. These observations are of some interest to students of evolution of the order Diptera as indicating that the primitive adults were sugar feeders. Morphologically, *Trichocera* is close to the base of the evolutionary tree of the order Diptera (Steyskal, 1974) since the adults have ocelli and the wings have 4 branches of radius and 3 branches of media reaching the wing margin, and two anal veins. The male terminalia of many species are very simple, close to those of primitive Mecoptera from which the order Diptera may have evolved (Crampton, 1942).

We have not collected *Trichocera* in Malaise traps, but Henry Knizeski of Mercy College, New York has shown us specimens of several eastern species of *Trichocera* which he collected in New York and Connecticut. W. J. Hanson and co-workers at Utah State University have collected many *Diazosma hirtipennis* in Malaise traps in the summer. This is the only species of winter crane fly active in the summer.

TAXONOMY

Alexander (1919, 1942) published two keys to the Trichoceridae of eastern United States. Since then he described two new species, *T. brevicornis* and *T. fattigiana,* from Georgia (Alexander, 1952) and reported *T. bituberculata* Alexander from Massachusetts and *T. annulata* Meigen from New Jersey (Alexander, 1965, 1967). In addition he noted that *T. saltator* Harris is a European species (Alexander, 1965). Since 1957 Dahl has published many papers on the Trichoceridae. Her publication on the Trichoceridae of Sweden (1966) included good figures and data on *Diazosma hirtipennis, T. annulata, T. hiemalis,* and *T. regelationis.* Her paper on Arctic and Subarctic Trichoceridae (1967) contained the description of *T. alexanderi,* here considered a synonym of *T. garretti.* "*Trichocera saltator*" of Alexander (1942) is reported here as *T. hiemalis* based on identifications made by Dahl. Byers (1976) studied and redescribed the types of *T. bimacula* Walker and *T. gracilis* Walker. In "World Catalogue of the Trichoceridae" Dahl and Alexander (1976) showed that *T. bimacula* Walker (1948) has priority over *T. venosa* Dietz (1921) and *T. fernaldi* Alexander (1927). Byers and May (1978) added to the description of *T. salmani* and figured the male and female based on specimens collected in Kansas.

In "The Crane Flies of California" Alexander (1967) included keys, figures, and data on several species of Trichoceridae that occur in eastern United States. Alexander (1981) wrote a fine summary of the family Trichoceridae in the "Manual of Nearctic Diptera."

Trichocera scutellata Say (1824) from Minnesota and *Trichocera brumalis* Fitch (1847) from New York are unrecognized because their types are lost. They are not treated further here.

Key to Species of Trichoceridae of the Eastern United States

Note: In this key and the following text we follow the terminology of the *Manual of Nearctic Diptera* (McAlpine et al., 1981). This differs from that used by Alexander in his many papers, summarized in his 1967 publication, particularly with regard to details of wing venation and male terminalia. We follow McAlpine in labeling certain structures of the female terminalia as tenth sternite and tergite, although Dahl (1980) published research indicating only nine segments in the abdomen of *Trichocera* larvae, pupae, and adults.

1\. Wing vein A_2 long, subsinuous, not curved evenly into wing margin (Fig. 1); wing veins with long, conspicuous dark setae; tibial spurs absent or poorly developed; ovipositor with cerci short-oval and fleshy (Fig. 26) .... *Diazosma hirtipennis* (Siebke)
– Wing vein A_2 short, evenly curved into wing margin (Figs. 2 and 3); wing veins with short, less conspicuous setae; tibial spurs well developed; ovipositor with downward curved, elongate, sclerotized cerci (Fig. 18) .... Genus *Trichocera* ... 2
2\. Wing with distinct dark spot in cell R behind origin of Rs and a dark cloud over r-m crossvein (Fig. 2) .... *Trichocera bimacula* Walker
– Wing without dark spot in cell R, entirely clear or with a cloud over r-m crossvein (Fig. 3) 3
3\. Abdomen distinctly annulate, tergites obscurely yellowish, their posterior borders brownish .... *Trichocera annulata* Meigen
– Abdomen entirely brownish, rarely with posterior margins of tergites pale 4
4\. Wing with cloud over r-m crossvein (Fig. 3) 5
– Wing clear, sometimes with slight cloud in stigmal area, i.e. cell R_1 .. 6
5\. Wing membrane slightly dusky; male terminalia with bridge complete, gonostylus bearing a conspicuous earlike lobe at basal ⅓ (Fig. 16) .... *Trichocera garretti* Alexander
– Wing membrane clear hyaline; male terminalia with bridge incomplete; gonostylus simple or with slight basal swelling mesally (Fig. 12) .... *Trichocera regelationis* (Linnaeus)
6\. Gonostylus simple, without basal tubercle or lobe (Figs. 9, 11) 7
– Gonostylus with 1 or 2 short tubercles, a lobe, or elongate rod (Figs. 13–17) 8
7\. Sternite 9 without setae in middle (Fig. 9); praescutum grayish, usually with 4 longitudinal dark stripes .... *Trichocera bimacula* Walker
– Sternite 9 with setae all along posterior margin (Fig. 11); praescutum darker gray with 2 to 4 ill-defined dark longitudinal stripes .... *Trichocera brevicornis* Alexander
8\. Gonostylus with an elongate rod, about ⅓ as long as gonostylus; corners of tergite 9 with 2 tufts of long, reddish hairs (Fig. 17) .... *Trichocera salmani* Alexander
– Gonostylus with an earlike lobe, or 1 or 2 short tubercles; (Figs. 13–16); tergite 9 without 2 conspicuous tufts of long reddish hairs 9
9\. Gonostylus with distinct earlike lobe at basal ⅓ (Fig. 16) .... *Trichocera garretti* Alexander
– Gonostylus with 1 or 2 short tubercles on basal ⅓ (Figs. 13–15) 10

10. Gonostylus with a basal tubercle and another at basal ⅓ (Fig. 15) .... *Trichocera bituberculata* Alexander
- Gonostylus with only 1 basal tubercle (Figs. 13–14) 11

11. Gonocoxites joined by a complete bridge; parameres slender, scimitar-shaped; praescutum dark (Fig. 14) .... *Trichocera hiemalis* (DeGeer)
- Gonocoxites with incomplete bridge; parameres markedly angled with slender mesal projections to aedeagus (Fig. 13); praescutum usually with 4 well-defined dark longitudinal stripes ... *Trichocera fattigiana* Alexander

Diazosma hirtipennis (Siebke)
Figs. 1, 4, 8, 25, 26, 27

Trichocera hirtipennis Siebke, 1863: 184. Type from Dovre, Norway, nonexistent in Oslo Zoologisk Museum (*teste* Dahl and Alexander, 1976).

Trichocera (*Diazosma*) *subsinuata* Alexander, 1916: 124. Holotype male from Hall Valley, Platte Cañon, Colo., in NMNH.

Diazosma hirtipennis (Siebke) Edwards, 1928: 35. Dahl and Alexander, 1976: 12, list above synonymy.

Diagnosis.—The largest trichocerid in eastern United States, female 8–9 mm. long, wing 9–11 mm., general coloration brownish; praescutum without stripes. Wing infuscated, all veins with long setae, A_2 long, subsinuous, not curved into wing margin. Palpus with second segment shorter than third and fourth, fourth segment filiform, not constricted in middle as in most species of *Trichocera* (Fig. 4).

Male terminalia (Fig. 8).—Gonostylus simple, gonocoxite with incomplete bridge. Easily distinguished from species of *Trichocera* by sternite 9 which has no setae, and has posterolateral corners rounded, not pointed as in *Trichocera.*

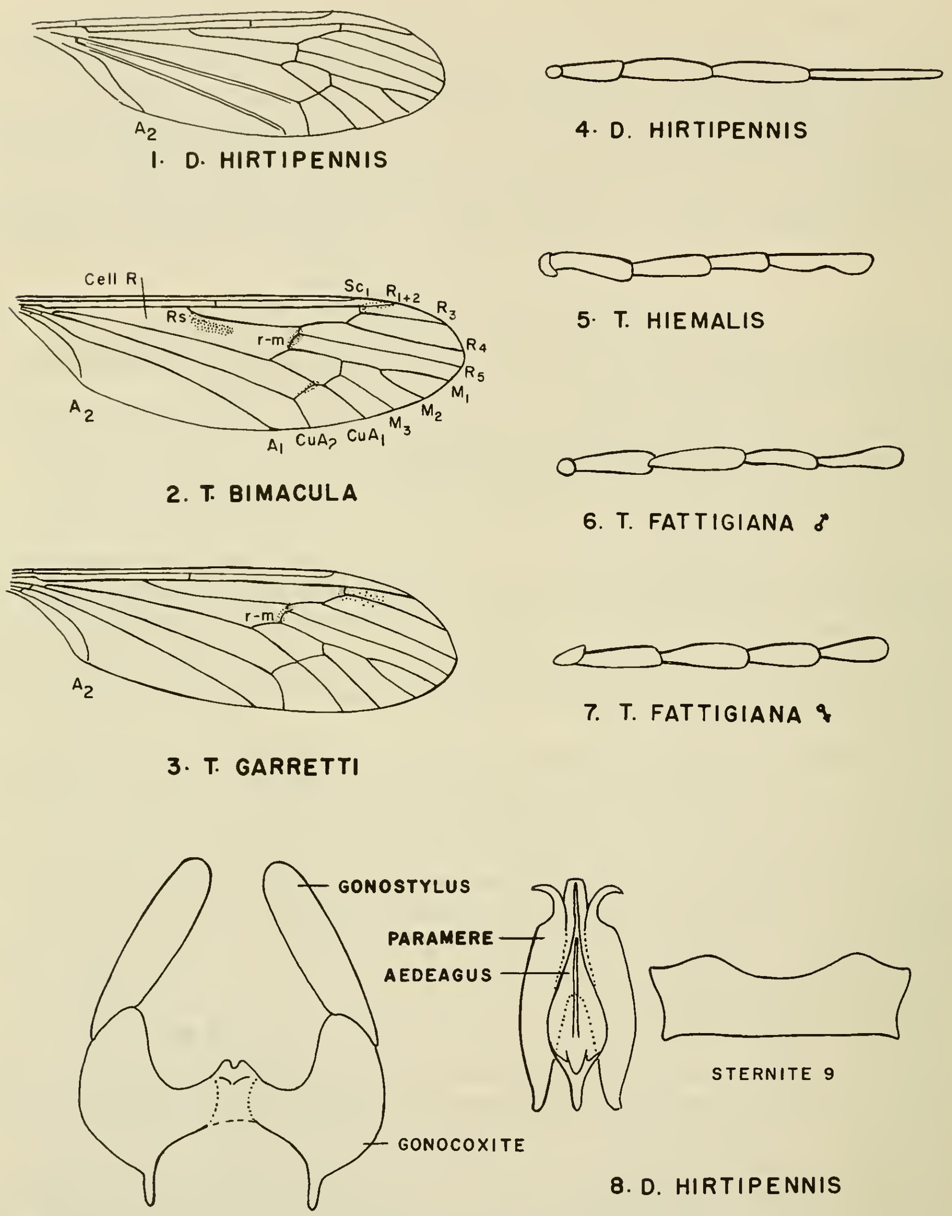
Female terminalia (Figs. 25, 26, 27).—Sternite 8 divided into two triangular plates, very different from apically notched sternite 8 of *Trichocera.* Sternite 9 broadly V- or Y-shaped, with very large foramen. Sternite 10 with 5 or 6 setae. Spermathecae with pigmented, sclerotized part of ducts shorter than diameter of a spermatheca, as in *T. fattigiana* (Fig. 18), but not in other species of *Trichocera* of eastern United States.

Distribution.—1 ♀, 1 ♂, Vermont, Windham Co., Halifax Gorge, June 7 and 8, 1973, G. K. Pratt, sweeping along hillside brook bordered by yew (*Taxus canadensis* Marsh), collected in mid-afternoon. 1 ♀, Vermont, Windham Co., Jacksonville, Laurel Lake, June 19, 1973, H. D. Pratt (PC), resting on side of white-painted house about 7 PM, approximately 15 m from swamps along a lake.

Natural history.—Both Vermont areas have hemlock and spruce trees immediately over the collection sites and have affinities with the Transition-Lower Canadian life zone. Alexander (1976: 13) reported *D. hirtipennis* from California, northern United States, and Canada from June to September. It is the only trichocerid on wing during the summer, all others are collected during the fall, winter, and spring. W. J. Hanson and co-workers at Utah State University collected many *Diazosma* in Utah in Malaise traps during the summer.

Trichocera annulata Meigen
Fig. 10

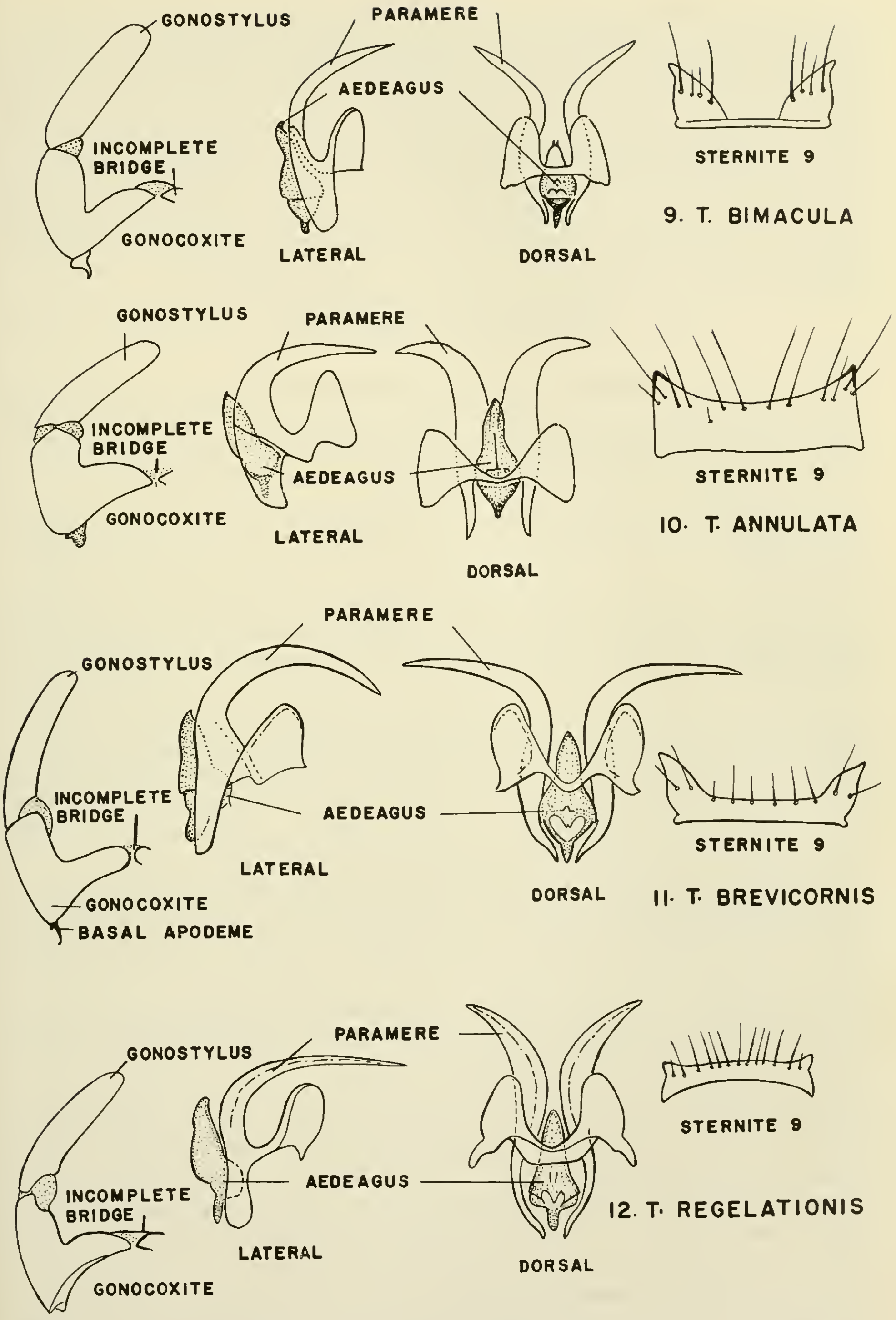
Trichocera annulata Meigen, 1818: 215. Type male from Austria in Museum National d'Histoire Naturelle, Paris, France (Dahl and Alexander, 1976: 15).



Figs. 1–7. 1–3, Wings. 1, *Diazosma hirtipennis.* 2, *Trichocera bimacula.* 3, *Trichocera garretti.* 4–7, Palpi. 4, *Diazosma hirtipennis.* 5, *Trichocera hiemalis.* 6, *Trichocera fattigiana,* male. 7, *Trichocera fattigiana,* female. 8, *Diazosma hirtipennis,* male terminalia.

Diagnosis.—Easily recognized by the annulate abdomen, tergites obscurely yellowish with brownish posterior borders; praescutum brownish with obscure darker central stripes.

Male terminalia (Fig. 10).—Gonostylus simple; gonocoxite with incomplete bridge; sternite 9 with middle portion usually with 4 setae on posterior margin.



Figs. 9–12. Male terminalia, *Trichocera* spp. 9, *T. bimacula.* 10, *T. annulata.* 11, *T. brevicornis.* 12, *T. regelationis.*

Female terminalia.—Similar to *T. brevicornis,* Fig. 21.

Distribution.—A widely distributed European species reported by Dahl and Alexander (1976) from "Western Canada; USA; Europe; western USSR; Asia Minor; Ethiopia; Algeria; south Australia; New Zealand." In North America reported by Alexander (1967) from "Alaska, B.C., Cal., Nfld., N.J. and Oreg." We have seen the following specimens: NEW YORK: 1 ♀, Armonk, 13–24, 1975, H. Knizeski, from Malaise trap (PC). NEW JERSEY: 1 ♂, Hadden Field, Nov. 13, 1963, M. D. Leonard (USNM). VIRGINIA: 30 ♂, 3 ♀, Arlington, Nov. 23–24, 1973, A. B. Gurney, swarming in backyard (PC, USNM); 8 ♂, Arlington, March 18, 1974, A. B. Gurney, swarming in backyard (PC).

Trichocera bimacula Walker
Figs. 1, 9, 20

Trichocera bimacula Walker, 1848: 48. Lectotype male from Nova Scotia, Canada, in British Museum (Nat. Hist.). Examined by Byers (1976) and Dahl and Alexander (1976) who published synonymy below.

Trichocera venosa Dietz, 1921: 236. Holotype female from Hazelton, Pa., No. 6412, in ANSP, examined by HDP in 1975.

Trichocera fernaldi Alexander, 1927: 70. Holotype male from Amherst, Mass., in NMNH.

Diagnosis.—The only eastern species of *Trichocera* with 2 or more spots on wing: a dark spot in cell R behind origin of Rs, varying from a minute dot to a large elongate dark spot, and another cloud over r-m crossvein and sometimes over m-cu crossvein (Fig. 2). A few specimens from swarms of males with spotted wings have no spots on wings, but praescutum and male terminalia of *bimacula* type. Praescutum usually with 4 longitudinal dark stripes, inner pair most distinct, lateral pair often subosolete. Abdomen usually entirely dark in females, sometimes faintly annulate in males (as in type of *bimacula*). In 1975 Dr. Christine Dahl compared the lectotype of *bimacula,* including male terminalia, with males from Georgia and believed they are identical. H. D. Pratt examined the holotype of *T. venosa* in 1975 and believes it is only a well-marked melanistic female of *bimacula.*

Male terminalia (Fig. 9).—Gonostylus simple; gonocoxite with incomplete bridge; sternite 9 with middle of posterior margin deeply and broadly excavated, without setae in middle.

Female terminalia (Fig. 20).—Sternite 9 apodeme with strongly sclerotized bowl-like tip; sternite 9 bilobed at tip; 3 spermathecae with long pigmented part of ducts each longer than diameter of spermatheca.

Distribution.—CANADA, NOVA SCOTIA: 1 ♂, lectotype of *bimacula,* Lt. Redman's Coll., in British Museum (Nat. Hist.) (Byers, 1976); MASSACHUSETTS: Amherst, holotype and 5 paratopotypes, Oct. 22, 1926, C. P. Alexander (USNM); 1 ♀, South Hadley, Nov. 2, 1935, M. Chapman (TC); CONNECTICUT: 1 ♂, Sleeping Giant St. Park, New Haven, Oct. 25, 1975, H. Knizeski (PC): NEW YORK: 5 ♂, Yonkers, Oct. 19, 1975, H. Knizeski (PC); 7 ♂, Ludlowville, Oct. 19, 1973, L. L. Pechuman (PC); NEW JERSEY: 2 ♀, Gloucester Co., Woodbury, Oct. 15, 1976, GKP (PC); PENNSYLVANIA: holotype ♀ of *T. venosa,* Hazelton, Oct. 4, 1920, W. G. Dietz (ANSP); MARYLAND: 1 ♀, Frederick Co., Cunningham Falls, Oct. 13, 1973, GKP (PC); 3 ♀, 7 ♂, Montgomery Co., Tacoma Park, Nov. 24, 1974, GKP (PC); VIRGINIA: 4 ♂, Falls Church, Nov. 2, R. W. Doane (CAS);

NORTH CAROLINA: 3 ♂, 2 ♀, Elkin, Nov. 16, 1975, HDP (PC); 1 ♀, Harmony, Iredell Co., Dec. 22, 1972, GKP & HDP (PC); 7 ♂, Wake Co., Nov. 24, 1951, H & M Townes (PC); SOUTH CAROLINA: 1 ♂, Greenville, Oct. 30, 1932, H. K. Townes (TC); 2 ♀, Greenville, Jan. 17, 1932, H. K. Townes (TC); SOUTH CAROLINA: 1 ♂, Oconee Co., I-85 at Hartwell Reservoir, Dec. 22, 1976, GKP & HDP (PC); GEORGIA: hundreds of ♂ and ♀ collected with net, in light trap or in molasses trap, Atlanta, Nov. 4 to Feb. 4, HDP (CAS, CU, DMNH, KU, PC, TC, NMNH, WSU); many ♂ and ♀, Oconee Co., Nov. 20 to Dec. 7, 1972, GKP (PC); MICHIGAN (Alexander, 1965); OHIO: 2 ♂, 5 ♀, Dayton, Montgomery Co., Nov. 7, 1974, G. Dahlem (DMNH); 2 ♀, Randolph, Montgomery Co., Nov. 8, 1974, G. A. Coovert (DMNH); KANSAS: Lawrence, Douglas Co., Dec. 27, 1976, G. W. Byers & E. M. May (KU, recorded by Byers and May, 1978).

Trichocera bituberculata Alexander
Fig. 15

Trichocera bituberculata Alexander, 1924: 81. Holotype male from Bethel, Alaska, in NMNH. Alexander, 1965: 15. Reported from Alas., and Massachusetts.

Diagnosis.—Wings with pale brownish tinge. Praescutum black, slightly pruinose.

Male terminalia (Fig. 15.)—Gonostylus with basal tubercle about twice as large as second tubercle at about one-fourth length of gonostylus; gonocoxite apparently with incomplete bridge; aedeagus covered hood-like by fused basal portion of parameres; parameres long, slender, pointed; 9th sternite with many setae in two irregular rows.

Distribution.—Known from two ♂: holotype, Bethel, Alaska, September 15, 1917, A. H. Twitchell; metatype ♂, Amherst, Massachusetts 11/12/47, E. Coher, both specimens in Alexander Collection, now in NMNH. Figure 15 made from Massachusetts specimen.

Trichocera brevicornis Alexander
Figs. 11, 21

Trichocera brevicornis Alexander, 1952: 89. Holotype male from Atlanta, Ga. in NMNH.

Diagnosis.—Type slide in the Alexander Collection, now in the U.S. National Museum, with the antennae shorter than the fore femur (hence the name *brevicornis*) is different from hundreds of males from Atlanta, the type locality, with the antennae longer than the fore femur. The males listed below in the distribution section have the antennae longer than the fore femur but otherwise resemble the type of *brevicornis* in having clear wings, simple gonostylus, incomplete bridge between the gonocoxites, and straplike sternite 9 with a few setae along posterior border. There is considerable variation in the proportion of the basal flagellar segments. Further study may determine that more than one species is involved. The female terminalia illustrated in Fig. 21 is based on specimens from Atlanta, Georgia.

Distribution.—VERMONT: 6 ♂, Laurel Lake, Jacksonville, Oct. 1, 1976, HDP (PC); MARYLAND: 6 ♂, Garrett Co., Swallow Falls, Oct. 6, 1973, GKP (PC); NORTH CAROLINA: 1 ♂, Elkin, Nov. 16, 1975, HDP (PC); 1 ♂, Blue Ridge Parkway, Dec. 23, 1972, GKP & HDP (PC); SOUTH CAROLINA: Oconee Co., I-85 at Hartwell Dam, Dec. 22, 1972, GKP & HDP (PC); GEORGIA: holotype ♂, Atlanta, Nov. 25, 1945, P. W. Fattig (USNM); paratopotypes, 5 ♂ and ♀, Atlanta, Nov. 17, 1945–Jan. 7, 1946 (USNM); allotype ♀, Dallas, Dec. 9, 1945, P. W. Fattig (USNM); hundreds of ♂ collected by net, light trap, and molasses trap, Nov. 7–Feb. 10, Atlanta, HDP (PC); 1 ♂, Oconee Co., Ga. 207-US441, Dec. 2, 1972, GKP (PC); 1 ♂, Savannah, Dec. 18, 1981, GKP (PC); FLORIDA: 6 ♀, Gainesville, Nov. 12, 1979–Feb. 19, 1980, R. T. Sullivan (PC); these represent the most southeastern locality for the genus *Trichocera* known to the writers and may be *brevicornis*. KANSAS: 3 ♂, Douglas Co., Lawrence, Oct. 31, 1976, G. W. Byers (PC).

Trichocera fattigiana Alexander
Figs. 6, 7, 13, 18

Trichocera fattigiana Alexander, 1952: 88. Holotype male from Atlanta, Ga., in NMNH.

Diagnosis.—Last segment of palpus (Figs. 6, 7) ovoid, not constricted in middle as in other eastern species of *Trichocera*; praescutum light grayish-brown with 4 well-defined dark longitudinal stripes; wings with faint yellowish tinge.

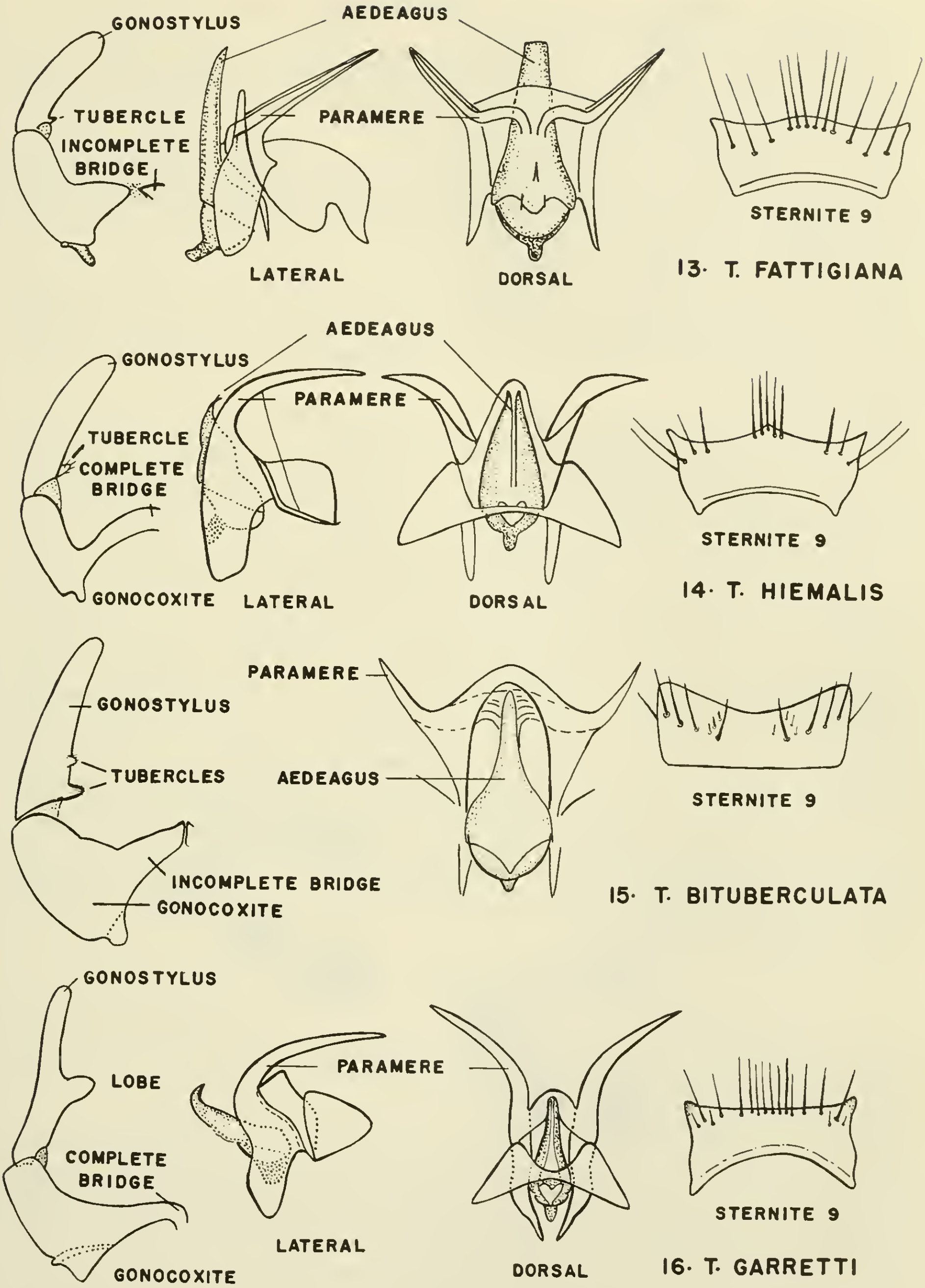
Male terminalia (Fig. 13).—Undissected males do not show the long, scimitar-shaped parameres arching forward toward base of abdomen as in males of other eastern species of *Trichocera*; gonostylus with distinct basal tubercle; gonocoxites with incomplete bridge; aedeagus with blunt tip. Very distinct from all other *Trichocera* in eastern United States in having sharply angled parameres which have a medial extension to aedeagus about one-third from tip; sternite 9 with a group of 6 or more setae in middle of posterior margin.

Female terminalia (Fig. 18).—The only species with sternite 9 rounded posteriorly. It is notched on posterior margin in other species. Sclerotized, pigmented ducts of spermathecae shorter than diameter of a spermatheca, as in *D. hirtipennis* (Fig. 25), whereas the sclerotized, pigmented ducts of spermathecae are longer than diameter of a spermatheca in other eastern species of *Trichocera*.

Distribution.—MARYLAND: 1 ♂, Frederick Co., Cunningham Falls, Oct. 13, 1973, GKP (PC); VIRGINIA: 1 ♂, Falls Church, 2 Nov., R. W. Doane (CAS); NORTH CAROLINA: 8 ♀, Elkin, Nov. 16, 1973, HDP (PC); 1 ♀, Harmony, Dec. 22, 1972, GKP & HDP (PC); GEORGIA; holotype ♂, Dec. 9, 1945, P. W. Fattig (USNM); hundreds of ♂ and ♀, Atlanta, Nov. 4 to Jan 23, most abundant in November and December, collected by net, and at light traps and molasses traps: males swarm in open woods rather than over lawns, HDP (PC); 1 ♂, Clarke Co., Nov. 15, 1972, GKP (PC); 3 ♂, Oconee Co., Athens, Nov. 12 to Dec. 2, 1972, GKP (PC); MISSISSIPPI: several ♂ and ♀, Claiborne Co., Rocky Springs, Nov. 26, 1977, G. W. Byers (PC); ILLINOIS: 1 ♂, University Woods, Urbana, V. E. Shelford (paratype in NMNH); KENTUCKY: 1 ♀, 4 ♂, Louisville, Oct. 30 to Dec. 2, HDP (PC); TENNESSEE: 1 ♂, Knoxville, Dec. 4, 1938, A. C. Cole (paratype in NMNH).

Trichocera garretti Alexander
Figs. 3, 16, 22

Trichocera garretti Alexander, 1927: 71. Holotype male from Marysville, B.C., Canada, in NMNH. Dahl and Alexander, 1976: 14 (Synonymy of *garretti* and *alexanderi*).



Figs. 13–16. Male terminalia, *Trichocera* spp. 13, *T. fattigiana.* 14, *T. hiemalis.* 15, *T. bituberculata.* 16, *T. garretti.*

Trichocera alexanderi Dahl, 1967: 59. Holotype male from Mt. Robson, B.C., Canada, in CNC, Ottawa, Canada.

Diagnosis.—Wings clear or tinged with blackish, usually with cloud over r-m crossvein and sometimes in stigmal area. Praescutum dark, in freshly collected males with two black, longitudinal stripes.

Male terminalia (Fig. 16).—gonostylus with blunt lobe mesally before middle, slender apical half distinctly pilose; gonocoxites joined by complete bridge; sternite 9 straplike with row of setae along posterior margin and a group of 5–8 or more setae in middle of a slightly membranous area.

Female terminalia (Fig. 22).—Ovipositor long and slender; sternite 9 apodeme thickened apically, somewhat hyaline, apex concave; sternite 9 notched apically; sternite 10 with 2 setae; 3 spermathecae with pigmented ducts longer than diameter of spermatheca.

Distribution.—This species has the widest distribution of any *Trichocera* in North America, from Alaska to Georgia. Reported by Alexander (1965, 1967) from British Columbia, California, Oregon, Utah, Washington, eastward to Maine, Massachusetts, and Maryland. Specimens examined: ALASKA: 2 ♀, 4 ♂, mine exit 10 miles W of College, Feb. 18, 1970 (PC, NMNH); VERMONT: 1 ♂, Windham Co., Wilmington, Jan. 27, 1976, GKP (PC); MASSACHUSETTS: 1 ♂, Amherst, Dec. 19, 1933, A. B. Gurney (USNM); NEW YORK: 1 ♂, 1 ♀, Coy Glen, Ithaca, Dec. 29, 1966 (CU); 1 ♂, Coy Glen, Ithaca, Feb. 26, 1958, L. Knutson, hovering over snow (CU); PENNSYLVANIA: 1 ♂, Glenside, March 21, 1908 (NMNH); MARYLAND: 1 ♂, Plummer's Island, Feb. 22, 1915, R. C. Shannon (NMNH); 1 ♂, Plummer's Island, Jan. 24, 1923, R. P. Currie (NMNH); VIRGINIA: 1 ♂, Vienna, Jan. 23, 1938, J. C. Bridwell (NMNH); 2 ♂, Petit Gap, B. R. Parkway, Nov. 25, 1973, HDP (PC); NORTH CAROLINA: 2 ♂, Elkin, Nov. 16, 1975, HDP (PC); OHIO: 4 ♂, Fairfield Co., April 9, 1950, H. V. Weems (NMNH); 2 ♂, Montgomery Co., Randolph, March 21, 1975, G. A. Coovert (DMNH, PC); GEORGIA: Atlanta, 4 ♀, hundreds of ♂, Nov. 4 to April 5, collected with net under hemlocks and Norway spruce, or in light traps or molasses traps.

Trichocera hiemalis (De Geer)
Figs. 14, 21

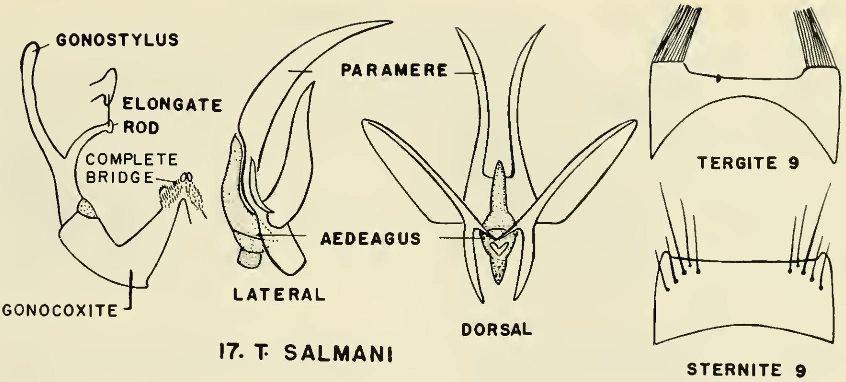
Tipula hiemalis De Geer, 1776, VI: 360. Neotype by Dahl, from Uppsala, Sweden, in Entomological Museum, Lund, Sweden (Dahl, 1966: 101).

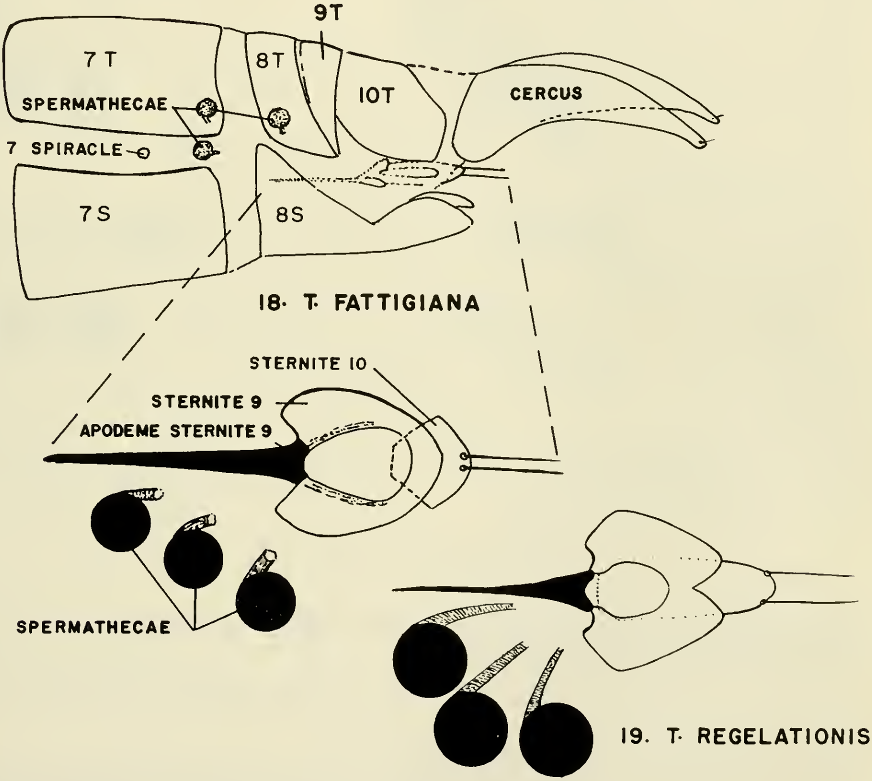
Diagnosis.—Wing clear; first flagellar segment long in both sexes.

Male terminalia (Fig. 14).—Gonostylus with basal tubercle; gonocoxites joined by complete bridge, sometimes with distinct point in middle; sternite 9 with a median point and a group of 2 or 6 or more setae in middle of posterior margin.

Female terminalia (Fig. 23).—Tip of apodeme of sternite 9 distinctly bowl-like; sternite 10 with 2 setae in American specimens but with up to 5 setae in European specimens according to Dahl (1966). Three spermathecae, each with pigmented sclerotized ducts longer than diameter of a spermatheca.

Distribution.—CANADA, QUEBEC: 2 ♂, Quebec, 20 and 26 April, 1941, H. K. Townes (TC); MAINE (Dahl, 1967). VERMONT: 1 ♂, 3 ♀, Laurel Lake, Jacksonville, Oct. 1, 1976, HDP (PC); NORTH CAROLINA: Iredell Co., 2 miles S of Harmony, Dec. 22, 1972, GKP & HDP (PC); GEORGIA: 12 ♂, 10 ♀, Atlanta,





Figs. 17–19. 17, Male terminalia, *Trichocera salmani.* 18, Female terminalia, *Trichocera fattigiana.* 19, Female terminalia, *Trichocera regelationis.*

Nov. 8 to Jan. 17, HDP (PC), collected by net, light trap, and molasses trap; 1 ♂, Oconee Co., Athens, Dec. 2, 1972, GKP (PC); KANSAS: 1 ♂, Douglas Co., 15 miles S of Lawrence, Jan. 12, 1972, G. W. Byers (PC); MICHIGAN: 6 ♂, Kellogg Forest, Kalamazoo Co., April 7, 1977; 1 ♂, Smith Creek, Barry Co., April 8, 1977 (Byers and May, 1978).

Trichocera regelationis (Linnaeus)

Figs. 12, 19

Tipula regelationis Linnaeus, 1758: 587. Type in collection of Linnaean Society of London, in poor condition according to Dahl (1966: 104).

Diagnosis.—Wing clear with light cloud over r-m crossvein; praescutum dark without obvious longitudinal stripes. Females may be confused with *garretti* but can be separated by shape of the apodeme of sternite 9 (compare Figs. 19 and 22). Some males of *bimacula* with a cloud over r-m crossvein but no spot in Cell R might be identified as *regelationis,* but *bimacula* have a different sternite 9, with no setae in middle of posterior margin.

Male terminalia (Fig. 12).—Gonostylus simple; gonocoxites with incomplete bridge; sternite 9 strap-like with a single or partial double row of 8 to 10 setae or more in middle portion.

Female terminalia (Fig. 19).—Apodeme of sternite 9 small and shallowly indented posteriorly; sternite 9 notched at tip; 3 spermathecae, each with pigmented duct longer than diameter of a spermatheca.

Distribution.—Reported by Alexander (1965) from Sweden, Canada, Maine, and Massachusetts. Specimens have been examined with the following data: CANADA, ONTARIO: Shaker Heights, April 5, E. D. McDonald Jr. (CU); VERMONT: 1 ♂, Windham Co., Jacksonville, Jan. 27, 1976, GKP, on snow when temperature was 5°C. after a cold spell when temperature fell to −29°C. (PC); 1 ♀, Windham Co., Jacksonville, Oct. 2, 1976, HDP (PC); MASSACHUSETTS: 1 ♂, S. Hadley, April 5, 1936, M. Chapman, (TC); NEW YORK: 8 ♂ and 2 ♀, Ithaca, March 18-21, April, 1966, L. and J. Schafrik (CU, PC); 2 ♂, Buttermilk Falls, St. Park, Ithaca, Nov. 25, 1967, G. and K. Eickwort (CU); 1 ♀, Ithaca, April 29, 1936, H. K. Townes (TC); 1 ♂, Bridgeport, Nov. 14, 1937, H. and M. Townes (TC); 6 ♂, Ludlowville, Jan 2, 1967, L. L. Pechuman; NORTH CAROLINA: 1 ♂, Blue Ridge Parkway, Dec. 23, 1972, GKP (PC).

Trichocera salmani Alexander

Figs. 17, 24

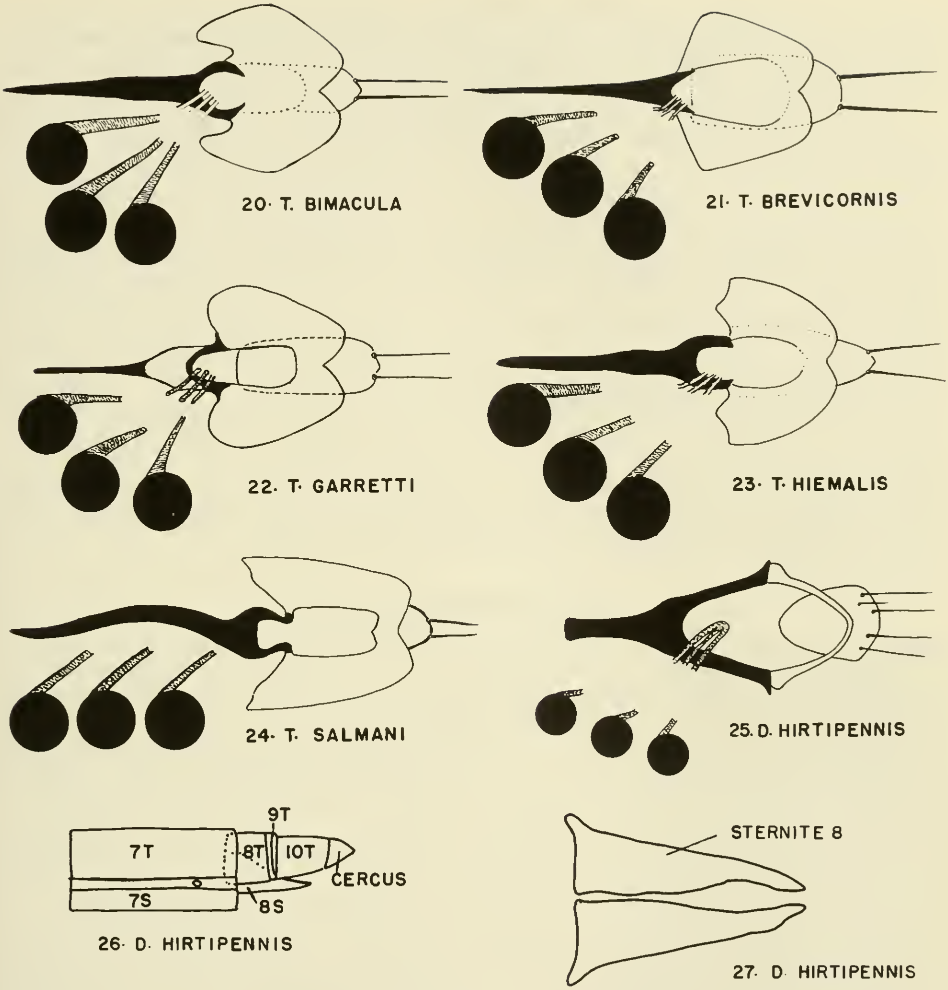
Trichocera salmani Alexander, 1927: 72. Holotype male from Amherst, Mass. in USNM. Byers and May, 1978: 31.

Diagnosis.—Apparently a rare and locally distributed species. Males easily distinguished by the gonostylus with elongate rod.

Male terminalia (Fig. 17).—Very distinct from all other species of *Trichocera* in eastern United States in having tergite 9 conspicuously bilobed with two tufts of long reddish setae, and gonostylus with an elongate rod about one-third as long as gonostylus. Gonocoxites connected by complete bridge with two hairy lobes and two plates at point of fusion. Drawing based on one male from type locality, Amherst, Massachusetts, and another from Tacoma Park, Maryland.

Female terminalia (Fig. 24).—One female collected with three males in Douglas Co., KS, by Byers and May (1978). Ovipositor smaller than in other *Trichocera* of eastern United States, with very slightly concave ventral margin. Apodeme of sternite 9 relatively longer than in other Nearctic *Trichocera,* bowl-like apical portion with slightly reflexed tips, not U-shaped as in *bimacula* or *hiemalis.*

Distribution.—MASSACHUSETTS: type ♂ collected inside Fernald Hall, Univ.



Figs. 20–27. 20–24, Female terminalia, *Trichocera* spp. 20, *T. bimacula.* 21, *T. brevicornis.* 22, *T. garretti.* 23, *T. hiemalis.* 24, *T. salmani.* 25–27, *Diazosma hirtipennis.* 25, Female terminalia. 26, Female abdomen. 27, Sternites 8.

of Massachusetts, Amherst, Jan. 22, 1927, K. A. Salman, in NMNH; other ♂ collected behind this building near Colorado blue spruce (*Picea pungens* Engelm.), Nov. 1, 2, 26, 1933, A. B. Gurney (PC, NMNH); MARYLAND: Tacoma Park, 3 ♂, Nov. 19, 1943, H. K. Townes (PC, NMNH); KANSAS: 3 ♂, 1 ♀, Breidenthal Reserve, Baldwin, Douglas Co., Jan. 23, 1977, Byers and May (KU) (Byers and May, 1978). Also reported from Ontario and eastern West Virginia by Alexander (1965).

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We particularly appreciate the assistance of the late C. P. Alexander, Amherst, Massachusetts, Christine Dahl of Lund and Uppsala, Sweden, and G. W. Byers,

Lawrence, Kansas, who contributed specimens, checked identifications, and discussed many problems in the taxonomy of the Trichoceridae. During this study many persons gave, loaned, or exchanged specimens. We greatly appreciate the aid of the persons listed below for all their help. Abbreviations of collections entered in the distributional data section of this paper are: AMNH—American Museum of Natural History, New York (P. W. Wygodinsky); ANSP—Academy of Natural Sciences, Philadelphia (W. W. Moss); CAS—California Academy of Sciences, San Francisco (P. H. Arnaud); CNC—Canadian National Collection, Ottawa (H. J. Teskey); CU—Cornell University, Ithaca, New York (L. L. Pechuman); DMNH—Dayton Museum of Natural History, Dayton, Ohio (G. A. Coovert); EML—Entomological Museum, Zoological Institute, Lund, Sweden (C. Dahl); FSCA—Florida State Collection of Arthropods, Gainesville, Florida (H. V. Weems, Jr.); KU—University of Kansas, Lawrence (G. W. Byers); PC—H. D. and G. K. Pratt, Atlanta, Georgia; TC—H. & M. Townes, Ann Arbor, Michigan; UM—University of Minnesota, St. Paul (P. J. Clausen); NMNH—National Museum of Natural History, Washington, D.C. (A. B. Gurney, G. Steyskal, F. C. Thompson, W. W. Wirth); UU—Utah State University, Logan, Utah (W. J. Hanson); and WSU—Washington State University, Pullman (W. J. Turner).

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SCOTINOPHARA SICULA A. COSTA, A MEDITERRANEAN SPECIES IN THE VIRGIN ISLANDS (HEMIPTERA: PENTATOMIDAE: PODOPINAE)

L. H. Rolston, Ludvik Hoberlandt, and Richard C. Froeschner

(LHR) Department of Entomology, Louisiana State University Agricultural Center, Baton Rouge, Louisiana 70803; (LH) National Museum (Natural History), Department of Entomology, CS-14800 Praha 4-Kunratice, Czechoslovakia; and (RCF) Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

Abstract.—A Mediterranean species of Podopinae, *Scotinophara sicula* (A. Costa, 1841), apparently has become established on St. Croix, Virgin Islands. Diagnoses are given for this genus and species.

Among pentatomids sent to the senior author by M. A. Ivie were six specimens of *Scotinophara sicula* (A. Costa, 1841) collected April 24, 1980, at light at Golden Grove, St. Croix, Virgin Islands. *Scotinophara* is not endemic in the Western Hemisphere, and heretofore *S. sicula* has been collected only in the Mediterranean region. There is no question as to the provenance of these specimens and apparently none as to their identity. They were compared to specimens from Sicily and Egypt, among which was one determined by Stål, another by Horvath and yet another by Schouteden as *S. sicula.* How this species was introduced into St. Croix is a mystery.

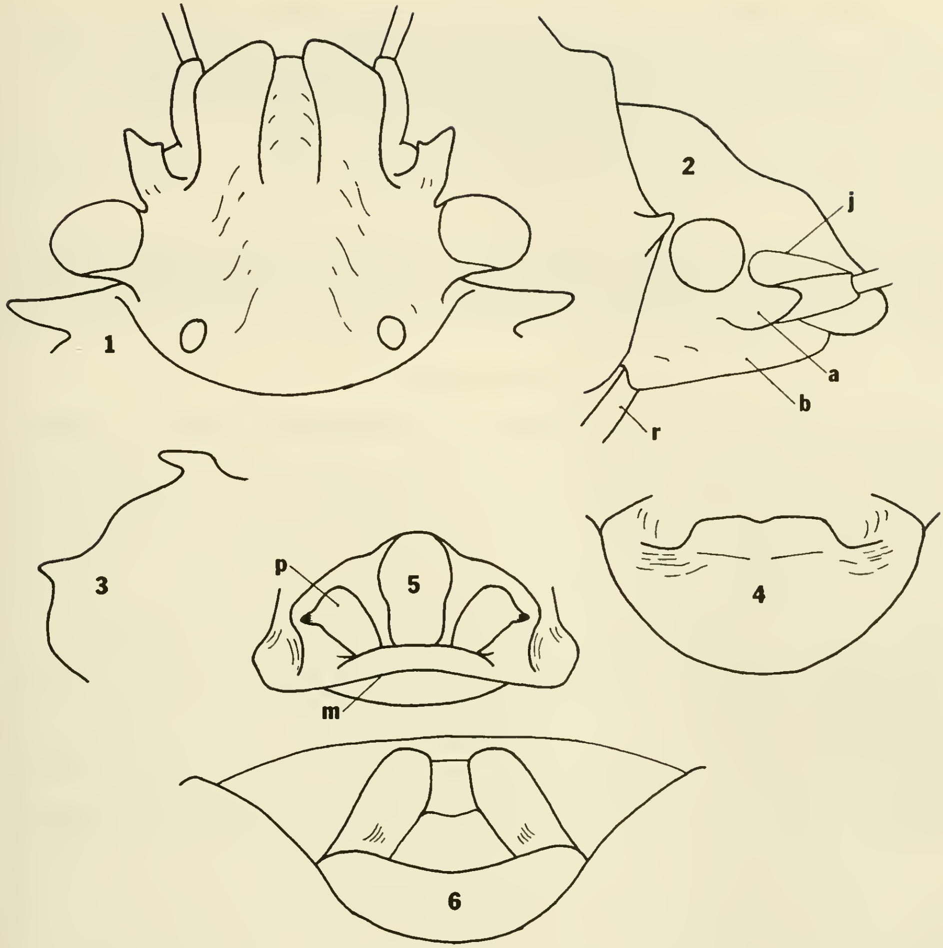
In the key to North American podopine genera by Barber and Sailer (1953), *Scotinophara* runs imperfectly to *Notopodops* Barber and Sailer. The latter genus has a slight, longitudinal, metasternal carina while *Scotinophra* does not. *N. omani* Barber and Sailer, the single representative of *Notopodops,* has the juga broadly contiguous before the tylus; in *S. sicula* the juga are separated by a narrow gap. The following descriptions separate *S. sicula* from other podopines.

In the references cited for *Scotinophara* the genus is described or keyed, or both, and/or there is a key to some species. In the references cited for *S. sicula* the species is described and the geographical origin of specimens noted.

Scotinophara Stål, 1867

Scotinophara Stål, 1867: 502, 503; Stål, 1876: 33–34; Horvath, 1883: 165–166; Atkinson, 1887: 193; Schouteden, 1903: 120; Schouteden, 1905: 29, 30–34; Cachan, 1952: 287; Vidal, 1949: 89; Linnavuori, 1970: 195–199.
Podops: Distant, 1902: 71, 72.

Diagnosis.—Dorsal margin of head in profile sinuous (Fig. 2). Bucculae of even height throughout length, not elevated into tooth anteriorly, abruptly truncate posteriorly. Eyes pedunculate; anteocular process absent (Fig. 1). Antennifers



Figs. 1–6. *Scotinophora sicula.* 1, Head and anterior margin of pronotum. 2, Right profile of head and anterior margin of pronotum: antennifer (a); buccula (b); lateral margin of jugum (j); rostrum (r). 3, Lateral margin of pronotum. 4, Pygophore, caudal view. 5, Genital cup: posterior margin (m); paramere (p). 6, Genital plates, caudoventral view.

entirely visible from above; antennae 5-segmented. Anterolateral angles of pronotum spinose; humeri toothed anteriorly (Fig. 3). Tubercle present in each cicatrice; pronotal disk unarmed. Scutellum reaching abdominal apex; frena extending along basal ¼. Coxae of each pair separated by less than width of coxae. Thoracic sterna sulcate longitudinally, without median carina. Ostiolar auricle about as long as diameter of tibia at apex. Posterolateral angles of sternites obtuse, little produced.

Scotinophara sicula (A. Costa, 1841)

Podops siculus A. Costa, 1841: 301–302, Pl. 6 fig. 8; Fieber, 1861: 350; Vidal, 1949: 112.

Scotinophara sicula: Horvath, 1883: 166–167, Pl. 2 fig. 10.

Juga reflexed laterally, longer than tylus, leaving quadrate incision at apex of head (Fig. 1). Spine on anterolateral angle of pronotum on each side projecting laterad of eye by about ½ width of eye; humeral tooth projecting laterad beyond basal part of humerus; anterolateral margin between spine and tooth sinuous, most strongly so in male (Fig. 3); pronotal disk transversely sulcate behind anterior margin and behind cicatrices. Rostrum reaching no farther than anterior margin of metacoxae.

Dorsal margin of pygophore sinuous from caudal view, mesially thin and convex (Fig. 4); from dorsal view posterior margin concave, anterior margin mesially emarginate (Fig. 5). Parameres flattened, apically truncate with lateral tooth. Genital plates as in Fig. 6.

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HARBORAGE LIMITATION AS A COMPONENT OF A GERMAN COCKROACH PEST MANAGEMENT PROGRAM (DICTYOPTERA: BLATTELLIDAE)

B. R. FARMER AND W. H. ROBINSON

(BRF) Department of Entomology, Mississippi State University, Mississippi State, Mississippi 39762; (WHR) Department of Entomology, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.

Abstract.—German cockroach adults and nymphs hide in cracks and crevices as small as 0.5 mm (nymphs) and 2.0 mm (adults). Chemicals usually do not reach cockroach harborages, and control is achieved only when the insects move out of their harborages and contact residual insecticides. It was hypothesized that limiting the amount of harborage and access to harborage may increase the effectiveness of residual insecticides in controlling German cockroaches.

The accessible cracks and crevices (= harborage access) in the bathroom and kitchen cabinets of three urban apartments were sealed with latex caulk or polyurethane foam. The apartments were treated with 0.5% chlorpyrifos and the percentage reduction of German cockroaches recorded for 1, 2, 6, and 20 wk. In spite of extensive efforts to limit the amount of harborage available to the German cockroach population, there was no significant difference ($P \leq 0.1$) in percentage reduction between the apartments with the bath and kitchen caulked and those without.

A large infestation of German cockroaches, *Blattella germanica* (L.), in a house or apartment usually indicates that there is an abundant amount of food, water, and hiding places in the habitat (Akers and Robinson, 1981). Food, water, and hiding place are some of the most important factors governing the size of a cockroach infestation, as well as the control or elimination of that infestation (Ross and Wright, 1977). Sherron et al. (1982) reported a correlation between large cockroach infestations and poor sanitation. Akers and Robinson (1981) reported finding large infestations "focused" at apartments with poor sanitation. Ono and Tsuji (1972) and Mueller (1978) reported the effects of food and water on reducing cockroach populations. Cochran (1983) showed that without food and water the reproductive cycle of the female German cockroach is severely affected.

Knowledge of the habits of German cockroaches can be used to design methods of control. Zungoli and Robinson (1982) reported an increase in the effectiveness of insecticides with crack-and-crevice rather than fan-spray application for control of these pests. Berthold and Wilson (1967) reported that German cockroaches prefer resting in cracks and crevices that are about 2.1 mm wide. Klunker (1977) reported that small German cockroach nymphs prefer to aggregate in cracks about

0.5 mm wide. He also found that the cracks preferred by nymphs for aggregation are 2–3 times larger than the smallest cracks the adult cockroaches are able to pass through. The use of caulking to seal cracks and crevices has been proposed as a control method. However, there has been no published research verifying this logical deduction.

The objective of the research reported here was to evaluate the effectiveness of chemical control of German cockroaches after caulking the accessible cracks and crevices in bathrooms and kitchens in urban apartments. The basic assumption was that by caulking or closing the cracks and crevices, nymph and adult German cockroaches would be denied harborage. With fewer harborages, cockroaches would not be able to escape contacting residues of insecticides in the habitat, and many of the cockroaches would be killed. The apartments with caulking should have a significantly greater reduction in the number of cockroaches than apartments that did not receive caulking.

Materials and Methods

The experiments were conducted in the Hunt Manor Apartments, a housing project administered by the Roanoke Redevelopment and Housing Authority, Roanoke, Virginia, from June 1981 to February 1982. Sanitation in all the apartments studied was considered poor (food scraps, dirty clothes and unclean dishes were present). The cockroach population in each apartment was evaluated with traps. The traps consisted of one-quart Mason jars with the inner rim coated with a thin layer of petroleum jelly, a paper towel secured around the exterior with an elastic band, and one tablespoon of boiled raisins placed in the jar as bait. A four dram, sponge-wicked vial was placed in the jar to provide water. Three traps were placed in the apartments for 48 h, then removed and the cockroaches in the traps counted. Apartments in which 10 or more cockroaches were trapped were chosen for the experiments. A total of five apartments were studied; in three apartments the bathrooms and kitchens were caulked, in two apartments no caulking was used.

All cracks, crevices, harborage access, and actual harborage areas in the two bathrooms and kitchen area were sealed with latex caulk and polyurethane foam. The caulk was used to seal long, extended cracks and crevices; the foam was used to seal large spaces which beads of caulk could not fill. The harborages in the bathrooms and kitchens in the control apartments were not sealed. Approximately 7–8 h per apartment were required to adequately seal all available harborages and harborage access. Seven to eight, 11-oz. tubes of caulking compound and one 16-oz. can of polyurethane foam were used to seal each apartment.

Harborage access was considered to be any crack or area a cockroach could enter (0.5–2.0 mm). All cabinets in the kitchen and bathroom were measured and actual harborage access determined in linear feet. Areas under the sinks, around the top and bottom of the toilet, and around the cabinets were measured and total harborage access determined. Total harborage access for these two rooms in the apartment was calculated and from this number the actual percentage of harborage sealed was determined.

Six traps were placed in each apartment for 24 h following the caulking and foam treatments: 1) under kitchen sink, 2) lower kitchen cabinet, 3) next to refrigerator, 4) under washing machine, 5) next to bathroom toilet; upstairs 6)

Table 1. Percentage reduction of German cockroaches in apartments following caulking of accessible harborages in kitchens and bathrooms and the application of 0.5% chlorpyrifos.

Apartment	Percentage Reduction			
	1 wk	2 wk	6 wk	20 wk
Caulked	36	72	22	59
Uncaulked	64	83	71	79

next to bathroom cabinet. The traps were removed after 24 h and the cockroaches counted. The number of males, females, females with egg cases, and nymphs were recorded. All apartments were then sprayed with 0.5% chlorpyrifos in water using a compressed air sprayer with the nozzle set at coarse-fan. A second application of 0.5% chlorpyrifos was performed at 7 wk. The post-trapping procedure was the same as that used for pretrapping. The traps were set out 1 wk, 2 wk, 6 wk, and 20 wk after the apartments were sprayed. The cockroaches trapped were tabulated and percentage control determined.

Data was analyzed using a Wilcoxon paired sample *t*-test ($P \leq 0.1\%$) to check for overall differences between treatments and controls.

RESULTS

The evaluation of this research is based on 1) the percentage reduction of the cockroaches in the apartments (bathrooms and kitchens), 2) the total number of cockroaches trapped, and 3) the amount of harborage accessible for caulking.

Percentage reduction.—There was no significant difference ($P \leq 0.1$) in the percentage reduction of cockroaches between the apartments in which the cracks and crevices in the bathrooms and kitchens were caulked and those not caulked (Table 1). In both the caulked and uncaulked apartments the percentage reduction of cockroaches increased during the two weeks following treatment with chlorpyrifos (Table 1). The apartments that were caulked had an average of 72% reduction at two weeks, and the uncaulked had an average of 83% reduction. There was only one application of chlorpyrifos to the apartments, consequently the percentage reduction decreased at six weeks. Following a second application of insecticide (following the 6 wk trapping), the percentage reduction showed an increase at 20 wk.

Number of cockroaches trapped.—The average number of cockroaches trapped in the caulked apartments declined steadily for two weeks following the chlorpyrifos treatment (Table 2). The average number of cockroaches trapped in the uncaulked apartments declined for the first week but remained the same for the second week. At the 20-wk trapping the number of cockroaches trapped was nearly the same for both caulked and uncaulked.

Amount of harborage caulked.—The amount of harborage access sealed with the latex caulk and foam was determined by measuring in linear feet the cracks and crevices in the bathrooms and kitchens. In the two areas combined there were approximately 96 linear ft. of external harborage access, and 143 linear ft. of internal harborage access. It was possible to seal approximately 83% of the external cracks and crevices, but only 41% of the internal cracks and crevices in the kitchens and bathrooms.

Table 2. Total number of German cockroaches trapped following caulking of accessible harborages in kitchens and bathrooms and the application of 0.5% chlorpyrifos.

Apartment	Cockroaches Trapped				
	Prespray[1]	1 wk	2 wk	6 wk	20 wk
Caulked 1	110a[2]	143a	16a	52a	74a
Caulked 2	45a	19a	28a	21a	23a
Caulked 3	85a	15a	6a	120a	3a
Uncaulked 1	11a	6a	1a	3a	31a
Uncaulked 2	127a	23a	30a	214a	31a

[1] Cockroaches trapped after caulking, but before insecticide application.

[2] Numbers within column followed by same letter were not significantly different at the 0.1% level (Wilcoxon paired sample *t*-test).

Discussion

The value of caulking cracks and crevices, in an attempt to deny cockroaches a hiding place, appears doubtful. In the kitchens and bathrooms in the apartments used in this research, there was no significant difference in cockroach control between the caulked and uncaulked apartments. There was apparently no benefit gained from the caulking. At least three factors may help to explain these results.

1) A large percentage of the accessible harborage in the bathroom and kitchen cabinets was not caulked. Only 41% of the internal cracks and crevices in the kitchen and bathroom areas were sealed. The openings that were not accessible to the caulking gun and foam probably were not contacted with the insecticide treatment. Apparently, the 59% that remained uncaulked was an adequate amount of harborage for the cockroach population in the kitchen and bathroom areas. Some areas, especially in kitchen cabinets, were inaccessible to either latex caulking or foam.

2) The low level of sanitation in the apartments tested may have provided additional or alternative harborage sites. Clothes, soft drink containers, newspapers, etc., may have been utilized by the adult and nymph cockroaches that were denied harborage in the cabinets.

3) The low level of sanitation in all the apartments may have decreased the effectiveness of the insecticide treatment. Gupta et al. (1973) treated with chlorpyrifos and reported 94% control in apartments with good sanitation, and 75% control in those with bad sanitation. In our research all the apartments had bad sanitation and chlorpyrifos gave 83% and 72% reduction in uncaulked and caulked apartments, respectively.

The successful use of caulking as a German cockroach control strategy (in apartments) may depend on cooperation from apartment residents in applying some or all of the caulk, improving the sanitation level, and decreasing alternative harborage sites. Used alone, caulking is probably not an effective strategy. The integration of several non-chemical strategies—caulking, sanitation, improved construction—with the careful application of a residual insecticide may significantly reduce German cockroach populations. Success may be dependent on construction practices in a given apartment building.

Caulking may have limited value in some apartment buildings as a pest control strategy but should not be discounted as a strategy in other situations. In some food processing operations there is a limited amount of alternative harborage, the sanitation level is excellent, and there is harborage accessible to caulking. Under these and similar conditions, caulking may significantly improve the effectiveness of chemical control. However, there may be situations in which it is more beneficial to leave the cracks and crevices open (uncaulked) and accessible to the application of insecticides with a crack-and-crevice device.

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A REVIEW OF MYCOPHAGY IN THE EUCINETOIDEA (COLEOPTERA), WITH NOTES ON AN ASSOCIATION OF THE EUCINETID BEETLE, *EUCINETUS OVIFORMIS*, WITH A CONIOPHORACEAE FUNGUS (BASIDIOMYCETES: APHYLLOPHORALES)

Quentin D. Wheeler and E. Richard Hoebeke

Department of Entomology, Cornell University, Ithaca, New York 14853.

Abstract.—Published records of hosts and microhabitats of species of the eucinetoid families Clambidae and Eucinetidae (Coleoptera) are reviewed. *Eucinetus oviformis* LeConte is reported breeding on the fungus *Coniophora olivacea* (Pers.) Karst. in mountainous western North Carolina. This represents the second known association of a eucinetid beetle with a basidiomycete host.

The superfamily Eucinetoidea was proposed by Crowson (1960) to include the families Clambidae, Eucinetidae, and Scirtidae (= Helodidae). Little is known about the hosts and habitats of eucinetoids. Larval scirtids are aquatic, except for the probable larva of *Veronatus,* found by Crowson (1981: 456) in damp humus-rich soil in New Zealand; no scirtids are known to be associated with fungi. The Clambidae and Eucinetidae, however, are considered principally mycophagous (Benick, 1952; Crowson, 1981, 1984), although there are relatively few published host records. The purpose of this paper is to provide a brief summary of published accounts of the hosts and microhabitats of Clambidae and Eucinetidae, and to record the association of a eucinetid beetle with a wood-rotting fungus in the southern Appalachians.

Review of Mycophagy in Eucinetidae and Clambidae

Among the seven species of *Eucinetus* occurring in North America, most host data are for *E. morio* LeConte. This species was first associated with slime mold (Myxomycetes) fruiting bodies by Weiss and West (1921) who found adults with a *Trichia* sp. (Trichiales, Trichiaceae) in New Jersey. Lawrence and Newton (1980) have recorded this species in eastern North America from *Arcyria pomiformis* (Leers) Rostafinski (Trichiales, Trichiaceae); *Fuligo septica* (L.) Wiggers (Physarales, Physaraceae); *Stemonitis axifera* (Bulliard) Macbride, *S. splendens* Rostafinski and *Stemonitis* sp. (Stemonitales, Stemonitaceae); and *Tubifera* sp. (Liceales, Reticulariaceae). One of us (QDW) has also collected adults and larvae of *E. morio* from fruiting bodies of *Stemonitis* sp. in North Carolina (Macon Co.) and Ohio (Franklin Co.).

Bruns (1984) recently discovered adults of *Eucinetus punctulatus* chewing on immature fruiting bodies of *Paragyrodon sphaerosporus* (Peck) Sing. (Agaricales, Bolitaceae) in several localities in Minnesota. Its larvae were found on the fresh pores and gills of *P. sphaerosporus* and *Paxillus involutus* (Batsch. ex Fr.) Fr. (Agaricales, Paxillaceae), probably feeding on the hymenium and spores. Bruns' observations were the first firm association of a eucinetid beetle with a basidiomycete host. An association of another North American eucinetid with a wood-rotting basidiomycete is given below.

Large numbers of adults of the European *Eucinetus meridionalis* Castelnau have been observed, along with larvae and pupae, in unidentified fungal growths under bark of logs and stumps (Perris, 1851), and larvae have been found feeding on fungus under bark of pitch pine (Gardner, 1969). Adults of *E. haemorrhoidalis* Germar, another common European species, have been recorded by Klausnitzer (1971, 1975) from a variety of habitats, including decaying plant remains, under bark, rotting stumps, and logs (especially *Pinus* and *Quercus*), fungus-infested roots of *Euphorbia* and grasses (Gramineae), *Polyporus* sp. (Basidiomycetes, Aphyllophorales, Polyporaceae) on *Betula,* and under stones.

Known microhabitats of other North American and European species of *Eucinetus* also suggest a close association with fungi. The western North American *E. infumatus* LeConte has been collected under bark of *Fraxinus, Cupressus,* and *Alnus* (Lawrence and Newton, 1980), and Keen (1895) reported larvae, pupae, and adults under loose bark of decaying spruce (*Picea*). Adults, larvae, and pupae of this species have been collected under bark of a dead Sargent cypress (*Cupressus sargenti* Jeps.) in Mendacino Co., California (borrowed from U.S. National Museum), and from a "basidiomycete on *Eucalyptus* inner bark" in Contra Costa Co., California by J. K. Liebherr. It will be interesting to determine whether other eucinetids are also mycophagous, particularly those adults that exhibit remarkable sucking adaptations of their mouthparts, such as *Jentozkus plaumanni* Vit, *Tohlezkus ponticus* Vit, and *Euscaphurus nikkon* Vit (Vit, 1977). All three species have been collected in habitats where both slime mold plasmodia and fungal hyphae are potentially abundant. Specimens of *T. ponticus* have been taken from soil samples among roots of spruce (*Picea*), in decomposing spruce stumps, and in the wood of decaying alder (*Alnus*) and beech (*Fagus*).

While only a single species of Eucinetidae is known to be associated with slime molds (i.e. *E. morio*), it may not be coincidental that there is evidence that some Clambidae are also slime mold associates. Unidentified species of Neotropical *Clambus* have been collected from fruiting bodies of the slime molds *Arcyria stipata* (Schweinitz) A. Lister, *Arcyria* sp., *Stemonitis axifera,* and *S. fusca* Roth on Barro Colorado Island and at Cerro Campana, Panama (Lawrence and Newton, 1980). *Clambus panamensis* Endrody-Younga has also been collected (by QDW) from fruiting bodies of *Stemonitis* sp. on Barro Colorado Island and Cerro Campana, Panama (Endrody-Younga, 1981; Wheeler, 1983). Crowson and Crowson (1955) successfully reared larvae of *Clambus minutus* Sturm and *Calyptomerus dubius* Marsham on hyphae and spores of mold in culture, probably *Mucor* sp. (Zygomycetes, Mucorales: Mucoraceae). *Clambus minutus* was observed to occur commonly "on more or less water-logged sticks lying partly in or adjacent to streams in shady situations" and in flood debris. Crowson (1979) found *Acalyptomerus asiaticus* Crowson occurring commonly in haystacks and similar accumulations of decaying vegetation. Grigarick and Schuster (1961) discovered various types of spores in the gut contents of *Loricaster rotundus* Grigarick and Schuster, surmising that this species probably feeds on fungi, at least in part.

EUCINETUS OVIFORMIS/CONIOPHORACEAE ASSOCIATION

During recent field studies of mycophagous and slime mold feeding Coleoptera in the southern Appalachian Mountains of western North Carolina, K. J. and Q. D. Wheeler discovered several life stages of *Eucinetus oviformis* LeConte in association with a wood-rotting basidiomycete fungus. Adults, pupae, and larvae were collected from mycelia of *Coniophora olivacea* (Pers.) Karst. growing in a large patch on a standing stump in a mixed hardwood-coniferous forest in Macon County, about 2 miles northwest of Highlands on September 14, 1982 (Q. W. Lot #82117). This series of specimens includes 33 larvae (tentatively separable into three size classes, possibly corresponding with instars), two pupae, and five adults. Voucher specimens of all life stages and the host fungus are deposited in the Cornell University Insect Collections. *Coniophora* belongs to the family Coniophoraceae (Aphyllophorales) and includes brown wood-rotting species related to the familiar dry-rot fungi of the Stereaceae (Alexopoulos and Mims, 1979). Bruns' (1984) record of eucinetid-Agaricales associations aside, no Eucinetidae have previously been associated with the extensive wood-rotting mycoflora (Gilbertson, 1984).

CONCLUSIONS

The association of *Eucinetus oviformis* with *Coniophora* reported here and the recent association of *E. punctulatus* with fungi of the Boletaceae and Paxillaceae (Bruns, 1983) provide an unambiguous indication of eucinetid-basidiomycete associations. The *Eucinetus-Coniophora* association points to the need to survey small, inconspicuous wood-rotting fungi as well as taxa producing larger fruiting bodies. Associations of eucinetids with both slime molds and Basidiomycetes, and slime mold feeding in Clambidae may indicate by outgroup comparison (Watrous and Wheeler, 1981) that the common ancestor of these lineages was associated with slime molds. Unfortunately, our knowledge of the hosts of both families is too sparse and fragmentary to support or refute this hypothesis. Crowson (1981) regards coleopterous associations with Myxomycetes to be of considerable antiquity, and Eucinetidae to be among the most primitive of the polyphagan beetles (Crowson, 1955, 1960). Ultimate resolution of questions about ancestral feeding habits and evolution of modern ones will rest on learning more about extant relationships between eucinetoids and their fungal hosts.

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REVIEW OF *CORTICIVORA* (LEPIDOPTERA: TORTRICIDAE) WITH ANALYSIS OF ITS TRIBAL RELATIONSHIPS AND DESCRIPTIONS OF NEW SPECIES

RICHARD L. BROWN

Mississippi Entomological Museum, Department of Entomology, Mississippi State, Mississippi 39762.

Abstract.—The genus *Corticivora* Clarke is reviewed and two new species, *C.* ***parva*** and *C.* ***chica***, are described. Relationships of *Corticivora* and allied genera to Eucosmini and Grapholitini are discussed.

The monotypic genus *Corticivora* was described by Clarke (1951) to include *C. clarki,* an unusual species reared from bark of *Pinus resinosa* Ait. in Connecticut. Clarke considered the genus to be structurally similar to *Gypsonoma* Meyrick (Eucosmini), but "clearly laspeyresiine" and "most nearly related to *Laspeyresia*" (Grapholitini, *Cydia*). *Corticivora* was described accurately as resembling *Gypsonoma* in having a forewing with all veins separate, a hindwing with veins Cu_1 and M_3 stalked and R_s and M_1 stalked, and well-developed, weakly sclerotized setose socii. The two genera were differentiated by the forewing venation with the origin of the internal vein (chorda) between veins R_1 and R_2 in *Corticivora* and between veins R_2 and R_3 in *Gypsonoma.* The two genera were further differentiated by the hindwing venation with M_2 and M_3 well separated in *Corticivora* (as in Grapholitini) and approximate in *Gypsonoma* (as in other Eucosmini). *Corticivora* was differentiated from *Cydia* by the presence of socii, the stalking of R_s and M_1 of the hindwing, and the scobinate-dentate form of the signa.

A group of unusually small olethreutine moths has been identified as two new species of *Corticivora,* both of which are smaller than all other known North American Tortricidae. In addition to their descriptions, the following modifications and additions are given for the generic and species description by Clarke (1951).

Corticivora Clarke

Head: Antennal scape with or without elongated scales covering pedicel.

Forewing: R vein weakly developed basally; R_3 basally approximate or remote from R_4; R_4 and R_5 basally approximate, connate, or stalked.

Hindwing: R weakly developed basally; termen slightly concave or straight.

Male genitalia: Apex of tegumen setose; socii arising from near apex of tegumen; gnathos lightly sclerotized; anellus expanded and flattened ventrally; caulis wide, flattened; valva with or without ventral emargination between sacculus and cucullus; cucullus narrow or broad, with or without stout setae on outer wall; aedeagus without non-deciduous cornuti.

Female genitalia: Sternite VII laterally lightly sclerotized or heavily sclerotized and invaginated, posteriorly covering anterior edge of lamella antevaginalis; tergite VIII setose and scaled; lamella antevaginalis large, posteriorly covering ostium and reduced lamella postvaginalis; ductus bursae moderately sclerotized posteriorly or unsclerotized; ductus seminalis originating from ductus bursae near corpus bursae; signa absent or weakly developed as scobinate-dentate cones.

Corticivora clarki **Clarke**

The original description by Clarke (1951) is expanded by the following additions.

Head: Scales of antennal scape short, not covering pedicel.

Forewing: 4.5–5.5 mm long, basal patch with basal and subbasal fascia separated by lighter ground color, outer edge angulate near middle.

Abdomen: Sternite II with well-developed caudal apodemes.

Male genitalia: Cucullus without stout setae on outer wall.

Female genitalia: Sternite VII heavily sclerotized except for anterior lateral area; median and posterior lateral areas smooth, heavily scaled; midlateral area rugose, sparsely scaled; medially directed invaginations deep; posterior median margin forming truncate projection beyond anterior margin of lamella antevaginalis. Tergite VIII laterally setose, heavily scaled, dorsally smooth or rugose, without setae or scales. Lamella antevaginalis scaled, setose; ductus bursae moderately sclerotized posteriorly near ostium.

New distribution records.—*Arkansas:* Washington Co., Devil's Den St. Pk., 30 May 1966, R. W. Hodges, 1 ♀. *Illinois:* Putnam Co., 25 June 1964, 1 ♂, 3 July 1961, 1 ♂, 8 July 1961, 2 ♂, 1 Aug. 1961, 1 ♀, M. O. Glenn. *Maryland:* Calvert Co., Camp Bay Breeze nr Lusby, 8 June 1963, O. S. Flint, 1 ♂, 1 ♀. *Michigan*: Presque Isle Co., Ocqueoc Lake, 25–26 July 1970, R. W. and E. R. Hodges, 2 ♂. *Washington:* Okanogan Co., 2 mi W Manzana, 29 July 1962, J. F. G. Clarke, 1 ♀, genitalia slide USNM 17832.

These specimens, which are in the National Museum of Natural History, indicate a widespread distribution of *C. clarki*. The female specimen from Washington differs from paratype females in having smaller signa and a smooth rather than rugose tergite VIII dorso-medially.

Corticivora parva **Brown, NEW SPECIES**

Figs. 1–4, 8

Description.—*Head* (Fig. 1): Uniformly creamy white, some specimens with isolated grayish-brown scales on antennal flagellum and lateral surface of labial palpus; scape with elongated scales covering pedicel; chaetosema with 4–6 bristles.

Thorax: Tegulae, mesonotum, and metanotum creamy white intermixed with varying amounts of light grayish brown, some scales dark basally, light apically.

Forewing (Fig. 2): 3.0–4.75 mm long; male costal fold and sex scales absent; ground color unicolorous with thorax, scales white tipped; basal patch with basal and subbasal fascia confluent, outer edge straight; basal patch, median fascia, median line between basal patch and median fascia, and pre-apical spot dark to light grayish brown; outer wing margin lined by dark-brown scales with white tips; fringe scales grayish brown with white tips; venation with R_4 and R_5 basally approximate, connate, or short stalked; termen straight.

Hindwing: Light grayish brown, without contrasting markings.

1

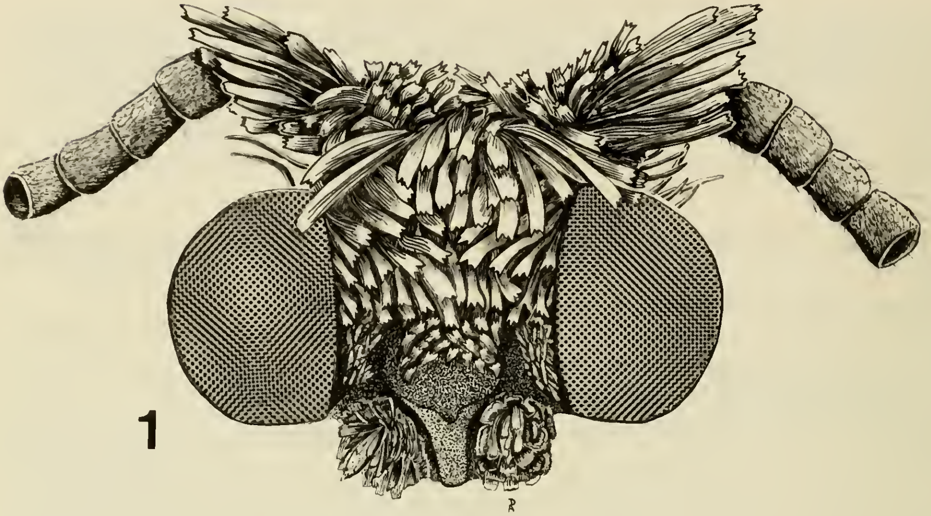


Fig. 1. *Corticivora parva,* frontal view of head.

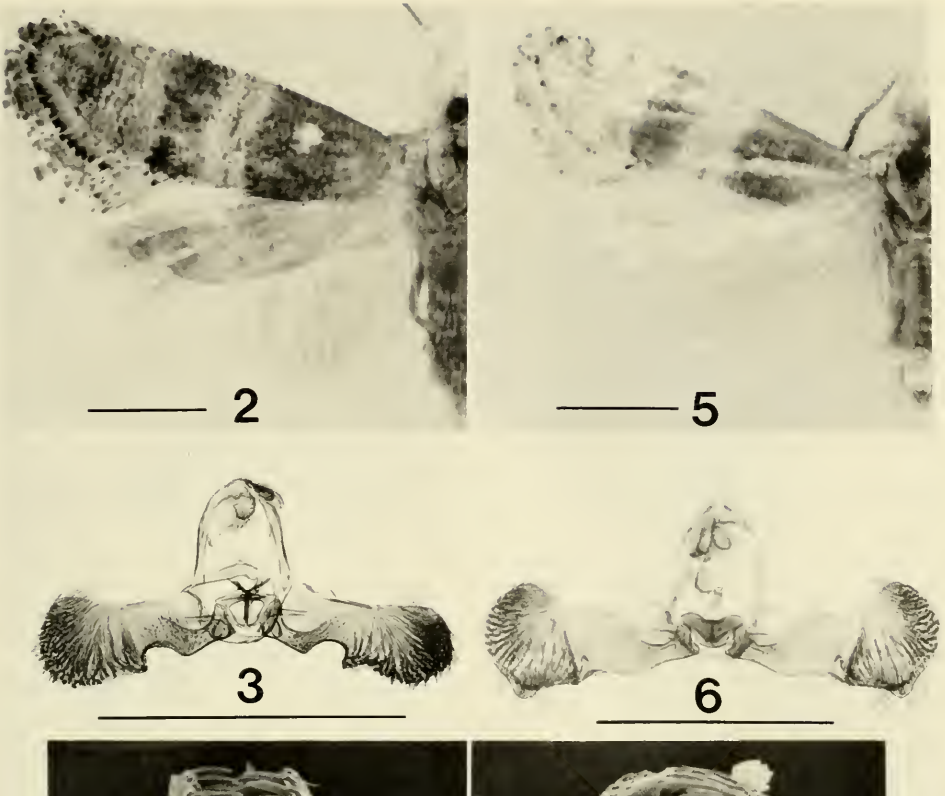
Abdomen: Light grayish brown dorsally, paler ventrally; sternite II with well-developed caudal apodemes.

Male genitalia (Figs. 3, 4): Socii broad, rounded, setose on all surfaces; aedeagus long, narrow, tapered, cornuti absent; cucullus delimited by deep ventral emargination of valva, with large, long setae on marginal and inner median surfaces and single, large, short seta on outer surface of ventral anterior angle (Fig. 4). Six preparations examined.

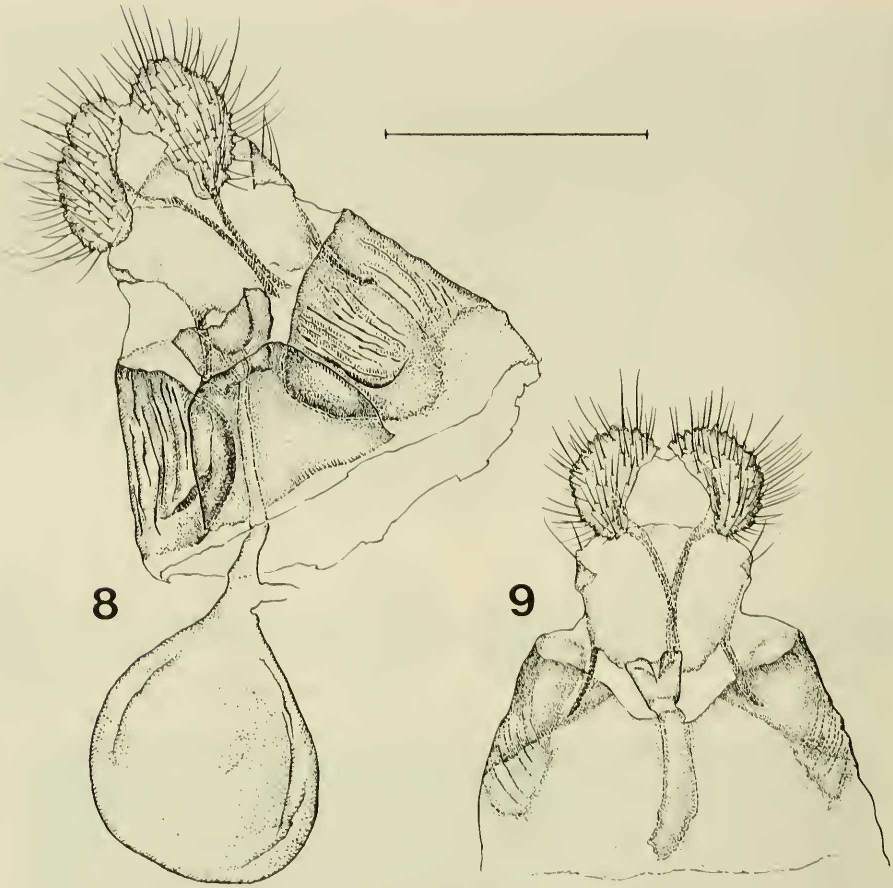
Female genitalia (Fig. 8): Sternite VII broadly sclerotized; median, trapezoid-shaped area and posterior lateral areas scaled; lateral area depressed, rugose, scaleless, more heavily sclerotized than median area, with oblique ridge variably developed between rugose area and medially directed invagination. Tergite VIII laterally setose, sparsely scaled, dorsally bare. Papillae anales widest at middle, subequal in width anteriorly and posteriorly, moderately setose as figured; sterigma forming a semi-flattened funnel leading into ostium; lamella antevaginalis enlarged, extending posteriorly beyond reduced lamella postvaginalis, without scales or setae; ductus bursae short, without sclerotization; corpus bursae without sclerotization. Eight preparations examined.

Holotype.—♂, Devil's Den St Pk, Wash. [ington] Co. Ark. [ansas], 24-VI-1966, R. W. Hodges; Photograph 211 on file, R. L. Brown; U.S.N.M. Type No. 100864. Data are given as on labels except for bracketed additional information. The holotype is double mounted (minute nadel in polyporus block), is in excellent condition except for scales removed from left valva, and is in the National Museum of Natural History, Smithsonian Institution.

Paratypes.—27 ♂, 11 ♀; *Alabama:* Hale Co., Black Warrior River, 13 mi SW Greensboro, 23-IV-66, J. B. Heppner, at blacklight, 3 ♂, 1 ♀, ♀ genitalia slide R. L. Brown 883 (JBH), 1 ♂, genitalia slide R. L. Brown 894 (RLB); Barbour Co., Blue Springs St Pk, 17-IV-76, at uv light, J. B. Heppner, 1 ♂ (JBH). *Arkansas:*



Figs. 2–7. 2–4, *Corticivora parva.* 5–7, *C. chica.* 2, Holotype imago. 3, Male genitalia, genitalia slide Tor 18. 4, Ventral view of valvae, 125×, SEM stub 94. 5, Paratype imago, Lake Placid, Fla. (USNM). 6, Male genitalia, genitalia slide DRD 1505. 7, Ventral view of valvae, 125×, SEM stub 93. Arrows in Figs. 4 and 7 indicate setae socketed on outer wall of valvae. Scale lines = 1 mm.



Figs. 8–9. Female genitalia. 8, *Corticivora parva*, genitalia slide R. L. Brown 883. 9, *C. chica*, genitalia slide USNM 17794. Scale line = 0.5 mm.

Sebastian Co., Hartford, 9-VI-1966, R. W. Hodges, 3 ♂, 1 ♀, ♀ genitalia slide USNM 17796; Washington Co., Devil's Den St Pk, R. W. Hodges, 30-V-1966, 1 ♂, genitalia slide USNM Tor 18, 3-VI-1966, 1 ♂, 21-VI-1966, 1 ♂ (USNM). *Florida:* Alachua Co., Archer Road Lab., 3 mi SW Gainesville, collected by J. B. Heppner at blacklight, 18-II-75, 1 ♂, 2-III-76, 1 ♂, 30-X-75, 1 ♀, genitalia slide R. L. Brown 891 (JBH); Gainesville, III-13-63, H. A. Denmark, 1 ♂ (FSCA); Highlands Co., Lake Placid, Archbold Biol. Sta., R. W. Hodges, 8–15 May 1964, 3 ♂, genitalia slide USNM 17833, 16–22 May 1964, 3 ♂, 3 ♀, ♀ genitalia slides USNM 17795, 17803, 17804 (USNM); 10 mi. S Lake Placid, Archbold Biol. Sta., J. B. Heppner, at blacklight, 2-V-1975, 1 ♂ (JBH), 1 ♂, SEM stub 94 (RLB), 6-V-1975, 1 ♂, 7-V-1975, 1 ♀, 8-VI-1975, 1 ♀ (JBH). *Georgia:* Lee Co., Chehaw State Park, 16-IV-76, J. B. Heppner, at uv light, 1 ♀, genitalia slide L. K. Miller 125773 (JBH). *Massachusetts:* Barnstable Co., Barnstable, C. P. Kimball, Jul. 17, 1952, 1 ♂, genitalia slide R. L. Brown 892, Jul. 20, 1952, 1 ♂ (UCB). *Mississippi:* Clarke Co., Clarkco St Pk, 6 mi N Quitman, 19-IV-76, J. B. Heppner, at uv light, 1 ♀, genitalia slide R. L. Brown 884, wing slide R. L. Brown 1042 (RLB); Franklin Co., Clear Springs Cpgd, 20 mi SW Meadville, 20-IV-76, J. B. Heppner, at uv light, 1 ♀, genitalia slide L. K. Miller 125773 (JBH). *Missouri:* Boone Co., Columbia, VI-22-1973, W. S. Craig, 1 ♂, genitalia slide L. K. Miller 1020772 (UMC). *South Carolina:* Oconee Co., Cherry Hill Recrtn Area-Rte 107, 2000′, 6 Sept. 1958, R. W. Hodges, 1 ♂, genitalia slide USNM 17802 (USNM). Deposition of paratypes is indicated by the abbreviated collection name given in parentheses following respective specimens (JBH—John B. Heppner, RLB—Richard L. Brown, USNM—National Museum of Natural History, Smithsonian Institution, FSCA—Florida State Collection of Arthropods, UCB—University of California, Berkeley, UMC—University of Missouri, Columbia).

Variation.—A female (RLB) from Clarke Co., Mississippi, differs from others dissected in having a seventh sternite with a rounded, rather than trapezoid-shaped, median area. The medially directed, sternal invaginations of this specimen are deeper and the oblique ridge, which is more developed, is covered by the elevated median area of the sternite. The grayish-brown shade of forewing fascia and inter-fascial areas varies from light (as in Fig. 5) to dark (as in Fig. 2) and is most evident in a series of specimens (USNM) collected by R. W. Hodges at Archbold Biological Station, Florida. The genitalia of lighter specimens do not differ noticeably from those of darker specimens.

Diagnosis.—*C. parva* differs from *C. clarki* in having elongate scales on the antennal scape and a forewing basal patch that has a straight, rather than angulate, outer edge. The two species are easily differentiated by the form of the male and female genitalia. In *C. clarki,* the male has a narrow and rounded cucullus and the female has signa in the corpus bursae, in contrast to the preceding description of *C. parva.* The females of *C. clarki* and *C. parva* are similar in having a seventh sternite with rugose lateral areas and medially directed invaginations. The median, elevated area of the sternite is much wider in *C. clarki* than *C. parva.* The sterigma of *C. parva,* although similar in form with *C. clarki,* differs in being more narrow and in lacking setae and scales. The following new species is separated from *C. parva* by differences in genitalia.

Corticivora chica Brown, New Species

Figs. 5–7, 9

Description.—As in *C. parva* except for the following:

Forewing (Fig. 5): 3.0–5.5 mm long.

Male genitalia (Figs. 6, 7): Valva with sinuate ventral edge, without deep ventral emargination; cucullus with large seta on inner surface of ventral lobe, with large, long setae on outer surface (Fig. 7); an acute projection present between cucullus and sacculus. Four preparations examined.

Female genitalia (Fig. 9): Sternite VII with median, heavily sclerotized, posteriorly scaled ridge; lateral posterior areas heavily sclerotized, rugose, scaled; remainder of sternite lightly sclerotized, scaleless. Sterigma narrow. Four preparations examined.

Holotype.—♂, Florida, Lake Placid, Archbold Bio. Sta., 1–7 May 1964, R. W. Hodges; U.S.N.M. Type No. 100865. The holotype is double mounted (minute nadel in polyporus block), is in excellent condition except for scales removed from left valva, and is in the National Museum of Natural History, Smithsonian Institution.

Paratypes.—*Florida:* Dade Co., Long Pine Key, Everglades Natl Pk, 28-IV-1975, J. B. Heppner, at blacklight, 1 ♀, genitalia slide R. L. Brown 890, wing slide R. L. Brown 1041 (RLB); Escambia Co., Pensacola, IV-12-1962, Shirley Hills, 1 ♀, genitalia slide R. L. Brown 895 (UCB), IV-10-1962, 1 ♂, genitalia slide D. R. Davis 1505 (USNM); Highlands Co., Archbold Bio. Sta., R. W. Hodges, 29 March 1959, 1 ♂, genitalia slide USNM 17834, 1–7 May 1964, 1 ♂, R. L. Brown photograph 210 on file, 8–15 May 1964, 1 ♂, 2 ♀, ♀ genitalia slides USNM 17794, 17805, 16–22 May 1964, 2 ♂, genitalia slide D. R. Davis 2765 (USNM); Archbold Bio. Sta., 3-21-65, S. W. Frost, 1 ♂, (USNM); Archbold Bio. Sta., 10 mi S Lake Placid, J. B. Heppner, at blacklight, 1-V-1975, 6 ♂, 2-V-1975, 1 ♂, 2 ♀, 3-V-1975, 1 ♂, R. L. Brown SEM stub 93 (RLB), 4-V-1975, 1 ♂, genitalia slide R. L. Brown 977 (RLB), 6-V-1975, 6 ♂, 9-V-1975, 1 ♀; Orange Co., Moss Park, 19 mi SE Orlando, 1-IV-1975, J. B. Heppner, at blacklight, 1 ♂.

Deposition of paratypes is indicated as for *C. parva.*

Variation.—The shade of forewing color varies in *C. chica* as in *C. parva.* A female specimen from Pensacola, Florida, differs from others in having the median ridge of the seventh sternite abruptly widened posteriorly rather than being uniform in width. This female and a male from the same locality have forewings 5.5 mm long, whereas other specimens have forewings 3.0–5.0 mm long. No variations in male genitalia of the Pensacola specimen or other specimens were observed.

Diagnosis.—Differences between *C. chica* and *C. parva* are given in the preceding description. The male of *C. chica* can be differentiated from both *C. parva* and *C. clarki* by the presence of large spines on the outer wall of the valva. The valva is also more arched apically in *C. chica* than in the other two species, as viewed from the ventral side (Figs. 4, 7). The female of *C. chica* differs from *C. parva* and *C. clarki* in lacking sternal depressions, which are easily visible in intact, scaled specimens of the latter two species.

Discussion.—Distribution and flight times.—The distribution of the genus appears to be relatively widespread in the United States, *C. clarki* occurring in Arkansas, Connecticut, Illinois, Maryland, Michigan, and Washington, *C. parva* occurring in Massachusetts and Southeastern United States, and *C. chica* occurring in Florida.

Corticivora clarki has emerged from pine bark from late June to early July in Connecticut (rearing conditions unknown) and has been collected in late May in Arkansas, early June in Maryland, late June through late July in Illinois, and in late July in Michigan and Washington. *C. parva* has been collected during a wide range of months: from late May to late June in Northwest Arkansas, during February, March, and late October in Gainesville, Florida, during May at Lake Placid, Florida, during September in South Carolina, during April in Alabama, Georgia, and Mississippi, and during July in Massachusetts. *C. chica* has been collected from late March to early May in Florida.

Hosts.—The hosts of *C. parva* and *C. chica* are unknown. *Pinus* is a suspect host of both species based on their relatedness with *C. clarki* and their collection localities.

TRIBAL AFFINITIES

Whereas the tribe Grapholitini was treated by Heinrich (1926) as a subfamily (Laspeyresiinae), Obraztsov (1946) and most recent workers have treated this group as a tribe. Danilevski and Kuznetsov (1968) divided the Grapholitini into two subtribes, viz. Dichroramphae and Laspeyresiae (Grapholitina). Razowski (1976) treated the Grapholitini as the subtribe Grapholitina of Eucosmini and considered the subtribes of Danilevski and Kuznetsov to be groups of species. Based on studies of male genital musculature, Kuznetsov and Stekolnikov (1977) maintained tribal status for the Grapholitini.

The tribe Grapholitini has historically been characterized by hindwing venation, which is somewhat variable, and by reduction characters of the male genitalia, viz. uncus absent, socii usually absent, gnathos membranous, valva simple and shortened, sacculus weakly setose basally and without spine clusters. One apparent apomorphic character that is characteristic of many Grapholitini is the broad, short, and elaborated ductus bursae of the female. Characters that many Grapholitini share with some of the advanced Eucosmini (*Epiblema* Hübner, *Phaneta* Stephens, *Eucosma* Hübner, *Rhyacionia* Hübner and related genera) and that are apomorphic relative to primitive Eucosmini and Olethreutini include the following: in the male, reductions of socii, uncus, gnathos, and saccular setae; the possession of an elongate, tapered, and often curved aedeagus that is elaborated with dentate projections and non-deciduous cornuti (as in *Rhyacionia*); and a broad cucullus relative to the shortened valvae; in the female, the reduction of the lamella antevaginalis, and the anterior position of the ostium bursae in a deep incisure of the seventh sternite.

If classification is to be based on monophyly, then a group should include only and all the descendents of a given ancestor. Regardless of whether *Grapholita* Treitschke, *Corticivora,* and presumed relatives are considered a tribe or a subtribe, their recognition as a group should be based on shared apomorphic characters, be they reductions or elaborations. Grapholitini does not appear to be such a monophyletic group because of its apparent radiation from within the more advanced Eucosmini. Whether *Eucosma, Phaneta, Rhyacionia,* or other related genus is a sister group of *Cydia* and *Grapholita* is not postulated at present. It is also questionable that all the genera presently included in Grapholitini arose from a common ancestor. In addition to *Corticivora,* other anomalous Grapholitini genera include *Larisa* Miller, *Talponia* Heinrich, *Ricula* Heinrich, *Satronia* Heinrich, *Pseudogalleria* Ragonot, and *Dichrorampha* Guenée.

Although *Corticivora* was considered similar to *Gypsonoma* by Clarke (1951), the apparent similarities may be retentions of ancestral characters, e.g. forewing with separated veins and presence of rounded socii. Although the socii are superficially similar in both genera, they differ in their origin from the tegumen, laterally in *Gypsonoma* and dorsally in *Corticivora,* as in the advanced Eucosmini. The elongate and tapered aedeagus in *Corticivora* indicates a closer relationship with the advanced Eucosmini than with *Gypsonoma.*

A comprehensive study of the world fauna of "Grapholitini" is needed to resolve ancestral relationships and to associate the currently included genera with their sister groups. Until this is accomplished, the group should be recognized as one that appears to have radiated from the advanced Eucosmini and one that may be polyphyletic. The advantage of maintaining Grapholitini as a categorical name for the sake of convenience may well be offset by the obscuring of natural relationships among the genera.

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In addition to the collectors of *Corticivora* specimens, I acknowledge the cooperation of Donald R. Davis, Smithsonian Institution, Jerry A. Powell, University of California, Berkeley, and William E. Miller, University of Minnesota, in loaning specimens under their care. Illustrative and photographic assistance was provided by Amy Trabka, New York City, for Figs. 8 and 9, David Adamski, Mississippi State University, for Figs. 1, 4, and 7, and Victor Krantz, Smithsonian Institution, for Figs. 2, 3, 5, and 6. The Mississippi State University Electron Microscope Center, Greta Tyson, Director, made scanning microscopic examinations possible; the printing of micrographs by Michael L. Sullivan is appreciated.

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A NEW SPECIES OF *PLASTOSCIARA* (DIPTERA: SCIARIDAE)

WALLACE A. STEFFAN

Bishop Museum, P.O. Box 19000-A, Honolulu, Hawaii 96819.

Abstract.—A new species, *Plastosciara arenicola,* is described from Grant County, Washington. The xeric collection site and the unusual modification of the foretibia distinguish it from most other Sciaridae. Illustrations of this new species are included.

The new brachypterous sciarid described here was collected by David Carmean, University of Washington, in a dry sandy habitat in eastern Washington. These flies were most common about 5 cm above the ground on the Basin Sagebrush, *Artemisia tridentata* Nuttall but were also observed on the sand. Antlions also were common in the vicinity.

Although there are numerous brachypterous species of Sciaridae throughout the world, only one other known species, *Parapnyxia* (*Xenopnyxia*) *armata* Mohrig and Mamaev (1970), has the apex of the foretibia so extensively modified. *P. armata,* described from Turkmen, SSR, was also collected on sand.

The terminology used in the following description generally follows McAlpine (1981) and Steffan (1981). Detailed discussions of sciarid morphology are found in Steffan (1966). Authors previously have used "width" to describe the anterior-posterior measurement of the eye bridge: the correct term should be "length."

Plastosciara arenicola **Steffan, NEW SPECIES**
Figs. 1–2

Male.—Eye bridge complete, 1–2 facets long; interfacetal hairs short and sparse. Anterior vertex with 2 weak median setae. Antenna: flagellomeres with short necks, about ⅕ length of flagellomeres, hairs sparse and length subequal to width of flagellomeres, hyaline sensilla sparse; flagellomere 4 (Fig. 2e) about 2 times longer than wide. Face with numerous short setae. Clypeus with 2–3 very short setae. Palpus 2 segmented (Fig. 2f), segment 1 with dorsolateral setae and broad patch of numerous dorsal hyaline sensilla, sensory pit absent. Thorax: acrostichal and dorsocentral setae weak; scutellum well developed; posteroventral projection of anepimeron broad, subquadrate. Legs: Foreleg: length of femur 0.36 mm; tibia 0.33 mm; basitarsomere 0.19 mm; dorsal apex of foretibia spur-like (Figs. 2b, d) extending well beyond base of basitarsomere, anteroapical setae unmodified; tibial spurs, 1:2:2; hind tibial spurs slender subequal to width of tibial apex. Pretarsal claws simple. Wing: length 0.70 mm. Venation as in Fig. 2a. Anterior veins thickened. Posterior veins reduced. Halter well developed. Abdomen: tergal and sternal setae short and sparse. Terminalia as in Figs. 2g, h; gonostylus elaborate,

Fig. 1. *Plastosciara arenicola.* Habitus.

appearing bilobed apically with 2 strong medial spines; ejaculatory apodeme simple.

Female.—Unknown.

Holotype male (slide mounted).—Washington, Grant Co., Sand Hollow Creek, S of I-90 near Columbia River, 7 April 1979, D. Carmean (Alt. 800 ft., SW ¼

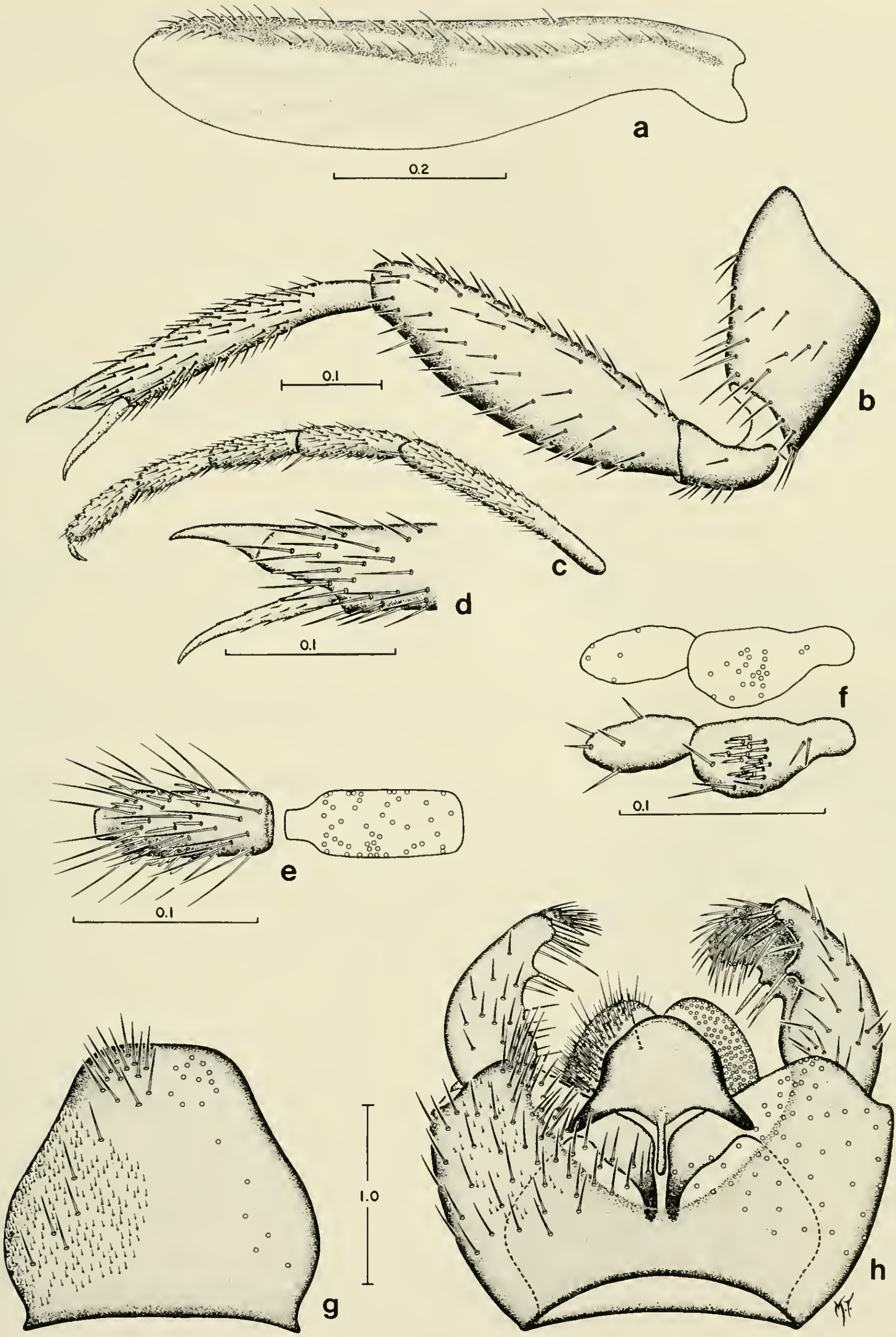

Fig. 2. *Plastosciara arenicola.* a, Wing. b, Coxa, femur and tibia of foreleg. c, Tarsomeres of foreleg. d, Apex of foretibia. e, Flagellomere 4. f, Maxillary palpus. g, Tergite 9. h, Male terminalia, ventral view; right gonostylus rotated to show mesal surface.

Sect of 27 T17N R23E, N. of State Highway 26, 2 mi SE of Vantagel). Paratypes, 3 slide mounted males, 4 males in alcohol, same data as holotype; males in alcohol, same data as holotype except 4 April 1980. The holotype and most of the paratypes are deposited in the James Entomological Collection at Washington State University, Pullman.

Systematics.—This species keys out to *Plastociara* in Steffan (1981), but this generic placement is questionable. It is placed in *Plastociara* pending a revision of the Nearctic Sciaridae. The male terminalia are similar in structure to those in some species of *Phytosciara* (*Prosciara*). *P. arenicola* can be distinguished from the one other Nearctic *Plastosciara, P. johnstoni* (Shaw), by the modified foretibia and the complex gonostylus.

Discussion.—Most Sciaridae are found in humid environments, so this species' presence in such a xeric habitat is unusual. The modification of the foretibia in *P. arenicola* and in *Parapnyxia armata,* the other known species inhabiting a xeric environment, suggests digging ability. Since females of both *P. arenicola* and *Parapnyxia armata* have not been found, they may be wingless.

Acknowledgments

I am grateful to Mark Thomas for preparing the illustrations and Cheryl Christensen for typing the manuscript.

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PROC. ENTOMOL. SOC. WASH.
86(2), 1984, pp. 291–294

A NEW SPECIES OF *HYPOMECIS* HÜBNER (LEPIDOPTERA: GEOMETRIDAE) FROM TEXAS AND FLORIDA

André Blanchard and Edward C. Knudson

(AB) 3023 Underwood, Houston, Texas 77025; (ECK) 808 Woodstock, Bellaire, Texas 77401.

Abstract.—A new North American geometrid moth, *Hypomecis longipectinaria,* is described and figured.

In the authors' series of *Hypomecis* Hübner (formerly *Pseudoboarmia* McDunnough) a group of specimens was found, which differ from all of the described species in several respects. At this writing, no female examples of the new species have been collected, but the superficial characters are adequately distinctive that the female should be easily recognized.

Hypomecis longipectinaria **Blanchard & Knudson, New Species**

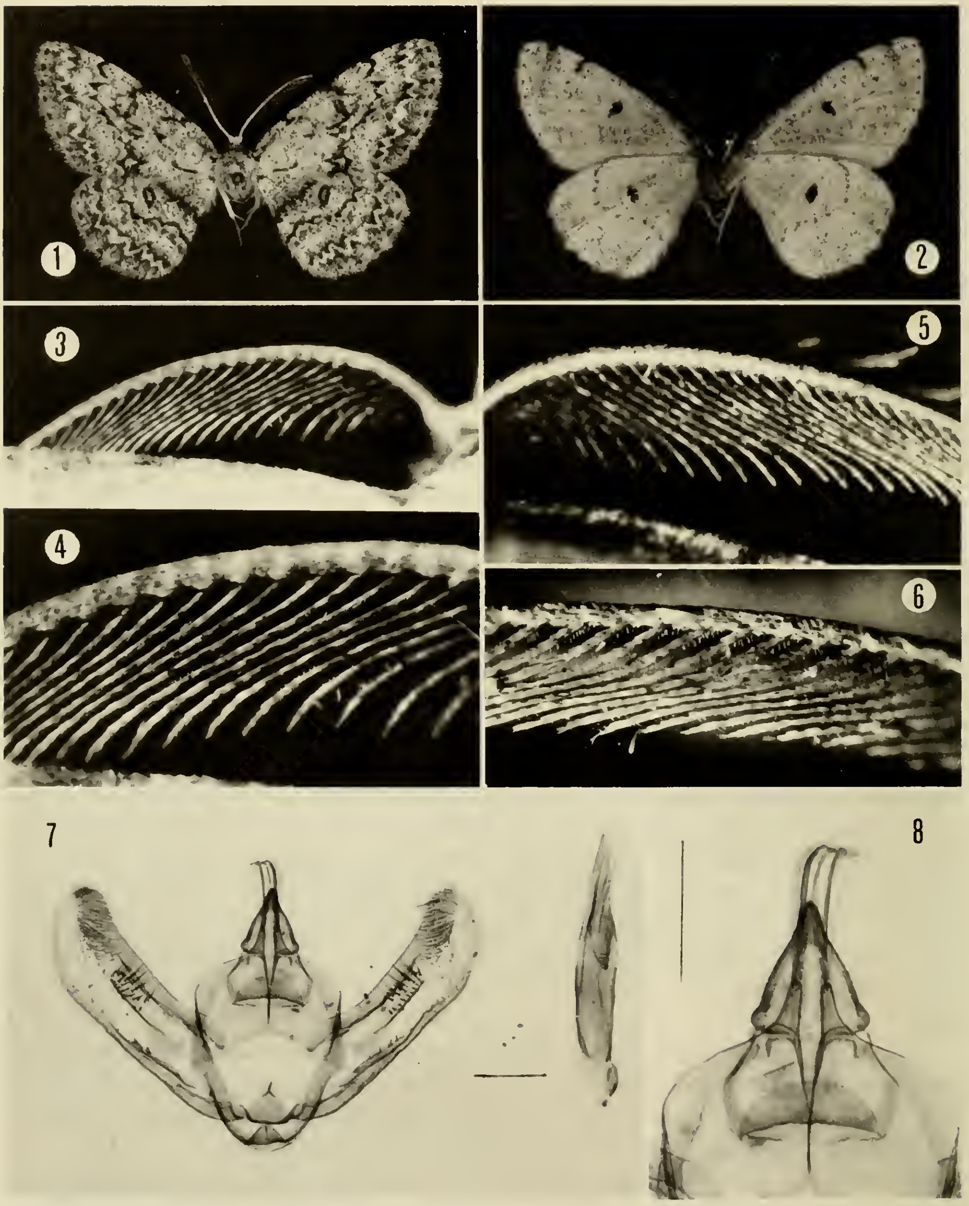
Figs. 1–8

Head: Front dark brown with whitish scaling at base just above tongue and a narrow band of whitish scaling at apex, anterior to antennae. Vertex brown; occiput whitish; collar dark brown. Labial palpi dark brown, barely exceeding front. Antennae with scape and dorsal surface of flagellum whitish; 40–46 segments (average number 43 segments (N = 8); bipectinate, except for terminal 7 or 8 segments, which are simple. Longest pectinations from 9.0 to 11.6 × as long as their basal segments (average 10.4, N = 8 specimens, N = 5 pectinations measured per specimen).

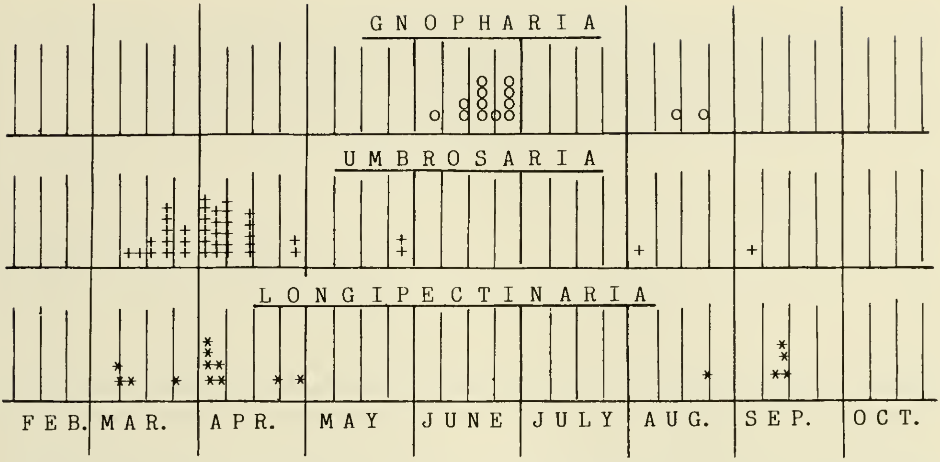
Thorax: Brownish white (cream color) to pale ochreous gray with scattering of fuscous scales, forming an indistinct dark band across tegulae. Legs concolorous, with darker scaling on anterior surface of forelegs. Hindtibia without hair pencil.

Abdomen: Concolorous, generally somewhat darker dorsally.

Forewings: Ground color brownish white to pale ochreous gray, suffused with fuscous. Maculation well represented and contrasted against pale ground. Antemedian line blackish brown; from costa at ⅕ distance from base; broadly angled outwardly over cell; angled inwardly to dorsum near base. Discal dot blackish brown, elliptical, with pale center. Median line blackish brown; from mid costa to mid dorsum, outwardly curved around discal dot, outwardly dentate on veins. Postmedian line blackish brown, from outer ⅓ of costa to outer ⅓ of dorsum, curving outwardly over cell, inwardly beyond mid disc to dorsum, sharply outwardly dentate on veins. Subterminal line blackish brown, margined outwardly with white, nearly vertical, outwardly dentate on veins. Terminal line consists of blackish brown dots on veins. Fringes pale ochreous gray.



Figs. 1–8. *Hypomecis longipectinaria* Blanchard & Knudson. 1, Holotype ♂, Texas, Montgomery Co., Conroe, 30-IV-70, A. & M. E. Blanchard coll., dorsal. 2, Same, ventral. 3, Lateral pectinations of left antenna of paratype, Texas, Montgomery Co., Conroe, 14-IX-77, E. Knudson coll. 4, Enlargement of basal ⅓ of antenna in Fig. 3. 5, Lateral pectinations of right antenna of holotype. 6, Medial pectinations of left antenna from specimen in Figs. 3, 4. 7, Genitalia of holotype ♂, aedeagus to the right, on slide AB 3215. 8, Dorsal view of genitalia of Fig. 7, enlarged to show processes of tegumen and terminal setae. Line segments in Figs. 7 and 8 represent 0.5 mm.



9.

Fig. 9. Temporal distribution of *Hypomecis gnopharia, umbrosaria,* and *longipectinaria* in Texas (from the authors' series). The symbols O, +, and * each represent one specimen.

Hindwings: Ground color and maculation similar to forewing, except for absence of median line and presence of prominent blackish brown extradiscal line.

Ventral surface of wings: Whitish brown to pale ochreous gray, discal dots strongly represented, postmedian lines well represented in half of the specimens examined, weakly represented or obsolete in remaining specimens.

Length of forewing: 15.0–19.5 mm (average 18.0 mm, N = 19).

Male genitalia (Figs. 7, 8): Uncus slightly longer than wide; valve with raised medial patch bearing 15 to 26 spines; saccular ridge bearing from 0 to 15 spines. Process of tegumen from 0.13 to 0.23 mm (average length 0.20 mm), terminal setae from 0.44 to 0.63 mm (average length .55 mm), average ratio of setae to process 2.40–3.70, average 2.75. Aedeagus slightly shorter than combined lengths of tegumen and uncus, vesica membranous.

Holotype (Figs. 1, 2).—♂, Texas, Montgomery Co., Conroe, 30-IV-70, genitalia slide AB 3215, collected by A. & M. E. Blanchard and deposited in the National Museum of Natural History.

Paratypes.—Same locality as holotype; 12-III-67, 1 ♂, genitalia slide AB 3213; 22-IV-69, 1 ♂, genitalia slide AB 3208; 22-III-72, 1 ♂, genitalia slide AB 3216; 9-IX-75, 1 ♂; 4-IV-76, 4 ♂, genitalia slide AB 5203; 14-IX-77, 1 ♂, genitalia slide AB 5304, all collected by A. & M. E. Blanchard. Same locality; 14-IX-77, 1 ♂; 9-III-82, 2 ♂, genitalia slides ECK 403, ECK 411; 10-IV-83, 2 ♂, all collected by E. Knudson. Texas, Tyler Co., Town Bluff, 15-IX-75, 1 ♂, collected by A. & M. E. Blanchard. Texas, Harris Co., Lake Houston, 22-VII-82, 1 ♂, genitalia slide ECK 475; Florida, Alachua Co., Gainesville, April 1972, 1 ♂, genitalia slide ECK 690; 21-VI-80, 1 ♂, all collected by E. Knudson.

Remarks.—This new species is very similar to both *Hypomecis umbrosaria* (Hübner) and *H. gnopharia* (Guenée), but can usually be differentiated by the much paler ground color of the wings and the noticeably longer pectinations of the male antennae. The male genitalia differs from all other North American species of *Hypomecis* in the length of the tegumen processes, their terminal setae, and their length ratio. According to Rindge (1973), the relative lengths of these processes and setae in the other four species are as follows: *luridula* (Hulst) setae from 6 to 15 times the length of the process; *buchholzaria* (Lemmer) setae 1½ times the length of the process; *umbrosaria* (Hübner) setae and process approximately equal in length; *gnopharia* (Guenée) process ¼ longer, on average, than setae. In *longipectinaria,* the setae range from 2.40 to 3.70 times the length of the processes, averaging 2.75.

Dr. Rindge, who reviewed the preliminary manuscript, made the suggestion that any information regarding the possible sympatry and synchronicity of *longipectinaria* and the two closely related species, *gnopharia* and *umbrosaria,* would prove to be of great interest. Accordingly, comparisons were made between *longipectinaria* and the authors' series of *gnopharia* and *umbrosaria.* All three species are sympatric in southeastern Texas (Harris and Montgomery counties); however, *gnopharia* and *umbrosaria* both have a much wider distribution in Texas, occurring in northeastern and central Texas as well. The habitat of *longipectinaria* appears to be confined to mixed evergreen and deciduous forest, whereas *gnopharia* and *umbrosaria* also occur in purely deciduous forest. The question of synchronicity is addressed in Fig. 9, which shows the dates of capture of each species in the authors' series. From this, it appears that in Texas *longipectinaria* and *umbrosaria* are synchronic, with a spring brood peaking in late March and early April and a smaller fall brood in August and September. *Hypomecis gnopharia* appears to have a very different temporal distribution, with a summer brood in June and possibly a fall brood similar to the other two species. As the above comparisons are made with a relatively small number of specimens, additional collecting may reveal a somewhat different pattern of distribution, both spatial and temporal. As *longipectinaria* is also known from Florida, it should occur in the intervening gulf coast states as well.

Ten genitalia preparations were made and measurements were made by ocular micrometer. Measurements of antennal pectinations (in situ) were made by ocular micrometer in six specimens and by photographic enlargement in two specimens. Figures 3, 4, and 6 represent the shortest pectinations measured; Fig. 5 represents the longest pectinations measured.

ACKNOWLEDGMENTS

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MATING BEHAVIOR AT BLOSSOMS AND THE FLOWER ASSOCIATIONS OF MIMETIC *TEMNOSTOMA* SPP. (DIPTERA: SYRPHIDAE) IN NORTHERN MICHIGAN

G. P. Waldbauer

Department of Entomology, 320 Morrill Hall, University of Illinois, 505 S. Goodwin, Urbana, Illinois 61801.

Abstract.—Adults of six species of vespoid-mimicking *Temnostoma* were taken from 11 species of blossoming plants. Over 96% of them were taken from *Anemone canadensis, Cornus stolonifera, Physocarpus opulifolius, Viburnum cassinoides* or *V. trilobum,* plants with large, white, conspicuous blossoms or compound inflorescences. Mating pairs of *Temnostoma alternans, T. balyras, T. barberi, T. venustum* and *T. vespiforme* were taken at these host plants, indicating that these species seek mates there. There is a pronounced sexual difference in behavior at the plants; most females were taken while feeding from blossoms while most males were taken while sitting on foliage or making patrolling flights about the plants. This is interpreted to mean that the males remain near the plants after feeding to intercept and mate with females, and that the females leave the host plants as soon as possible in search of oviposition sites. This interpretation is supported by direct observations of the mating behavior of *T. alternans,* and by the male-skewed sex ratios of the *T. alternans* and *T. vespiforme* samples taken from host plants.

Many species of Syrphidae visit blossoms to obtain nectar and pollen (Robertson, 1928a; Weems, 1953; Pollard, 1971; Gilbert, 1981; Owen, 1981). Nectar is presumably required for energy, and pollen is necessary to at least some species for normal ovarian development (Schneider, 1948; Frazer, 1972; Maier, 1978). Many Syrphidae, in common with many other insects (Parker, 1978), also seek mates at blossoms and other resources. Many males of both of the major syrphid subfamilies, the Eristalinae (= Milesiinae) and Syrphinae, make aerial patrols of blossoms frequented by females, often alternating the patrols with sitting on foliage. The males may pursue both conspecific and heterospecific flies in flight and often pounce on and swiftly initiate copulation with females feeding on blossoms (Gruhl, 1924; Collet and Land, 1975; Maier, 1978; Maier and Waldbauer, 1979a).

The mimetic eristaline Syrphidae, *Mallota bautias* (Walker), *M. posticata* (F.), *Somula decora* Macquart, and *Spilomyia hamifera* Loew, occur as adults in central Illinois from May to early July (Waldbauer and Sheldon, 1971; Waldbauer et al., 1977). In the mornings these species visit blossoms at the edge of the forest (Maier and Waldbauer, 1979a, 1979b). Both sexes feed from the blossoms, but females leave soon after feeding while males apparently remain much longer to sit on foliage and to make patrolling flights in search of females. This is indicated by the fact that in all four species about 90% of the females had been sitting on blossoms when they were captured, while from 75% to 94% of the males had been sitting on foliage or were flying when they were captured. These syrphids were mostly absent from the flowers in the afternoon. At that time, the males of *M. posticata* and *S. decora* were in the forest interior where they established territories at the larval habitats, wet, detritus-filled rot pockets at the bases of trees. They defended these territories against conspecific males and attempted to mate with females that came to the rot pockets to oviposit (Maier and Waldbauer, 1979a).

This study concerns the flower associations and the mate-seeking behavior at flowers of several species of the holarctic eristaline genus *Temnostoma*. All species of *Temnostoma* are specialized (high fidelity) mimics of vespoid wasps. Waldbauer and Sheldon (1971) and Waldbauer et al. (1977) defined specialized wasp mimics as having a wasp-like color pattern and one or both of the following characteristics: 1) a band of brown pigment along the costal margin of the wing simulating the furled vespoid wing, 2) some provision for imitating the long, dark antennae of the wasps. All North American *Temnostoma* have brown costal bands, and most, if not all of them, use their distally black forelegs to imitate long antennae.

Knowledge of the mate-seeking behavior of *Temnostoma* spp. is fragmentary. Maier and Waldbauer (1979a) reported that mating pairs of *T. trifasciatum* Robertson were found at flowers. Maier (1982) observed that *T. alternans* Loew and *T. balyras* (Walker) mated both at flowers and near the moist, decaying bole of a fallen tree, the habitat of the wood-boring larvae.

SAMPLING SITES AND METHODS

Collections of adult *Temnostoma* were made at three sites near the Straits of Mackinac (45°50′N, 84°50′W) in northern Michigan. The Reed Road site is inland, a transect in Emmet County that runs 10.5 km due south from a point 6.5 km south of Lake Michigan. The Wilderness site runs for 2.5 km along the shore of Lake Michigan in Emmet County. The Round Lake Road site (1 km long) is about 2.4 km north of Lake Michigan in Mackinac County on the opposite (north) side of the Straits. The locations of these sites are given in detail by Waldbauer (1983). The area was cut over early in this century and is now characterized by mixed stands of second growth coniferous and non-coniferous trees on the uplands and by spruce-tamarack bogs on the lowlands. The inland Reed Road site is significantly different phenologically from the two sites on or near Lake Michigan. The cooling effect of the lake delays the development of vegetation and the appearance of Syrphidae by more than two weeks at the latter two sites (Waldbauer, 1983).

Samples were taken with a hand net at forest edges on 15, 16 and 22 May, on every clear or partly clear day from 2 June to 18 August, and on 25 August and 4 September in 1982. Sampling usually began in the morning before syrphids appeared at flowers and continued until their numbers diminished from early to mid-afternoon. Each plant species in blossom was checked several times to determine if it attracted mimetic Syrphidae; plants that attracted them were sampled regularly as long as they were in blossom. Every specimen of *Temnostoma* seen was pursued; about 75% were caught. The specimens were segregated according to whether they were taken from a blossom, from the foliage of the host plant,

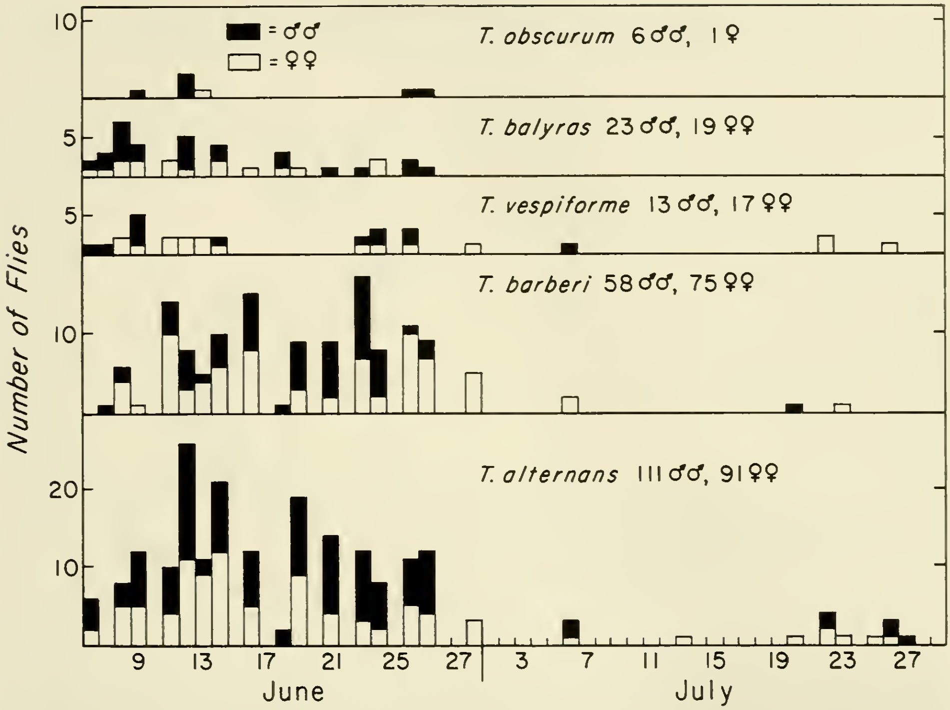

Fig. 1. The seasonal distribution of 5 species of *Temnostoma* taken from blossoming plants at the Reed Road site during the summer of 1982.

or in flight about the host plant. Mating pairs were kept together and mounted on the same pin. Syrphidae were identified by the author; voucher specimens are retained in his collection. Voucher specimens of the plants were deposited in the herbarium, Department of Botany, University of Illinois.

Results and Discussion

Flower Associations

Six species of *Temnostoma* were taken at blossoming plants: *T. alternans* Loew, *T. balyras* (Walker), *T. barberi* Curran, *T. obscurum* Loew, *T. venustum* Williston, and *T. vespiforme* (L.). *Temnostoma venustum* was taken only once, at the Round Lake Road site on 4 July. The other species did not differ greatly from each other in seasonal occurrence. At the Reed Road site they were abundant in June and, except for *T. obscurum* and *T. balyras*, were present in declining numbers in July (Fig. 1). *T. balyras* and *T. obscurum* appear to have had a shorter flight season than the others, but late-flying individuals may have been missed because these two species were far less abundant than the others. There was no clear tendency for one sex to appear before the other (Fig. 1).

While *Temnostoma* were taken from 11 plant species (Table 1), 96.2% of them came from only five species: *Anemone canadensis, Cornus stolonifera, Physocarpus opulifolius, Viburnum cassinoides,* and *V. trilobum.* All of these plants have white, open and highly visible blossoms with nectar and/or pollen readily acces-

Table 1. Blossoming plants on or near which 6 species of *Temnostoma* were captured during the summer of 1982. The total number of flies is given. A superscript indicates the number of mating pairs included in the total. Data in part from Waldbauer (1983).

	T. alternans	*T. balyras*	*T. barberi*	*T. obscurum*	*T. venustum*	*T. vespiforme*	Total
Anemone canadensis L.	58^7	7	48^1	3	0	10	126
Cornus alternifolia L.f.	0	0	4^1	0	0	0	4
C. rugosa Lam.*	2	0	1	0	0	1	4
C. stolonifera Michx.	44^1	18^2	22	3	0	13	100
Nasturtium officinale R. Br.	0	0	1	0	0	0	1
Pastinaca sativa L.	10	0	2	0	0	3	15
Physocarpus opulifolius (L.)*	144^9	2	44	5	0	29	224
Rhus glabra L.	0	0	1	0	0	0	1
Viburnum cassinoides L.**	63^3	2	31^1	1	2^1	33^2	130
V. lentago L.	0	2^1	0	0	0	0	2
V. trilobum Marsh.	64^5	14	31^2	1	0	3	113
Totals	383	45	185	13	2	92	720

* Collections from Wilderness site only.
** Collections from Round Lake Road and Reed Road sites.
All other collections from Reed Road only.

sible; all but *A. canadensis* have large, actinomorphic, aggregate inflorescences and all but the herbaceous *A. canadensis* are woody shrubs. *A. canadensis* plants bear single blossoms with large and conspicuous petal-like sepals. Robertson (1928b) and Weems (1953) observed that the great majority of flowers visited by North American Syrphidae have white, yellow or green blossoms. Many of the syrphid flowers listed by Robertson (1928a) and Weems (1953) also have aggregate inflorescences. It appears from Table 1 that *T. alternans* and *T. vespiforme* may have a preference for *P. opulifolius* and *V. cassinoides*. However, this is not a fair conclusion because the various plants listed blossomed at different times and places.

The different species of blossoms exploited by the *Temnostoma* spp. more or less succeeded each other as the season progressed, the population of flies shifting from one plant species to another as each passed its blossoming peak. This is well illustrated by the data for *T. alternans* from the Reed Road site (Fig. 2). The collections from *A. canadensis,* which has an exceptionally long blossoming period, show the decline of the *T. alternans* population in July. The last few individuals appeared on *Pastinaca sativa,* an introduction from Europe, in late July (Fig. 2). It is improbable that they represent a partial second generation because the development of the wood-boring larva is probably too slow to permit two generations per season. Maier (1978) found that the larvae of *Mallota posticata,* which live in rot cavities in trees, require 2.5 to 3.5 months to complete larval development. *P. sativa* continues to blossom at a time when native syrphid flowers have become scarce or absent; its introduction may well have fostered the survival of late-emerging *Temnostoma.*

Mate Seeking at Blossoming Plants

The samples taken at blossoming plants include mating pairs of five of the six species of *Temnostoma* that are known to occur in northern Michigan, proving

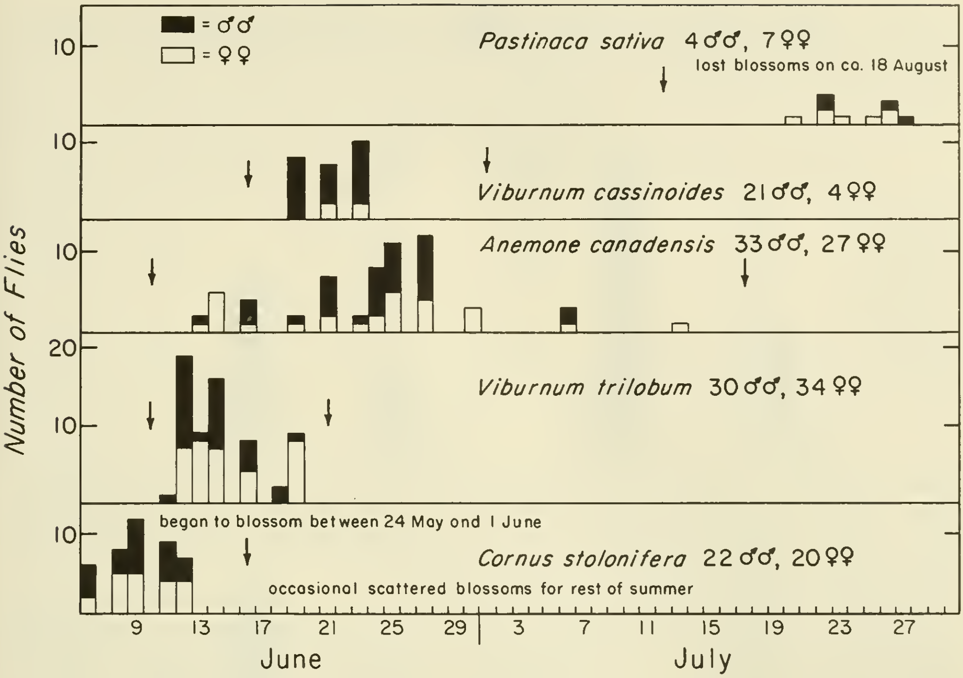

Fig. 2. Seasonal distribution of *Temnostoma alternans* on its major host plants at the Reed Road site during the summer of 1982. Arrows indicate the approximate first and last dates of the blossoming period of the plants from which the flies were collected.

that these species mate at or near the flowering plants that they visit to obtain pollen and nectar. Some, if not all, of these species also mate at the oviposition sites (Maier, 1982). The number of mating pairs taken at each plant species is indicated by a superscript in Table 1. When caught, almost 64% were on blossoms, 33% were sitting on foliage, and only one pair was taken in flight (Table 2). There is a preponderance of pairs from blossoms because copulation is frequently initiated there, and because the females usually continue to feed while mating. The only specimens of the rare *T. venustum* taken during the study were a mating pair sitting in the end-to-end position on *V. cassinoides* foliage a few centimeters from an inflorescence. No mating pairs of the scarce *T. obscurum* were taken, but the sampling data (see below) suggest that they also seek mates at blossoms.

The samples of *T. alternans, T. balyras, T. barberi* and *T. vespiforme* are large enough to justify more detailed conclusions about the mating behavior of these species at their host plants. The individuals in these samples were categorized according to whether they were taken in flight, from blossoms or from the foliage of the plant. All four samples show a pronounced difference between the sexes in their behavior at the host plant (Fig. 3). The majority of the females, from 57% in *T. balyras* to 86% in *T. vespiforme,* were taken while they were feeding from blossoms. Almost all of the remaining females were taken from foliage. Males, conversely, were taken from blossoms only from 12% to 20% of the time. The distribution between the "foliage" and "flight" categories of males taken while they were not feeding varied with the species (Fig. 3). There is little doubt that

Table 2. Numbers of mating pairs of 5 species of *Temnostoma* that were caught while flying near or sitting on the blossoms or foliage of their host plants during the summer of 1982. The plants are those in Table 1. Specimens taken at the Reed Road, Wilderness and Round Lake Road sites are included.

	Position when caught:				
	On blossom	On foliage	In flight	Unknown	Total
T. alternans	16	8	1	0	25
T. balyras	2	1	0	1	4
T. barberi	3	2	0	1	6
T. venustum	0	1	0	0	1
T. vespiforme	2	0	0	0	2
Totals	23	12	1	2	38

the great majority of both sexes taken from blossoms were actually feeding. Periodic observations showed that few individuals simply sat still on an inflorescence. They usually moved from blossom to blossom, and many of them were observed probing blossoms with their mouthparts.

Chi square tests of independence show that the behavior of all of these species except *T. balyras* differed significantly by sex. The *T. alternans* and *T. vespiforme* data were tested using 3 × 2 contingency tables with the "blossom," "foliage" and "flight" categories entered separately. Three × 2 contingency tables for *T. balyras* and *T. barberi* included an unacceptable number of cells with expected values below 5; therefore, the data for these species were tested using 2 × 2 tables (1 df continuity corrected (Sokal and Rohlf, 1969, p. 566)) with the "foliage" and "flight" categories lumped as a "non-feeding" category. (*T. alternans*: $\chi^2 = 156$, $P < 0.005$; *T. vespiforme*: $\chi^2 = 33$, $P < 0.005$; *T. balyras*: $\chi^2 = 3.5$, $P > 0.05$; *T. barberi*: $\chi^2 = 38$, $P < 0.005$.)

Two factors, both of which relate to the sexual difference in parental investment (Blum and Blum, 1979), probably contribute to the difference in the proportions of males and females captured at blossoms. First, females presumably spend more time feeding than do males. They probably require a greater food intake than males because the females are larger and because they produce a much greater biomass of gametes. It seems, however, that a second factor, a sexual difference in mating behavior, probably accounts for most of the difference. The males, which can greatly increase their fitness by mating repeatedly and thus fathering more progeny, remain at the host plant after they finish feeding, taking waiting stations on foliage or making patrolling flights to intercept females. The females, however, apparently leave the host plant as soon as possible in search of oviposition sites.

Sexual differences in mating behavior at the host plants are also indicated by the male-skewed sex ratios in the *T. alternans* and *T. vespiforme* samples and by direct observations of the behavior of *T. alternans.* Males greatly outnumbered females in the *T. alternans* and *T. vespiforme* samples (Fig. 3), the sex ratios departing significantly from 1.0 ($\chi^2 = 57$ and 9, respectively, $P < 0.005$). The true sex ratios of the populations are not known, but the assumption of a 1.0 ratio is supported by Maier and Waldbauer's (1979a) finding that the sex ratios of four

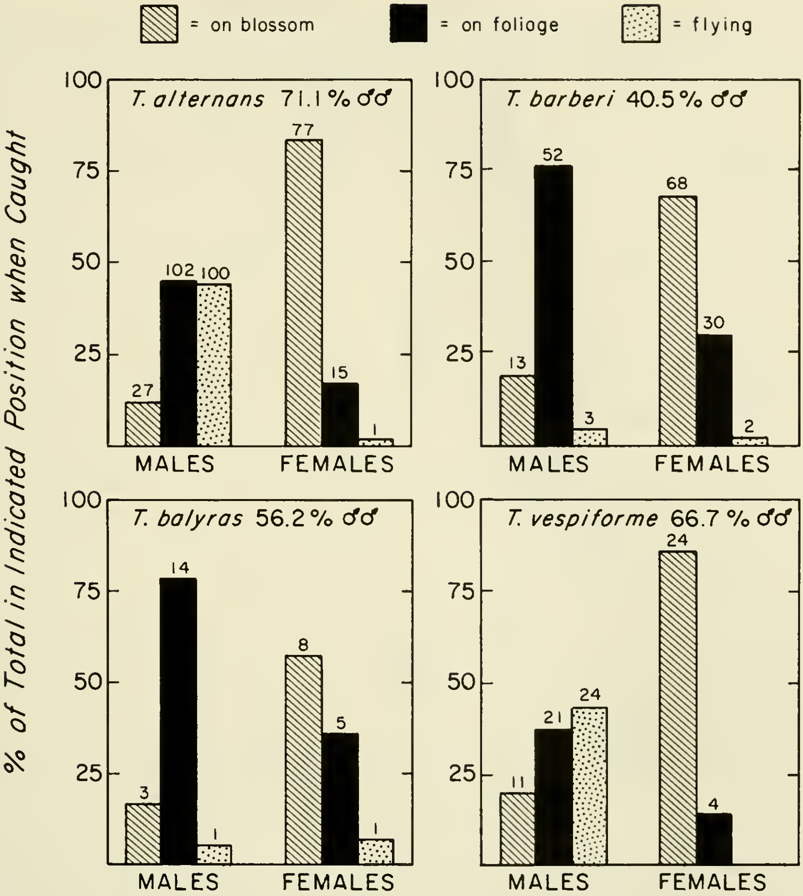

Fig. 3. Percent of each sex of 4 species of *Temnostoma* that were caught while flying near or sitting on the blossoms or the foliage of the plants in Table 1. Sample size is given above each bar. The percent of males in each sample is indicated. Specimens taken at the Reed Road, Wilderness and Round Lake Road sites during the summer of 1982 are included.

other eristaline Syrphidae reared in the laboratory did not depart significantly from 1.0. The skewed sex ratios might be taken to indicate that males were more easily seen than females because of their greater mobility. However, females were actually more conspicuous than males because they are larger and because they were more frequently on the white inflorescences where contrast rendered both sexes more visible than on foliage or in flight. It is much more likely that males outnumber females in the samples simply because the males spend more time at the host plants.

The sex ratios of the *T. balyras* and *T. barberi* samples were not significantly skewed in favor of males (Fig. 3). *T. balyras* males outnumbered females, but the difference is not significant ($\chi^2 = 0.5$, $P > 0.5$). *T. barberi* females significantly outnumbered the males ($\chi^2 = 6$, $P < 0.025$). The difference in sex ratios between the samples of these two species and *T. alternans* and *T. vespiforme* may well be

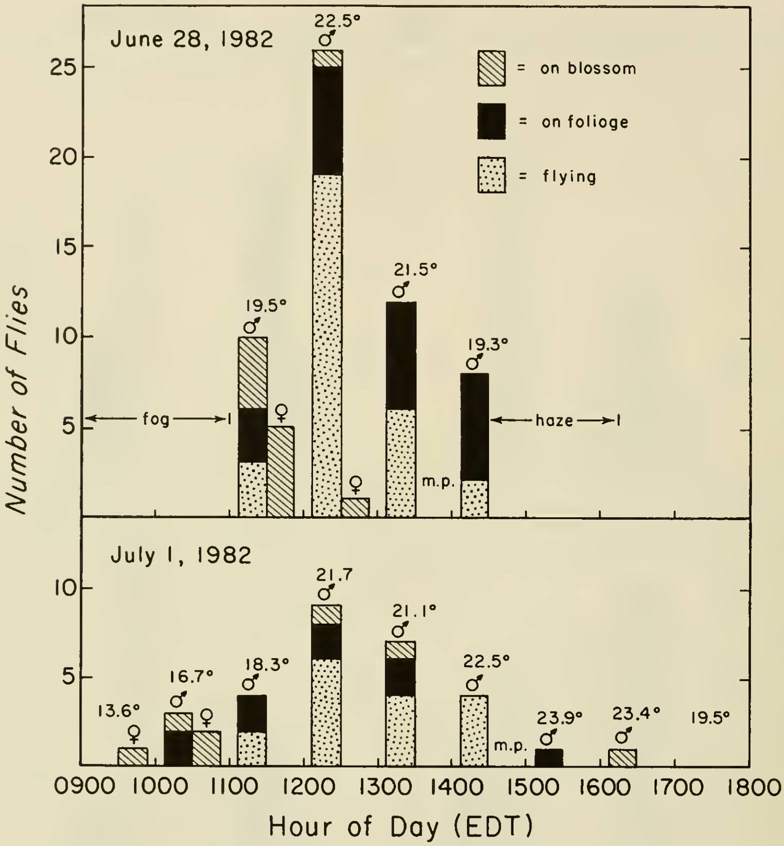

Fig. 4. Number of each sex of *Temnostoma alternans* that were caught hourly while flying near or sitting on the blossoms or the foliage of *Physocarpus opulifolius* at the Wilderness site. The temperature at breast height in the shade is indicated over all hours in which samples were taken. On 1 July samples were taken during the second half of each hour. On 28 June they were taken during the entire hour. M.P. indicates that a mating pair was taken.

real, but it could be at least partly the result of sampling bias. *T. balyras, T. barberi* and *T. obscurum* are all similar in size and appearance. They are darker than either *T. alternans* or *T. vespiforme* and are also much smaller, especially the males. Thus, while individuals on blossoms (mainly females) are almost as conspicuous as the larger species, individuals in flight or on foliage (mainly males) are relatively difficult to see. The question of sampling bias will be resolved only by direct observations of the behavior of these small species.

Direct observations of the behavior of *T. alternans,* which was abundant, large, and distinctive enough to be identified in the field, corroborate the results of the sampling procedure. In the samples (Fig. 3) about 43% of the *T. alternans* males were taken in flight and about 44% were taken from foliage. Observation also showed that males divide their non-feeding activity between sitting on foliage and making patrolling flights in search of females. It was not possible to observe the males' entire flight paths around large clumps of tall shrubs, but on many occasions males were seen to fly circuits about patches of *Anemone canadensis,* an herb that is only about 45 cm tall. On another occasion 12 males were observed in early afternoon on a clump of short *V. cassinoides* shrubs about 3 m in diameter. They generally alternated 10–25 second bouts of sitting on foliage with patrolling flights of about the same duration around the shrubs. Patrolling males seemed to pay particular attention to blossoms. On several occasions males patrolling various host plants pounced on females feeding on blossoms. The pairs coupled almost immediately, with the male on top of the female and both facing in the same direction. Shortly thereafter they switched to the end-to-end position. The females then usually continued to feed as they pulled the males over the blossoms. Some of these females flew to other inflorescences, dragging the males behind them. In a few instances a second male landed on a pair on an inflorescence and attempted to copulate with the female. Patrolling males also made brief attempts to copulate with other males and more persistent attempts to copulate with recently killed females that the author placed on inflorescences.

The activities of *T. alternans* at the host plant varied with the time of day. During the cool of very early morning a few individuals were seen basking in the sun on leaves. Females were numerous only in early morning, but occasional mating pairs and lone females were seen later in the day. Both sexes were most likely to be feeding in the morning. Males devoted the largest portion of their time to patrolling flights in late morning and early afternoon. On clear warm days the number of *T. alternans* present declined quite noticeably after noon, although a few individuals were present until late afternoon. It is likely that most males retreated to the forest to seek females at oviposition sites as reported by Maier (1982). The activity patterns at host plants are illustrated by Fig. 4. July 1 was clear and sunny throughout and shows the activity pattern typical of such days. On July 28 flies were absent during the foggy early morning and the hazy afternoon.

Temnostoma vespiforme was much less abundant than *T. alternans* and, although this species can be distinguished in the field, there were relatively few opportunities to observe its behavior. Males rest on foliage and make patrolling flights of the host plants, and females continue feeding as they mate. Few observations were made of the behavior of *T. balyras* and *T. barberi* because it was not possible to distinguish these species in the field. However, the samples of these species (Fig. 3) indicate that the males make far fewer patrolling flights than do males of *T. alternans* and *T. vespiforme.* It is probable that *T. balyras* and *T. barberi* normally intercept females from waiting stations on foliage. However, it is possible that the number of these males in flight was underestimated because their dark color and small size make them difficult to see in flight. Only 12 males and one female of *T. obscurum* were taken in the samples, but even this small sample suggests that, like *T. balyras* and *T. barberi,* the males engage in mate-seeking behavior at the host plants. All of the *T. obscurum* males were taken from foliage and the one female was taken from an inflorescence.

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THE TAXONOMIC STATUS OF *LOTOPHILA* LIOY, WITH A REVIEW OF *L. ATRA* (MEIGEN) (DIPTERA: SPHAEROCERIDAE)[1]

Allen L. Norrbom and Ke Chung Kim

The Frost Entomological Museum, Department of Entomology, The Pennsylvania State University, University Park, Pennsylvania 16802.

Abstract.—*Lotophila* Lioy, the senior objective synonym of *Olinea* Richards, is resurrected as a monotypic genus for *L. atra* (Meigen). A detailed redescription of *L. atra* is given and its phylogenetic relationship within the subfamily Copromyzinae is discussed. Information on its distribution and biology are compiled and a lectotype is designated.

Lotophila atra (Meigen) is a common coprophagous species in much of the Holarctic region. It is easily recognized from other Copromyzinae by the absence of an apical spur on the hind tibia and the presence of 4–5 pairs of stout marginal scutellar setae.

Originally described in the genus *Borborus* (Meigen, 1830), *L. atra* was confused for many years with the unrecognizable nominal species *Scatophora carolinensis* Rob.-Desv., *Olina hirtipes* Rob.-Desv., and *Borborus geniculatus* Macquart. Duda (1923, 1938) and Richards (1930, 1961) largely clarified its taxonomic status, and Richards (1961) placed it in *Olinea* Richards, a monotypic subgenus of *Copromyza* Fallén (s. lat.). *Olinea,* however, is a junior synonym of *Lotophila* Lioy (1864), a genus proposed for *Borborus lugens* Meigen and a second, unrecognizable species, *B. punctipennis* Meigen. Richards (1930) designated *B. lugens* as the type species of *Lotophila,* however, Duda (1923) considered *B. lugens* a junior synonym of *B. ater* Meigen. After examining the type specimens of both nominal species we share this opinion, thus *B. ater* becomes the type of *Lotophila,* making *Lotophila* the senior objective synonym of *Olinea.*

Although recent workers have continued to treat *Olinea* as a subgenus of *Copromyza,* it is our opinion that *Lotophila* should be given generic rank in the tribe Copromyzini. *Lotophila* is the sister group of the genera *Gymnometopina* Hedicke, *Dudaia* Hedicke, and *Metaborborus* Vanschuytbroeck. All four taxa share three apomorphic characters of the male: 1) a triangular, convex sclerite, here termed the postphallic sclerite, present between the basiphallus and sternite 10; 2) the genital arch (fused epandrium and sternite 8) without lateral clefts; and, 3) clefts at least partially separating the cerci from the genital arch. *Gymnometopina,*

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Dudaia, and *Metaborborus* share several additional apomorphies: a narrow, posterior lobe on the median part of sternite 6 of the male; the male cerci completely separated from the genital arch; absence of the genal seta; and the arms of the male hypandrium narrow basally, not broad and triangular.

Here, we redescribe the genus *Lotophila* and *L. atra* and discuss its geographic distribution and infraspecific variation. We use the morphological terms of Kim and Cook (1966) and McAlpine (1981).

Genus *Lotophila* Lioy

(*partim*) *Borborus auct.*; Meigen, 1830: 198–209.
(*nec*) *Scatophora* Robineau-Desvoidy, 1830: 811 (*fide* Duda, 1938: 16).
(*nec*) *Olina* Robineau-Desvoidy, 1830: 812 (*fide* Duda, 1938: 15–16).
Lotophila Lioy, 1864: 1113 (Type-species: *Borborus lugens* Meigen, by designation of Richards, 1930: 264, = *B. ater* Meigen).
Borborus (*Olina*); Duda, 1923: 58, 99–101.
Scatophora; Spuler, 1925: 1–3.
Copromyza (*Olina*); Richards, 1930: 263–264, 315–316.
Borborus (*Borborus*); Duda, 1938: 35–36.
Copromyza (*Olinea*) Richards, 1961: 561–562 (Type-species: *Borborus ater* Meigen).

Description.—*Male:* Head—largely pruinose, length about equal to height; genal seta small; postocular setae in single row. Thorax—acrostichal setae in two complete rows; scutellum with four to five pairs of marginal macrosetae, all about equal in length except slightly larger apical pair (Fig. 5); katepisternum without macroseta on upper part. Legs—hind tibia without ventral apical spur or anteroventral seta. Wing—cell dm elongate, crossvein dm-cu in apical third of wing; vein M reaching wing margin; vein Cu_1 ending short distance beyond dm-cu. Abdomen—sternite 8 and epandrium completely fused, no cleft in genital arch; hypandrial apodeme greatly reduced; cerci partly fused to genital arch; postphallic sclerite present between basiphallus and sternite 10; basiphallus with epiphallus greatly reduced. *Female:* Head, thorax, legs, and wing as in male. Abdomen—terminalia telescoped at rest; two spermathecae present, apodeme opposite duct opening small, its apex membranous.

Lotophila atra (Meigen)

Figs. 1–10

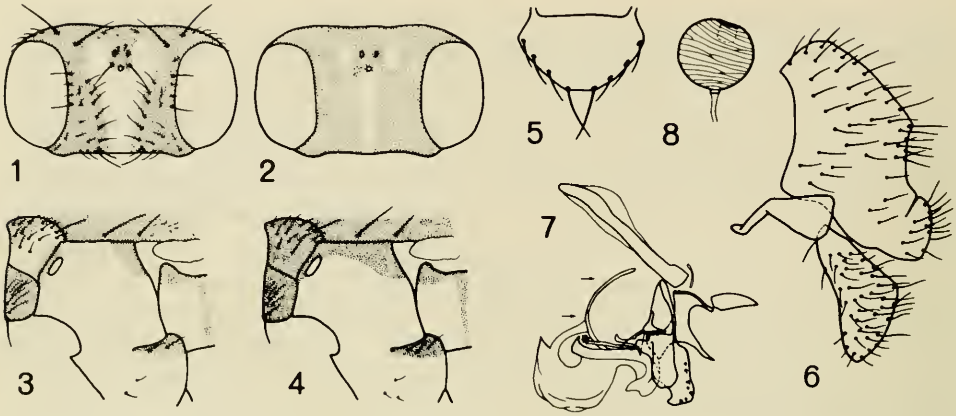
Borborus ater Meigen, 1830: 203.
Borborus modestus Meigen, 1830: 203 (*fide* Duda, 1923: 101).
Borborus lugens Meigen, 1830: 205.
(*nec*) *Scatophora carolinensis* Robineau-Desvoidy, 1830: 811 (*fide* Duda, 1938: 16).
(*nec*) *Olina hirtipes* Robineau-Desvoidy, 1830: 812 (*fide* Duda, 1938: 15–16).
(?) *Borborus geniculatus* Macquart, 1835: 567 (*fide* Richards, 1961: 562).
Lotophila lugens (Meigen); Lioy, 1864: 1113.
Olina ferruginea Becker, 1908b: 198 (*fide* Duda, 1938: 36).
Borborus (*Olina*) *geniculatus*; Duda, 1923: 99–101.
Scatophora carolinensis; Spuler, 1925: 1–3.

Copromyza (*Olina*) *hirtipes*; Richards, 1930: 315–316.
Borborus (*Borborus*) *ater* Meigen; Duda, 1938: 35–36.
Copromyza (*Olinea*) *atra* (Meigen); Richards, 1961: 562.

Type-data.—Syntypes of *B. ater* and *B. lugens* were examined. *ater:* Lectotype ♂ (here designated) and 2 ♀ paralectotypes, each with a label with "Coll. Winth." in typing and "ater" in Duda's writing, a red "Type" label, and Duda's determination label with "Olina geniculata." According to Dr. Ulrike Aspöck (personal communication) there are 3 additional males in the type series in the Naturhistorisches Museum Wien. *lugens:* Lectotype ♀, labelled with "lugens," apparently in Meigen's writing. Becker (1902) reported 2 specimens of *lugens* in Winthem's collection in the Naturhistorisches Museum Wien, but Duda (1923) and Dr. Ruth Contreras-Lichtenberg (personal communication) found only the above specimen, which we designate as the lectotype.

Description.—Mostly blackish species, about 2.5–4.0 mm long; in general, macrosetae relatively short and stout. *Male:* Head–gena bare of pruinosity except along anterior and ventral margins, height about 3/5 of long diameter of eye; parafacials yellow; frons with entire anterior margin yellow, the rest blackish, pruinosity usually as in Fig. 1; arista pubescence 0.01–0.02 mm long. Thorax—proepisternum pruinose; postpronotal lobe usually with most of lateral portion bare of pruinosity; scutum pruinose, density sometimes varying, producing faint pattern of longitudinal stripes; one pair of dorsocentral macrosetae (prescutellars); anepisternum largely bare, usually as in Fig. 3; katepisternum bare except for posterior half of dorsal margin and narrowly along sternal suture; anepimeron with anterior 3/5 bare; scutellum pruinose. Legs—femora dark red-brown to black, except at extreme base and apex, posterior side largely bare of pruinosity; tibiae same color as femora, base and extreme apex yellowish; fore coxa usually with basal 1/3–1/2 brownish, the rest yellow; mid tibia with two small anterior macrosetae at about 2/5 and 2/3, small posteroventral at about 2/3, dorsal at about 7/8, and whorl of 7–8 preapicals at 9/10; hind tibia with small dorsal preapical at 9/10; fore and hind metatarsi without apical spurs. Wing—length subequal to body length; r-m at about 2/5–1/2 distance from bm-cu to dm-cu; crossveins unbanded. Abdomen—sternite 5 very irregularly shaped, anteriorly with broad internal projection, more developed on left side; sternite 6 with large posterior projection on right tip; cercus fused to genital arch, but with cleft from posterior corner to middle (Fig. 6); surstylus somewhat triangular in lateral view, relatively flat; basiphallus (Fig. 7) with very small epiphallus and sharply pointed pre-epiphallus arising at about its middle; distiphallus very complex, with numerous hooklike structures and long, thin, dorsal projection medially; paramere also complex, bilobed. *Female:* Head, thorax, legs, and wing as in male. Abdomen—tergite 5 narrow, about 3/10–2/5 as wide as syntergite; sternite 2 usually 1.5–2 times as wide as sternites 3 and 4; sternite 4 usually very weakly sclerotized; sternite 5 about 1/4–1/3 as wide as syntergite; tergites 6 and 7 and sternites 6 and 7 weakly sclerotized; intersegmental sections of terminalia with 3 lightly sclerotized longitudinal bands; spermatheca relatively small, surface sculptured with concentric rings, duct opening with small external collar (Fig. 8).

Biology.—Adults of *L. atra* have been found on dung of horses, cows, sheep, dogs, man, and pigs, as well as on carrion and decaying fungi (Howard, 1900;



Figs. 1–8. *Lotophila atra* (Meigen). 1,3,5,8, ♀, State College, Pennsylvania. 2,4, ♂, 10 mi. E. Toluca, Mexico. 6,7, ♂, Auburndale, Massachusetts. 1–2, Head dorsal view. 3–4, Anepisternum. 5, Scutellum. 6, Outer male genitalia, lateral view. 7, Inner male genitalia, lateral view. 8, Spermatheca.

Richards, 1930; Coffey, 1966). Only cow dung has been reported as a suitable substrate for larval development (Laurence, 1954, 1955; Schumann, 1962; Coffey, 1966; Poorbaugh et al., 1968; Papp, 1971), although considering the distribution of *L. atra,* other materials may also be utilized. We collected numerous individuals on a deer carcass in Rothrock State Forest, Pennsylvania, several miles from the nearest farms. Nevertheless, although we were able to rear *L. atra* on cow dung, females failed to oviposit in rotting mushrooms, decaying meat, carrion from a dead groundhog, and CSMA medium (putrifying mixture of wheat bran and alfalfa meal). Laurence (1954, 1955) studied the ecology of cow dung communities and reported seasonal variation in the abundance and time of development of *L. atra.* Females appear to prefer fresh cow dung for oviposition, as they are found on it much less commonly once it has begun to crust. The eggs are usually laid in crevices or on the underside of the dung. Adults of both sexes commonly rest on nearby grassblades and other low vegetation, typically near the top. As with many sphaerocerids, when disturbed, they will often crawl down into the vegetation rather than fly away. We have observed mating pairs on the nearby vegetation and on the cow dung itself.

Lotophila atra is sometimes terricolous, occuring in mouse runs, rabbit holes (Richards, 1930), and rodent burrows (Hackman, 1963). It also has been taken in soil traps (Papp, 1976; Rohácek, 1980). Richards (1930) recorded it throughout the year in Britain and it apparently is multivoltine in central Pennsylvania.

Lotophila atra may be dispersed by jet streams, as Glick (1960) collected it an airplane trap at 500 ft. in Illinois. Dave Reling (personal communication) has also taken it in an airplane net at 500 ft. over State College, Pennsylvania.

Schumann (1961, 1962) described the egg and larval stages of *L. atra* and Laurence (1954) reported *Pentapleura pumilo* Nees (Braconidae) as a parasitoid in England. Phoretic mites are uncommon on *L. atra,* although numerous histiostomatid hypopi were present on two males and three females examined from California (CAS, CNC) and on a female from Washington (WSU).

Infraspecific variation.—A few examined specimens exhibited an interesting pattern of variation in several characters. The series from Mexico differs from typical *L. atra* in the color of the fore coxa, which is almost completely brownish, and in pruinosity, with the bare area on the frons divided (Fig. 2), the postpronotal lobe completely pruinose, and the pruinose area on the anepisternum larger (Fig. 4). In the females, abdominal sternite 2 is no wider than sternite 3, and sternite 4 is as strongly sclerotized as the other sternites. In the males, the genitalia are almost identical to typical *L. atra,* but the marginal hooklike structures on the distiphallus are located at the base of the dorsal projection (same level as lower arrow, Fig. 7) and the posterior corner of the surstylus tends to be more acute in lateral view. Two males from Arizona appear to fit into a cline between the Mexican populations and typical *L. atra.* They resemble the Mexican specimens in all but anepisternal pruinosity, which is normal (Fig. 3). A male from Tibet also closely resembles the Mexican specimens except that the marginal hooks on the distiphallus are even higher on the dorsal projection (same level as upper arrow, Fig. 7) and the surstylus is not as acute posteriorly. Since similar variation apparently occurs independently in these widely separated populations, we regard them both as conspecific with typical *L. atra.*

Distribution.—*L. atra* occurs in most of the middle latitudes of the Holarctic region, extending further north in maritime areas, and further south at high elevations. Palearctic records include the Canary Islands (Becker, 1908a; Frey, 1958), the Madeira Islands (Becker, 1908b), the Azores (Hackman, 1960), the Faeroes, England, Scotland, Wales (Richards, 1930), Finland (Hackman, 1965), U.S.S.R.: Estonia and Latvia (Hackman, 1972), France (Séguy, 1934), Spain (Strobl, 1900), the Pyrenees, Corsica (Duda, 1923), the Balearic Islands (Papp, 1973b), Czechoslovakia (Rohácek, 1978), Hungary (Papp, 1971), Rumania (Richards, 1930), Greece (Vanschuytbroeck, 1962), Afghanistan (Richards, 1962), U.S.S.R.: Tadzhikskaya (Papp, 1979), Mongolia (Papp, 1973a), and U.S.S.R.: maritime region near Vladivostok (Petrova, 1968). Among the Palearctic specimens examined, only the one from Tibet noticeably extends the known range. In the Nearctic region *L. atra* occurs from Newfoundland south to Florida, west through the midwest and Great Plains, and throughout the west from British Columbia to California. It seems rare in the southeastern United States, but probably occurs throughout the northern and central mountains of Mexico.

Material examined.—726 specimens including 367 ♂ and 359 ♀. We list only those specimens of distributional or ecological significance; a complete list is available from the authors upon request. Lectotype, 2 paralectotypes of *ater*; lectotype of *lugens*; NORWAY: Bergen, 11.v.1922, 1 ♂ (UTA); SWEDEN: Pr. Jemtland, Aare, 16.vii.1929, 1 ♂ (USNM); SPAIN: Calicia Pontevedia, 23.viii.1979, 1 ♂ (USNM); SOVIET UNION: Zlatoust, Ufa, 27.viii.1927, 2 ♂ (USNM); CHINA: Yu-Long-Gong, Tibet border, 14,000 ft., 14.viii.1930, 1 ♂ (USNM); CANADA: BRITISH COLUMBIA: Bowser, 22.vi.1955, 1 ♀ (CNC); ONTARIO: Ottawa, Rockcliffe, "at bleeding maple," 20.iv.1955, 1 ♂ (CNC); NEWFOUNDLAND: Port Saunders, 6.viii, 1 ♂ 5 ♀ (AMNH); U.S.A.: WASHINGTON: Blue Mts., 8–11 mi. S. of Cloverland "reared from cow excrement," 30.vi.1956, 4 ♂ 6 ♀ (WSU); Colfax, "on pig excrement," 12.vii.1956, 1 ♂ (WSU); Pullman, "on pig excrement," 17.viii.1955, 1 ♀ (WSU); CALIFORNIA: Inyo Co., White Mts., 3100 m, 26.v.1973, 1 ♂ (CAS); Madera Co., Green Mt., 7600 ft., 20.viii.1971, 1 ♀ (CAS); Marin Co., Mill Valley, 25.ix.1965, 1 ♂ (CAS); San Diego Co., Rincon, 24.v.1937, 2 ♂ 1 ♀ (CAS); ARIZONA: White Mts., Coulter Ranch, 28.vi.1947, 1 ♂ (USNM); Alpine, 23.vi.1947, 1 ♂ (USNM); COLORADO: Electra Lake, 8400 ft., 29.vi.1919, 1 ♂ (USNM); MINNESOTA: Itasca St. Pk., 25.vi.1960, 3 ♂ (FEM); INDIANA: Lafayette, "on human excrement," v.1918, 1 ♂ (USNM); NEW HAMPSHIRE: Mt. Washington, 4800 ft., 14.vii.1958, 3 ♂ 1 ♀ (CNC); NEW YORK: Cold Spring Harbor, 2.vii.1931, 1 ♂ (ANSP); PENNSYLVANIA: Centre Co., "reared ex. cow dung," 15.v.1982, 7 ♂ 12 ♀ (FEM); State College, "airplane net at 500 ft.," 4.ix.1981, 1 ♂ (FEM); Mifflin Co., Rothrock St. Forest, "on deer carcass," 28.iv.1982, 4 ♂ 7 ♀ (FEM); WASHINGTON, D.C.: "on human feces," 16.v.1899, 1 ♂ 1 ♀ (USNM); NORTH CAROLINA: Swain Co., Mt. Collins, 5900 ft., "carrion," 17.v.1972, 1 ♂ 4 ♀ (SMC); TENNESSEE: Sevier Co., Gatlinburg, "carrion," 17.v.1972, 3 ♂ 2 ♀ (SMC); ARKANSAS: Washington Co., 26.iv.1969, 1 ♀ (UAF); GEORGIA: Black Rock Mt. St. Pk., 4.vii.1953, 1 ♀ (UTA); FLORIDA: Citrus Co., "cave," 25.vii.1895, 1 ♀ (USNM); MEXICO: Hidalgo, 10 mi. W. of Huachinango, 6650 ft., 22.viii.1962, 1 ♀ (KSU); Popocateptl, 12,000 ft., 11.viii.1936, 1 ? (USNM); Mexico, 10 mi. E. of Toluca, 8900 ft., 31.vii.1954, 6 ♂ 4 ♀ (CNC).

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We sincerely thank Ulrike Aspöck and Ruth Contreras-Lichtenberg of the Naturhistorisches Museum Wien for the loan of type material of *Borborus ater* and *B. lugens.* We are also indebted to the following institutions and individuals for the loan of study material: American Museum of Natural History, New York; Academy of Natural Sciences, Philadelphia (ANSP); California Academy of Sciences, San Francisco (CAS); Carnegie Museum of Natural History, Pittsburgh; Canadian National Collection, Ottawa (CNC); Illinois Natural History Survey, Urbana; Iowa State Univ., Ames; Kansas State Univ., Manhattan (KSU); Museum of Comparative Zoology, Harvard Univ., Cambridge, Massachusetts; Ohio State Univ., Columbus; South Dakota State Univ., Brookings; Steve Marshall, Guelph, Ontario (SMC); Univ. of Arkansas, Fayetteville (UAF); Univ. of Arizona, Tucson; Snow Museum, Univ. of Kansas, Lawrence; Univ. of Massachusetts, Amherst; U.S. National Museum, Washington, D.C. (USNM); Univ. of Texas, Austin (UTA); Washington State Univ., Pullman (WSU). Earlier drafts of this paper were kindly read by Karl Valley, A. G. Wheeler, Jr., Ginter Ekis, and Dave Shetlar. Thelma Brodzina typed the manuscript.

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NATURAL HISTORY AND EVOLUTION OF *LYCOPERDINA FERRUGINEA* (COLEOPTERA: ENDOMYCHIDAE) WITH DESCRIPTIONS OF IMMATURE STAGES

JAMES PAKALUK

Department of Entomology, Cornell University, Ithaca, New York; Present address: Department of Entomology, University of Kansas, Lawrence, Kansas 66045.

Abstract.—Information on feeding biology, reproduction, host specificity, and the evolution of *Lycoperdina ferruginea* LeConte is presented. This species, which is primarily a gasteromycetophage, is widely distributed throughout North America. A description of the larva and pupa, including illustrations, is included. Known fungal host associations for species of *Lycoperdina* are summarized.

Lycoperdina ferruginea is the only Nearctic representative of a genus otherwise known from the Palaearctic and Ethiopian Regions (Strohecker, 1953). Although previous authors (Blatchley, 1910; Lawrence, 1977; Peterson, 1960) have noted the association between the puffball beetle *Lycoperdina ferruginea* and the fruiting bodies of the gasteromycete *Lycoperdon,* little is known about the biology of this beetle. Herein, I discuss various aspects of the natural history and evolution of this species. The larva and pupa are described in detail and illustrated.

Most North American endomychids have secretive habits; thus, they are rarely collected. *Lycoperdina ferruginea,* however, is commonly encountered, sometimes in large numbers. Adults (Fig. 2) are distinguished from all other North American beetles thus: often feeding upon spores of Lycoperdaceae; large size (6–8 mm); distinct pronotal foveae, pronotum with a well-developed stridulatory membrane; apparently contiguous procoxae. Most members of *Lycoperdina* are believed to be associated with puffballs. In addition to a discussion of host specificity in *Lycoperdina ferruginea,* I briefly review and summarize known host associations for other species of *Lycoperdina.*

METHODS

For examination, larvae were cleared in warm Nesbitt's solution and mounted directly into Hoyers medium. Selected structures (mouthparts and legs) were disarticulated to allow more accurate interpretation. Magnifications up to ×1000 were used for observation and illustration. All larval illustrations were prepared with an American Optical Microstar compound microscope equipped with a drawing tube. Pupal illustrations were made with a Wild M-5 dissecting microscope and a drawing attachment. The adult habitus was prepared by tracing the image projected from a 2 × 2 transparency.

I examined about 1000 adults and vouched each with labels dated "1982." Figure 15 is a summary of the known distribution of *Lycoperdina ferruginea.* Localities which could not be readily located on a standard reference map were omitted, and all unique state records without more specific locality information are represented by large dots at the geographic center of the state or province. Precise collecting data are on file at the Cornell University Insect Collection, Ithaca, New York. Dates of collections and habitat information are summarized under "Natural History." Acronyms in Table 1 designate insect depositories for particular specimens and follow those proposed by Arnett and Samuelson (1969).

NATURAL HISTORY

Lycoperdina ferruginea has been collected during all months of the year, and I have commonly taken it in central New York from the fruiting bodies of puffballs. Most collections were from forest litter situations (Fig. 16) or directly from the sporocarps of Lycoperdaceae (Figs. 17, 18). Collections from other fungi are considered either accidental host associations or direct feeding upon non-preferred alternate hosts.

It is not clear how many generations *Lycoperdina ferruginea* has per year since pupae have been collected in February, May, and June; early instar larvae have been collected in October and December; and teneral specimens have been recorded from each month March through September inclusive. From these data, I believe *Lycoperdina* does not have discrete breeding periods; reproduction and development are dictated primarily by host availability. Development of puffballs is variable, but most begin fruiting in the late summer or early fall and the gleba matures soon thereafter. This is an important aspect of larval development, since feeding upon host spores cannot begin until the gleba is fully mature. The larval mouthparts are highly adapted for sporophagy, and Lawrence (1977) has referred to the mandibular morphology of this animal as a "spore mill." The mola is greatly enlarged (with numerous tubercles), and the mandibular apices are reduced and truncate. These two modifications are particularly well suited for feeding upon spores in a spore-filled medium, such as the mature gleba of puffballs. In general, the larval mouthparts are similar to the feeding systems of microphagous larval forms outlined by Lawrence (1977) and Lawrence and Newton (1980).

Lycoperdina ferruginea and other species of *Lycoperdina* are probably not obligatorily gasteromycetophagous, although they do exhibit a strong preference for puffballs. Table 1 shows the known host associations for species of *Lycoperdina.* It is not clear whether reports from non-Lycoperdaceae are accidental occurrences or actual records of mycophagy upon alternate, non-preferred hosts, since direct feeding was not observed and gut contents were not examined. It is not uncommon to collect *Lycoperdina ferruginea* from forest litter or debris. Therefore, single or infrequent host associations are questionable, since this species inhabits a microhabitat that is especially rich in decaying organic matter that may potentially serve as a substrate for fungal growth. Obligate gasteromycetophagy for this group should not be discounted due to the occurrence of these beetles on other hosts since host specificity for a particular species may vary geographically, or seasonally, or both (Newton, In press). For mycophagous Coleoptera, the larval stages generally have a more restricted diet, so it is possible that the larvae are obligate gasteromycete feeders while the adults tolerate a greater diversity of fungal hosts.

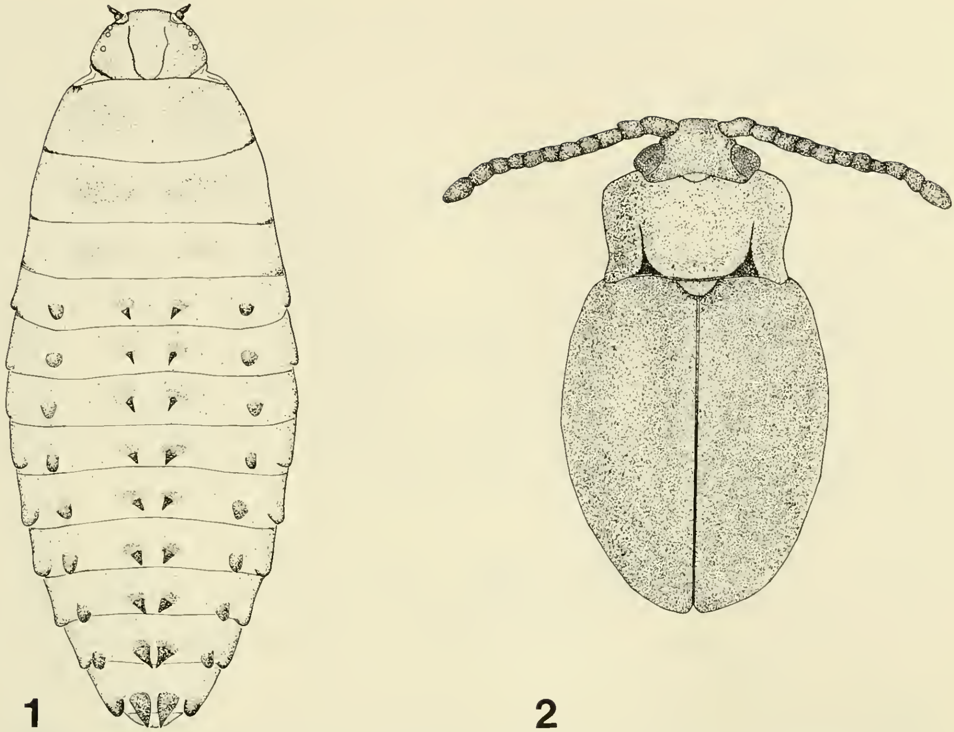
Table 1. Summary of known fungal associations for species of *Lycoperdina*.

Species	Fungus	Source
L. ferruginea LeConte	*Lycoperdon pyriforme*	Numerous sources
	L. perlatum	Pers. observ.[1]
	L. molle	Label data (LSUC)
	L. cf. *subvelatum*	Label data (LSUC)
	L. umbrinum	Pers. observ.[1]
	Peziza sp.	Label data (USNM)
	"Mushroom"	Label data (MCZC)
	Calvatia giganteum	Label data (FMNH)
	C. cyathiformis	Label data (LSUC)
L. penicillata Marseul	*Bovista plumbea*	Benick, 1952
	Lycoperdon gemmatum	Benick, 1952
L. succincta (Linnaeus)	*Lycoperdon gemmatum*	Benick, 1952
	Geastrum triplex	Sunhede, 1977
	Bovista nigrens	Horion, 1961
L. bovistae (Fabricius)	*Lycoperdon bovistae*	Benick, 1952
	L. excipuliforme	Rehfous, 1955
	L. caelatum	Benick, 1952
	L. gemmatum	Benick, 1952
	L. pyriforme	Benick, 1952
	Clitocybe splendens	Benick, 1952
	C. nebularis	Rehfous, 1955
	Bovista sp.	Ganglbauer, 1899
	Geaster fimbriatus	Rehfous, 1955
	G. rufescens	Rehfous, 1955
	Armillaria mellea	Rehfous, 1955
	Lactarius piperatus	Rehfous, 1955
	Russula delica	Rehfous, 1955
	Collybia fuscipes	Rehfous, 1955

[1] Host voucher specimens are deposited in the Herbarium of the Département de Botanique, Université de Liége, Liége, Belgium.

Acarid mites representing a new genus are commonly associated with this beetle and its fungal host. The deutonymph often occurs in large numbers inside the host fungus and is phoretic upon the adult and larva (Fig. 19). Reports of phoretic mites on beetle larvae are rare (Barry O'Connor, pers. comm.), and the significance of this behavior needs to be more fully examined. The adult mite is highly modified for life in a spore-filled puffball, since it "swims" through the ocean of spores with ease, but is incapable of walking outside the fruiting body (Barry O'Connor, pers. comm.). Deutonymphs of this mite species, or possibly a congener, were found on *Lycoperdina mandarinea* Gerstaecker from China (Barry O'Connor, in litt.). I have also collected acarid mites of yet another new genus from *Scleroderma citrinum* that was colonized by *Caenocara occulata* (Coleoptera: Anobiidae) in Tennessee.

The larvae of *Lycoperdina ferruginea* are relatively long-lived, and it is likely that most individuals overwinter as mid- to late-instar larvae. The fruiting bodies of most Lycoperdaceae are durable and often persist for a full year. Puffballs provide the larvae with a plentiful food source, as well as a stable habitat that

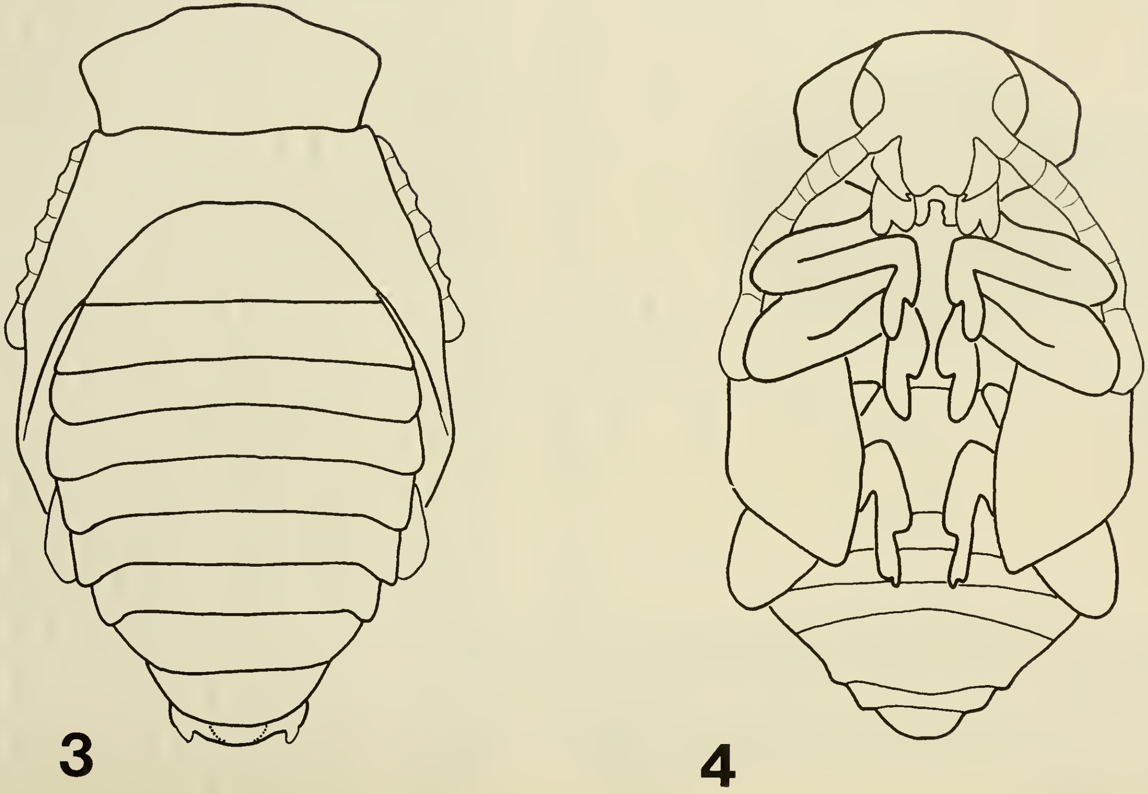


Figs. 1, 2. *Lycoperdina ferruginea.* 1, Larval habitus (dorsal). 2, Adult habitus (dorsal).

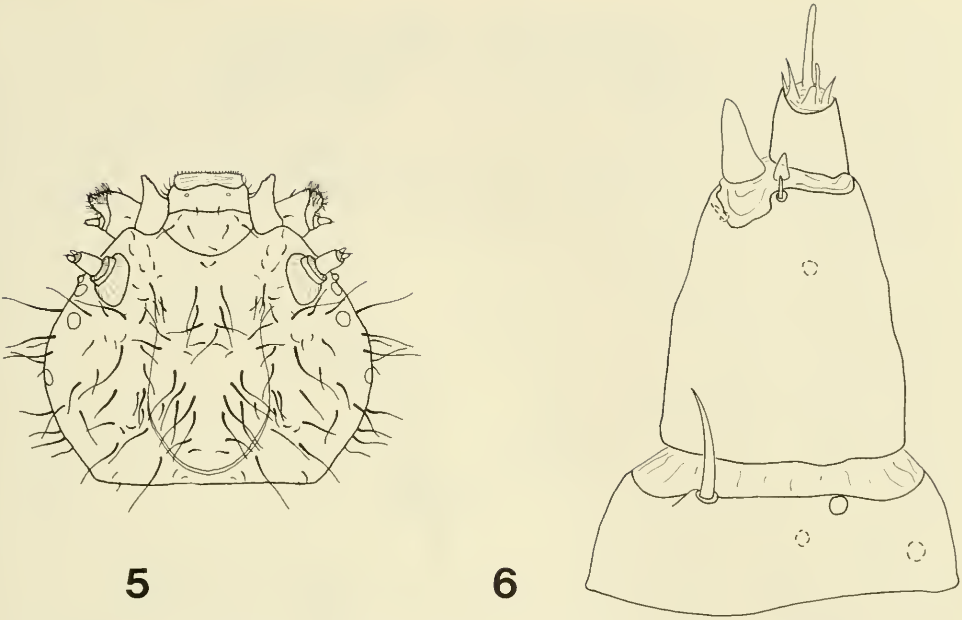
offers protection from predation and severe weather. The beetle pupates within the host fruiting body, and as many as eight pupae have been recorded in a single sporocarp, although the average is about three to four. The preferred location for pupation appears to be within the sterile base. Pupae are generally found within the spore mass only if available space within the sterile base has been utilized by other beetles which have burrowed into the spongy material.

Throughout their ontogeny, larvae frequently leave individual fruiting bodies and wander about, usually migrating to a different fruiting body. (Many species of *Lycoperdon* are gregarious and have large numbers of sporocarps in a small area (Fig. 18)). The larvae reenter a puffball to moult or feed. Their entrance into and their exit from the fruiting body is often via a hole that they have chewed through the peridium, although they also utilize the apical pore. Larval wandering behavior may contribute to spore dispersal in at least one of two ways. First, the larvae occassionally leave the external surface (peridium) of the puffball while wandering, so it is possible that their spore-covered bodies may brush spores onto an organic substrate, such as a rotting log. More important, however, is that the holes they chew in the peridium increase the likelihood of spore dispersal. Sunhede (1974, 1977) reports that similar gnaw-holes made by *Lycoperdina succincta* (Linnaeus) in *Geastrum triplex* enhance spore liberation.

The reasons for larval wandering in *Lycoperdina ferruginea* are unknown, but I will suggest three possible explanations for this behavior. 1) A small number of



Figs. 3, 4. *Lycoperdina ferruginea,* pupa. 3, Dorsal habitus. 4, Ventral habitus.



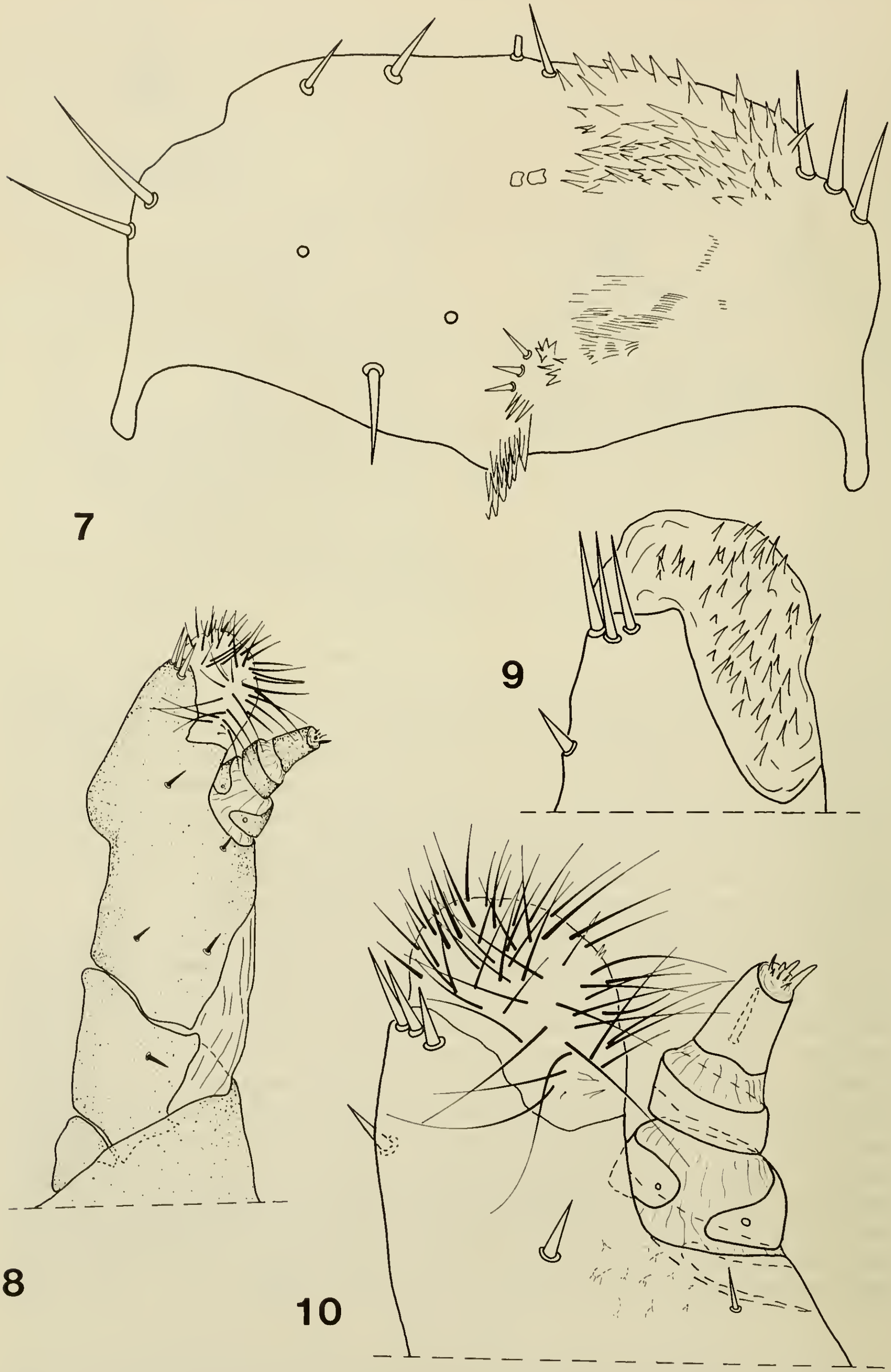
Figs. 5, 6. *Lycoperdina ferruginea,* larva. 5, Cranium (dorsal). 6, Antenna (ventral).

eggs are laid within a single fruiting body, but the food reserves within the puffball are insufficient for complete larval development. 2) Large numbers of eggs are deposited within each puffball, so the larvae must seek out nearby fruiting bodies for an additional, unexploited source of spores. 3) If a single female lays most or all of her eggs within a single fruiting body, and if food reserves within the puffball are sufficient for larval development, then wandering may be a device to prevent sib-matings. This presupposes that mating takes place, in at least some instances, before adults have left their puffball host following pupation.

The adults are predominantly brachypterous, although macropterous forms are present in low numbers. I selectively examined the wing condition of approximately 100 beetles from series that varied temporally and geographically. Both males and females were examined, and there was no genital variation among comparable forms. Only two macropterous individuals were recorded, one from Louisiana and the other from Michigan. From these data, I believe macroptery is maintained within the species at a low level. It should be emphasized, however, that fully winged forms are not necessarily capable of flight. Puffballs, or at least groups of puffballs, are somewhat isolated from each other, and their fruiting bodies are generally persistent for about a year. Thus, puffball feeders occupy stable habitats that are moderately isolated from each other. Both of these criteria are consistent with the conditions necessary to maintain a selective advantage for flight polymorphism within a species (see Harrison, 1980).

EVOLUTION

This section is based in part on the geological and climatological data for North America presented by Matthews (1979). Historical premises that I have accepted



Figs. 7–10. *Lycoperdina ferruginea,* larval mouthparts. 7, Epipharynx (left half) and labrum (right half). 8, Maxilla (ventral habitus). 9, Maxilla, mala (dorsal). 10, Maxilla, mala (ventral).

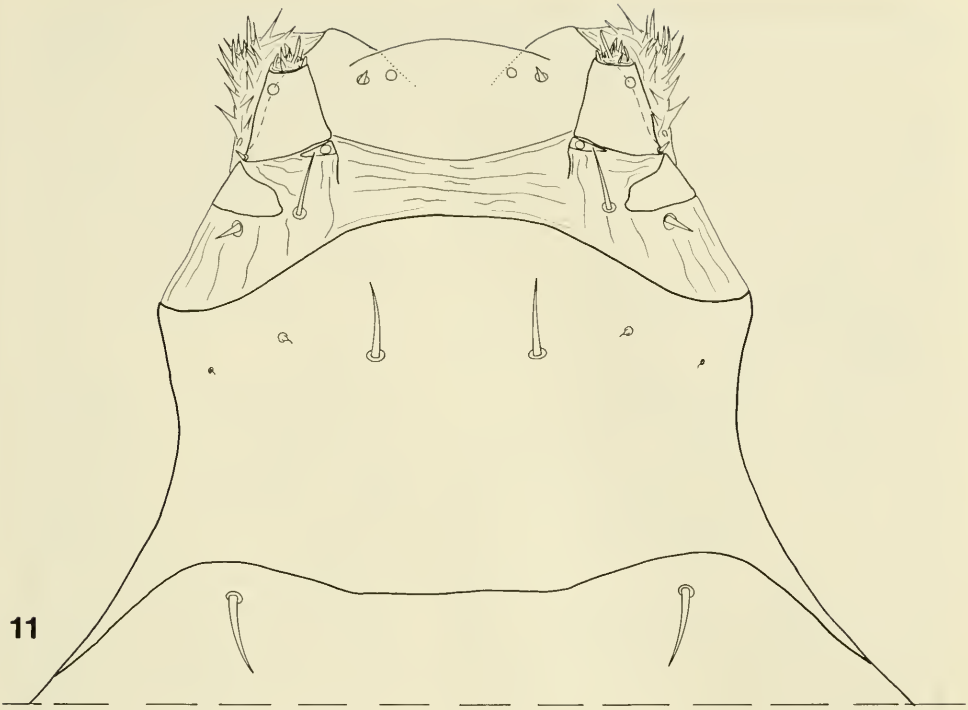


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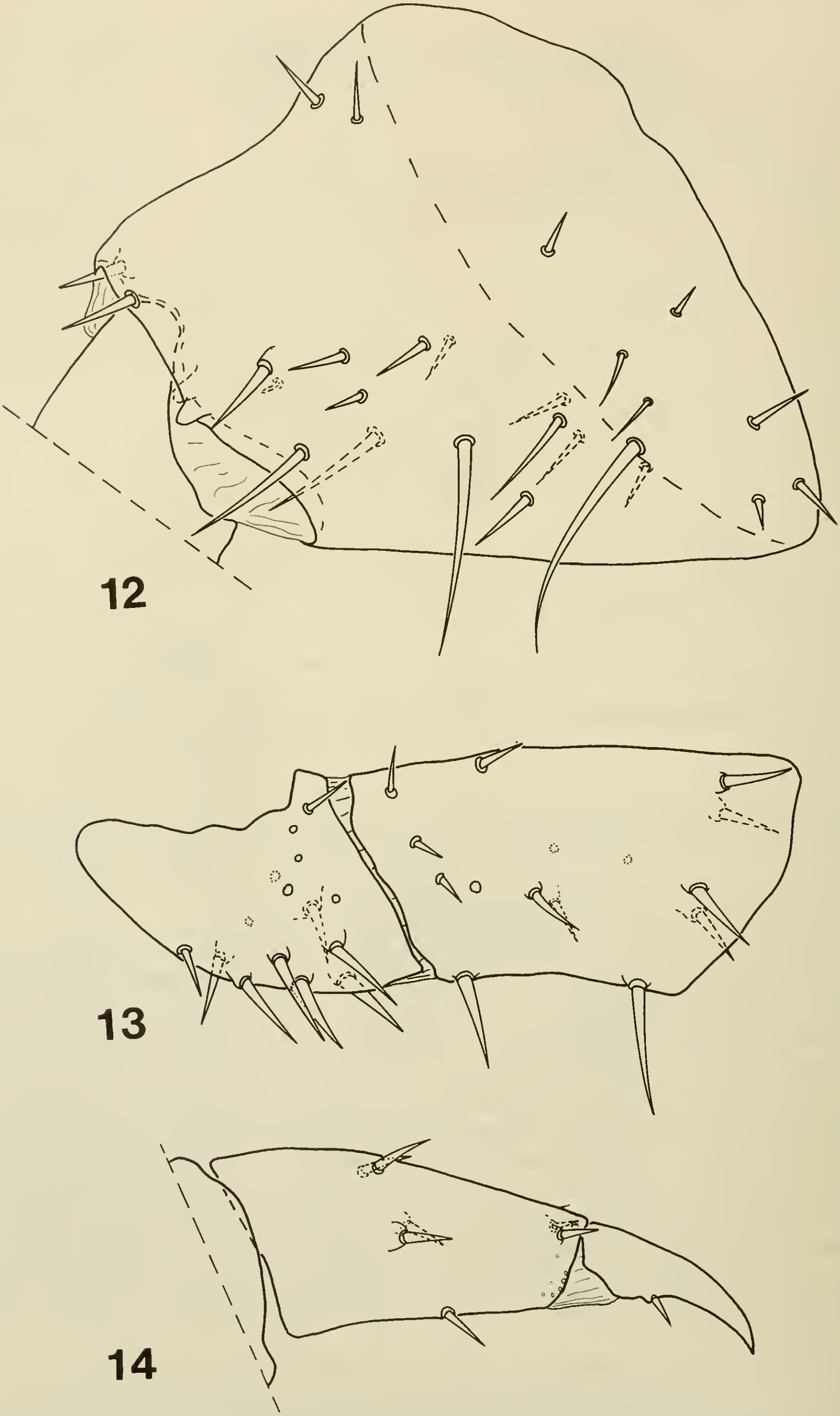
Fig. 11. *Lycoperdina ferruginea,* larval labium, distal portion of prementum (ventral).

which have influenced the following discussion and conclusions are: a redated Tertiary time scale placing the beginning of the Quaternary at about 1.6 million years ago, a recurring Beringian land bridge from the late Cretaceous until the late Pliocene, and a unique vegetational (and perhaps insect) character of each interglacial period, thus dismissing the concept of Geofloras.

Fossil *Lycoperdina* are known from the Oligocene (Strohecker, 1953), and this provides a minimum age for the genus. Given the relatively slow rate of evolution for *Lycoperdina* (see below), vicariance probably occurred between a widespread ancestral Beringian species about 3 million years ago. This event resulted in *Lycoperdina ferruginea* and its sister, probably the Siberian *L. koltzei* Reitter (see Strohecker, 1970). Puffballs were well established in North America at this time (Vincent Demoulin, in litt.), and they provided a widespread and abundant food source throughout the region east of the North American Cordillera and not much south of successive glacial advances. Genera preferring open grasslands and steppe, such as *Bovista* and *Calvatia,* may have been dominant in the north, while *Lycoperdon* was probably widespread and abundant in southern forested regions (Vincent Demoulin, in litt.). As the Wisconsin glaciation retreated about 10,000 years ago, *Lycoperdina ferruginea* began a northward migration extending to its present range.

Several speculations about *Lycoperdina ferruginea* and its relatives are: (1) Brachyptery is probably common throughout this group, but percentages of macropterous individuals may vary significantly both between species and between



Figs. 12–14. *Lycoperdina ferruginea*, larval leg. 12, Coxa. 13, Trochanter and femur. 14, Tibia and tarsungulus.

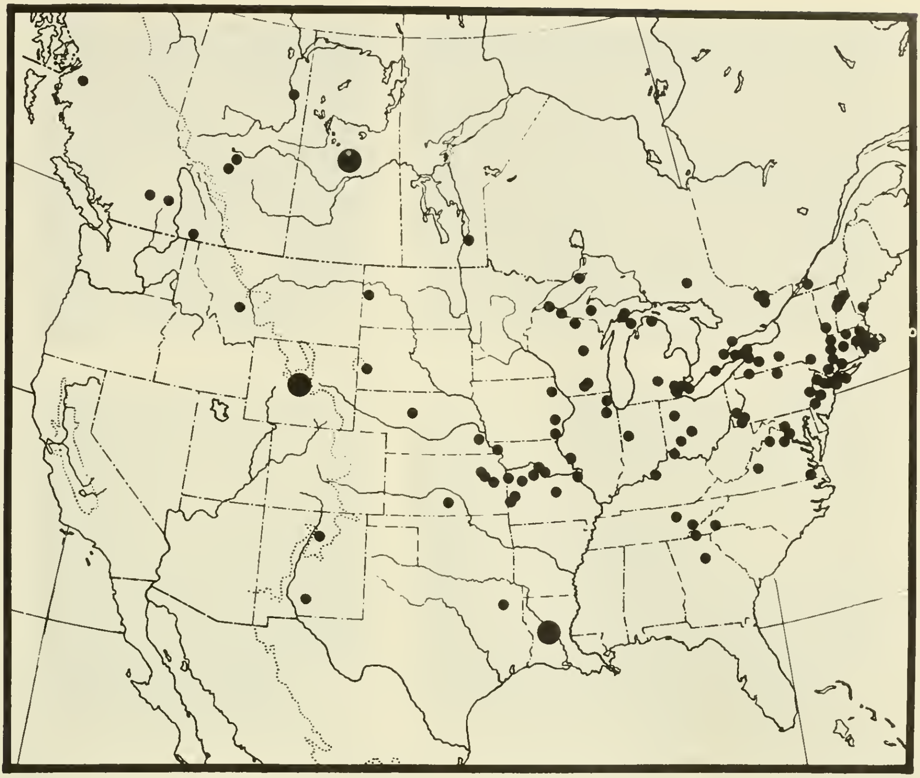


Fig. 15. Known distribution of *Lycoperdina ferruginea* in North America.

populations of a species.[1] (2) Based on out-group comparisons, brachyptery is an ancestral condition, thus consistent reduction of flight wings is a result of common ancestry rather than independent parallel loss. (3) Conditions selecting for brachyptery have probably changed in intensity through time, so Pleistocene *Lycoperdina* may have been almost entirely macropterous. Thus, they may have possessed strong and rapid dispersal capabilities.

Whitehead (1972) discussed two general patterns of speciation: islandic, which is relatively fast, and continental, which is relatively slow. Wheeler (1979) discussed gasteromycetophagy in relation to speciation patterns of *Creagrophorus* (Coleoptera: Leiodidae), and I concur that due to the widespread occurrence of puffballs (and possibly alternate, non-preferred hosts; see "Natural History") in suitable microhabitats, puffball feeders were probably unaffected by rapid climatic changes of the Pleistocene and thus demonstrate a continental pattern of speciation. Wheeler attributes the slow rate of speciation in *Creagrophorus* to the highly

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[1] Dr. Strohecker has kindly examined the wing condition for 11 species of *Lycoperdina*, and he reports the occurrence of aptery or brachyptery for all 11 species. The species he examined are: *L. angusta* Arrow, *L. apicata* Fairmaire, *L. castaneipennis* Gorham, *L. koltzei* Reitter, *L. mandarinea* Gerstaecker, *L. morosa* (Arrow), *L. mus* Arrow, *L. pencillata* Marseul, *L. pulvinata* Reitter, *L. succincta* (Linnaeus), *L. validicornis* Gerstaecker. I have also examined brachypterous specimens of *L. bovistae*.

Figs. 16–19. *Lycoperdina ferruginea* habitats. 16, Hardwood forest in central New York. 17, *Lycoperdon pyriforme* sporocarps on prostrate log. 18, *Lycoperdon pyriforme* with well-developed apical pores. 19, *Lycoperdina ferruginea* larva, with phoretic acarid mites, wandering on peridium of *Lycoperdon pyriforme.*

vagile winged adults. How might brachyptery affect rates of speciation within *Lycoperdina,* and given the present predominantly flightless condition, how could *L. ferruginea* have dispersed so thoroughly throughout North America?

If a high level of brachyptery is a post-Pleistocene condition, there is little difficulty explaining *Lycoperdina*'s extensive North American distribution. If, however, *Lycoperdina ferruginea* has a long history of almost complete brachyptery, is a transcontinental distribution by natural dispersal mechanisms possible? I think this phenomenon can be easily explained: macropterous individuals, although rare, are sufficiently represented to maintain adequate interdemic gene flow. Ball and Negre (1972) discovered similar conditions in North American *Calathus* (Coleoptera: Carabidae), and I agree that in predominantly brachypterous species, macroptery may be sufficiently maintained to instill good dispersal power. I believe the widespread distribution of *Lycoperdina ferruginea,* without apparent geographical variation, are indicators of adequate dispersal and gene flow that have retarded reproductive segregation.

Description of Last Instar Larva

With characters of Endomychidae (Lawrence, 1982). Length at midline about 10 mm; body elongate (Fig. 1); widest at middle, gradually tapering anteriorly and posteriorly.

Cranium (Fig. 5) about as long as wide; 4 pairs of ocelli. Frontal suture U-shaped, almost reaching posterior margin of cranium; coronal suture absent. Antenna (Fig. 6) small, reduced. Sensory appendage triangular, anteroventrad and subequal in length to antennal segment III. Antennal segment I short, broad; 1 ventral and 2 dorsal pores; 1 large ventral seta as in Fig. 6. Segment II longest; subcylindrical, slightly tapering distally; 1 dorsal pore; 1 small dorsal seta and 1 small ventral seta, each near apex. Segment III small, about as long as sensory appendage; apex truncate, with 6 processes as in Fig. 6; longest apical process subequal in length to segment III. Labrum (Fig. 7, left half) transverse, about 2× as wide as long; with 2 sets of pores; 5 pairs of setae, with a single seta on midline. Epipharynx (Fig. 7, right half) with patch of short spines distad as figured; patch of spines and setae posteriorly along midline. Mandible (cf. Lawrence, 1977; Figs. 10–11) short, broad; apex truncate; molar enlarged, small teeth present; protheca membranous. Maxilla (Fig. 8–10) with small subtriangular juxtacardo. Cardo pentangular, with 1 seta. Stipes elongate; 2 setae proximad, 1 seta near base of palp, 1 seta centrally near base of mala, 6 anteroventral setae on mesal margin. Mala membranous, with dense fringe of hairs ventrally; many short spines dorsally. Palpifer small; palpus three-segmented. Palpal segment I an incomplete sclerotized ring with 2 ventral pores. Segment II narrower, about as long as segment I. Segment III elongate, subcylindrical; dorsal digitiform sensillum present; 8 apical sensory processes. Labium (Fig. 11) reduced; prementum short; postmentum large, well developed. Palp two-segmented, first segment a highly reduced mesal sclerite.

Prothorax about 2× as wide as long, broadest posteriorly; 2 large notal plates, each centrally depressed. Mesothorax and metathorax about 4× as wide as long; each with 2 small tergal plates subequal in size. Legs (Figs. 12–14) increasing in size posteriorly. Coxa (Fig. 12) subquadrate; 7 dorsal setae, 19 ventral setae. Trochanter (Fig. 13) subtriangular; 4 ventral pores, 2 dorsal pores; 6 ventral setae, 3 dorsal setae. Femur (Fig. 13) elongate, about 2× as long as wide; 1 pore ventrally, 2 pores dorsally; 3 setae on dorsum, 9 setae on venter. Tibia (Fig. 14) elongate, narrowing distally; 4 ventral setae, 3 dorsal setae; rows of micropores distally on both ventral and dorsal surface. Tarsungulus (Fig. 14) unisetose.

Abdominal terga I–IX with dorsolateral and lateral verrucae becoming approximate posteriorly. Paired dorsal spines along midline increasing in size caudally. Segments I–VIII about 4–5× as wide as long; segment III broadest; segment VIII about 3× as wide as long; segment IX about 2× as wide as long. Segment X reduced, posteroventrally positioned. Urogomphi absent.

Description of Pupa

As shown in Figs. 3–4. Partially enclosed by larval skin. Dorsum covered with fine pubescence; ventrites completely lacking setae. Head shape and dimensions similar to adult. Labrum elongate, extending to apex of mandibles, with emarginate apex. Mandibular apices bidentate, sclerotized. Abdominal spiracles I–V tuberulate, functional; tracheae well-developed. Spiracles VI–VII marked externally, not functional. Spiracle VIII barely visible externally, not functional.

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ETHOLOGY OF *LAPHRIA FERNALDI* (BACK) (DIPTERA: ASILIDAE) IN SOUTHEAST WYOMING[1]

R. J. LAVIGNE AND S. W. BULLINGTON

Entomology Section, University of Wyoming, Box 3354, University Station, Laramie, Wyoming 82071.

Abstract.—The behavior of a western coniferous forest asilid, *Laphria fernaldi* (Back), was studied in southeast Wyoming. Prey, predominantly Coleoptera and Hymenoptera, are captured in aerial flights. No prey manipulation occurs once the asilid returns to the feeding site. Mating without prior courtship is completed on perch sites one to nine meters above the forest floor.

Described by Back (1904) as *Dasyllis fernaldi,* this species was subsequently placed in the genus *Bombomima* by Enderlein (1914). There it remained until Nagatomi (1964) synonomized *Bombomima* with *Laphria,* thus placing *fernaldi* in the latter genus. This change of status was supported by Martin (1965).

This species, like other species formerly placed in *Bombomima* and species in the genus *Mallophora,* strongly resemble bumblebees in size, shape and color patterns and have been referred to as mimics (Bromley, 1930). Toads, at least, quickly learn to associate these color patterns with stinging hymenopteran models after one error of judgment (Brower et al., 1960) suggesting that this is batesian mimicry. Waldbauer and Sheldon (1971) maintain that for *Laphria flavicollis* Say and *L. thoracica* Fabricius, insectivorous birds are the main selective agents which determine the morphology and behavior of the mimics.

A widespread distribution has been attributed to *L. fernaldi* in the western United States and Canada, specimens being cited from: Colorado (type locality) (Back, 1904; Cockerell, 1917; James, 1938, 1941); Nebraska, South Dakota (Jones, 1907); Oregon (Cole and Lovett, 1921); Utah (Brown, 1929; Knowlton and Harnston, 1938); Washington, Idaho, New Mexico, Arizona, Montana (Adisoemarto, 1967); British Columbia (Criddle, 1921) and Alberta (Adisoemarto, 1967). Because there appears to be a complex of species involved (Bullington, unpublished data), some of these records may be in error. However, comparison of specimens from our study population with specimens taken from a variety of locations in Colorado have convinced us that the specimens referred to in the present paper are definitely *Laphria fernaldi.*

METHODS

James (1938) refers to *B. fernaldi* as a coniferous forest denizen and it is within a predominantly lodgepole pine forest that our study was conducted. The study

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site was located in the Snowy Range Mts., Albany Co., Wyoming, in a moderately wooded area across the North Fork of the Little Laramie River from the USFS North Fork Campground (elev. 2577 m). The area was bisected by an old logging road which at one point expanded into a large clearing. Most recorded activities were within the forest bordering the clearing. Fallen and cut logs of various dimensions were scattered over the forest floor, but most branches and small dead trees had been removed by campers seeking firewood.

Methods of study of this population were similar to those described in Lavigne (1982) for *Neoitamus vittipes.* Additionally, individuals were marked by placing dots of various colors of Testors model airplane paint (Pla Enamel, the Testor Corporation, Rockford, Illinois) on the dorsum of the thorax. Each specimen was marked the first time it was encountered and had a specific designation, such as B_3 (= 3 blue dots). With this method we individually marked 12 specimens in 1978 (12 ♂), 3 in 1979 (2 ♂, 1 ♀) and 43 in 1981 (36 ♂, 7 ♀). A few additional observations were made on a small population at Battle Creek Campground, Sierra Madre Mts., July 25–26, 1978.

Extensive observations were made on this species in 1978 (7/25–9/9) and again in 1981 (7/16–9/20), while we were engaged in a study of male territoriality (Lavigne and Bullington, unpublished data). Incidental observations also were made during the adult flying season in 1979 (7/21–9/9) when time permitted. Specimens upon which this paper is based have been placed in the entomological collection of the Smithsonian Institution, Washington, DC as: R. J. Lavigne, Voucher Spec. #47.

Weather conditions appeared to be the dominating influence on *L. fernaldi* activities during all three years. Activities largely ceased on cloudy days and on rainy days the asilids would disappear. Intermittent rain showers or all day rains were common in August, thus limiting opportunities for the flies to feed, mate and oviposit.

Each sunny morning male *L. fernaldi* would appear on rocks or on logs between 0845 and 1005 h, whenever the log surface temperature reached ca. 27°C. In late afternoon between 1700 and 1800 h, the asilids usually would leave the logs. Followed males flew 20–25 m in interrupted flights eventually disappearing into the tree canopy, where it is presumed they spent the night. As the season progressed and the angle of the sun changed, logs would be sunlit for shorter periods and asilids would leave them at an earlier time.

FORAGING AND FEEDING BEHAVIOR

All observed *Laphria fernaldi* males foraged from sunny spots on logs (Fig. 1) which they constantly patrolled. We speculate that females foraged within the tree canopy. In only five instances over a four year period were females observed with prey in the study area; in four, the female was resting in sunlight on the surface of a log. The remaining female was found clinging to a rock in a clearing with a bumblebee as prey. The sky was cloudy. Other observed females were engaged in mating, oviposition, or resting but never foraging. Subsequent foraging data refer to male activity.

The heads of males are almost constantly in motion presumably in order to evaluate both potential prey and potential mates and/or competitors. Often the whole body is turned. Attack flights are initiated from log surfaces in response to moving insects. However, apparently particular characteristics of potential prey are important in stimulating an attack since a great variety of insects are ignored, though obviously seen.

Once initiated, the prey capture dart may be a straight line attack or, if the potential prey, such as a syrphid or dragonfly exhibits evasive action (N = 6), the chase may be a long and convoluted flight. Observed foraging flights ranged from ⅓ m to 11 m. Unsuccessful flights (N = 51) covered the same distances, whereas successful capture darts (N = 11) covered 1⅓ to 7 m. It is interesting, however, that the means for successful capture darts ($\bar{x}$ = 11.8 m) are very close to those for unsuccessful ones ($\bar{x}$ = 12.3 m). All prey were collected while airborne (N = 20).

Contact and capture may not mean that the prey is impaled. Six additional capture darts ended with the release of the collected item before the asilid landed.

Prey selection apparently functions on the basis of visual discrimination. On four occasions, asilids circled insects (all bees) and then returned to their perch without making an attack suggesting a learned response. Another time a male flew halfway towards a small bee and then returned to its log. Conversely, errors are made. In one case a dandilion seed was the captured item, not an insect.

Once prey are captured they are manipulated and impaled during a short hover prior to landing. The prey was usually still struggling when the asilid landed with the prey positioned (Fig. 2), facing forward, between its legs. Unlike most other asilid species, no manipulation takes place during feeding.

The length of time males spend feeding is inordinately short in comparison to that spent by other asilids whose prey are proportionately large. For example, the mean feeding time for three specimens of the cantharid, *Podabrus lateralis* LeConte, was 4 min. Complete feeding times were recorded for 13 prey, ranging from 2 to 27 min ($\bar{x}$ = 9.5).

Feeding asilids were often forced to move quickly with prey impaled upon their probosces. In one instance, an ant grabbed a feeding asilid's leg who responded by flicking off the ant and flying to a new perch. In addition to foraging ants, asilids responded to moving spiders. Larger predators were also a potential disturbance. Various species of birds hawked in the vicinity of the logs and both chipmunks and squirrels used the logs as runways.

While feeding was in progress, and even afterwards, small numbers of tiny flies flitted about the asilid's proboscis. Some landed on the proboscis and others on the prey where the partially digested contents oozed from the open wound. When the harrassment was too great, the asilid would fly rapidly to a new perch.

Once feeding ceased prey were discarded in one of two ways: in flight (N = 16) or when the asilid pushed the prey off its proboscis with its foretarsi on site (N = 10). The logs from which the asilids foraged, were partially decayed and often housed colonies of carpenter ants, *Camponotus* sp. Those that didn't, usually served as roofs for nests of *Formica* sp. Both kinds of ants were constantly foraging and discarded prey were quickly collected and taken into the nests.

While male foraging activity has been observed as early as 0845 h (log surface temp. 23°C) and as late as 1729 h (log surface temp. 31°C), feeding records only cover the hours 0928 to 1649. The five female feeding records cover the time period 1120 h to 1537 h.

Prey Selection

Records of prey taken by bumblebee mimetic *Laphria* are few. Bromley (1930) states that this group of asilids "seem to prefer as prey, insects of the 'buzzing'

Fig. 1. One of the log sets patrolled by males in the coniferous forest habitat of *Laphria fernaldi*.

Fig. 2. Male *Laphria fernaldi* with winged reproductive *Formica* sp. as prey showing size difference between predator and prey.

rather than the 'fluttering' type of flight" and commonly take Coleoptera and occassionally Hymenoptera as prey. MacFarlane (1973) lists 17 instances where bumblebees served as prey; however, his single record for *L. fernaldi* does not occur in his listed citation (i.e. Brown, 1929).

Table 1. Numbers and percentages of measured prey of different taxa captured by males and females of *Laphria fernaldi* at the North Fork study site, Medicine Bow Nat'l. For., Wyoming. This listing does not include 13 prey, which were recognized as to taxa but were carried off by asilids, or prey collected at other locations.

	Males				Females			
Taxa	No.	%	Size Range (mm)	$\bar{x}$	No.	%	Size Range (mm)	$\bar{x}$
Coleoptera	32	51.6	3.5–14.5	6.9	2	50	8.5–16.3	12.4
Diptera	8	12.9	6.7–11.1	7.4				
Hemiptera	1	1.6	3.6					
Hymenoptera	18	29.0	6.1–15.7	9.6	2	50	6.1–10.9	8.5
Lepidoptera	2	3.3	9.9–12.4	11.2				
Plecoptera	1	1.6	4.8					
Total	62	100	3.5–15.7	7.8	4	100	6.1–16.3	10.5

Measured prey ranged widely in size, but were considerably smaller than the predator. Females were larger ($\bar{x}$ = 15.9, r = 15–17.4 mm, N = 6) than males ($\bar{x}$ = 13.6, r = 10.1–15.4 mm, N = 10), and took slightly larger prey. Prey taken by females ranged from 6.1–16.3 mm ($\bar{x}$ = 10.5, N = 4); those taken by males ranged from 3.5–15.7 mm ($\bar{x}$ = 7.8, N = 62). The predator to prey size ratio, based primarily on male captures, was 1.61:1 (1.74:1 for ♂; 1.51:1 for ♀).

Separation of prey records on the basis of taxa taken show that Coleoptera (51.5%) and Hymenoptera (30.3%) were favored by both sexes (Table 1). Observed recorded prey not collected by the investigators, when added to the figures in Table 1 increase the dominance of Coleoptera in the prey record to 43 (54.4%). The total number of Hymenoptera increases to 22 (27.7%), that of Diptera to 9 (11.4%) and Hemiptera to 2 (2.5%).

There is little doubt that male *L. fernaldi* exhibit selectivity in their choice of prey as seen by the list of prey. Additionally, on numerous occasions insects flew well within the attack range of the asilid and yet were acknowledged only by a head turn.

Following is a listing of prey taken by *L. fernaldi.* The number of observations and sex, when known, of the predator are indicated in parentheses following the prey taxa. All captures were made at the North Fork study site unless otherwise indicated. COLEOPTERA, Buprestidae: *Chrysobothris laricis* VanDuzee, VIII-2-78 (♂), VIII-11-78 (♂), *Chrysobothris trinervia* (Kirby), VIII-11-78 (♂), *Melanophila drummondi* (Kirby), Pingree Park, Roosevelt Nat'l. For., CO, VIII-26-53 (♀) (R. H. Painter), *Melanophila lecontei* Obenb., VII-26-78 (♂); Cantharidae: *Podabrus lateralis* LeConte, VII-26-78 (3 ♂), VII-28-78 (2 ♂), VII-31-78 (2 ♂), VIII-2-78 (♂), VIII-4-78 (♂), VIII-10-78 (♂); Cerambycidae: *Acmaeops proteus* Kirby, VIII-2-78 (♂), VIII-4-78 (♂), VIII-10-78 (♀), VIII-16-78 (♂), *Cosmosalia nigrolineata* (Bland), VII-26-78 (♂), VII-23-81 (♂), VII-29-81 (♂), *Gnathacmaeops pratensis* (Laicharting), VII-28-78 (♂), *Judolia gaurotoides gaurotoides* (Casey), The Sinks, Fremont County Youth Camp, ca. 18 mi SW Lander, VII-1-73 (♂) (R. J. Lavigne), *Leptura propinqua* Bland, VII-29-81 (♀), *Xestoleptura behrensi* (LeConte), Salmon laSac, Kittas Co., WA, VII-26-69 (♂) (C. J. Horning), undet., VII-26-78 (♂); Elateridae: *Athous pallidipennis* Mann, VIII-4-78 (♂), *Ctenicera breweri* (Horn), VIII-5-78 (♂), undet., VII-26-80 (♂); Meloidae: undet., VII-27-78 (♂); Scarabaeidae: *Aphodius* *fimentarius* L., VII-25-81 (♂), *Aphodius scobriceps* LeConte, VII-25-81 (♂). DIPTERA, Asilidae: *Eucyrtopogon* sp., VIII-27-78 (♂); Bibionidae: *Bibio* sp. VIII-19-78 (♂), VIII-20-78 (♂); Muscidae: undet., Syrphidae: *Metasyrphus* sp., prob. *lapponicus* Zett., VIII-1-78 (♂)., HEMIPTERA, Miridae: *Lygus* sp., VIII-10-78 (♂). HYMENOPTERA, Apidae: *Bombus bifarius* Cresson, Pingree Park, Roosevelt Nat'l. For., CO, 9000′, VIII-19-30 (♂) (D. A. Wilbur), *Bombus bifarius nearcticus* Handlirsch, Grassy Lake, Targhee Nat'l. For., WY, VIII-10-66 (♂), *Bombus mixtus* Cresson, VIII-1-78 (♂); *Psithyrus fernaldae* Franklin, Olga, WA, VII-14-09 (♂); Colletidae: *Colletes* sp., VII-27-78 (♂), VII-26-79 (♂), VIII-1-78 (♂); Formicidae: *Formica* sp. (winged reproductives), VIII-2-78 (♂), VIII-13-78 (♂), VIII-20-78 (♂), VIII-26-78 (2 ♂), VIII-23-81 (♂), Battle Creek Campground, Medicine Bow Nat'l. For., VII-25-78 (♂); Halictidae: undet., VII-16-78 (♀), *Halictus* sp., west of Cody, Rte. 16 overlook, North Fork, Shoshone R., VI-27-77 (♂) (R. J. Lavigne, Ichneumonidae: *Spilichneumon nubivagus* (Cresson), VIII-30-81 (♂); Pompilidae: undet., VIII-13-78 (♂), VII-22-81 (♂); Sphecidae: undet., VIII-19-78 (♂), VII-23-81 (♂); Tenthredinidae: *Tenthredo anomocera* Rohwer, VIII-10-78 (♂); Vespidae: *Vespula vulgaris* (L.), Cameron Pass, Gould, CO, VIII-8-78 (♀). PLECOPTERA, Nemouridae: undet., VIII-4-78 (♂).

MATING

As with most species of Asilidae, mating occurs without prior courtship. Males dart with equal vigor at females and other males that appear on or in the vicinity of the log patrolled by the male. Upon contact, the male grapples with the other asilid often forcing it off the log into the ground cover. If the encountered asilid is a female, copulation usually takes place. Encountered males are chased away without apparent injury.

Initial copulation is in the male atop female position, but almost immediately the pair take positions facing in opposite directions (Fig. 3). The pair then flies to a high perch somewhere within 10 m of the copulation site. Perch heights varied from 1 to 9 m ($\bar{x} = 4.7$, N = 11). While copulating, both sexes open and close their wings intermittently as well as occasionally cleaning their eyes and then the foretarsi. Just prior to the cessation of copulation, the female arches her body and moves forward. The male relaxes his gonopods, releases the female and flies off leaving the female resting on the substrate (N = 5).

Initial observations of mated pairs (N = 14) were made between 1002 h and 1617 h, with all but three occurring between 1002 h and 1245 h. Only three matings were observed in their entirety. These copulations at 1058 h, 1112 h and 1614 h lasted 121, 86 and 79 min, respectively.

A pair apparently seeks moderate temperatures for extended matings. Temperatures on log surfaces in sun at the time copulations were initiated varied from 20° to 47°C ($\bar{x} = 32$°C). Temperatures at heights the pair flew to varied from 22° to 31°C ($\bar{x} = 26.6$°C). It may well be, however, as Baker (1983) suggests, citing the example of *Scatophaga stercoraria* (L.), that males select where to take the copulated female in order to reduce the risk of being displaced by another male.

Multiple matings apparently occur although this strategy was only observed once. On August 26th, at the end of a mating, the female (with frayed wings suggesting old age) was collected. She was released 15 min. later in the vicinity of an unmarked male who immediately flew in her direction, made contact and

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Fig. 3. Mated pair of *Laphria fernaldi* in typical copulatory position.

Fig. 4. Female *Laphria fernaldi* ovipositing in entrance of carpenter bee burrow.

copulated with her in the grass beside the log. The male kept trying to fly while the female clung to a grass stalk. After 13 min. the male removed his gonopods from the female's ovipositor and flew. The female crawled into the shade under a pine cone and died.

Males apparently are able to distinguish between their own species and their bumblebee model, *Bombus melanopygus* Nylander, only upon close inspection. Twice *L. fernaldi* males flew 2 m to hover 2.5 cm behind bumblebees working thistle blossoms. The bumblebees would "kick" with their hind legs at the asilids who subsequently retreated to their former perches after 10–15 sec.

OVIPOSITION

All known larvae of the Laphriinae occur in dead wood (Lavigne et al., 1978). "In *Laphria, Lampria* and *Bombomima* the ovipositor is short and the eggs are laid in shallow crevices of dead wood." (Bromley, 1946). Bromley was referring primarily to eastern species with which he was familiar. Similar oviposition sites were recorded for species of European *Laphria* by Melin (1923). *Laphria fernaldi* oviposition habits do not differ significantly from those previously mentioned, although no one has noted hovering prior to site selection.

Females of *L. fernaldi* were rarely seen except when they appeared on large logs for the purpose of oviposition. Typical oviposition behavior was as follows. A female would fly along a log ca. 5 cm above the surface. Intermittently she would hover 2.5–4 cm above a dark area, usually the entrance to a carpenter bee tunnel or a crack in the wood. If the site was "suitable," she would land next to the hole, reverse position and move backwards to the lip of the convexity (Fig. 4). The ovipositor would then be extruded in various directions within the hole. When extruded, it is covered with long erect hairs which presumably have a sensory function. The ovipositor is intermittently retracted and extruded while the female is in position. It may be removed from the depression any time within 15 sec to 5 min and the female will then fly outward and resume her flight along the log seeking new sites. If disturbed by an organism while ovipositing, such as a carpenter ant, the female will fly 15–20 cm down the log and, as soon as the intruder has departed, will return to the same hole. In one instance a bee was in the hole and the asilid returned 4 times to attempt to utilize the burrow. Having been chased off each time, it flew 9 m up into a pine tree and finally out of the area. Of the 58 times females were observed placing their ovipositors in potential sites, 24% were in carpenter bee holes, 20% in elongate cracks in the log surface, and 14% were under bark.

All observed females searching for oviposition sites were seen between July 27 and August 10. Mated pairs, however, were seen as late as August 26. Oviposition attempts were observed as early as 0957 h and as late as 1715 h, but the majority (12 out of 18) occurred between 1012 h and 1340 h. Temperatures on the log surface where females were ovipositing ranged from 23°C to 48°C ($\bar{x} = 34.5$°C). In 50% of the cases where females were searching for oviposition sites, they were accosted by males who forced them into the grass alongside the logs and attempted copulation.

EGGS

Sculpturing on asilid egg chorions was first mentioned by Melin (1923) who commented "The *Laphria* species all have oval-shaped eggs, with rounded poles, reddish brown and somewhat shiny. The shells are firm and furnished with facet-like ridges." He then proceeded to illustrate a single line drawing showing a hexagonal pattern, referring to the sculpturing on egg chorions of *L. ephippium* Fabricius, *L. flava* Linn., *L. gibbosa* Linn., *L. gilva* Linn. and *L. marginata* Linn.

Fig. 5. Chorionic sculpturing of eggs of *Laphria fernaldi* (SEM photo, 800×).

Eggs of *Laphria fernaldi* were dissected from the abdomens of dried pinned females. The insects were first relaxed and then a lateral slit was made between the tergites and sternites which allowed the eggs to be removed easily without destroying the specimen. The mature eggs were oval and reddish brown. They ranged in length from 0.75 to 0.93 mm ($\bar{x} = 0.8$, N = 50) and in width from 0.55 to 0.6 mm ($\bar{x} = 0.57$).

With the advent of the scanning electron microscope (SEM) a new tool became available for examination of the chorionic sculpturing on insect eggs. Musso (1981) used it successfully to produce pictures of eggs of some French asilid species. Two species of *Andrensoma* (the only Laphriinae tested) were the only ones that had the type of sculpturing he designated as "(a) pigmented eggs with a thick chorion of irregular polygon surface structure." His SEM picture of the chorionic sculpturing is somewhat similar to that which we have found on the chorion of *L. fernaldi* (Fig. 5). Dr. Fred Lawson (Entomology, University of Wyoming), who kindly took the SEM photo, agrees with us that sufficient differences exist to suggest that SEM photos of eggs could be a useful taxonomic tool in suggesting phylogenetic relationships.

Longevity of Adults

Because of the large size of adult *L. fernaldi* in relation to wing span and because individual males were extremely active, we were interested in adult longevity. In other words how could such large insects, that apparently fed infrequently for short time periods expend such huge amounts of energy and not expire rapidly? Marking of individuals in 1978 was initiated halfway through the season; three individuals were observed intermittently over 10 day periods and one was known to survive 12 days. The population was practically nonexistent in 1979, but one male was found to have survived 16 days. Greater emphasis was placed on longevity in 1981 when every observed individual was marked. Despite diligent searching, only 7 individuals were recorded as surviving longer than 10 days as follows: 11, 13, 13, 16, 18, 29, 30 days ($\bar{x} = 18.5$). All were males. It is probable that these figures are a reasonable estimate of longevity for individuals, even though the seasonal distribution of this population may extend 65 days. The constraints of working in a forest combined with the flying abilities of the asilids would seem to preclude obtaining more definitive data for *L. fernaldi.* Additionally, individuals appear at odd times of the year. We have collected specimens with the following data: May 16th, June 27th and July 3rd, which fall well outside the range of dates for the population reported herein, i.e. mid July to late September.

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NEW SPECIES OF ISOMETOPINAE (HEMIPTERA: MIRIDAE) FROM MEXICO, WITH NEW RECORDS FOR PREVIOUSLY DESCRIBED NORTH AMERICAN SPECIES

THOMAS J. HENRY

Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % National Museum of Natural History, Washington, D.C. 20560.

Abstract.—Four new species of Miridae *Corticoris* ***pallidus***, *C.* ***pintoi***, *C.* ***pubescens***, and *Myiomma* ***keltoni*** are described from Mexico. The adult of *C. pintoi* is illustrated and the fifth-instar nymph is described; a revised key to the genus *Corticoris* is provided; and new records are given for seven previously described North American Isometopinae.

Most, if not all, isometopine bugs (Hemiptera: Miridae) are predatory and, therefore, are potentially important biocontrol agents. Wheeler and Henry (1978) reviewed the feeding habits of the Isometopinae, studied the biology of four eastern North America species, and showed that *Corticoris signatus* (Heidemann) and *Myiomma cixiiforme* (Uhler) preyed on obscure scale, *Melanaspis obscura* (Comstock). Recently, Ghauri and Ghauri (1983) provided a record of their new genus and species *Totta zaherii* preying on tea scale, *Fiorinia theae* Green, in northern India.

Taxonomic work for the New World taxa has been summarized (Henry, 1977, 1979, 1980; Henry and Herring, 1979). Ghauri and Ghauri (1983) included in their paper a key to the world genera, but, unfortunately, they overlooked my key to the New World genera and descriptions of three new genera (Henry, 1980), Schuh's (1976) establishment of the subfamily Psallopinae to accommodate *Psallops* Usinger, and the transfer of *Isometocoris* Carvalho and Sailer from Isometopinae to Psallopinae (Henry and Maldonado, 1982).

In this paper I describe three new species of *Corticoris* McAtee and Malloch and one new *Myiomma* Puton. The adult of *C. pintoi*, new species, is illustrated and the fifth-instar nymph described; a revised key to the genus *Corticoris* is provided; and additional distribution and/or host records are given for seven previously described species found in North America.

The following abbreviations are used for institutions cited in this paper: BRI (Biosystematic Research Institute, Agriculture Canada, Ottawa); UCR (University of California, Riverside); and USNM (U.S. National Museum of Natural History, Washington, D.C.).

Corticoris pallidus Henry, NEW SPECIES

Holotype female.—Length 2.36 mm, width 1.12 mm, general coloration black with hemelytra pale, except for basal half of clavus; pubescence short, recumbent, and white to brownish. *Head:* Width 0.58 mm, vertex 0.18 mm, ocelli 0.12 mm apart; uniformly shiny black; eyes emarginate posterior to ocelli. *Rostrum:* Length 1.10 mm, extending nearly to base of ovipositor. *Antenna:* Segment I, length 0.10 mm, pale yellowish brown, slightly darker basally; II, 0.52 mm, brownish black, apical ⅕ white; III, 0.18 mm, brownish black, apex white; IV, 0.14 mm, fusiform, brown. *Pronotum:* Length 0.36 mm, basal width 0.96 mm; shiny black; lateral margins flattened; posterior margin nearly straight; calli raised, smooth, and shiny with a deeply impressed line behind each; disc deeply and evenly punctate. Mesoscutum and scutellum uniformly black; scutellum weakly punctate. *Hemelytron:* Whitish, basal ½ of clavus black; apex of clavus and quadrate mark on apex of corium fuscous; middle of cuneus and posterior ½ of embolium shaded with brown; membrane translucent brown, veins whitish. *Venter:* Abdomen brown, first segment brownish yellow laterally; thoracic area shiny black; ostiolar evaporative area brown, whitish on anterior raised area. *Legs:* Coxae brown, paler apically; femora dark brown, apices whitish; tibiae brown, apices whitish; tarsi and claws brown.

Male.—Unknown.

Type data.—Holotype ♀: 24 mi. W. La Ciudad, Durango, Mexico, 7000′, 21 July 1964, L. A. Kelton coll. (BRI).

Remarks.—*Corticoris pallidus* is remarkably similar to *C. pulchellus* in the coloration of the dorsum (Henry and Herring, 1979; Fig. 3), except the fuscous mark of the corium is larger and more nearly quadrate on *pallidus.* These two species do differ significantly in the coloration of the antennae, legs, and venter. The second antennal segment (except for a subapical fuscous band), legs, and abdomen on *pulchellus* are uniformly whitish; on *pallidus* the second antennal segment is brownish black with the apex white, the femora and tibiae are brown with the apices whitish, and the abdomen is brown.

Corticoris pintoi **Henry, New Species**

Fig. 1

Holotype female.—Length 2.12 mm (range of 5 paratypes, 2.16–2.32 mm); width 1.08 mm (1.04–1.12). *Head:* Width 0.58 mm (0.56–0.58), vertex 0.20 mm (0.20–0.22), ocelli 0.12 mm apart (0.10–0.12); shiny black, with area between vertex and tylus pale yellow. *Rostrum:* Length 1.16 mm (1.14–1.20). *Antenna:* Segment I, length 0.08 mm (0.10–0.14), white, black on basal ½ of ventral aspect; II, length 0.54 mm (0.54–0.56), white at apex and on dorsal aspect, ventral aspect black or fuscous; III, length 0.18 mm (0.18–0.20), black; IV, length 0.14 mm (0.12–0.14 mm), black. *Pronotum:* Length 0.34 mm (0.34–0.38), basal width 0.92–0.94); whitish, with wide region anterior to raised calli black; strongly and evenly punctate. Scutellum and mesoscutum black; scutellum granulate and transversely rugose. *Hemelytron:* White, with basal ½ of clavus, one irregular band across apical ⅓ of embolium and corium and apex of clavus, and narrow band through middle of cuneus black; membrane smoky brown. *Venter:* Undersurface of thorax shiny and mostly black, with xyphus, coxal cleft, and anterior and dorsal margin of propleura, whitish; abdomen whitish with basal area and posterior margins of segments fuscous. *Legs:* Femora white with distinct subapical fuscous bands; tibiae whitish on dorsal surface, fuscous ventrally; tibiae and claws fuscous.

Male.—Unknown.

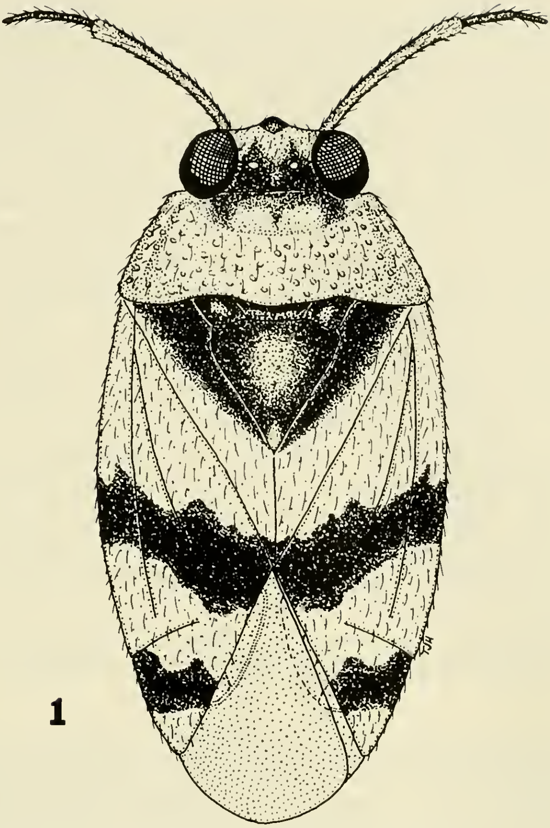

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Fig. 1. *Corticoris pintoi*, n. sp., dorsal habitus of holotype female.

Type data.—Holotype ♀: Mexico, Baja Calif. Sur., 31 rd. km W. of Vizcaino, ca. 27′29″N, 113′44″W, 26 Mar. 1980, John D. Pinto coll., taken beating *Fouquieria* sp. (Fouquieriaceae) [branches thickly covered with lichen] (U.S. National Museum of Natural History (USNM) Type No. 75742). Paratypes: 7 pinned ♀ (1 adult, 8 5th instars, and 1 4th instar in alcohol); same data as for holotype (California Academy of Sciences, San Francisco, UCR, USNM).

Remarks.—In Henry and Herring (1979), *Corticoris pintoi* will key to couplet 5 with *libertus* (Gibson) and *mexicanus* Henry and Herring. It can be separated from *libertus* and *mexicanus* by the overall white coloration (Fig. 1) with the mostly black head, black anterior mark on the pronotum, black scutellum, the one black band across the apical ⅓ of the hemelytron and one across the cuneus, and the long 2nd antennal segment that is subequal to the width of the head.

Fifth-instar nymph.—Length 1.88–2.04 mm (n = 5), width 1.04–1.16 mm, form elongate oval, generally pale grayish brown, strongly mottled and speckled with darker brown. Head width subequal to length of 2nd antennal segment, tylus acutely produced into short tubercle, vertex pale, slightly wider than dorsal width of an eye, frontal area with a brown U-shaped line, area between anterior margin of eye, side of tylus, and base of 1st antennal segment dark brown. Antenna pale, mottled with darker brown, brown whitish apically; 2nd segment pale brown, mottled with darker brown, brown coalescing to form a band next to whitish apex, length 0.40–0.48 mm; segment III brown, white apically; segment IV uniformly brown. Pronotum subquadrate, about 3.6× wider than long, dark brown through entire length behind eyes, pale grayish brown laterally; scutellar area dark brown basally, mottled brown on apical ½; wing pads brown, interrupted with paler spots and a large, pale, grayish-brown area at middle along costal margin. Abdomen grayish brown with numerous small brown spots and a row of larger spots between meson and lateral margin; dorsal scent gland and surrounding spot dark brown. Femora brown, pale apically; tibiae strongly brown spotted.

Remarks.—Wheeler and Henry (1978) provided a key to separate the nymphs of two eastern species of *Corticoris*. Now that nymphs of *pintoi* are available for study, it is even more apparent that immatures have excellent characters for separating species. *Corticoris pintoi* is similar to *pulchellus* in dorsal markings and to *signatus* in having spotted legs. This new species can be separated from the latter two species by the much larger spots on the tibiae and the brown-mottled 2nd antennal segment with a subapical dark-brown band. In *pulchellus* and *signatus* segment II is distinctly shorter than the width of the head.

I have the pleasure of naming this attractive new species after its collector, John D. Pinto (UCR).

Corticoris pubescens **Henry, New Species**

Figs. 2–3

Holotype female.—Length 2.68 mm (range of 5 paratypes 2.44–2.76), width 1.36 (1.16–1.36), general coloration black with pale yellow areas on head and pronotum; hemelytra whitish, marked with fuscous or black. *Head:* Width 0.66 mm (0.64–0.68), vertex across ocelli 0.26 mm (0.24–0.26), ocelli 0.14 mm (0.12–0.14) apart; shiny black with area behind and just in front of ocelli and narrow inner margins of eyes pale yellowish; eyes emarginate to posterior margin of head behind ocelli. *Rostrum:* Length 1.26 mm (1.24–1.36), extending to base of ovipositor. *Antenna:* Segment I, length 0.12 mm (0.10–1.12), white with a fuscous band around middle; II, 0.64 mm (0.60–0.66), brown to fuscous on ventral aspect and apical ¼ of dorsal aspect, basal ¾ of dorsal aspect pale or whitish; III, 0.18 mm (0.20), fuscous; IV, 0.14 mm (0.14–0.16), fuscous. *Pronotum:* Length 0.44 mm (0.40–0.44), basal width 1.06 mm (0.96–1.04), smooth, shiny black with anterior angles, posterior angles, narrow basal margin, and posterior mesal part of disc pale yellowish; disc shiny and sparsely and finely punctate; calli raised with a wide, deeply impressed line behind calli; lateral margins flattened and somewhat recurved; posterior margin emarginate on either side of meson; pubescence long and thickly set, setae much longer than spaces separating their bases, especially long setae bridging gap over impressed line behind calli. Mesoscutum and scutellum black, with narrow apical margin of scutellum pale yellow. *Hemelytron:* Whitish with a larger fuscous to black area at middle of corium; pubescence pale or white, long, and dense, setae longer than distance between their bases; cuneus whitish with inner apical margin fuscous; membrane smoky brown, veins paler. *Venter:* Abdomen brown with the apical 3 segments paler; sternum black; propleuron black with anterior and posterior margins pale yellowish; xyphus black with ventral margin pale yellow. *Legs:* Coxae pale yellow or whitish; femora pale yellow or whitish, sometimes with a subapical fuscous band, especially on profemur, bands nearly absent on remaining femora or broken into indistinct spots; tibiae brownish, darker basally; tarsi and claws brown.

Male.—Length 3.06–3.16 mm (n = 3), width 1.32–1.36 mm. *Head:* Width 0.68 mm, vertex 0.24 mm, ocelli 0.14 mm apart. *Rostrum:* Length 1.22–1.30 mm. *Antenna:* Segment I, length 0.10–0.12 mm; II, 0.76–0.78 mm; III, 0.16 mm; IV, 0.12 mm. *Pronotum:* Length 0.42–0.44 mm, basal width 1.06–1.08 mm. *Genitalia:* Left paramere (Fig. 2); right paramere (Fig. 3).

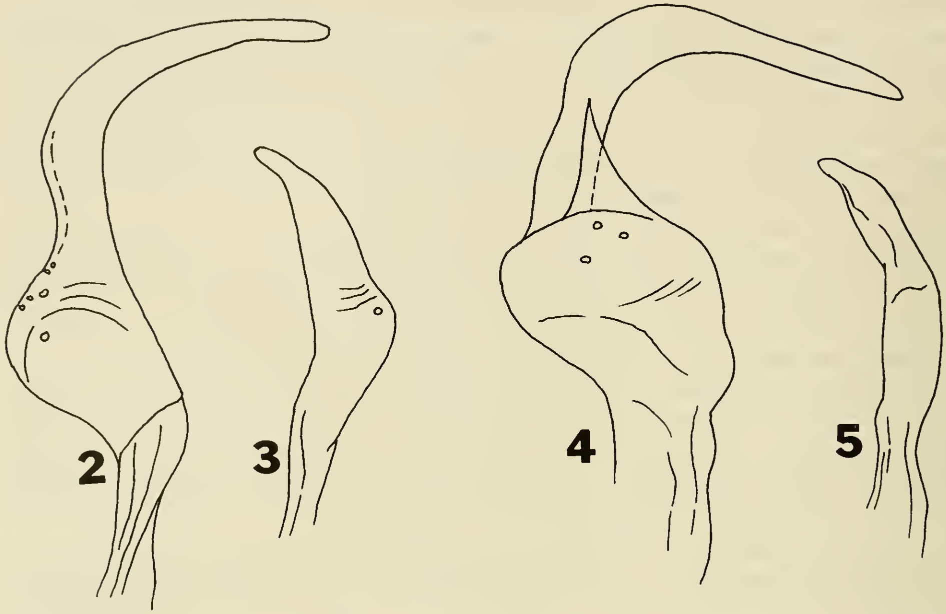
The male of this species is very similar to the female in the coloration of the head, pronotum, and legs, but differs by the more elongate form, the hemelytra lacking distinct fuscous marks on the corium, and the longer and thicker second antennal segment that is yellowish brown and more strongly pubescent.

Type data.—Holotype ♀: 10 mi. W. of El Salto, Durango, Mexico, 9000′, 24 June 1964, L. A. Kelton coll. (BRI). Paratypes: 1 ♂, same data as for holotype (BRI); 2 ♀, 3 mi. E. of El Salto, Durango, Mex., 21 June 1964, L. A. Kelton coll. (BRI); 2 ♀, 8 mi. E. of El Salto, Durango, Mex., 8200′, 25 June 1964, L. A. Kelton coll. (BRI, USNM); 2 ♂, 1 ♀, 9 mi. W. La Ciudad, Durango, Mex., 10 June 1964, L. A. Kelton coll. (BRI, USNM).

Remarks.—*Corticoris pubescens* is most similar to *mexicanus* Henry and Herring in color and body structure, but *pubescens* differs in having the second antennal segment subequal to the width of, instead of shorter than, the head, less distinct subapical bands on the femora, and the abdomen uniformly brown instead of banded.

REVISED KEY TO SPECIES OF *CORTICORIS* (FEMALES)

1. Dorsum uniformly dark brown .... *unicolor* (Heidemann)
– Dorsum not uniformly dark brown, hemelytra with extensive pale areas 2
2. Corium largely pale or whitish with only a small fuscous mark at apex .. 3
– Corium pale testaceous or whitish, but with large fuscous or black patches or bands 4
3. Legs and abdomen uniformly pale or white; second antennal segment whitish with a black subapical band .... *pulchellus* (Heidemann)
– Legs and abdomen not uniformly pale or white, instead femora dark brown with apices pale and abdomen brown; second antennal segment brownish black with the apex pale or white .... *pallidus,* new species
4. Head and pronotum uniformly black 5
– Head and pronotum with extensive white, yellow, or yellowish brown areas 6
5. Second antennal segment pale on dorsal aspect; vertex as wide or wider than an eye; apex of cuneus fuscous or black .... *signatus* (Heidemann)
– Second antennal segment mostly brown, paler on basal ½ and apex; vertex much narrower than an eye; apex of cuneus pale .... *infuscatus* Henry and Herring
6. Scutellum uniformly whitish or yellowish brown .... *libertus* (Gibson)
– Scutellum black, sometimes pale at apex 7
7. Base of vertex and tylus black; pronotum pale or whitish except narrowly fuscous on and in front of calli (Fig. 1) .... *pintoi,* new species



Figs. 2–5. Paramers of isometopines. *Corticoris pubescens:* 2, left paramere; 3, right paramere. *Myiomma keltoni:* 4, left paramere; 5, right paramere.

– Vertex pale or yellowish; pronotum with extensive fuscous or black areas 8

8. Length of second antennal segment shorter than width of head; each femur with a wide, black, subapical band; abdomen pale or yellowish with anterior margin of each segment fuscous (banded) .... *mexicanus* Henry and Herring

– Length of second antennal segment subequal to width of head; front femur with a distinct, fuscous or black, subapical band, bands becoming obsolete on middle and hindfemora; abdomen brown with genital segments paler brown .... *pubescens,* new species

Myiomma keltoni **Henry, New Species**

Figs. 4–5

Holotype male.—Length 3.56 mm (paratype male ca. 3.40 mm; membrane damaged), width 1.32 mm (1.24), general coloration dull to shiny black. *Head:* Width 0.60 mm (0.60), vertex across ocelli 0.16 mm (0.18), ocelli 0.08 mm (0.08) apart; uniformly shiny fuscous to black, except for the narrow, yellowish side of head behind eyes; scattered with erect setae on frons. *Rostrum:* Length 1.16 mm (1.04), extending just beyond metacoxae. *Antenna:* Segment I, length 0.10 mm (0.08), fuscous; II, 0.82 mm (0.80), greatest diameter 0.10 mm (0.10), black with apex whitish, thickly set with recumbent black setae, setae pale on apex; III, 0.20 mm (0.18), black; IV, 0.16 mm (0.18), black. *Pronotum:* Length 0.44 mm (0.40), basal width 1.10 mm (1.12); shiny black, weakly transversely rugose; basal margin emarginate on either side of meson; mesoscutum black with lateral ridges paler;

scutellum black and transversely rugose. *Hemelytron:* Mostly dull black with inner ½ of corium and apical ½ of clavus more brownish or grayish black, set with erect, black, bristlelike setae; embolium shiny black with base pale or whitish; cuneus shiny black with basal margin white to yellowish white; membrane fumate. *Venter:* Shiny fuscous to black; ostiolar evaporative area white. *Legs:* Uniformly fuscous to black, except for paler brown or yellowish apical ⅓ of tibiae. *Genitalia:* Left paramere (Fig. 4); right paramere (Fig. 5).

Female.—Length 3.12 mm, width 1.28 mm. *Head:* Width 0.58 mm, vertex 0.16 mm, ocelli 0.10 mm apart. *Rostrum:* Length ca. 1.30 mm (bent). *Antenna:* Segment I, length 0.08 mm; II, 0.80 mm; III, 0.26 mm; IV, 0.16 mm. *Pronotum:* Length 0.38 mm, basal width 1.08 mm.

The female of this species is very much like the male in the overall black coloration with the same pale markings. Females differ in the more grayish-brown corium and clavus, the more distinct pale apices of the tibiae, a pale-yellow apex on the scutellum, and the distinctly more slender second antennal segment.

Type data.—Holotype ♂: San Cristobal, Chiapas, Mexico, 16-17-VII-1969, L. A. Kelton coll. (BRI). Paratypes: 1 ♂, 1 ♀, same data as for holotype (BRI, USNM).

Remarks.—*Myiomma keltoni* will run to couplet 3 of my key (Henry, 1979) with *cixiiforme* and *fusiforme* based on the overall blackish coloration and large size. This attractive species can be separated from both of the latter by the lack of white along inner margins of the eyes (or a white spot on the frons), the brownish, rather than black, corium and clavus, the pale area at the base of the embolium, and the more slender second antennal segment.

I am naming this species after its collector, Leonard A. Kelton (BRI), who has been very kind in lending specimens of Miridae, including many of the Isometopinae used in this study.

New Records for Previously Described Species

Corticoris infuscatus Henry and Herring.—This species was described from single females collected in the states of Mexico and Oaxaca, Mexico (Henry and Herring, 1979). I have identified a third female taken in Jilotepec, Mexico, Mex., 2-IX-1969, by L. A. Kelton (BRI).

Corticoris signatus (Heidemann).—This species was described from Texas (Heidemann, 1908) and later reported from the District of Columbia, Florida, and Pennsylvania (summarized by Henry and Herring, 1979). I have identified the following specimens which represent new country records for Canada and Mexico, and a new state record for North Carolina: *Canada.*: 1 ♀, Vineland, 22-VII-1963, L. A. Kelton, on hickory (in crevices of bark) (BRI); 4 ♂, 8 ♀, Vineland Sta., 27 Jul. 1964, W. L. Putnam, on "Plumbark." *Mexico.*: 1 ♀, 23 mi. W. Durango, Durango, 7500′, 26 June 1964, L. A. Kelton (BRI). *United States.*: 2 ♂, 7 ♀, Raleigh, Wake Co., North Carolina, 26 May 1981, D. L. Stephan, on trunk of *Acer rubrum* L. infested with *Melanaspis tenebricosa* (Comstock) (USNM).

Corticoris unicolor (Heidemann).—This species was described from Arizona (Heidemann, 1908) and later reported from Durango, Mexico (Henry and Herring, 1979). I have identified 1 additional female taken 25 miles south of Durango, Durango, Mexico, Hwy 45, 24 Jul. 1964, by L. A. Kelton (BRI).

Lidopus heidemanni Gibson.—This species was described from Texas (Gibson, 1917) and later reported from Florida, Illinois, North Carolina, Tennessee, and

Tamaulipas (near Soto la Marina), Mexico (Henry, 1979). The following are new state records for Mexico: 1 ♂, 11 km N Autlan, Jalisco, Jul. 30–Aug. 1, 1978, taken at light, Plitt and Schaffner (USNM); 1 ♀, 5 mi. S. Monterrey, Nuevo Leon, 16-VII-1963, H. and A. Howden (BRI); and 1 ♂, Orizaba, Veracruz 12–22 Aug. 1961, R. and K. Dreisbach (USNM-Knight coll.).

Myiomma cixiiforme (Uhler).—This species was described from the District of Columbia, Maryland, and West Virginia (Uhler, 1891) and later reported from Delaware, Florida, New York, Pennsylvania, Texas, Virginia, and Quebec (summarized by Henry, 1979). I have examined the following specimens which represent a new province record for Canada and a new country record for Mexico: *Canada.*: 9 ♀, Niagara, Ontario, 25-VII-1963, L. A. Kelton, on hickory [in crevices of bark] (BRI); 7 ♀, Vineland, Ont., 22-VII-1963, L. A. Kelton, on hickory; 1 ♀, Vineland Sta., Ont., 27 Jul. 1964, W. L. Putnam, on "Plumbark" (BRI); 1 ♀, Ottawa, Ont. 17-VII-1953, J. F. McAlpine, on "Bleeding Elm." *Mexico.*: 1 ♂, 1 ♀, Nuevo Leon, S/Manzano, June 1980, I. Trevino (USNM).

Myiomma fusiforme Henry.—This species was described from a single female collected in Durango, Mexico (Henry, 1979). I have identified an additional female collected 8 miles east of El Salto, Durango, Mexico, at 8200′, 25 June 1964, by L. A. Kelton (BRI).

Wetmorea notabilis McAtee and Malloch.—This species was described from a single female taken in the Dragoon Mts., Arizona (McAtee and Malloch, 1924) and later reported from Oracle, Arizona and Puebla (northwest of Acatlan), Mexico (Henry, 1980). Recently, I examined two females collected 18 miles NW of Guadelajara, Jalisco, Mexico, in a pine-oak area, 30-IV-1961, by Howden and Martin (BRI). These specimens represent a considerable southern range extension and a new state record for *notabilis.*

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A NEW *STIBADIUM* FROM TEXAS AND A REDESCRIPTION OF *STIRIODES EDENTATUS* (GROTE) (NOCTUIDAE: LEPIDOPTERA)

ANDRÉ BLANCHARD AND EDWARD C. KNUDSON

(AB) 3023 Underwood, Houston, Texas 77025; (ECK) 808 Woodstock, Bellaire, Texas 77401.

Abstract.—A new noctuid moth, *Stibadium caesium,* is described from a single male specimen collected in Texas. *Stiriodes edentatus* (Grote) is reported from Texas. Imagines, male genitalia, and terminal sclerotizations of abdomen are figured.

A new species of noctuid, *Stibadium caesium,* is described below from a single male collected on south Padre Island by the junior author. *Stiriodes edentatus* is reported from Texas for the first time from two male specimens collected in Big Bend National Park by the junior author. Originally, these were also thought to represent a new species, but later proved to represent examples of *edentatus,* a highly variable species previously known from Mexico and southern Arizona.

Stibadium caesium **Blanchard & Knudson, NEW SPECIES**

Figs. 1–4

Head: Front and vertex whitish gray. Labial palpi whitish, with blackish scales along lateral surface, exceeding front by ⅓ of an eye diameter. Antennae simple, clothed dorsally with whitish scales; ventrally minutely pubescent. Collar whitish gray.

Thorax: Entirely whitish gray.

Abdomen: Whitish gray (later removed for dissection).

Forewings: Ground color pale bluish gray, consisting of a mixture of white and pale fuscous scales. Antemedial line obscure, fuscous, beginning on dorsal margin at ⅓ distance from base, outwardly oblique, fading out beyond cell. Postmedian line narrow, fuscous, beginning on dorsal margin ⅓ distance from tornus, outwardly oblique and bluntly angled beyond cell, not traceable to costa. Median space more suffused with fuscous than basal or subterminal space. Beyond postmedian line inner half of subterminal space more suffused with white; outer half suffused with fuscous. At costa, just before apex, an obscure subtriangular fuscous patch. Terminal line obscure, fuscous, slightly crenulate. Fringe pale fuscous. Undersurface of forewing fuscous, except for costal margin, which is whitish, and outer subterminal space, which is pale bluish gray.

Hindwings: Fuscous, paler towards base, with faint whitish postmedian line. Fringe contrastingly white. Undersurface of hindwing whitish.

Length of forewing: 14.2 mm.

Male genitalia (Figs. 2, 3, 4): Including sclerotization of 8th abdominal segment.

Figs. 1–8. 1–4, *Stibadium caesium.* 1, Holotype ♂, Cameron Co., Texas, South Padre Island, 24-X-82. 2, Male genitalia of holotype, slide ECK 668. 3, Aedeagus of holotype (vesica inflated), slide ECK 668. 4, Sclerotizations of 8th abdominal segment of holotype, slide ECK 668. 5–8, *Stiriodes endentatus* (Grote). 5, ♂, Brewster Co., Texas, Big Bend National Park, near Nugent Mt., 13-IX-82, length of forewing 8.1 mm. 6, ♂ genitalia of specimen in Fig. 5, slide ECK 666. 7, Aedeagus of specimen in Fig. 5, slide ECK 666. 8, Sclerotization of ♂ 8th abdominal segment, Big Bend National Park, Dugout Wells, 13-IX-82, slide ECK 674. Lines in Figs. 2, 3, 4, 6, 7, 8 represent 1 mm.

Holotype.—♂, Cameron Co., Texas, south Padre Island, 24-X-82, collected by E. Knudson and deposited in the National Museum of Natural History.

Remarks.—This species is unique in the genus, because of its pale bluish gray coloration and obscure maculation. The male genitalia are very similar to other members of the genus, particularly *Stibadium spumosum* Grote. Until more specimens are collected, it is uncertain whether this species is confined to the sand dune habitat of south Padre Island, or represents a stray example from northern Mexico, where relatively little moth collecting has been done.

***Stiriodes edentatus* (Grote)**

Two examples of this noctuid were collected in Big Bend National Park, 13-IX-83, by the junior author. Forewings vary from lemon yellow to pale tawny yellow, with brown markings (as in Fig. 5) or immaculate (not illustrated). Hindwings cream colored, unmarked. Length of forewing 8.0 and 8.1 mm in the two male examples. Dr. Robert Poole, who has examined both Texas specimens and made the above determination, has commented that these examples represent the extreme end of the weakly maculate forms of *edentatus,* so much so, that initially they were thought to represent an undescribed species. However, examination of the genitalia showed no significant differences from examples in the N.M.N.H. This species occurs in Mexico and Arizona and exhibits considerable variation in wing color and pattern. The above records are apparently the first from Texas (R. Poole, pers. comm.).

In Texas, *edentatus* may be confused with *Stiriodes obtusus* (Herrich-Schäffer), which it resembles fairly closely. All the examples of *obtusus* before us are larger, with heavier maculation on the forewing, and darker hindwings with a well defined postmedian line. *Stiriodes obtusus* is not known to occur in Big Bend, but the junior author has one specimen from Seminole Canyon, which is about 80 miles due east.

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The authors are extremely grateful to Robert Poole for examining the specimens included herein and for reviewing the preliminary MS. Collections in Big Bend National Park by the junior author were made under terms of a permit supported in part by the Florida State Collection of Arthropods (FSCA).

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NOTES ON THE SHORE FLY GENUS *DIEDROPS* (DIPTERA: EPHYDRIDAE)

WAYNE N. MATHIS

Department of Entomology, NHB 169, Smithsonian Institution, Washington, D.C. 20560.

Abstract.—The following new species in the genus *Diedrops* Mathis and Wirth is described: *D. steineri* (Panama: Chiriqui). A revised key to the species is presented.

This paper presents notes on the genus *Diedrops* Mathis and Wirth in the form of a new species description, a revised key, and a slightly revised characterization of the genus. The genus *Diedrops* now includes three species. Perspective for this paper was given in a recent review of Dagini (Mathis, 1982), and further details concerning generic placement, etc., can be found in that publication. For convenience and continuity, the descriptive format essentially follows that in Mathis (1982).

The descriptive terminology follows that published in the recent *Manual of Nearctic Diptera, Vol. 1* (McAlpine, 1981) with one exception. I have followed Sabrosky (1983) in using "microtomentum" rather than pruinescence or pollinosity for the dustlike vestiture over much of the cuticular surface. Three head ratios and two venational ratios, used in the species' descriptions, are defined here. Frons width-to-length ratio: frontal height (from the anterior margin of the frons to a line between the posterior pair of ocelli)/frontal width (at the level of the anterior ocellus); eye-to-cheek ratio: genal height (immediately below the eye)/ eye height; eye width-to-face length ratio: face length (in profile from anterior margin of eye to anterior margin of face)/eye width (greatest length along plane of eye); costal vein ratio: the straight line distance between R_{2+3} and R_{4+5}/distance between R_1 and R_{2+3}; M vein ratio: the straight line distance along M basad of crossvein dm-cu/ distance apicad of crossvein dm-cu.

Genus *Diedrops* Mathis and Wirth

Diedrops Mathis and Wirth, 1976: 126 [type-species: *Diedrops aenigma* Mathis and Wirth, by original designation].—Mathis, 1977: 555 [generic key]; 1982: 6–10 [review].

Diagnosis.—*Head:* Ocellar bristles lacking; lateroclinate fronto-orbital bristles 2, sometimes weakly developed; mesofrons in depression; arista moderately long, although not twice length of 1st flagellomere, minute setulae on at least basal ⅔, sometimes to apex, but generally appearing bare; 1st flagellomere nearly twice length of second antennal segment; face shieldlike, shallowly and evenly protrudent over entire height; facial setae uniformly sparse and subequal in size except those along oral margin, the latter setae longer, especially laterally; lacking facial series of setae extendent from midfacial height to posteroventral angles of face; genal bristle present, conspicuous.

Thorax: Prescutellar acrostichal bristles 1 pair; scutellar bristles variable as to comparative lengths; postpronotum bare of setulae; anterior notopleural bristle only slightly smaller than posterior one; level of insertion of posterior notopleural bristle especially as compared to anterior bristle variable; proepisternum with scattered setulae; katepisternal bristle conspicuously weaker than anepisternal bristle; apex of vein R_{2+3} approximate to vein R_{4+5}, distance between these at apex less than ½ that between veins R_{4+5} and M; capitellum coloration variable; armature of forefemur variable.

Abdomen: Male abdomen and terminalia as follows: 5th sternum divided, each sternite with setulae more densely clustered toward posteromedian angle. Epandrium shieldlike, cerci and cercal cavity occupying dorsal ½ to ⅓, ventral margin emarginate, setulose, and perhaps representing fused surstyli; gonite at least 3 times higher than wide, with posterodorsal gonal arch, latter with ventromedian process; aedeagal apodeme comparatively large, J-shaped, ventral portion wider; aedeagus 2–3 times longer than wide, in lateral view, variously shaped.

Discussion.—In my review of the tribe Dagini (Mathis, 1982) I hypothesized that the lineage giving rise to the genus *Diedrops* was one of three that formed an unresolved trichotomy. The other two lineages are those from which *Psilephydra* and *Dagus* + *Physemops* arose. With the addition of a third species to *Diedrops,* one character I used breaks down and needs to be reassessed. Within the tribe Dagini, I stated previously (1982:5) that only in specimens of the *Dagus* + *Physemops* lineage was the posterior notopleural bristle inserted more dorsad compared to that of the anterior bristle. In the new species of *Diedrops,* however, the posterior bristle is also distinctly elevated. In the other two species of *Diedrops, D. aenigma* and *D. hitchcocki,* the posterior bristle is inserted at a very slight elevation from the level of the anterior bristle. But in specimens of *D. byersi* the posterior bristle is distinctly inserted at an elevated level, similar to specimens of *Dagus* or *Physemops.* I still am of the opinion that an elevated insertion is an apotypic character, and consequently, that *Diedrops* is closely related to the *Dagus* + *Physemops* lineage. Repositioning *Diedrops* resolves the trichotomy with *Psilephydra* and *Dagus* + *Physemops* (*Psilephydra* is now the sister group to the remaining lineages of the tribe) but creates another, with *Diedrops, Dagus,* and *Physemops* as the included genera. Although each of the genera in this trichotomy is well characterized, the relationships between them remain unresolved.

KEY TO SPECIES OF *DIEDROPS*

1. Face distinctly bicolored, with a wide, brown, median stripe about the width of the distance between the eyes, face, otherwise, silvery gray to whitish; fore- and midfemora of male with row of prominent, robust setae along posteroventral surface (Panama) .... *D. steineri,* new species
– Face unicolorous, silvery gray; leg setation of sexes similar, weak, lacking row of robust setae 2
2. Anepimeron bare of setulae; anterior scutellar seta nearly equal to length of posterior seta; wing apex rounded; vein R_{2+3} nearly parallel to vein R_{4+5}; length of basitarsus equal to or shorter than combined length of

remaining tarsomeres for each leg; larger species, length 4.13 to 4.53 mm (Mexico) .... *D. aenigma* Mathis and Wirth

– Anepimeron with 1 to several setulae near anterior margin; anterior scutellar seta distinctly smaller than posterior one, usually less than one-half length; wing apex bluntly rounded; apex of vein R_{2+3} slightly sinuate; length of basitarsus larger than combined length of remaining tarsomeres for each leg; smaller species, length 2.78 to 3.52 mm (Peru) .... *D. hitchcocki* Mathis and Wirth

***Diedrops steineri*, NEW SPECIES**
Figs. 1–6

Diagnosis.—Resembling *D. aenigma* but differing from it as follows: moderately small to medium-sized shore flies, length 2.38 to 3.33 mm.

Head (Fig. 1): Frons width-to-length ratio 0.29; vestiture of frons uniformly microtomentose, appearing dull, vestiture of mesofrons not distinguished from that of parafrons; face, in lateral view, conspicuously arched just below facial prominence, thereafter nearly flat, vertical; facial setae comparatively longer and more conspicuous; face distinctly bicolored, with a wide, median, brown stripe; eye width-to-face ratio 0.40; anteroventral margin of eye bluntly rounded; eye-to-cheek ratio 0.60.

Thorax: Setae of dorsocentral and acrostichal series generally more strongly developed; usually with a larger pair of prescutellar acrostichal setae; anteroventral scutellar bristle strongly developed, subequal in size to apical scutellar bristle; posterior notopleural bristle inserted at level distinctly higher than anterior bristle; length of basitarsus slightly longer or subequal to combined length of remaining tarsomeres for each leg; capitellum of halter mostly yellowish. Wing with apex bluntly rounded; vein R_{2+3} evenly and very shallowly arched on basal ¾, thereafter shallowly dipping toward vein R_{4+5} distally; costal vein ratio 15.50; vein M ratio 1.18.

Abdomen (2–6): Dorsum slightly lighter in color than mesonotum; tergum 1 and anterior ½ of tergum 2 grayish, other terga blackish brown; length of 3rd tergum of male only slightly shorter than combined length of 4th and 5th terga; 5th tergum of male with posterior margin shallowly emarginate; male terminalia as in Figs. 2–6.

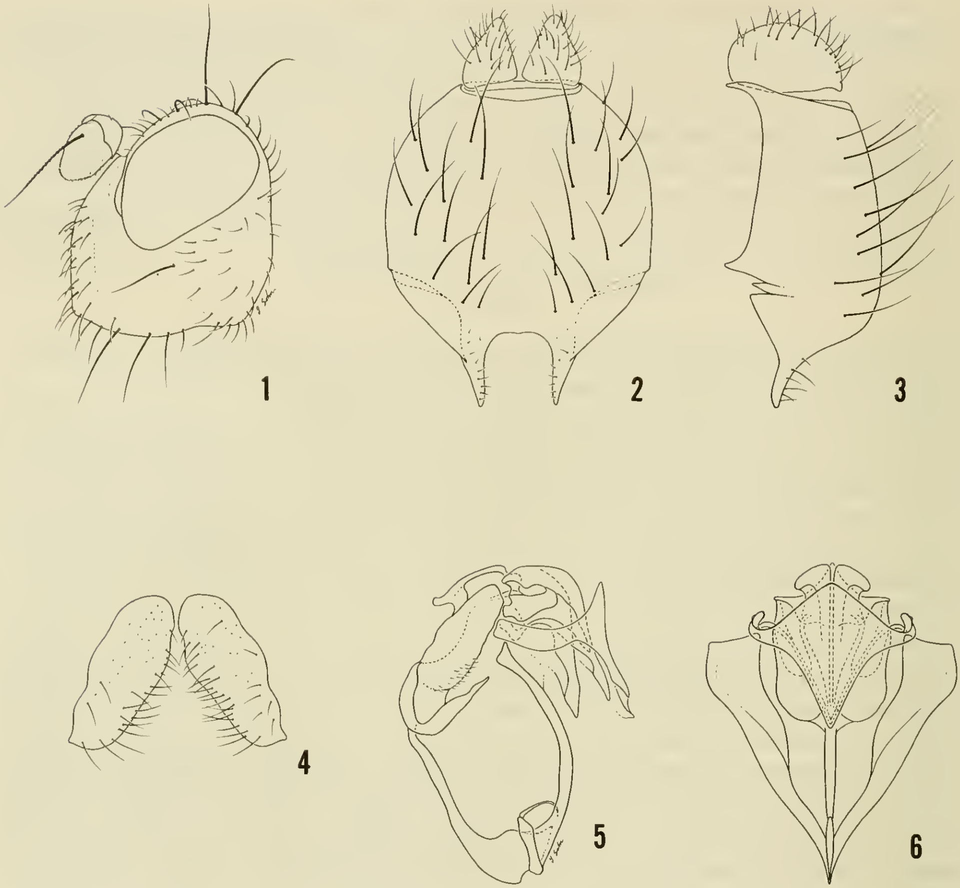
Type material.—Holotype male is labeled "PANAMA, Chiriqui, Bambito, Rio Chiriqui Viejo 1770 m, 3 June 1983." "Collected by P.J. Spangler R.A. Faitoute W.E. Steiner." The holotype is double mounted (minute nadel in a plastic elastomer block), is in excellent condition, and is in the National Museum of Natural History, Smithsonian Institution, USNM 101202. The allotype female and 37 paratypes (26 ♂, 11 ♀; USNM) bear the same locality data as the holotype.

Etymology.—The specific epithet is a Latinized genitive patronym to honor Mr. Warren Steiner, the collector of the type series.

Distribution.—This species is presently known only from the type-locality in Panama.

Remarks.—This is the third species to be named in *Diedrops*. The vertical brown stripe down the middle of the face is the most easily seen character for distinguishing the species and readily separates it from congeners.

Unlike the other two species, this species exhibits some sexual dimorphism.



Figs. 1–6. *Diedrops steineri.* 1, Head, lateral view. 2, Epandrium, posterior view. 3, Epandrium, lateral view. 4, Fifth sternites, ventral view. 5, Internal male genitalia, lateral view. 6, Internal male genitalia, posterior view.

Males have a row of prominent, robust bristles along the posteroventral surface of both the fore- and midfemora. Presumably these play a role in courtship or copulatory behavior, although no observations have been made to confirm this.

The collector of the type series, Mr. Warren Steiner, reported that this species was collected by sweeping immediately over rocks in a small stream. This habitat is characteristic of other species of the tribe, especially in the sister genera, *Dagus* and *Physemops.* I have collected specimens of the latter genera in similar habitats. As this habitat has only been sporadically sampled, I suspect that numerous additional species in all genera of Dagini will yet be discovered.

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CYTOGENETIC STUDY IN MALES OF NEARCTIC GENERA OF GERRIDAE (HEMIPTERA: HETEROPTERA)

Diane M. Calabrese and Peter Tallerico

(DMC) Department of Biology and The Wildlife Sanctuary, Dickinson College, Carlisle, Pennsylvania 17013; (PT) Nursing Department, Pennsylvania State University, University Park, Pennsylvania 16802.

Abstract.—Chromosome numbers and sex chromosome mechanisms determined on the basis of study of spermatogenic tissue are reported for six species of Gerridae: *Neogerris hesione* (Kirkaldy) (♂, N = 11 + XO), *Metrobates hesperius* (Uhler) (♂, N = 12 + XY), *Rheumatobates rileyi rileyi* Bergroth (♂, N = 9 + XY), *Trepobates pictus* (Herrich-Schaeffer) (♂, N = 12), *Limnoporus notabilis* (Drake and Hottes) and *L. canaliculatus* Say (♂, N = 9 + XY). A preliminary pattern of correspondence emerges when chromosome numbers and sex determination mechanisms are superimposed on a phylogenetic reconstruction for the Gerridae.

Here we report chromosome numbers and sex determination mechanisms for representatives of five genera of Gerridae (Hemiptera: Heteroptera), including three for which such information has not yet been published. We also comment on the apparent congruence between cytogenetic and morphological characters in the family.

Many concepts have been associated with congruence: stability in classification, stability with addition of characters, stability with addition of groups; but there is no general agreement on a definition (cf. Rohlf and Sokal, 1980; Schuh and Polhemus, 1980; Mickevich, 1978). Ultimately, congruence refers only to correspondence. We compare chromosome numbers and sex determination mechanisms among genera we studied in the context of a phylogenetic reconstruction of the genera produced by one of us (Calabrese, 1980).

Materials and Methods

Neogerris hesione (Kirkaldy) was collected in southern Florida, *Metrobates hesperius* Uhler, *Rheumatobates rileyi rileyi* Bergroth and *Trepobates pictus* (Herrich-Schaeffer) were collected in Cumberland County, PA. *Limnoporus canaliculatus* Say was collected in central Florida by A. Zera. *Limnoporus notabilis* Drake and Hottes was collected in Haney, British Columbia by John Spence.

At least five specimens of each species were field-fixed (15 ml glacial acetic acid, 45 ml absolute ethanol, 5 ml. acetone). Within two weeks testes were dissected out of males. Each testis was stained for 3–5 minutes with a drop of lacto-proprio orcein. A standard squash was made. Slides were sealed in temporary mounts and scanned for figures at 40×. Metaphase I figures found were photographed at about 1500× under oil with a Bausch and Lomb (B&L) phase contrast microscope with a B&L C-35 camera attachment. Figures were subsequently enlarged when prints were made.

RESULTS

Chromosome numbers and sex determination mechanisms are summarized as follows (N = ♂): *Neogerris hesione* (Fig. 1), 11 + XO; *Metrobates hesperius* (Fig. 2), 12 + XY; *Rheumatobates rileyi* (Fig. 3), 9 + XY; *Trepobates pictus* (Fig. 4), 12 —; *Limnoporus notabilis* (Fig. 5), 9 + XY; *Limnoporus canaliculatus* (Fig. 6), 9 + XY.

Restriction of kinetochores to the terminal ends of meiotic chromosomes is evident in all species studied and *m* chromosomes are consistently absent (Fig. 1–6).

DISCUSSION

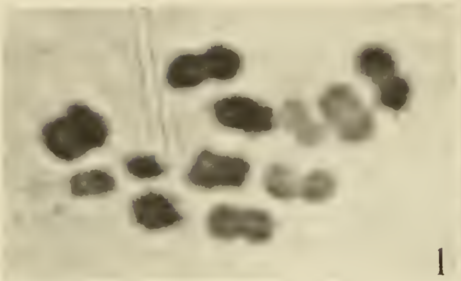
Study of additional genera (Figs. 1–6) of Gerridae supports our suggestion that the XO sex determination mechanism is not universal among the Gerridae (Calabrese and Tallerico, 1982) as Ueshima (1979) has proposed.

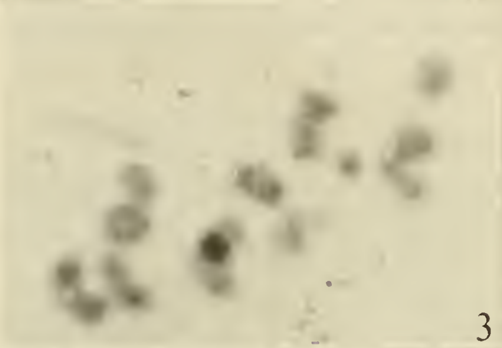
These are the first results reported for *Metrobates*, *Rheumatobates* and *Trepobates*. Jande (1959) reported that in *Neogerris parvulus* N = 11 + XO. Our results for *Neogerris hesione* agree with his. We previously reported (Calabrese and Tallerico, 1982) also that *Limnoporus dissortis* shows a diploid number of 21 and an XO sex determination mechanism in the male. We report here different results for *L. notabilis* and *L. canaliculatus* (N = 9 + XY, Figs. 5–6).

Although we do not suggest that there is consistency of chromosome number and sex determination mechanism within genera, we do suggest that results based on the species studied, in the context of a phylogenetic reconstruction (Calabrese, 1980), indicate a general trend toward higher chromosome number and in some cases away from an XY male in highly derived groups of Gerridae (e.g. *Metrobates*, *Trepobates*). Anderson (1982) reports a diploid number of 25 (no sex determination mechanism given) for *Ptilomera breddini* Hungerford and Matsuda. The *Ptilomera* group is hypothetically more derived than the *Gerris*, *Limnoporus* and *Neogerris* groups, but is ancestral to the *Trepobates* and *Metrobates* (Calabrese, 1980). And, Cheng and Newman (in prep.) report a diploid number of 30 + XO for several species of *Halobates*, a genus which hypothetically belongs to the most derived clade of gerrid genera (Calabrese, 1980; Anderson, 1982).

Potential for increase in chromosome number through fragmentation exists in the Heteroptera because of the holokinetic nature of heteropteran chromosomes (cf. comprehensive discussion by Schrader (1947)). The tendency for more derived Heteropteran groups to have more chromosomes has also been cited by others. For example, the Pentatomomorpha exhibit the tendency (Leston et al., 1958), as do some Lygaeid groups (Ueshima and Ashlock, 1980). Ueshima and Ashlock (1980) wisely caution against the expectation of finding a universal trend within the Heteroptera.

There is good evidence that the XY sex determination mechanism is ancestral in certain familial groupings of Heteroptera: in the Lygaeidae (Ueshima and Ashlock, 1980), the Miridae and Nabidae (Leston, 1957), the Triatominae of the Reduviidae (Ueshima, 1966), and the Coreoidea and Pyrrhocoroidea (Schaefer,





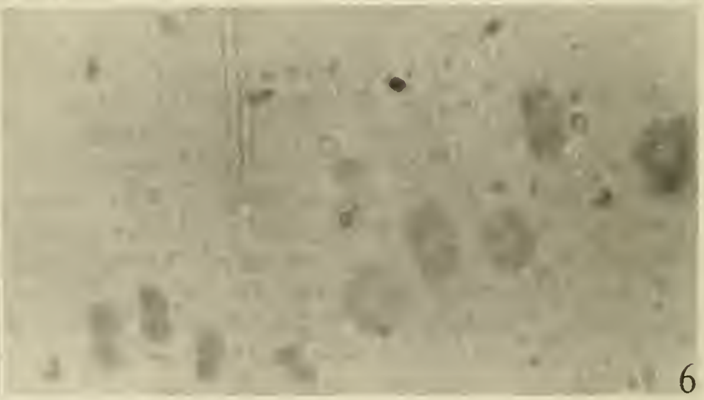


Fig. 1. *Neogerris hesione,* 2N = 22 + XO, ca. 6000×.
Fig. 2. *Metrobates hesperius,* 2N = 24 + XY, ca. 6000×.
Fig. 3. *Rheumatobates rileyi,* 2N = 18 + XY, ca. 6000×.
Fig. 4. *Trepobates pictus,* 2N = 24, ca. 6000×.
Fig. 5. *Limnoporus notabilis,* 2N = 18 + XY, ca. 6000×.
Fig. 6. *Limnoporus canaliculatus,* 2N = 18 + XY, ca. 6000×.

1964). Ueshima (1979) has suggested that the XX-XO sex determination mechanism is primitive in the Heteroptera. Based on our studies of Gerridae (discussed herein), studies of Mesoveliidae (Calabrese and Tallerico, in press), and the study of Veliidae (Onopa, 1981), we do not find sufficient evidence to consider an XO sex determination mechanism to be ancestral, at least within the Gerromorpha.

ACKNOWLEDGMENTS

We are grateful to Carl W. Schaefer for useful criticism of an earlier draft of this manuscript. Lanna Cheng and Lester Newman generously gave us permission to use their unpublished chromosome data on *Halobates.* Anthony Zera and John Spence collected Gerrids for us and in that way assisted us greatly. This work was supported by NSF grant DEB 81-16763 to Calabrese.

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SPECIES OF *SIBINIA* GERMAR (COLEOPTERA: CURCULIONIDAE) ASSOCIATED WITH *MIMOSA PIGRA* L.

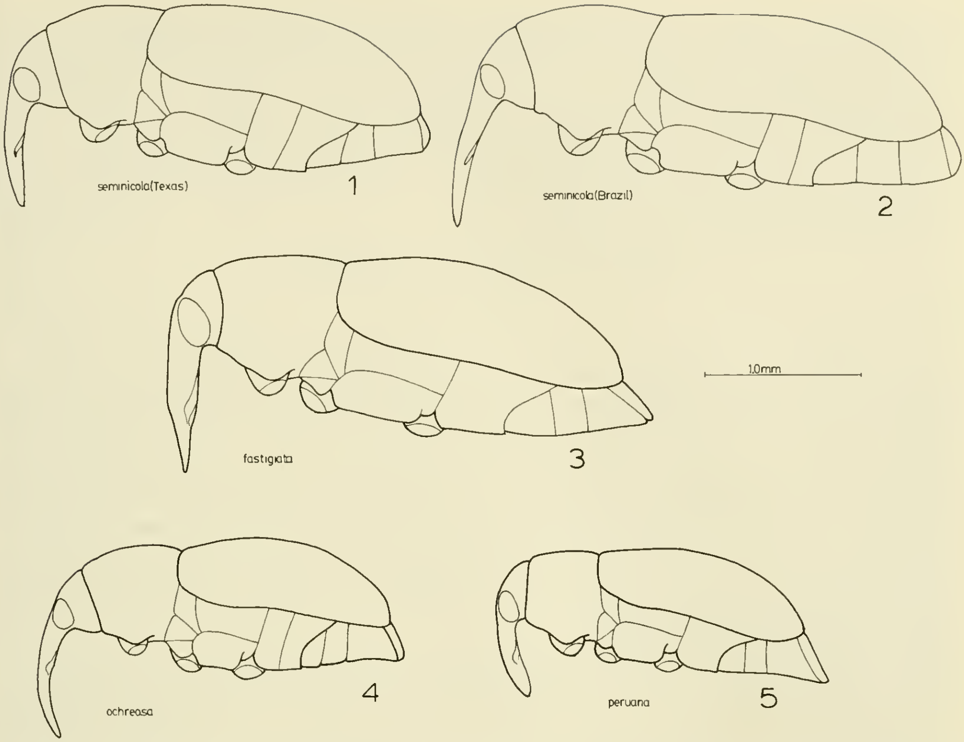
WAYNE E. CLARK

Department of Zoology-Entomology, Alabama Agricultural Experiment Station, Auburn University, Alabama 36849.

Abstract.—Four species of the weevil genus *Sibinia, S. seminicola* Clark, *S. fastigiata* Clark, *S. ochreosa* Casey, and *S. peruana* Pierce, have *Mimosa pigra* L. as host. A key to adults of these species is presented. *S. seminicola,* with populations in Texas and Mexico, is newly reported from southeastern Brazil and northeastern Argentina. The known range of *S. fastigiata* is extended from Mexico and Central America to include Brazil and Peru. The larvae and pupae of *S. seminicola* and *S. ochreosa* are described, as are the larvae of *S. fastigiata* and *S. peruana.* Pupae of the latter two species are unknown.

A monograph of New World weevils of the genus *Sibinia* (Clark, 1978) listed four species, all of the subgenus *Microtychius* Casey, as developing on *Mimosa pigra* L. Two of these, *S. seminicola* Clark and *S. fastigiata* Clark, develop in seeds of this mimosoid legume. The other two, *S. ochreosa* Casey and *S. peruana* Pierce, develop in the flower buds. The four species have been reported to occur widely throughout Mexico and Central America (Clark, 1978, 1979), the ranges of *S. seminicola* and *S. ochreosa* extending into southern Texas, and those of *S. ochreosa* and *S. peruana* into South America. Specimens of *Sibinia* were collected recently on *M. pigra* by John A. Winder of the Australian CSIRO Biological Control Unit at Curitiba, Parana, Brazil. The Australians' interest in these weevils arose out of their search for potential agents for biological control of this plant which is a noxious weed in the Northern Territory of Australia (Miller and Pickering, 1978). Additional specimens of *Sibinia* were obtained from Guillermo Kuschel of the Division of Scientific and Industrial Research, Auckland, New Zealand (NZAC), Sergio Vanin of the Museu de Zoologica da Universididade de Sao Paulo (MZSP), and Donald R. Whitehead of the Systematic Entomology Laboratory, USDA, Washington, D.C. These specimens significantly extend the known ranges of *S. seminicola* and *S. fastigiata.* The information contained here, along with information on the life histories of the species published elsewhere (Clark, 1978), should be of value to scientists interested in these and other insects associated with *M. pigra.*

Descriptions of the larvae utilize terminology proposed by Anderson (1947); pupal descriptions follow Burke (1968). All were developed from specimens prepared by techniques described by Ahmad and Burke (1972), except as noted by Clark et al. (1978).



Figs. 1–5. *Sibinia* spp., habitus of female, lateral views. 1, *S. seminicola* (Texas). 2, *S. seminicola* (Brazil). 3, *S. fastigiata*. 4, *S. ochreosa*. 5, *S. peruana*.

Adults of *Sibinia* Species Associated with *Mimosa pigra*

Adults of the four species of *Sibinia* associated with *M. pigra* are distinguished from other Curculionoidea (*Apion* spp., *Chalcodermus serripes* Champion, and *Pselaphorhynchites* spp.) likely to be collected on the same plants by the characters which distinguish all members of the tribe Tychiini (Clark et al., 1977). The most easily observed of these characters is the structure of the second abdominal sternum which is angled posteriorly so that the sides of sternum 2 cover the sides of sternum 3 (Figs. 1–5). The species are distinguished from each other by the characters in the following key.

1. Larger *Sibinia*, length 2.19–3.45 mm; scales on pronotum and elytra viridis or ferruginous, or fulvous *and* ferruginous in more-or-less distinct pattern 2
– Smaller *Sibinia*, length 1.58–2.05 mm; scales on pronotum and elytra pale ochreous to citrinous, darker scales, if present, limited to lateromedian pronotal vittae and small lateromedian elytral maculae 3
2. Rostrum of female (Figs. 1, 2) slender, distal portion slightly tapered; article II of male protarsus only slightly concave on inner surface . . . . *seminicola*
– Rostrum of female (Fig. 3) stout basally, short distal portion subulate; article II of male protarsus deeply concave on inner surface . . . . . . *fastigiata*

3. Protarsus of male with inner surface of article II concave; rostrum of female (Fig. 5) short, stout; pygidium and 5th abdominal sternum of female strongly produced (Fig. 5) .... *peruana*
– Protarsus of male with inner surface of article II unmodified; rostrum of female (Fig. 4) abruptly narrowed distad of antennal insertions, distal portion long, curved, slender; pygidium and 5th abdominal sternum of female less strongly produced (Fig. 4) .... *ochreosa*

Sibinia seminicola and *S. fastigiata*

Figs. 1–3

The range of *S. seminicola* was initially described as Texas and northeastern Mexico, that of *S. fastigiata* as Mexico, Honduras, and Panama (Clark, 1978). The discovery of both species in South America significantly extends their known ranges and reveals an interesting biogeographical pattern. The range extensions themselves are not surprising because the host plant, *M. pigra,* is widely distributed throughout the neotropics (Turner, 1959). The pattern consists of populations of *S. seminicola* in Texas and Mexico in apparent disjunction with those in Brazil and Argentina. The two populations are separated by all of Central America, northern South America, and the Amazon Basin. The intervening area appears to be occupied by *S. fastigiata.*

The specimens of *S. seminicola* from Brazil were all collected on *M. pigra* or reared from pods of this plant. The Argentine specimens have no host plant data.

The following are previously unrecorded collection data on the South American *S. seminicola* examined. ARGENTINA: *Entre Rios,* Rio Bravo, 2 Feb 1943, G. Kuschel (1 ♂, 1 ♀, NZAC); BRAZIL: *Bahia,* Medeiros Neto, 19 Jan 1981, J. A. Winder, pod emergence (25 ♂, 19 ♀); the same, except 13 Feb 1982 (7 ♂, 5 ♀); Teixeira de Freitas, 21 Jan 1981, J. A. Winder, pod emergence (3 ♂, 2 ♀); *Goiás,* Itumbiara, 1 May 1981, J. A. Winder (1 ♂); *Minas Gerais,* Rio Pomba, Laranjal, 23 Mar 1981, J. A. Winder (1 ♀), *Rio de Janeiro,* Campos, 23 Feb 1981, J. A. Winder, pod emergence (1 ♀); the same, except 26 Mar 1981 (5 ♂, 3 ♀).

The South American *S. fastigiata* have the following previously unreported label data. BRAZIL: *Para,* Jacareacanga, Dec 1968, M. Alvarenga (1 ♂, 1 ♀, MZSP); PERU: *Loreto,* Rio Marañon, Quebrada Cayaru, 3 Mar 1977, Prance et al. #24662A, *Mimosa* sp. (4 ♂, 5 ♀, USNM).

Minor morphological differences distinguish the specimens of *S. seminicola* from the U.S. and Mexico from those from Brazil and Argentina. The rostrum of the female is longer and more slender in the South American specimens, and the pygidium and apical portion of sternum 5 are slightly narrower as well as being more distinctly produced (cf. Figs. 1, 2). Conversely, the Brazilian specimens of *S. fastigiata* do not differ significantly from those from Mexico and Central America. Female Peruvian *S. fastigiata,* however, have the rostrum distinctly narrower and have the pygidium more strongly produced than do the Mexican, Central American, and Brazilian specimens examined. In addition, both male and female Peruvian *S. fastigiata* have ferruginous instead of viridis scales.

Sibinia ochreosa and *S. peruana*

Figs. 4, 5

According to Clark (1978), *S. ochreosa* occurs in Texas, Mexico, Honduras, Nicaragua, and Brazil, and *S. peruana* occurs in Mexico, Guatemala, Honduras, Costa Rica, Peru, Brazil, Paraguay, and Argentina. The latter species is also known from Panama (Clark, 1979).

Previously unpublished collection records for *S. ochreosa,* all of them South American, are as follows. ARGENTINA: *Entre Rios,* Rio Bravo, 2 Feb 1943, G. Kuschel (2 ♂, 2 ♀, NZAC); BRAZIL: *Bahia,* Itamarajú, 6 Apr 1980, J. A. Winder (1 ♀); Medeiros Neto, 13 Jan 1981, J. A. Winder (1 ♂); *Espirito Santo,* Linhares, 10 Feb 1981, J. A. Winder (2 ♀), the same, except 3 Mar 1980 (2 ♂, 2 ♀); *Minas Gerais,* Januária, 5 May 1981, J. A. Winder (1 ♀); Nanuque, 16 Oct 1980, J. A. Winder (2 ♀); São João de Manhuaçú, 20 Mar 1981, J. A. Winder (1 ♀); *Pará,* Jacareacanga, Nov 1968, M. Alvarenga (36 ♂, 22 ♀, MZSP); *São Paulo,* São Paulo, 10 May 1981, J. A. Winder (1 ♂).

Previously unpublished locality records for *S. peruana,* likewise all South American, are the following. BOLIVIA: Trinidad, 1 Jan 1949, G. Kuschel (3 ♂, 1 ♀, NZAC); BRAZIL: *Amapá,* Rio Negro, Tapuruguara, 4–5 Feb 1963, J. Bechyne (1 ♀, MZSP); *Minas Gerais,* Januária, 5 May 1981, J. A. Winder, collected on *Mimosa pigra* (4 ♀); *Pará,* Jacareacanga, Dec 1968, M. Alvarenga (3 ♂, 8 ♀, MZSP).

The striking differences in the rostrum and pygidium which distinguish females of *S. ochreosa* from those of *S. peruana* may have some significance in resource partitioning in the two species. In females of *S. ochreosa* (Fig. 4) the rostrum is long and slender, the distal portion attenuate, smooth, and glabrous, whereas in *S. peruana* (Fig. 5) the female has a short stout rostrum with a sculpted, relatively stout distal portion. *S. peruana* has a more strongly produced pygidium and 5th abdominal sternum.

LARVAE AND PUPAE OF *SIBINIA* SPECIES ASSOCIATED WITH *M. PIGRA*

The larvae and pupae described below are the only ones of members of the genus *Sibinia* to be so treated since the description of *S. setosa* (LeConte) by Rogers et al. (1975). Clark et al. (1978) compared larvae and pupae of species of *Tychius* Germar with those of *S. setosa* and of *S. sodalis* Germar, a European species described by Scherf (1964). There do not appear to be any larval characters by which all four *Sibinia* species associated with *M. pigra* can be distinguished from *S. setosa* and *S. sodalis.* The larvae of *S. ochreosa, S. peruana,* and *S. sodalis* possess bicameral thoracic spiracles. The last, however, is distinguished by having bicameral abdominal spiracles as well. Larvae of *S. seminicola* and *S. ochreosa* agree with *S. sodalis* in numbers of thoracic and abdominal postdorsal setae. The pupa of *S. setosa* is distinguished from those of the species associated with *M. pigra* in having four instead of three pairs of posterolateral setae on the pronotum. The larvae and pupae of the *Sibinia* species associated with *M. pigra* are distinguished from each other by the characters presented in Table 1.

Sibinia seminicola and *S. fastigiata*

Figs. 6, 8–10, 14

Larvae of these relatively large members of the subgenus *Microtychius* develop in the pods of *M. pigra* and feed on the seeds. Clark (1978) reported that larvae of *S. seminicola* feed on green, unripened seeds, and that pupation occurs within the pods while the latter remain on the plants. Adults were reared from pods. Adults of *S. fastigiata* were collected on flowers of *M. pigra,* and a single larva was subsequently collected in an *M. pigra* pod. Adults of this species have not

Table 1. Summary of diagnostic characters of larvae and pupae of *Sibinia seminicola, S. fastigiata, S. ochreosa,* and *S. peruana.*

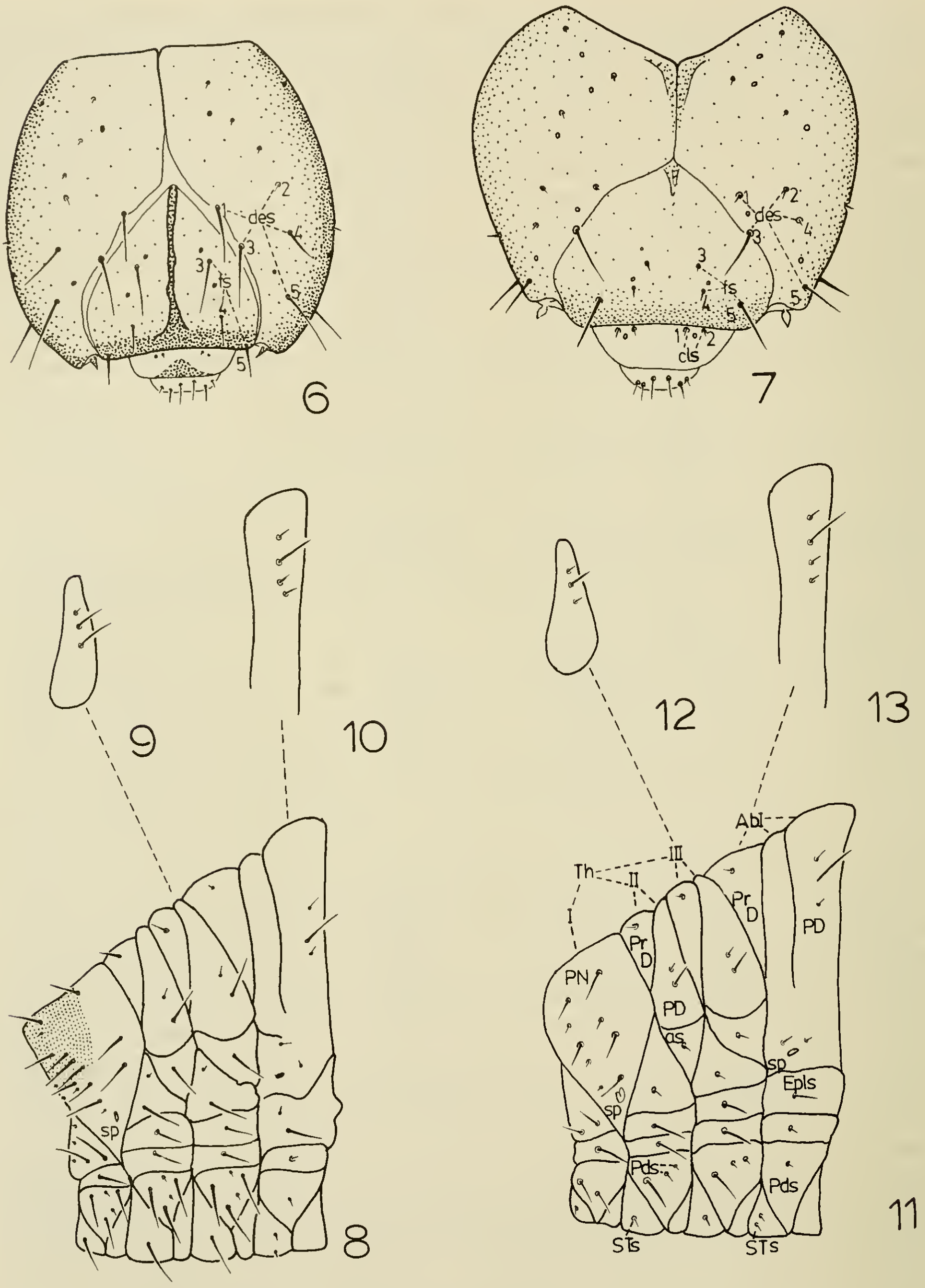
	seminicola	*fastigiata*	*ochreosa*	*peruana*
Head of larva				
Posterior portion (Figs. 6, 7)	Truncate	Truncate	Cleft	Cleft
Endocarina (Figs. 6, 7)	Long	Long	Short	Short
Frontal setae 3 & 4 (Figs. 6, 7)	Long	Long	Short	Short
Dorsal epicranial setae 1 & 4 (Figs. 6, 7)	Long	Minute	Minute	Minute
Ventral epicranial seta 1	Long	Minute	Minute	Minute
Clypeal seta 2 (Figs. 6, 7)	Absent	Present	Present	Present
Labral rods	Short	Short	Long	Long
Ventral malar setae (Figs. 14, 15)	3	3	4	4
Premental setae	Long	Long	Short	Short
Thorax of larva				
Long pronotal setae	11	11	5	5
Spiracle	Unicameral	Unicameral	Bicameral	Bicameral
Prodorsal setae	Long	Long	Short	Short
Postdorsal setae (Figs. 8, 9, 11, 12)	2	3	2	3
Alar setae (Figs. 8, 11)	Minute	Minute	Long	Long
Pedal setae (prothorax) (Figs. 8, 11)	3 long + 2 short	3 long + 2 short	2 long	3 long
Pedal setae (mesothorax & metathorax) (Figs. 8, 11)	3 long + 2 short	3 long + 2 short	1 long + 2 short	2 long + 2 short
Sternal setae (Figs. 8, 11)	Long	Short	Short	Short
Abdomen of larva				
Postdorsal setae sterna I–VII (Figs. 8, 10, 11, 13)	3	4	3	4
Epipleural seta II (Figs. 8, 11)	Minute	Minute	Absent	Absent
Postdorsal setae sternum IX	Short	Short	Long	Long
Episternal setae sternum IX	Short	Short	Long	Long
Pedal setae sternum IX	2 minute	2 minute	1 minute	1 minute
Eusternal setae sternum IX	2 long	2 long	1 minute	1 minute
Head of pupa				
Length of distirostral seta	Greater than ½ width of rostrum	—	Less than ½ width of rostrum	—
Abdomen of pupa				
Posterior processes of tergum 9	Invisible from above	—	Visible from above	—

been reared, and pupae have not been collected. The characters separating the larvae of *S. seminicola* from those of *S. fastigiata* are summarized in Table 1.

Larva of *S. seminicola* (Figs. 6, 8, 14).—*Body:* robust, slightly curved; 2.6–3.5 mm long (20 larvae); pale milky white, integument shining, rugose; abdominal sterna with transverse rows of minute asperities. *Head* (Fig. 6): uniformly dark yellowish brown; truncate posteriorly; width 0.48–0.51 mm (6 larvae); ocellar areas without subcutaneous pigment; accessory appendage of antenna long, conical, sides nearly straight, surface papillous; endocarina distinct throughout length of frons. Frontal setae: 1 and 2 absent; 3 longer than 4; 4 long; 5 about as long as 3. Dorsal epicranium: seta 1 long, located adjacent to frontal suture; seta 2 minute; seta 3 long; seta 4 long, but shorter than 3; seta 5 long; 1 sensillum present posterior to seta 1. Posterior epicranium: 3 pairs of minute setae and 2 pairs of sensilla. Lateral epicranium: seta 1 short; seta 2 long; 1 sensillum present between setae 1 and 2. Ventral epicranium: seta 1 long, seta 2 minute. Clypeus: seta 1 minute, seta 2 absent; 1 sensillum present. Labrum: seta 1 long, seta 2 long, seta 3 short; lateral sensilla absent; median sensillum absent. Epipharynx: labral rods short, stout, widely separated; 4 stout anterolateral setae and 6 anteromedian setae present, median pairs of the latter longest; 4 median spines and 3 pairs of sensory pores present. Mandible: with 3 apical teeth; setae 1 and 2 minute; 1 sensillum present. Maxillary palpus: consists of 2 articles; basal article with 1 minute seta and 1 sensillum; apical article with 1 sensillum; dorsal malar area with 2 subequal, conical, acuminate setae, 1 short, pointed seta, and 2 short, blunt setae; ventral malar area (Fig. 14) with 3 setae, basal seta longer than proximal pair. Stipes: seta 1 long, seta 2 minute; setae 3 and 4 long, subequal; 3 sensilla present. Labium: palpus consists of 1 article with 1 sensillum, a small sensillum also present near base of each palpus; glossa with 2 apirs of minute setae and 2 pairs of sensilla; postmental seta 1 absent; seta 2 long, seta 3 minute. *Thorax* (Fig. 8): pronotum with 11 long setae and 3 minute setae, in addition to 2 minute anterolateral setae; spiracle unicameral; prodorsum of mesothorax and that of metathorax with 1 long seta; postdorsum of mesothorax and that of metathorax with 2 setae, seta 1 short, seta 2 long; alar area of each segment with 1 long seta; spiracular area with 1 minute seta; pleural fold of prothorax with 2 long setae; pleural fold of prothorax with 2 long setae, that of mesothorax and of metathorax with 1 long seta; epipleural fold of each segment with 1 long seta; pedal area with 3 long setae and 2 short setae; sternal area with 1 long seta. *Abdomen:* spiracles unicameral, air tubes short, annuli indistinct. Segments I–VII (Fig. 8): each with 3 dorsal folds; prodorsum of each segment with 1 minute seta; postdorsum with 3 setae, seta 1 short, seta 2 long, seta 3 short; spiracular areas each with 2 minute setae; epipleural areas with 1 long seta and 1 minute seta; pleural areas with 1 minute seta; pedal areas with 1 minute seta; eusternal areas with 2 minute setae; sternellum present. Segment VII: prodorsum with 1 minute seta; sternellum present. Segment VIII: prodorsum with 1 minute seta; postdorsum with 1 long seta; spiracular area with 1 minute seta; episternal area with 1 long seta; pleural area with 1 minute seta; pedal area with 1 minute seta; eusternal area with 2 minute setae. Segment IX: postdorsum with 1 short seta; episternal area with 1 minute seta; pleural area with 2 minute setae; eusternal area with 2 long setae. Anus: terminal.

Twenty-six larvae (20 entire specimens and 6 slide mounts) taken from pods of *Mimosa pigra* collected 28 July 1971 at Brownsville, Cameron County, Texas, determined by association with reared adults, were examined.

Pupa of *S. seminicola.*—Length: 3.1–4.0 mm. *Rostrum:* 1 pair of distirostral setae located near middle of rostrum, each seta borne on summit of rounded tubercle, length of a distirostral seta less than ½ width of rostrum. 2 pairs of basirostral setae located just distad of ocular area, each seta borne on summit of rounded tubercle; basirostral setae slightly longer than distirostrals, proximal pair



Figs. 6–13. *Sibinia* spp., larvae. 6, *S. seminicola,* head capsule. 7, *S. ochreosa,* head capsule. 8, *S. seminicola,* thorax and abdominal segment I. 9, *S. fastigiata,* postdorsum of metathorax. 10, *S. fastigiata,* postdorsum of abdominal segment I. 11, *S. ochreosa,* thorax and abdominal segment I. 12, *S. peruana,* postdorsum of metathorax. 13, *S. peruana,* postdorsum of abdominal segment I. Abbreviations (after Ahmad and Burke, 1972): *Ab*—abdomen; *as*—alar seta; *cls*—clypeal seta; *fs*—frontal seta; *PD*—postdorsum, *Pds*—pedal setae; *PN*—pronotum; *PrD*—prodorsum; *sp*—spiracle; *STs*—sternal stea; *Th*—thorax.

usually longer than distal pair. 1 pair of interorbital setae, each seta borne on summit of conical tubercle; interorbitals longer and stouter than basirostrals and distirostrals. 1 pair of frontal setae, each seta borne on summit of conical tubercle; frontals about as long as interorbitals, separated from each other by distance much greater than length of a frontal seta. 1 pair of supraorbital setae, each seta borne on low, blunt tubercle. *Pronotum:* 1 pair of anteromedian setae which are separated from each other by distance much greater than length of an anteromedian seta. 2 pairs of anterolateral setae. 1 pair of discal setae located directly posterior to anteromedian setae, these more widely separated than anteromedian setae. 1 pair of posteromedian setae, and 3 pairs of posterolateral setae. *Mesonotum and Metanotum:* 1 pair of mesonotal and 1 pair of metanotal setae. *Abdomen:* 2 pairs of discotergal setae on terga 1–7, tergum 8 with only 1 pair of discotergals, those on posterior segments larger than the ones on anterior segments. 1 pair of laterotergal setae on 1st 7 or 8 terga, each seta borne on summit of low, indistinct tubercle. Segment 9 bearing a pair of short to long, sharply pointed, widely separated posterior processes which are not visible from above; abdomen devoid of ventral setae. *Femora:* each femur bearing 2 setae.

Thirteen pupae, collected in pods of *Mimosa pigra,* 27 July 1971, at Brownsville, Cameron County, Texas, determined by association with reared adults, were examined.

Larva of *S. fastigiata.*—The larva of *S. fastigiata* is known from a single slide–mounted specimen taken from an *M. pigra* pod collected 9 mi. N Matias Romero, Oaxaca, Mexico, 23 July 1974, by W. E. Clark. It differs from the larva of *S. seminicola,* described above, in the characters summarized in Table 1.

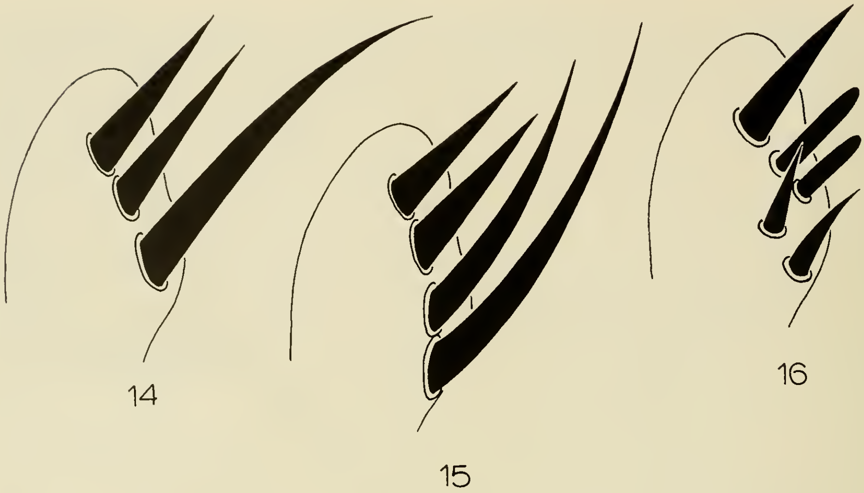
Pupa of *S. fastigiata.*—The pupa of *S. fastigiata* has not been collected.

Sibinia ochreosa and *S. peruana*

Figs. 4, 5, 7, 11–13, 15, 16

These small *Microtychius* develop in flower buds of *M. pigra.* Clark (1978) reported that pupae of *S. ochreosa* were found in flower buds on the plants, but that when flowers were removed from the plants larvae emerged and formed pupal cells in a sand-peat moss substrate. Adults of *S. peruana* were reared from larvae which emerged from flowers also infested by larvae of *S. ochreosa.* Pupae of *S. peruana* were not observed in flower buds, but more field work might reveal habits similar to those of *S. ochreosa.* The characters separating the larvae of *S. ochreosa* from those of *S. peruana* are summarized in Table 1.

Larva of *S. ochreosa* (Figs. 7, 11, 15, 16).—*Body:* elongate, slightly curved; length 2.1–2.6 mm (10 larvae); pale milky white, surface shining, smooth; sterna without asperities. *Head* (Fig. 7): uniformly light yellowish brown; emarginate posteriorly; width 0.28–0.33 mm (5 larvae); ocellar areas with subcutaneous pigment; accessory appendage of antenna short, smooth, sides rounded; endocarina ca. ¼ as long as frons. Frontal setae: 1 and 2 absent; 3 minute; 4 short, but longer than 3; 5 much longer than 4. Dorsal epicranium: seta 1 minute, located adjacent to frontal suture; seta 2 minute; seta 3 long; seta 4 minute; seta 5 long, 1 sensillum present posterior to seta 1. Posterior epicranium: seta 1 minute; seta 2 long; 1 sensillum present between setae 1 and 2. Ventral epicranium: setae 1 and 2 minute. Clypeus: with 2 minute setae and 1 sensillum. Labrum: seta 1 long; seta 2 longer



Figs. 14–16. *Sibinia* spp., larval malar areas. 14, *S. seminicola,* dorsal malar area. 15, *S. ochreosa,* dorsal malar area. 16, *S. ochreosa,* ventral malar area.

than 1; seta 3 shorter than 1; lateral sensilla present; median sensillum absent. Epipharynx: labral rods short, stout, widely separated; 4 anterolateral and 6 anteromedian setae, median pair of the latter longest; 4 median spines; 3 pairs of sensory pores. Mandible: setae 1 and 2 minute; 1 sensillum present. Maxilla: palpus consists of 2 articles, basal article bears 1 minute seta and 1 sensillum; apical article bears 1 sensillum; dorsal malar area (Fig. 16) with 3 acuminate setae and 2 blunt setae; ventral malar area (Fig. 15) with 4 long, acuminate setae, basal member longest; stipes with seta 1 long, seta 2 minute, setae 3 and 4 long, subequal; with 3 sensilla. Labium: palpus consists of 1 article with 1 sensillum, a small sensillum also present near base of each palpus; glossa with 3 pairs of minute setae and 1 pair of sensilla; postmental seta 1 absent; seta 2 long; seta 3 short. *Thorax* (Fig. 11): pronotum with 5 long setae and 4 or 5 short setae, in addition to 2 minute anterolateral setae; spiracle bicameral; prodorsum of mesothorax and that of metathorax with 2 setae, seta 1 short, seta 2 long; alar area of each segment with 1 minute seta; spiracular area with 1 minute seta; pleural fold of prothorax with 2 long setae; pleural fold of mesothorax and that of metathorax with 1 long seta; epipleural fold of each segment with 1 long seta; pedal area of pronotum with 2 long setae, pedal area of mesothorax and that of metathorax with 1 long seta and 2 short setae; sternal area of each segment with 1 minute seta. *Abdomen:* spiracles unicameral, air tubes short, annuli indistinct. Segments I–VII (Fig. 11): each with 3 dorsal folds; prodorsum with 1 minute seta; postdorsum of each segment with 3 setae, seta 1 short, seta 2 long, seta 3 short; spiracular area with 2 minute setae; epipleural area with 1 long seta; pleural area with 1 minute seta; pedal area with 1 minute seta; eusternal area with 2 minute setae; sternellum present. Segment VIII: prodorsum with 1 minute seta; postdorsum with 1 long seta; spiracular area with 1 minute seta; episternal area with 1 long seta; pleural area with 1 minute seta; pedal area with 1 minute seta; eusternal area with 2 minute setae. Segment IX: Postdorsum with 1 long seta; episternal area with 1 long seta; pleural area with 1 minute seta; eusternal area with 1 minute seta. Anus: terminal.

Nineteen larvae (10 entire specimens and 9 slide mounts), from flower buds of *Mimosa pigra,* collected 1 April 1972, at Brownsville, Cameron County, Texas, by W. E. Clark, determined by association with reared adults, were examined.

Pupa of *S. ochreosa.*—Aside from the smaller size, the pupa of *S. ochreosa* differs from that of *S. seminicola* only in the following features: *Rostrum*: length of a distirostral seta equal to approximately ½–⅔ width of rostrum. Frontal setae separated from each other by distance approximately equal to length of a frontal seta. Posterior processes on tergum 9 long, visible from above.

Three pupae, from flower buds of *Mimosa pigra,* collected at Brownsville, Texas, by W. E. Clark, determined by association with reared adults, were examined.

Larva of *S. peruana.*—The larva of *S. peruana* is known from 6 slide mounted specimens collected 3 mi. S. Tamuin, San Luis Potosi, Mexico, 2 August 1974, by W. E. Clark, from flowers of *M. pigra.*

Pupa of *S. peruana.*—The pupa of *S. peruana* has not been collected.

ACKNOWLEDGMENTS

The descriptions were part of a dissertation submitted to the Department of Entomology, Texas A&M University, College Station, Texas, in partial fulfillment of requirements for the Ph.D. degree. I thank H. R. Burke for direction provided on the dissertation and for suggestions improving the present paper. John Winder also read an early draft of the manuscript and suggested improvements. Specimens of adult weevils are deposited in the collections of the institutions named above, as well as in the collections of the CSIRO Division of Entomology at Indooroopilly, Queensland, Australia, and in the personal collection of the author. Specimens of larvae and pupae are in the collection of the Department of Entomology, Texas A&M University. I thank K. L. S. Harley and associates of CSIRO and the individuals and institutions named above for making these specimens available for study.

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THE NOONA DAN EXPEDITION: DESCRIPTIONS OF TWO NEW SPECIES OF BRUCHIDAE (COLEOPTERA) FROM THE PHILIPPINES

JOHN M. KINGSOLVER

Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % U.S. National Museum of Natural History, Washington, D.C. 20560.

Abstract.—Two new species of Bruchidae, *Sulcobruchus* ***bakeri*** and *Bruchidius* ***sapamoroensis***, are described from material collected in the Philippines by the Noona Dan Expedition of 1961–62. Comparisons are made with closely related species.

Insect collections from the Noona Dan Expedition (1961–62) to the Philippines, Solomon and Bismarck Islands (Peterson, 1966) contained two undescribed species of Bruchidae from the Philippines. These are described below.

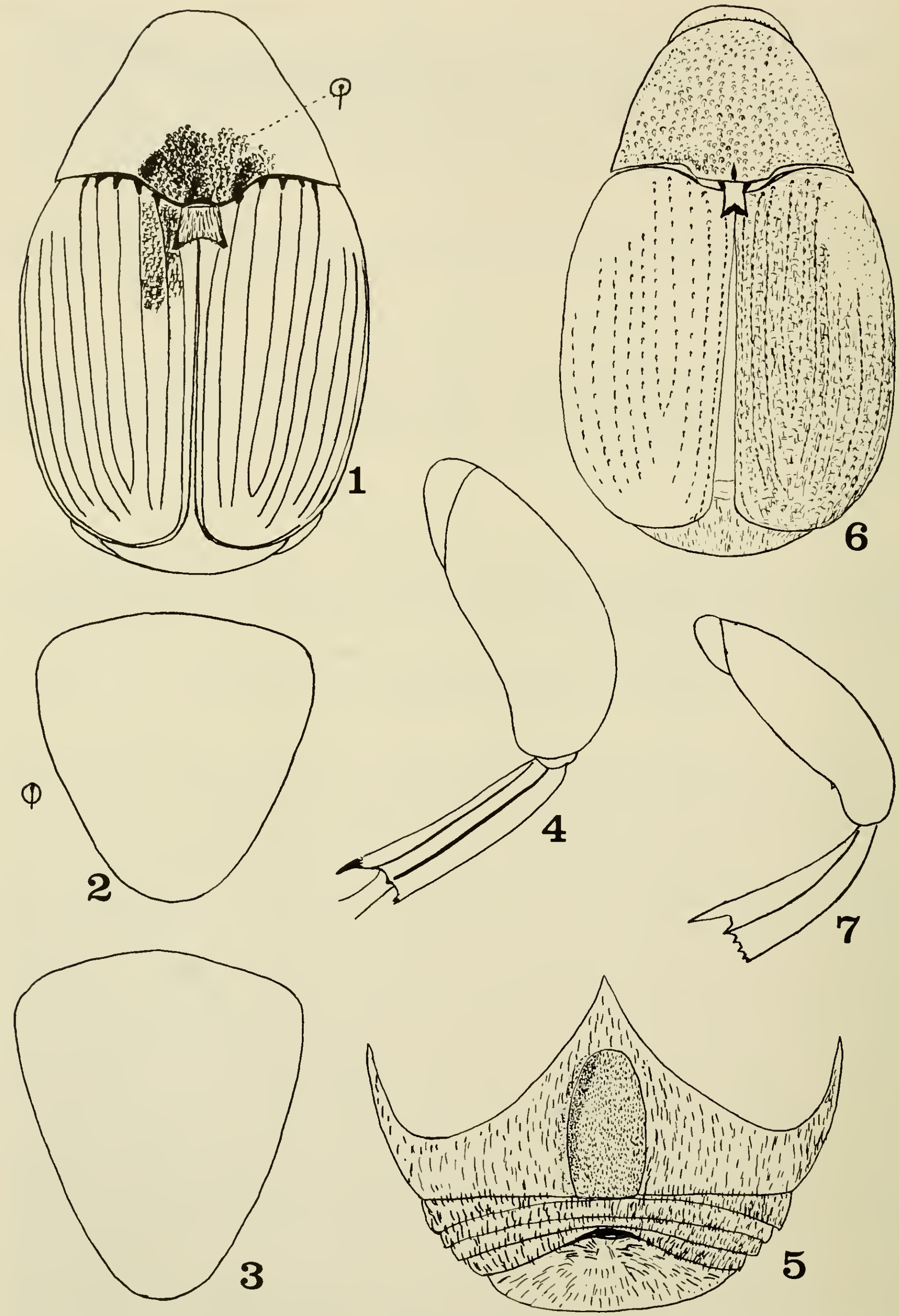
Sulcobruchus bakeri **Kingsolver, NEW SPECIES**

Figs. 1–5, 9–15

Length.—3.25–4.0 mm; width.—2.0–2.1 mm.

Color.—Body and appendages shining black, eyes reddish brown. Vestiture of fine gray setae evenly distributed over body except for dense sutural band extending to third stria on each side.

Structure.—Body short, broad (Fig. 1). Head short (Fig. 15), frons convex; eyes prominent, finely faceted, each with ocular sinus about ¾ vertical length of eye; frontal carina expanded dorsally into triangular boss, vertex and frons densely, evenly foveolate, each foveola with centrally located seta directed toward median boss; clypeus pentagonal, foveolate (as on frons) in basal ¾, apical ¼ microreticulate; labrum arcuate, microreticulate; epistomal ridge beaded; postocular lobe narrow, setose; antenna (Fig. 15) slender, reaching middle of metepisternum, segment 1 clavate, 2 moniliform, 3 conical, 4–10 slightly eccentric, subequal in size, 11 fusiform. Pronotum campaniform, evenly convex, prescutellar lobe prominent, emarginate, medially sulcate; a deep marginal impression either side opposite stria 2; disk evenly foveolate, intervals reticulate, each foveola with centrally located seta, lateral carina present in basal ½ but indicated in apical ½ by narrow band of densely placed setae; cervical sulcus nearly completely circling pronotum, briefly obsolete only on dorsum; prosternum triangular, ⅔ as long as apically contiguous procoxae. Mesosternum reduced to small triangular strap; scutellum short, broadly expanded apically. Elytra together slightly longer than broad; striae normal, deeply, narrowly impressed, individual punctures each with short, yellowish seta; intervals microreticulate, setose; apices of striae free 5, and 6 sometimes conjoined; bases of striae 2, 3, 4, and 5 each with prominent denticle.



Figs. 1–7. 1–5, *Sulcobruchus bakeri.* 1, Habitus, dorsal. 2, Pygidium ♂. 3, Pygidium ♀. 4, Metaleg. 5, Abdomen, ♂, ventral aspect. 6–7, *Bruchidius sapamoroensis.* 6, Habitus, dorsal. 7, Metaleg.

Abdomen with sternites telescoped; apex of pygidium approximate to 1st abdominal sternum, basal sternum with broad, shallow concavity lined with slender, flat setae arranged in longitudinal, parallel rows (Fig. 5); male pygidium as in Fig. 2, surface densely set with rounded microfoveae, each fovea with fine seta set in its dorsal rim, extreme apex truncate or slightly emarginate; female pygidium more narrowly elongate than in male (Fig. 3); metacoxa broad, strongly punctate; metaleg as in Fig. 4; metafemur flat, slightly sulcate ventrally near apex, ventral margin finely carinate, without denticles; metatibia with short, slightly curved mucro, lateral carina ending in short denticle, 2 small coronal denticles.

Male genitalia.—(Figs. 9–14). Median lobe slender in apical ½ (Fig. 13), ventral valve deeply emarginate and produced into ventrally directed, falcate hooks with rounded setose dorsal lobe extending between hooks; internal sac armed with 20–25 thornlike denticles apically and masses of minute, rounded denticles in basal ½ of sac; lateral lobes massive (Fig. 10, 11, 12), each with a blunt terminal process and with ventral margin angulate, dorsal margin setose.

Holotype ♂.—(Philippines) Cuernos Mts., Negros, Baker (USNMNH #100692).

Paratypes.—Acc. #1024, Bur. Agr. P.I., C. R. Jones, 1 ♀ (USNMNH). Philippines: Palawan, Brookes Point, Uring Uring, 22 August 1961, Noona Dan Exp. 61–62, in Malaise trap, 1♂. (Zoologisk Museum, Copenhagen).

Sulcobruchus bakeri, new species, is most closely related to *S. rugulosus* (Pic) NEW COMBINATION, also from the Philippines. In the new species, the male ventral abdominal sulcus extends only to the caudal margin of the basisternum whereas in *S. rugulosus,* the sulcus extends shelflike beyond the caudal margin. Distinct differences are also present in the male genitalia in the lateral profile of the lateral lobes and in the form of the terminal hooks on both the lateral and median lobes.

Sulcobruchus kingsolveri Arora, described from India, is distinctive in that the vestiture is yellowish brown rather than cinereous as in all other described species, the ventral sulcus in the male is represented by only a distortion of setal arrangement along the midline of the basisternum, and hooks are lacking on the lateral and median lobes in the male genitalia (Arora, 1977: 86).

I have seen only two female specimens of *Sulcobruchus sauteri* (Pic) from Japan. This species differs from *S. bakeri* principally in its shorter body hairs, narrower scutellum, basal denticles on the third and fourth striae only (second, third, fourth, and fifth in *S. bakeri*), and the denticle terminating the metatibial lateral carina prominent and nearly as long as the mucro (short and inconspicuous in *S. bakeri*).

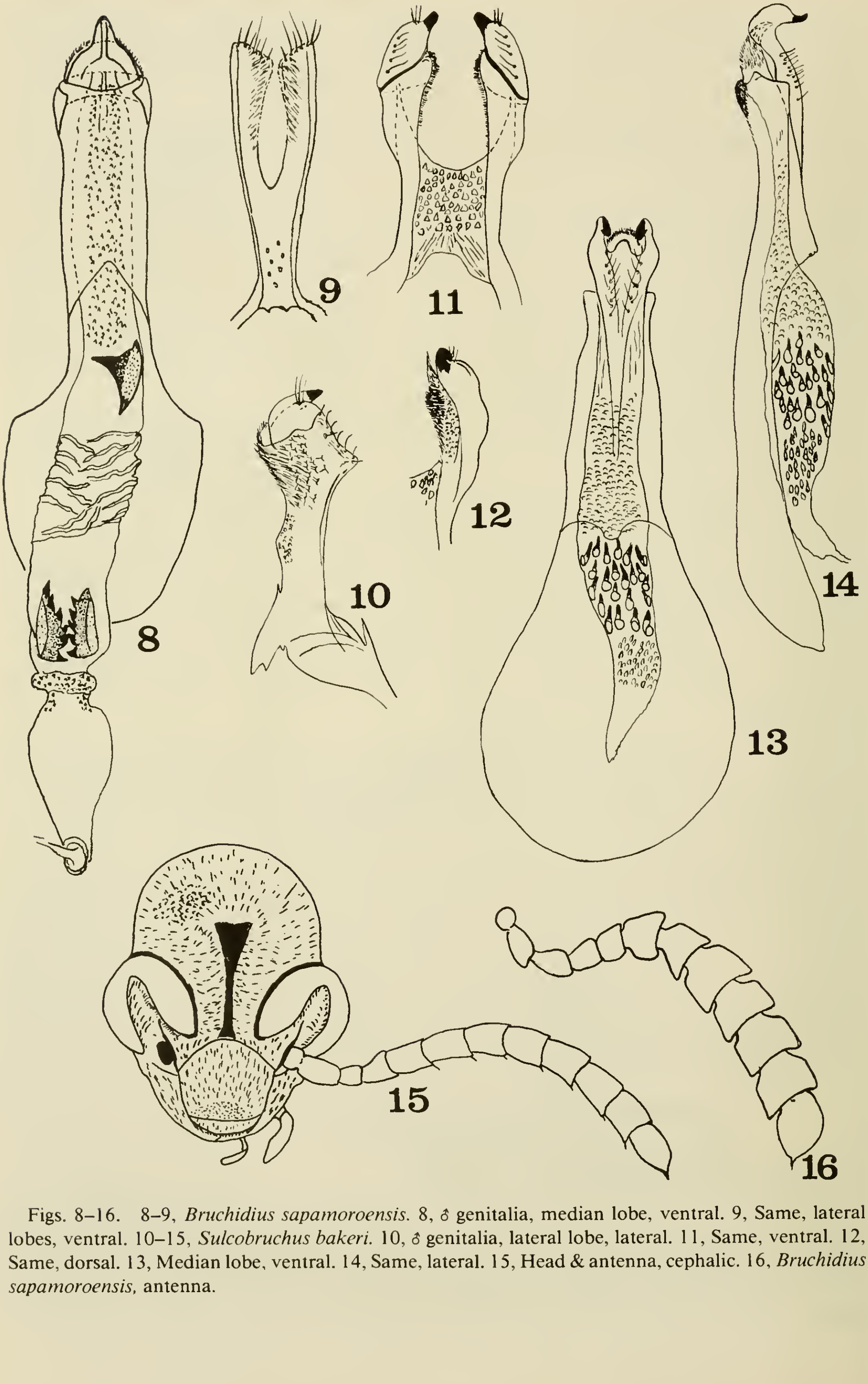
This species is named for Charles Fuller Baker who advanced the knowledge of the Philippine insect fauna by his extensive collecting.

Bruchidius sapamoroensis **Kingsolver, NEW SPECIES**

Figs. 6, 7, 8, 9, 16

Length male.—1.5 mm; width.—0.9 mm.

Color.—Body entirely black, antenna reddish yellow, pro- and mesolegs yellow with base of mesofemur infuscate, mesoleg yellowish with base of metafemur and apex of metatibia infuscate. Vestiture of fine gray and brassy setae evenly distributed on pronotum; elytra with indistinct banding of more densely placed gray setae; venter with evenly distributed gray setae.



Figs. 8–16. 8–9, *Bruchidius sapamoroensis*. 8, ♂ genitalia, median lobe, ventral. 9, Same, lateral lobes, ventral. 10–15, *Sulcobruchus bakeri*. 10, ♂ genitalia, lateral lobe, lateral. 11, Same, ventral. 12, Same, dorsal. 13, Median lobe, ventral. 14, Same, lateral. 15, Head & antenna, cephalic. 16, *Bruchidius sapamoroensis*, antenna.

Structure.—Body short, broad (Fig. 6). Head turbiniform, eyes protuberant, depth of ocular sinus ½ length of eye; vertex, frons, and clypeus shallowly, densely microfoveolate, each foveola setiferous, setae on vertex and clypeus directed anteriorly, those on frons toward frontal carina, anterior margin of clypeus and labrum corneus; postocular lobe short, inconspicuous; antenna (Fig. 16) not strongly modified, apex scarcely reaching beyond humerus. Pronotum campaniform, evenly convex, lateral margins slightly arcuate, lateroposterior angles acute, lateral margins not carinate, cervical sulcus short; pronotal disk shallowly cribrate with shallow, rounded foveolae separated by narrow, ridgelike interspaces, each foveola with a fine seta arising from its center; prosternum short, triangular, separating procoxae for ⅔ their length; mesosternum narrowly triangular between mesocoxae apically. Elytra together as wide as long, apices separately rounded, striae regular with 1–4 noticeably deflected laterad basally, 3 and 4 each ending basally in fine, acute, subbasal denticle on small, transverse gibbosity, 5 and 6 deflected mesad at extreme base, 4 and 5 converging apically, remaining striae ending free apically; each stria fine, deep, finely punctate and setiferous; intervals densely punctate, microrugulose under 50 ×, each puncture setiferous. Abdomen with basal sternum 4 × length of 2nd, 2nd, 3rd, and 4th successively shorter, 5th emarginate to receive apex of pygidium, basal segment with setiferous basal pit; pygidium strongly convex, finely, densely, evenly punctate, punctures nearly concealed by dense vestiture. Pro- and mesolegs normal for genus; metafemur (Fig. 7) incrassate with ventral face flat, mesoventral margin near apex with single fine denticle, metatibia gradually widened toward apex, with ventral and lateral carinae strong, lateroventral carina lacking, mucro short, only slightly longer than lateral denticle, corona with 3 denticles.

Male genitalia.—Median lobe (Fig. 8) about 6 × as long as wide; ventral valve ogival with narrowly rounded apex, dorsal valve semicircular, sensitive; internal sac sparsely lined with small acute denticles in basal ½, a large thornlike sclerite at middle, and 2 slender, serrate sclerites at apex, apical closure valve circular. Lateral lobes (Fig. 9) slender, slightly expanded on mesal margin at apices.

Holotype male and 1 paratype male.—Philippines, Mindanao, Curuan District, Sapamoro, 16 Dec. 1961, Noona Dan Exp. 61–62. Deposited in the Zoologisk Museum, Copenhagen.

The male genitalia of this species indicates a close relationship with the Indian *Bruchidius cassiae* Arora (1977) but is much smaller (1.5 mm vs. 2.77 mm). It does not seem to be closely related to any other Philippine species.

Sapamoro is a farm near Curuan. Specimens were collected in a small patch of primary forest (Petersen, 1966, p. 292). The specific name is taken from the type locality.

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EXTERNAL MORPHOLOGY OF EGGS OF THE SPINED SOLDIER BUG, *PODISUS MACULIVENTRIS* (SAY) (HEMIPTERA: PENTATOMIDAE)

P. L. Lambdin and G. Q. Lu[1]

Department of Entomology and Plant Pathology, University of Tennessee, Knoxville, Tennessee 37901.

Abstract.—A description and scanning electron photomicrographs of eggs of the spined soldier bug, *Podisus maculiventris* (Say) are provided. Each female deposited 12 (1–29) eggs in clusters on plastic substrates placed on the inside of rearing dishes. The microsculpture is primarily composed of a series of irregularly spaced chorionic spines often connected by a serous mantle. Each egg possessed 16 (14–20) long, filamentous aero-micropyles encircling the pseudoperculum.

The spined soldier bug, *Podisus maculiventris* (Say), is a common polyphagous predator comprising an important component of the predator complex for insect pests on soybeans (Waddill and Shepard, 1975). Eggs of beneficial insects are often not considered in field surveys as a factor in control strategies. Although spined soldier bug females oviposit on exposed surfaces of outer leaves and stems, their eggs are often overlooked or misidentified.

The numerous studies of pentatomid eggs have been documented by Cobben (1968) and Hinton (1981). Because only brief references exist regarding the external structure of spined soldier bug eggs (Esselbaugh, 1946; Southwood, 1956; Coppel and Jones, 1962), we have provided a description and scanning electron photomicrographs of the eggs that may be useful in future field and laboratory studies on the species.

MATERIALS AND METHODS

Spined solder bug populations were maintained under laboratory conditions modified from those described by Mukerji and LeRoux (1965). Male-female pairs (n = 40) were placed in 3.5 × 9.5 cm petri dishes with a green plastic strip placed around the inside of each dish to facilitate egg collection.

The apical region for each filamentous aero-micropyle of 100 eggs was coated with vaseline and compared with a similar untreated group to determine if plugging the aperture would affect eclosion. Egg clusters, coated with gold-palladium in a Denton vacuum evaporator (DV-515), were photographed using an ETEC Autoscan scanning electron microscope.

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[1] Visiting Professor, Acad. of Agric. of Inner Mongolia, Inst. of Pl. Prot. Huhhot, People's Rep. of China.

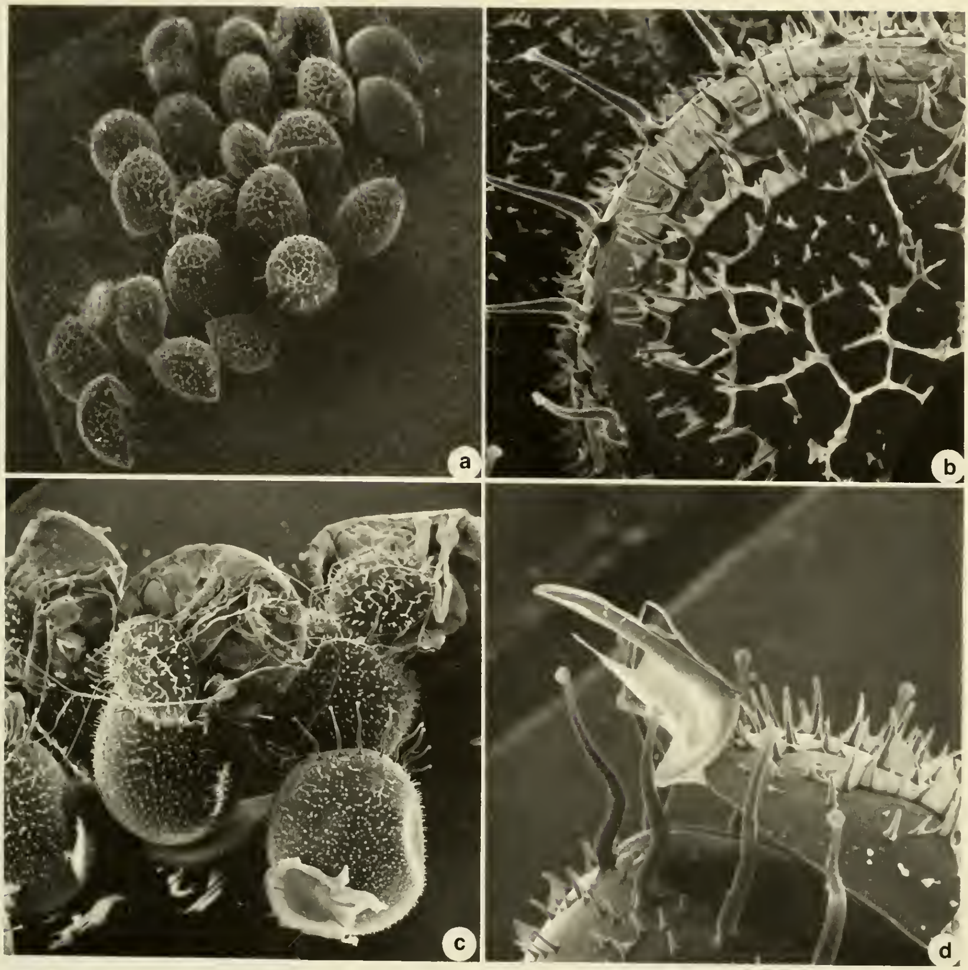

Fig. 1a–d. Eggs of *Podisus maculiventris*. a, Egg cluster (340×). b, Pseudoperculum and aeromicropyle detail (680×). c, Eclosion (520×). d, Hatching spine (680×).

RESULTS AND DISCUSSION

In the laboratory, females more frequently oviposited on plastic strips placed on the inside of petri dishes than on other sites. The barrel-shaped eggs were laid upright with the posterior pole attached to the substrate by a spumescent mass (Fig. 1a). The number of eggs laid per female is known to vary depending on the temperature and food source (Mukerji and LeRoux, 1969; Evans, 1982). Each female (n = 40) laid 12 (1–29) eggs primarily in clusters with a mean fecundity rate of 268 (92–533) eggs. Each egg was 1(1–1.2) mm long, 1 (1) mm wide, and weighed 0.41 mg. Eggs were pearly-white at deposition but changed to golden brown after 48 h followed by more intensive darkening with embryonic development until eclosion.

The unusual microsculpture of the chorionic surface resulted from the presence of diamond-shaped reticulations and the series of variable shaped spines (apically acute or blunt) often connected by a draping, waxlike material giving the surface a mazelike appearance (Fig. 1b). As indicated by Hinton (1981), this carinal pattern may function to retain a boundary layer of air which establishes a humidity gradient sufficient to retard excessive water loss. This hypothesis may be supported in part by the occurrence of longer spines on the pseudoperculum where exposure to sunlight is most intense because of the position and arrangement of the eggs when laid on leaves and stems.

An anterior eclosion line, devoid of chorionic spines, demarcated the pseudoperculum (Fig. 1b, c). Each egg (n = 317) possessed 16 (14–20) s-shaped, aero-micropyles evenly spaced in a circle posterior to the eclosion line. Each aero-micropyle was slightly bent basically resulting in the apical area projecting away from the egg's surface. The function of these filaments has not been clearly demonstrated. They were considered micropyles by Southwood (1956) and Coppel and Jones (1962), aeropyles by Esselbaugh (1946), and aero-micropyles by Cobben (1968) and Hinton (1981). The small medial aperture (Fig. 1d) present in the capitate apical region may provide a means of gas exchange. Only a 70% egg hatch occurred for eggs (n = 100) where the filaments had been coated with vaseline compared to 95% for the control group (n = 100). A possible secondary function of these sticky filaments may be as a defensive mechanism to inhibit egg parasites (e.g. *Telonomus podisi* Ashmead).

The process of hatching was consistent with that described by Southwood (1956) for other pentatomids. The t-shaped hatching spine (Fig. 1d) attached to a deltoid membrane was morphologically similar to those described by Hinton (1981) for other pentatomids.

The number of aero-micropyles present was reported to be a reliable character for separating eggs of *Podisus* species by Warren and Wallis (1971). Because of the high phenotypic variability for aero-micropyles on spined soldier bug eggs (Esselbaugh, 1946) and the overlapping with numbers reported for three other species in the genus (Coppel and Jones, 1962), their use as a diagnostic character may be most difficult at this time. Cobben (1968) concluded the microsculpture of the chorion was of taxonomic value, especially at the species level, for many heteropteran species; however, additional studies are needed on other species of *Podisus* before adequate comparisons can be made.

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PROC. ENTOMOL. SOC. WASH.
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NEW GENERIC SYNONYMIES IN THE EPICAUTINA (COLEOPTERA: MELOIDAE: MELOINAE)

John D. Pinto

Department of Entomology, University of California, Riverside, California 92521.

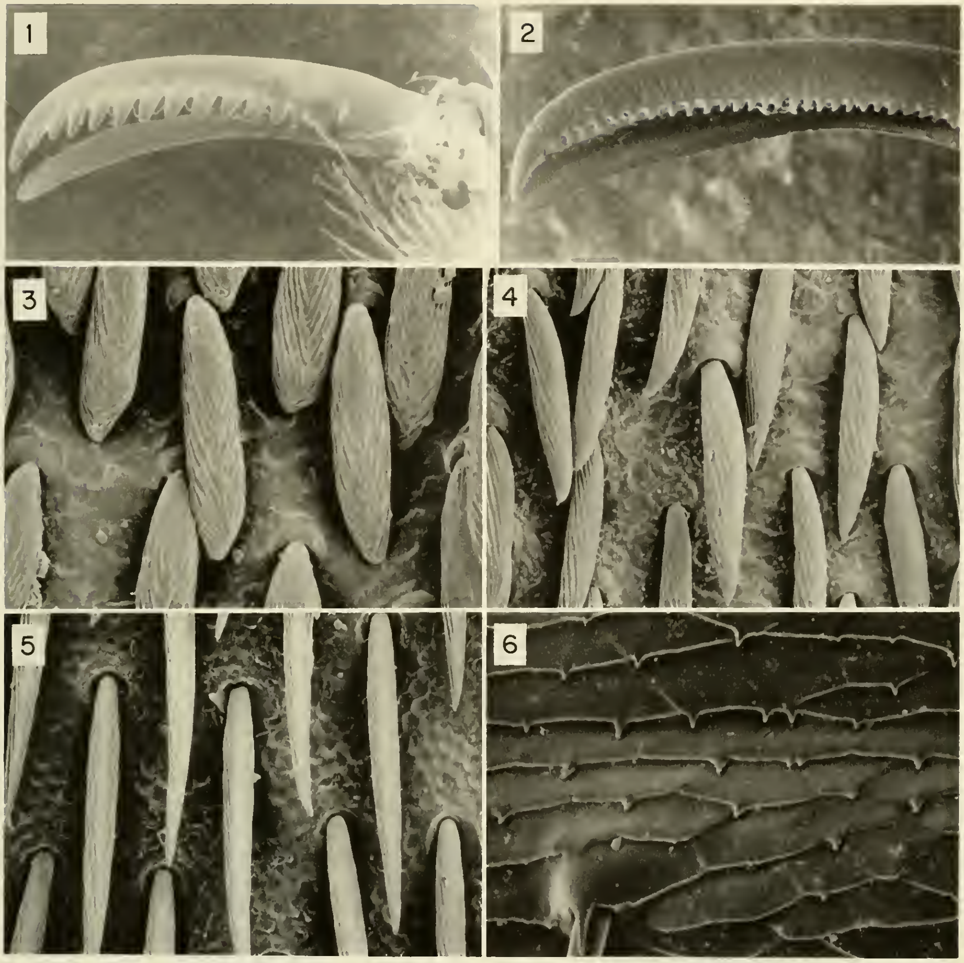
Abstract.—*Anomalonychus* Saylor and *Pleuropompha* LeConte are herein treated as junior synonyms of *Epicauta*. No important features can be marshalled to justify continued generic status. The single South American species included in *Anomalonychus* is most similar to the *laevicornis* group of *Epicauta*, a small assemblage of species from southern Mexico. The two species historically placed in *Pleuropompha* are most closely related to *Epicauta delicata* Mathieu and members of the *vittata* group of *Epicauta*.

The most recent classification of the Meloidae (Kaszab, 1969) recognizes six epicautine genera. Revisionary studies of New World *Epicauta* now underway indicate that generic status for two of these, *Pleuropompha* LeConte and *Anomalonychus* Saylor, is not justified. Both are herein reduced to junior synonyms of *Epicauta* Dejean (NEW SYNONYMIES).

The recognition of *Pleuropompha* and *Anomalonychus* has been supported only by the excessive weighting of a few characters. Generic status for both could be tolerated as long as defining characters were considered unique, and relationships to the subdivisions of *Epicauta* remained unclear. It is now possible to hypothesize the affinity of *Pleuropompha* and *Anomalonychus* species to subgroups of *Epicauta*. Also, their "diagnostic" features are now known to occur in *Epicauta*. In my opinion, an argument for continued generic status can no longer be made.

Anomalonychus is a replacement name by Saylor (1940) for *Anomalonyx* Denier (1935) (*nec* Weise, 1903). Denier based this genus on the Brazilian species *Epicauta fumosa* Germar. He considered the genus similar to *Epicauta* except for the presence of denticulate claws (Fig. 1). Kaszab (1952) also utilized antennal structure as a distinguishing feature. Similar modifications of claws and antennae are now known in species of the *laevicornis* group of nominate *Epicauta*.

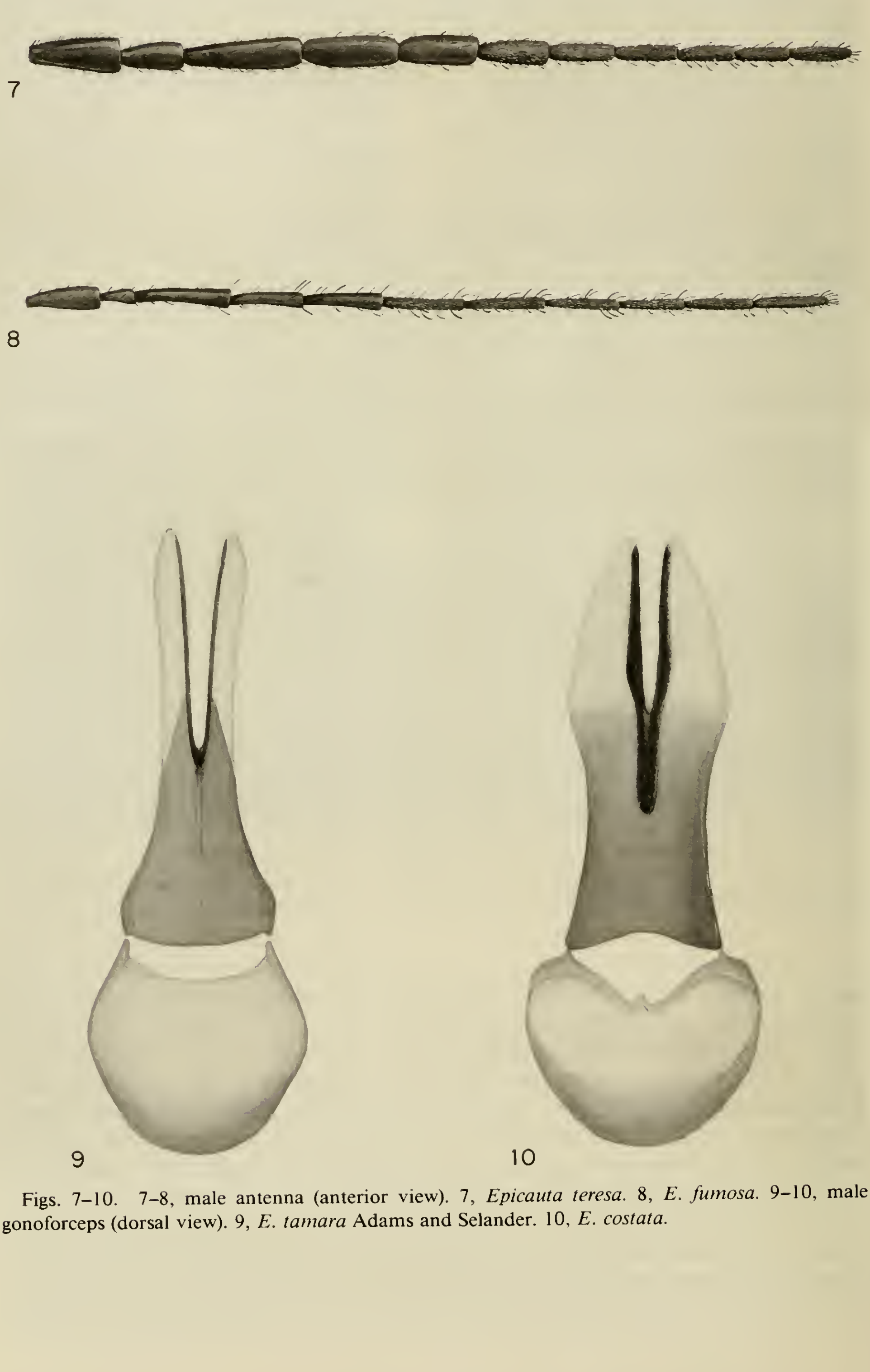
The *laevicornis* group is composed of four southern Mexican species, *E. curvicornis* (Haag-Rutenberg), *E. laevicornis* Werner, *E. hubbelli* Werner and *E. teresa* Mathieu (Pinto, in prep.). Members of the group are relatively elongate and slender blister beetles, and have long, filiform antennae with segments I–V (VI) modified in males. Segments I–V are subglabrous and shiny (Fig. 7) in males of all species. In *E. hubbelli* and *E. curvicornis* some of the modified segments are distorted; in *E. teresa* and *E. laevicornis* they are simply elongate and slightly inflated. Other pertinent features of the group include the moderately enlarged maxillary and labial palpi of males, and a concave metasternum in males of all



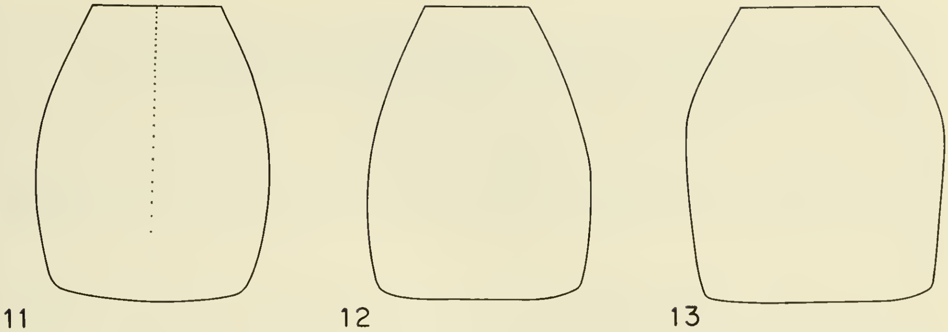
Figs. 1–6. 1–2, adult claw. 1, *Epicauta fumosa* (130×). 2, *E. curvicornis* (160×). 3–5, elytral setae. 3, *E. costata* (720×). 4, *E. tricostata* (720×). 5, *E. abadona* Skinner (540×). 6, *E. costata*, tergite of abdominal segment IV (1800×).

species except *E. teresa*. In *E. curvicornis*, but in no other member of the group, the tarsal claws are denticulate (Fig. 2).

Most of the features characterizing *Anomalonychus* occur within the *laevicornis* group. Antennal structure in males of *fumosa* is similar to that in *E. teresa* and *E. laevicornis* (cf. Figs. 7, 8). In all three species segments I–V are slightly inflated, subglabrous and elongate. Similarly, the denticulate claws in *fumosa* are paralleled by those in *E. curvicornis* (cf. Figs. 1, 2). In both, numerous teeth occur on the ventroanterior and ventroposterior margin of each claw. Also, *fumosa* and members of the *laevicornis* group are similar in body shape and size, and the metasternum is concave in at least some populations of *fumosa*. The metasternum is distinctly concave in males that I have examined from Rio de Janeiro and Espirito Santo, Brazil, but not in representatives from Nova Teutonia, Brazil. Other dif-



Figs. 7–10. 7–8, male antenna (anterior view). 7, *Epicauta teresa*. 8, *E. fumosa*. 9–10, male gonoforceps (dorsal view). 9, *E. tamara* Adams and Selander. 10, *E. costata*.



Figs. 11–13. Pronotum (dorsal view). 11, *Epicauta costata.* 12, *E. delicata.* 13, *E. abadona.*

ferences between these populations suggest that more than a single species is involved. The only characteristic of *fumosa* not found in the *laevicornis* group is the presence of both suberect and recumbent clothing setae on the elytra. All of the elytral setae are recumbent in the latter. Additionally, *fumosa* males lack the enlarged palpi of the *laevicornis* group. Although generic status for *fumosa* clearly is inappropriate, additional testing will be needed to determine if similarities shared with the *laevicornis* group are homologous.

Pleuropompha was erected by LeConte (1862) for *Lytta costata* LeConte. A second species, *tricostata,* was added by Werner in his 1943 revision of the genus. Both species occur in southwestern North America. *Pleuropompha* has been distinguished from *Epicauta* by the costate elytra and the squamiform setae on the head, pronotum and elytra (Figs. 3, 4). No other adult distinctions are known. Larval and internal adult anatomy do not differ from *Epicauta* and fail to support generic separation (MacSwain, 1956; Gupta, 1965; Pinto, 1977). Courtship behavior is distinctive in both species, but the difference is little more than an embellishment of patterns known in *Epicauta* (Pinto, 1973).

Although the character combination of elytral costae and squamiform dorsal setation in *costata* and *tricostata* remains distinctive there is no basis for weighting these traits excessively. Costate elytra also occur in the unrelated South American species *Epicauta costipennis* Borchmann, and the dorsal setae of *tricostata* are clearly intermediate to the highly squamiform setation in *costata* and more typical clothing setae in numerous *Epicauta.* Interestingly the squamiform setae in both species retain a microstructure similar to that of their unmodified homologues in other *Epicauta* (cf. Figs. 3–5).

In my opinion, the species of *Pleuropompha* belong to the nominate subgenus of *Epicauta* where they are most similar to *Epicauta delicata* Mathieu, a rare northern Mexican species, and species of the *vittata* group as defined by Adams and Selander (1979) and Agafitei and Selander (1980). Both adult and larval anatomical details support this placement. One of the most striking similarities is in male genitalic structure. As pointed out in Mathieu (1983), *E. delicata* and members of the *vittata* group possess incompletely sclerotized gonostyli. In these species there is a narrow strip of sclerotization that runs along the medial surface of each gonostylus (Fig. 9). All other surfaces are membranous and unpigmented.

This feature also occurs in *costata* and *tricostata* (Fig. 10). As far as I know, similar structure is approached only in *E. nigritarsis* LeConte (Pinto, in prep.), a species considered phenetically similar to the *vittata* group by Adams and Selander (1979).

Adults of *costata* and *tricostata* are most similar to those of *E. delicata*. In addition to the genitalia, other similarities include the slender and elongate body shape, subfiliform and elongate antennae, an elongate pronotum which is widest at the middle (Figs. 11, 12) rather than at the apical ⅓–¼ as in most other *Epicauta* (Fig. 13), elongate male foretarsi with divided pads, and two expanded metatibial spurs.

Larval features suggest similar relationships. Larvae of *E. delicata* are unknown but those of *costata* and *tricostata* resemble members of the *vittata* group. Although these evaginations are best developed in the posterior ½ of the tergites in *costata* and *tricostata* (Fig. 6), they also occur on at least some of the anterior reticulations. Evaginated cuticular reticulations on the anterior ½ of the abdominal tergites are characteristic of the *vittata* group. Also a short terminal seta on antennal segment III (ca. ¾ as long as segment II) occurs in the *vittata* group and in *costata* (Pinto, 1977), and the presence of three setae on segment II of the labial palpi, a trait distinctive to most *vittata* group species but not other *Epicauta* according to Adams and Selander (1980) occurs in *tricostata* (MacSwain, 1956; Pinto, 1977).

ACKNOWLEDGMENTS

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NEOTROPICAL PYRALID MOTHS TRANSFERRED FROM ANERASTIINAE (AUCTORUM) TO PHYCITINAE

JAY C. SHAFFER

Department of Biology, George Mason University, Fairfax, Virginia 22030.

Abstract.—Eight named species of neotropical pyralid moths are transferred from Anerastiinae (Auctorum) to Phycitinae. Of these, *Coenochroa monomacula* Dyar and *Metacrateria miasticta* Hampson are synonymized under *Coenochroa californiella* Ragonot. The other six species are redescribed, and the genitalia, wings, and heads illustrated.

In my revision (Shaffer, 1968) of the North American fauna of the polyphyletic Anerastiinae (Auctorum) I transferred *Anerastia* and six other genera to the Phycitinae and applied the name Peoriinae Hulst, 1890 to the natural group formed by the remaining genera. A similar study (Shaffer, 1976) of the Neotropical fauna covered only the Peoriinae, thereby leaving in limbo 11 specific names properly belonging to the Phycitinae. The present paper treats eight of these names. Types of the remaining three species (*Rhinaphe endonephele* Hampson, 1918; *R. ignetincta* Hampson, 1918; and *Anerastia hemirhodella* Hampson, 1901) are in the British Museum (Natural History), need to be reexamined, and will be covered in a future paper.

Of the eight specific names dealt with herein, only two can be given proper generic assignment, *Coenochroa monomacula* Dyar and *Metacrateria miasticta* Hampson are synonymized under *Coenochroa californiella* Ragonot. Four others, *Saluria jordanella* Ragonot, *Anerastia mictochroella* Ragonot, *Euzophera conquistador* Dyar, and *E. mabes* Dyar are known only from females, all but *mabes* from unique specimens. *E. climosa* was described from seven specimens; but, as Heinrich (1956) has pointed out, the type series consists of more than one species. *E. tintilla* was described from a single male.

Four of the five Dyar species were originally assigned to *Euzophera,* and later referred to the Anerastiinae by Heinrich (1956) on the basis of the reduced tongue. Though none properly belong to *Euzophera,* and while their generic affinities are unclear, they are nonetheless phycitines. This paper is presented in the hope that it will lead to the discovery of additional material of these species.

The ISCC-NBS Color-Name Charts were used in describing colors. In a few instances, as with very small markings, only very general color designations could be given. A Nikon filar occular micrometer was used with a Nikon S-Ke II microscope to measure minute structures such as teeth and spines on the bursa, ductus bursae, and vesica. These measurements are somewhat imprecise as few such structures ever lie exactly in the plane of focus and can be measured flat.

Museum collections are referred to by the following acronyms: BMNH, British

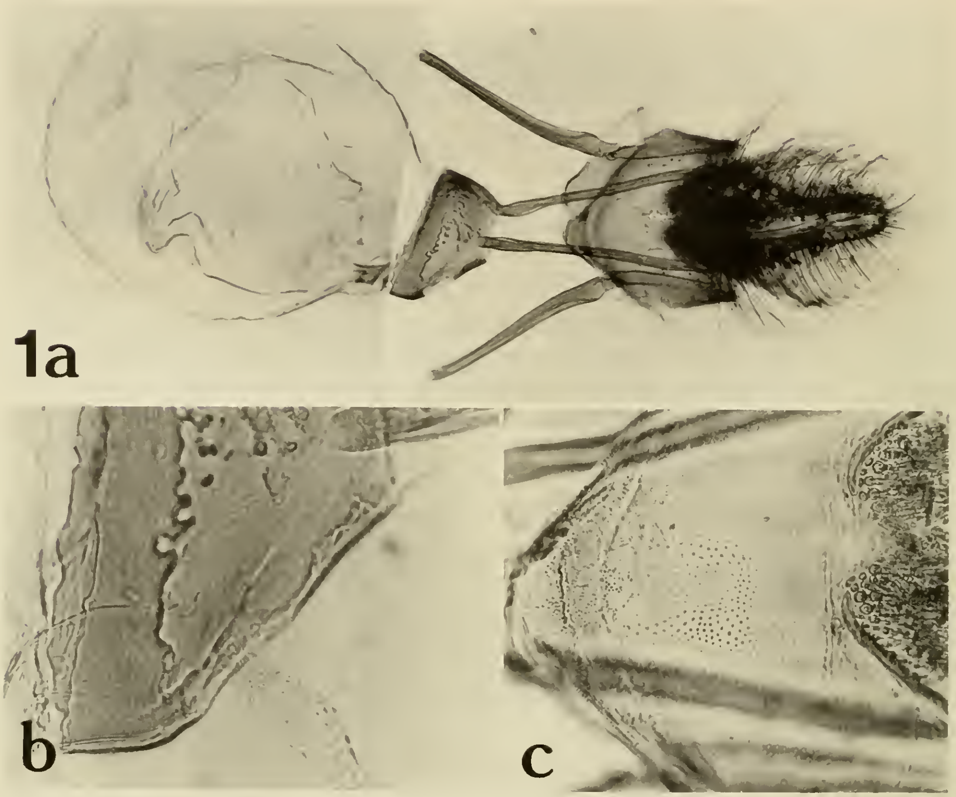

Fig. 1. *Saluria jordanella,* holotype. a, Female genitalia; b, enlargement showing origin of ductus seminalis; c, enlargement of ostium.

Museum (Natural History), London; MNHN, Muséum National d'Histoire Naturelle, Paris; and USNM, National Museum of Natural History, Washington.

I thank Dr. P. Viette of the Muséum National d'Histoire Naturelle in Paris for the loan of specimens of *S. jordanella* and *A. mictochroella.*

Saluria jordanella **Ragonot**

Figs. 1, 9, 15

Saluria jordanella Ragonot, 1888: 44. Hampson in Ragonot, 1901: 360, plate 37, fig. 20.

Description.—Frons light orange yellow. Maxillary palpi minute. Tongue greatly reduced, clothed with white scales. Female antennae filiform, cilia about one-half as long as segment width. Eye diameter 0.6 mm. Ocelli normally developed, conical, black with clear centers. Vertex moderate orange yellow. Occiput laterally moderate orange yellow, streaked with white; dorsally white, the white extending around chaetosemata. Patagia and tegulae moderate orange yellow.

Forewing radius 11 mm; basal line orange yellow; antemedial line orange yellow mixed with brown anterior to A_1 fold; both lines oblique, extending posterolaterally. Ground between basal and antemedial lines yellowish white with a few scattered brown scales. Poorly defined white discal spot at outer margin of cell; brown transverse posterior line half way between cell and outer wing margin, this line moderate orange yellow posterior to Cu_2. Ground distal to antemedial line a mixture of white and orange yellow with a few scattered brown scales, orange yellow color forming poorly defined bar in anterior half of cell and extending to costal margin. Eleven veins; R_2 from cell very near to R_{3+5}; R_3 stalked with R_5 about half its length. M_2 short-stalked with M_3, from lower outer angle of cell; Cu_1 from near the angle. Hindwing with seven veins; M_{2+3} fused, stalked with Cu_1 about half its length; from lower outer angle of cell; Cu_2 from near the angle.

Male genitalia unknown.

Female genitalia with ovipositor broadly lobed, densely setose. Anterior apophyses nearly straight; posterior straight, 1.1 times as long as anterior. Eighth segment collar narrow laterally, with shallowly emarginate dorsal extensions. Ostium sclerotized, broadly triangular, 1.8 times as wide as long; ventral surface with curved, transverse subapical sclerotized band; dorsal surface with numerous ventrally directed minute setae, each approximately 10–15 μm long. Ductus bursae short, membranous. Bursa round, posterior one-sixth forming a dorsoventrally shallow collar, dorsally convex, and irregularly sclerotized, ventrally concave and weakly sclerotized. Signum absent, bursa surface smooth. Ductus seminalis from left side of bursa collar, slender, membranous.

Holotype.—♀, labeled: "TYPE" [red label]; "Goya corrientes" [Argentina]; "Saluria jordanella Rag. type orig. pl. XXXVII f. 20"; "1901 coll. E. L. Ragonot Muséum Paris"; "♀ genitalia on slide 1182 J. C. Shaffer." [MNHN].

The frons is partly denuded and only the basal segments of the labial palpi and a few segments of each antennal shaft are preserved.

The female genitalia are phycitine and differ markedly from those of *Saluria*, but proper generic placement must await association with male specimens. The species is known only from the holotype.

Anerastia mictochroella **Ragonot**

Figs. 2, 10, 16

Anerastia mictochroella Ragonot: 1888; 49; 1901: 404, plate 40, fig. 10.

Description.—Frons conical, mostly pale orange yellow with lesser number of white scales. Labial palpi porrect; basal segments white, second and third a mixture of white and pale orange yellow scales, many of the latter being brown distally. Tongue minute. Female antennae filiform. Eye diameter 0.68 mm. Ocelli normally developed, conical, black. Vertex pale orange yellow to white. Occiput brown and pale orange yellow laterally, brown dorsally. Patagia and tegulae light orange yellow.

Forewing radius 12.0 mm; basal and antemedial lines extending obliquely outward toward posterior wing margin, separated by brown color posterior to radius; basal line light orange yellow, separated from thorax by white spot posterior to A_2; ground between antemedial and transverse posterior lines forming conspicuous trapezoid, nearly uniformly brown between radius and A_1 fold, a complex mixture of white, brown, and light orange yellow posterior to A_1 fold. Discal spot white, with a few brown scales posteriorly; a line of brown and light orange yellow connecting spot with transverse posterior line. Transverse posterior line white,

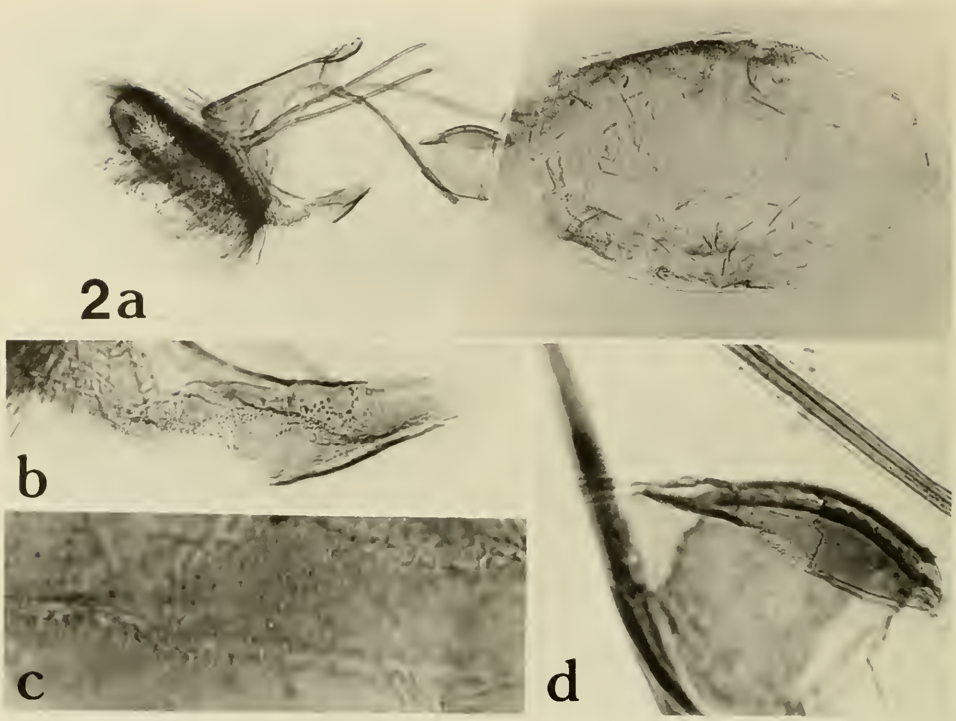

Fig. 2. *Anerastia mictochroella,* holotype. a, Female genitalia; b, ostium; c, ostium spines; d, origin of ductus seminalis.

narrow; ground pale orange yellow distal to transverse posterior line. Fringe with narrow brown lines separated by white. Ten veins; R_2 well separated from origin of R_{3+5}; R_3 stalked with R_5 about half its length; from near upper outer angle of cell; M_{2+3} fused, from lower outer angle; Cu_1 from near the angle. Hindwing with 7 veins; M_{2+3} fused, stalked with Cu_1 about ⅓ its length, from lower outer angle of cell; Cu_2 from very near the angle.

Male genitalia unknown.

Female genitalia with ovipositor broadly lobed, densely setose; anterior apophyses curved ventrally; posterior nearly straight, 1.2× as long as anterior. Eighth segment collar longest middorsally, strongly angled laterally, incomplete ventrally. Ostium ventrally sclerotized as triangular plate, dorsally membranous and with numerous minute ventrally directed spines, each about 8–10 μm long. Ductus bursae short, membranous. Bursa elliptical, neck a well sclerotized collar, dorsoventrally very shallow, strongly convex dorsally, concave ventrally; surface smooth. Ductus seminalis from left side of sclerotized bursa collar; slender, membranous.

Holotype.—♀, labeled: "TYPE" [red label]; "Goya Corr. Rep. Arg." [Argentina: Corrientes]; "Anerastia mictochroeella Rag. type orig, pl. XL fig. 10"; "1901 coll. E. L. Ragonot Muséum Paris"; "♀ genitalia on slide 1186 J. C. Shaffer." [MNHN].

Maxillary palpi are not visible on the holotype, and are either minute or absent.

The female genitalia are phycitine, but do not match those of *Anerastia.* Proper generic placement must await association with male specimens. The species is known only from the holotype.

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Fig. 3. *Coenochroa californiella*, holotype of *miasticta* Hampson, female genitalia.

Coenochroa californiella **Ragonot**

Figs. 3, 4, 11, 17

Coenochroa californiella Ragonot, 1887: 20. Shaffer, 1968: 61-64 (complete synonymy and description).
Coenochroa monomacula Dyar, 1914: 348. New Synonymy.
Metacrateria miasticta Hampson, 1918: 79. New Synonymy.

Type material examined.—*miasticta*, holotype ♀, labeled: "Type"; "Presidio, Mexico. Forrer."; "Metacrateria miasticta, type ♀. Hmpsn"; "Godman-Salvin Coll. 1904.—1. B.C.A. Lep. Het. Platytes interlineata Zell."; "Pyralidae Brit. Mus. Slide No. 10917." [BMNH]. *monomacula*, holotype ♂, labeled: "Cabima Pan May 20. .11 August Busck" [Panama]; "Coenochroa monomacula Type Dyar" [red handwritten label]; "Type No. 16433 U.S.N.M." [red label]; "Genitalia Slide By Jay Shaffer USNM 55450" [remounted by JCS]. [USNM]. *monomacula* paratypes.—♀, labeled: "La Chorrere May 12 Pan Aug. Busck"; "Genitalia Slide By Jay Shaffer USNM 55442"; ♀, labeled: "La Chorrera May 12 Pan Aug. Busck" [Panama]; "Genitalia Slide By Jay Shaffer USNM 55443." [USNM].

Both paratypes are females, not one male and one female as listed by Dyar.

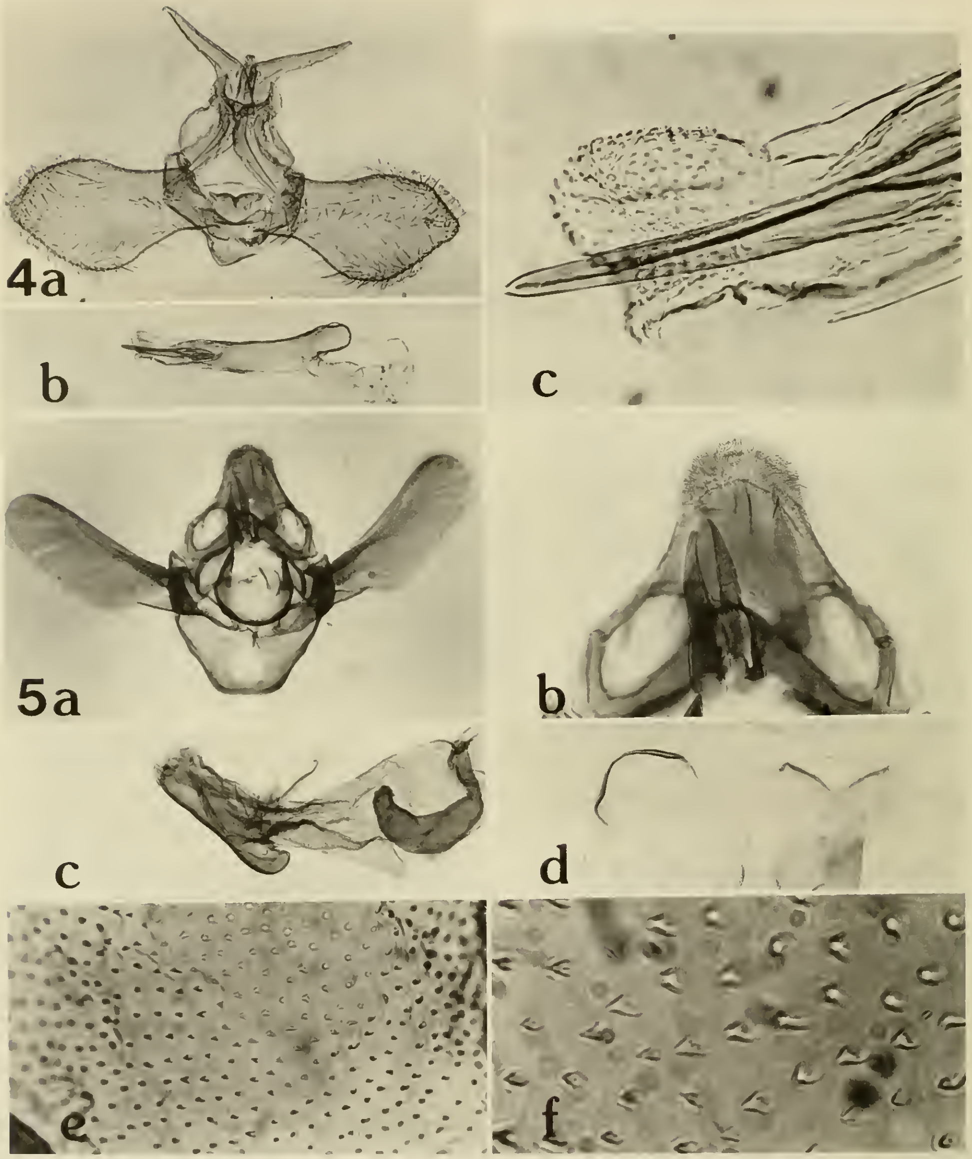
The species is widely distributed in North America from British Columbia to southern California and east to Kansas and central Texas. I have few records from Mexico, but many from the United States, including the border area from San Diego, California to Brownsville, Texas. Morphologically the types of *miasticta* and *monomacula* closely match other material of *californiella*, and I consider all these specimens to be conspecific.

Euzophera climosa **Dyar**

Figs. 6, 19, 22

Euzophera climosa Dyar, 1914: 335. Heinrich, 1956: 315.

Description.—Labial palpi obliquely ascending, 2.0× as long as eye diameter. Maxillary palpi short, cylindrical, not reaching end of frons. Tongue greatly reduced. Male antennae with shaft sublaminate, basal segments unmodified, cilia



Figs. 4–5. 4a, *Coenochroa californiella,* holotype of *monomacula* Dyar, male genitalia; b, aedeagus; c, aedeagus tip. 5a, *Euzophera tintilla,* holotype, male genitalia; b, uncus and gnathos; c, aedeagus; d, eighth abdominal segment; e–f, enlargements of vesica teeth.

densely set, each about one-seventh as long as segment width. Eye diameter 0.6 mm. Ocelli minute, black with clear centers.

Forewing radius (holotype) 6.25 mm; ground almost uniformly moderate yellowish brown, just perceptibly lighter in broad band on distal $^1/_7$ of wing. Costal band yellowish white, posterior margin convex, extending to middle of cell, terminating before wing base and wing apex. Eleven veins; R_2 short stalked with

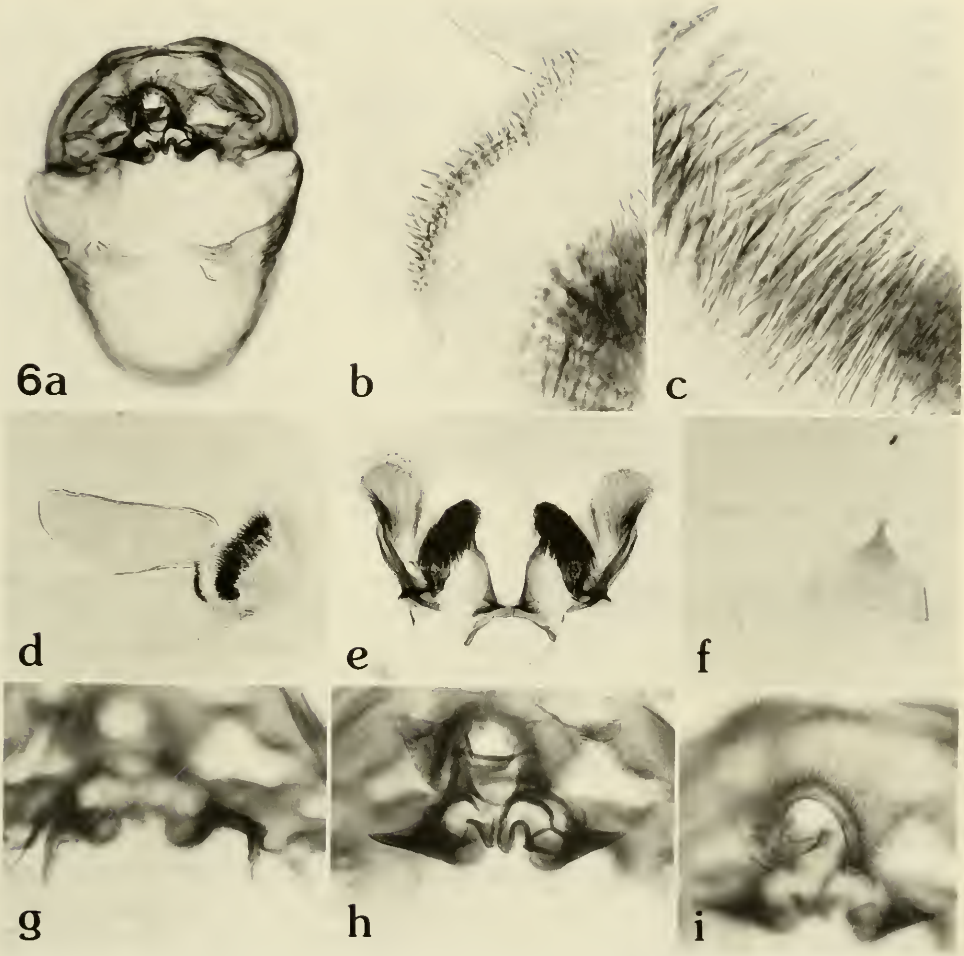


Fig. 6. *Euzophera climosa,* holotype. a, Male genitalia; b–c, cornuti; d, aedeagus; e, valvae (reduced); f, eighth abdominal segment; g, gnathos medial process, anterior arms; h, gnathos medial process, lateral arms; i, apex of uncus.

R_{3+5}; R_3 stalked with R_5 for about $^2/_3$ its length, from before upper outer angle of cell; M_2 short stalked with M_3, from lower outer angle. Hindwing uniformly grayish yellowish brown. Seven veins; Sc and Rs long stalked, forking near wing margin; M_{2+3} fused, short stalked with Cu_1, from lower outer angle; Cu_2 from well before the angle.

Male genitalia with uncus scoop shaped, posterior margin a smooth U-shaped ring; dorsal surface finely pubescent. Gnathos with lateral arms short, broad, transversely directed; apical process bilobed, posteriorly bearing pair of broad-based, laterally directed spines, anteriorly bearing slender laterally directed arms, each angled 90° ventrally near its distal end. Vinculum broadly rounded, 1.25 × as broad as long. Valve each with hairy pad 2.75 × as long as wide, extending ventro-distally from base of costa; ventral margin of pad slightly concave, dorsal margin slightly convex; distal end of pad protruding from ventral margin of valve giving valve bilobed aspect. Aedeagus 2.5 × as long as maximum width, 0.9 mm long, broadest medially; vesica with one large and one much smaller patch of numerous sclerotized blades. Blades up to about 120 micrometers long in large patch, up to about 25 micrometers long in small patch. Vesica also bearing widely scattered minute triangular cusps, each about 10 micrometers wide at base. Eighth segment hair tufts absent.

Female genitalia unknown.

Holotype.—♂, labeled: "March 15.31:12"; "Rio Trinidad Pan" [Panama]; "A Busck coll"; "Type No. 16389 U.S.N.M." [red label]; "Euzophera climosa Type Dyar" [red handwritten label]; "♂ Genitalia Slide, 12·May·1934 C.H. #2127"; "Genitalia Slide By Jay Shaffer USNM 55449" [remounted by JCS]. [USNM].

Conspecific paratype.—♂, labeled: "Rio Trinidad Mar .12 Pan" [Panama]; "A Busck coll"; "♂ Genitalia Slide, 21·May·1934 C.H. #2137"; "Genitalia Slide By Carl Heinrich USNM 55451." [USNM].

Other material examined.—♂, Tumatumari, Potaro River, Guyana, June 28, 1927, genitalia slide USNM 55452; ♂, St. Jean, Maroni, French Guiana, genitalia slide USNM 55453. [USNM].

E. climosa was described from three males and four females. Of the two male paratypes only one is conspecific with the holotype. The female paratypes represent more than one species, and at present it is not possible to determine which, if any, are of the same species as the holotype. The species shows affinities with *Laetilia,* but is not congeneric and is best left in *Euzophera* until *Laetilia* and its relatives are revised.

Euzophera tintilla **Dyar**

Figs. 5, 12, 18

Euzophera tintilla Dyar, 1914: 334. Heinrich, 1956: 315.

Description.—Frons oblique, pale orange yellow. Labial palpi obliquely ascending, slender, 1.6 times as long as eye diameter; all surfaces pale orange yellow with numerous scattered dark-brown scales, these forming broad subapical band on third segment. Maxillary palpi cylindrical; short, just reaching anterior margin of eye; yellowish white. Tongue minute. Male antenna with scape pale orange yellow on all sides; shaft filiform, lacking basal modifications, finely ciliate, cilia about one-third as long as segment width. Eye diameter 0.9 mm. Ocelli normally developed, conical, black with clear centers. Vertex pale orange yellow. Occiput pale orange yellow dorsally; same laterally, but with black spot behind eye. Patagia and tegulae pale orange yellow with scattered light-brown scales.

Forewing radius 9.5 mm; ground pale orange yellow with diffuse yellowish pink spot posterior to cell between antemedial and transverse posterior lines. Antemedial line prominent, black, strongly curved distally between costa and A_2, reflexed distally posterior to A_2. Transverse posterior line black, nearly straight, bent distally beyond M_{2+3} fork. Black discal spot at lower outer angle of cell, narrowly extended anteriorly along closing vein of cell. Terminal line of black spots between the veins. Eleven veins; R_2 free from cell; R_{3+4} stalked with R_5 about half length of R_5; M_{2+3} short stalked, from lower outer angle of cell; Cu_1 from near the angle. Hindwing with seven veins; Sc and Rs long stalked, forking near wing margin; M_{2+3} fused, short stalked with Cu_1, from lower outer angle of cell; Cu_2 from well before the angle.

Procoxae pale orange yellow, black at base and apex. All tarsi brown, each segment pale orange yellow apically. Mesotibia pale orange yellow with black band two-thirds toward apex.

Male genitalia with uncus tapering posteriorly, apical margin broadly rounded, naked; dorsal surface densely setose. Gnathos with lateral arms strongly curved; apical process bilobed with pair of long posterior processes, each gradually tapering to a point. Transtilla incomplete, forming pair of narrow curved bars. Juxta U-shaped. Vinculum broad, truncate, about 1.2 times as broad as long. Aedeagus somewhat flattened; cornuti absent; vesica with numerous minute triangular teeth, each about 7 micrometers wide basally. Eighth segment lacking special modification.

Female genitalia unknown.

Holotype.—♂, labeled: "Porto Bello 4/17-24 Pan" [Panama]; "A Busck 1912 coll"; "Type No. 16386 U.S.N.M." [red label]; "Euzophera tintilla Type Dyar" [red handwritten label]; "fig"; "♂ Genitalia Slide, 11·May·1934. C.H. #2123"; "Genitalia Slide By Jay Shaffer USNM 55448" [remounted by JCS]. [USNM].

The species was described from a single male specimen. In Heinrich (1956) it keys out to venation group II, division A, and shares many features in common with genera 131 (*Laetilia*) through 151 (*Cactobrosis*), but does not fit well into any existing phycitine genus. I believe that it is best left in *Euzophera* until proper placement can be made.

Euzophera conquistador **Dyar**

Figs. 7, 14, 21

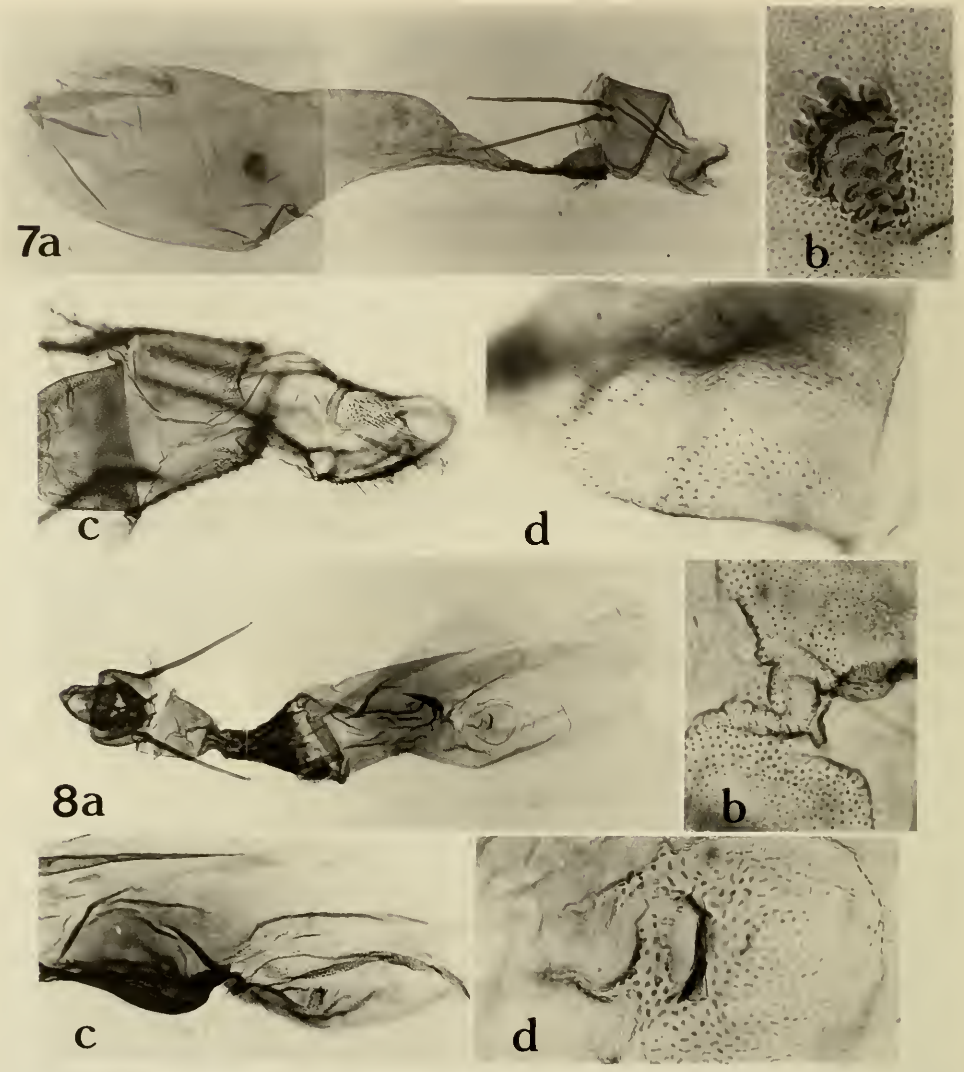
Euzophera conquistador Dyar, 1914: 335. Heinrich, 1956: 315.

Description.—Frons purplish brown. Labial palpi porrect, slender, 3.0 times as long as eye diameter. Maxillary palpi short, cylindrical, nearly reaching end of frons. Tongue greatly reduced. Female antennae filiform. Eye diameter 0.64 mm. Ocelli moderately well developed, conical, black. Patagia and tegulae a mixture of pale orange yellow and purplish brown.

Forewing radius 9.5 mm; ground purplish brown, indistinct broad antemedial band of pale orange yellow directed diagonally outward between costa and A_1 fold, reflexed inward posterior to A_1 fold. Small, indistinct discal spot of pale orange yellow over closing vein of cell. Narrow subterminal band of pale orange yellow parallel to outer wing margin. Eleven veins; R_2 free from cell; R_{3+4} stalked with R_5 for about half its length, from well before outer angle of cell; M_1 from the angle; M_2 stalked with M_3 for about one-third its length, from lower outer angle; Cu_1 from well before the angle. Hindwing with seven veins; Sc and Rs long stalked; M_{2+3} fused, very short stalked with Cu_1, from lower outer angle; Cu_2 from well before the angle.

Male genitalia unknown.

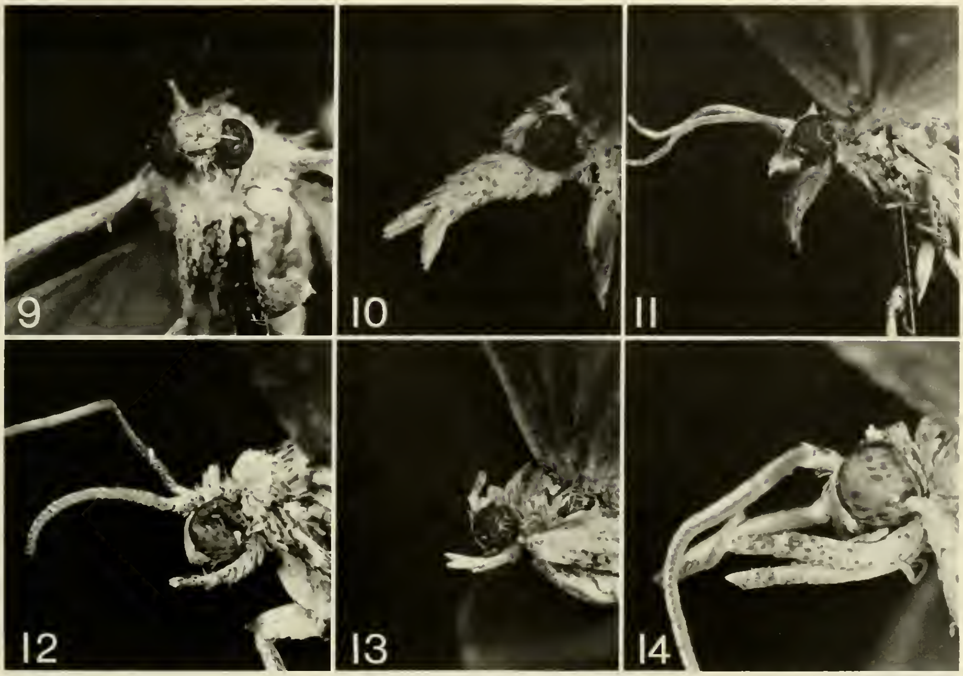
Female genitalia with ovipositor finely pubescent; anterior apophyses straight, 1.7 × as long as posterior; posterior straight, slender. Eighth segment collar wedge-shaped in lateral view, entire surface very finely setose, posterior margin bearing long setae. Ostium a moderately well sclerotized collar, inner surface set with numerous very fine short spines. Ductus bursae smooth, gradually broadening into bursa. Bursa bearing a single signum, in form of rounded pear-shaped plate 0.20 mm wide by 0.22 mm long, bearing about three dozen inwardly directed



Figs. 7–8. 7a, *Euzophera conquistador,* holotype, female genitalia; b, signum; c, ventral view of ostium and ovipositor; d, ostium spines. 8a, *Euzophera mabes,* holotype, female genitalia; b, ostium; c, signum and origin of ductus seminalis; d, signum.

scales, these largest and most crowded on side opposite ductus seminalis origin. Bursa surface set with minute, subelliptical scales, these largest and most prominent around signum (here about 7 × 12 μm); smaller, subtriangular, and inconspicuous elsewhere (here about 5 μm wide), ending abruptly at posterior end of bursa. Ductus seminalis from posterior half of bursa, slender, funnel-shaped at junction with bursa.

Holotype.—♀, labeled: "Cabima Pan May 16-31 .11 August Busck" [Panama]; "Type No. 16390 U.S.N.M." [red label]; "Euzophera conquistador Type Dyar" [red handwritten label]; "♀ Genitalia Slide, 12·May·1934. C.H. #2129"; "Genitalia Slide By Jay Shaffer USNM 55447" [remounted by JCS]. [USNM].



Figs. 9–14. 9, *Saluria jordanella*, holotype. 10, *Anerastia mictochroella*, holotype. 11, *Coenochroa californiella*, holotype of *monomacula* Dyar. 12, *Euzophera tintilla*, holotype. 13, *Euzophera mabes*, holotype. 14, *Euzophera conquistador*, holotype.

The species was described from a single female. Whatever its original state it is now in less than perfect condition, and perhaps fresh specimens would show more detailed wing markings than I have described. The genitalia are phycitine, but proper generic placement is uncertain.

Euzophera mabes Dyar

Figs. 8, 13, 20

Euzophera mabes Dyar, 1914: 334. Heinrich, 1956: 315.

Description.—Labial palpi obliquely ascending, slender, 2.0 times as long as eye diameter. Maxillary palpi short, cylindrical. Tongue greatly reduced. Female antennae sublaminate, lacking basal modifications, finely and densely ciliate, cilia length about one-fifth segment width. Eye diameter 0.6 mm. Ocelli normally developed, elliptical, black with clear centers. Patagia light orange. Tegulae purplish gray.

Forewing radius 7.5 mm; ground light yellowish brown distally to brownish orange base on posterior half of wing. Strong dark brown antemedial band; broadest in cell, sharply angled distally at A_1 fold. Narrow brown transverse posterior line, parallel to orange-brown subterminal line. Terminal line of brown spots between veins. Eleven veins; R_2 free from cell; R_{3+4} stalked with R_5 for about half its length, from near upper outer angle of cell; M_1 from the angle; M_2 stalked with M_3 for about ⅖ its length, from lower outer angle; Cu_1 from before the angle. Hindwing brown, darker apically. Seven veins; Sc and Rs long stalked; M_{2+3}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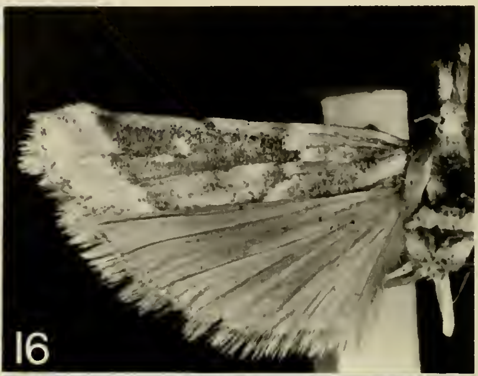
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fused, short stalked with Cu_1, from lower outer angle of cell; Cu_2 from well before the angle.

Male genitalia unknown.

Female genitalia with ovipositor broadly lobed, bearing fine scattered hairs. Eighth segment moderately well sclerotized; posterior margin reflexed inward and deeply emarginate ventrally with sides connected midventrally by narrow bridge at anterior margin of segment. Ostium broad, dorsal surface moderately well sclerotized laterally, ostium membranous elsewhere; inner surface set with numerous minute sharp spines, each about 5–7 μm long. Ductus bursae formed of longitudinal folds of thickened membrane. Bursa with small eliptical plate-like signum, 80 by 30 μm, bearing 3 unequal rounded laminar projections. Bursa surface set with numerous minute elliptical scales, each about 5 by 7 μm wide and bearing longitudinal furrows giving digitate appearance; scales orientated with rounded ends of digits directed away from signum; scales best developed near signum, smaller and less evident in anterior and posterior regions of bursa. Ductus seminalis from bursa near and posterior to signum; very slender, funnel shaped at junction with bursa.

Holotype.—♀, labeled: "Taboga Isl Pan Febr. 12 August Busck" [Panama]; "Type No. 16387 U.S.N.M." [red label]; "Euzophera mabes Type Dyar" [red handwritten label]; "fig"; "♀ Genitalia Slide, 16·May·1934 C.H. #2135"; "Genitalia Slide by Jay Shaffer USNM 55446" [remounted by JCS]. [USNM].

The other specimen listed by Dyar (USNM genitalia slide 55454), a female from Porta Bello, Panama, appears not to be conspecific with the holotype, but matches a Rio Trinidad female (USNM genitalia slide 55455) paratype from the *E. climosa* series.

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Figs. 15–22. 15, *Saluria jordanella,* holotype. 16, *Anerastia mictochroella,* holotype. 17, *Coenochroa californiella,* holotype of *monomacula* Dyar. 18, *Euzophera tintilla,* holotype. 19, *Euzophera climosa,* holotype. 20, *Euzophera mabes,* holotype. 21, *Euzophera conquistador,* holotype. 22, *Euzophera climosa,* holotype.

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86(2), 1984, pp. 396–399

LEPTOCERA (*PTEREMIS*) RONDANI IN NORTH AMERICA (DIPTERA, SPHAEROCERIDAE)

S. A. MARSHALL

Department of Environmental Biology, University of Guelph, Guelph, Ontario, Canada N1G 2W1.

Abstract.—The three North American species formerly placed in *Leptocera* subgenus *Pteremis* Rondani are discussed, and two of them are relegated to other genera of the Limosininae. A new species, *Leptocera* (*Pteremis*) ***wirthi***, is described from specimens collected in Northwest Territories, Alberta, Saskatchewan, and Quebec. Two new combinations, *Aptilotus parvipennis* (Spuler) and *Pterogramma flavifrons* (Spuler), are given.

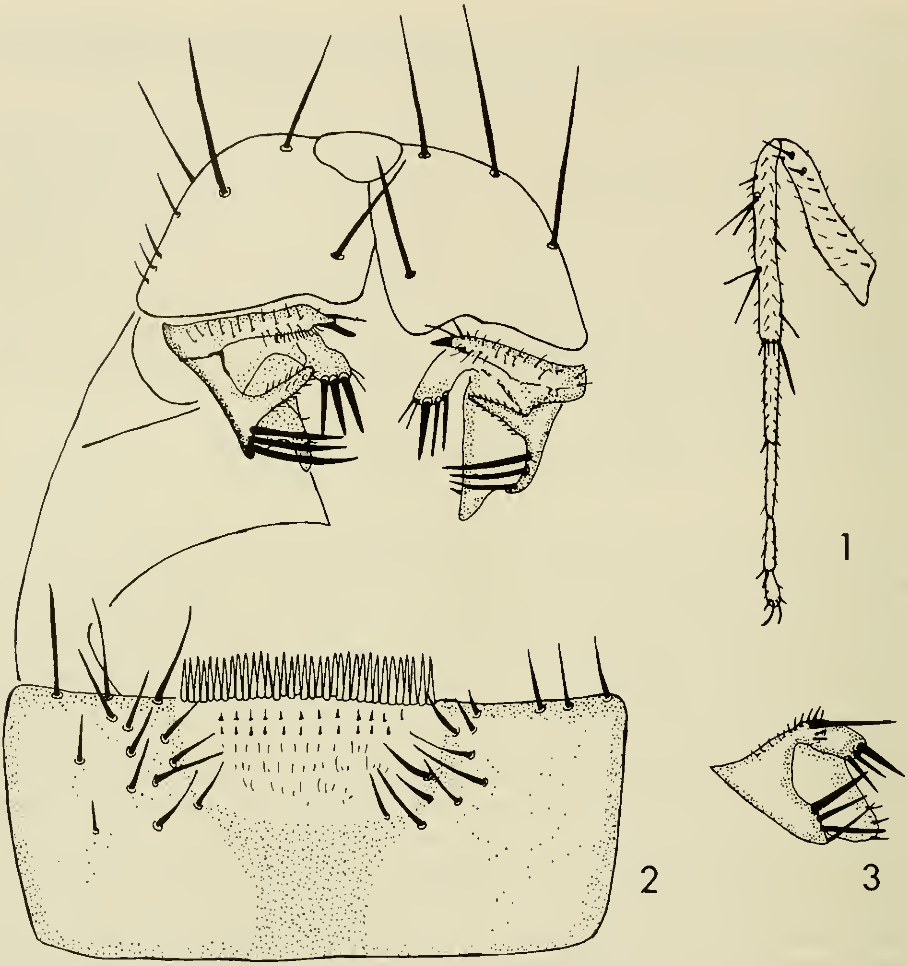
Pteremis Rondani, a subgenus of *Leptocera* Olivier, has as its type species *Borborus nivalis* Haliday, which is a synonym of *P. fenestralis* (Fallén). This is a very variable, Palaearctic species, ranging from fully winged to brachypterous. Two other Palaearctic species have been placed in this subgenus. *Leptocera* (*Pteremis*) *kaszabi*, was described by Papp (1973) on the basis of one specimen from Mongolia, and *Leptocera* (*Pteremis*) *canaria* was described by Papp (1977) on the basis of 4 specimens from the Canary Islands. Three North American species were described in the subgenus *Pteremis* by Spuler (1924). These 3 species have little more in common with each other, with Spuler's diagnosis of *Pteremis*, or with *P. fenestralis*, than a common tendency towards wing reduction. None of Spuler's *Pteremis* have a preapical ventral bristle on the midtibia, which is characteristic of *Pteremis* and other subgenera of *Leptocera*, or the long apical, posteroventral midtibial bristle lying flat against the midbasitarsus that is characteristic of the subgenus *Pteremis*.

The species that Spuler described as *Pteremis parvipennis* belongs in the *pulex* group of the genus *Aptilotus* Mik, new combination. The species which Spuler described as *Pteremis flavifrons* clearly belongs in the genus *Pterogramma*, new combination, and may in fact be *Pterogramma palliceps* Johnson. According to Richards (1963) part of the series of *Pterogramma sublugabrina* (Malloch) on which Spuler based the genus *Pterogramma* are actually *Pterogramma palliceps* as well. Spuler's *Pteremis flavifrons* agrees with *Pterogramma palliceps* in such important characters as the greatly reduced lower orbital bristle, the yellow head, the porrect, somewhat pointed antennae, the greatly reduced interfrontal bristles, and the strongly divergent veins R^{1+2} and Rs. The only external difference between *P. flavifrons* (known only from the holotype female which was examined) and *Pterogramma palliceps* is the somewhat reduced wing of *flavifrons*, in which crossvein dm-cu is lost. Similar wing reduction has been noted as variation within a number of species in the Limosininae. Roháček (1975) illustrates a series of *Pullilimosina heteroneura* (Haliday) wings ranging from fully winged to a brachypterous form in which crossvein dm-cu is lost. Although *Pteremis flavifrons* appears to be a reduced-wing form of *Pterogramma palliceps*, formal placement of these species into synonomy is deferred until a complete revision of North American *Pterogramma* can be undertaken.

The third species which Spuler described in *Pteremis*, the species *unica*, is difficult to place due to the poor condition of the holotype female (the only known specimen of this species). When it was described, it was largely de-bristled and Spuler was unable to describe any head chaetotaxy. This specimen now lacks one antenna, both aristae, almost all head bristles, many leg bristles, and most notal bristles. It is not possible to confirm or refute the placement of *unica* in *Pteremis*; however, it is the only one of Spuler's 3 *Pteremis* that could possibly belong in this group, and it is therefore retained in *Pteremis*. To my knowledge there is only one other species of *Pteremis* in North America. It is very closely related to *P. fenestralis*, and is described as new below.

***Leptocera* (*Pteremis*) *wirthi*, NEW SPECIES**
Figs. 1-3

Description.—Size 1.3–2.0 mm. Color black, with a heavy pruinosity; legs, halter and pleural sutures brown. Interfrontal plate slightly higher than wide, bordered by 4 long interfrontal bristles, the upper pair slightly shorter; small interfrontal setulae below lower interfrontal bristle. One distinct orbital setula between lower orbital bristles, other orbital setulae smaller. Postvertical bristle as long as middle interfrontal bristle, postocellar bristle absent. Face tuberculate between antennae, concave below. Eyes 3 × as high as gena; vibrissal angle small, with a long vibrissa, a small subvibrissal setula; genal bristles small. Katepisternum with a posterodorsal bristle reaching ¾ of distance to wing base, and a minute dorsal setula. Midtibia with long dorsal bristles (Fig. 1), a preapical ventral bristle and an apicoventral bristle usually lying flat along tarsus. Wing strongly reduced to fully developed; crossvein dm-cu absent in reduced forms, dm-cu complete and cell dm slightly appendiculate in fully developed forms; wings most commonly slightly shorter than abdomen with dm-cu complete but cell dm not appendiculate. Wing length variable even within series from a single collection. Second costal sector shorter than third, costa very slightly bypassing tip of R^{4+5}. Halter well developed, clavate, even in specimens with greatly reduced wings. Setulae of dorsocentral areas enlarged but only 1 pair of distinct dorsocentral bristles; acrostichal setulae in 4–6 rows between dorsocentral areas; in a row of 4 between the prescutellar dorsocentral bristles; the middle pair of prescutellar acrostichal bristles slightly enlarged. Scutellum 1.5 × as wide as long, with 4 pairs of marginal bristles, the basal pair slightly longer than scutellar length, the apical pair slightly longer than scutellar width. Abdomen of male with sternite 1 + 2 shorter than sternites 3 and 4, sternite 5 about half as long as sternite 4, with its posteromedial area weakly sclerotised and covered with posteriorly weakened rows of setulae; posteromedial margin with a long comb-like row of bristles (Fig. 3). Surstylus complex, divided into bilobed anterior and posterior parts (Fig. 3). Parameres narrowed medially, spatulate at apex, broad basally. Female abdomen gradually tapering; tergite 8 extended laterally, weakly sclerotised dorsally. Cercus short, blunt, slightly longer than epiproct, with apical bristle twice as long as cercus, preapical bristles shorter. Each spermatheca oval, tapering gradually to stem. Epiproct with 2 dorsal bristles.



Figs. 1–3. *Pteremis wirthi* and *fenestralis.* 1, *P. wirthi* midleg (anterior). 2, *P. wirthi* terminalia and sternite 5 (ventral). 3, *P. fenestralis* left surstylus (ventral).

Holotype ♂.—Quebec. Mt. Albert, Gaspe Provincial Park, 5.vii–24.vii.1980, pan trap, C. Dondale. Paratypes: QUEBEC. 1 ♂: Great Whale R., 10.vii.1949, J. R. Vockeroth; 1 ♂: Mt. Ste. Marie, Low, 1800′, 20.ix.1965, J. R. Vockeroth; 1 ♂: Beechgrove, 2.x.1964, J. R. Vockeroth. SASKATCHEWAN. 1 ♂: Assiniboia, 23.vi.55, on ground among *Carex* roots, J. R. Vockeroth. ALBERTA. 1 ♂: Lancaster Park, 28.vi.1963, J. R. Vockeroth. NORTHWEST TERRITORIES. 8 ♀, 7 ♂: Aklavik, 8.ix.1931, O. Bryant (these specimens in poor condition). Northwest Territories specimens in California Academy of Sciences, holotype and other paratypes in Canadian National Collection.

Comments.—*P. wirthi* is externally very similar to the European *P. fenestralis. P. fenestralis* is larger, has a longer katepisternal bristle and has a brown gena in contrast to the pruinose grey gena of *P. wirthi.* The male surstyli are remarkably similar (Figs. 2 and 3) but consistently differ in the shape of the anterior lobe and chaetotaxy of the posterior lobe. *P. wirthi* differs from *P. unica* in having the eyes

3× as high as the gena instead of only 1.5× as high as in *unica.* The description of the Mongolian species, *P. kaszabi,* indicates that it is not within the size range of *P. wirthi* and that it differs in other features such as having only 3 pairs of interfrontal bristles.

Papp (1977) states that the other Palaearctic species, *P. canaria* "may be easily distinguished from any known sphaerocerid species: it has one strong ventral preapical bristle on its mid tibia but it has no ventroapical bristle on mid tibia and no mid metatarsal bristle." This apparent lack of the long ventroapical bristle (the main diagnostic feature of *Pteremis*) is remarkable, but *P. canaria* is otherwise very similar to *P. wirthi.* The male surstylus is very close to that of *P. wirthi* and *P. fenestralis.* It shares the digitiform inner ventral process with *P. wirthi* but is more similar to *P. fenestralis* in details of chaetotaxy and in having a short, blunt anterodorsal process.

Etymology.—*P. wirthi* is named after W. W. Wirth, Systematic Entomology Laboratory, USDA, Washington, D.C., in recognition of his patience with my many loan requests.

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PROC. ENTOMOL. SOC. WASH.
86(2), 1984, pp. 400–410

EURYTHRIPS AND *TERTHROTHRIPS* (THYSANOPTERA: PHLAEOTHRIPIDAE) FROM SOUTHERN BRAZIL, WITH ONE NEW SPECIES, NEW COLLECTION SITES, AND KEY

CHARLES F. GERDES

Division of Science, Northeast Missouri State University, Kirksville, Missouri 63501.

Abstract.—A new species of Phlaeothripidae, *Terthrothrips* ***marginatus***, is described and illustrated. A key to the new species and 8 allied species, all from new collection sites, is presented. These are the first new records for the 8 allied species since their original descriptions. *Plemmelothrips* is a new synonym of *Terthrothrips.*

Hood (1950, 1952, 1954, 1957, 1960) described 78 species of litter thrips in the tribe Glyptothripini, family Phlaeothripidae, from southern Brazil (below 22° South latitude). Sixty-six species were based exclusively on type-series collected from Nova Teutonia, Santa Catarina, while five species were based on type-series from both Nova Teutonia and Erechim, Rio Grande do Sul. The remaining seven species were based on material from six sites in three States: Rio de Janeiro, Rio Grande do Sul, and São Paulo. The only other species from southern Brazil in this tribe was described by Bergroth (1896) from Santa Catarina. This paper reports a new species and new records for 8 species in the Glyptothripini from Seara and Concordia, Santa Catarina. The species belong in the genera *Eurythrips* and *Terthrothrips,* which were considered closely related by Stannard (1957) and Mound (1977). The eight species were recorded previously only from Nova Teutonia by Hood (1954, 1957). No other records from southern Brazil have been added to these two genera since Hood (1960).

The 236 Seara specimens comprising the eight species were collected in January 1960, while 466 type specimens of the same species from Nova Teutonia were collected from August 1952 to October 1955 for *Eurythrips* and from February 1953 to October 1955 for *Terthrothrips.* However, none of the Nova Teutonia specimens were collected in December, January or March, and no specimens from these months could be found among unidentified material in the Hood collection. Therefore, the Seara additions greatly increase the known material during austral summer. The two Concordia specimens were collected in October 1959. Macropterous and brachypterous forms were collected in all seasons at Nova Teutonia, but at both Nova Teutonia and Seara the brachypterous form predominated. In this respect the similarity of forms would indicate that no drastic microclimatic difference existed. However, many of Hood's species exclusively from Nova Teutonia were found only in certain seasons or were known only from brachypterous or macropterous forms. Also, many of these species were based on general shape of body parts, color, and reticulation.

Hinds (1902) established *Eurythrips* for two species from Massachusetts. He was impressed by the dimensions of the head capsule and antennae. The former was described "as long or somewhat longer than wide" and the antennae were "fully twice as long as the head and thicker than in most species." Karny (1925) erected *Terthrothrips* for *Phloeothrips sanguinolentus* Bergroth (1896) from southern Brazil. Hood (1935) described *Terthrothrips* as having a "head decidedly longer than broad" and antennae "unusually long and slender, 2.7 to 3.3 times as long as head." Stannard (1955, 1957) published keys and descriptions to genera of Glyptothripini, and he stated in 1957 that total antennal length was the criterion for separation of *Eurythrips* and *Terthrothrips.* Species with each antenna shorter than 2½ times the head capsule length were placed in *Eurythrips* while species exceeding this value were placed in *Terthrothrips.* Mound (1977) separated *Eurythrips* and *Terthrothrips* in a key to genera by the characters of the fore tibiae and head. *Eurythrips* lacked small tubercles on the fore tibiae and had a variable head shape; *Terthrothrips* had small tubercles frequently present and a relatively long head with curved cheeks deeply incut behind large eyes. Mound (1977, fig. 58) implied that antennal length was also important in the separation of these two genera. I agree with Mound (1977) who stated that "the short-headed *Eurythrips* forms are so different from the long-headed *Terthrothrips* forms that it seems useful to recognize two genera" although a few species have characteristics of both genera.

Hood (1935) published a key to *Terthrothrips* species that contained only three species, one of which was transferred later to another genus. The most recent key to *Eurythrips* species was by Mound (1976). After examination of the type series of these two genera in the New World the two antennal lengths and four new ratios in couplet 1 of the following key are presented especially to aid in separating closely related species of *Terthrothrips,* none of which was in Hood's 1935 key.

KEY TO SPECIES OF *EURYTHRIPS* AND *TERTHROTHRIPS* FROM SOUTHERN BRAZIL

1\. In both sexes, usually head capsule long, eyes large, width across eyes similar to or slightly greater than width across cheeks, fore tibia with small tubercles along inner margin. Female antennal segment III at least 80 μ long, IV at least 75 μ long. Female ratios of body parts equal to or greater than following: antennal segments III and IV each with length/width, 1.75; abdominal segment X, length/basal width, 1.90; same segment, length/distal width, 3.70 .... *Terthrothrips* Karny 2

– In both sexes, usually head capsule short, eyes small, width across eyes less than across cheeks, fore tibia without small tubercles along inner margin. Female antennal segment III shorter than 80 μ, IV shorter than 75 μ. Female ratios less than values given in alternative above .... *Eurythrips* Hinds 8

2\. Antennal segments III–VIII light yellow, almost no difference in shades. Abdominal segment II yellow 3

– Two or more of antennal segments III–VII brownish. Abdominal segment II yellow or brown 4

3. Head with distinct reticulated striation completely across area posterior to major postocular setae. Maxillary stylets inserted only to posterior edge of head capsule. Metanotal pelta with 6–9 longitudinally elongated polygons between central setae ....*Terthrothrips irretitus* Hood

– Head with sparse weak striation in area posterior to major postocular setae. Maxillary stylets inserted ⅓ of distance from posterior edge of head capsule to major postocular setae. Metanotal pelta with 4–5 roughly quadrate polygons between central setae in brachyptera, more polygons in macroptera .... *Terthrothrips balteatus* Hood

4. Abdominal segment II yellow, IV brown, no sharp contrast in shade between II and IV 5

– Abdominal segments II and IV brown, II slightly lighter in shade than IV 6

5. Metanotal pelta with distinct dark posterior margins; without complete posterior extension, only a few weak striae between dark margins. Maxillary stylets inserted ⅓ of distance from posterior edge of head capsule to major postocular setae .... *Terthrothrips marginatus,* new species

– Metanotal pelta without dark posterior margins; with narrow posterior extension, polygons of extension elongated and unusually small. Maxillary stylets inserted ⅓–¾ of distance from posterior edge of head capsule to major postocular setae .... *Terthrothrips bucculentus* Hood

6. Maxillary stylets inserted ⅓ of distance from posterior edge of head capsule to major postocular setae. Fore femur and tibia brownish, slightly lighter than brown head capsule. Metanotal pelta with posterior extension, each polygon of extension similar in length and width; with heavy ridges just lateral to central setae .... *Terthrothrips brunneus* Hood

– Maxillary stylets inserted ½–¾ of distance from posterior edge of head capsule to major postocular setae. Fore tibia and distal ½ of fore femur yellow, head capsule brown. Metanotal pelta without posterior extension, without heavy ridges lateral to central setae 7

7. Antennal segment III light yellow medially, V light brown medially. Metanotal pelta with 5 polygons between central setae, each central seta ¾ as long as distance between them, more polygons in microptera and brachyptera ....*Terthrothrips peltatus* Hood

– Antennal segments III and V light brown medially, almost same shade. Metanotal pelta with 8 polygons between central setae, each central seta ½ as long as distance between them .... *Terthrothrips defectus* (Hood)

8. Antennal segment IV with 2 sense cones on inner ½. Metanotal pelta with broad posterior extension of longitudinally elongated polygons ....*Eurythrips trifasciatus* (Hood)

– Antennal segment IV with 1 sense cone on inner ½. Metanotal pelta without posterior extension 9

9. Abdominal tergite II striated between submedial anterior pair of setae. Abdominal segment VIII with male glandular area a narrow band across anterior end ....*Eurythrips bisetosus* (Hood)

– Abdominal tergite II smooth between submedial anterior pair of setae.

Abdominal segment VIII with male glandular area occupying most of segment .... *Eurythrips hemimeres* Hood

Discussion of Species

All specimens listed as new records are in the Illinois Natural History Survey, Champaign. Abbreviations are: mac = macropterous, br = brachypterous.

***Eurythrips bisetosus* (Hood)**

Porcothrips bisetosus Hood, 1954: 35–38.
Eurythrips bisetosus: Mound, 1976: 31, 38, 42, 45, 49; Mound, 1977: 227, 239, 241.

New record.—Brazil, Santa Catarina, Seara, 27°09'S, 52°15'W, January 1960, Fritz Plaumann coll., 37 br ♀, 14 br ♂.

Mound (1976) regarded *E. bisetosus* as closely related to *E. hemimeres* and keyed them out at the same couplet but did not use the striation pattern of abdominal tergite II (present key, couplet 9) which was described by Hood (1957).

***Eurythrips hemimeres* Hood**

Eurythrips hemimeres Hood, 1957: 142; Mound, 1976: 31, 38, 42, 49, 53; Mound, 1977: 227, 234, 241.

New record.—Brazil, Santa Catarina, Seara, 27°09'S, 52°15'W, January 1960, Fritz Plaumann coll., 1 mac ♀, 44 br ♀, 26 br ♂.

Mound (1976) pointed out that *E. hemimeres* was the most abundant species collected by F. Plaumann in southern Brazil. Actually, all 155 specimens were from Nova Teutonia. The 71 Seara specimens also represented the most abundant species from that site.

***Eurythrips trifasciatus* (Hood)**

Porcothrips (?) *trifasciatus* Hood, 1954: 38–39.
Eurythrips trifasciatus: Mound, 1976: 32, 39–40, 44, 59–60; Mound, 1977: 229, 234, 241.

New records.—Brazil, Santa Catarina, Seara, 27°09'S, 52°15'W, January 1960, Fritz Plaumann coll., 15 mac ♀, 2 br ♂; Santa Catarina, Concordia, October 1959, Fritz Plaumann coll., 1 mac ♀.

This species was described from 1 micropterous female, but Mound (1976) reported that the macropterous form was in Hood's material. Hood's collection at the U.S. National Museum included 34 unidentified macropterous females grouped with the type series and from Nova Teutonia. Hood apparently believed they were the same species. The high proportion of macroptery is unusual for *Eurythrips.* All 15 Seara females had the short *Eurythrips*-like antennal segments III and IV, which were less than 80 μ and 75 μ long, respectively. The average head width across the eyes for the Seara females was 93.5% of the width across the cheeks, which was near typical *Terthrothrips* values. However, macropterous forms of *Terthrothrips* tend to have head widths across the eyes relatively greater, with some specimens having this width greater than across the cheeks. Fourteen females had the tube length/basal width ratio falling in the *Eurythrips* range.

However, the majority of specimens fell in the *Terthrothrips* range using the other 3 ratios of couplet 1. Brachypterous males are reported here for the first time.

Terthrothrips balteatus **Hood**

Terthrothrips balteatus Hood, 1957: 152; Mound, 1976: 32; Mound, 1977: 227, 233, 237, 242.

New record.—Brazil, Santa Catarina, Seara, 27°09′S, 52°15′W, January 1960, Fritz Plaumann coll., 4 mac ♀, 16 br ♀, 8 br ♂.

Hood (1957) stated that *T. balteatus* was "the only species of the genus with blackish brown body, yellow second abdominal segment, and yellow antennae." Hood clarified in the detailed description that antennal segments I and II were not yellow. *Terthrothrips irretitus* possesses a yellow second abdominal segment and yellow antennal segments III–VIII (couplet 2) but is distinctive in the characters in couplet 3.

Terthrothrips brunneus **Hood**

Terthrothrips brunneus Hood, 1957: 148–149; Mound, 1976: 32, 62; Mound, 1977: 242.

New record.—Brazil, Santa Catarina, Seara, 27°09′S, 52°15′W, January 1960, Fritz Plaumann coll., 3 mac ♀, 5 br ♀, 4 br ♂.

This is the first record of males in this species. The 4 males were oedymerous, having moderately enlarged fore femora and tibiae. Brachypterous females are also recorded here for the first time.

Terthrothrips bucculentus **Hood**

Terthrothrips bucculentus Hood, 1957: 145–146; Mound, 1976: 32, 62; Mound, 1977: 227, 242.

New record.—Brazil, Santa Catarina, Seara, 27°09′S, 52°15′W, January 1960, Fritz Plaumann coll., 2 mac ♀, 1 br ♂.

Hood (1957) recorded 138 specimens of this species from Nova Teutonia but only 3 specimens were found at Seara.

Terthrothrips defectus **(Hood), New Combination**

Plemmelothrips defectus Hood, 1957: 144–145.
Eurythrips defectus: Mound, 1977: 227, 234, 241.

New record.—Brazil, Santa Catarina, Seara, 27°09′S, 52°15′W, January 1960, Fritz Plaumann coll., 6 mac ♀, 5 br ♀, 6 br ♂.

Hood (1957) stated that *Plemmelothrips* was allied to *Terthrothrips* but that the former had stouter antennae, a short and broad head, and less protruding eyes. *Plemmelothrips* is a monotypic genus and a new synonym here of *Terthrothrips.* Mound (1977) stated that *P. defectus* was intermediate in structure between *Eurythrips* and *Terthrothrips* but did not indicate the characters he considered. All the Seara females had the 2 tube ratios of couplet 1 in the *Terthrothrips* range but a few of the antennal ratios fell in the *Eurythrips* range. However, the lengths of antennal segments III and IV were completely in the *Terthrothrips* range, agreeing with the Nova Teutonia material. Interestingly, the holotype had each antenna 2.6 times as long as the head capsule, agreeing with the concept of

Stannard (1957) that antennae longer than 2½ times the head capsule length were typical of *Terthrothrips.*

Terthrothrips irretitus Hood

Terthrothrips irretitus Hood, 1957: 150–151, 153; Mound, 1976: 32, 62; Mound, 1977: 227, 233, 237, 239, 242.

New records.—Brazil, Santa Catarina, Seara, 27°09′S, 52°15′W, January 1960, Fritz Plaumann coll., 3 mac ♀; Santa Catarina, Concordia, October 1959, Fritz Plaumann coll., 1 mac ♀.

The Seara and Concordia specimens agree with the Nova Teutonia material in having maxillary stylets inserted only to the posterior edge of the head capsule (Mound, 1977, fig. 13). This is an unusual character state for *Terthrothrips* but works well in separating species in the key (couplet 3).

Terthrothrips marginatus Gerdes, New Species

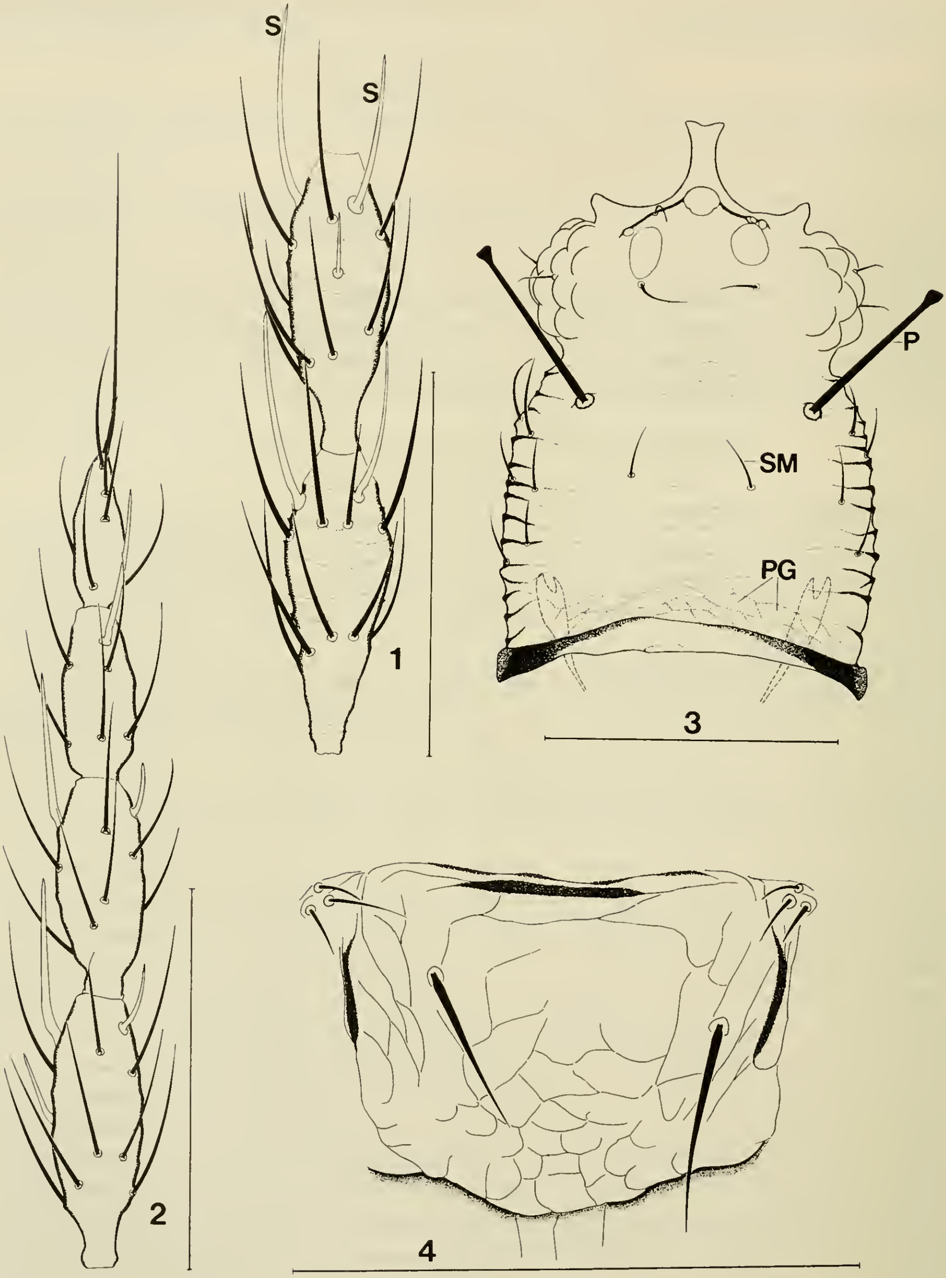
Figs. 1–7

The following description is of the holotype unless stated otherwise. *Terthrothrips marginatus* may be separated from other species in the genus by the prominent dark posterior margin of the metanotal pelta and relatively short antennal segments III and IV. This species is similar to *T. balteatus* and *T. bucculentus* but may be separated from them in the key.

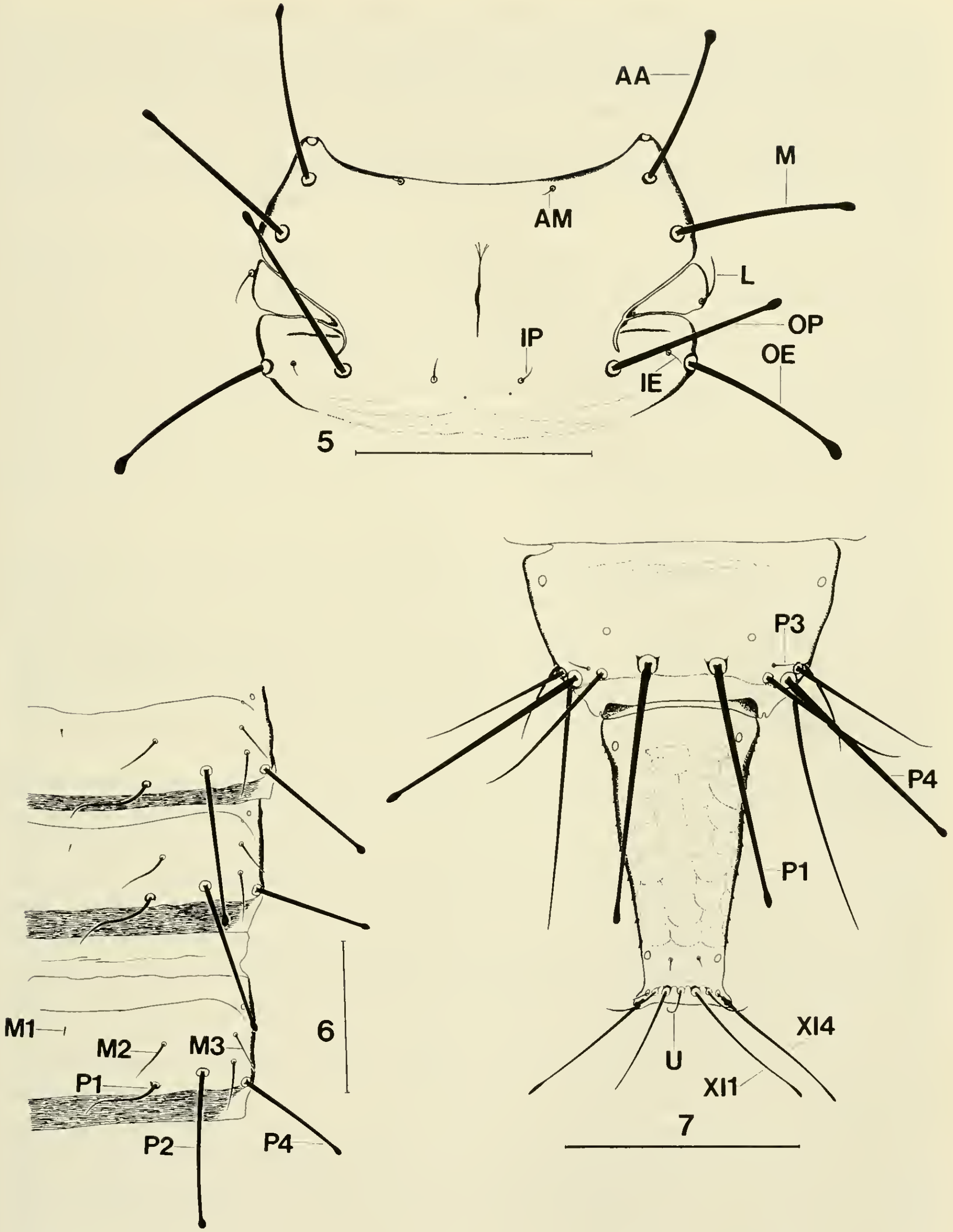
Antenna.—Segment VIII light yellow, almost clear; III–VII yellow-brown without sharp difference in shade between adjacent segments; I and II brown, darkest; VIII with pedicel narrower than medial width. Sense cones on distal ⅓ of each segment (inner ½, outer ½): III, 1, 2; IV, 1, 2; V, 1, 2; VI, 1, 2; VII, 0, 1. Type series with 1–2 small cones on middle ⅓ of IV–V. Setae (basal ½, distal ½): I, 5, 6; II, 7, 5; III, 6, 6; IV, 6, 6; V, 6, 5; VI, 7, 3–4; VII, 6–8, 5; VIII, 6, 8.

Head capsule.—Yellow-brown, darker medially than antennal segments I and II. One pair of submedial setae (SM) about ½ of distance from posterior edge of eyes to posterior edge of capsule. About 24 small acute postocular setae; on each side 3 between major postocular seta (P) and edge of capsule in dorsal aspect; remainder on lateral and ventral sides. One pair of ventral major acute submedial setae about ⅓ of distance from ventroposterior edge of capsule to eyes. About 10 well-demarcated polygons (PG) between SM and posterior edge of capsule. Four weak transverse striae between SM and posteromedial PG. About 5 weak transverse striae between SM and posterior edge of eyes. Posteromedial PG each with longer axis near transverse plane of head and usually 3–4 × longer than short (longitudinal) axis. Capsular setae acute except P with enlarged tips. Each eye with 4–5 ommatidia along lateral edge in dorsal aspect; with 1 ommatidial seta on dorsal ½, 2 on ventral ½. Each cheek with about 15 short protuberances, warty or slightly sharp, along lateral edge in dorsal aspect. Dorsal occipital margin with a few weak striae in medial ⅓. Maxillary stylets inserted ⅓ of distance from dorsoposterior edge of capsule to P. Ocellar setae: 1 pair just posterior to hind ocelli, 1 pair on ridges proceeding posterolaterally from fore ocellus; both pairs acute, small. Distance between hind ocelli about 1½–2 × width of either ocellus.

Prothorax.—Yellow-brown. Four pairs of long setae with expanded apices: anteroangular pronotals (AA), midlateral pronotals (M), outer epimerals (OE), outer posteromarginal pronotals (OP). Four pairs of much smaller acute setae:



Figs. 1–4. Holotype of *Terthrothrips marginatus.* 1, Antennal segments III–IV. 2, Antennal segments V–VIII. 3, Head capsule, dorsal aspect. 4, Metanotal pelta. Setae: P = postocular; SM = submedial. PG = polygons. S = sense cone. Each scale line = 100 μ.



Figs. 5–7. Holotype of *Terthrothrips marginatus.* 5, Dorsal prothoracic plates. 6, Right portion of abdominal terga III–V. 7, Abdominal segments IX–XI, dorsal aspect. Setae: AA = anteroangular pronotal; AM = anteromarginal pronotal; IE = inner epimeral; IP = inner posteromarginal pronotal; M = midlateral; OE = outer epimeral; OP = outer posteromarginal pronotal; L = minor lateral; M1, M2, M3 = 1st through 3rd medial; P1, P2, P3, P4 = 1st through 4th posterior; U = unpaired of segment XI; XI1, XI4 = 1st and 4th paired of segment XI. Each scale line = 100 μ.

anteromarginal pronotals (AM), minor laterals (L), inner epimerals (IE), inner posteromarginal pronotals (IP). One pair of minute clear areas posteromedial to IP. Some specimens with L inserted just lateral to plate. Praepectus with prominent dark striae and complete medial division. Probasisternum with complete medial division, striae less prominent than on praepectus; each ½ with 2 acute short setae near anterior edge and with posteromedial notch. Prospinasternum without setae or prominent striae, with narrowed posterior extension dorsally overlapping mesopraesternum.

Mesothorax.—Yellow-brown. Mesopraesternum thinner medially, with striae over entire surface, 1 minute lateral and 1 minute submedial pair of acute setae. Mesonotum roughly triangular with anterior projection inserted ventrally to pronotum, posterior margin darker, faint anastomosing striae on anterior ⅔, light Y-shaped area at middle of posterior margin. Mesonotal setae: posterior margin with longest pair nearest Y-shaped area, thinner pair lateral to longest, 2 shortest pairs near lateral angles of mesonotum, all acute. Two pairs of light maculae anterior and slightly lateral to thinner pair and within striated ⅔. Holotype with additional seta at right lateral angle of mesonotum.

Metathorax.—Yellow-brown. Metanotal pelta roughly quadrate with central pair of setae acute; about 10 well-demarcated PG posteromedial to central setae, more quadrate than dorsal posteromedial PG of head capsule; obliquely-oriented striae lateral and posterior to central setae; each anteromarginal corner with 3 minute acute setae in close trianglar pattern; 3 striae extending posteriorly from middle ⅓ of posterior margin; dark transverse margins lateral to 3 posteromedial striae and lateral to central setae. Metanotum posterior and lateral to pelta smooth; extreme lateral areas obscured by wings.

Wings.—Type series completely brachypterous. Fore wing with 1 basal short acute and 3 more distal long enlarged setae near costal edge. Hind wings obscured.

Fore leg.—Coxa with 1 major enlarged seta, 1 small acute seta dorsomedial to major seta, 3 small acute setae anteroventral to major seta. Tibia and tarsus generally yellow-brown, femur more brownish than tibia; coxa brown; trochanter yellow. Femur with about 20 well-demarcated transverse striae on both ventral and dorsal surfaces; about 32 dorsal and 24 ventral short acute setae, straight to slightly curved. Tibia with poorly-demarcated transverse striae; about 30 dorsal and 24 ventral short acute setae, setae on distal ½ longer than on basal ½. Tarsus with about 8 acute setae on both dorsal and ventral surfaces, including short thicker seta basal to inner acutely-rounded spur.

Middle and hind legs.—Generally yellow-brown, femur slightly darker than tibia. Setae acute: middle leg with about 40 femoral, fewer on inner than outer side, 50 tibial, 10 tarsal; hind leg with about 30 femoral, fewer on inner than outer side, 60 tibial, 10 tarsal. About 15 dorsal femoral striae, tibial striae more prominent than on fore tibia.

Abdominal color.—Segment II yellow, almost as light as antennal segment VIII; III yellow anteriorly, brown posteriorly; IV–V dark yellow-brown; VI–IX lighter than V; X generally yellow-brown, lighter along basal margin and in distal ½.

Abdominal terga I–VII.—Pelta of I: anterior extension roughly quadrate with random pattern of weak striae; base with weak striae more closely spaced; lateral wings small, generally smooth. Setae of I: 1 sublateral short acute pair, 1 lateral long pair with enlarged apices, 1 short acute pair just anterior to enlarged setae.

Setae of II: longest pair enlarged at apices, posterolateral; second longest pair acute, lateral to longest; 3 short acute pairs, anterolateral to longest, anterior to longest, and submedial. Pattern shared by III–VII: P2 and P4 long with enlarged apices; P3 short, acute, anteromedial to P4; M1 submedial, short, acute; M3 short, acute, anterior to P3. Weak sparse striation on II–VII. Anterior margin of III–VII: no setae, 1 pair of lateral pores. Wing-holding setae: P1 with greatest curvature on IV–VI, barely sigmoid on III; M2 barely curved on III–IV, slightly sigmoid on V–VI.

Abdominal terga VIII–IX.—Setal pattern different from III–VII. Posterior ⅓ of VIII: P1 slightly curved, blunt; P2–P3 shorter, acute; P2 posterior to line connecting P1 and P4; P3 just medial to P4; P4 long, with enlarged apex. Middle ⅓ of VIII: M1 shortest, acute, submedial; 1 minute pair of light spots between M1; 1 pair of pores anterior to M1. Anterior ⅓ of VIII: no setae, 1 pair of lateral pores, weak sparse striation. Posterior ⅓ of IX: P1 and P4 long, with enlarged apex; P2 ⅔ as long as P4, acute; P3 shortest, acute, anterolateral to P2. 1 pair of sublateral pores anterior to setae. No setae on anterior ⅔. Anterior ⅓ of IX: 1 pair of lateral pores, weak sparse striation.

Segments X–XI.—Setae of X: 1 minute acute pair between dorsal posterolateral pores, 1 minute acute ventroposterior pair. X: 1 dorsal anterolateral pair of pores; 9 longitudinal rows of scales, about 8 scales/row. Setae of XI: 1 unpaired medi-odorsal (U) and 9 pairs (XI1–XI9); U short, highly curved, acute; XI1, XI4, XI6, longest, slightly enlarged apices; XI2, XI5, XI8–9, highly curved, acute, shorter than XI1, XI4, XI6; XI3 and XI7 shortest, acute.

Measurements of holotype (allotype).—L = length, W = width. Measurements are in microns. Antennal segments: L of I, 47(41); W of I, 38(33); L of II, 58(53); W of II, 32(25); L of III, 82(70); W of III, 28(25); L of IV, 78(68); W of IV, 26(23); L of V, 74(64); W of V, 25(22); L of VI, 58(53); W of VI, 23(20); L of VII, 46(40); W of VII, 20(18); L of VIII, 43(37); W of VIII, 14(12). Head capsule: L, 199(177); frontal W, 77(68); ocular W, 117(101); postocular W, 94(88); cheek W, 129(115); subbasal W, 122(108); basal W, 129(113); postocular seta, 70(51). Prothoracic W: 207(188). Prothoracic setae: AA, 77(55); M, 83(65); OE, 83(63); OP, 82(69). Fore wing L distal to subbasal setae: 33(26). Abdominal segments: W of IV, 321(217); L of X, 129(95); basal W of X, 69(56); distal W of X, 33(29); seta IXP1, 114(78); seta IXP4, 102.

Measurements of type series.—Measurements include holotype and allotype and are stated as follows: mean ± standard deviation, N = number of specimens measured. Females are first, males are in parentheses. Antennal segments: L of III, 81.5 ± 2.50, N9 (73.0 ± 3.58, N7); W of III, 26.8 ± 0.91, N9 (24.5 ± 0.56, N7); L of IV, 75.8 ± 2.19, N8 (68.5 ± 3.32, N7); W of IV, 26.5 ± 0.77, N8 (23.9 ± 0.47, N7). Head capsule: L, 198.0 ± 6.26, N9 (179.9 ± 3.48, N7); frontal W, 75.2 ± 2.06, N9 (68.6 ± 1.54, N7); ocular W, 118.0 ± 2.92, N9 (104.0 ± 2.38, N7); postocular W, 97.2 ± 2.02, N9 (85.3 ± 2.16, N7); cheek W, 131.9 ± 3.52, N9 (116.0 ± 3.65, N7); subbasal W, 123.6 ± 5.41, N9 (109.9 ± 4.81, N7); basal W, 130.8 ± 5.74, N9 (116.0 ± 4.24, N7). Pronotal W, 211.9 ± 11.57, N8 (195.0 ± 7.72, N6). Fore wing L distal to major subbasal setae, 25.2 ± 5.55, N9 (26.7 ± 5.96, N7). Abdominal segments: W of IV, 320.4 ± 16.46, N9 (219.0 ± 17.76, N7); L of X, 121.6 ± 4.77, N9 (98.3 ± 3.27, N7); basal W of X, 67.4 ± 1.50, N9 (57.0 ± 1.07, N7); distal W of X, 33.1 ± 0.93, N9 (29.4 ± 0.45, N7).

Male glandular areas.—Abdominal segment VIII of all ♂ paratypes with glandular area having straight anterior and posterior borders, occupying complete width of VIII, and ending within about 20 μ of anterior and posterior edges of sternite.

Types and type locality.—♀ (holotype), ♂ (allotype), 8 ♀ and 6 ♂ (paratypes). Brazil, Santa Catarina, Seara, 27°09'S, 52°15'W, January 1960, Fritz Plaumann coll. All deposited in Illinois Natural History Survey, Champaign, except for 1 ♀ paratype deposited in Senckenberg Museum, Frankfurt-am-Main, West Germany.

Etymology.—From Latin *marginatus* = margined, in reference to dark cuticular posterior margins of metanotal pelta (Fig. 4).

Terthrothrips peltatus **Hood**

Terthrothrips peltatus Hood, 1957: 146–147; Mound, 1976: 32, 62; Mound, 1977: 237–238, 242.

New record.—Brazil, Santa Catarina, Seara, 27°09'S, 52°15'W, January 1960, 2 mac ♀, 9 br ♀, 6 br ♂.

This species displayed intermediate wing lengths between the completely fringed macropterous and approximately 100 μ-long brachypterous forms at both sites. Hood (1957) referred to some intermediate wing lengths as micropterous, but the almost continuous gradient in wing lengths for specimens in this tribe led me to refer to all forms with less than fully-developed wings as brachypterous. For example, the 9 brachypterous females of *T. peltatus* from Seara had the following mean ± standard deviation for the fore wing length distal to the major subbasal setae: 124.4 ± 66.16. This may be compared to the smaller deviation in the brachypterous females of *T. marginatus.*

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THE LARVAE AND PUPAE OF THREE PHYCITINE SPECIES (LEPIDOPTERA: PYRALIDAE) THAT OCCUR IN FLORIDA[1]

Larry R. Grimes and H. H. Neunzig

Department of Entomology, North Carolina State University, Raleigh, North Carolina 27650.

Abstract.—The last stage larvae and the pupae of *Hypargyria slossonella* (Hulst), *Davara caricae* (Dyar), and *Sarasota plumigerella* Hulst are described. Larvae of these species were collected from *Hippocratea volubilis* L., *Carica papaya* L. and *Coccoloba uvifera* (L.), respectively. Information on feeding behavior and seasonal occurrence of the 3 species is included.

Heinrich's 1956 revision of the Phycitinae included many species found in tropical America. We provide information on the immature stages of three of these phycitines that occur in the United States in southern Florida. Of these, *Hypargyria slossonella* (Hulst) feeds as a larva on *Hippocratea volubilis* L., and appears to be of no economic importance; however, one of the others, *Davara caricae* (Dyar) is a pest of the fruit of papaya (*Carica papaya* L.) (Bruner et al., 1945), and the third, *Sarasota plumigerella* Hulst, feeds on the leaves, flowers, and seed capsules of sea grape (*Coccoloba uvifera* (L.)), which is sometimes used in ornamental plantings.

Materials and Methods

Insects included in this study were all collected as larvae from host plants. Notes were made of feeding damage at the time larvae were collected, and photographs of feeding injury were taken either in the field or upon returning to the laboratory. A small number of the last stage larvae present at the time of collection were killed in hot water, and subsequently fixed and preserved in Kahle's fluid; the remaining larvae were reared to obtain pupae and adults. Pupae were fixed and preserved like the larvae.

Larvae were reared in either Ziplock® plastic bags or large plastic refrigerator trays containing part of the host plant and usually a small amount of moist sand. Following adult emergence, genitalia slides were prepared of representative specimens and identifications made following Heinrich (1956).

Information on the color of living larvae is given in parentheses. All other color descriptions are based on preserved larvae and pupae. The setal nomenclature follows Hinton (1946) for larvae, and Neunzig and Merkel (1967) for pupae.

Measurements are for preserved specimens. The widths of the larval head

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capsule, larval body and pupal body were measured at the widest points. Lengths of pupae may be somewhat exaggerated because abdominal segments tend to expand during fixation.

All the material is deposited in the NCSU Insect Collection, Raleigh.

***Hypargyria slossonella* (Hulst)**

Salebria slossonella Hulst, 1900a: 170.

Last stage larva (Figs. 1, 7, 10).—Length 13.2–17.0 mm, avg. 15.5 mm; width 1.9–2.2 mm, avg. 2.1 mm.

Color.—Head pale yellowish-brown with pale brown to brown tonofibrillary platelets (faint green undertones and brown to black platelets in living larva); labrum yellowish-brown; antennae yellowish-brown; mandibles mostly yellowish-brown, reddish-brown distally; spinneret pale brown.

Prothoracic shield pale whitish-yellow to pale yellowish-brown, with some darker markings, to mostly brown (pale brown to mostly black with yellowish-green to lime green undertones posteromesally in living larva); most pigmentation on ventral part of shield represents anterior part of sst and est stripes.

Prespiracular plates pale yellowish-brown with brown platelets and sometimes other maculation (pale brown with green undertones to mostly black in living larva).

Remainder of prothorax mostly yellowish-white (mostly pale yellowish-white to green in living larva); sst and est stripes, when present, dark brown to black (purple to dark brown or black in living larva).

Meso- and metathorax and abdomen mostly yellowish-white, sometimes with faint, fragmented red md and sd stripes (green to reddish-brown md and sd stripes and pale yellow to yellow overlap of segments dorsally in living larva) and dark brown to black sst and est stripes (sst and est stripes dark reddish-brown or purple to black in living larva) (interstitial areas and area ventral to stripes in living larva pale yellow, yellowish-green, or lime green, sometimes mottled with red).

Mesothoracic SD1 pinacula rings dark brown (black in living larva).

Eighth abdominal segment SD1 pinacula rings dark brown (dark brown to black in living larva).

Thoracic legs mostly pale brownish-yellow (brown and pale brown in living larva).

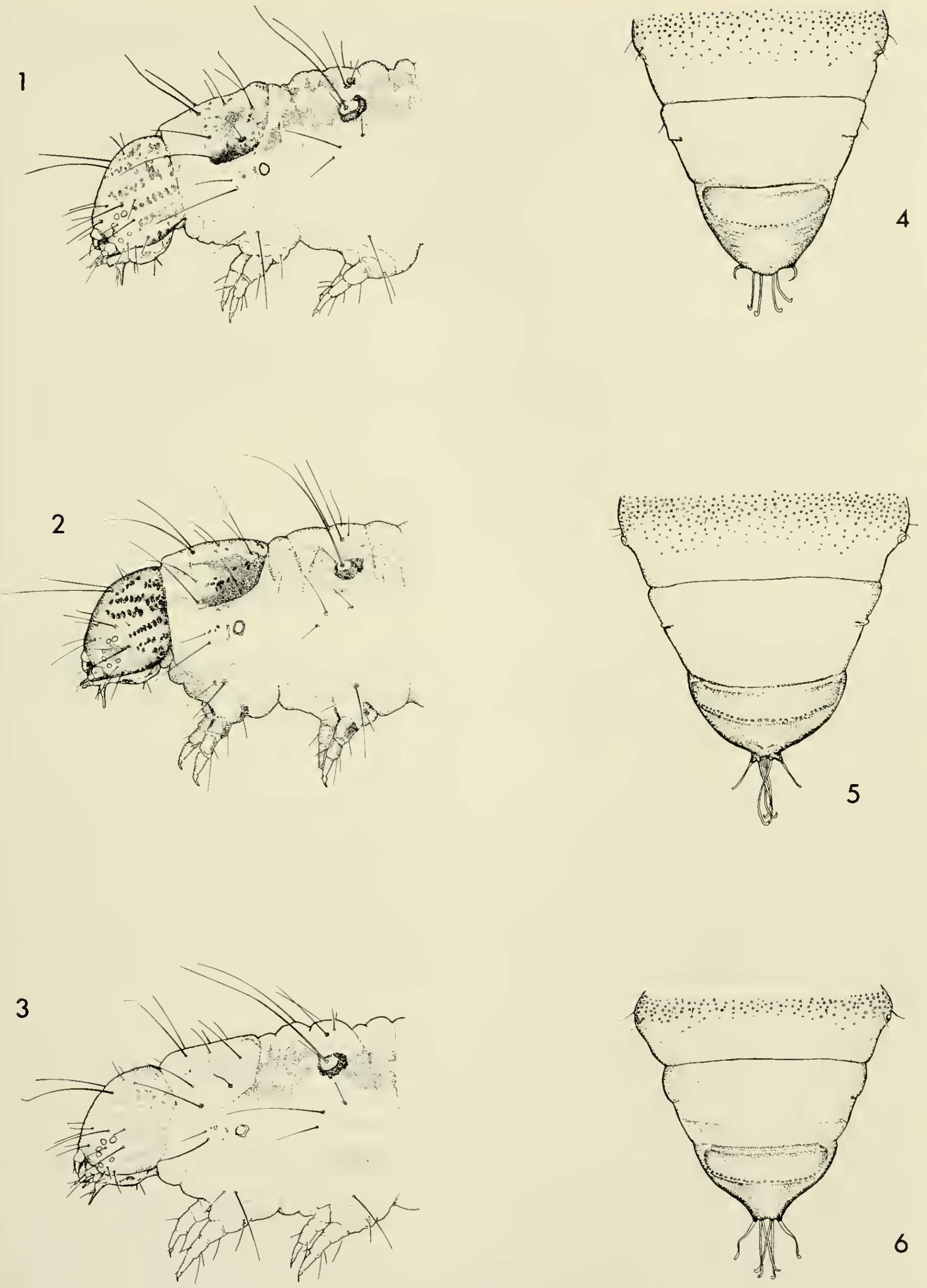
Anal shield whitish-yellow to brownish-yellow with darker platelets and maculation (sometimes with broad black maculation laterally in living larva).

Pinacula pale brown to dark brown (D and SD1 pinacula sometimes dark reddish-brown to black, relatively large and distinct in living larva).

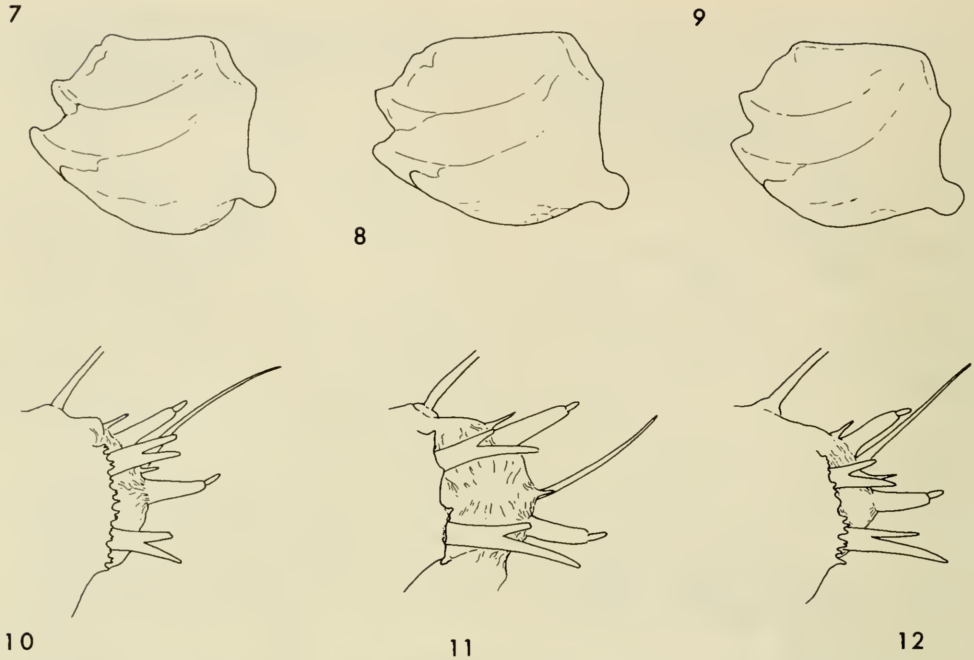
Tonofibrillary platelets on remainder of body indistinct.

Head.—Width 1.25–1.55 mm, avg. 1.47 mm; surface slightly sculptured; adfrontals reach ca. ⅔ distance to epicranial notch; AF2 setae usually at level of forking of epicranial suture; AF2 setae usually slightly below imaginary line between P1 setae; P1 setae further apart than P2 setae; labrum shallowly emarginate; mandibles simple, distal teeth distinct; mesal sensilla trichodea forked with 2 teeth; spinneret long, ca. 7× as long as medial breadth.

Prothorax.—Shield with distance between D1 setae less than distance between XD1 setae, on each side distance between SD1 and SD2 setae greater than distance



Figs. 1–6. 1–3, Lateral view of head, prothorax, and mesothorax of last stage larvae. 1, *Hypargyria slossonella.* 2, *Davara caricae.* 3, *Sarasota plumigerella.* 4–6, Dorsal view of caudal segments of pupae. 4, *H. slossonella.* 5, *D. caricae.* 6, *S. plumigerella.*



Figs. 7–12. 7–9, Right mandible of last stage larva in mesal view. 7, *Hypargyria slossonella.* 8, *Davara caricae.* 9, *Sarasota plumigerella.* 10–12, Distal part of left maxilla of last stage larva in dorsal view. 10, *Hypargyria slossonella.* 11, *Davara caricae.* 12, *Sarasota plumigerella.*

between SD1 and XD2 setae, distance between D1 and D2 setae greater than distance between D1 and XD1 setae, and XD2, SD1 and SD2 form an acute angle; prothoracic L setae nearly vertical.

Meso- and metathorax.—SD1 pinacula rings of mesothorax well developed; on each side of mesothorax and metathorax D1 and D2 pinacula fused and SD1 and SD2 pinacula usually fused; SD1 setae on mesothorax ca. 2× as long as SD1 setae on metathorax.

Abdomen.—Anterior segments with D2 setae ca. 0.8 mm long, D1 setae ca. 0.5× as long as D2 setae; distance between D1 and D2 setae on each side of segments 3–6 slightly less than distance between D1 and SD1; segments 1–7 lack pinacula rings at base of SD1 setae; crochets in a tri- to biordinal ellipse, number on prolegs of segments 3, 4, 5, 6 and anal segment 66–84, 68–86, 60–84, 70–94, and 56–90, respectively; spiracles of segment 8 with vertical diam. ca. 2× those of segment 7, with horizontal diam. ca. 1.1× distance between L1 and L2 setae; SD1 rings of segment 8 relatively broad and complete; SD1 setae of segment 8 ca. 1.8× as long as SD1 setae of segment 7; 2 SV setae on each side of segments 8 and 9; on each side of segment 9, D1 usually about equidistant from D2 and SD1; all pinacula separate.

Pupa (Fig. 4).—Length 7.3–9.2 mm, avg. 8.3 mm; width 2.2–2.5 mm, avg. 2.4 mm.

Color.—Yellowish-brown to pale reddish-brown; 10th abdominal segment dark reddish-brown; gibba mostly dark reddish-brown.

Head.—Slightly wrinkled; pilifers usually narrowly separated by labial palpi; length of maxillae 4.7–5.4 mm, avg. 5.0 mm; setae minute.

Thorax.—Prothorax slightly wrinkled; spiracles present, mesothorax slightly wrinkled, without punctures; metathorax slightly wrinkled with ca. 45 punctures on each side of meson, extending ca. ⅔ distance from meson to lateral margin; setae minute.

Abdomen.—Segments 1–4 with proximal ⅔ densely punctate dorsally; punctures of 4 not reaching spiracles; segments 5–7 with distinct punctures encircling proximal ½ to ⅔ of segments; spiracles elliptical, slightly raised, length ca. 0.06 mm; segment 4 with D1, SD1 and L2 setae; segments 5–7 with D1, SD1, L2, and SV2 setae; segment 8 with L2 setae; segments 9 and 10 without setae; gibba 3.5–3.7× as wide as median length; caudal margin of gibba with small punctures; cremastral "spines" consisting of 2 relatively robust, hooked, mesal "spines," 2 shorter, slender, simple adjacent "spines," and 2 lateral, relatively robust, short, simple "spines."

Material examined.—Florida, Upper Key Largo, 6 larvae, *Hippocratea volubilis,* 21-V-1978, L. R. Grimes; 10 larvae, *H. volubilis,* 20-V-1979, L. R. Grimes, 10 pupae reared from additional larvae, same data.

Distribution.—*H. slossonella* is found in the United States only in southern Florida. It apparently also occurs in Mexico in the state of Oaxaca (Heinrich, 1956).

Biology.—Like most tropical insects, *H. slossonella* has several generations each year. Heinrich (1956) listed February, March, and April as months in which adults were collected in southern Florida. During the present study, early to half-grown larvae were collected in late May, and these became adults in June and July. Probably additional generations are produced in late summer and fall.

Small larvae consume the upper or lower epidermis and mesophyll of leaves of the liana *Hippocratia volubilis* L. As the larvae develop they form small, loose protective structures on the host plant from silk, frass, and surrounding leaves. The initial external evidence of larval feeding consists of pale areas on the outer surface of the leaves (Figs. 13, 14). Late stage larvae silk together larger clusters of whole, partially eaten, and dead leaves. Several larvae frequently inhabit each enclosure. Larger, somewhat more tightly constructed, frass and silk tubes are made by each larva (Fig. 15), and entire parts of leaves are consumed, particularly the leaf margins (Fig. 15). Pupation occurs primarily in the soil.

***Davara caricae* (Dyar)**[2]

Ulophora caricae Dyar, 1913: 218.

Last stage larva (Figs. 2, 8, 11).—Length 12.5–15.2 mm, avg. 13.9 mm; width 1.9–2.4 mm, avg. 2.2 mm.

Color.—Head yellowish-brown with dark brown to black tonofibrillary platelets and brown to dark brown broadly distributed suffusions, including a patch associated with the ocelli (suffusions sometimes black in living larva); labrum yel-

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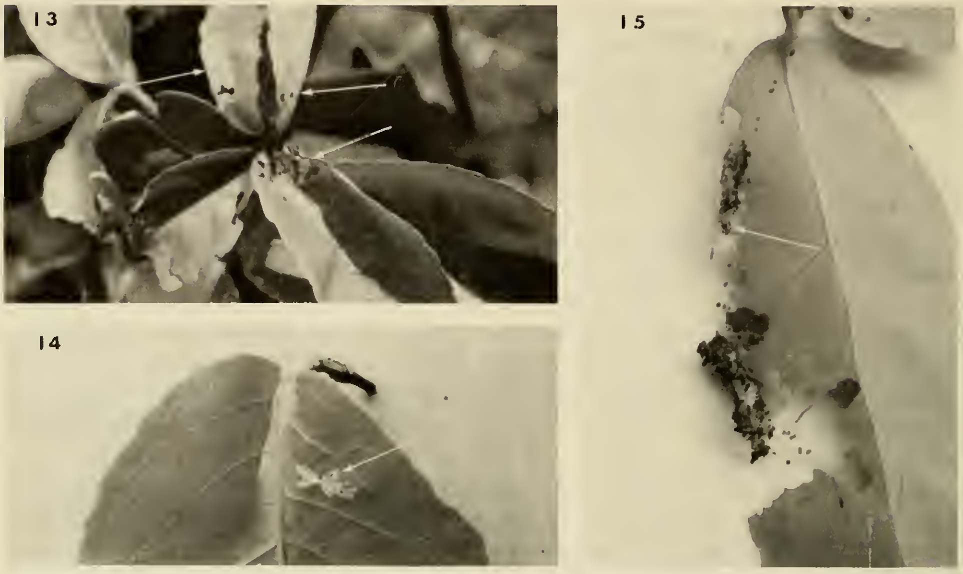
[2] According to Heinrich (1956), *Davara caricae* (Dyar) is probably a junior synonym of *Davara columnella* (Zeller).



Figs. 13–15. 13, Injury (arrows) to terminal leaves of *Hippocratea volubilis* by small larvae of *Hypargyria slossonella.* 14, Feeding damage (arrow) to leaf of *H. volubilis* by early stage larva of *H. slossonella.* 15, Feeding injury, frass and silk enclosures, and larva (arrow) of *H. slossonella* (*H. volubilis* leaf).

lowish-brown; antennae light brown to brown (dark brown to black in living larva); mandibles yellowish-brown, reddish-brown distally; spinneret pale brown.

Prothoracic shield mostly yellowish-brown dorsally and mostly dark brown (black in living larva) ventrally; some dark brown (black in living larva) along dorsomesal margins and dark brown (black in living larva) platelets; pigmentation in ventral areas of shield forming anterior part of sst and est stripes.

Prespiracular plates mostly yellowish-brown with dark brown (black in living larva) platelets and other dark brown maculation.

Remainder of prothorax mostly yellowish-white (living larva whitish-yellow sometimes suffused with red); sst and est stripes dark brown to black; usually dark brown to black anteroventrally.

Meso- and metathorax and abdomen mostly yellowish-white with relatively indistinct brown md and sd stripes (sd stripe fragmented and sometimes very faint) (md stripe purplish-brown and sd stripe reddish-brown mottled with purplish-brown in living larva) and dark brown partially fused sst and est stripes (sst and est stripes dark purplish-brown in living larva) (interstitial areas and region ventral to stripes in living larva whitish-yellow, sometimes mottled with red).

Mesothoracic SD1 pinacula rings dark brown (black in living larva).

Eighth abdominal segment SD1 pinacula rings dark brown (dark brown to black in living larva).

Thoracic legs mostly brown to dark brown (sometimes black in living larva).

Anal shield brownish-yellow with darker platelets and maculation.

Pinacula brown to dark brown (sometimes black in living larva), relatively small.

Tonofibrillary platelets on remainder of body indistinct.

Head.—Width 1.05–1.22 mm, avg. 1.8 mm; surface slightly sculptured; adfrontals reach ca. ⅔ distance to epicranial notch; AF2 setae usually near forking of epicranial suture; AF2 setae below an imaginary line between P1 setae; P1 setae further apart than P2 setae; labrum distinctly emarginate; mandibles simple, distal teeth distinct; mesal sensilla trichodea with 2 teeth; spinneret long, ca. 6.5× as long as median breadth.

Prothorax.—Shield with distance between D1 setae less than distance between XD1 setae, on each side distance between SD1 and SD2 setae greater than distance between D1 and XD2 setae, distance between D1 and D2 greater than distance between D1 and XD1 setae, and XD2, SD1, and SD2 setae form an acute angle; prothoracic L setae nearly vertical.

Meso- and metathorax.—SD1 pinacula rings of mesothorax well developed; on each side of mesothorax and metathorax D1 and D2 pinacula fused and SD1 and SD2 pinacula fused; SD1 setae on mesothorax ca. 2× as long as SD1 setae on metathorax.

Abdomen.—Anterior segments with D2 setae ca. 0.7 mm long, D1 setae ca. 0.8× as long as D2 setae; distance between D1 and D2 setae on each side of segments 3–6 slightly less than distance between D1 and SD1; segments 1–7 lack pinacula rings at base of SD1 setae; postspiracular tonofibrillary platelets relatively well developed on segments 3–6; crochets in a tri- to biordinal ellipse, numbers on prolegs of segments 3, 4, 5, 6, and anal segment 50–58, 52–66, 52–60, 54–66, and 42–48, respectively; spiracles of segment 8 with vertical diam. ca. 1.7× those of segment 7, with horizontal diam. ca. 1.2× distance between L1 and L2 setae; SD1 pinacula rings of segment 8 relatively broad and complete; SD1 setae of segment 8 ca. 1.5× as long as SD1 setae of segment 7; 2 SV setae on each side of segments 8 and 9; on each side of segment 9, D1 distinctly closer to SD1 than to D2; all pinacula separate.

Pupa (Fig. 5).—Length 7.0–8.4 mm, avg. 8.0 mm; width 2.3–2.5 mm, avg. 2.4 mm.

Color.—Yellowish-brown to pale reddish-brown; 10th abdominal segment dark reddish-brown; gibba mostly dark reddish-brown.

Head.—Slightly uneven; pilifers not separated by sclerite of labial palpi; length of maxillae 5.0–5.4 mm; avg. 5.2 mm; setae minute.

Thorax.—Prothorax wrinkled; spiracles present; mesothorax wrinkled, without punctures; metathorax slightly wrinkled with ca. 60 punctures on each side of meson extending about ⁴⁄₅ distance from meson to lateral margin; setae minute.

Abdomen.—Segments 1–4 with proximal ⅔ densely punctate dorsally; punctures of 4 almost reaching spiracles; segments 5–7 with distinct punctures encircling proximal ½ to ⅔ of segments; spiracles elliptical, slightly raised, length ca. 0.07 mm; segment 4 with D1, SD1, and L2 setae; segments 5–7 with D1, SD1, L2, and SV2 setae; segments 8, 9, and 10 without setae; gibba 4.5× as wide as median length; caudal margin of gibba with small punctures; cremastral "spines" consisting of 4 centrally located, posteriorly directed, relatively robust "spines" with strongly curled tips, and 2 outer postero-laterally directed, relatively robust, slightly hooked "spines"; outer "spines" ca. ½–⅔ length of inner "spines."

Material examined.—Florida, Plantation Key, 12 larvae, *Carica papaya,* 16-V-1979, L. R. Grimes, 2 pupae reared from additional larvae, same data.

Distribution.—In the United States, *D. caricae* occurs only in southern Florida (Heinrich, 1956). The species also is common in Central and South America.

Biology.—Adults have been collected most months of the year in southern Florida and in Central and South America (Heinrich, 1956; Kimball, 1965). Eggs are usually placed on the developing fruit, or sometimes on other parts, of papaya (*Carica papaya* L.). Small larvae feed primarily on the leathery surface of the fruit, usually covering themselves with small amounts of silk and frass. Preferred sites for feeding are in crevices between fruits, between fruits and stems, and between the peduncle and stem. Frequently, several larvae feed together, and, in time, thick mats of frass collect on the fruits or other parts of the host plant, concealing the larvae (Figs. 16, 18). Late instars carve shallow chambers in the surface of the fruit (Fig. 17). Larvae apparently seldom enter the fleshy inner pulp. Pupation occurs in the soil.

***Sarasota plumigerella* Hulst**

Sarasota plumigerella Hulst, 1900b, 222.

Last stage larva (Figs. 3, 9, 12).—Length 8.5–11.5 mm, avg. 10.2 mm; width 1.6–2.0 mm, avg. 1.8 mm.

Color.—Head yellowish-white to yellowish-brown with pale brown tonofibrillary platelets (yellowish-brown with pale brown to brown platelets and sometimes faint green undertones in living larva); labrum yellowish-brown; antennae yellowish-brown; mandibles yellowish-brown, reddish-brown distally; spinneret pale brown.

Prothoracic shield yellowish-white to yellowish-brown usually with pale brown to dark brown patch (sst and est stripe) laterally, brown to dark brown usually at base of SD setae, and sometimes brown platelets and other small amounts of brown maculation (yellowish-brown with pale brown to black maculation in living larva).

Prespiracular plates yellowish-white to yellowish-brown with brown platelets.

Remainder of prothorax mostly yellowish-white, sometimes with red mottling; sst and est stripes dark brown (pale brown to dark reddish-brown or black in living larva).

Meso- and metathorax and abdomen mostly yellowish-white, sometimes with faint to moderately distinct, usually fragmented, pale brown to brown md and sd stripes (stripes pale to dark reddish-brown in living larva) and pale brown to dark brown, strongly fused, sst and est stripes (stripes pale brown to dark reddish-brown to black in living larva) (interstitial areas and area ventral to stripes, in living larva, whitish-yellow, sometimes pink or mottled with pink).

Mesothoracic SD1 pinacula rings dark brown (black in living larva).

Eighth abdominal segment SD1 pinacula rings dark brown (sometimes black in living larva).

Thoracic legs mostly pale brownish-yellow (brown and pale brown in living larva).

Anal shield brownish-yellow, sometimes heavily suffused with dark brown (suffusions sometimes black in living larva).

Pinacula pale brown to dark brown (some pinacula sometimes black in living larva).

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Figs. 16–20. 16, Papaya (*Carica papaya*) fruit and accumulated frass and silk of larva of *Davara caricae*. 17, Last stage larva of *D. caricae* and characteristic shallow feeding injury on surface of fruit of papaya. 18, Accumulations of frass and silk of larva of *D. caricae* on trunk of papaya. 19, Fruit of sea grape bored into by larvae of *S. plumigerella*. 20, Cluster of fruit of sea grape (*Coccoloba uvifera*) with accumulations of frass and silk of larvae of *Sarasota plumigerella* along raceme.

Tonofibrillary platelets on remainder of body indistinct.

Head.—Width 0.99–1.19 mm, avg. 1.12 mm; surface rugulose; adfrontals reach ca. ⅔ distance to epicranial notch; AF2 setae usually at level of forking of epicranial suture; AF2 setae usually on or slightly below imaginary line between P1 setae; P1 setae further apart than P2 setae; labrum shallowly emarginate; mandibles simple, distal teeth distinct; mesal sensilla trichodea, with 2 teeth; spinneret long, ca. 6.5× as long as median breadth.

Prothorax.—Shield with distance between D1 setae less than distance between XD1 setae, on each side distance between SD1 and SD2 setae greater than distance between SD1 and XD2 setae, distance between D1 and D2 setae greater than distance between D1 and XD1, and XD2, SD1, and SD2 form an acute angle; prothoracic L setae nearly vertical.

Meso- and metathorax.—SD1 pinacula rings of mesothorax well developed; on each side of mesothorax and metathorax D1 and D2 pinacula usually separate and SD1 and SD2 usually fused; SD1 setae on mesothorax ca. 2× as long as SD1 setae on metathorax.

Abdomen.—Anterior segments with D2 setae ca. 0.5 mm long, D1 setae ca. 0.8× as long as D2 setae; distance between D1 and D2 setae on each side of segments 3–6 greater than distance between D1 and SD1; segments 1–7 lack pinacula rings at base of SD1 setae; crochets in a triordinal ellipse, number on prolegs of segments 3, 4, 5, 6, and anal segment 64–66, 62–66, 64–66, 66–74, and 66–70, respectively; spiracles of segment 8 with vertical diam. ca. 2× those of segment 7, with horizontal diam. ca. 1.1× distance between L1 and L2 setae; SD1 rings of segment 8 relatively broad and complete; SD1 setae of segment 8 ca. 1.9× as long as SD1 setae of segment 7; 2 SV setae on each side of segment 9; D1 usually closer to SD1 than to D2; all pinacula separate.

Pupa (Fig. 6).—Length 7.3 mm; width 2.1 mm.

Color.—Yellowish-brown to pale reddish-brown; 10th abdominal segment dark reddish-brown; gibba mostly dark brown.

Head.—Slightly wrinkled; pilifers separated by labial palpi; length of maxillae 4.4 mm; setae minute.

Thorax.—Prothorax slightly wrinkled; spiracles present; mesothorax slightly wrinkled, without punctures; metathorax slightly wrinkled with ca. 40 punctures on each side of meson, extending ca. ¾ distance from meson to lateral margin; setae minute.

Abdomen.—Segments 1–4 with proximal ½ to ⅔ densely punctate dorsally; punctures of 4 not reaching spiracles; segments 5–7 with distinct punctures encircling anterior ½ to ⅔ of segments; spiracles elliptical, slightly raised, length ca. 0.05 mm; segment 4 with D1, SD1, and L2 setae; segments 5–7 with D1, SD1, L2 and SV2 setae; segments 8, 9, and 10 without setae; gibba 4× as wide as median length; caudal margin of gibba with row of small punctures; cremastral "spines" consisting of 4, centrally located, relatively long, closely associated, hooked, "spines" and 2 outer, curved, almost as long, similar "spines."

Material examined.—Florida.—Lower Matecumbe Key, 3 larvae, *Coccoloba uvifera,* 23-V-1981, L. R. Grimes; 1 pupa reared from an additional larva, same data.

Distribution.—*S. plumigerella* apparently occurs only in southern Florida (Heinrich, 1956).

Biology.—According to Heinrich (1956) and Kimball (1965), adults of *S. plumigerella* have been collected only in March and April. Obviously, more than one generation occurs each year, however, for during the present study larvae were collected in May, and adults were reared from some of these larvae in June.

Host plants recorded for *S. plumigerella* are seagrape (*Coccoloba uvifera* (L.)) and white mangrove (*Laguncularia racemosa* Gaertner). Leaves, flowers, and fruit may be eaten. On seagrape, larvae frequently feed on the fruit, boring into and usually completely hollowing out individual berries (Fig. 19). A silk and frass covering, which conceals the larva, is laid down along the racemes and around the base of the developing achenes (Fig. 20). Pupation occurs in the soil.

ACKNOWLEDGMENTS

Host plant determinations were made by J. W. Hardin of the Botany Department, North Carolina State University (scientific names of host plants follow Long and Lakela (1971)).

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ETHOLOGY OF *NEOCERDISTUS ACUTANGULATUS* (DIPTERA: ASILIDAE) IN SOUTH AUSTRALIA[1,2]

Robert J. Lavigne

Entomology Section, University of Wyoming, Box 3354, University Station, Laramie, Wyoming 82071.

Abstract.—A field study of the ethology of *Neocerdistus acutangulatus* in South Australia revealed the following facts. Prey taken by *N. acutangulatus* represented seven insect Orders, suggesting opportunistic euryphagy, although both sexes showed a predilection for Diptera. Mating, without prior courtship, took place in the tail-to-tail position. Eggs were deposited singly in the soil.

The present paper is the third in a series dealing with the ethology of South Australian robber flies. The first paper dealt with *Neoitamus vittipes* (Macquart) (Lavigne, 1982a) and the second with *Neoscleropogon elongatus* (Macquart) (Lavigne, 1982b).

While on sabbatical at the Waite Agricultural Research Institute (November 1978–May 1979), I investigated the behavior of *Neocerdistus acutangulatus* (Macquart) in a horse paddock owned by L. Walter, one km east of One Tree Hill, SA during the period April 5 to 30, 1979. One Tree Hill is a small village, east of Elizabeth, near Para Wirra National Park.

Published records of the occurrence of *Neocerdistus acutangulatus* are few. Macquart (1847), describing it in the genus *Asilus,* gave for the locality both "Nouvelle-Hollande" and "Tasmanie." For some reason Hardy changed the spelling of the species name in 1926 so that it read *acutangularis.* He retained this misspelling in his later papers and the error has been repeated in subsequent literature. In the same paper Hardy (1926), established *Neoitamus abditus* White as a synonym: "There is no species from Tasmania that fits Macquart's description so well as White's *N. abditus,* so there can be little doubt concerning the correctness of this synonymy." On this basis, Hardy provided the following distribution: "Tasmania, Victoria and New South Wales, February to April." In a later paper (1935) however, he stated "It is possible that there is more than one species incorporated under this name . . . . the name, however, is generally applied to the Tasmanian form, which also occurs in the vicinity of Melbourne. If the name be applicable to a species from New South Wales, and that may possibly be distinct,

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Fig. 1. Horse paddock, one km east of One Tree Hill, SA, in which a population of *Neocerdistus acutangulatus* was studied.

it will be necessary to revert to White's specific name for the present form." The species whose behavior is described in this paper was identified by Mr. Gregory Daniels, the current authority on Australian Asilidae.

In addition to the South Australian population, on which this paper is based, the author, during a trip to Canberra, ACT and return, collected the species 5.4 km SW of Stawell, Victoria in the Grampians (10.iv.79) and in Back Street State Forest, 19 km east of West Wyalong, NSW (14.iv.79). The Grampians population existed in a habitat similar to that described for the South Australian population. In Back Street State Forest, the asilids were observed foraging from leaves and dead limbs of *Acacia* sp. and *Eucalyptus* sp. at heights up to three meters.

The dominant vegetation in the SA horse paddock was *Eucalyptus fasciculosa* F. Muell. (pink gum) with an understory of grass, primarily *Stipa* sp. and *Pentaschistis thunbergii* (Kunth) Stapf, a bunch grass. Occasional patches of the shrub, *Daviesia ulicina* Sm. were present in the area (Fig. 1).

The paddock was triangular, encompassing a fenced area of 30.5 km^2. Based on observations made on random transects, the population of asilids was estimated to be 75 to 100 individuals. The sex ratio ($\bar{x}$ 1:1) was obtained intermittently throughout the study by counting males and females observed during standardized time periods. Males dominated the population in early April, whereas females tended to dominate in late April.

The population was widely distributed although there appeared to be a greater density of asilids on and along a riding path which intersected the paddock. With the exception of activity associated with oviposition, almost all (88%) actions performed by *N. acutangulatus* were initiated on the surface of strips of fallen *Eucalyptus* bark.

The period during which adult asilids could engage in their behavioral patterns was most certainly constrained by factors of weather. On five of the 11 days the site was visited, there was rain in the morning hours (before 1000 h). On three additional days the morning sky was overcast, but cleared later in the day; however, on one of these days it began to rain about 1700 h. Some days there would be intermittent rain showers. Temperatures on site during periods of observation ranged from a high of 30°C (6.iv.79) to a low of 17°C (27.iv.79).

METHODS

Methods for gathering and analyzing ethological data on *N. acutangulatus* were the same as those described for *Neoitamus vittipes* (Macquart) in Lavigne (1982a).

FORAGING AND FEEDING

Perch sites, from which *N. acutangulatus* launched attacks on potential prey, were somewhat variable. Sand, surface debris, broken branches, and fallen *Eucalyptus* bark were all utilized; however, as indicated earlier most activities were initiated from fallen *Eucalyptus* bark. Exclusive of soil surface, heights where foraging individuals were observed varied from 15 to 61 cm.

All forage flights were directed at insects that were airborne, and varied in distance from 13 to 61 cm. While attempting forage flights, this species often became entangled in the vertical vegetation, primarily grass and thus failed to catch prey. Obviously the strategy of using large pieces of *Eucalyptus* bark, while excellent for mating purposes, reduces changes for prey capture since asilids must sometimes fly up through the vegetation to reach potential prey. Conversely, bibionid flies which comprised 20% of this asilid's diet, also used the bark as landing sites, thus making them particularly vulnerable. Curculionid beetles, with open elytra in flight, also were very vulnerable because of their slowness; these small beetles constituted an additional 15% of the diet of *N. acutangulatus.*

In all instances where feeding asilids were watched for extended periods of time, prey were manipulated at least once. Of the 12 feedings, 42% of the prey were manipulated once, 42%, twice and 16%, three times. Manipulation consisted of the asilid raising the anterior portion of the body, resting the apex of the fore and middle femora on the substrate and utilizing these same tarsi to change the position of the prey prior to reimpaling it. The hind legs were always used as stabilizers and to maintain position (Fig. 2). During feeding, soft bodied prey balloon, which is related to the injection of proteolytic enzymes and subsequent food pumping (Lavigne and Holland, 1969; Musso, 1968).

In the single instance where an entire feeding was recorded, the female landed with a tiny curculionid beetle impaled, following a 61 cm forage flight at 1426 h. Two minutes later, the beetle was manipulated and reimpaled on the asilid's proboscis. During the period 1435–1440 h, the asilid was harrassed several times by tiny black ants. Each time she would fly into the air, but would land again on the same piece of *Eucalyptus* bark, although at a different location. At one point upon relanding, she cleaned ovipositor, wings and left middle leg in that order. The female defecated at 1445 h and subsequently wiped her ovipositor on bark to clean it. At 1449 h she pushed the prey off her proboscis with her fore tarsi.

Once feeding is completed, the asilid's fore tarsi are used to push the prey's

Fig. 2. Mated pair of *Neocerdistus acutangulatus* with female manipulating unidentified bibionid (Diptera). Note the use of fore and midtarsi to reposition prey, while hindtarsi are used to maintain position.

Fig. 3. Same mated pair of *Neocerdistus acutangulatus* resting on fallen branch of *Eucalyptus fasciculosa.* Note how repositioned prey is held with the fore tarsi. Note also vertical position of male claspers encircling female's ovipositor.

Table 1. Relation between length of *Neocerdistus acutangulatus* and that of its prey.

	Predator length (mm)*			Prey length (mm)			No. prey measured	Mean ratio of predator: prey
Sex	Min.	Max.	Mean	Min.	Max.	Mean		
Male	8	11	9.5	1	6	2.96	51	3.2
Female	9.25	12.25	11.1	1	7	3.73	85	3.0
Combined	8	12.5	10.5	1	7	3.44	136	3.05

* 10 predators of each sex were measured from the One Tree Hill population.

exoskeleton off of its proboscis. Of 28 prey discards observed, 50% were accomplished on the feeding site, while the remainder occurred as the asilid flew, often during pursuit of a new prey item. In one instance, the asilid was observed to hover 7.5 cm from the feeding site while pushing the prey off its proboscis.

Prey Selection

Based on 136 measured prey, the "preferred" prey length was 3.44 mm, although the prey varied from 1 to 7 mm. Females were slightly larger than males (11.1 vs 9.5 mm) and captured, on the average, slightly larger prey (3.73 vs 2.96 mm) (Table 1). The mean predator to prey ratio for this species was 3.05, very close to that (2.9) for *Neoitamus vittipes* (Lavigne, 1982a). *N. vittipes,* while slightly larger ($\bar{x}$ 12.1 mm) than *N. acutangulatus,* also takes slightly larger prey ($\bar{x}$ 4.2 mm).

While males captured representatives of five Orders, females took representatives of seven Orders, indicating that this species is euryphagic, as defined by Lavigne and Holland (1969). The most intense predation by both sexes, however, was on members of the Order Diptera (Table 2). This predilection for Diptera is shared in somewhat greater degree by at least three species of *Neoitamus* (Lavigne, 1982a). Although only approximately 20 insect families are included among the array of prey, it is suspected that this asilid species is opportunistic, attacking those prey existing in the same microhabitat, when they fly within view of the asilid. There was no evidence of cannibalism in this species. Since the same landing sites are used continuously, it was not to be expected.

Here follows a list of prey taken by *N. acutangulatus.* Specific identifications were made where possible, but because of the primitive state of taxonomy in some groups, definitive identification was often impossible. "It is probably not realized by many people that about 40% of Australia's insect fauna is still undescribed, adding further difficulties to the determination of specimens" (Murray S. Upton, CSIRO, Manager, Australian National Insect Collection—Pers. Commun.). The number of records and sex of the predator are indicated in parentheses following the prey record. The collected prey are housed at Waite Agricultural Research Institute, Adelaide, South Australia.

COLEOPTERA, Curculionidae: undet., 19.iv.79 (♂, 2 ♀), 20.iv.79 (2 ♂, 5 ♀), 23.iv.79 (2 ♀), 24.iv.79 (5 ♀), 26.iv.79 (4 ♀, ?), 27.iv.79 (♀). DIPTERA, Anthomyiidae: undet., 18.iv.79 (♀), 19.iv.79 (♂), 23.iv.79 (3 ♂, 2 ♀), 24.iv.79 (♀), 26.iv.79 (♂); Bibionidae: *Dilophus* sp., 6.iv.79 (4 ♂, 8 ♀), 18.iv.79 (2 ♂, ♀), 19.iv.79 (♂, 8 ♀), 20.iv.79 (3 ♂), 23.iv.79 (♀), 24.iv.79 (♂, 2 ♀); Cecidomyiidae: undet., 19.iv.79 (♀), 20.iv.79 (♂), 23.iv.79 (6 ♂, 4 ♀), 24.iv.79 (7 ♂, ♀), 26.iv.79 (♀); Chironomidae:

Table 2. Numbers and percentage of prey of different Orders taken by *Neocerdistus acutangulatus*.

Order	Male		Female		Unknown		Total	
	No.	%	No.	%	No.	%	No.	%
Coleoptera	3	2	21	13.8	1	0.7	25	16
Diptera	42	27.6	51	33.5	1	0.7	94	62
Hemiptera-Heteroptera			3	2			3	2
Hemiptera-Homoptera	3	2	6	3.8	1	0.7	10	7
Hymenoptera	5	3.3	8	5.2			13	9
Isoptera			5	3.3			5	3
Lepidoptera	1	0.7	1	0.7			2	1
Total	54	35.6	95	62.3	3	2.1	152	100

undet., 23.iv.79 (♀); Dolichopodidae: undet., 5.iv.79 (♀); Mycetophilidae: undet., 23.iv.79 (♀), 24.iv.79 (♀), 27.iv.79 (♂), 30.iv.79 (♀); Sciaridae: undet., 19.iv.79 (♂), 23.iv.79 (♀), 27.iv.79 (2 ♀); 30.iv.79 (♂); Tipulidae: undet., 23.iv.79 (♀), 27.iv.79 (♀). HEMIPTERA-HETEROPTERA, Lygaeidae: *Nysius* sp., 28.iv.79 (♀), undet., 19.iv.79 (♀), 28.iv.79 (♀). HEMIPTERA-HOMOPTERA, Cicadellidae: undet., 19.iv.79 (♂), 23.iv.79 (?), 28.iv.79 (♀); Psyllidae: *Creiis* sp., 18.iv.79 (♂), 23.iv.79 (♀), 24.iv.79 (♂), *Glycaspis* sp., 24.iv.79 (♀), undet., 5.iv.79 (♀), 6.iv.79 (2 ♀). HYMENOPTERA, Braconidae: *Apanteles* sp., 18.iv.79 (♂); Encyrtidae: Encyrtinae, 23.iv.79 (♀); Formicidae (winged reproductives); *Iridomyrmex* sp., 24.iv.79 (♀), Myrmicinae, 20.iv.79 (♀), Ponerinae, 5.iv.79 (♂), 19.iv.79 (♂), 24.iv.79 (♀), *Rhytidoponera* sp., 6.iv.79 (♀); Tiphiidae: Thynninae, 23.iv.79 (♀). ISOPTERA, Rhinotermitidae (winged reproductives): *Heterotermes ferox* (Froggatt), 5.iv.79 (♀, ?), 19.iv.79 (2 ♀), 26.iv.79 (2 ♀). LEPIDOPTERA, Glyphipterigidae: *Glyphipteryx anaclastis* Meyrick, 23.iv.79 (♀), 26.iv.79 (♂).

MATING

Strategies used by *N. acutangulatus* to ensure survival of the species did not differ markedly from those exhibited by *Neoitamus vittipes* (Lavigne, 1982a).

No formalized courtship was exhibited by males. Upon observing a female, the male initiates a short flight which puts him in contact with her. The following description of a mating is typical of those observed.

10:39 Male resting on fallen *Eucalyptus* bark; female flew in and landed 20 cm distant; male immediately flew towards her and landed on her dorsum; copulation ensued in male atop female position; after 15 seconds the pair took the tail-to-tail position (Fig. 3).
10:42 Female cleaned eyes and fore tarsi.
10:45 Cleaning activity was repeated.
10:53 Male buzzed wings, lifted off surface, disengaged genitalia and flew 15 cm away, landing on the same strip of bark; female remained stationary.

Of the 63 mated pairs observed, only six occurred on a substrate (sand, tree roots and broken branches) other than fallen *Eucalyptus* bark. Two of these pairs were resting in sunlight on tree trunks at heights of 1⅓ m and 1⅔ m in late afternoon. Probably they were responding to increasing shade encroachment resulting from the changing angle of the sun's rays as do *Cyrtopogon auratus* Cole adults that spend the night in the tree canopy (Lavigne, 1970).

Males fly from one strip of fallen bark to another in apparent searching flights. When a male lands on a site supporting a female, the female usually reacts almost immediately and flies a straight line distance with the male in pursuit. An immediate response is not always elicited and the male may either fly and land on the resting female or wait until she initiates a forage flight before pursuing her. If the site is occupied by a male, a male-to-male encounter occurs as the other male is landing. The two males occasionally make contact, the faster one landing atop the other and exhibiting copulatory movements. Usually, however, they fly in different directions upon approaching each other closely. Landing males are apparently mistaken for females by other males and the subsequent flight pattern serves to identify the individual's sex.

Pairs were observed in copula as early as 1037 h and as late as 1631 h. The majority of pairs (76%), however, were seen between 1300 h and 1530 h. Temperatures taken on the sites where mated pairs were resting ranged from 19 to 30°C ($\bar{x}$ 23.5°C).

As previously mentioned, once copulation took place in the male over female position, only a few seconds (10–20) elapsed before the tail-to-tail position was achieved (Fig. 3). Five complete matings were observed with the following elapsed times: 8, 9, 12, 12, 14 minutes. Separation occurs when the male releases his claspers and flies away.

Of the 63 mated pairs, 11 females (17.5%) were feeding on prey when observed. Both individuals remained quiet throughout except for prey manipulation and/or cleaning activity by females.

On two occasions mated pairs were accosted by a second male. The male would fly in, land atop the female and attempt to copulate. The strategy behind such an apparently useless act had always eluded me until I made the following observation. This involved an eight minute "complete" mating. A second male landed two cm in front of a mated male and then flew at the mated pair. The "startled" mated male released his claspers and flew. As he did so, the intruding male landed atop the female and copulated with her. Obviously, sexual harassment sometimes provides a competitive advantage and this may be especially important when populations are small and females are at a premium.

Interestingly enough, once this copulatory act was completed the same female only remained unmated for an additional three minutes before a third male made contact, which resulted in copulation. This pair was startled by a galloping horse and flew out of the observer's sight. This species, like some other species lacking courtship (Bullington and Lavigne, 1980; Lavigne et al., 1980), utilizes multiple mating.

Oviposition

No published records exist concerning oviposition behavior nor have eggs of any members of the genus *Neocerdistus* been described.

The process by which *N. acutangulatus* oviposits is as follows. The female lands on soil directly or on debris covered soil. She then moves her ovipositor laterally back and forth "testing" the substrate. If the substrate is unsuitable, the asilid will move 1–2 cm and repeat the motions. Once a suitable site is located, probably

Fig. 4. Female *Neocerdistus acutangulatus* ovipositing in soil amid debris covering substrate.
Fig. 5. Egg of *Neocerdistus acutangulatus* recovered from soil (magnified 47×).

cracks in the soil, the ovipositor is forced into the substrate with lateral motions (Fig. 4). Based on two egg recoveries, there is apparently only one egg deposited at each site. After 40 to 65 seconds, the ovipositor is removed. While removing the ovipositor, the female brings it between her hind legs and in a series of sweeping motions pushes dirt into the hole, thus ensuring that the egg is covered. At the tip of the ovipositor are two short dorsal-ventrally flattened cerci which aid in

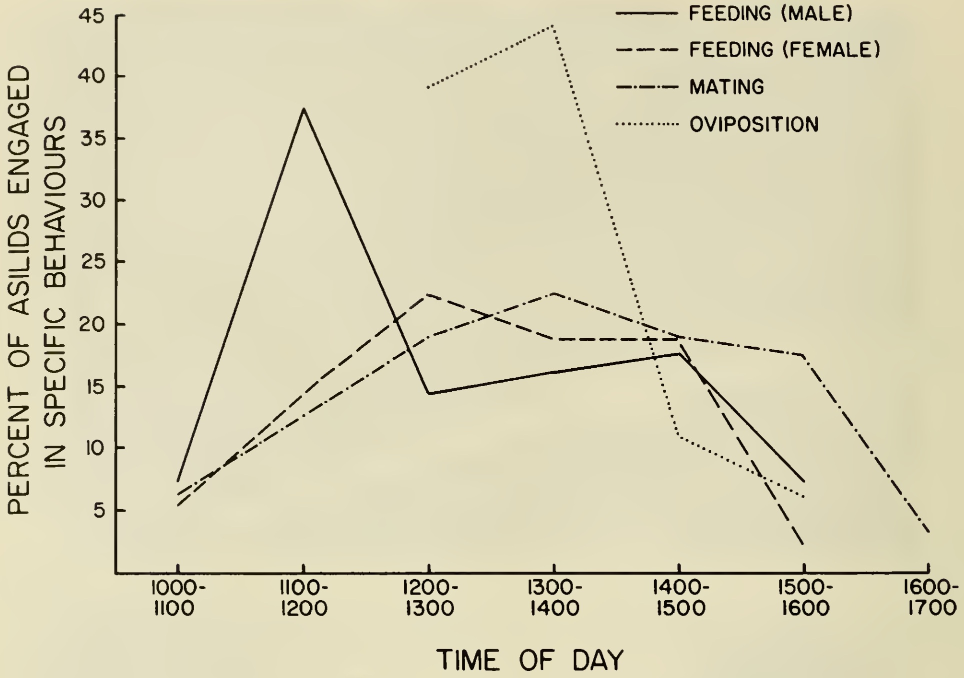

Fig. 6. Mean diurnal rhythm of activity for *Neocerdistus acutangulatus* one km east of One Tree Hill, SA. Percentage of asilids engaged in specific behavior patterns was calculated from the total number of observations for each behavior; i.e. 146 feeding observations, 63 mating observations and 18 observations of ovipositing females.

moving the particles of soil. This structure is similar to that seen on the ovipositor of *Efferia helenae* (Bromley) which also sweeps dirt into the hole following oviposition (Lavigne and Holland, 1969).

Single females were followed after having been observed ovipositing. Each followed female made two more oviposition attempts before I lost sight of them. At each oviposition site I would place a 2 dram vial. Once the female was lost to sight, I would return, place the mouth of the vial over what was assumed to be the oviposition hole and press downwards. Soil and debris would be forced up into the vial; it would be inverted and 70% ethanol would be added and the vial was then corked. The solution thus formed was subsequently examined in the laboratory for the presence of eggs. A more reliable but considerably more time consuming method is to use an empty metal frozen juice container instead of a vial, thus increasing the amount of soil collected and thereby decreasing the chance that the oviposition hole was missed.

Several females were observed exhibiting oviposition behavior around the edge of a large (1 by 3 m) depression, which apparently retained water at certain times. Substrate surface temperatures where ovipositing females (N = 13) were observed ranged from 21 to 33.5°C ($\bar{x}$ 27.4°C).

The earliest oviposition was observed at 1220 h and the latest at 1507 h. With three exceptions, however, all ovipositing females were observed between 1220 h and 1340 h.

Eggs were white when first deposited and retained this color in 70% ethanol. The two recovered eggs measured 0.9 and 1.0 mm long and 0.44 and 0.45 mm wide, respectively (Fig. 5). At a magnification of 70×, there was no visible sculpturing of the chorion. What appeared to be fully mature eggs were dissected from the ovarioles of 3 females that had been observed exhibiting oviposition search movements. These females had been collected and immediately immersed in 70% ethanol. The 69 white dissected eggs measured 0.9–0.98 mm in length ($\bar{x}$ 0.94) and 0.41–0.42 mm in width ($\bar{x}$ 0.41)

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A NEW GENUS AND SPECIES OF DELTOCEPHALINE LEAFHOPPER FROM PANAMA (HOMOPTERA: CICADELLIDAE)

Dwight M. DeLong and Paul S. Cwikla

Department of Entomology, The Ohio State University, 1735 Neil Ave., Columbus, Ohio 43210.

Abstract.—A new genus of deltocephaline leafhopper, ***Cumbrenanus***, from Panama is described. *C.* ***panamus***, new species, is designated as the type-species.

Through the kindness of Henk Wolda, Smithsonian Tropical Research Institute, Panama, we were able to examine a number of deltocephalines collected at lights from Las Cumbres, Panama. In this paper we describe a new genus and species based on this material. We feel that new generic status is warranted because of the enlarged socle of the aedeagus.

Cumbrenanus **DeLong and Cwikla, New Genus**

Type-species.—*Cumbrenanus panamus,* New Species.

Medium sized deltocephaline leafhopper, body parallel-sided. Head as wide as pronotum. Crown produced, anterior margin angularly rounded. Forewing longer than abdomen, appendix well-developed, central anteapical cell not divided, outer anteapical cell narrow, almost as long as central anteapical cell, recurrent veins not present, color of forewing pale brown subhyaline, veins in apical half dark brown, rest light brown, brown spots on clavus, median portion of wing and on costa.

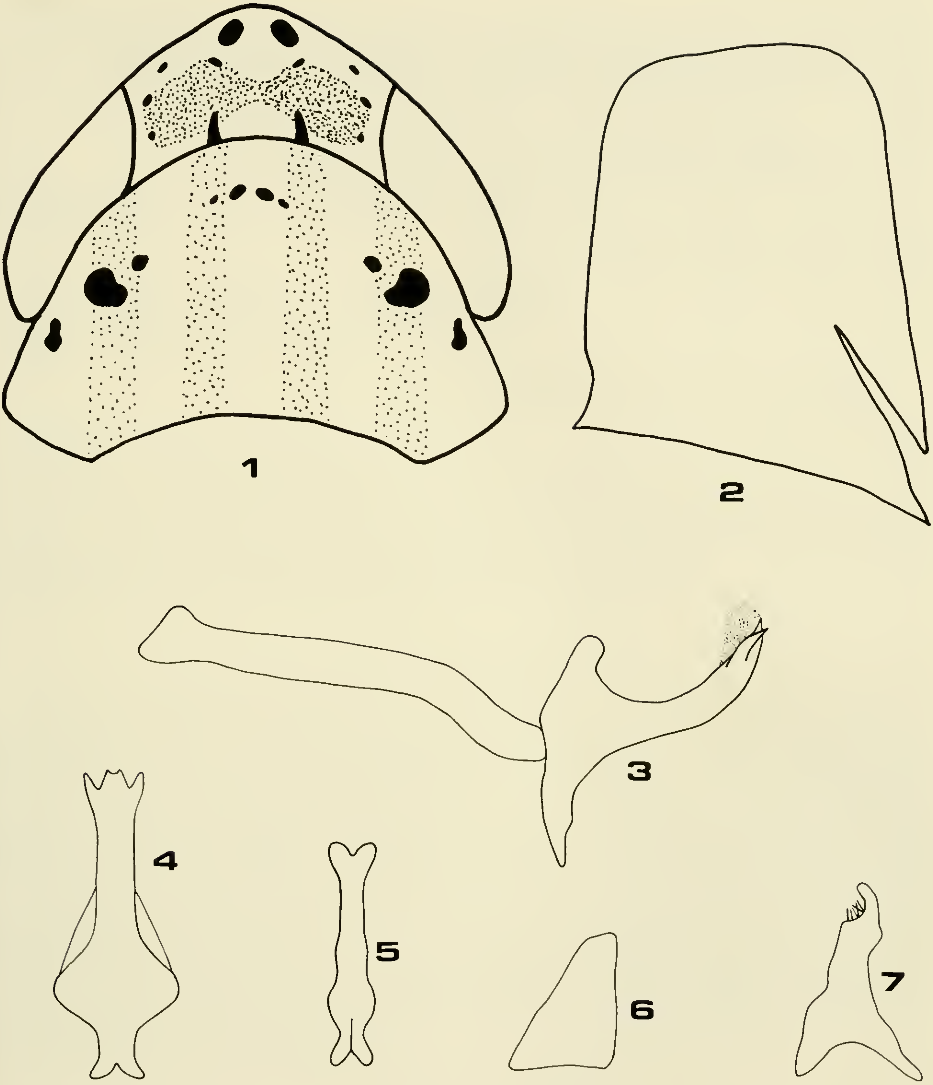
Pygofer somewhat rounded apically, macrosetae irregularly placed on distal ⅓, pygofer processes absent, anal tube elongate, membraneous dorsally. Genital plates triangular, macrosetae uniserriate and subapical. Style with apophysis short and slightly curved, apex blunt, preapical lobe absent, macrosetae on lateral margin, ventral arm long. Connective linear, articulated with the aedeagus. Aedeagus stout, pair subapical processes present, socle well developed, bifurcate in ventral view. Gonopore apical.

Diagnosis.—This species is related to and will key to *Kanorba* Oman in Linnavuori's key to the Neotropical Deltocephalini genera (1959: 84). It can be separated from *Kanorba* and all other Deltocephalini by the long linear connective articulating with the aedeagus, and the well developed bifurcated socle.

Cumbrenanus panamus **DeLong and Cwikla, New Species**

Figs. 1–7

Length of male 4.7 mm. Female unknown. Crown produced. Color: Crown white with pair of proximal round black spots at apex, disc containing a bright



Figs. 1–7. *Cumbrenanus panamus.* 1, Head and pronotum, dorsal aspect. 2, Male pygofer, lateral aspect. 3, Aedeagus and connective, lateral aspect. 4, Aedeagus, ventral aspect. 5, Connective, ventral aspect. 6, Left plate, ventral aspect. 7, Right style, dorsal aspect.

orange irregular patch, narrowly joined at middle, bordered by white and 8 small black spots, posterior margin of crown with pair of triangular black patches. Pronotum mostly dark gray with paler border at base and small black spots along anterior margin, 4 longitudinal stripes running length of pronotum. Scutellum with darker gray basal angles and white apex. Forewings pale brown subhyaline, veins in apical ½ dark brown, remainder light brown with few brownish spots on clavus, median portion of wing and on costa.

Pygofer roundly truncate apically. Male genital plates about 1⅓ times as long as wide at base. Style with apophysis rather broad, apex blunt, extending caudally. Aedeagus short, broad at base with apex membraneous, pair of subapical processes present; socle well developed, bifurcate in ventral view. Connective elongate and narrow.

Holotype male.—Las Cumbres, Panama, light, 18-X-1977, H. Wolda. Deposited in the DeLong Collection, The Ohio State University.

C. panamus is the only included species in *Cumbrenanus.* It can be distinguished from species in other related genera by the pair of subapical aedeagal processes and the well developed, bifurcate socle.

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PROC. ENTOMOL. SOC. WASH.
86(2), 1984, pp. 435–438

CEREAL LEAF BEETLE, *OULEMA MELANOPUS* (L.) (COLEOPTERA: CHRYSOMELIDAE): DENSITY AND PARASITOID SYNCHRONIZATION STUDY IN WASHINGTON COUNTY, MARYLAND 1977-1979[1]

Charles L. Staines, Jr.

Maryland Department of Agriculture, Plant Protection Section, 50 Harry S Truman Parkway, Annapolis, Maryland 21401.

Abstract.—A three year study was begun in 1977 to study population densities of *Oulema melanopus* (L.) and its parasitoids and the synchronization of their life histories. The egg parasitoid *Anaphes flavipes* (Foerster) and the larval parasitoid *Tetrastichus julis* (Walker) were the most abundant parasitoids. Both species reached peak populations approximately one week after *O. melanopus.* Overall parasitization was 44.7% of the eggs and 8.3% of the larvae.

Oulema melanopus (L.) was first identified from Michigan in 1962. Since then this pest of small grains has spread through the eastern United States (Haynes and Gage, 1981). In 1963 the United States Department of Agriculture (USDA) began a survey of the parasitoid complex of *O. melanopus* in Europe (Dysart et al., 1973). This resulted in the introduction and establishment of four parasitoids (Maltby et al., 1971; Stehr, 1970; Stehr and Haynes, 1972; and Stehr et al., 1974). This complex is composed of the egg parasitoid *Anaphes flavipes* (Foerster) (Hymenoptera: Mymaridae); and the larval parasitoids *Tetrastichus julis* (Walker) (Hymenoptera: Eulophidae), *Diaparsis temporalis* Horstmann, and *Lemophagus curtus* Townes (Hymenoptera: Ichneumonidae). In 1977, a study was begun to determine the population density of *O. melanopus* and the density and life history synchronization of the parasitoids.

Materials and Methods

Ten oat (*Avena sativa* L.) fields, larger than 1.2 ha, were selected within the 160 km^2 study area. Washington County was chosen as the study area because it had the highest acreage of oats in the infested area of Maryland. Each field was divided into 10 plots. Weekly collections were made of all *O. melanopus* eggs and larvae from 52 cm of row in all of the 10 plots in each field.

The eggs were rolled off the leaves using a probe and placed in a 50 × 9 cm petri dish, with a maximum of 50 eggs per dish. A piece of moistened filter paper was placed in each dish to prevent dessication. The eggs were held in the laboratory

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[1] Maryland Department of Agriculture Contribution No. 24.

Table 1. Population density of *Oulema melanopus* and its parasitoids in Washington County, Maryland 1977.

Week	No. eggs	No. parasitized	% parasitized	Mean % parasitism	No. larvae	No. parasitized	% parasitized	Mean % parasitism
2	230	8	3.47	3.5 ± 6	49	0	0	0
3	331	40	12.08	21.8 ± 17.66	82	1	1.21	1.33 ± 2.3
4	578	262	45.32	39.4 ± 22.8	177	1	0.56	0.25 ± 0.5
5	565	422	74.69	79.85 ± 15.44	164	13	7.92	24.33 ± 34.37
6	512	476	92.29	92.66 ± 4.09	77	7	9.09	7.44 ± 13.35
7	402	374	93.03	93.37 ± 6.23	26	12	46.15	13.62 ± 24.41
Total	2618	1582	60.42	62.3 ± 21.6	575	34	5.91	24.82 ± 32.14

at 21°C for 7 days. If the eye spots of *A. flavipes* pupae were not visible by this time the egg was considered non-parasitized (Anderson and Paschke, 1968).

Larvae were placed in vials of 15% ethyl alcohol with a maximum of 50 larvae per vial. The vials were held at 0°C until the larvae were dissected under a binocular microscope. Parasitoids were identified using Montgomery and DeWitt (1975).

Surveys started on approximately 1 May each year. The earliest planted field was checked 7 days prior to the starting date to see if *O. melanopus* activity had begun. The surveys continued until after peak larval population.

RESULTS AND DISCUSSION

The survey began as scheduled in 1977 and 1978. In 1979 adult activity was sufficient to start on 23 April. Surveys were conducted for 6 weeks in 1977, 7 weeks in 1978, and 9 weeks in 1979. Fields were lost from the survey in 1977 (one plowed between weeks 3 and 4) and 1979 (2 harvested as green silage between weeks 8 and 9).

The results of the survey are summarized in Tables 1–3. In 1977 and 1978 all recovered larval parasitoids were *T. julis*.

In 1979 three larvae were recovered parasitized by *D. temporalis* and four by *L. curtus*. From these results it is apparent that *D. temporalis* and *L. curtus* are not significant mortality factors to *O. melanopus* populations in Maryland.

Table 2. Population density of *Oulema melanopus* and its parasitoids in Washington County, Maryland 1978.

Week	No. eggs	No. parasitized	% parasitized	Mean % parasitism	No. larvae	No. parasitized	% parasitized	Mean % parasitism
2	116	0	0	0	0	0	0	0
3	206	0	0	0	0	0	0	0
4	248	6	2.41	1.2 ± 3.79	5	0	0	0
5	572	38	6.64	8.91 ± 10.28	45	1	2.22	3.33 ± 10.53
6	1131	349	30.85	36.65 ± 26.79	170	28	16.47	19.42 ± 18.76
7	1085	875	80.64	85.27 ± 15.91	314	19	6.05	12.81 ± 14.72
8	647	529	81.76	80.88 ± 20.58	101	22	21.78	32.42 ± 28.38
Total	4005	1779	44.41	47.58 ± 12.16	635	70	11.02	15.67 ± 17.05

Table 3. Population density of *Oulema melanopus* and its parasitoids in Washington County, Maryland 1979.

Week	No. eggs	No. parasitized	% parasitized	Mean % parasitism	No. larvae	No. parasitized	% parasitized	Mean % parasitism
1	443	1	0.22	1.38 ± 3.92	0	0	0	0
2	1243	25	2.01	2.32 ± 5.22	0	0	0	0
3	1742	19	1.09	1.71 ± 1.73	28	0	0	0
4	2021	225	11.13	16.82 ± 11.46	813	33	4.05	7.36 ± 9.66
5	2120	1294	61.03	63.49 ± 12.25	1089	53	4.86	5.80 ± 5.27
6	2048	1714	83.69	84.25 ± 6.92	1162	63	5.42	5.59 ± 4.51
7	1497	1338	89.37	91.33 ± 5.99	566	49	8.65	8.31 ± 7.96
8	297	285	95.95	97.36 ± 2.63	113	102	90.26	91.25 ± 6.84
9	23	21	91.30	80 ± 27.38	9	9	100	100
Total	11,434	4922	43.04	41.30 ± 11.24	3780	309	8.17	11.31 ± 6.92

A. flavipes is a significant mortality factor of *O. melanopus* in Maryland. Lee and Barr (1976) and Dysart (1971) report that it is poorly synchronized with *O. melanopus* and that *A. flavipes* populations are low in the early part of the season but rapidly increase. Synchronization with *O. melanopus* is good; at the peak density of *O. melanopus* eggs, *A. flavipes* parasitized between 30% to 84% during the 3 year period. Peak *A. flavipes* populations occur about 1 week after peak *O. melanopus* egg density.

Populations of *T. julis* were present throughout the study area but the percent parasitism was low when *O. melanopus* populations were high. The high rate of parasitism.by this parasitoid observed in late season *O. melanopus* larvae is similar to that reported by Gage and Haynes (1975). The parasitoid population increased over the three year period but did not match the population increase of *O. melanopus*, even though *T. julis* has a high reproductive potential (Haynes and Gage, 1981). Haynes (1973) hypothesized that the lack of population growth of *T. julis* is a result of *A. flavipes* parasitizing a high proportion of the late season *O. melanopus* eggs leaving very few to hatch into larvae for the second generation of *T. julis*.

In this survey an average of 85.7% (range 80–96%) of the eggs during the last two weeks were parasitized by *A. flavipes*. While the numbers of *T. julis* adults active in the field were not recorded in the last two weeks the results present strong circumstantial evidence supporting Haynes' (1973) hypothesis.

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I thank M. Wilson and M. Anderson for their assistance in collecting the field samples, and T. L. Burger and his staff at the USDA Cereal Leaf Beetle Lab for the parasitoid determinations. P. Barbosa, University of Maryland, and W. F. Gimpel, Jr., Maryland Department of Agriculture, commented on an earlier draft of this manuscript. The results published here were part of a cooperative USDA APHIS—Maryland Department of Agriculture project.

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THE DISTRIBUTION OF THE WESTERN BUDWORM, *CHORISTONEURA OCCIDENTALIS* FREEMAN (LEPIDOPTERA: TORTRICIDAE), IN WYOMING[1]

MICHAEL G. POGUE AND ROBERT J. LAVIGNE

(MGP) Department of Entomology, Fisheries, and Wildlife, 219 Hodson Hall, University of Minnesota, St. Paul, Minnesota 55108; (RJL) Entomology Section, Plant Science Division, University of Wyoming, P.O. Box 3354, University Station, Laramie, Wyoming 82071.

Abstract.—*Choristoneura occidentalis* Freeman distribution in Wyoming, based largely on ultraviolet light trap data, is presented. Additionally, larval and pupal collections were made on the major host, Douglas fir, *Pseudotsuga menziesii* (Mirb.) Franco var. *glauca* (Beissn.) Franco.

Choristoneura occidentalis Freeman is a widely distributed western polychromatic species, difficult to distinguish other than by genital dissection. Until 1967, *C. occidentalis* was considered to be a western form of the spruce budworm, *Choristoneura fumiferana* (Clemens) (Freeman, 1967). Consequently, it is surprising that, although the species is recorded from southern British Columbia to northern New Mexico, no published records exist for Wyoming (Freeman, 1967; Stehr, 1967; Powell, 1980). The purpose of this paper is to fill in this distribution gap. Additionally, by establishing a long series in the University of Wyoming insect collection, taxonomists will have access to material should the necessity arise for the naming of additional species based on subsequent physiological and genetic studies.

Like the spruce budworm, *C. occidentalis* exhibits periodic population explosions, which are detrimental to both lumber and recreation industries. Unpublished records for Wyoming suggest that these outbreaks are infrequent, although once initiated they may be widespread and extend over several years. McKnight (1967) mentions an outbreak that terminated in 1936 in Cody Canyon, Shoshone National Forest, Park County. Other population explosions occurred in the Front Range forests of Colorado in 1958 and 1959. These outbreaks were widespread in susceptible stands in Colorado and had extended into northcentral Wyoming in the Big Horn and Shoshone National Forests by 1962 (McKnight, 1967). The Missoula Forest Insect Laboratory reported an infestation in Yellowstone National Park in 1952 which, when discovered, extended over 2000 acres. By 1956, the infestation had spread to 142,500 acres of Douglas fir (Johnson, 1957).

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METHODS

During the summer of 1980, an extensive survey was made of shelterbelts and forested areas throughout Wyoming for the purpose of determining the distribution of Tortricinae. Adult collections were made primarily with an ultraviolet light trap. Larval and pupal collections were also made to augment the light trap data.

RESULTS

In Wyoming, *Choristoneura occidentalis* collections were associated with four species of conifers: 1) Douglas fir—*Pseudotsuga menziesii* (Mirb.) Franco var. *glauca* (Beissn.) Franco, 2) Limber pine—*Pinus flexilis* James, 3) Lodgepole pine—*Pinus contorta* Dougl., and 4) Englemann spruce—*Picea englemannii* Parry, all of which are hosts listed by Stehr (1967). Based on light trap data, *C. occidentalis* was most abundant in 1980 in a Douglas fir—Limber pine forest in Sinks Canyon, 19.4 km (12.1 mi) SW of Lander, Fremont Co., on July 23, 1980.

As noted by Stehr (1967), the major host of *C. occidentalis* is Douglas fir. We found larvae and pupae associated with new cones of Douglas fir at Pine Creek Ski Area, 7.4 mi NE of Cokeville, Lincoln Co., on July 17, 1980. Last instar larvae were found in burrows at the base of the cones which they apparently used as shelters when not feeding on the needles. Pupae were found just above the base of the cones in needles tied together with silken shelters spun by the last instar larvae. Pupae were collected and reared, with adults emerging between July 19 and August 1.

Though uncommon, *C. occidentalis* has been collected from shelterbelts (3 in Platte County and 2 in Laramie County) on five different dates from June 30 to July 14. Shelterbelts, common throughout Wyoming, often contain at least one row of conifers and might be expected to act as reservoirs of *C. occidentalis*. However, the known hosts are not used in Wyoming shelterbelts. Two possibilities exist to explain the presence of this moth in shelterbelts: 1) unknown host, or 2) aerial dispersal.

An unknown host seems improbable because only one to three specimens were collected from each shelterbelt. Conversely, in localities in which the known hosts are present, 10 to several hundred adults were collected.

Aerial dispersal by summer thunderstorms or prevailing winds seems a more likely possibility. Morris (1963) recognizes two forms of long range dispersal of *C. fumiferana* in New Brunswick: 1) convectional transport and 2) turbulent transport. Convectional transport is the movement of segments of a population from one area to another by prefrontal or air mass storm cells. Turbulent wind transport causes the gradual and continual downwind spreading of populations by surface winds. Both dispersal forms could transport *C. occidentalis* to shelterbelts in eastern Wyoming. In all cases Douglas fir occurs within 16 to 72 km of these sites and is the probable source of shelterbelt specimens. The Laramie Range, with elevations of 2438 to 2743 m, borders the western edges of Platte and Laramie Counties. Severe thunderstorms, which move in an easterly direction, can build up over the range and possibly pick up portions of *C. occidentalis* populations and redeposit them in shelterbelts. Prevailing winds in summer also move from west to east and moths in normal flight above the tree canopy could be transported several kilometers (Morris, 1963).

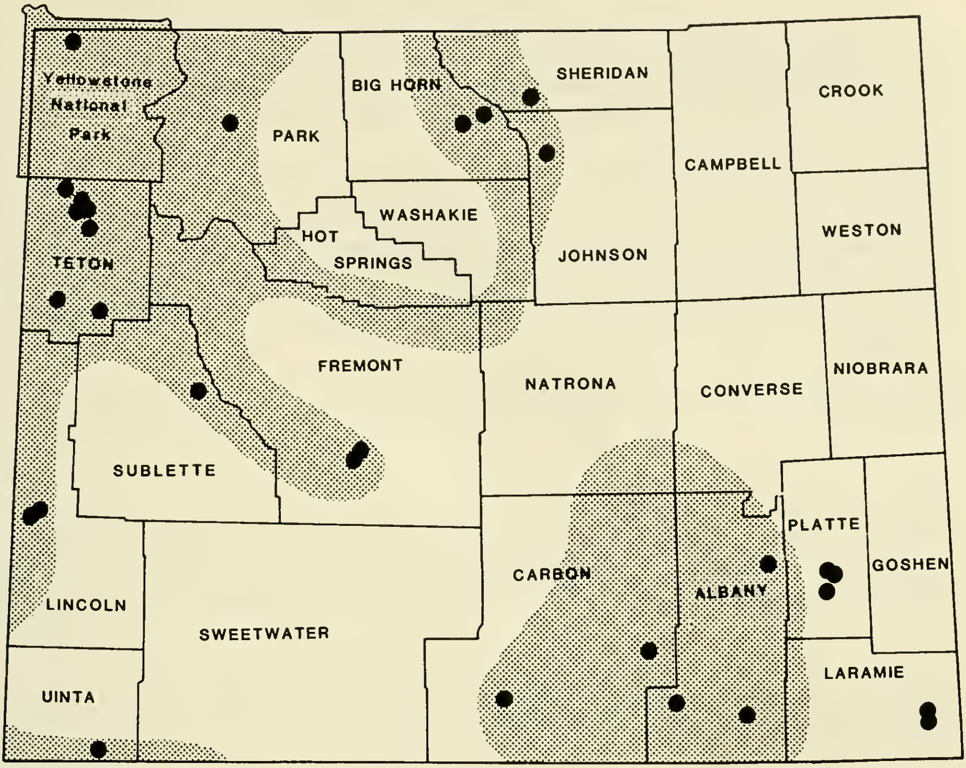

Fig. 1. Distribution of *Choristoneura occidentalis* Freeman (closed circles) and that of its major host, Douglas fir, *Pseudotsuga menziesii* (Mirb.) Franco var. *glauca* (Beissn.) Franco (shaded areas), in Wyoming.

Choristoneura occidentalis has a seasonal range from June 30 to August 18 in Wyoming. The accompanying map (Fig. 1) illustrates the currently known Wyoming distribution of this species.

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We thank Akira Mutuura of the Biosystematics Research Institute, Ottawa, Ontario, for identifying the initial series of *C. occidentalis.* We also thank John M. Schmid of the Rocky Mountain Forest and Range Experiment Station, Ft. Collins, Colorado for unpublished information concerning the outbreaks of *C. occidentalis* in Wyoming. Loans of specimens from Julian P. Donahue, Natural History Museum of Los Angeles County, Ron Leuschner, Manhattan Beach, California, and J. F. Gates Clarke, USNM, were greatly appreciated.

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THE GENUS *ZAPHYMATOCERA* SATO (HYMENOPTERA: TENTHREDINIDAE) IN JAPAN, WITH DESCRIPTION OF A NEW SPECIES

ICHIJI TOGASHI

Ishikawa Prefecture College of Agriculture, Suematsu, Nonoichi-machi, Ishikawa Prefecture 921, Japan.

Abstract.—*Zaphymatocera nipponica,* new species, from Japan is described and figured. This is the first record for the genus in Japan.

The genus *Zaphymatocera* Sato previously contained only one species, *Zaphymatocera typica* Sato, from Korea. Recently, I found a species of this genus in Japan. It is described below and represents the first record of *Zaphymatocera* for Japan.

Genus *Zaphymatocera* Sato

Zaphymatocera Sato, 1928:180. Type-species.—*Zaphymatocera typica* Sato, monotypic.

Generic characters.—Body robust. Inner margins of eyes nearly parallel or very slightly converging below; malar space distinct; anterior margin of clypeus truncate; postorbital furrow present; 3rd and 4th antennal segments subequal in length; mesepisternum with distinct prepectus; stub of analis of forewing straight; cell M present in hindwing; tarsal claw simple.

The simple tarsal claws place *Zaphymatocera* close to *Monophadnus, Stethomostus,* and *Apareophora* in Japan, but *Monophadnus* lacks a prepectus, *Stethomostus* lacks cell M in the hindwing and has the third antennal segment longer than the fourth, and *Apareophora* lacks a prepectus and has the stub of the analis in the forewing turned up at its apex.

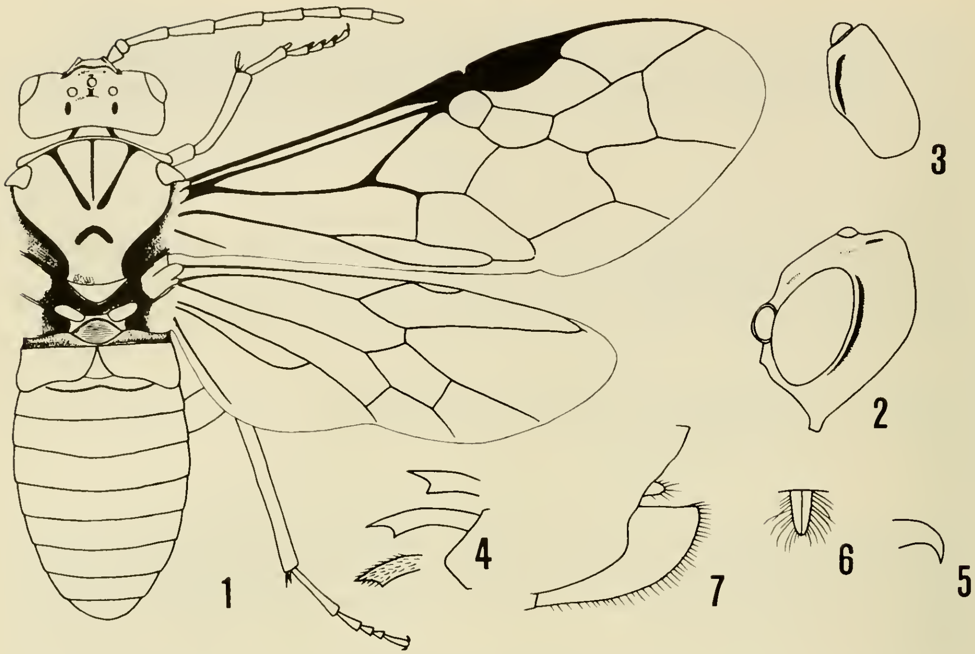
Range.—East Asia (Korea and Japan).

Zaphymatocera nipponica, NEW SPECIES

Figs. 1–10

Female.—Length 6 mm. Black, with following parts yellow: latero-posterior portion of pronotum, tegula, parapteron, and cenchri; labrum, posterior margin of tergite 9, and cerci reddish yellow; apices of mandibles reddish brown. Antenna black. Wings hyaline; stigma and veins brown to dark brown. Legs dark brown to black, with following parts reddish yellow: all knees and tibiae except for apices.

Head: postocellar area transverse, nearly flattened, without a median furrow; interocellar and postocellar furrows slightly depressed; lateral furrows distinct (Fig. 1); OOL: POL:OCL = 1.28:1.00:0.85–0.71; frontal area nearly flattened; median fovea concave and circular in outline; lateral foveae distinct, with a conical



Figs. 1–7. *Zaphymatocera nipponica.* 1, Dorsal view, female. 2, Head, profile. 3, Mesepisternum, lateral view. 4, Front tibial spur, lateral view. 5, Tarsal claw. 6, Sawsheath, dorsal view. 7, Sawsheath, lateral view.

projection in middle (Fig. 10); supraclypeal area gently convex; malar space nearly as long as diameter of front ocellus; postorbital furrow distinct; clypeus nearly flattened, truncate anteriorly; labrum short, anterior margin rounded.

Antenna slightly shorter than costa of forewing (ratio between them about 1.0: 1.1); relative lengths of segments about 1.6:1.0:5.0:5.2:5.2:4.4:4.4:3.6:3.6. Pedicel wider than long (Fig. 1).

Thorax: mesoscutellum slightly convex; mesepisternum with prepectus, separated by a distinct furrow (Fig. 3); metascutellum nearly flattened. Wing venation as in Fig. 1; radiellan cell with short appendiculation (Fig. 1). Legs: foretibial spur as in Fig. 4; hindbasitarsus shorter than following 4 segments combined (ratio between them about 1.0:1.5); claw simple (Fig. 5). Abdomen: sawsheath as in Figs. 6, 7; saw as in Fig. 8.

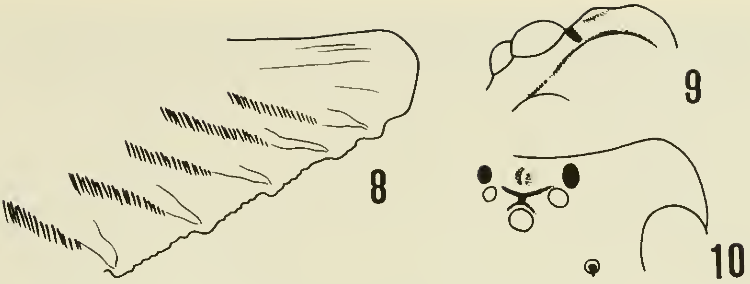
Head and thorax covered with fine setigerous punctures but mesosternum nearly impunctate, shining; posterior ¼ of mesoscutellum covered with fine reticulate sculptures; post-tergite impunctate, shining; metascutellum with several fine transverse striae; abdominal tergites shagreened.

Male.—Unknown.

Distribution.—Honshu, Japan.

Holotype.—♀, May 3, 1963, Mt. Horyu, Noto Peninsula, Ishikawa Pref., I. Togashi leg. Preserved in the Entomological Laboratory of Kyushu University, Fukuoka (Type No. 2399).

Paratypes.—1 ♀, May 2, 1971, Kamairagawa, Atsumi-machi, Yamagata Pref.,



Figs. 8–10. *Zaphymatocera nipponica*. 8, Apical portion of lancet. 9, Postocellar area, lateral view. 10, Postocellar area, oblique view.

K. Shirahata leg; 1 ♀, Apr. 23, 1972, Senami, Yoshinodani-mura, Ishikawa Pref., I. Togashi leg; 2 ♀, May 3, 1977, Chugu Spa, foot of Mt. Hakusan, Ishikawa Pref., I. Togashi leg. One paratype is preserved in the National Museum of Natural History, Washington, D.C.; the others are deposited in the Laboratory of Biology, Ishikawa Prefecture College of Agriculture, Ishikawa.

Remarks.—This new species is very closely allied to *Zaphymatocera typica* Sato (1928), but is separated from the latter by the ratio between OOL and POL (in *typica*, the ratio between OOL and POL is 1.37:1.0); by the postocellar area (in *typica*, the postocellar area is convex and has a median furrow); and by the coloration of tarsi (in *typica*, the tarsi are brownish white).

Variation.—In some paratypes, a small moundlike protuberance is found near the anterior margin of the postocellar area (Figs. 9 and 10), and all tibiae are entirely reddish yellow without dark brown to black maculation at their apices.

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THREE NEW TORTRICIDS (LEPIDOPTERA) FROM TEXAS

André Blanchard and Edward C. Knudson

(AB)3023 Underwood, Houston, Texas 77025; (ECK) 808 Woodstock, Bellaire, Texas 77401.

Abstract.—Three new species of the family Tortricidae (Lepidoptera), *Pelochrista* ***collilonga***, *Grapholita* ***hieroglyphana***, and *Anopina* ***texasana***, are described from examples collected by the authors in Texas. Male and female imagines and genitalia are figured. A lectotype for *Anopina wellingtoniana* (Kearfott) is designated.

The new tortricid moths described here were collected 13–17 years ago by the senior author and again recently by the junior author, which made the series adequate to entertain description. Examples were studied by Dr. J. F. Gates Clarke at the National Museum of Natural History, where they were found to represent new taxa. Photographs of imagines and genitalia were prepared by the senior author.

Pelochrista collilonga A. Blanchard & E. Knudson, New species

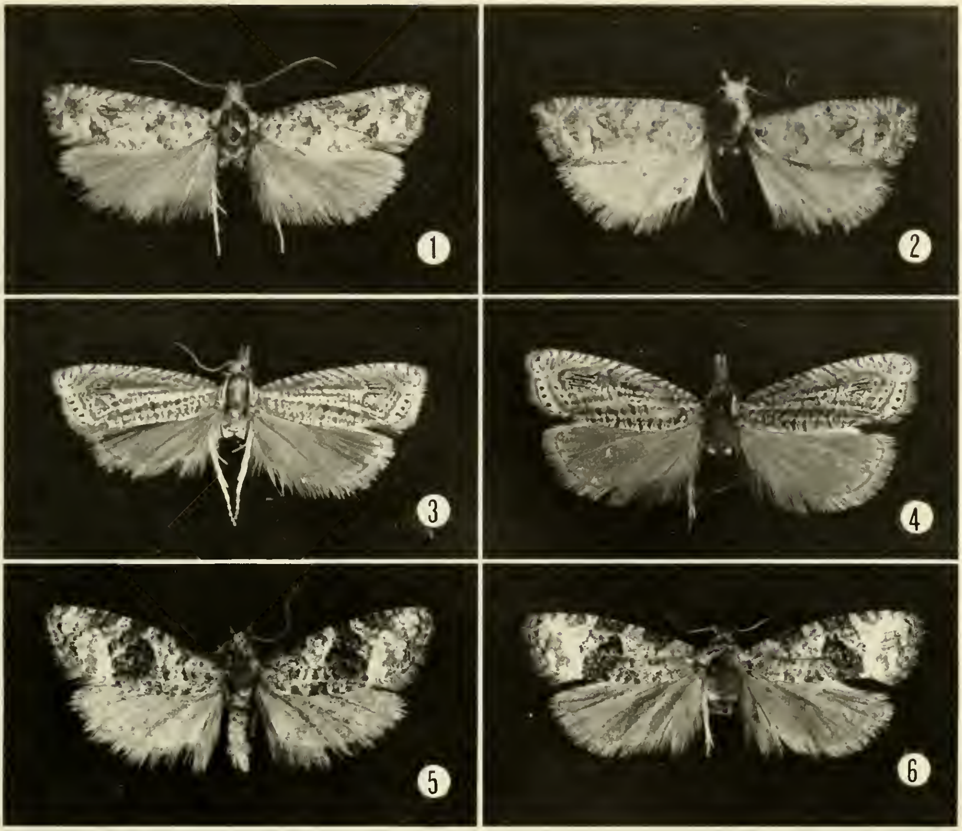
Figs. 1, 2, 7, 8

Head: Front and vertex pale ochreous. Labial palpi pale ochreous, exceeding front by nearly 1 eye diameter. Antennae simple, pale ochreous, with scale rings interrupted on ventral surface by exposed setae. Collar pale ochreous.

Thorax: Tegulae, patagia, and mesonotum pale ochreous.

Forewing: Costal fold extending ¼ distance from base to apex. Ground color pale ochreous, variably reticulated with irregular vertical bands of orange brown scales. Sub-basal fascia orange brown, extending from dorsum ¼ distance from base, angled outwardly to lower margin of cell, thence angled inwardly toward costa. The costal portion of sub-basal fascia obsolete. Sub-basal fascia is margined outwardly by a few blackish scales. Median fascia consists of an orange brown pre-tornal spot and an orange brown, subrectangular spot, just above and basad of pre-tornal spot, separated from it by ground color. Both of these spots variably margined by blackish scales. Ocelloid area consists of two vertical rows of shining pale ochreous scales, enclosing a few black scales. Above ocelloid area is a fuscous preapical spot. Costa strigulate with pale ochreous and orange brown, the outer 4 pale strigulae geminate. Orange brown apical spot preceded by a pale strigula, which is connected to outer bar of ocelloid area by a band of shiny pale ochreous scales. Fringe consists of 2 scale rows, the inner with pale ochreous scales banded with fuscous near their apices, the outer entirely pale ochreous.

Hindwing: Pale fuscous, fringe slightly lighter.



Figs. 1–6. 1, *Pelochrista collilonga,* holotype ♂, Lake Brownwood State Park, Texas, 21-IV-76. 2, *Pelochrista collilonga,* paratype ♀, Hemphill Co., Texas, Lake Marvin, 2-VII-78. 3, *Grapholita hieroglyphana,* holotype ♂, Guadaloupe Mts., Texas. Nickel Creek, 10-VII-68. 4, *Grapholita hieroglyphana,* paratype ♀, Culberson Co., Texas, Sierra Diablo Wildlife Management Area, 14-VII-69. 5, *Anopina texasana,* holotype ♂, Jeff Davis Co., Texas, Mt. Locke, 6700′, 26-IV-81. 6, *Anopina texasana,* paratype ♀, Culberson Co., Texas, Sierra Diablo Wildlife Management Area, 16-IX-82.

Length of forewing: Males (N = 6) 4.8–8.7 mm, average 6.7 mm. Females: (N = 3) 6.1–8.2 mm, average 7.2 mm.

Male genitalia (Fig. 7): Valva with extremely elongate and narrow neck between cucullus and sacculus. Cucullus with strong anal seta. Four preparations examined.

Female genitalia (Fig. 8): Ovipositor with well developed papillae anales. Apophyses posteriores ⅓ the length of apophyses anteriores. Lamella postvaginalis setose, with small medial foramen. Lamella antevaginalis present as sclerotized rim enclosing anterior half of ostium. Ductus bursae with a few sclerotized streaks on posterior surface. Corpus bursae with two large, blunt, thorn-like signa. Two preparations examined.

Holotype (Fig. 1).—♂, Lake Brownwood State Park, Brown Co., Texas, 21-IV-66, genitalia slide A.B. 975, collected by A. & M. E. Blanchard and deposited in the National Museum of Natural History.

Paratypes.—Culberson Co., Texas, Sierra Diablo Wildlife Management Area, 27-VI-81, 3 ♂ (genitalia slides ECK 621, ECK 543), 1 ♀ (genitalia slide ECK 635); 11-VI-82, 1 ♂; Terrel Co., Texas, Sanderson, 28-IX-80, 1 ♂ (genitalia slide ECK 634); Hemphill Co., Texas, Lake Marvin, 2-VII-78, 2 ♀ (genitalia slide ECK 629); all collected by E. Knudson.

Remarks.—This new species has a wing pattern resembling that of *Pelochrista reversana* (Kearfott), but that species lacks the orange tints of *collilonga* and has a more contrasting pattern. The male genitalia of *collilonga* differ from other North American species of *Pelochrista* in the narrow and elongate neck of the valva, approaching *Pelochrista fuscoparsa* (Walsingham) most closely in this character.

Grapholita hieroglyphana **A. Blanchard & E. Knudson, New Species**

Figs. 3, 4, 9, 10

Head: Front and vertex dull ochreous. Labial palpi dull ochreous, dusted with fuscous, exceeding front by 1½ eye diameters; 2nd segment brushlike, obscuring 3rd segment. Antennae dull ochreous, except for terminal 5 or 6 segments, which are blackish brown; scale rings nearly complete, except for exposed finely setose region along ventral surface of flagellum. Collar dull ochreous.

Thorax: Tegulae and patagia ochreous with dull purplish brown median stripe. Mesonotum dull purplish brown with narrow ochreous median stripe.

Forewing: Ground color bright yellow; costa with about 20 dark purplish brown, outwardly oriented strigulae. Basal ¾ of wing marked with multiple rows of shining dark purplish brown spots, which form nearly vertical, interrupted lines, some of which join the costal strigulae. These spots also tend to fuse longitudinally, to form horizontal streaks over the cell, and below cell, the latter extending from base to near tornus. Just before tornus, there are 2 purplish brown lines, more or less parallel to termen, which enclose 4 black dots; the otuer line extends halfway to costa, the inner line is continuous, outwardly convex and enclosing 4 strong horizontal black dashes between it and the outer margin of cell. Beyond the outer line, just before termen, are 4 or 5 strong black dots. Termen slightly notched below apex. Terminal line dark purplish brown, interrupted at notch by a streak of ground color. Fringe shiny golden yellow at certain angles of light incidence, at other angles, blackish. Undersurface of wing brownish with faint dark intervenular streaks, mainly beyond cell. Costal strigulae weakly represented.

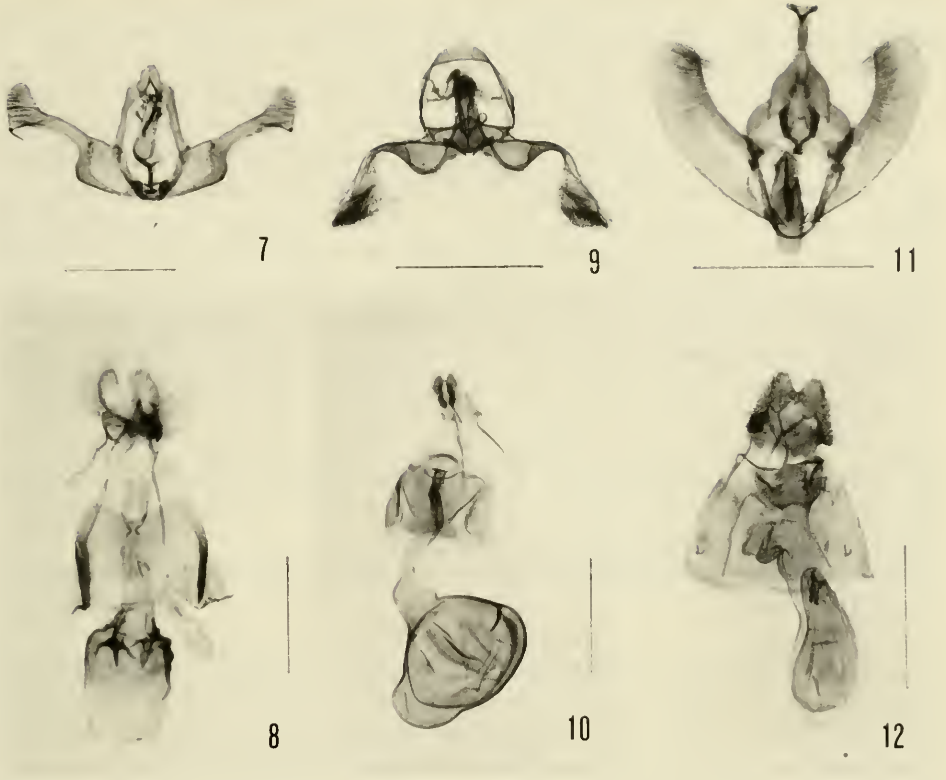
Hindwing: Pale fuscous with a few white spots just before termen. Fringe as in forewing.

Length of forewing: Male: 6.1 mm, females: (N = 2) 6.8–7.4 mm.

Male genitalia (Fig. 9): Apex of tegumen not setose. Valva with pronounced neck incurvation; neck not setose. Apex of cucullus pointed. 1 preparation examined.

Female genitalia (Fig. 10): Apophyses posteriores half as long as apophyses anteriores. Sterigma broad and well sclerotized; lamella antevaginalis scaled. Posterior surface of ductus bursae sclerotized for about ½ its length. Corpus bursae with small microtrichia and a thin thorn-like signum. Two preparations examined.

Holotype (Fig. 3).—♂, Guadaloupe Mts., Texas, Nickel Creek, 10-VII-68, genitalia slide AB 1246, collected by A. & M. E. Blanchard and deposited in the National Museum of Natural History.



Figs. 7–12. Genitalia. Line segments represent 1 mm. 7, *Pelochrista collilonga,* holotype ♂, slide AB 975. 8, *Pelochrista collilonga,* paratype ♀, slide ECK 635, Culberson Co., Texas, Sierra Diablo Wildlife Management Area,27-VI-81. 9, *Grapholita hieroglyphana,* holotype ♂, slide AB 1246. 10, *Grapholita hieroglyphana,* paratype ♀, slide ECK 631, Culberson Co., Texas, Sierra Diablo Wildlife Management Area, 27-VI-81. 11, *Anopina texasana,* paratype ♂, slide ECK 181, same data as holotype. 12, *Anopina texasana,* paratype ♀, slide ECK 626, from specimen in Fig. 6.

Paratypes.—Culberson Co., Texas, Sierra Diablo Wildlife Management Area, 14-VII-69, 1 ♀, genitalia slide AB 4411, collected by A. & M. E. Blanchard; same locality, 27-VI-81, 1 ♀, genitalia slide ECK 631, collected by E. Knudson.

Remarks.—This new species has a distinctive pattern, which should serve to separate it from other North American *Grapholita.* The male genitalia are similar to both *Grapholita molesta* (Busck), and *angleseana* (Kearfott), but in both cases, in *hieroglyphana,* the neck of the valva is narrower and the cucullus more acutely pointed. The female genitalia of *hieroglyphana* is somewhat similar to *Grapholita prunivora* (Walsh) and *packardi* Zeller, but from these it differs in the much longer ductus bursae.

Anopina texasana **A. Blanchard & E. Knudson, New Species**

Figs. 5, 6, 11, 12

Head: Front and vertex pale fuscous, grizzled, composed of whitish scales banded with fuscous. Labial palpi upturned, extending to just above eye, smooth scaled, whitish obscurely banded with fuscous. Antennae of male prismatic, brown dorso-laterally, finely setose ventrally; in female, simple, sparsely setose ventrally. Collar dark fuscous.

Thorax: Tegulae and patagia whitish, peppered with blackish scales. Mesonotum mostly fuscous anteriorly, whitish posteriorly, with white posterior tuft.

Forewings: Ground color white, strongly marked on costa with three fuscous spots; a trapezoidal spot ⅓ distance from base, another trapezoidal spot near middle, and a subtriangular pre-apical spot. A large fuscous median dorsal patch extends across cell and joins the median costal spot to form a complete median fascia. This fascia is peppered with jet black scales and bright orange brown scales, mainly over middle. Below basal costal spot, a few small fuscous spots, peppered with black scales, extend towards dorsum, forming an incomplete sub-basal fascia. An elongate fuscous spot extends from near tornus towards pre-apical spot. Remainder of wing white, obscurely marked with fuscous over basal half. Scattered bright orange brown scales variably present over basal half and near apex. 3 to 5 black dots are present along apical half of termen. Fringe composed of white scales banded with fuscous.

Hindwing: Pale fuscous, fringe concolorous.

Length of forewing: Males: (N = 11) 5.8–8.0 mm, average 6.8 mm; female: (1 example) 7.2 mm.

Male genitalia (Fig 11): Uncus spatulate, narrowed at base, slightly dilated apically. Socii digitate, moderately setose, gnathos with acute middle process; fultura superior complete, not setose. Sacculus not produced, with only minute dentations along outer margin. Aedeagus with tip attenuate, caecum not curved; vesica with long straight cornutus. Three preparations examined.

Female genitalia (Fig 12): Apophyses posteriores ⅔ length of apophyses anteriores. Sterigma with lamella postvaginalis subtriangular, setose; lamella antevaginalis broad, well sclerotized, not setose. Ductus bursae membranous, extremely short; corpus bursae membranous, with diverticulum near junction of ductus bursae, lacking signum. In Fig. 12, ovoid spermatophore lies within corpus bursae.

Holotype (Fig 5).—♂, Jeff Davis Co., Texas, Mt. Locke, 6700′, 26-IV-81, collected by E. Knudson and deposited in the National Museum of Natural History.

Paratypes.—Same data as holotype, 6 ♂ (genitalia slides ECK 181 and ECK 728); same locality, 27-V-74, 1 ♂, collected by E. Knudson. Same locality, 6-IX-69, 1 ♂ (genitalia slide AB 2867), collected by A. & M. E. Blanchard. Culberson Co., Texas, Sierra Diablo Wildlife Management Area, 16-IX-82, 1 ♀ (genitalia slide ECK 626); same locality, 11-VI-82, 1 ♂; Brewster Co., Texas, Big Bend Nat. Park, Chisos Basin, 29-III-82, 1 ♂, collected by E. Knudson.

Remarks.—This new species is similar to *Anopina wellingtoniana* (Kearfott), a species which is so far not known from Texas. Dr. Clarke has compared the two species and provided the following comment: "The two species, *A. wellingtoniana* (Kearfott), and *texasana* are similar, but the terminal area of the forewing of the former is largely white with a conspicuous row of black terminal spots; the terminal area of the latter is crossed by a grayish curved fascia and the terminal row of spots is obscure. The male genitalia of *texasana* have a distally truncated uncus, but that of *wellingtoniana* is terminally broadened with a lateral protuberance on each side ventrally. In the female genitalia there is a broadly expanded area anterior to the ostium in *texasana*, which is lacking in *wellingtoniana*." In the course of his investigation, Dr. Clarke noted that although one specimen of *wellingtoniana* in the NMNH was selected by Obraztsov as a *lectotype* in 1956, he could find no publication in which the *lectotype* designation was mentioned. It becomes necessary, therefore, to assign the *lectotype* designation to this specimen.

Anopina wellingtoniana **(Kearfott)**

Lectotype.—♂, consisting of head, thorax, and left wings and bearing the following data: Wellington, B.C., G. W. Taylor, May; red label: TYPE. collection of W. D. Kearfott; small white label: slide 1274; white handwritten label: *Olethreutes wellingtoniana* Kearf. Cotype; fourth label: male genitalia on slide. C.H. 26 Apr. 1922; green slide label: Genitalia slide by C.H. 1922 USNM 25504; large white label: N. Obraztsov select. Dec. 1956. The specimen is in the National Museum of Natural History, Washington, D.C.

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TWO NEW GENERIC NAMES FOR GROUPS OF HOLARCTIC AND PALEARCTIC ARCTIINI (LEPIDOPTERA, ARCTIIDAE)

D. C. Ferguson

Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % National Museum of Natural History, Washington, D.C. 20560.

Abstract.—Research to identify and define all genera closely related to the nearctic *Apantesis* Walker and *Grammia* Rambur, which are herein treated as distinct, led to the conclusion that two mainly palearctic genera of this group are unnamed. These new genera are described as *Holoarctia,* with *Nemeophila cervini* Fallou as the type species, and *Palearctia,* with *Arctia glaphyra mannii* Alpheraky as the type species. *Neoarctia sordida* McDunnough is referred to the synonymy of *Holoarctia cervini.* An identification key is provided for the four closely related genera, *Holoarctia, Palearctia, Neoarctia,* and *Hyperborea.*

During my recent research toward a comprehensive generic revision of a large section of the holarctic Arctiini, it became apparent that *Nemeophila cervini* Fallou, 1864, from the Alps, belongs to a discrete group of three species for which no generic name is available. *Grammia* Rambur, 1866, and *Orodemnias* Wallengren, 1885 (the latter a junior synonym of *Grammia*), have been used for *cervini,* but neither applies to it because their type species, *Bombyx quenseli* Paykull, 1793, is not congeneric. The unexpected discovery of a closely related new species, *Orodemnias fridolini* Torstenius, 1971, with its almost circumpolar distribution from Sweden through Russia and Siberia to Alaska, has aroused widespread interest in the group, and I thought it important to provide needed generic names and summarize my conclusions concerning the relationships of these moths without further delay.

The genus represented by *cervini,* which I shall call *Holoarctia,* n. gen., belongs to a small, arctic-alpine complex of four closely related but conveniently distinguishable genera. Of these, only *Neoarctia* Neumoegen and Dyar and *Hyperborea* Grum-Grshimailo have been named. *Neoarctia* is a genus of three species known only from the Rocky Mountain region from Colorado to the Yukon Territory, and *Hyperborea* is a genus of only one mainly Siberian species that occurs also in Alaska (Ferguson, 1972: 222). In order to define and discuss the generic status of *cervini* and to make meaningful comparisons, I here include also a description of the fourth genus of this complex, a central Asian group of probably 10 or 12 species for which I herein propose the name *Palearctia,* n. gen.

***Holoarctia* Ferguson, New Genus**

Figs. 1–5, 10, 11, 15

Type species: Nemeophila cervini Fallou, 1864.

Diagnosis.—Forewing pattern (Figs. 1–5) with full complement of 5 transverse pale bands, usually apparent at least at costa, but sometimes in part suffused or

Figs. 1–9. 1, *Holoarctia cervini* (Fallou) ♂, Wallis. 2, same, ♀, Zermatt. 3, *H. pungeleri* (Bang-Haas) ♂, "Tunkinsche Weisberge, Sajan Gbg., Turan, 2000 m. Juli" (BMNH). 4, *H. fridolini* (Torstenius) ♂, Mile 21, Teller Road, Seward Peninsula, Alaska, 22 July 1976, Alaska Lepid. Surv. 5, same, ♀, Toolik Lake, Alaska, 14 July 1975, Alaska Lepid. Surv. 6, *Palearctia naryna* (Bang-Haas) ♂, no data (described from Narynsk, Tien Shan region). 7, *P. glaphyra mannii* (Alpheraky) ♂, no data (USNM). 8, same, ♀, no data (USNM). 9, *P. erschoffi* (Alpheraky) ♂, no data (USNM). About natural size.

confluent; species of *Palearctia* (Figs. 6–9), *Neoarctia,* and *Hyperborea* have no more than 4 transverse bands. Longitudinal band in 1st anal fold of forewing always absent, but present in species of *Palearctia* and *Hyperborea.* Hindwing whitish or yellow, marked with the usual dark spots; these may be confluent, reduced, or absent, or entire hindwing may be suffused with dark shading.

Male genitalia (Figs. 10, 11).—Uncus tapering apically to a nearly straight or only slightly bent tip, not strongly bent in hooklike configuration characteristic of *Neoarctia* and some species of *Palearctia*; valve stout, simple, tapered, not truncated or bilobed, but its shape extremely variable in *cervini*; juxta longer than wide, medially cleft basally, somewhat convex, bilaterally spinulate distally; aedeagus stout, somewhat bowed, with one dorsal patch of small spines distally; everted vesica longer than half length of aedeagus.

Female genitalia (Fig. 15).—Ductus bursae straight, flattened, sclerotized for slightly less than its full length, shorter than corpus bursae, only about half as long as ductus bursae of species of *Neoarctia*; corpus bursae almost globular, with two signa; proximal part of ductus seminalis enormously enlarged, not obviously coiled, about as much distended as corpus bursae and having appearance of a second lobe; anterior apophyses lost.

Remarks.—The included species are *Holoarctia cervini* (Fallou), of the Alps of France, Switzerland, and Austria, Mongolia (see Alberti, 1971: 375), and the Rocky Mountains of Alberta and British Columbia, Canada (= *Neoarctia sordida*

McDunnough, 1921, new synonymy); *H. fridolini* (Torstenius), which I consider to be a distinct species and not a subspecies of *cervini* as originally described, found in northern Sweden, the Kola Peninsula in Russia, arctic Siberia, and Alaska; and *H. pungeleri* (Bang-Haas, 1927), from the Sayan Mountains, central Siberia.

I am aware that the spelling of *Holoarctia* is similar to that of *Holarctia* M. E. Smith, a synonym of *Grammia* Rambur (Arctiidae), and *Holarctias* Prout, a synonym of *Scopula* Schrank (Geometridae), and that it disregards a recommendation of the Code that names with small differences of spelling be avoided. However, it is not a homonym (Int. Code Zool. Nomen., Art. 56(a)).

Palearctia **Ferguson, New Genus**

Figs. 6–9, 12–14, 16

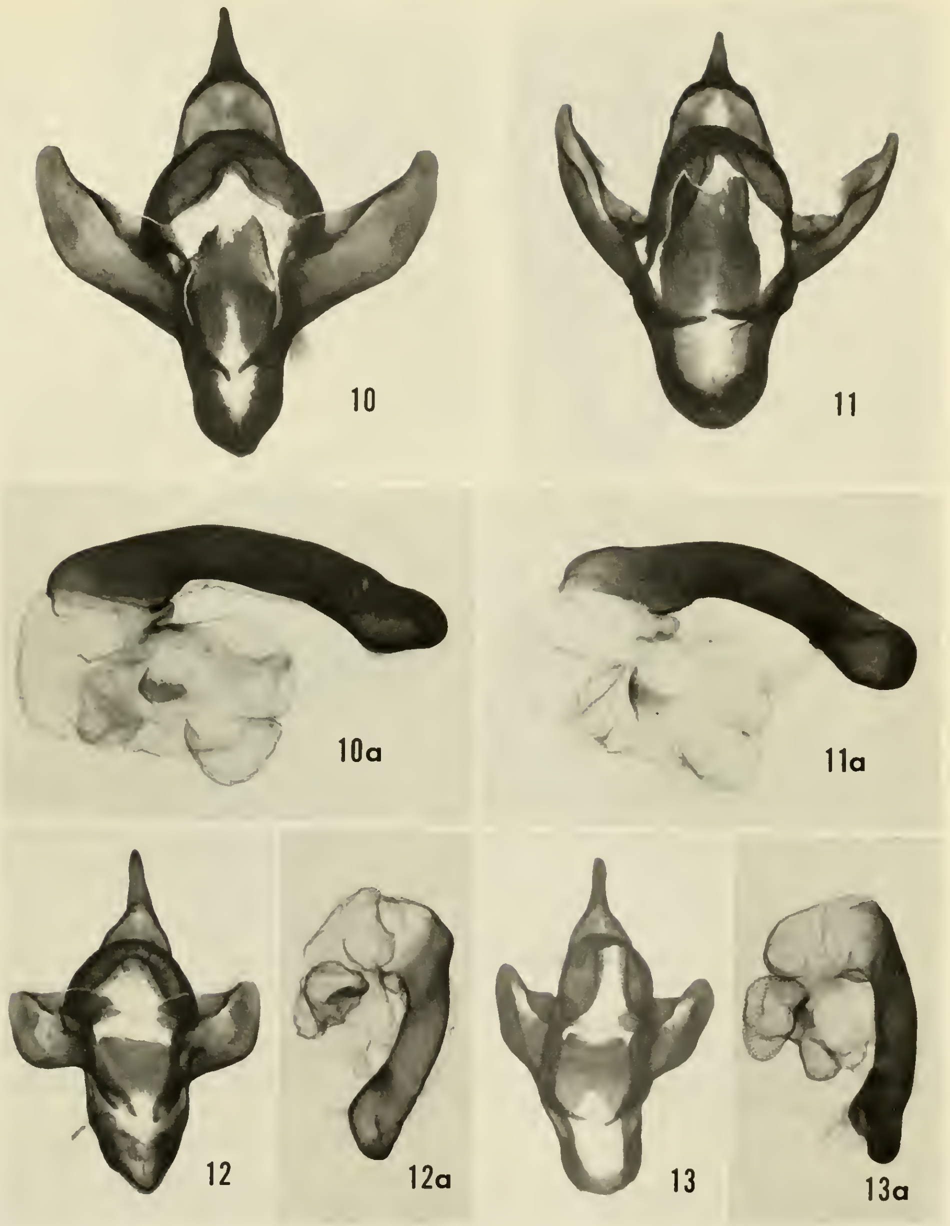
Type species: Arctia glaphyra mannii Alpheraky, 1881.

Diagnosis.—Forewing pattern like that of *Holoarctia* species except that no more than 4 transverse bands may be seen at costa, and longitudinal band in 1st anal fold is present. Hindwing red, orange, pink, yellow, or white (rarely all dark), with 3 or more dark submarginal spots that may be connected to form a continuous band, and with or without dark discal spot. Palpi shorter than those of other genera in group, hardly protruding beyond frontal hair in either sex.

Male genitalia (Figs. 12–14).—Eighth segment peculiar in that eighth sternite is lost or nearly so, i.e. unsclerotized. Otherwise similar to those of *Holoarctia* except that uncus has base reduced or narrowed relative to size of process; juxta less elongated, variable but usually about as wide as long and without spines or spicules; valve variable from short, stubby and truncated to about same length as that of *Holoarctia* species but, if elongated, tip bent inward (Fig. 14); also, base of costa produced inwardly as a strong sclerite toward posterolateral angle of juxta, a character not found in other genera of group, and probably representing a remnant of the transtilla as seen in many members of the *Arctia-Hyphoraia* and *Phragmatobia-Ocnogyna* groups; aedeagus short, curved, with a distal patch of minute spines dorsally just before vesica, less conspicuous than those of *Holoarctia* (or sometimes absent) and not situated on a humplike elevation as in species of *Holoarctia*; vesica smaller, more compact, but with about same arrangement of lobes and scobinate surfaces as *Holoarctia*.

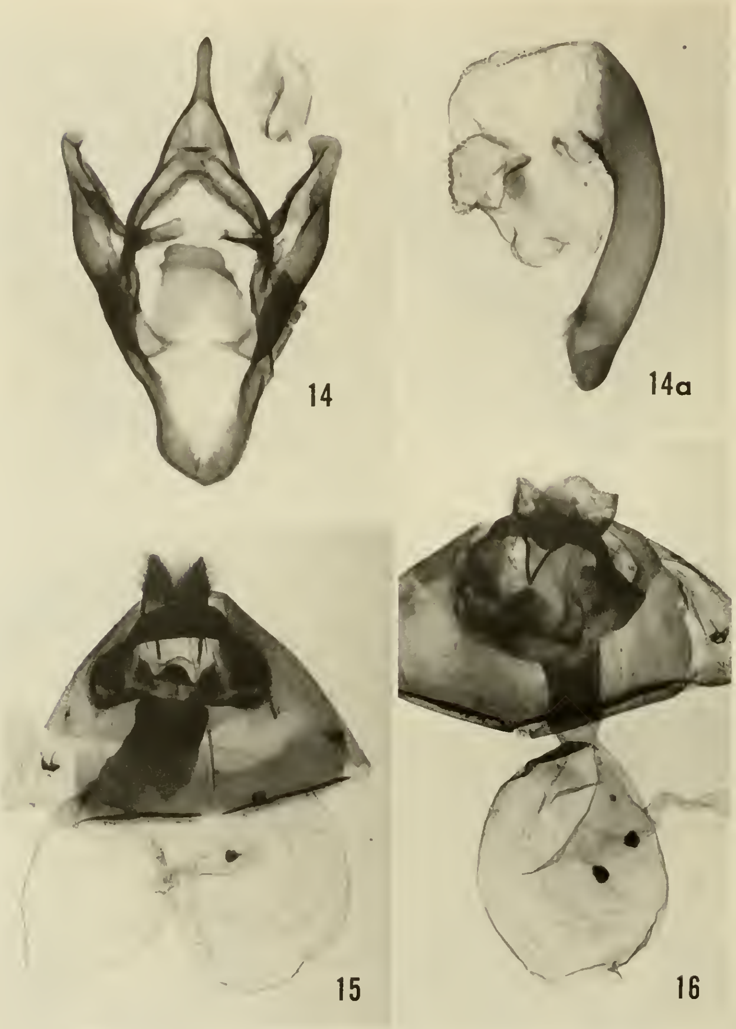
Female genitalia (Fig. 16) (based on one specimen of type species only).—Like those of *Holoarctia* species, but ductus bursae less sclerotized at ostium, ductus seminalis not greatly enlarged, and corpus bursae with rudimentary third signum in addition to two fully developed ones. Anterior apophyses present but reduced.

Remarks.—I include in the genus *Palearctia* all of the subspecies, forms and aberrations treated by Bang-Haas (1927: 62–68) under *Micrarctia glaphyra* Eversmann, *M. buraetica* Bang-Haas, and *M. kindermanni* Staudinger; by Seitz (1910: 83–84) under *Micrarctia rupicola* Grum-Grshimailo, *M. postflavida* Hampson (Fig. 14), *M. glaphyra* Eversmann, and *M. kindermanni* Staudinger; and by Draudt (1931: 78–79) under *M. glaphyra* Eversmann, *M. buraetica* Bang-Haas, *M. kindermanni* Staudinger, *M. erschoffi* Alpheraky (Fig. 9), and *M. ladakensis* Bang-Haas. I examined and dissected the type species of *Micrarctia* Seitz, 1910, namely *Nyctemera trigona* Leech, and do not consider it to be congeneric with or closely related to any of the above. "*Micrarctia*" *y-albula* (Oberthür) and



Figs. 10–13. Male genitalia. 10, *Holoarctia cervini*, the Alps. 10a, aedeagus of same. 11, *H. fridolini*, Alaska. 11a, aedeagus of same. 12, *Palearctia glaphyra mannii*, no data. 12a, aedeagus of same. 13, *P. naryna*, no data. 13a, aedeagus of same.

"*M.*" *sieversi* (Grum-Grshimailo), included in the same genus by Seitz, also are not congeneric and belong in the *Phragmatobia-Ocnogyna* group. I have examined and dissected 6 distinct species of *Palearctia* and would deduce from the illustrations in works of the above authors that there must be several more species

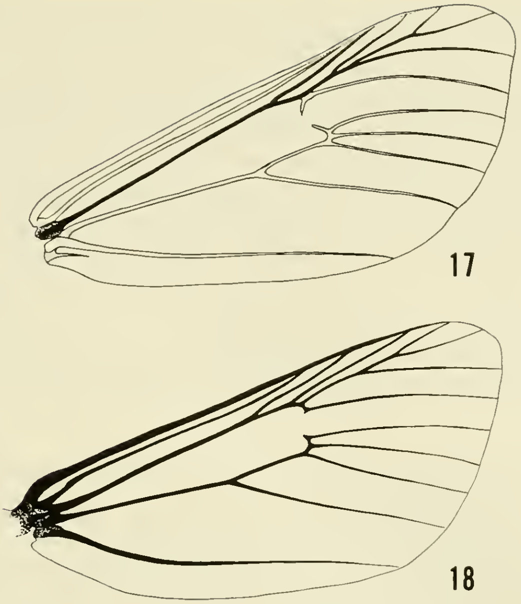


Figs. 14–16. Male and female genitalia. 14, *Palearctia postflavida* ♂, "Skoio La," July 1887, J. H. Leech (BMNH). 14a, aedeagus of same. 15, *Holoarctia fridolini* ♀, Alaska. 16, *Palearctia glaphyra mannii* ♀, no data. Figures of genitalia not to scale.

among the many named forms. I chose to designate *mannii* (Figs. 7, 8, 12, 16) as the type species as it is the only one of which I have seen both sexes. The species of *Palearctia* are badly in need of revision, but material is not easily obtained. They occur in the mountains of Kashmir, Tibet, Sinkiang, Mongolia, and adjacent regions of the U.S.S.R. *Palearctia glaphyra mannii* was described from between 6500 and 10,000 feet in the Kuldja district, Tien Shan Mountains, Sinkiang.

DISCUSSION

The genera *Neoarctia, Holoarctia, Palearctia, Hyperborea, Grammia,* and *Apantesis* Walker, *Notarctia* M. E. Smith, and *Chelis* Rambur belong to a complex



Figs. 17–18. Venation. 17, *Holoarctia cervini* (Fallou); radial veins in solid black. 18, *Grammia quenseli* (Paykull).

of closely related genera that I will call the *Holoarctia-Grammia* series. The superficially similar palearctic genus *Cymbalophora* Rambur is not one of them but appears to be an aberrant member of the *Arctia-Hyphoraia* series, according to its venation and genitalia. The classification of those genera treated here and of the Arctiini in general has been much complicated by historical misconceptions. Contrary to what was implied by its generic placement until now, *cervini* is not most closely related to species of *Grammia* but would have been better assigned to *Neoarctia*. McDunnough (1921: 167) noted this, if only indirectly, when he described *Neoarctia sordida* from Banff, Alberta, referring to it as "a new species of *Neoarctia,* probably closest to *cervina* (sic) Fall. from the Alps." I examined the type of *sordida* and concluded that it represents the very same species as *cervini* (not the Eurasian and Alaskan *fridolini,* as one would have expected). *Grammia* is a relatively large North American genus of about 30 species, of which only two, *quenseli* (Paykull) and *turbans* (Christoph), extend also into the Palearctic Region. All of the species formerly included in *Apantesis* in North American lists (e.g. Hodges et al., 1983: 117) I now refer to *Grammia* with the exception of *phalerata* (Harris), *vittata* (F.), and *nais* (Drury) (plus two others that will be treated later), which are the true *Apantesis* species, and *proxima* (Guérin-Méneville), which I remove to *Notarctia* M. E. Smith, 1938.

The group consisting of *Neoarctia, Holoarctia, Palearctia,* and *Hyperborea* may be distinguished from other Arctiini by unique combinations of features that will be described in more detail in my forthcoming revision. All have reduced eyes, most have reduced antennal branches, and nearly all are diurnal. The forewing venation never has an accessory cell, except perhaps in rare aberrant specimens, and it has a radial system with 4 branches arising beyond the end of the discal cell (Fig. 17), like most arctiids (3 in *Grammia, Notarctia,* and *Apantesis*—Fig. 18); the male genitalia have a normal uncus with wide base and slender process (unlike the triangular uncus of many arctiid genera), generally no development of the transtilla, a rather simple, flat valve, and a special kind of juxta that is generally as long as or longer than wide and often medially cleft basally. The genus *Grammia,* on the other hand, has a different and highly characteristic kind of valve with a stout basal half, a node or ridge near the middle, and an abruptly flattened, blade-like distal half. The form of the valve in *Grammia* remains remarkably constant throughout the whole diverse array of species from *quenseli* and *turbans* to such extreme forms as *virgo* (L.), *arge* (Drury), and *placentia* (J. E. Smith), with never a suggestion of anything transitional to the type of valve found in the *Holoarctia-Hyperborea* group. The problem is not in distinguishing these genera from *Grammia* but from one another. To help clarify the differences, I have prepared the following key.

KEY TO THE FOUR GENERA OF THE *NEOARCTIA-HYPERBOREA* GROUP

1. Forewing never with longitudinal, pale stripe in 1st anal fold (Figs. 1–5). Arctic Eurasia and the Alps, Alaska, and the Rocky Mts. 2
– Forewing nearly always with longitudinal, pale stripe in 1st anal fold (Figs. 6–9). Central Asia, Siberia, Alaska 3
2. Forewing with 3–4 transverse bands only (sometimes indistinct or lost), longitudinal bands or lines wanting; median space marked only with an enlarged pale patch at costa. Juxta not spinulate; aedeagus straight, with two spinulate patches apically; uncus bent subapically in a somewhat hooklike form. Rocky Mts., Colorado to Yukon .... *Neoarctia*
– Forewing with full complement of 5 transverse bands in addition to at least partial, thin, longitudinal vein lines; median space marked with two separate transverse bands toward costa except in occasional, very dark specimens. Juxta with spinulate patches; aedeagus bowed, with one spinulate patch apically; uncus essentially straight. Arctic Eurasia to Alaska, Mts. of Central Asia and western Canada .... *Holoarctia*
3. Male genitalia with valve entire, not bilobed; juxta without spinules or penicilli. Male antennae obviously bipectinate. Forewing with or without vein pattern, and with antemedial and/or medial bands, or vestiges of them, present at least between costa and 1st anal fold. Hindwing with ground color red or yellow, rarely white or all black. Central Asia .... *Palearctia*
– Male genitalia with valve bilobed, and juxta bearing a pair of denticulated penicilli in posterolateral corners. Male antennae with very short branches, appearing simple without magnification. Forewing always with fully developed vein pattern but entirely without antemedial or medial bands between costa and 1st anal fold. Hindwing ground color whitish. Siberia and Alaska .... *Hyperborea*

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86(2), 1984, pp. 460–461

NOTE

Pineus boerneri Annand (Homoptera: Adelgidae): A New or Another Record from The People's Republic of China?

While sampling pine plantations in Liaoning Province in northeastern China during 1982, I discovered two infestations of *Pineus boerneri* Annand (Homoptera: Adelgidae) previously recorded only from Formosa, New Zealand and the United States (see Annand, P.N. 1928, A Contribution Toward a Monograph of the Adelginae (Phylloxeridae) of North America). Specimens that I collected on May 13 from *Pinus tabulaeformis* Carr. at Zheng Chio (123°40′E, 41°15′N) and on May 18 from *Pinus thunbergiana* Franco at Luta (121°40′E, 39°00′N) are identical to ones I collected in the United States during 1981 and 1982 from dying *Pinus resinosa* Ait. throughout southern New England (McClure, M. S. 1982, Ann. Entomol. Soc. Amer. 75: 150–157) and from *P. thunbergiana* and *P. densiflora* Sieb. and Zucc. in Connecticut (McClure, M.S. unpublished data). My studies in Connecticut suggested that this adelgid was introduced into the eastern United States and revealed that it can injure and kill *P. resinosa* (McClure, M. S. 1982, see above).

The sampling sites in Liaoning Province, China were pure stands of 15-year-old pines. I examined four branches each in the lower crown of five trees at both plantations and counted the number of adelgids, living and dead, occurring on 50 cm^2 of three-year-old growth of each branch. The number of nymphs which had died during winter (these remain firmly affixed to the branch) was compared with the number of living individuals to determine percent overwinter mortality.

All 10 trees were infested with *P. boerneri.* Mean number (± one SD) of living adelgids per 50 cm^2 of branch was 42.0 ± 7.9 at Zheng Chio and 10.0 ± 1.6 at Luta. All living adelgids ($n = 260$) were either fourth instar nymphs or adults. Hundreds of eggs of *P. boerneri* were also present on each branch because adults were ovipositing when samples were taken. Mean (± one SD) percent mortality incurred by nymphs during winter was high at Luta (76.6 ± 2.4) and even higher at the northernmost sampling site, Zheng Chio (97.2 ± 2.8) where the average length of the frost-free season is only 160 days and where minimum winter temperature sometimes reaches −23°C.

I argued in a previous paper (McClure, M.S. 1982, see above) that *P. boerneri,* first described by Annand (1928, see above) from *Pinus radiata* Don in California, is probably the same species as *Pineus laevis* described by Maskell (1885, Trans. New Zealand Inst. 17: 13–19) as *Kermaphis pini* var. *laevis* from three exotic pines in New Zealand. In their recent checklist of forest insects of China, Yang and Wu (1981, A Checklist of the Forest Insects of China) also consider *P. boerneri* to be the same as *P. laevis.* Regardless of whether or not these names are synonyms, it is certainly reasonable to suspect that the adelgid which I collected in northeastern China in 1982 is the same as the one collected in May 1935 on pines in Shanghai (121°35′E, 31°20′N) and in Wenling (121°20′E, 28°20′N), Zhejiang Province, China and subsequently identified as *P. laevis* (Maskell) by Takahashi (1937, Trans. Natur. Hist. Soc. Formosa 27: 11–14) and the unidentified *Pineus* illustrated in

Handbook of Forest Insect Pests in Northeast China (1974). Indeed, the morphological features of the adelgids which I collected from southern New England and from Liaoning Province, China closely conform to the detailed descriptions and drawings of Takahashi (1937, see above). Unless Takahashi's 1935 specimens are examined it will remain uncertain whether my discovery represents a new or another record of *P. boerneri* in The People's Republic of China.

I conducted this study while serving as a member of the United States Integrated Pest Management Delegation to The People's Republic of China. The trip, made under the auspices of the Science and Technology agreement between the two countries was jointly funded by the U.S. Department of Agriculture, Office of International Cooperation and Development and the Chinese Ministry of Forestry. I am grateful to my travel companions Drs. D. L. Dahlsten, G. L. DeBarr and R. L. Hedden for their help and support throughout the study.

Mark S. McClure, *Department of Entomology, The Connecticut Agricultural Experiment Station, New Haven, Connecticut 06504.*

PROC. ENTOMOL. SOC. WASH.
86(2), 1984, pp. 461–462

NOTE

Notes on a Hilltop Aggregation of *Lytta magister* Horn (Coleoptera: Meloidae)

On 22 March 1983 I was ascending a lava ridge (ca. 620 m elevation) W of the headquarters area at Organ Pipe Cactus National Monument, Pima County, Arizona. At about 09:30, just below the E side of the ridge crest, I encountered a small aggregation of *Lytta magister* Horn on and around a flowering brittlebush (*Encelia frutescens* Gray). Within 1 m radius around the bush I found 3 pairs of *Lytta magister* in copulo, and an additional 8 single males. All beetles were relatively inactive when I first located them, but 2 (one male in copulo and a single male) were feeding on encelia petals. Encelia petals, when offered to 3 other single males, were eaten entirely. In the next 30 min several other individuals began feeding on encelia petals, and single males were twice observed to attempt mounting when encountering other males. A check of adjacent encelia bushes revealed several other single males, but no massive aggregation was found. I failed to find other *Lytta magister* aggregations on encelia located lower on the surrounding slopes. Based on the pairs found and the behavior of single males when encountering other conspecifics, it appears the aggregation existed for mating and reproductive purposes, and the aggregation centered around ridge-top encelia bushes.

It has been suggested that hilltop aggregations evolved due to the dispersed distribution of one or both sexes in space and time. Both sexes seek out landmarks or landmark resources, effectively increasing the probability of encountering a member of the opposite sex, and thereby increasing their potential lifetime reproductive success. Thus females visit landmarks where males aggregate and reproduction is effected. "Hilltopping" has been described as a reproductive strategy for other insect species that are found on the hilltops joining the ridges where my observations were made (see Alcock, 1981, Behav. Ecol. Sociobiol. 8: 309–317; 1983, 13: 57–62; 1983, Anim. Behav., 31: 518–525). The males of these hilltopping species (the wasp *Hemipepsis ustulata* Dahlbohm, the butterfly *Atlides halesus* (Cramer), and an undescribed bot fly *Cuterebra* sp., respectively) are territorial, which does not appear to be the case for *Lytta magister.* Large aggregations of *Lytta magister* have been reported previously (Werner et al., 1966, Univ. Ariz. Agric. Exp. Stn. Tech. Bull. 175), with collections being made at several species of flowers. At these aggregations no feeding was observed, but they were considered to be mating swarms. Hilltopping was not noted, but Selander (1958, Trans. Kansas Acad. Sci. 61: 77–80) located what may have been hilltopping individuals on the Pinacate lava cap about 65 km SW from where my observations were made.

For the aggregation described here the petals of encelia appeared to be a favored food, and during the spring of 1983 encelia was in flower nearly everywhere along the slopes and ridges. In a situation where a resource used by individuals is evenly distributed and abundant, it is possible that both sexes seek out the preferred resource on landmarks as part of a strategy to increase encounters with the opposite sex for reproductive purposes, a strategy analogous to the territorial hilltopping previously mentioned. Such a resource use mating strategy has been suggested for other insect species (Alcock, 1983, Am. Mid. Nat. 109: 309–315). I suggest that *Lytta magister* may adopt such a strategy in certain circumstances.

I thank Joe McAuliffe for companionship in the field. John Alcock graciously helped in identifying the blister beetle for me. The observations were made during field work financed by a Graduate Student Research Grant from the University of Montana.

Paul Hendricks, *Department of Zoology, University of Montana, Missoula, Montana 59812.*

BOOK REVIEW

The Marsh Flies of California (Diptera: Sciomyzidae). By T. W. Fisher and R. E. Orth. Bulletin of the California Insect Survey, Vol. 24. vii + 117 pp., 1983. (Publicity Dept., Univ. Calif. Press, 2223 Fulton St., Berkeley, Calif. 94720; 50 E 42nd St., Rm. 513, N.Y., N.Y. 10036; 2–4 Brook St., London, W1Y 1HA, England). Cost: $20.00.

This is one of the finest regional studies of the taxonomy of a group of flies published during recent years. Fisher and Orth's survey of the Sciomyzidae of California is based on their 20+ year study of western North American sciomyzids, which has involved extensive collecting (including monthly collections at 4 localities in southern California between 1962 and 1966), as well as life cycle work on certain species.

Fisher and Orth examined some 24,000 specimens and published a large number of basic taxonomic papers as background for their review. The study includes 49 species in 13 genera for California, plus 8 species from neighboring states. A key to the genera of Sciomyzidae of America north of Mexico is included, as well as keys to all species in California. The taxonomic treatment of adults is unusually well supported by 223 excellent drawings. Orth's figures of the male genitalia are particularly clear and accurate. Fisher and Orth have made considerably more use of the female genitalia in species recognition than have most specialists in the family. Extensive biological information is included, as well as a table showing the mollusk hosts of California species, with appropriate literature citations. Tables are included to summarize the distribution of adults collected in representative habitats at selected sites, and to summarize temporal distribution. The geographical distribution of each species in California is mapped. The value of using a gas-powered vacuum collector is shown.

The editors and production staff are to be complimented on the excellent format and quality of the publication.

Lloyd Knutson, *Chairman, Insect Identification and Beneficial Insect Introduction Institute, Agricultural Research Service, USDA, Beltsville, Maryland 20705.*

SUMMARY REPORTS OF SOCIETY OFFICERS FOR 1983

EDITOR
(Calendar Year 1983)

A total of 144 manuscripts was received and processed from November 1, 1982 to October 31, 1983. Four numbers of the *Proceedings* were published in 1983. The 868 + viii pages represented 105 regular scientific articles, 20 scientific notes, 2 book reviews, 2 obituaries, 2 announcements, minutes for 9 Society meetings, reports of officers for 1982, table of contents for volume 85, index to new taxa for volume 85, and PS Form 3526. Editorial charges were entirely or partially waived for 15 articles totaling 82 pages. Full editorial charges were paid for immediate publication of 11 articles totaling 87 pages. Seven lengthy articles included full editorial charges for 28 pages. Beginning with the January issue, the *Proceedings* was published in a larger format, 7″ × 10″ rather than the old 6″ × 9″.

In October, the Society published *Memoir* No. 11, *A Systematic Study of the Japanese Chloropidae (Diptera)* by Kenkichi Kanmiya. The 370 page *Memoir* is available from the Society at a cost of $18.00. *Memoir* No. 12, *The Holarctic Genera of Mymaridae (Hymenoptera: Chalcidoidea)* by Michael E. Schauff, is in press and may be available by the end of 1983.

Dr. Raymond J. Gagné was appointed Associate Editor in February. He has processed all incoming manuscripts since his appointment and has been in charge of preparing the January 1984 issue of the *Proceedings*, our 100th anniversary issue. Dr. Gagné attended the Allen Press Editorial Workshop in Lawrence, Kansas, August 25–27.

Publications Committee: E. Eric Grissell, John M. Kingsolver, Wayne N. Mathis, George C. Steyskal, Thomas E. Wallenmaier, Raymond J. Gagné (*Associate Editor*), and David R. Smith (*Editor*).

TREASURER
(1 November 1982 to 31 October 1983)

Summary	General Fund	Special Publication Fund	Totals
On hand, 1 November 1982	30,262.09	27,313.80	57,575.89
Total Receipts	53,910.68	25,703.30	79,613.98
Total Disbursements	49,418.92		49,418.92
On Hand, 31 October 1983	34,753.85	53,017.10	87,770.95

Thomas J. Henry, Treasurer

PROC. ENTOMOL. SOC. WASH.
86(2), 1984, pp. 465–468

SOCIETY MEETINGS

898th Regular Meeting—October 6, 1983

The 898th Regular Meeting of the Entomological Society of Washington was called to order by President Manya B. Stoetzel at 8:00 p.m. on October 6, 1983, in the Naturalist Center, National Museum of Natural History. Forty-four members and twelve guests attended. Minutes of the previous meeting were read and approved with the correction that "Plant Pest Society" should read "Pest Science Society."

Membership Chairman White read the names of the following applicants for membership:

David Adamski, Dept. of Entomology, Mississippi State University.
Victor Blackburn, 15806 Plainview Lane, Bowie, MD.
Miloje Brajkovic, Institute of Zoology, Belgrade, Yugoslavia.
David W. Bushman, 3204 Westfield Avenue, Baltimore, MD.
John T. Doyen, 201 Wellman Hall, University of California, Berkeley, CA.
Frank D. Fee, 522 Fairway Road, State College, PA.
Charles S. King, Box 195, Mahopac Falls, NY.
John W. Kliewer, 9805 Meadow Knoll Court, Vienna, VA.
John LaSalle, Dept. of Entomology, University of California, Riverside, CA.
S. T. Munte, 1216 28th Street, N.W., Washington, DC.
D. P. A. Sands, CSIRO Division of Entomology, Indooroopilly, Qld., Australia.
Miner J. Sloan, Shell Oil Company, 1025 Connecticut Avenue N.W., Washington, DC.
B. A. Steinly, 1008 West College Street, Peoria, IL.
Anne M. Wieber, 719 Hillsboro Drive, Silver Spring, MD.
Brian M. Wiegmann, 8221 Laurel Drive, Baltimore, MD.
Norman E. Woodley, Systematic Entomology Laboratory, USDA, Washington, DC.

President Stoetzel acknowledged the receipt of a bequest to the Society from the estate of the late C. P. Alexander. President Stoetzel also appointed two committees: the Nominating Committee for 1983 consisting of T. L. Bissel, L. M. Russell, T. J. Spilman, Chairman; the Auditing Committee for 1983 consisting of J. M. Kingsolver, R. V. Peterson, D. A. Nickle, Chairman.

The speaker for the evening was Dr. Robert Traub of the University of Maryland School of Medicine, Baltimore, Maryland. His talk was entitled "Adaptive modifications and convergent evolution in fleas, with notes on host specificity and zoogeography." The emphasis in the talk was on the structural and physiological adaptations enhancing survival of the flea on its host. Structure and adaptive characteristics of genal and pronotal combs were used to demonstrate convergent evolution of this character. The relationship of fleas to human diseases was also discussed.

Warren Steiner exhibited specimens of a flea which he found on a ferret badger in Malaysia.

Thomas Wallenmaier exhibited a copy of a "Bibliography of Identification Keys for European Insects" covering 1880–1973.

Visitors were introduced and the meeting was adjourned at 9:00 p.m., after which refreshments were served.

Thomas E. Wallenmaier, *Recording Secretary*

899th Regular Meeting—November 3, 1983

The 899th Regular Meeting of the Entomological Society of Washington was called to order by President Manya B. Stoetzel at 8:00 p.m. on November 3, 1983, in the Naturalist Center, National Museum of Natural History. Thirty-three members and nine guests attended. Minutes of the previous meeting were read and approved with the correction that the speaker at the October 1983 meeting was from the University of Maryland School of Medicine.

Membership Chairman White read the name of the following applicant for membership:

Deborah Waller, 5154 Piedmont Place, Annandale, VA 22003.

Editor David Smith announced that Memoir Number 11, "A Systematic Study of the Japanese Chloropidae (Diptera)" by Kenkichi Kanmiya has now been published.

The Nominating Committee proposed the following slate of nominees:

President-elect: Donald M. Anderson.
Corresponding Secretary: Richard G. Robbins.
Recording Secretary: Thomas E. Wallenmaier.
Treasurer: Thomas J. Henry.
Editor: Raymond J. Gagné.
Program Chairman: Jeffrey R. Aldrich.
Custodian: Victor L. Blackburn.
Membership Chairman: Geoffrey B. White.

Thomas Wallenmaier moved that the motion tabled at the February, 1983 meeting be taken from the table. This motion, that the Society explore means of supporting the Insect Fauna of North America project, was then discussed and President Stoetzel appointed Dr. Wallenmaier to establish a committee to explore the subject.

The speaker for the evening was Mr. Christopher Wagnon, Park Naturalist for the Clearwater Nature Center in Clinton, Maryland. His talk was entitled "*Gryllus* on the Grill—Introduction to Insects as People Food." Mr. Wagnon discussed the use of insects as human food beginning with the ancient Greeks, including detailed answers to the question: Why eat insects? He then described various methods of cooking those insects that are readily available in Maryland. At the conclusion of the talk a demonstration of insect cooking methods was given, and a delicious buffet of insect foods was offered to the members. Delicacies such as "Grasshopper Gumbo," "Hopper Newburg," and "Infested Fudge" were sampled by some of the braver members.

T. J. Spilman showed an article on the biology and control of the cat flea by Olkowski, Olkowski, and Daar, in the IPM Practitioner.

Richard Robbins exhibited photographs of the burial place of the famous naturalist William T. Davis on Staten Island, NY.

Victor Adler described the unusual behavior of female cockroaches that he recently observed.

Thomas E. Wallenmaier, *Recording Secretary*

900th Regular Meeting—December 8, 1983

The 900th Regular Meeting of the Entomological Society of Washington was called to order by President Manya B. Stoetzel at 8:00 p.m. on December 8, 1983, in the Naturalist Center, National Museum of Natural History. Twenty-four members and seven guests attended. Minutes of the previous meeting were read and approved.

Membership Chairman White read the names of the following applicants for membership:

Mary E. Hooker, 2216 38th St., N.W., Washington, DC 20009.
Alexander D. Huryn, Department of Entomology, University of Georgia, Athens, GA 30602.
Michael A. Ivie, Department of Entomology, 103 Botany and Zoology Building, Ohio State University, Columbus, OH 43210.
Laura Torres Latorre, LLanten #26, Col. Xotepingo, Mexico, 21, D.F. C.P. 04610.
Donald G. Manley, Pee Dee Experiment Station, P.O. Box 5809, Florence, SC 29502.
Judith A. Mollet, Department of Entomology, University of California, Riverside, CA 92521.
Benedict B. Pagac, Jr., 427 Yellow Springs South, Laurel, MD 20707.
Richard B. Root, Section of Ecology and Systematics, Corson Laboratories, Cornell University, Ithaca, NY 14853-0239.

Mr. White also gave his annual report, stating that there were 50 new members in 1983.

The Treasurer gave his annual report that appears on page 464 of this issue.

The proposed budget for 1984 is $53,300.00. The Auditing Committee certified that all financial records of the Society were in order.

The Editor gave his annual report, stating that 144 manuscripts were received and processed, four numbers of the *Proceedings* were published, and Memoir No. 11 was published and Memoir No. 12 was in press.

The Custodian gave his annual report.

The Nominating Committee submitted a list of candidates. No nominations were received from the floor. It was moved by Steyskal and seconded by Ramsey that all members on the proposed list of candidates be elected to their respective offices. The motion was unanimously approved.

President Stoetzel presented a proposed change in the Society by-laws to establish the office of Associate Editor as an elected position.

It was moved by Larew and seconded by Aldrich that an ad hoc committee be set up with Larew as chairman to investigate the possibility of the Society establishing a scholarship fund in entomology studies.

The speaker for the evening was Dr. Daryl L. Faustini, Research Scientist, Phillip Morris, Richmond, Virginia. His talk was entitled "Cribriform pore plates: Pheromone production sites in the Coleoptera." Setiferous sex patches on the forelegs of *Tribolium* beetles were discussed. The cribiform plates contained ducts and were the sites of a secretion which was investigated. Using bioassay techniques and gas chromatography, a pheromone was isolated. Then other species of *Tribolium* were examined and histological investigations showed the location of a gland in the foreleg. Many excellent slides were shown.

Ted Spilman noted that the rare book display at the National Agricultural Library is featuring the life and work of C. V. Riley, a noted American entomologist.

At the conclusion of the meeting Manya Stoetzel presented mementos to each of the officers for 1983 in appreciation for their service. The gavel was passed by Manya Stoetzel to the new President, Neal O. Morgan, who adjourned the meeting at 9:45 p.m. Refreshments were served following the meeting.

Thomas E. Wallenmaier, *Recording Secretary*

PUBLICATIONS FOR SALE BY THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

MISCELLANEOUS PUBLICATIONS

ynipid Galls of the Eastern United States, by Lewis H. Weld	$ 5.00
ynipid Galls of the Southwest, by Lewis H. Weld	3.00
Both papers on cynipid galls	6.00
dentification of Alaskan Black Fly Larvae, by Kathryn M. Sommerman	1.00
nusual Scalp Dermatitis in Humans Caused by the Mite *Dermatophagoides*, by Jay R. Traver	1.00
Short History of the Entomological Society of Washington, by Ashley B. Gurney	1.00
ictorial Key to Species of the Genus *Anastrepha* (Diptera: Tephritidae), by George C. Steyskal	1.50
axonomic Studies on Fruit Flies of the Genus *Urophora* (Diptera: Tephritidae), by George C. Steyskal	2.00

MEMOIRS OF THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

o. 1.	The North American Bees of the Genus *Osmia*, by Grace Sandhouse. 167 pp. 1939	$15.00
o. 2.	A Classification of Larvae and Adults of the Genus *Phyllophaga*, by Adam G. Boving. 95 pp. 1942	(out of print)
o. 3.	The Nearctic Leafhoppers, a Generic Classification and Check List, by Paul Wilson Oman. 253 pp. 1949	15.00
o. 4.	A Manual of the Chiggers, by G. W. Wharton and H. S. Fuller. 185 pp. 1952	15.00
o. 5.	A Classification of the Siphonaptera of South America, by Phyllis T. Johnson. 298 pp. 1957	15.00
o. 6.	The Female Tabanidae of Japan, Korea and Manchuria, by Wallace P. Murdoch and Hirosi Takahasi. 230 pp. 1969	15.00
o. 7.	Ant Larvae: Review and Synthesis, by George C. Wheeler and Jeanette Wheeler. 108 pp. 1976	11.00
o. 8.	The North American Predaceous Midges of the Genus *Palpomyia* Meigen (Diptera: Ceratopogonidae), by W. L. Grogan, Jr. and W. W. Wirth. 125 pp. 1979	12.00
o. 9.	The Flower Flies of the West Indies (Diptera: Syrphidae), by F. Christian Thompson. 200 pp. 1981	10.00
o. 10.	Recent Advances in Dipteran Systematics: Commemorative Volume in Honor of Curtis W. Sabrosky. Edited by Wayne N. Mathis and F. Christian Thompson. 227 pp. 1982	11.00
o. 11.	A Systematic Study of the Japanese Chloropidae (Diptera), by Kenkichi Kanmiya. 370 pp. 1983	18.00
o. 12.	The Holarctic Genera of Mymaridae (Hymenoptera: Chalcidoidae), by Michael E. Schauff. 67 pp. 1984	5.00

ack issues of the Proceedings of the Entomological Society of Washington are available at $25.00 per volume o non-members and $13.00 per volume to members of the Society.

rices quoted are U.S. currency. Postage extra except on prepaid orders. Dealers are allowed a discount of 10 er cent on all items, including annual subscriptions, that are paid in advance. All orders should be placed with he Custodian, Entomological Society of Washington, c/o Department of Entomology, NHB 168, Smithsonian nstitution, Washington, D.C. 20560.

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(ISSN 0013-8797)

PROCEEDINGS
of the
ENTOMOLOGICAL SOCIETY of WASHINGTON

CENTENNIAL VOLUME

PUBLISHED QUARTERLY

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THE
ENTOMOLOGICAL SOCIETY
OF WASHINGTON

ORGANIZED MARCH 12, 1884

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All correspondence concerning Society business should be mailed to the appropriate officer at the followi address: Entomological Society of Washington, c/o Department of Entomology, NHB 168, Smithsonian Ins tution, Washington, D.C. 20560.

MEETINGS.—Regular meetings of the Society are held in the Natural History Building, Smithsonian Institutio on the first Thursday of each month from October to June, inclusive, at 8 P.M. Minutes of meetings are publish regularly in the *Proceedings*.

MEMBERSHIP.—Members shall be persons who have demonstrated interest in the science of entomolog Annual dues for members are $15.00 (U.S. currency) of which $13.00 is for a subscription to the Proceedin of the Entomological Society of Washington for one year.

PROCEEDINGS.—Published quarterly beginning with January by the Society at Washington, D.C. Membe in good standing receive the Proceedings of the Entomological Society of Washington. Nonmember subscriptio are $25.00 per year, domestic, and $27.00 per year, foreign (U.S. currency), payable in advance. All remittanc should be made payable to *The Entomological Society of Washington.*

The Society does not exchange its publications for those of other societies.

Please see this issue for information regarding preparation of manuscripts.

STATEMENT OF OWNERSHIP

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PROC. ENTOMOL. SOC. WASH.
86(3), 1984, pp. 469–485

ON THE BIONOMICS, ANATOMY, AND SYSTEMATICS OF *WAGNERONOTA* (COLEOPTERA: MELOIDAE)

RICHARD B. SELANDER

Professor, Departments of Genetics and Development and of Entomology, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801.

Abstract.—Some aspects of the bionomics of *Wagneronota aratae* (Berg), including male courtship behavior, are described from observations made in Catamarca, Argentina. The species is widely distributed in northwestern Argentina, where adults feed on the leaves and flowers of *Zizyphus mistol* (Rhamnaceae) and, occasionally at least, invade potato fields. The pattern of courtship behavior is basically like that of *Pyrota.* The triungulin larva has hypertrophied, extended spiracles on abdominal segment I, a specialization paralleled in the nemognathine genus *Tetraonyx* and in an unidentified Asian *Meloe* but previously unknown in the tribe Lyttini. In the adult stage *Wagneronota* is the largest of the Meloidae, reaching a maximum length of 4½ cm. The larger of two egg masses obtained from captive females (4220 eggs) is, numerically, the largest recorded for a coleopteran. On the basis of behavioral and anatomical characters, Kaszab's assignment of *Wagneronota* to a systematic position near *Pyrota* in Pyrotina is amply confirmed.

Wagneronota aratae (Berg) enjoys the distinction of being, as an adult, by far the largest of all blister beetles and, it seems to me, one of the most handsome. In addition, it may well prove to have the greatest fecundity of any coleopteran. Although named a century ago and familiar to several generations of Argentine and foreign entomologists, the species has nevertheless remained poorly studied anatomically and virtually unknown bionomically up to this time. In this work, intended as the first in a series treating the Latin American lyttine-pyrotine complex of genera, I summarize available distributional data, record recent behavioral observations, describe the egg and triungulin larva, redescribe the adult, and discuss the systematic position of *Wagneronota.*

BIONOMICS

Geographic distribution.—Northwestern Argentina, from Jujuy and Santiago del Estero to Mendoza and San Luis, at low and moderate elevations (2000 m or less) (Fig. 1). The following records are available:

ARGENTINA: *Catamarca:* (DEI, MLP) 6 (1 labeled II-87); Andalgalá, 28-I-60, Willink & Tomsic (IML) 1; Belén, III-39 (IML) 3; Belén to Andalgalá, III-39 (FGW, IML) 2; same, no date (IML) 1; Hualfín, 3-I-49, Ares (IML) 1; 5 km N Santa María, 1900 m, 14-II-83, Selander & Peña (RBS) 28. *Córdoba:* Guanaco Muerto, X-72, Martínez (AM) 1. *Jujuy:* (Bosq, 1943). *La Rioja:* (AM, BM, IML)

8; Mascasín, XI-61, from Walz (RBS) 20, II-64, Martínez (AM) 5. *Mendoza:* (BM, MLP) 3. *Salta:* (MLP) 1; San Carlos, 21-I-50, Monrós (IML) 1. *San Juan:* (MLP) 1; Astica and Usno (Viana and Williner, 1973). *San Luis:* San Gerónimo (Viana and Williner, 1972). *Santiago del Estero:* 25-II-47, Meyer (IML) 4; no date, Wagner (MLP) 1; Campo Grande, III-43 (AM) 1; Fernández, II-58, from Walz (RBS) 8; Fries, I-52 (AM) 1; Icaño, Wagner (MLP) 10; Río Salado, Kohler, Mason (BM, FREY, MLP, USNM) 8; Sumampa (Villa Union), X-44, Prosen (AM) 1. *Tucumán:* (MLP) 2; Amaicha del Valle, 1978 m, 23/27-XII-64, Selander & Storch (RBS) 2, 1-II-64, Heller (IML) 1. *Country label only:* (BM, FREY, IML, MLP) 7.

Seasonal distribution.—Adults have been collected from October to March. Three-fourths of the records fall in the period January–March.

Habitat and feeding behavior.—The only food plant recorded previously is potato (*Solanum tuberosum*). According to Bosq (1943), adults are found "frequently in plantings . . . , eating the leaves." Hayward (1960) reported damage to potato plants in Tucumán. But despite these reports, the species apparently does not invade potato fields with any regularity, since it is not mentioned in any of several Argentine works devoted to potato pests (e.g., Blanchard, 1929). Two adults (male and female) that R. Storch and I took at light in Amaicha del Valle, Tucumán, in 1964 refused both *Solanum elaeagnifolium* and lettuce.

On the afternoon of 14 February 1983, while collecting with me near Santa María, Catamarca, Luis Peña called my attention to an adult of *Wagneronota aratae* feeding on a flower of a small tree later identified as representing *Zizyphus mistol* (Gris.) (Rhamnaceae). This plant, commonly called *mistol,* is widespread in northwestern Argentina, where it is well known as a source of edible fruit, medicinal products, and wood (Alvarez, 1919). In the Santa María Valley we found it restricted largely to the flood plain of the Río Santa María and adjacent low, sandy areas supporting xerophytic vegetation. For several days we had collected from this plant more or less casually, taking *Epicauta atomaria* (Germar) and a similar, unidentified *Epicauta* in small numbers. Stimulated by Peña's discovery, we now began to examine *Zizyphus* trees in earnest and shortly found a population of 70 *Wagneronota* in a small tree, near a cultivated field (Fig. 2).

The beetles were distributed from the top of the tree (at about 5 m) to middle height, for the most part in dense groups. Both here and in captivity they freely permitted contact with other individuals. Their first response when approached was to hold still; subsequently they began to crawl over the vegetation, and about 10 individuals took to flight, heading downwind at heights of 5–7 m. Later the same day we returned to the tree and observed the remaining beetles (about 30 in all) until dark. At first they were concentrated in two compact groups, often standing on each other, with very little movement, and that quite leisurely. As it grew darker, individuals began to clean themselves and then to move out, crawling up the stems and occasionally nibbling on a leaf or flower. There was no courtship earlier in the day or at this time. At 8:30 pm we turned on the car lights, close to the tree, but none of the beetles was attracted to the lights. The next morning only a single adult remained in the tree, and it had left by the afternoon of the next day. On that afternoon I made a transect running a mile north from the tree, examining about 75 *Zizyphus* trees for *Wagneronota* without success. Considering the apparently low population density of adults in the area and their highly

Fig. 1. Geographic distribution. Open circle represents a provincial record.

gregarious behavior, it would seem that we had been decidedly fortunate in finding even one group.

The sample of adults obtained near Santa María was maintained in captivity for two weeks with virtually no mortality on a diet of *Zizyphus* leaves and flowers.

Grooming.—The antenna is cleaned by passing it through the mouthparts. This behavior involves trapping the antenna in the angle between the forefemur and foretibia, bringing the foreleg in front of and slightly below the mandibles, and

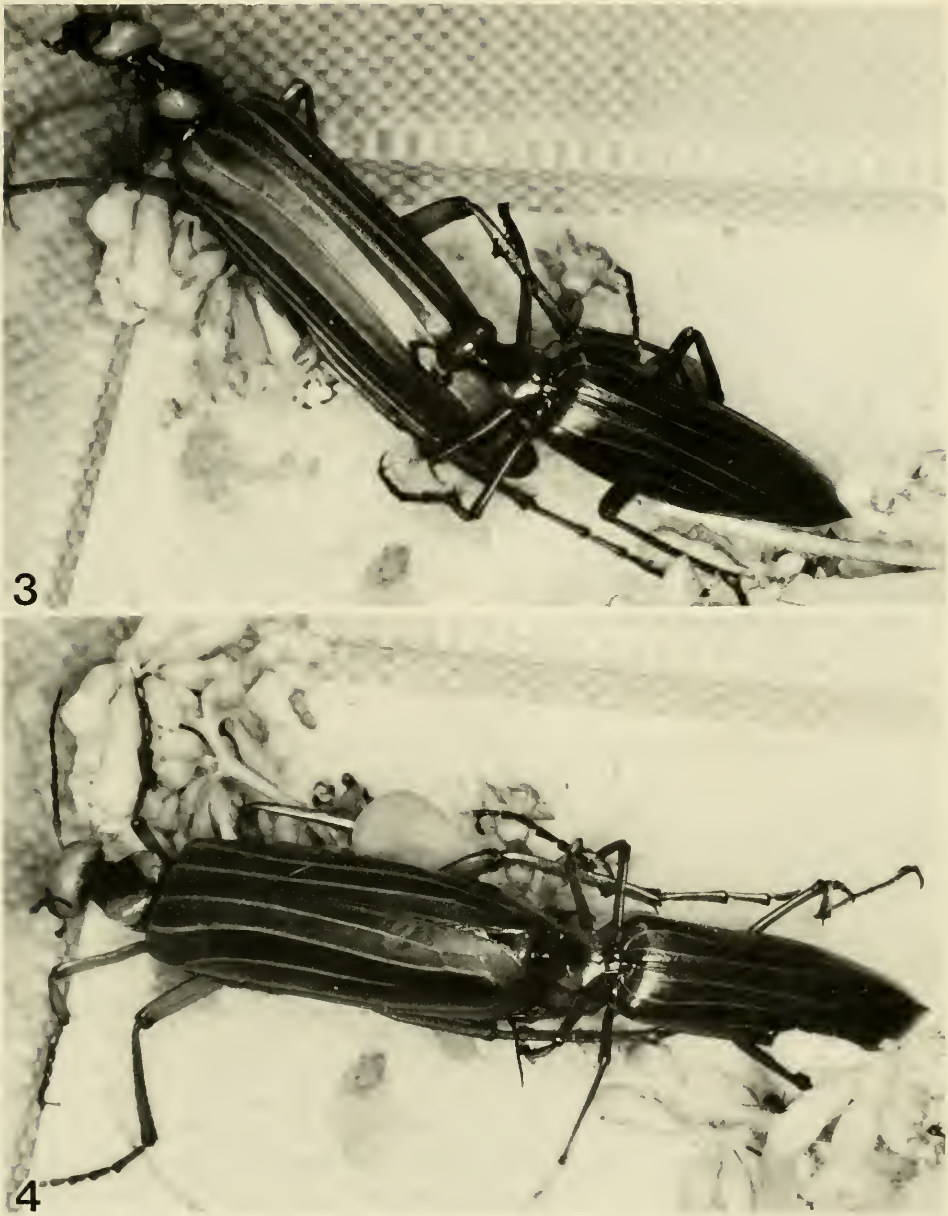
Fig. 2. *Zizyphus mistol* tree that supported a large aggregation of adults of *Wagneronota aratae* in the Río Santa María Valley, 1900 m, Catamarca, Argentina. Chilean entomologist Luis E. Peña in the foreground.

holding it there to brace the antenna as it passes from base to apex through the mouthparts. The elytra are cleaned by brushing the mid- and/or hindlegs over them. The forelegs clean the other legs and are then cleaned with the mouthparts.

Courtship.—Although some of the beetles were feeding in the afternoon when we first found them, in captivity they were almost totally inactive in the presence of light. Yet when the light in the room was extinguished at night we could soon hear the beetles moving about in their cages, and by leaving them in the dark for an hour or more and then turning on the light I was able to observe and photograph courtship, feeding, and other behavior.

In all I observed perhaps 20 bouts of courtship behavior, largely involving females which were disturbed and moving. None of the bouts lasted more than a few minutes after observation began and none led to copulation. Under the circumstances, my observations are sufficient only to establish some of the more obvious features of the behavior, and in particular the positional relationships of the male and female.

The male remains fixed behind the female, with his head at or near the end of her elytra. From this position he grasps each of her hindtibiae with his corresponding forelegs by pinching the tibia between the fourth and fifth tarsal segments. Often he holds the middle of the tibia, but the grasp may be made at or near the base or slip to that position from the middle. The male's mid- and hindlegs generally remain on the substrate, but I occasionally saw a male grasp the female's hindtibiae with the midtarsi as well as the foretarsi. Initially and later, during interruptions of antennation, the male's antennae are directed diagonally forward.



Figs. 3–4. Courtship behavior. 3, Male in usual position behind female. 4, Male with head inserted under female's elytra.

Once in position the male lowers the head and presses the mouthparts on the female, with the maxillary palpi spread to the sides and in extensive contact with her elytra or abdomen. The antennae are then folded at the joint between segment I, which projects forward and down, and segment II, directing the flagella obliquely back and down, where they are vibrated rapidly against the female in extended bouts (Fig. 3). Initially and periodically thereafter the male tries to insert the


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Fig. 5. Courtship behavior, showing beginning of abdominal curvature.

mouthparts under the ends of the female's elytra, evidently in an effort to make palpal contact with the dorsum of her abdomen. Rarely the entire head was thrust under the female's elytra (Fig. 4). While antennation is in progress, the male curves the abdomen forward (Fig. 5), eventually bringing the apex of his genitalia to the tip of the female's abdomen, where it is held at least momentarily. In a few cases I detected a single genital stroke, in which the end of the abdomen was brought under the female's abdomen and then brushed back over the last one or two sterna, before the actual genital presentation.

Antennation was continuous during both abdominal curvature, stroking, and genital presentation. Commonly the female moved her legs or body in response to genital presentation, interrupting the male's behavior.

In none of my observations did the male mount the female or touch her with the antennae when they were extended forward. Nor did he ever release his grasp of the female's hindtibiae while courtship was in progress. I suspect that genital presentation occurs cyclically when the female is relatively calm and sedentary and that, as part of the cycle, antennation is periodically either modified in form or spontaneously interrupted.

So far as observed, the courtship behavior of *Wagneronota* is very similar to that of species of *Pyrota* Dejean (Selander, 1964). The principal distinctive features of *Wagneronota* are (1) ability and apparent willingness of the male to perform antennation and genital presentation without inserting the mouthparts beneath the female's elytra and (2) the apparent lack of a mounted phase of courtship, in which the male releases the leg grasp, moves forward over the female, and antennates and palpates her body from a fully mounted position.

The male's foretarsal grasp is facilitated by modifications of the last two segments of the tarsus described and illustrated by Denier (1932), who conjectured (wrongly) that they might be adaptive in manipulating the female's antennae. Modifications of the male's antenna and maxillary palpus are relatively slight. The antenna is longer and thinner than in the female. The last two segments of the maxillary palpus are a little enlarged and are flattened ventrally, but membranous, densely setate areas, present ventrally on one or both of these segments in most species of *Pyrota*, are lacking. Since rubbing of the palpi over the elytral surface of the female is a conspicuous feature of the mounted phase of courtship in *Pyrota*, the weakness of the modification of the palpus in *Wagneronota* might be interpreted as evidence that the phase is absent. However, some species of *Pyrota*, such as *P. mutata* Gemminger, with no stronger modification of the palpus than in *Wagneronota* nevertheless have a fully developed mounted phase. As in *Pyrota*, the posterior margin of the male's last visible abdominal sternum is turned dorsad distally, evidently as an adaptation for genital presentation from directly behind the female.

Response to contact.—As indicated above, the adults commonly rest and feed in proximity to each other. In such situations and in other encounters there was no suggestion of antagonism among them. Physical contact with conspecifics seemed to be ignored generally, although I occasionally saw an individual lower the head and antennae when another one walked over him. Yet throughout the period that I kept adults in captivity they remained unusually sensitive to foreign stimuli, both visual and tactile. As an example of this sensitivity, a male that I touched lightly with my finger remained absolutely motionless for 20 minutes. When handled roughly adults "feigned death," flexing the legs (but not drawing them in closely to the body) and occasionally producing droplets of yellow fluid at the femorotibial joints.

Eggs.—Captive females produced four egg masses, two of which I recovered intact. The eggs are subcylindrical, tapered moderately from the middle to the posterior end, and blunt at both ends. The color is pale yellow. Mean length in a sample of 7 unhatched eggs was 1.37 (.013) mm and mean width .37 (.003) mm. Estimated egg volume, applying the formula for the volume of a cylinder, is .144 mm^3. The eggs have a sweet, perfume-like odor that was immediately detectable when the cages in which they were laid were opened. I have noted the same or a very similar odor in vials of eggs of several species of *Epicauta*.

The two intact egg masses of *Wagneronota* contained 3780 and 4220 eggs, respectively. Numerically, the latter mass is by far the largest recorded for a meloid. The previous record for a single oviposition was 3854 eggs, laid by a female of *Meloe laevis* Leach (Pinto and Selander, 1970). Unless the adult life of *Wagneronota* is unusually short for a meloid, and there is nothing to suggest that it is, the total number of eggs produced by a female of *Wagneronota* probably exceeds that of any other beetle.

Incubation time, at ambient temperature and 100% RH, was 12 days for three egg masses in which hatching occurred.

DESCRIPTION OF TRIUNGULIN LARVA

Figs. 6–8

Color uniform light brown. Cuticle of posterior dorsal surface of head and anterior ⅓ of meso- and metanotum distinctly reticulate; reticulations coarse, transverse.

Head transversely oval, nearly 1¼× as wide as long. Epicranial suture complete

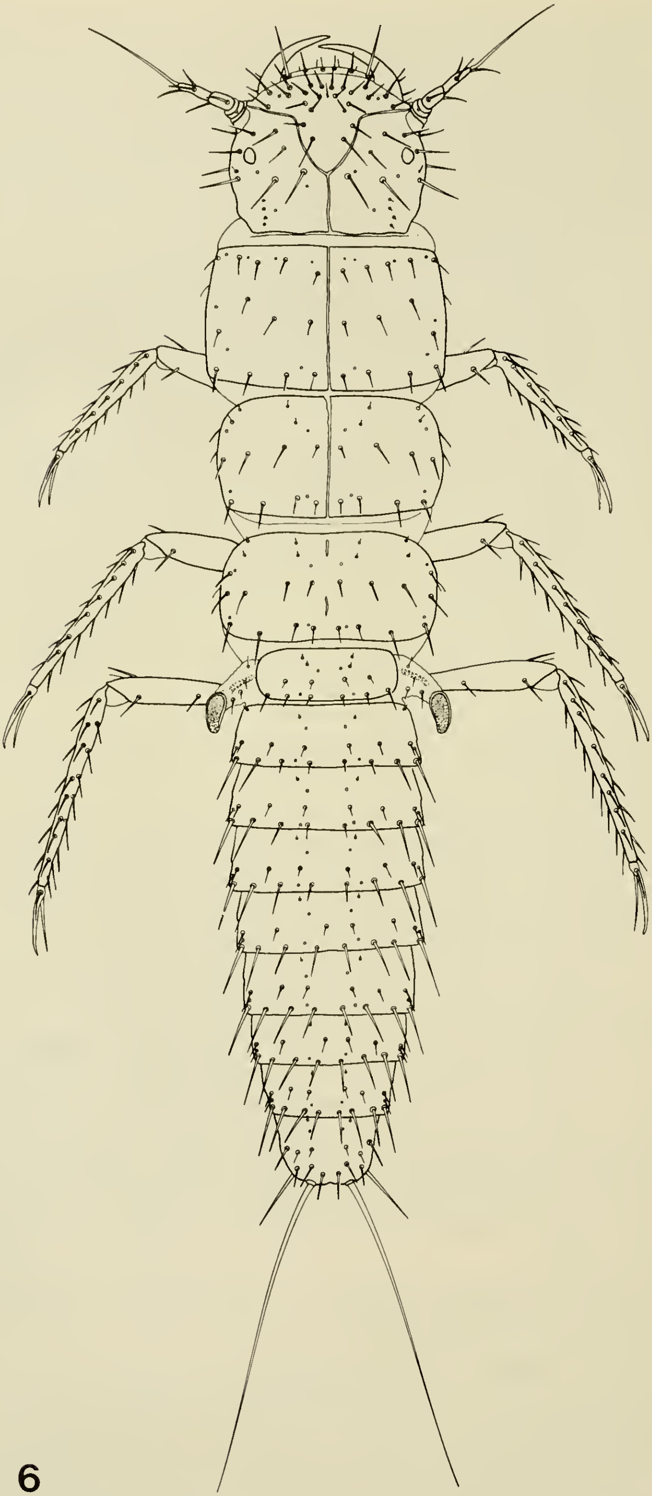

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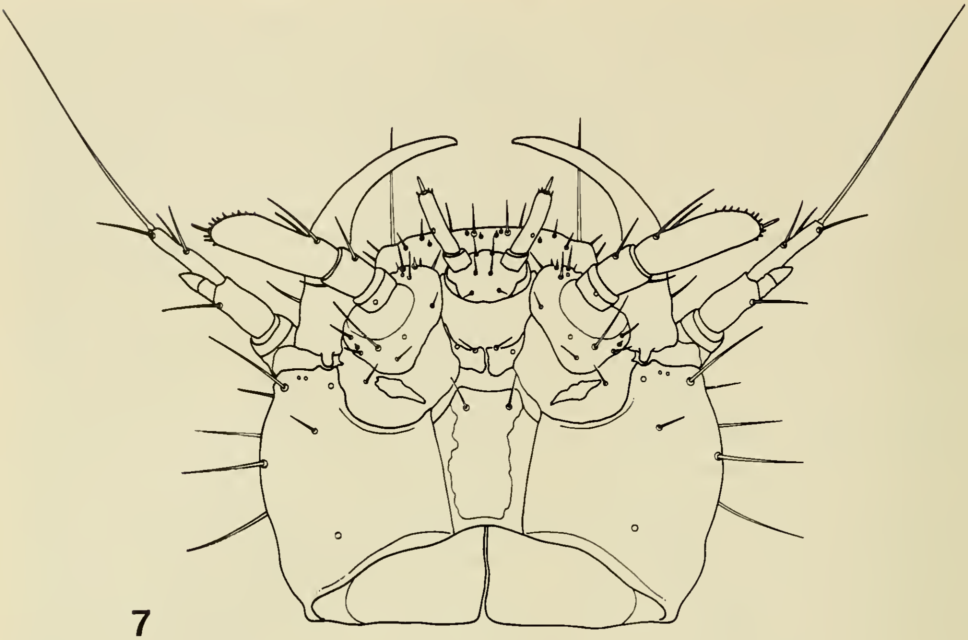
Fig. 6. Triungulin larva, dorsal view.

to base of mandible; stem about ⅓ as long as head. Six major setae on posterior dorsal surface of head; these and major lateral setae on each side about ¼ as long as head. Front with 4 setae between arms of epicranial suture before they turn laterad; transverse row of 8 setae between antennae and similar row of 8–9 setae on anterior margin. Clypeus with similar median transverse row of 8 setae. Gula longer than wide; anterior margin projecting well anteriad of anteroventral margin of head capsule; gular setae surpassing anterior gular margin. Labrum well sclerotized, only partially recessed, about ½ as wide as head; six dorsal marginal (DM) setae; DM_1 short; ratio of lengths of DM_1, DM_2, and DM_3 1:1.5:3.5; DM_3 as long as maxillary palpal segment III. Eye small, slightly longer than wide; greatest diameter equal to width of maxillary palpal segment II. Mandible slender, lacking teeth, $\frac{7}{10}$ as long as head. Antennal segment I short, 1¾× as wide as long; II 2× as long as wide, 2¼× as long as I, with 2 setae, which are nearly as long as segment; sensory appendix long, slender, acute, about ⅗ as long as II, its basal ⅓ a membranous tube; cone itself ⅗ as long as wide; III slender, 5× as long as wide, 1½× as long as II, with 3 setae like those on II, terminal seta 2⅗ as long as III. Maxilla with seta of cardo in membrane, not on sclerite; mala ventrodistally with 2 moderately long setae, 1 short seta, and 1 cone-like, 2-segmented sensory appendix, dorsally with 4 setae along median margin and 2 along distal margin. Maxillary palpus large, prominent; segment I short, about ¾ as long as antennal segment I, 2× as wide as long; II as wide as long, 2× as long as I, with seta on each side, about as long as segment; III nearly 3× as long as wide and nearly 3× as long as II, basally with long mesolateral and 2 dorsal setae, all attaining sensory area or nearly so; sensory area of III oblique, extending to distal ⅖ of segment, set with 40 large papillae (cone-like setae); 2-segmented sensory appendix very long, slender, ⅕ as long as segment. Labium with prementum II divided on midline, each half with short seta and sensory pit; prementum I with 3 pairs of setae ventrally and anterior marginal row of 4 short, stout setae dorsally. Labial palpus elongate, slender; segment I as wide as long, as long as maxillary palpal segment I; II cylindrical, slightly curved, 3× as long as wide, 3× as long as I, with 2 dorsobasal setae, nearly attaining apical sensory area; apex of II with 7 short setae, 5 of these on oblique dorsal sensory area; 2-segmented sensory appendix of II about $\frac{3}{10}$ length of segment, 2× as wide as appendix on maxillary palpal segment III.

Thorax with line of dehiscence complete on pro- and mesonotum, faintly indicated, discontinuous on metanotum; setae short or of moderate length. Pronotum rectangular, ⅗ as long as wide, nearly as long, and more than 1½× as wide, as head; 28 major setae, roughly in 3 rows; posterior (marginal) row (PR) with 8 setae; PR_3 and PR_4 more than 2× as long as PR_1 and PR_2. Meso- and metanotum oval, about ½ as long as wide, slightly narrower than pronotum. Mesonotum with 20 major setae, primarily in 2 rows; lateral setae longer than median setae; PR with 8 setae. Prosternum with paired setae in anterior (AR), median (MR), and posterior (PR) rows long; ratio of lengths of AR_1, MR_1, and PR_1 1:1:1.8; AR_1 slightly longer than maxillary palpal segment III. Meso- and metasternum with setae AR_1 tiny; MR_1 and PR_1 slightly longer than counterparts on prosternum.

Abdomen with sterna of all segments heavily sclerotized; pleurites separated from tergites by very fine suture; tergites with setae in median row (MR) short; median setae in MR and PR shorter than lateral ones, difference progressively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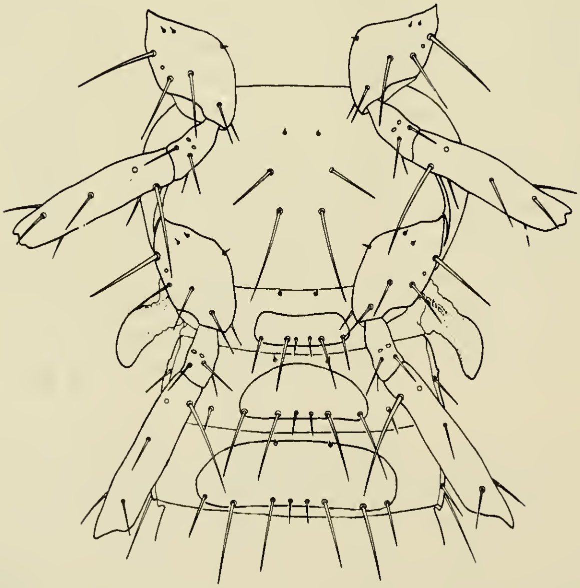
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Figs. 7–8. Triungulin larva. 7, Head, ventral view. 8, Metathorax and abdominal segments I–III, ventral view.

less marked posteriad. Segment I with spiracle greatly enlarged, located on prominent lateral, membranous, tubular extension of segments; tube with 3 dorsal setae; atrium funnel-shaped, lined with hexagonal cellular reticulation; peritreme pyriform; tergite I narrower than rest, with only 4 setae in MR and only 6 in PR;

ratio of lengths of PR_1, PR_2, and PR_3, roughly 1:2:4. Sternite I narrowed, rectangular, 2× as wide as long, with only 6 setae in PR; PR_2 longer than PR_3, more than 2× as long as PR_1. Segments II–VIII similar to one another in form and setation; tergites with 8 setae in MR and 8 in PR; MR_4 caudad of others in MR, near base of PR_4; 2 setae (1 marginal) on pleurite, both large; sternites with 8 setae in PR. Tergite V $^3/_{10}$ as long as wide, ratio of lengths of setae PR_1, PR_2, PR_3, and PR_4 about 1:1.3:1.6:1.7; PR_4 ¾ as long as tergite. Sternite II narrowed, with seta PR_4 in membrane laterad of sternite; setae on sterna III–VIII all on sternites. Sternite V nearly ⅖ as long as wide; ratio of lengths of setae PR_1, PR_2, PR_3, and PR_4 about 1:2.3:2.3:1.3; PR_2 as long as sternite. Segment IX with row of 10 long setae ventrally at anus; caudal seta 5½× as long as tergite V; adjacent large seta ⅕ as long as caudal seta.

Mesothoracic spiracle smaller in diameter than eye; abdominal spiracles II–VIII subequal to one another in diameter, ½ diameter of mesothoracic spiracle.

Legs long, slender, without lanceolate setae. All segments of legs II and III noticeably longer than those of leg I; tibia III nearly 1½× as long as tibia I. Ratio of lengths of femur, tibia, and tarsungulus 1:1.2:0.5 on leg I, 1:1.5:0.4 on leg III. Femora with ventral major seta set near base. Tarsungulus with ventral (bladelike) seta nearly attaining apex.

Body length 2.0 mm; caudal seta length .55 mm.

Remarks.—In numbering the setae in a transverse row I follow my previous convention (Selander, 1982) of counting from the midline of the body.

If one ignores the shape of the gula, *Wagneronota* keys to *Pyrota* in MacSwain (1956). Moreover, it agrees in nearly every character with his diagnoses of the tribe Pyrotini (which I prefer to regard as a subtribe of Lyttini) and genus *Pyrota.* MacSwain's (1956) study included only three pyrotine species, all belonging to *Pyrota.* Since his study appeared I have obtained the larvae of 11 additional species of *Pyrota,* and on the basis of these and the larva of *Wagneronota aratae,* I would modify MacSwain's diagnosis of the Pyrotina to read as follows:

Labrum at least partially recessed beneath head. Mandible slender, lacking teeth. Antennal segment II long, much longer than wide. Abdomen with fine suture between tergites and pleurites. Abdominal tergites II–VIII with 8 setae (not 6 as stated by MacSwain) in median row; lateralmost seta (MR_4) caudad of others, near base of PR_4. Abdominal sternum well sclerotized, with large, undivided sternite on each of segments I–IX; sternite I with setae of PR reduced from 8 to 6; II with seta PR_4 in membrane at side of sternite. Abdominal spiracle I much larger than others on abdomen, dorsal, on tergite; spiracles II–VIII lateroventral, on pleurites. Legs without lanceolate setae.

Among the many differences between *Wagneronota* and *Pyrota,* the following are noteworthy: In *Wagneronota* (1) the gula is elongate; (2) the maxillary palpus is enlarged; (3) there are fewer setae on the dorsum of the epicranium and on the thoracic nota and fewer (8 rather than 10) in the PR of abdominal tergites II–VIII; (4) in the PR of the thoracic nota and abdominal tergites the median setae are shorter than the lateral setae; and (5) abdominal spiracle I is hypertrophied and located on a lateral extension of the abdomen.

There is nothing in *Pyrota* comparable to the elaboration of abdominal spiracle I in *Wagneronota.* Marked hypertrophy and extension of this spiracle is, however, characteristic of the nemognathine genus *Tetraonyx* Latreille (MacSwain, 1956) and an unidentified species of *Meloe* Linnaeus from Turkestan described by Zakhvatkin (1932). In all three cases the enlarged peritreme is connected to the trachea by a deep funnel-shaped atrium, the sclerotized surface of which is strongly reticulate. The reticulation in *Wagneronota* forms what appear to be hexagonal cells but are actually deep cups, each containing a blunt median papilla. In the *Meloe,* judged from Zakhvatkin's work, the pattern is precisely the same. Zakhvatkin illustrates this pattern also for the mesothoracic spiracle and abdominal spiracle III, and it is present in at least the mesothoracic spiracle of *Wagneronota* (I cannot determine the nature of the atrial lining of the small spiracles on abdominal segments II–VIII). In many species of *Tetraonyx* the atrium has a similar, cellular structure but the cups lack median papillae; in other species the reticulation takes the form of large rectangular cells, with a row of long setae or spines lining the atrium internally near its middle. On all tracheal branches leading to abdominal spiracles in *Wagneronota* there is a sclerotized bar or lever that is evidently capable of pinching off the trachea. What appears to be essentially the same mechanism was described and figured for the *Meloe* larva by Zakhvatkin. Both *Wagneronota* and the *Meloe* retain the full complement of abdominal spiracles; in *Tetraonyx* spiracles II–V are unusually small and VI–VIII have been lost (MacSwain, 1956).

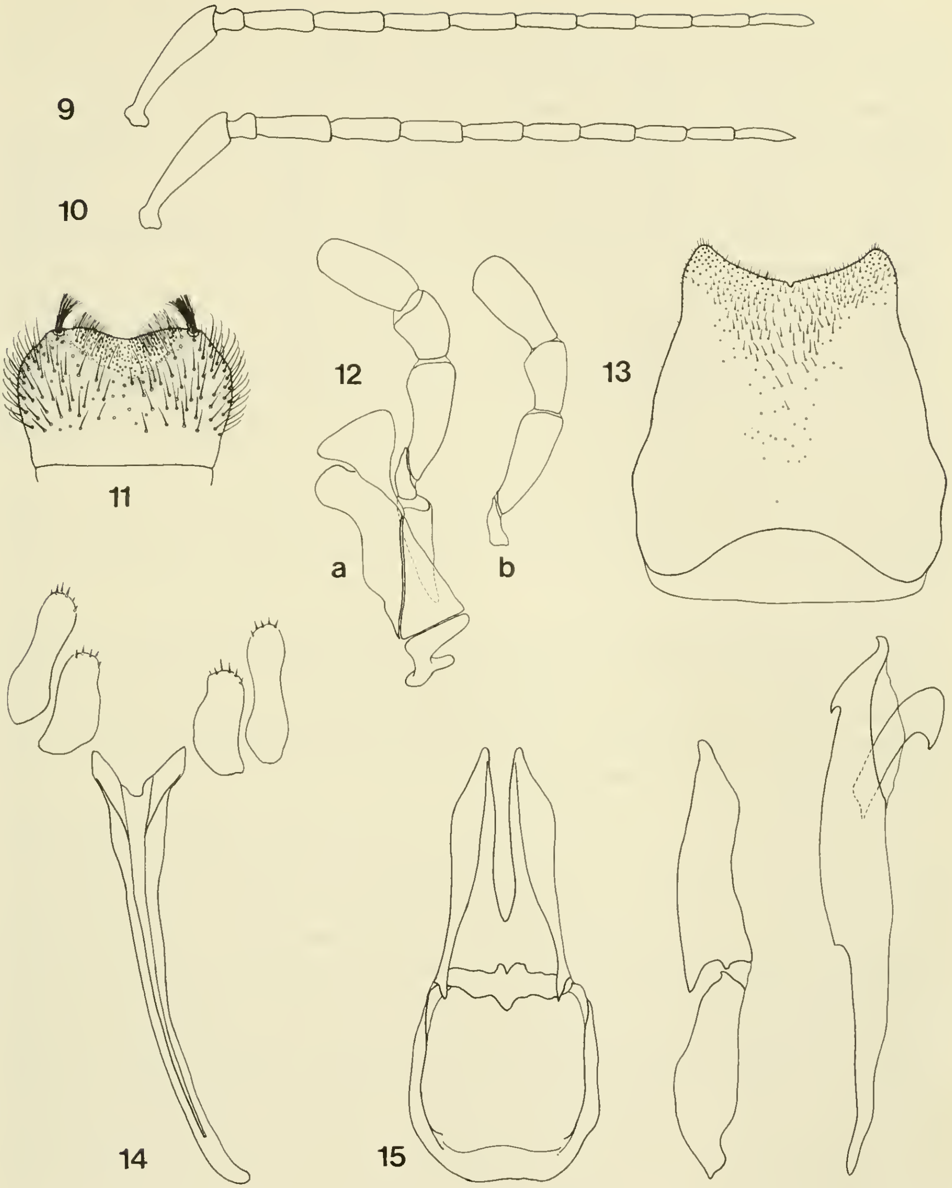
In *Meloe* the spiracular extension is apparently consolidated with abdominal tergite I. In *Tetraonyx* the extension, although itself sclerotized externally, arises from a membranous lateral area of the abdomen. In both genera the extension is just large enough to contain the enormous atrium. In *Wagneronota* the extension is only partially filled by the atrium and is sclerotized only in the distal region surrounding it, thus allowing for, presumably, considerable amplitude of movement. In this genus, at least, it is evident that the extension has some function other than accommodating the atrium.

While both *Meloe* and *Tetraonyx* are phoretic as triungulins, hypertrophy of abdominal spiracle I is apparently not directly adaptive in phoresy, since *Wagneronota* is non-phoretic. Because of its open form, it seems unlikely that the atrium guards the trachea against dust or pollen grains. One possibility worth investigating is that the atrium is capable of trapping an air bubble. In larvae feeding on liquid provisions of a host bee this might provide a temporary supply of oxygen and prevent flooding of the trachea if the abdomen were submerged in the food.

Description of Adult

Figs. 9–15

Head largely orange; median spot on vertex, anterior ½ of clypeus, narrow margin around eye, and entire underside of head black; black spot on vertex rarely expanded to fuse with eye margining. Labrum, mandibles, antennal segments I–II, maxillary palpus, and last segment of labial palpus orange, finely margined with black. Antennal segment III piceous; rest of flagellum black. Pronotum black in anterior ½, orange in posterior ½ except along margins and on disk, where anterior black area extends posteriad as a broad triangle nearly reaching basal margin. Scutellum black. Elytra immaculate orange-brown. Hind wings dark brown, with apical region and posterodistal margin pale. Legs, except for piceous forecoxa, orange, often darker than head and pronotum. Venter of body black except last



Figs. 9–15. Adult anatomy. 9, Antenna, male. 10, Antenna, female. 11, Labrum, female. 12, Maxilla, male (a), and maxillary palpus, female (b), ventral views. 13, Sixth (visible) abdominal sternum, male, ventral view. 14, Abdominal segment IX, male, dorsal view. 15, Genitalia, male (ventral and lateral views of gonoforceps, lateral view of aedaegus).

2 visible abdominal segments deep orange and preceding 2 sterna with an orange lateral spot. All clothing setae except minute erect setae on head and elytron black. Length 18–45 mm, usually 30 mm or more.

Head quadrate; greatest width above eyes about $^{9}/_{10}$ length (to base of labrum); dorsal margin rounded; tempora poorly defined; median sulcus poorly developed;

vertex flattened above eye; front flat; antennal callosity small, hardly elevated; cuticle of vertex and front of head very shiny, smooth, with few very small, scattered punctures, superficially glabrous but actually with minute seta in each puncture; underside of head sparsely, very finely punctate, with erect setae of moderate length. Labrum finely, sparsely punctate, emarginate, with conspicuous, dense tuft of setae on each side of emargination. Maxilla with galea broadly triangular; lacinia rounded; palpal segments moderately heavy, not elongated. Labium with segment III unusually small, glabrous. Eye very large, broad, prominent. Antenna slender, extending several segments beyond base of pronotum; segment I much longer than others, becoming progressively thicker distad; flagellum filiform, with segments elongate, compressed. Neck densely punctate.

Pronotum $\frac{9}{10}$ as wide as long; sides rather evenly convergent from middle to apex, with distinct subbasal angle, often produced as a massive spine; disk weakly concave in apical ⅓, flat elsewhere; cuticle as on vertex, with center of disk nearly impunctate. Scutellum small, rounded apically; exposed portion impunctate.

Elytron with 3 strongly elevated costulae; cuticle much less shiny than head and pronotum, densely, finely punctate, superficially glabrous but actually with minute, widely scattered setae; intervals between punctures microgranulate and punctulate.

Thorax with venter very finely punctate, clothed with long, fine black setae which are apparently easily lost through abrasion; mesepisterna distinctly separated on midline, each with well defined marginal area which is moderately tapered medianly but not acuminate. Abdominal sternum sparsely, very finely striopunctate, with fine, short setae; fifth (visible) sternum broadly, shallowly emarginate. Pygidium shallowly emarginate.

Legs long, slender, for most part sparsely setate. Tibiae straight, not bowed; posteroventral margin of foretibia pubescent, densely lined with recumbent, sericeous setae; dorsal edge of midtibia densely lined with short, coarse, setae of uniform length. Fore- and midtibial spurs slender, spiniform; hindtibial spurs thickened, outer one especially so, at least 2× as wide as inner spur; both spurs obliquely truncate, apically acute. Tarsi laterally compressed; segments not bilobed; pads (pale ventral pubescence) well developed, dense, parted on foretarsus, finely divided on midtarsus, broadly divided on hindtarsus; claws not denticulate.

Male.—Eye larger and proportionately wider than in female. Antenna longer; segment I and flagellar segments more elongate in form; basal flagellar segments tending to be weakly curved. Maxillary palpus with segments III and IV somewhat shortened, flattened ventrally but not otherwise modified. Sixth (visible) abdominal sternum with posterior margin turned abruptly dorsad, providing an extensive, sclerotized vertical surface between prominent, divergent, angulate lateral lobes; dorsal margin fringed with setae; segment IX as in Fig. 14. Genitalia as in Fig. 15; aedeagus with 2 well developed hooks; dorsal hook massive. Legs longer than in female. Foretarsus moderately swollen; last segment strongly curved, with pad rounded, confined to base of segment; ventrolateral slots in segment widened and deepened, providing for extreme flexure of tarsal claws.

Female.—Sixth abdominal sternum truncate, with shallow depression on midline in posterior ½.

Remarks.—In addition to genitalic characters and modification of the male's foretarsi for grasping the female's hindlegs in courtship, the male differs from the

Table 1. Comparison of anatomical ratios in males and females. For each sex, N = 10.

Ratio[a]	Males Mean	Males SE	Females Mean	Females SE	t	P
Head: W/L	.91	.010	.93	.008	−1.603	.126
MDE/Head W	1.07	.007	1.03	.007	3.710	.002
Eye: W/L	.62	.007	.59	.005	3.884	.001
MDE/ID	2.36	.032	2.26	.025	2.476	.023
Ant. I L/Head W	.59	.011	.48	.004	9.890	<.001
Ant. III L/Head W	.31	.005	.26	.003	21.279	<.001
Pron.: W/L	.86	.012	.88	.019	−.949	.355
Foretib. L/Pron. L	1.46	.024	1.25	.017	7.166	<.001
Hindtib. L/Pron. L	2.03	.033	1.88	.024	43.862	<.001

[a] W = width, L = length, MDE = maximum distance across head at eyes, ID = interocular distance on front.

female in having larger eyes and longer antennae and legs. As indicated in Table 1, the male eye is both wider and more prominent than in the female. The degree of dimorphism of the eyes, as reflected in the ratio MDE/ID, is comparable to that in the Tenuicostatis Group of *Pyrota* (Selander, 1983). Mean ratios for the two sexes are nearly identical to those in *P. tenuicostatis* (Dugès), which, like *W. aratae,* is apparently strongly nocturnal. Greater mean length of antennal segments I and III in the male is established in Table 1 on the basis of sexual comparison of the ratios of length of these segments to the width of the head. The magnitude of the sexual difference in leg length is indicated using the ratios of the lengths of the fore- and hindtibia to the length of the pronotum. Mean relative foretibial length is 17% greater in the male than in the female; the comparable value for the hindtibia is 8%.

As shown in Table 1, there is no significant sexual dimorphism in the ratio of width to length for either the head or pronotum.

In the description of the adult given above maxillary palpal segments designated III and IV are, respectively, the penultimate and ultimate. I have for some time incorrectly regarded the meloid maxillary palpus as being 3-segmented. Segments designated II and III in some of my previous papers are, properly, III and IV. (I refer here specifically to free palpal segments; if Schneider (1981) is correct in asserting that the fixed palpifer on the dorsal surface of the body of maxilla is a true palpal segment, the palpus is actually 5-segmented.)

SYNONYMY

Genus *Wagneronota* Denier

Wagneria Denier, 1932: 90; 1933: 241.

Wagneronota Denier, 1935a: 26 [New name for *Wagneria* Denier (1932), preoccupied in Diptera]. Kaszab, 1959: 77.

Type-species: Lytta aratae Berg; fixed by original designation and monotypy.

Wagneronota aratae (Berg)

Lytta aratae Berg, 1883: 66 [Holotype (unique), male, from Mendoza Province, Argentina, Brachmann, in Berg Collection, Museo de La Plata, examined].

Epicauta aratae, Bruch, 1914:403.
Wagneria aratae, Denier, 1932: 91–92, figs. c–g.
Wagneronota aratae, Denier, 1935b: 170. Hayward, 1960: 23. Viana and Williner, 1972: 16; 1973: 15.
Wagneronota aratai [*sic*], Bosq, 1943: 12. Kaszab, 1959, fig. 2.

SYSTEMATIC POSITION OF *WAGNERONOTA ARATAE*

Denier (1932) noted an affinity between *Wagneronota* and *Pyrota* but suggested an even closer relationship between *Wagneronota* and the Old World *Cyaneolytta* Péringuey. Kaszab (1959, 1969) included *Wagneronota* in the Pyrotini, where the genus is shown in his phylogenetic tree (1959) as the closest relative of *Pyrota.* While adults of *Cyaneolytta* have the slender body form of *Wagneronota* and in many species attain relatively large size, I see no real basis for postulating a special relationship between the two genera. For one thing, *Cyaneolytta* has none of the male secondary sexual modifications found in *Wagneronota.* Morever, as Kaszab (1959) has shown, *Cyaneolytta* is typically lyttine in that vein M_2 in the apical region of the hindwing arises at the juncture of media with cubitus rather than further anteriad, at the point where the vertical vein meets the base of media. On the other hand, whether one considers sexual behavior, larval anatomy, or adult anatomy, *Wagneronota* is basically very similar to *Pyrota.*

Kaszab (1959) did not justify his phylogenetic arrangement of the pyrotine genera, which in my opinion seems quite arbitrary. I know of no derived characteristic shared only by *Wagneronota* and *Pyrota* that would justify isolating these genera from the other pyrotines, and on a purely phenetic basis it is by no means evident that *Lyttamorpha* Kaszab and *Glaphyrolytta* Martínez are more distant from *Pyrota* than is *Wagneronota.* In fact, *Lyttamorpha* and *Glaphyrolytta* more closely resemble *Pyrota* in characters of the male genitalia and abdomen than does *Wagneronota.*

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BIOLOGY OF *TRIMERINA MADIZANS,* A PREDATOR OF SPIDER EGGS (DIPTERA: EPHYDRIDAE)

B. A. Foote

Department of Biological Sciences, Kent State University, Kent, Ohio 44242.

Abstract.—Information is presented on the natural history, life cycle, and larval feeding habits of *Trimerina madizans* (Fallén), an uncommon but widely distributed species of Ephydridae. Females oviposit into the egg masses of the wetland spider *Hypselistes florens* (Cambridge), a species of Micryphantidae. Larvae destroy the spider eggs and form puparia within the silken covering of the egg masses. The developmental period from egg deposition to emergence of adults averages 23 days. Apparently there is only one generation a year in the latitude of northern Ohio. Information is given on a species of Ichneumonidae (Hymenoptera) whose larvae also attack the eggs of *Hypselistes.* The life cycle of *T. madizans* is contrasted and compared to that of *Scatella picea* (Walker), an algae-feeding, r-selected species of Ephydridae.

The family Ephydridae is generally considered to be closely related to the family Drosophilidae within the superfamily Drosophiloidea (Hennig, 1958; Griffiths, 1972). Although the two families differ in number of species (Drosophilidae, 2500 species; Ephydridae, 1400), both are widely distributed, have larvae that are largely microphagous, and have short generation times. Species of Drosophilidae are usually encountered in shaded woodland habits and have larvae that ingest mostly heterotrophic microorganisms such as yeasts and bacteria (Carson, 1971; Heed, 1968). In contrast, ephydrids are most commonly found in unshaded wetland habitats, and many species have larvae that feed primarily on autotrophic microorganisms such as algae (Deonier, 1972; Foote 1979). Interestingly, both families contain species that seemingly have abandoned the microphagous feeding habit and shifted to other nutrient sources. For example, predation on spider eggs occurs in both families. In Hawaii, larvae of species of the scaptomyzine genus *Titanochaeta* have been reported to attack the developing eggs of the spider family Thomisiidae (Wirth, 1952; Heed, 1968). Similarly, larvae of the ephydrid genus *Trimerina* prey on eggs of wetland spiders belonging to the family Micryphantidae in both Europe (Becker, 1926) and North America (Scheiring and Foote, 1973).

The present paper outlines the life cycle, describes the larval feeding behavior, and presents natural history observations of *Trimerina madizans* (Fallén). Additionally, a contrast is drawn between *T. madizans,* a highly specialized and probably K-selected species, and *Scatella picea* (Walker), a very trophically generalized and r-selected taxon within the family Ephydridae.

LIFE HISTORY

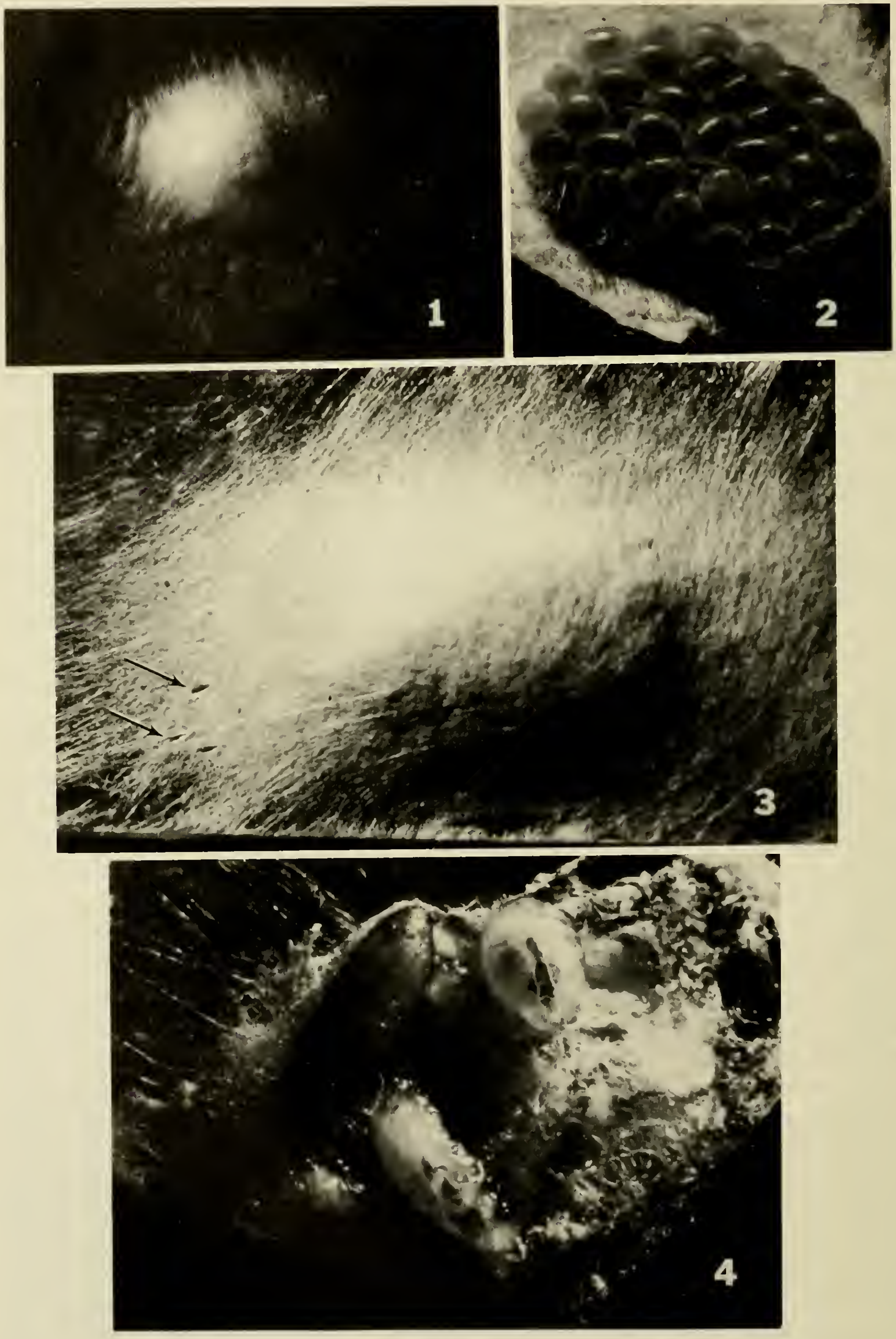
The genus *Trimerina* was established by Macquart (1885) for *Notiphila madizans* Fallén, a species originally described in 1813. The genus has remained monotypic. It has a holarctic distribution, with records available for Europe (Becker, 1926; Dahl, 1959) and North America (Wirth, 1965). In the Nearctic Region, *T. madizans* has a transcontinental distribution, ranging from Ontario to Saskatchewan and Montana, south to New York, Colorado, and California. The genus is currently placed in the tribe Psilopini of the subfamily Psilopinae (Wirth, 1965).

Adults of *T. madizans* have been found most commonly in open wetlands having dense stands of herbaceous vegetation. In Scandinavia, Dahl (1959) recorded this species as uncommon in moist meadows, and Scheiring and Foote (1973) reported it as being relatively rare in the sedge-meadow habitat in Ohio. All habitats in which adults of *Trimerina* were found possessed dense growths of herbaceous reed-like vegetation. In northeastern Ohio, adults were swept from stands of broad-leaved cattail (*Typha latifolia* L.), bur-reed (*Sparganium eurycarpum* Engelm.), and sedges (*Carex* spp.). Other species of Ephyridae commonly collected with *Trimerina* adults belonged to the genera *Hydrellia* and *Notiphila.* The host spider deposits its egg masses on flattened herbaceous stems and leaves, usually 0.5–1.0 m. above the substrate (Fig. 1).

Females held in laboratory breeding chambers had a longevity that ranged between 30 and 80 days and averaged 57 days (n = 12), (Table 2). Males usually died before females and had an average longevity of 40 days (n = 5). None of the reared females mated or oviposited, so no information is available on the premating or pre-ovipositing periods. The only information on fecundity is that a female, which was collected in nature on June 15, 1979, contained 20 recognizable eggs. Repeated dissections of reared females varying in age from 5 to 25 days revealed no developing eggs in the ovarioles or any sign of ovarian activity. These results, coupled with the failure to find infested spider egg masses in nature during late summer, suggest that *T. madizans* is univoltine. Adults probably overwinter, become active in late April and May, and begin ovipositing in late May and early June. Adults emerging from summer-formed puparia apparently enter into a reproductive diapause that lasts until the following spring.

Eggs were found beneath the silken covering of egg masses deposited by the marsh-inhabiting spider *Hypselistes florens* (Cambridge), a species of the family Micryphantidae. Apparently females of *Trimerina* are rather specific as to their oviposition site, as neither eggs nor larvae were encountered in egg masses of other species of spiders that occurred in the habitat. For example, no eggs were found in 15 egg masses of *Hyposinga variabilis* (Emerton), a small species of Araneidae that was frequently abundant in the same habitats in which *Hypselistes* occurred. Infected egg masses of *Hypselistes* were easily recognized by the presence of small, slit-like oviposition scars on the silken covering of the mass (Fig. 3). These slits were almost always located at either side of the egg cluster, and no eggs were found lying within the egg cluster itself. Only one egg was found below each slit, although the number of slits per egg mass was quite variable. The number of fly eggs present per infested egg mass varied from 1 to 7 and averaged 3.0 (n = 6). Occasionally, no egg was found below a slit, suggesting that false oviposition had occurred. Each egg was somewhat ovoid in shape, white in color, and lacked any sort of recognizable chorionic pattern. The incubation period for six eggs lasted two days. Newly hatched larvae moved away from the egg shells to the cluster of spider eggs and began feeding.

The infestation rate of spider egg masses sampled in northeastern Ohio was



Figs. 1–4. 1, Egg mass of the spider *Hypselistes florens* on cattail leaf. 2, Egg cluster of *H. florens.* 3, Ovipositor scars of *Trimerina madizans* on spider egg mass. 4, Larvae and puparium of *T. madizans* within spider egg mass.

Table 1. Infestation rates of two spider egg predators.

Week of (1979)	Number of Egg Masses Collected	Infested by *Trimerina* (%)	Infested by Ichneumonid (%)
June 17	7	1 (14.3)	2 (28.6)
June 24	34	2 (5.9)	1 (2.9)
July 1	63	3 (4.8)	22 (34.9)
July 8	49	0 (0.0)	27 (55.1)
July 15	36	6 (16.7)	13 (36.1)
July 22	26	0 (0.0)	14 (53.9)
July 29	2	0 (0.0)	0 (0.0)
Aug. 5	0	—	—
Aug. 12	8	0 (0.0)	4 (50.0)
Aug. 19	5	0 (0.0)	2 (40.0)
Totals	230	12 (5.2)	85 (37.0)

quite variable, ranging from 0.0 to 16.7%, and averaging 5.2% (Table 1) during 1979 (230 egg masses examined). Infested egg masses were restricted to the period between June 17 and July 18, even though a few egg masses were found as late as mid-August.

All of the developmental stages were completed within the egg mass (Table 2). The larval period ranged from 7 to 10 days and averaged 8.6 days (n = 7). The pupal period varied from 12 to 14 days and averaged 12.7 days (n = 3). The number of *Trimerina* larvae and/or puparia (Fig. 3) per infested egg mass varied from 1 to 6 and averaged 3.1 (n = 13). The number of spider eggs in uninfested egg masses (Fig. 2) ranged from 28 to 51 and averaged 35.2 (n = 5).

The number of spider eggs destroyed by the feeding of *Trimerina* varied according to the number of larvae present in an egg mass. In general, if two or more larvae were present all of the eggs were consumed (Fig. 4). If only one *Trimerina* larva was present, at least one-third of the eggs remained uneaten. The data suggest that an individual larva requires at least six eggs to complete larval development. An egg complement of 35, the average number recorded for field-collected egg masses, thus would permit the development of four or five larvae.

The egg masses of *Hypselistes* were also utilized by larvae of Phoridae (Diptera) and Ichneumonidae (Hymenoptera). As Table 1 indicates, the most important insect enemy of the egg masses was *Gelis* sp., an ichneumonid, which infested 85 of 230 (37%) masses that were collected in northeastern Ohio during 1979. In contrast, only 12 of the 230 (5.2%) contained larvae and/or puparia of *Trimerina*, and none was infested by phorid larvae. Results in other years were similar except for an occasional occurrence of an undetermined species of Phoridae. However, in no sample did the phorid infestation rate exceed 2.0%.

Only rarely were egg masses doubly infested. Out of a total of 312 egg masses collected over a four-year period, only two were encountered that contained immature stages of both *Trimerina* and the ichneumonid. On May 22, 1982, an egg mass was obtained from a cattail leaf that contained two nearly mature larvae of *Trimerina* and one newly hatched ichneumonid larva. There were no viable spider eggs remaining in the mass, and the ichneumonid larva died within two days.

Table 2. Life history data for *Trimerina madizans.*

Characteristic	*n*	Range	$\bar{x}$	SD
Adult longevity	7	30–80	57.1	20.0
Incubation period	6	—	2.0	—
Larval period	7	7–10	8.6	1.0
Pupal period	3	12–14	12.7	1.2

The *Trimerina* larvae formed puparia and eventually emerged as adults. On May 26, 1982, an egg mass was collected that contained five *Trimerina* and three ichneumonid eggs along with 38 apparently viable spider eggs. Three of the *Trimerina* eventually became adults, but all of the ichneumonid larvae died shortly after hatching. Available data suggest that although oviposition by one species of egg predator is not inhibited by the presence of eggs, larvae or puparia of a second species, only one species of predator can complete larval development within one egg mass. The reason for this phenomenon remains unknown, but it did not appear that there was any direct interference or attack by one species of larva on the developmental stages of the second species. The relatively high infestation rate shown by the ichneumonid compared to that of *Trimerina* (37 vs. 5%) implies that the wasp is more successful in locating egg masses and ovipositing within them.

The oviposition scars of the ichneumonid were easily distinguished from those of *Trimerina* in that they were much smaller and resembled pin pricks rather than elongate slits. Additionally, they tended to be more widely scattered over the surface of the silken covering of the egg mass and not concentrated towards either side as was true with *Trimerina.* The greatest number of unhatched ichneumonid eggs found in an egg mass was four, although several egg masses showed evidences of multiple oviposition probes. Up to 22 apparent oviposition scars were found in one egg mass. As in *Trimerina,* larval development of the ichneumonid took place entirely within the egg mass, with most or all of the spider eggs being consumed. Mature larvae subsequently spun cocoons within the egg mass. The larval period lasted eight days; the pupal period, six days in the one larva whose development was monitored. Although evidence is scanty, it appears that the ichneumonid is multivoltine. The rate of infestation seemingly increased during June and into July, whereas *Trimerina* levels decreased (Table 1).

The only indication that the immature stages of *Trimerina* were being attacked by parasitoid Hymenoptera was the discovery of two fly puparia that each contained a larva of an undetermined species of wasp. There was no evidence that the spider that deposited an egg mass presents any danger to ovipositing *Trimerina,* as the egg masses are not guarded or even tended by the female spider. Obviously, the timing of oviposition is critical for females of *Trimerina,* as the spider egg masses are suitable for larval development for only a restricted period of time. The incubation period of the spider eggs ranged between 10 and 15 days. It is very doubtful if first instar or even second-instar larvae can cope with newly hatched spiderlings, even though young spiders remained within the egg mass for one to three days after hatching. In contrast, third-instar larvae were seen preying

Table 3. Comparative life history data for two species of Ephydridae.

Character	*Trimerina madizans*	*Scatella picea**
Adult longevity	57.1+ days	28.0 days (original data)
Fecundity	20?	310.5
Incubation period	2.0 days	1.9 days
Larval period	8.6 days	6.1 days
Pupal period	12.7 days	4.8 days
Gens./year	1?	Many
Larval food	Spider eggs	Algae
Habitat	Stable	Unstable

* Data obtained from Connell and Scheiring (1982).

upon spiderlings remaining with the egg covering. To ensure successful completion of larval development females of *Trimerina* probably must oviposit within the first four days after the spider egg masses are deposited.

DISCUSSION

Many if not most species of Ephydridae are best categorized as being r-strategists as defined by Pianka (1970). Certainly those species occurring in physically unstable and temporally varying shoreline habitats that are subject to repeated and unpredictable flooding must allocate most of their available energy to reproductive efforts. Thus, such species as *Scatella picea* that are associated with the mudshore habitat (Scheiring and Foote, 1973) are relatively short lived as adults, have very high fecundities, abbreviated developmental times, are trophically generalized, and show high vagility (Connell and Scheiring, 1981, 1982). In contrast, trophic specialists must expend a considerable fraction of their energy in searching for a suitable food resource that frequently is uncommon and relatively hidden. As a result, certain components of the life cycle have been modified. In *T. madizans,* for example, the adult life span is somewhat extended, egg production is greatly curtailed, the developmental period is lengthened, and the number of generations produced per year is dramatically reduced. Table 3 compares certain life history traits for *S. picea* and *T. madizans.* It is obvious that the two species are dramatically different in such life cycle components as adult longevity, fecundity, pupal period, and number of generations produced per year. Apparently these two species represent endpoints on the r-K continuum in the family Ephydridae, although a detailed study of the population biology of *T. madizans* that could be compared and contrasted to the demographic data available for *S. picea* is sorely needed.

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PREY SELECTION BY THE NEOTROPICAL SPIDER *MICRATHENA SCHREIBERSI* WITH NOTES ON WEB-SITE TENACITY

TODD E. SHELLY

Department of Biology, University of California, Los Angeles, California 90024.

Abstract.—Prey selection and web-site tenacity are described for a population of *Micrathena schreibersi* on Barro Colorado Island, Panama. Prey selection was analyzed by first comparing web contents with insect samples obtained from sticky trap samples and by then comparing web-caught items actually being consumed with items left unattacked and uneaten. Webs exhibited no positive or negative selectivity for Coleoptera, nematocerous Diptera, or parasitoid Hymenoptera. They did, however, catch a higher proportion of ants and a lower proportion of non-nematocerous Diptera than expected from the sticky trap samples. Among items caught in the web, *M. schreibersi* fed indiscriminately upon Coleoptera, ants, non-nematocerous Diptera, and parasitoid Hymenoptera but tended to ignore nematocerous Diptera. Individuals had high web-site tenacity, and of 20 spiders monitored 15 remained in the same site for 17 days.

Prey selection by web-building spiders includes two principle components. First, webs may catch a nonrandom sample of the available prey. This deviation largely reflects differing abilities for web avoidance and escape among potential prey (Eisner et al., 1964; Turnbull, 1960; Robinson and Robinson, 1970, 1973; Olive, 1980). While numerous researchers (e.g., Bilsing, 1920; Hobby, 1930, 1940; Parmenter, 1953; Robinson and Robinson, 1970) have compliled lists of dietary items, fewer studies (e.g., Kajak, 1965; Uetz et al., 1978; Uetz and Biere, 1980; Brown, 1981) have compared web contents with potential prey in the environment. Second, among items caught in the web, the spider may then feed on preferred prey but reject unsuitable prey. Such discrimination has been observed for a variety of species and may reflect chemical or mechanical defenses of the prey (Robinson and Robinson, 1973), hunger level of the spider (Bristowe, 1941), the spider's familiarity with the prey (Turnbull, 1960), or the energetic costs associated with feeding on particular prey (Uetz and Biere, 1980).

The present study compares the web contents of *Micrathena schreibersi* (Perty) with sticky trap samples of available prey. Field work was conducted at one site over a relatively short period of time thus reducing potential complications arising from habitat and seasonal differences in prey availability. As Olive (1980) and Uetz et al. (1978) found, however, prey availability may vary over short vertical distances, and to examine this possibility potential prey were sampled at several different heights.

In addition, a second comparison was made between captured items being eaten and those left unattacked and uneaten. Since prey ignored during the day may have been consumed at night with the web, uneaten prey did not necessarily represent rejected prey. This comparison, however, does quantify the probability of immediate attack upon different types and sizes of captured prey. While several studies (e.g., Robinson, 1969; Harwood, 1974) provide detailed descriptions of the attack and wrapping behaviors used for different prey, only Uetz and Biere (1980) have quantified attack probabilities for particular types and sizes of prey.

Materials and Methods

The study was conducted between July 31 and August 16, 1980, on Barro Colorado Island (BCI), Panama. This time period falls near the middle of a rainy season, which annually extends from late April to mid-December (Croat, 1978). The island is covered by a lowland tropical moist forest (Holdridge et al., 1971). *Micrathena schreibersi* was most abundant on the island's central plateau, and all work was conducted there.

Little is known about the biology of *M. schreibersi* despite its wide distribution throughout Central America (Chickering, 1961). Females are large and brightly colored. The mean wet weight and body length of nine adult females were 180.8 mg (SD 17.7) and 11.7 mm (SD 1.20), respectively. Dorsally, the triangular abdomen is yellow with black margins and bears 10 prominent spines of various colors (white, black, red). Females appeared to construct and tend webs during the day and consume them at night. In four nights of searching, I never saw a female or an intact web. On BCI *M. schreibersi* females are abundant only in the mid to late wet season (July to December) and are rarely found during the rest of the year (Lubin 1978). Males are smaller and less conspicuous than females and are less frequently encountered. Measurements of prey selection and web-site tenacity were made only for mature females in this study.

Flying insects were sampled at 10 different sites. At each site I implanted a 2.7 m PVC pole (diameter 25 mm) by driving 0.30 m–0.45 m of its length into the ground. Wooden rods (length 30 mm; diameter 5 mm) were then fastened to the pole at 0.3 m intervals (from 0.3 m to 2.1 m above ground). Fastened at one end, each rod projected perpendicularly from the vertical pole and hence was parallel to the ground's surface. Insects were collected on tanglefoot covered traps suspended from the wooden rods. Each trap was a 15 cm by 23 cm rectangle of 3 mm thick transparent plastic coated on both sides with tanglefoot. Insects were sampled during the day only on August 6–9. Each day the traps were set between 0800 h–0900 h, taken down between 1600 h–1700 h, and stored overnight in closed boxes. Aside from Diptera and Hymenoptera, all trapped insects were identified to order. Flies were categorized as either nematocerous or non-nematocerous, and hymenopterans were subdivided into bees and wasps, parasitoids, and winged ants. All trapped insects were measured to the nearest 0.1 mm using a dissecting microscope equipped with a disc micrometer.

Each day of the study I walked through different areas of the forest (between 0900–1630 h) and examined every web encountered. All caught items were collected and labelled as either eaten (those observed being consumed) or uneaten (those stuck in the web but not being consumed). Uneaten prey were also examined for evidence of wrapping. For each web thus sampled, the height of the spider

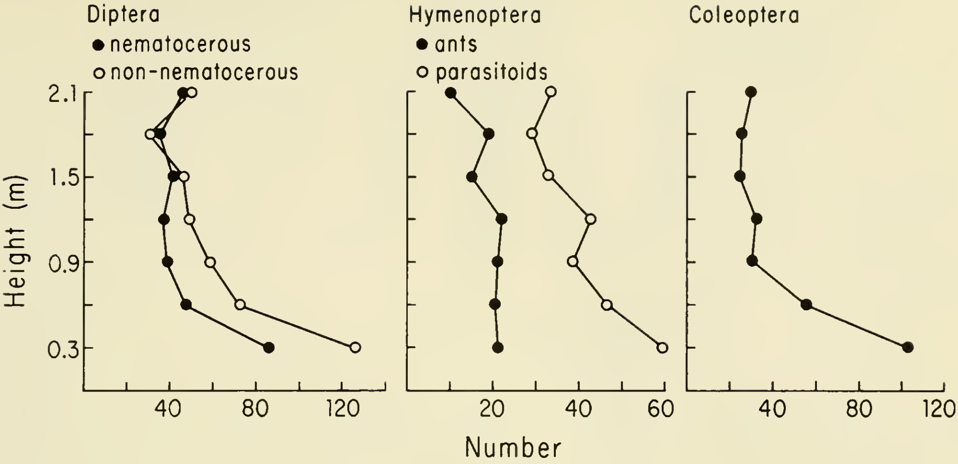

Fig. 1. Vertical distributions of the major prey categories. Each value represents the total number of individuals captured on 10 sticky traps suspended at a particular height. See text for details of sampling method.

was also recorded. Collected prey were later assigned to the appropriate prey category and measured to the nearest 0.1 mm.

Prey selectivity was quantified using Ivlev's (1961) index of electivity. Electivity (E) is calculated as follows: $E = (r_i - p_i)/(r_i + p_i)$ where r_i is the proportion of the predator's diet represented by prey type (or size class) i, and p_i is the proportion of the available prey represented by prey type (or size class) i. Values of E ranges from -1.0 (complete avoidance) to $+1.0$ (complete preference). In this study electivity values with absolute values less than 0.40 were not considered to differ from zero. (This arbitrary value was chosen primarily to facilitate discussion of the results. Ivlev's index is a descriptive measure only, and standard statistical analyses are inapplicable.) In addition, two sets of electivity values were calculated. For web selectivity (E_w) r_i is the proportion of the web contents (both eaten and uneaten items) represented by prey type i, and p_i is the proportion of available prey (as measured by the sticky traps) represented by prey type i. For spider selectivity (E_s) r_i is the proportion of the spider's observed diet (the eaten prey) represented by prey type i, and p_i is the proportion of the web contents (both eaten and uneaten items) represented by prey type i.

RESULTS

Micrathena schreibersi generally constructed vertical webs in relatively open sections of the forest or at the edges of tree-fall gaps. Most web sites were shaded, and only rarely was a web placed in an area that received direct sunlight. Various web support structures were utilized, including leaf tips, herbaceous stems, woody vines and branches, and palm fronds. The circular webs averaged 27.4 cm in diameter and 580 cm^2 in catching area (n = 9).

Individuals may remain at a particular web-site for several weeks. On July 31 I marked the location of 20 occupied webs. These sites were then revisited daily for 17 days, and the presence or absence of the spider and the web was recorded.

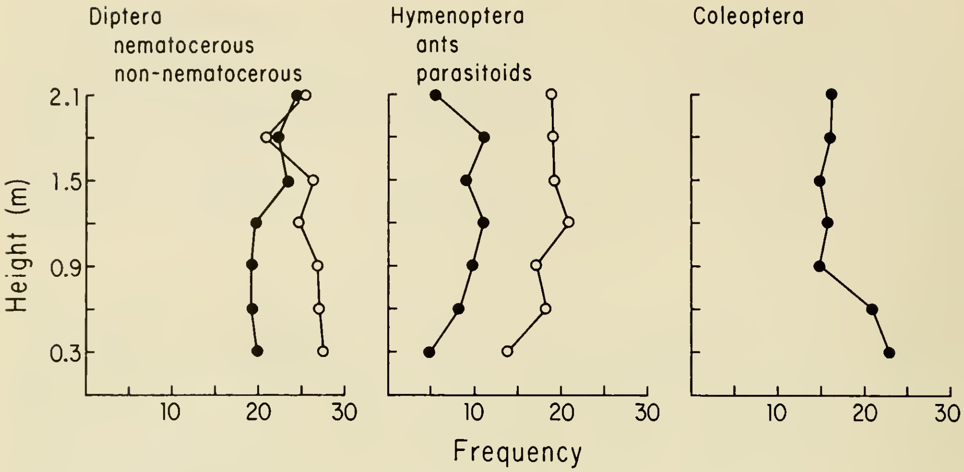

Fig. 2. Relative abundances of major prey categories over all heights sampled. Each value represents a proportion of the total number of individuals captured on 10 sticky traps suspended at a particular height. See text for details of sampling method.

In terms of the number of spiders remaining at their initial site, the results obtained were as follows: Day 1—17; Day 2 to 6—16; Days 6 to 17—15. In no instance was a spider absent but the web present; spider and web were always both present or both absent. In addition, in examining a 2 m–3 m radius about each vacated website, I never observed the presence of a newly constructed web.

Five prey categories comprised 89.0% of the total sample, and vertical abundance patterns were examined for these groups only. Beetles, parasitoid Hymenoptera, nematocerous and non-nematocerous Diptera all exhibited a similar trend in vertical abundance (Fig. 1). That is, the greatest numbers of individuals were collected at the two lowest sampling heights (0.3 m and 0.6 m). While similar numbers of parasitoid Hymenoptera were captured at the two lowest sampling heights, nearly twice as many beetles, nematocerous and non-nematocerous Diptera were captured at 0.3 m than 0.6 m. Ants were captured in relatively constant numbers over all sampling heights.

Although the numbers of trapped individuals varied greatly with height for four prey categories, each major category comprised a relatively constant proportion of the total sample at each height (Fig. 2). Similarly, within each category size frequency distributions did not vary with height in any obvious manner (Fig. 3). Thus, while the abundance of flying insects varied with height, the taxonomic and size composition of this fauna did not.

The vertical distribution of *M. schreibersi* did not closely match that observed for available prey (Fig. 4). *Micrathena schreibersi* preferred web-sites between 0.6 m–0.9 m, and approximately 45% of the spiders measured were within this range. Thus, while traps nearest the ground caught the greatest numbers of flying insects, only 31% of *M. schreibersi* were found below 0.6 m.

A total of 385 insects representing five orders were taken from 276 webs of *M. schreibersi.* Approximately 95% of these insects belonged to those 5 prey categories which were most abundant in the sticky trap samples. Consequently, analysis of both web and spider selectivities will focus only upon these groups. In addition,

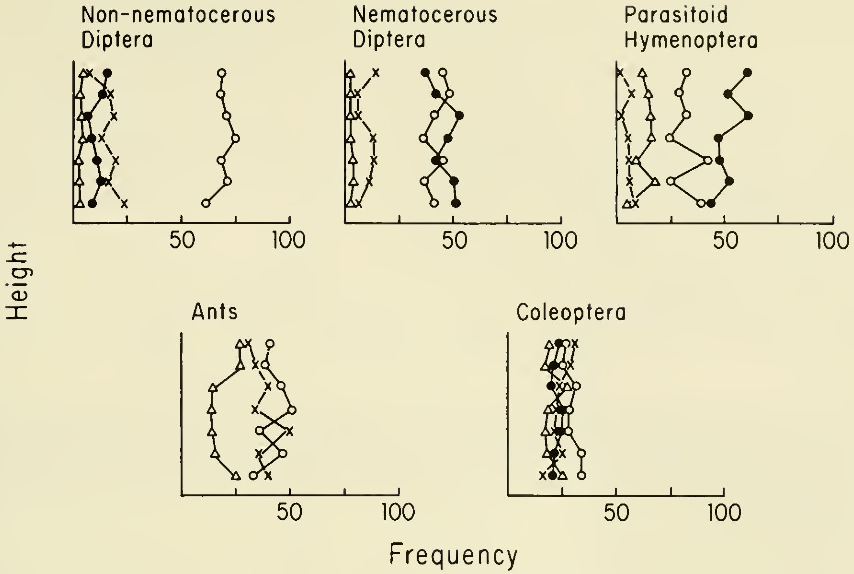

Fig. 3. Size frequency distributions for the major prey categories over the 7 heights sampled. Within a category each value represents the proportion of individuals captured at a particular height that fell within a particular 1 mm interval. The symbols used for the various size classes are: 0–1 mm (●), 1–2 mm (○), 2–3 mm (×), and >3 mm (△).

since the composition of the flying insect fauna did not much vary with height, both the data regarding prey availability and diet were combined over all heights.

Web selectivity values did not differ greatly from zero for beetles, nematocerous Diptera, or parasitoid Hymenoptera (Table 1). Ants, however, comprised a large proportion of the web contents relative to their proportion on the traps. Conversely, non-nematocerous Diptera represented a small proportion of the web contents compared to their proportion on the traps.

Only 2 groups, nematocerous Diptera and ants, were found in webs in sufficient numbers to allow meaningful calculation of web selectivity values for different size classes. Nematocerans less than 1 mm were relatively less abundant in webs than on the traps, while the opposite was true for those between 1 mm–2 mm (Table 2a). Web selectivity values, however, did not differ greatly from zero for either size class. The majority (55%) of ants in webs were 5 mm–8 mm long (Table 2b). In contrast, most (76%) ants on the sticky traps were less than 3 mm long. Consequently, web selectivity values for the 1 mm–2 mm and 2 mm–3 mm size classes were large and negative, while those for larger classes were all large and positive. Among the larger size classes, electivity values were not different from zero for 3 mm–4 mm and >8 mm but were large and positive for all remaining intervals.

Aside from nematocerous Diptera, *M. schreibersi* were observed to consume prey types in proportions roughly equal to their proportion in the web (Table 3). Spider selectivity values for beetles, ants, non-nematocerous Diptera, and parasitoid Hymenoptera were all less than 0.15 (absolute value). In contrast, the E_s value for nematocerous Diptera was large and negative. As the E_s values imply, the majority (58%) of uneaten prey were nematocerous Diptera. Most of these,

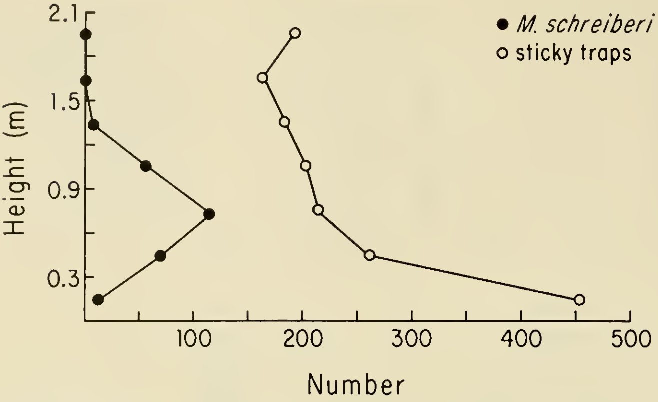

Fig. 4. Vertical distribution of *M. schreibersi* and available prey. Heights of hub-resting spiders were measured to the nearest cm and then placed into 0.3 m intervals. Values for prey represent the total number of insects captured on 10 sticky traps suspended at a particular height. See text for details of sampling method.

in turn, did not appear to have been wrapped. Many, in fact, were observed struggling in web while stuck by a single wing. In contrast, most of the other uneaten insects had clearly been attacked and wrapped.

Only ants were eaten in sufficient numbers to allow meaningful calculation of spider selectivity values for different size classes. *Micrathena schreibersi* appeared to ignore 1 mm–2 mm ants (4 eaten/18 uneaten; $E = -0.65$) but consume all larger size classes in proportions approximately equal to their proportions in the web. E_s values were less than 0.09 (absolute value) for all size classes >2 mm. Among the remaining groups, only beetles and nematocerous Diptera had large enough numbers of eaten and uneaten individuals to permit comparison. Mean body lengths for eaten ($\bar{x} = 3.9$ mm; SD = 2.1) and uneaten ($\bar{x} = 3.4$ mm; SD = 1.9) beetles were not significantly different ($t = .09$; $P < .5$). However, mean body lengths for eaten ($\bar{x} = 1.9$ mm; SD = 1.1) and uneaten ($\bar{x} = 0.9$ mm; SD = 0.31) nematocerans differed significantly ($t = 3.9$; $P < .001$).

Table 1. Web selectivity (E_w) values for prey types collected from webs of *M. schreibersi*.

	Collected from Webs (Eaten and Uneaten)		Captured on Traps		
Insects	No.	R_i	No.	p_i	E_w
Coleoptera	48	12.5	320	19.2	−0.21
Nematocerous Diptera	91	23.6	337	20.2	+0.08
Non-nematocerous Diptera	31	8.0	453	27.1	−0.54
Ants	170	44.1	119	7.1	+0.72
Parasitoid Hymenoptera	31	8.0	264	15.8	−0.33
Others	14*	3.6	175**	10.4	—

* Others include: Lepidoptera (4), Aculeate Hymenoptera (5), Homoptera (5).

** Others include: Lepidoptera (2), Aculeate Hymenoptera (2), Homoptera (80), Thysanoptera (27), Hemiptera (8), Orthoptera (5), Collembola (3), Zoraptera (4), Plecoptera (3), Isoptera (21), Psocoptera (20).

Table 2. Web selectivity (E_w) values for size classes of nematocerous Diptera and ants collected from webs of *M. schreibersi.*

a. Nematocerous Diptera

	Collected from Webs (Eaten and Uneaten)		Captured on Traps		
	No.	r_i	No.	p_i	E_w
0–1	27	29.7	138	40.7	−0.16
1–2	60	65.9	163	48.1	+0.16
2–3	3	3.3	31	9.1	−0.47
3	1	1.1	7	2.1	+0.31

b. Ants

	Collected from Webs (Eaten and Uneaten)		Captured on Traps		
	No.	r_i	No.	p_i	E_w
0–1	0	0.0	0	0.0	—
1–2	22	12.9	43	36.7	−0.48
2–3	17	10.0	46	39.3	−0.59
3–4	14	8.2	7	6.0	+0.15
4–5	16	9.4	3	2.6	+0.57
5–6	19	11.1	3	2.6	+0.62
6–7	49	28.8	7	6.0	+0.65
7–8	26	15.3	2	1.7	+0.80
8	7	4.1	6	5.1	−0.10

DISCUSSION

Field studies of prey selection invariably rely upon sampling methods which yield biased estimates of both available and actual prey. The extent to which these sampling biases affect measurement of prey selection must therefore be assessed.

Sticky traps have an inherent bias resulting from the fact that different insects have different abilities to detect and avoid a trap. Although the traps used in this study were transparent, application of the tanglefoot to the plastic produced a light blue color. By rendering the trap more visible, this color may have allowed the more visually acute insects (e.g., bees, butterflies) to successfully avoid capture. Large wasps, for example, have been observed to actively avoid suspended traps (Robinson and Robinson 1973). While small insects may be less able to avoid traps, Olive (1980) has suggested that they may be passively carried around traps by air currents. This bias appeared to be unimportant for this study, however, since (1) winds were typically very light and (2) during approximately 3 h of observation I never saw an insect being passively carried around a trap.

Regarding actual prey, the "encounter and examine" method of sampling web contents is subject to a "handling time" bias. That is, small prey that are rapidly consumed are less likely to be sampled than larger items that require longer processing times. Since *M. schreibersi* catches and consumes relatively small insects, this sampling bias perhaps represented the greatest potential source of error in the study. In particular, the dietary importance of small Diptera and parasitoid Hymenoptera may have been underestimated.

Since no other sampling methods were used simultaneously, the effects of these

Table 3. Spider selectivity (E_s) values for prey types collected from webs of *M. schreibersi.*

	Collected from Webs (Eaten only)		Collected from Webs (Eaten and Uneaten)		
Insects	No.	r_i	No.	p_i	E_s
Coleoptera	30	11.8	48	12.5	−0.03
Nematocerous Diptera	16	6.3	91	23.6	−0.58
Non-nematocerous Diptera	27	10.6	31	8.0	+0.14
Ants	146	57.2	170	44.1	+0.13
Parasitoid Hymenoptera	26	10.2	31	8.0	+0.12
Others	10*	3.9	14**	3.6	—

* Others include: Lepidoptera (2), Aculeate Hymenoptera (4), Homoptera (4).
** Others include: Lepidoptera (4), Aculeate Hymenoptera (5), Homoptera (5).

potential biases could not be adjusted with correction factors (e.g., Taylor, 1962). As a result, these effects will inevitably be included in any analysis of prey selection. This notwithstanding, the present findings are believed to at least highlight some major features of the predatory behavior of *M. schreibersi.* These features were:

(1) *Micrathena schreibersi* generally remained at a particular web-site for several weeks. Interestingly, 4 of the 5 individuals that abandoned a web-site did so within the first 2 days of observation. While not conclusive, this finding suggests that these spiders had only recently selected web-sites, "sampled" them for 1 or 2 days, and then abandoned them as unfavorable. The fact that no movements were noted after Day 6 further suggests that females, once having found a suitable site, tend to remain at that site. While this interpretation is consistent with Janetos' (1982) decision rule hypothesis for web-site tenacity, residency periods noted here were much longer than those recorded for the temperate species he studied. Working with 12 orb-weaving species, Janetos (1982) found the majority of intermovement intervals to be less than 1 day. Based largely on this finding, Janetos (1982) proposes that orb-weavers as a whole be considered active foragers which, because of low web construction costs, frequently abandon sites in search of prey "hot spots." The high site fidelity of *M. schreibersi,* however, seriously challenges the validity of this generalization.

(2) Most *M. schreibersi* did not construct their webs at heights where total prey abundance was greatest. Since the taxonomic and size composition of the flying insect fauna varied only slightly with height, *M. schreibersi* was apparently not responding to the vertical distribution of a particular type (at least at the ordinal level) or size of prey. Since a wide range of supports was used, it appears unlikely that the observed distribution reflected the distribution of a limited number of suitable web-sites. Moreover, it is unlikely that spiders near the ground were overlooked, since individuals are large and brightly colored and easily spotted in the field. Interspecific competition did not obviously inhibit use of lower web-sites, since no other species of similar size constructed webs closer to the ground (Shelly, per. obs.). High web-sites, however, may reduce risks of predation by ground-dwelling predators.

(3) Webs displayed positive selectivity for ants and negative selectivity for non-nematocerous Diptera. This result may reflect (1) the relative abilities of these prey types to avoid and/or escape webs and/or (2) placement of webs in areas

having high ant and low non-nematocerous Diptera abundances. While a rigorous assessment of these explanations is not possible, two observations suggest the former explanation to be more likely. First, I carefully searched the area (3–4 m radius) around 41 webs and never found an active ant's nest. Second, ants appeared to be less capable of escape than flies of similar size. I threw an ant (n = 15; body lengths 5–7 mm) or a horse fly (n = 15; body lengths 6.5–8 mm) into 30 different webs from which spiders had been removed. I then recorded whether or not the insect escaped within two minutes. A significantly ($t = 4.2$, $P < .001$; Sokal and Rohlf, 1969: 607) greater proportion of horse flies (47%) escaped than ants (13%).

(4) Among web-caught items, *M. schreibersi* was more likely to attack larger prey. Numerous studies (e.g., Robinson and Robinson, 1970, 1973; Riechert and Tracy, 1975; Turnbull, 1960) note rejected prey, but few studies quantify attack vs. ignore probabilities for different prey. Here, the tendency of *M. schreibersi* to ignore small ants and most nematocerous Diptera probably does not reflect avoidance but rather the inability of these small, weak-flying insects to escape or damage the web. Thus, *M. schreibersi* may have ignored these weak prey only to consume them with their web in the evening. Interestingly, the mean body length of nematocerans being consumed was approximately twice that of nematocerans caught in the web but ignored. Similar selection for larger prey has also been demonstrated for the congener *M. gracilis* (Uetz and Biere, 1980).

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MECHANISM OF POLLINATION BY PHORIDAE (DIPTERA) IN SOME *HERRANIA* SPECIES (STERCULIACEAE) IN COSTA RICA

ALLEN M. YOUNG

Invertebrate Zoology Section, Milwaukee Public Museum, Milwaukee, Wisconsin 53233.

Abstract.—The mechanism of pollination of *Herrania* flowers (Sterculiaceae) by phorid flies (Diptera: Phoridae) in Costa Rica is described in detail for the first time. Two undescribed phorid species, *Megaselia* sp. and *Dohrniphora* sp., are frequent visitors to the red or purple flowers of *H. purpurea* and *H. nitida,* and to the smaller, white flowers of *H. albiflora.* The flowers of all species are highly specialized for visitation and pollination by small-sized insects such as phorids. The behavior of the flies at the freshly-opened flowers indicates that they follow nectary cues and appear at flowers only at dawn and dusk when flowers exude a strong, musty (aminoid) scent and are most receptive for pollination. There appears to be some degree of coadaptation of flower morphology and phorid behavior suggesting phorids to be important pollinators of *Herrania.* Phorids land either upon the petaloid staminodes that form a barrier between the style and concealed anthers (in petal hoods or pouches) or on the long, dangling petal ligules of the hermaphroditic flowers. These insects enter the petal hoods, probably guided by stomate-type nectaries inside, and pick up large quantities of pollen on notal and head areas. Pollen-laden phorids often crawl through the central area of a flower, brushing the stigma and style and thereby causing pollination. Phorids may orient themselves towards the pistil area by elaboration of a scent from specialized trichomes or elaiophores on the ovary and basal area of the flower.

The purpose of this paper is to report for the first time the mechanism of effective pollination of *Herrania purpurea* (Pittier) R. E. Schultes, *H. albiflora* Goudot, and *H. nitida* (Poepp.) (Sterculiaceae, tribe Byttneriereae) by phorid flies (Diptera: Phoridae) in Costa Rica. Posnette (1944) observed phorids on *Herrania* flowers in Trinidad and suspected them to be pollinators. Cuatrecasas (1964) has summarized the floral, fruit, and vegetative characters that closely unite *Herrania* and *Theobroma* within the Byttneriereae. Although there has been considerable study of insect-mediated pollination in *T. cacao* L. ("cacao," "cocoa") for obvious economic reasons (e.g., Billes, 1941; Posnette, 1944; Soetardi, 1950; Glendinning, 1962; Hernandez, 1965, and many other papers), far less is known about the pollinators and pollination mechanisms of other *Theobroma* species and *Herrania* species. Given the great divergence in the size, coloration, and fragrance properties of flowers in both genera, it is most likely that very different groups of primary pollinators are involved. Various authors (e.g., Entwistle, 1972 and Bystrak and Wirth, 1978 give good reviews) have discussed the evidence favoring insect-mediated pollination in *T. cacao,* in which the primary pollinators are believed to be certain genera and species of Ceratopogonidae (Diptera), based largely upon daytime studies in cacao plantations. In the present paper I describe the behavior of phorids that results in the pollination of *Herrania,* but do not rule out the possibility of other types of pollinating animals also being capable of such a process. Although phorid flies are known to be frequent visitors at many different flower species in the British Isles (Disney, 1980), little if anything has been determined as to their role as effective pollinators.

Methods and Materials

All of my observations on the three species of *Herrania* were carried out in a "garden" plot of these trees (Fig. 1) situated at "Finca Experimental La Lola," near Siquirres (10°06'N, 83°30'W), Limon Province, Costa Rica, a region of lowland tropical rain forest. The plot of *Herrania* (Fig. 1) was originally established about 25 years ago, amidst the cacao plantation of this locality. In two species, *H. purpurea* and *H. nitida,* both with showy blood-red to purplish flowers, inflorescences exude a distinctive musty scent which is even noticeable in withered, fallen flowers. The third species, *H. albiflora,* with smaller white flowers (Fig. 2), has no noticeable fragrance (when checked over a 24-hour period).

There is a total of 20 *H. purpurea* trees (D.B.H. range of 3.0–5.0 cm and height range of 1.8 to 4.5 meters) in the garden, 5 *H. albiflora* (D.B.H. range of 3.0–4.5 cm and height range of 2.4 to 4.0 meters) and 2 *H. nitida* (D.B.H. of 3.0 and 3.5 cm and heights of 3.2 and 4.0 meters), and all of these trees are arranged in rows. The area is either grazed by horses or cleared by periodic cutting (Fig. 1).

Observations on the abundance of new flower buds and open flowers on all of the *Herrania* trees in the garden area were made on the following dates: 21–22 July 1982, 8–10 December 1982, 25–27 February 1983 and 12–16 March 1983. February and March are relatively drier months at "La Lola" than are most other months, although daily light showers occur during these periods. From one to three days were spent during each of three periods (July and December 1982 and February–March 1983) making around-the-clock observations on the activity of insects at freshly-opened flowers of those species in bloom at the time. Nighttime observations, usually from 1900 to 2100 hours, were made with the use of red cellophane over a small flashlight. In addition to daytime observations, dawn-dusk observations consisted of observing flowers from about 0530 to 0800 hours and 1600 to 1830 hours. When insects were seen on the flowers, further observations were made on how they moved into the flower and exited from it. Care was taken to note the presence of pollen on the bodies of insects seen exiting from the flowers, and voucher collections were made for all insects found in the flowers. The observations allowed me to determine at what times of the day insects were most active at the flowers. Insects bearing pollen were examined carefully with a binocular dissecting microscope to determine if the pollen carried was that of *Herrania.* Samples of *Herrania* pollen were taken directly from flowers, although, since the pollen of related species of this genus are very similar (Taylor, 1965), I was unable to associate pollen on insects with each species of *Herrania* being studied.

Anthesis, pollen liberation, and periods of peak fragrance-release were examined by observing marked (with small color-capped pins) flowers of *H. purpurea* at

Fig. 1. The *Herrania* "garden" at Finca Experimental La Lola, near Siquirres, Limon Province, Costa Rica (top) showing the trees studied for phorid pollination, and satyrid butterflies feeding on fluids exuded from rotting *H. purpurea* flower fallen on a *Heliconia* leaf (below). Note the very elongate petal ligules of the dead flower.

various times of the day and night. The flowers were also checked at various times over a 24-hour period to determine if liberal amounts of nectar could be seen in them, and if so, the locations. Finally, I collected several specimens of *H. purpurea* for preliminary scanning electron microscopy: an examination was made of floral parts, including: pistil and ovary, petaloid staminodes, ligules associated with petals, stamens and anthers. Emphasis was placed on detecting possible nectaries and glandular hairs (trichomes) responsible for fragrances. The electron microscopy was carried out at the Great Lakes Center associated with the University of Wisconsin–Milwaukee, and details of the methods used are summarized elsewhere (Young et al., 1984). An examination of pollen and location of pollen grains was also made.

General observations on the condition of flowers at various times of the day were also made, with an emphasis on comparing activity of pollinators at flowers in drier and wetter periods.

RESULTS

Phenological notes.—During July 1982, intense flowering was noted in *H. purpurea,* and to a lesser extent in *H. albiflora.* Fifteen of 20 *H. purpurea* had full-sized floral buds and open flowers at that time. A pronounced difference in the abundance of flowers on trees of both species was found between late rainy season (December 1982) and mid-dry season (February 1983) censuses, with a sizable reduction in flowering in the latter period (Table 1). Although these samples were limited to rather short census periods, I believe that they represent real biological differences in flowering patterns, judging also from the presence or absence of smaller flower buds and fruits (to be summarized in a later paper). For the purposes of the present paper, I assume that the observed differences are representative of temporal changes in flowering intensity in both species, and particularly for *H. purpurea,* which provided the largest sample. Additionally, one of the two *H. nitida* trees had 106 buds (in various stages of development as judged by size differences) and two freshly-opened flowers on 13 March 1983. As noted in Table 1, there is considerable variation in the numbers of flowers on individual trees, but during both census periods, flower buds were more numerous than open flowers. Development of new buds may be rapid, since one *H. nitida* tree on 26 February 1983 had 40 buds and no open flowers, and about two weeks later (13 March) the number of buds had more than doubled. Daily output of freshly-opened flowers on *Herrania* trees is very low, ranging from one to five in most cases. During the dry period, successful rainy days precede "bursts" of flowering in *H. purpurea.* For example, following three days in which there was moderate rainfall for two to six hours each day, three of the 20 trees had a combined total of 40 new buds and four freshly-opened flowers. Prior to this, all of these trees had practically no large buds and open flowers.

A phenological pattern for adult *Herrania* trees at this locality can be tentatively derived from the most extensive data set available, that of *H. purpurea.* During the rainy season there is a very high abundance of new flower buds and with a daily output of a few open flowers in each inflorescence on each tree. Flowering, as suggested by casual observations in July 1982, most likely "peaks" during the middle of the rainy season, but there is some flowering throughout the year on many individual trees. A greater percentage of trees are in flower during the rainy season than in the drier period. During the drier period ("veranillo") flowering is greatly reduced, but small bursts occur when there are several successive days of moderate rainfall. I view month-to-month flowering in these trees to be a very fluid phenomenon, governed largely by influence of rainfall and other environmental factors on internal physiological systems related to fruit development and

Table 1. Abundance of flower buds and open flowers on two species of *Herrania* (Sterculiaceae) at different times of the year at "Finca Experimental La Lola," near Siquirres, Limon Province, Costa Rica.

		Numbers of Flowers on *Herrania* Trees							
		H. purpurea (*n* = 20 trees)				*H. albiflora* (*n* = 5 trees)			
Census Period	Season	Total Open Flowers	$\bar{x}$ ± SD	Total Buds	$\bar{x}$ ± SD	Total Open Flowers	$\bar{x}$ ± SD	Total Buds	$\bar{x}$ ± SD
10 Dec. 1982	Late rainy	17	1.41 ± 3.44	213	21.25 ± 22.27	8	0.84 ± 1.32	87	11.61 ± 9
26 Feb. 1983	Dry	1	—	38	1.95 ± 3.74	0	—	9	1.50 ± 2

The range in numbers of flower buds and open flowers on *H. purpurea* trees was 0–64 and 0–12 respectively during the late rainy season census, and 1–5 for buds during the subsequent dry season census. During the late rainy season the height range for flowers was 0.24 to 4.80 meters while during the dry season it was 0.1 to 2.1 meters on these 3–4 meter tall trees. For *H. albiflora* during the late rainy season there was a range of 12–20 buds per tree and during both seasons flowers were 0.1 to 2.0 meters on trunks 2 to 3 meters high.

Following a few rainy days in March 1983, 3 trees of *H. purpurea* had a combined total of 40 buds and 4 open flowers, one *H. albiflora* had 3 buds and 2 open flowers, and one of 2 *H. nitida* had 107 buds and 2 open flowers.

maturation. During the dry season, for example, *H. purpurea* trees are loaded with very high numbers of mature fruit (A. M. Young, unpublished observations), a time of relatively low flowering. Less extensive data from other *Herrania* at this locality suggest similar phenological patterns.

Diurnal flowering pattern.—In all three species, full-sized flower buds begin to split open usually after dark but before 2000 hours, and flowers are fully open by 0600 to 0800 hours the following day. During the rainy season, buds sometimes begin splitting open between 1600 and 1800 hours. These conclusions are drawn from (1) following the opening patterns of a total of 32 *H. purpurea* flowers (27 in December 1982 and 5 in March 1983) and four *H. nitida* flowers (March 1983), and (2) casual observations at various times of the day and night on flowers of all three species. If flowers are not pollinated on the day of opening, they often wither and fall off by the following evening, and during the dry season flower drop even occurs in the afternoon hours in hot, dry weather. Freshly-opened flowers have maximal fragrance from about 0600 to 0900 hours, and during the rainy season, if they are still on trees, a second period of fragrance from about 1600 to 1900 hours.

Anthers fully dehisce during the morning and afternoon hours in the rainy season. But during the dry season, anthers of all three species fully dehisce much earlier in the morning, very soon after flowers are fully open. Freshly open flowers have no signs of copious nectar flow at any time of the day, nor is there a noticeable crepuscular cycle of generous nectar production. During the daytime, the inner surfaces of petal hoods of *H. purpurea,* particularly in the rainy season, are often coated with patches of liberated pollen, easily spotted by the creamy white to yellow color of pollen against the dark red or purplish tissue.

Evidence of phorid pollination.—During the rainy season in particular, fallen withered flowers of *H. purpurea* attract a variety of juice-feeding insects, including satyrid butterflies (Fig. 1), presumably lured by the strong musty scent which is associated with both fresh and withered flowers. Occasionally cecidomyiid midges are seen resting on exposed floral parts of *H. purpurea* during the rainy season, but their numbers are very low and visitations number only four out of approximately 65 insect-flower observations. In spite of lengthy observations when these insects were found on flowers, these midges were never seen to enter into the central style area or peripheral petal hoods. Leaf cutter ants, *Atta* spp., are frequent severe defoliators of the leaves and flowers of *Herrania* at this locality. At least three species of ants occasionally visit the flowers. Other dipterans observed occasionally at open flowers include *Bradysia* (Sciaridae). None of these organisms, however, exhibit the regular behavior of visiting open flowers in high frequency and in the numbers observed for phorids. No bees were seen on flowers of any *Herrania* species at this locality, and observations were made at various times of the day and night, including the 0400 to 0700 hours when certain groups of pre-dawn bees (e.g., *Ptiloglossa*-Colletidae and some Halictidae) are active.

By far the most abundant insect on the flowers of all three species during both rainy and dry seasons were flies (body length 4–7 mm) of the family Phoridae. Two undescribed species from genera, *Megaselia* and *Dohrniphora,* were recorded from *Herrania* flowers. Unfortunately it was not possible to determine species for the phorid genera collected from *Herrania,* largely because all specimens were female and it is virtually impossible to make species determinations with females (e.g., Disney, 1981).

During the rainy season (July and December 1982 periods), from one to six phorids were observed simultaneously on a single flower of *H. purpurea.* Individuals of both genera were only observed at the flowers during the early morning period (0600 to 0730 hours) and late afternoon to dusk (1650 to 1800 hours), suggesting a strongly crepuscular activity pattern associated with flowering activity *H. purpurea.* During the dry season observations (March 1983) several phorids were found on the few *H. nitida* flowers and *H. albiflora* flowers, but only during the early morning hours (0600 to 0730 hours). Whereas during the rainy season the flies were regular visitors to freshly-opened and roughly 8-hour-old flowers on a daily basis, during the dry season there was considerable day-to-day variation in their occurrence, and on mornings, they are totally absent. Although another phorid genus, *Chonocephalus,* was found breeding in rotting cacao pods very close to the garden near the end of the dry season in 1982 (late March and early April), none of these were found on *Herrania* flowers. Judging from voucher samples collected from flowers, the abundance of *Megaselia* and *Dohrniphora* species was very similar. Each genus was represented by one undescribed species.

Pollinating activity of these phorids was indicated by the repeated observation of individual flies entering petal hoods without pollen on their bodies, and then exiting, usually from 4 to 15 seconds later, with generous amounts of pollen on the notum and head. The pollen was visible against the dark background color of these bristle-covered flies. Upon exiting from a flower in this manner, a phorid would fly to another flower on the same inflorescence, or, more frequently, leave the observation site. Several observations were made of phorids, laden with pollen, moving through the central area of the flower, brushing against the style and then either (a) flying away, or (b) squeezing between the petaloid staminodes and reentering a petal hood. Two approach patterns to open flowers were repeatedly

Fig. 2. Top, left to right: inflorescence of *H. purpurea* showing open flowers and large (full-size) floral buds (left) and view of a freshly-opened flower showing the petaloid staminodes and proximal sections of petal ligules. Below, left to right: *H. purpurea* with petal hoods held open to expose the light-colored anthers and pollen; freshly-opened flowers of *H. albiflora.*

observed: (a) most frequently, phorids would alight on the elongate, suspended ligules and rapidly crawl up to the flower and enter it; (b) phorids would land directly on a petaloid staminode and enter the flower. All movements were rapid, characterized by a typical "jerky" walking pattern common to phorids. On several

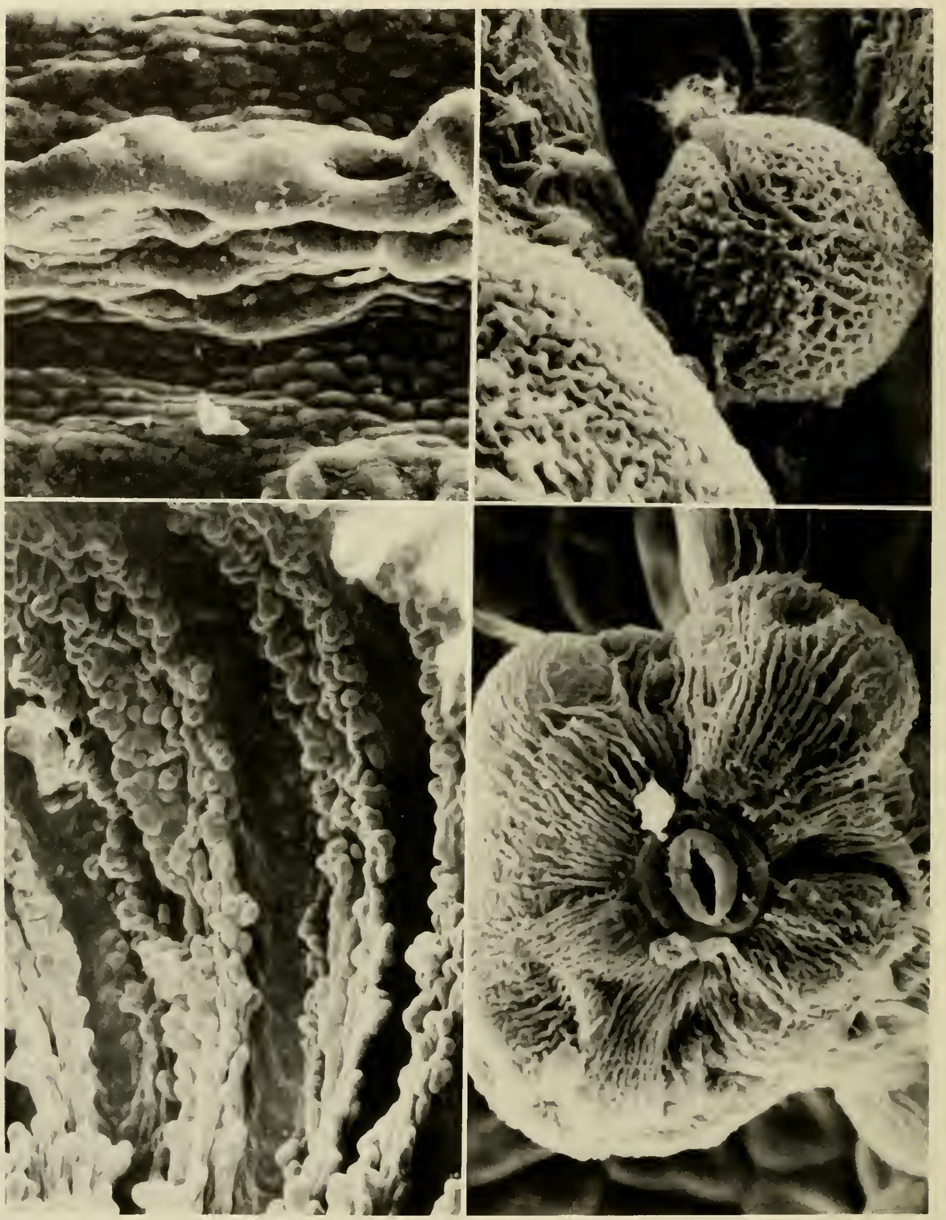

Fig. 3. Scanning electron microscope photographs of the petal ligule and petal hood floral parts in *H. purpurea.* Top, left to right: ridge of intertwining bulbous cells forming a pronounced ridge on concave (adaxial) surface (left) (180×), and *H. purpurea* pollen grain (1800×) lodged between sulci of convex (abaxial) surface. Below, left to right: inner surface of petal hood (27×) in vicinity of anther sacs, and showing distinct ridges of bulbous cells, possibly nectar guides; a stomate-type nectary (630×) opening between bulbous cells of previous photograph.

occasions, phorids would land on ligules and then fly away, without entering the flower. Phorids did not alight on closed buds in inflorescences or on adjacent bark or moss. Frequently, several phorids would show up at a flower at about the same time, and depart in the same manner. A total of eight phorids were collected from

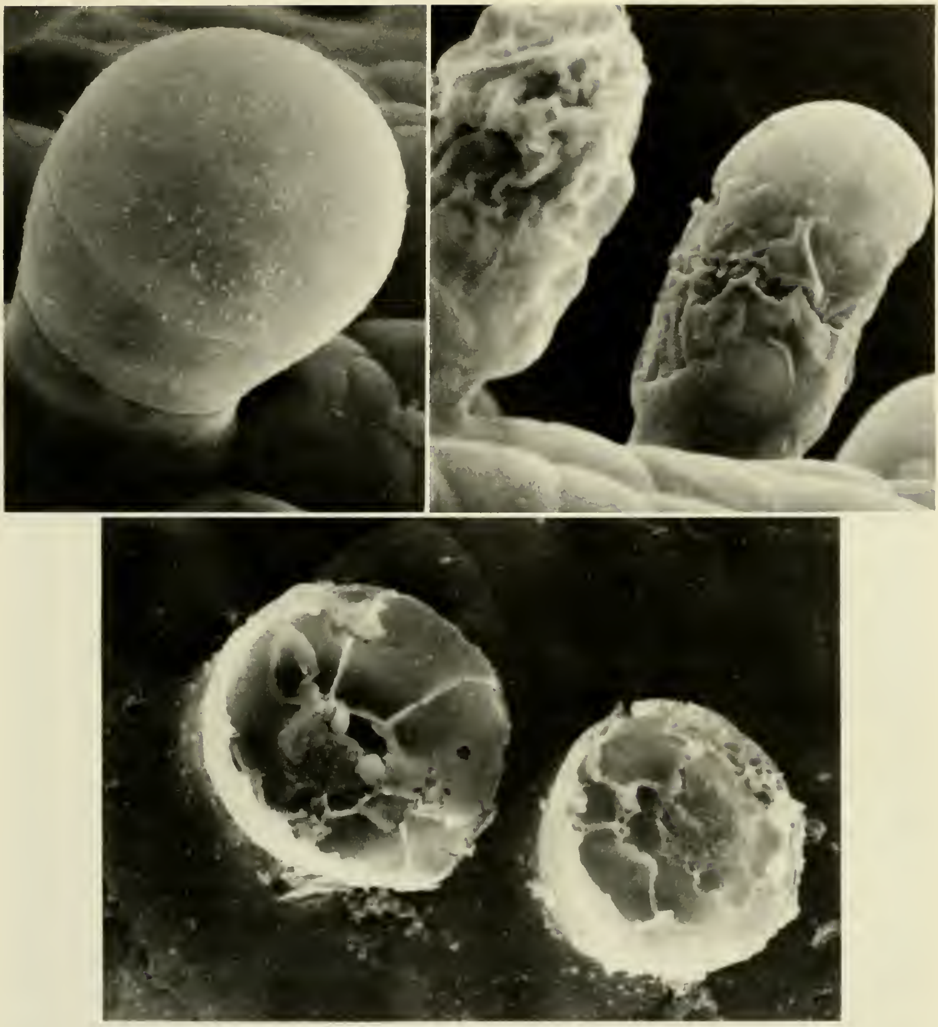

Fig. 4. Suspected elaiophores or oil (fragrance)-secreting trichomes on the surface of the ovary in *H. purpurea.* Top, left to right: short, bulbous elaiophore or trichome (2520×), possibly a young developmental stage, and elongate elaiophore or secretory structure (1800×) with convoluted surface. Lower: basal area of possibly chewed- or broken-off elaiophore or secretory trichome (252×).

Herrania flowers, although many more were observed, and of these, all were female and six had pollen on their bodies. Pollen deposition on the stigma and style of *H. purpurea* is of the scattered or "smear" type (Fig. 3), and involves the placement of many pollen grains (range of 15–95) by a single phorid on one visit to the style area. Germination of pollen on the style, in addition to the stigma, is common in all three species of *Herrania* studied (Fig. 3). Fully-dehisced anther sacs (Fig. 3) characterize virtually all open flowers by 1500 hours on the day they open.

The highly convoluted surfaces of the ligules of *H. purpurea* (Fig. 4) are probably glandular. Pollen grains (Fig. 4) are lodged on the ligule surface, presumably by phorids exiting petal hoods after brushing against dehisced anthers, and grains are also scattered on the inner surface of the petal hoods (Fig. 4), the site of stomate-type nectaries (Fig. 4). The range in number of pollen grains found adhering to the inner surface of petal hoods following a peak period of anther dehiscence is 58 to 430 for a total of n = 25 petal hoods examined. The exine of *H. purpurea* pollen grains is moderately sculptured (Fig. 4), a condition related to the ability of grains to lodge both on the sides of petal hoods and in the bristles of phorids and other insects. The surface of the ovary and basal area of the flower of *H. purpurea* has many peg-like rounded projections, presumably glandular trichomes or elaiophores producing fragrance compounds or nutritive substances attractive to insects (Fig. 5). These structures include both small, almost bulb-like projections with smooth surface as well as elongate ones with convoluted surface (Fig. 5). It is frequently found that the ovary surface has "bare" patches where some of these structures appear to have been broken off or chewed off (Fig. 5). When phorids come into contact with the style, they sometimes orient head-downwards towards these structures on the ovary surface. Movements of phorids in the flowers are so rapid that I was unable to determine if they had contact with these structures.

DISCUSSION

The results reported in this paper suggest the following pollination mechanism in *Herrania* species at "La Lola" in Costa Rica. Flowers open primarily just before dawn and anthers dehisce shortly thereafter. At the time of opening flowers exude a strong musty (aminoid) scent that attracts large numbers of phorid flies (*Megaselia* and *Dohrniphora* species), all females. As noted by Percival (1965) for other fly-pollinated plants, the phorids are attracted to the dangling, elongate petal ligules, which initially function as a landing site for pollinators. Pollination then takes place in the manner described above. Pollination in both *Theobroma* and *Herrania* can result from pollen grains being deposited in this manner (Cuatrecasas, 1964). Orientation of phorids to the style area may be enhanced by the liberation of suspected fragrance compounds or nutrients associated with the glandular trichomes or elaiophores (see Simpson and Neff, 1981) coating the ovary and basal area of the flower. During the mid-morning and afternoon hours, phorids are absent from the flowers. During the rainy season, flowers often remain fresh in appearance by dusk of the same day of opening, and fragrance is again detected at this time of the day. There is a second pulse of phorid activity at these flowers, and additional pollination may occur. Dusk visitation may allow phorids to pick up payloads of pollen which are then used to pollinate freshly-opened flowers the following day. If this is the case, *Herrania* flowers may exhibit, particularly during the rainy season, overlapping pistillate and staminate phases (e.g., Baskin et al., 1981; Bawa and Beach, 1981), although confirmation of such patterns awaits further study.

The closely related Bombacaceae often have tufts of nectaries at the base of the sepals and are bat-pollinated (Cronquist, 1981). Pollination systems involving flies may also involve the positioning of a floral reward system at the base of the flower (e.g., Philbrick, 1983). Simpson and Neff (1981) describe the nutritive oils secreted by specialized glandular tissue in the Solanaceae, which provide a lipid-rich reward for bees to feed to their young. Stomate-type nectaries, of the kind found on the inner surface of the petal hoods, are known from a variety of plants

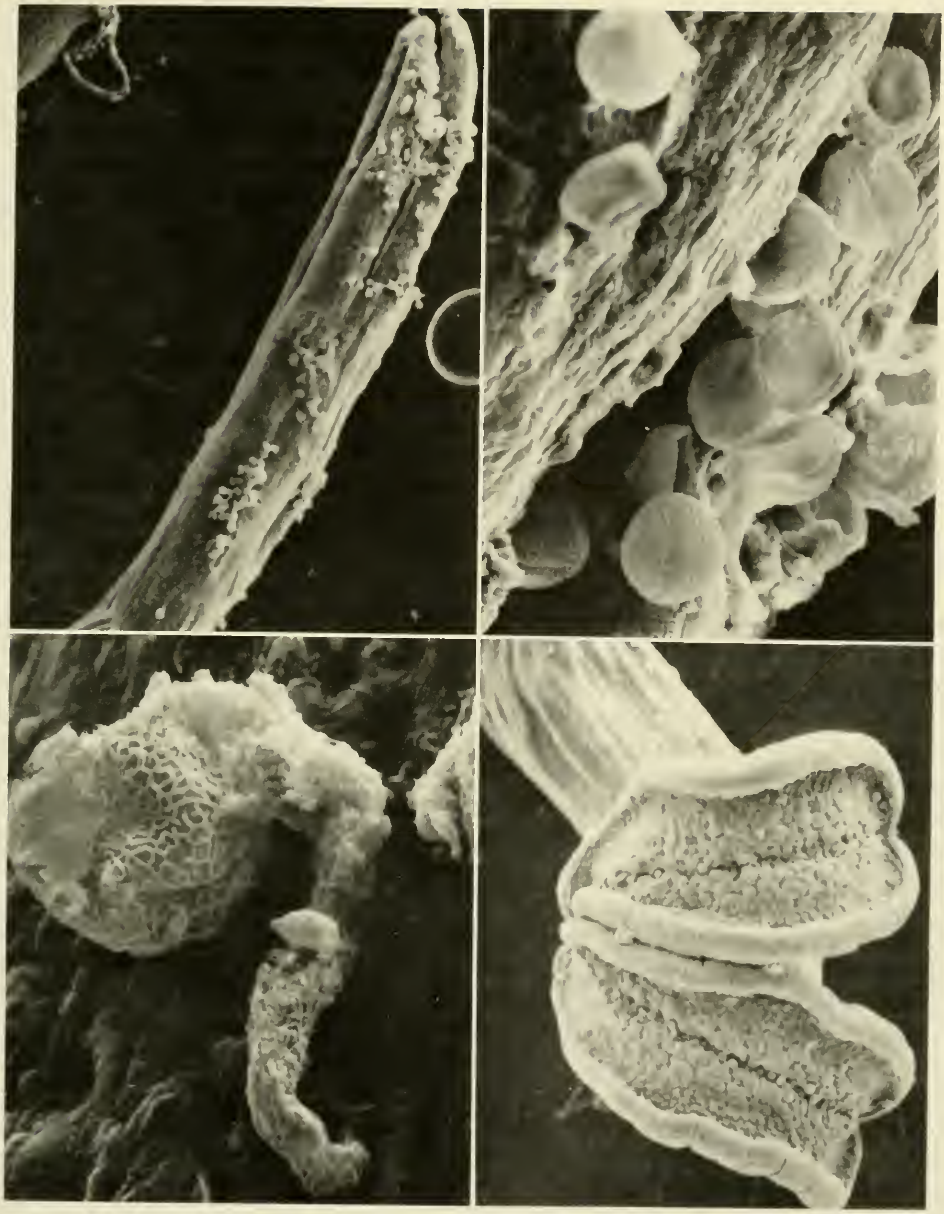

Fig. 5. Pollen distribution and pollen tube growth on the style of *H. purpurea* and dehisced anthers. Top, left to right: natural distribution of pollen grains, presumably a "smear" from one or more phorids (Diptera) along the style (left, 50×) and closeup of lodged pollen grains (right, 630×). Note sculptured exine of pollen grains, also seen in Fig. 3. Below: germination of a pollen grain on the style (1440×) and dehisced anthers with all but a few pollen grains liberated (45×).

(e.g., Fahn, 1979). Kevan and Baker (1983) mention that the short proboscis of dipterans is adapted to getting nectar from shallow areas on floral parts. Phorids may extend their probosci into the stomate-type nectaries for feeding. In a related study (Young et al., 1984), stomate-type nectaries were found in *Theobroma* species as well, not only on the petal hoods but also on the petal ligules. Further studies will focus upon the determination of the secretory functions of these structures in both genera. Tentatively I assume that the available data indicate a pollinator-reward system located primarily in two areas of *Herrania* flowers: (a) nectaries scattered on the inside of the petal hood, and (b) secretory structures located on the ovary and also in the basal area. The behavior of phorid flies in *Herrania* flowers is such that they come into contact with these areas of the flower, and in doing so, (a) pick up pollen and (b) smear pollen on the stigma and style. To what extent any of the *Herrania* species are self-compatible awaits an experimental approach. But some indirect data suggest that self-compatibility might exist: (a) there is very high fruit set on individual trees, as noted primarily for *H. purpurea,* (b) most trees bear fruit, and (c) in instances in which only one individual has flowers (such as seen in *H. albiflora*) this tree subsequently has fruit. Such observations cannot rule out the possibility of pollen being obtained from trees outside the garden area (which is highly unlikely, since all of the trees at "La Lola" are planted, i.e., introduced), and that there is some inter-tree transfer of pollen within the garden plot. Although both in wild and cultivated *Theobroma* cacao fruit set on a per tree basis is often low, lowest yields are typical of self-incompatible varieties.

The markedly crepuscular activity of phorids at *Herrania* flowers is most likely related to (a) the synchronization of anthesis with pollinator activity, and (b) ecological constraints for small-bodied, dark-colored flies to be active during the hottest hours of the day. Dusk pollination systems in the tropics involving small insects may be more frequent than previously believed (e.g., Gibbs et al., 1977), and it is physiologically less stressful for small dark-colored flies to be active early and late in the day (Willmer, 1982). To what extent discovery of receptive *Herrania* flowers at dawn and dusk is related to how phorids perceive color remains unknown, although certainly the strong scent of *H. purpurea* and *H. nitida* play major roles. Percival (1965) reports that flowers with full-red or purple colors and aminoid scents are usually fly-pollinated, although such adaptations, in conjunction with other floral features, are also found in bat-pollinated plants in the tropics (e.g., Steiner, 1983). The moderately-sculptured exine of *Herrania* pollen is consistent with insect-mediated pollination, particularly when contrasted to the very smooth-surfaced pollen grains of a wind-pollinated rain forest understory tree in Costa Rica (see Bawa and Crisp, 1980). *Herrania* pollen falls into the type adapted for insect vectors (Heslop-Harrison, 1979). The presence of what appear to be nectaries and other glandular structures, and a strong scent in at least two of the species studied, all point to a pollination system involving animals.

Posnette (1944) called attention to the probable role of phorids in *Herrania* pollination, and noted that at least some *Theobroma* species had very different dipteran pollinators (namely Ceratopogonidae). Phorids such as *Megaselia* are known to breed in various kinds of plant and animal debris (e.g., Disney and Evans, 1982; Villa, 1980; A. M. Young, unpublished field data) as well as in fungi and other microhabitats (Disney, 1982a, b). Similar to what Villa (1980) found for *M. scalaris* (Loew) feeding in the larval stage upon rotting amphibian eggs in Nicaragua, I have found larvae of this species in rotting larvae of the social paper wasp *Polybia simillima* Smith in Costa Rican rain forest. Phorids such as *M. scalaris* and other *Megaselia* species that undergo their life cycles in carrion (e.g., Kneidel, 1983) might be attracted to flowers with strong aminoid or carrion-like fragrances (e.g., *Herrania*). In general, phorids associated with *Herrania* flowers most likely breed in the damp, shaded understory of rain forest and some kinds of agricultural habitats such as well-shaded cacao. *Herrania* very likely evolved along streams in lowland Neotropical rain forests (e.g., Cuatrecasas, 1964; J. Leon, unpublished manuscript) in partially-shaded habitats, and such habitats may also have been suitable for pollinators such as the Phoridae. When *Herrania* is grown in an open garden plot situation as seen at "La Lola," influences of the dry season may be greater than would be expected in the natural habitat, and one manifestation is the rapid wilting of flowers prior to dusk on the day they open.

My preliminary data suggest that *Herrania* species are pollinated principally by phorids. The observed phenological patterns of flowering would suggest that the interaction is highly unspecialized, since phorids would not have sufficient floral resources available throughout the year. In natural habitats however, the association might be more stable throughout the year, particularly in rain forests where understory trees might not experience the effects of dry periods as much as canopy species. As a basis for further experimental studies, the following discussion is therefore offered.

Some dipterans have specialized pollination associations with plants (e.g., Warmke, 1952; Percival, 1965; Kevan and Baker, 1983). The floral structure of *Herrania,* in which both pollen and presumed floral rewards are highly concealed within the flower, warrants a specialized pollinator, and the behavior of phorids in the flowers suggests such an association. Yet to what extent phorids are specialized to be *Herrania* pollinators is not known. Nectar, presumably present in only small amounts, and pollen are not readily accessible to insect visitors in the manner noted for bat-pollinated plants (Steiner, 1983). Phorids most likely forage opportunistically on a broad range of nutritive resources associated with the lowland tropical rain forest habitat. Some recent studies have shown, however, that relatively unspecialized dipteran pollinators can sustain high levels of fruit set in plant populations through their high numerical abundance, ability to thrive well under cool moist forest conditions, and relatively low energy demands (Mesler et al., 1980; Levesque and Burger, 1982). In the natural habitat of *Herrania,* phorids, rather than bees, would be the most effective pollinators due to their affinity for moist, shaded forest conditions, relatively low energy needs (relative to bees), and attraction to the aminoid scent of the flowers. Although bee pollination cannot be ruled out by this study, it seems that the elaborate pollination mechanism of *Herrania* is adapted principally to phorids as pollen vectors. Heavily-shaded forest understories are not conducive to bee pollination (e.g., Anderson and Beare, 1983). Yet some plant species have both "major" and "minor" pollinators (Lewis and Zenger, 1983) and the combined effects of both groups determine fruit set patterns. Phorids may be part of a primary group of insect pollinators associated with forests (Baumann, 1978). It is difficult, however, to conclude that the extant floral structure and physiology are adaptations to the extant pollinators, since other types of pollinators, no longer extant, might have been part of the original selection pressure underlying the coevolved association (Janzen, 1980).

In both *Theobroma* and *Herrania* the basic floral design is the same: the flower is hermaphroditic with a concave petal base and anthers alternating with staminodes (see Cuatrecasas, 1964). Behaviorally, both the flowers of *T. cacao* and the *Herrania* species studied here follow similar diurnal cycles of anthesis and design of the floral reward system (e.g., Walker, 1959; Gorrez, 1962; Sampayan, 1966; Stejskal, 1969; Young et al., 1984). The inference in floral design for *T. cacao,* and presumably for other *Theobroma* species, has been selection away from selfing with stout staminodes preventing the transfer of pollen to the stigma and style of the same flower (see the review of Bystrak and Wirth, 1978). Extending such reasoning to *Herrania,* a closely allied genus, the possibility exists that most or all species are also self-incompatible. If this is the case, then the observed high abundance of fruit (relative to cacao) on species such as *H. purpurea* indicates that an apparently high abundance of phorids results in considerable transfer of pollen among different trees in the somewhat artificial setting typified by the "La Lola" garden. Experiments are underway to determine whether or not *H. purpurea* is self-incompatible, and to what degree are phorids capable of transferring pollen between trees at this locality. These studies will be conducted principally during the lengthy rainy season at "La Lola" since the dry season is a time of greatly reduced flowering in *Herrania* at this locality. The timing of flowering in tropical trees relative to prevailing rainfall patterns varies greatly in different climatic zones of Costa Rica (e.g., Opler et al., 1976), and the drier periods at "La Lola" appear to be more stressful to *Herrania* in terms of flowering.

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NEW UNITED STATES RECORDS FOR TWO HETEROPTERA: *PELLAEA STICTICA* (PENTATOMIDAE) AND *RHINACLOA PALLIDIPES* (MIRIDAE)

Thomas J. Henry

Systematic Entomology Laboratory, ARS, USDA, ℅ U.S. National Museum of Natural History, Washington, D.C. 20560.

Abstract.—Pellaea stictica (Dallas), a widespread Neotropical pentatomid, is reported for the first time from Texas, and *Rhinacloa pallidipes* Maldonado, a mirid known formerly only from Puerto Rico, is reported from Florida. A brief taxonomic review and diagnostic characters are given to help distinguish these species from the related U.S. fauna.

This paper is provided to make available the records of two Heteroptera previously not known to occur in the United States. Reported are the pentatomid *Pellaea stictica* from Texas and the mirid *Rhinacloa pallidipes* from Florida. Pertinent literature and diagnostic information are provided.

***Pellaea stictica* (Dallas)**

Pellaea stictica, originally described in the genus *Rhaphigaster* (Dallas, 1851), is a Neotropical stinkbug known from Argentina, Brazil, Colombia, Ecuador, Guyana, Mexico (Oaxaca and Yucatan) and Panama (Kirkaldy, 1909). Rolston (1976) confirmed that *Pellaea* was the correct generic placement for the species, and Rolston and McDonald (1981) later included *Pellaea* in section 2 of a 3 part key to the Pentatomini of the Western Hemisphere. Distant (1891) provided a color figure of the adult. The host of this species is unknown.

This new U.S. record is based on a male and female (U.S. National Museum of Natural History [USNM]) taken alive on citrus at Weslaco, Hidalgo Co., Texas, 14 Oct. 1983, on the grounds of the Texas A. & I. Citrus Center, by J. V. French. In addition to the above records, there are specimens in the USNM collection from Costa Rica, Mexico (Jalisco), Paraguay, Peru, and Venezuela.

Pellaea stictica is easily distinguished from all other pentatomids in the U.S. by the dark reddish-brown dorsum spotted and marbled with yellowish orange, the pale undersurface of the body with blue-black to black spots (including spiracular openings), and pale legs with 2 blackish stripes on each tibia and femur.

***Rhinacloa pallidipes* Maldonado**

Recently, F. W. Mead (Fla. Dept. Agric., Gainesville) sent to me an adult female plant bug (USNM) collected alive on Brazilian pepper, *Schinus terebinthifolius* Raddi, at Hollywood, Broward Co., Florida, 27 Oct. 1983, by L. J. Daigle. I identified the specimen as *Rhinacloa pallidipes* by using Maldonado's (1969) key to the Puerto Rican species of *Rhinacloa* and comparing it to types housed in the USNM. This is the first report of the species in the United States and the only record since its original description from Puerto Rico (Maldonado, 1969).

Rhinacloa pallidipes is very close to *R. punctipes* Maldonado, also previously known only from Puerto Rico. The two species can be distinguished only by a slight variation in the degree of darkness of the spots on the pale hindfemora. It is my opinion that this small difference is only infraspecific variation and that upon study of additional material the species will prove to be conspecific. In the U.S. fauna, *Rhinacloa pallidipes* is most similar to *R. forticornis* (Reuter) in the general dark coloration of the dorsum and antennae, but it can be separated from *forticornis* by the yellowish-brown, dark-spotted femora and the dark, satinlike patch on the anterior part of the propleura immediately behind the eyes.

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CULEX (CULEX) MOLESTUS FORSKÅL (DIPTERA: CULICIDAE): NEOTYPE DESIGNATION, DESCRIPTION, VARIATION, AND TAXONOMIC STATUS[1]

RALPH E. HARBACH, BRUCE A. HARRISON, AND ADEL M. GAD

(REH, BAH) Walter Reed Biosystematics Unit, NHB-165, National Museum of Natural History, Washington, D.C. 20560, USA; (AMG) Research and Training Center on Vectors of Diseases, Faculty of Science, Ain Shams University, Cairo, Egypt.

Abstract.—A neotype male and alloneotype female from Rosetta, Egypt, are designated and described for *Culex molestus* Forskål, 1775. The male, female, pupa, and larva are described and illustrated. Variation encountered in the adult, pupal, larval, and egg stages is discussed. The taxonomic status of *molestus* is discussed and evaluated in light of morphological, behavioral/physiological and crossing variations. A decision is made regarding the status of *molestus* that will help stabilize the nomenclature of the *pipiens* complex.

The species, subspecies, and infraspecific forms that have been and still are attributed to the *pipiens* complex of *Culex* (*Culex*) represent one of the major outstanding problems in mosquito taxonomy. This problem has persisted for decades because of interpretational difficulties and controversy associated with a number of perplexing biological issues: autogeny/anautogeny, stenogamy/eurygamy, anthropophily/zoophily/ornithophily, homodynamy/heterodynamy, morphology (including DV/D and D/V ratios, and siphon indices), taxonomy (absence of type-specimens and misidentifications), distributions (confounded by introductions) and hybridization (hybrid swarms, and crossing studies confused by rickettsial symbionts). A world-wide study of these issues is desirable; unfortunately a comprehensive undertaking is beyond the scope of this study. However, for nomenclatural purposes, problems such as the absence of type-specimens can be resolved, and certainly should be, because the delimitation and fixation of names form the basis for taxonomic concepts.

During the past four years the senior author has been working on the taxonomy of the *pipiens* complex in the Middle East, and more recently on a revision of the *Culex* (*Culex*) of northern Africa and southwestern Asia. These efforts have highlighted the taxonomic instability and misunderstanding surrounding the identification of members of the *pipiens* complex in this region. Marshall and Staley (1937), Jobling (1938), Marshall (1944), Knight (1951), and Christophers (1951) attempted to outline stable morphological characters for *Cx. molestus* Forskål,

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[1] The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the supporting agencies.

and other members of the *pipiens* complex. However, since the 1950's it has become more apropos to define *molestus* on the basis of behavioral and physiological traits. *Culex molestus* was recently elevated to specific status on the basis of premating isolation behavior (Miles 1977a, Knight 1978) between members of the *pipiens* complex in Australia. Unfortunately, no attempt has been made to define *molestus* morphologically, as originally described by Forskål prior to the use of behavioral and physiological traits.

Recently, Belkin (1977) firmly established the priority of *Cx. quinquefasciatus* Say over *Cx. fatigans* Wiedemann, and Sirivanakarn and White (1978) designated a neotype to fix the identity of *quinquefasciatus*. We feel that similar stabilization is badly needed for *molestus* and other nominal forms, and is essential for resolving the taxonomy of the *pipiens* complex.

Background and Methods

Past efforts to resolve the taxonomic status of *molestus* were hampered because of uncertainty about the location of Forskål's type-specimens. For this reason, there have been no prior attempts to designate a neotype for this species. However, we believe that the original specimens of *molestus* are non-extant and that a neotype should be designated.

According to Zimsen (1964) and Knight (1972), Petrus (Peter) Forskål died 12 years before the description of *molestus* was published posthumously by Carsten Niebuhr (Forskål, 1775). Forskål succumbed, presumably to malaria, during the "Arabian Journey," a scientific expedition to Egypt and other Arab countries that was supported by the Danish Government. Before his death, Forskål sent collections of natural history specimens home, but some of these were lost en route. Specimens of *molestus,* if they were ever sent, may have been part of the collections which never reached their destination. All attempts to locate Forskål's specimens of *molestus* have failed. Stone et al. (1959:256) and Knight and Stone (1977:219) indicate that the location of type-material is unknown. In fact, there are handwritten notes in the Stone/Knight files in the NMNH indicating there is "negative evidence" for the existence of type-specimens for *molestus.* Although Linnaeus received Egyptian and Arabian specimens from Forskål, there is no evidence that mosquitoes were included (Jackson, 1913). Zimsen (1964) mentions that a number of insect species described by Fabricius came from the Forskål collections; however, none of the mosquitoes described by Fabricius came from Egypt or Arabia. Furthermore, a recent check of the Universitetets Zoologiske Museum, Copenhagen, revealed there are no specimens of *molestus* associated with the Fabricius Collection (L. Lyneborg, personal communication).

We made extensive collections of immature mosquitoes in Egypt between 15 March and 13 May, 1983. Areas surveyed in the south included Abu Simbel near the Sudanese border, the Nile Valley from the Aswan High Dam north to Idfu, and the Red Sea coast between Qusier and Bernice. Areas surveyed in the north were Siwa Oasis, El-Faiyum, the Red Sea coast from Suez to Ras Shukheir, and the Nile Delta. While working in the Nile Delta we made collections in Rosetta, Cairo, and Alexandria, the three specific type-localities for *molestus.* Adults matching Forskål's description of *molestus* were reared from all the areas collected. A neotype (specific information is provided with the designation below) and alloneotype were selected from material collected at Rosetta. Specimens reared with the neotype and alloneotype include 14 adults (3 males with pupal exuviae; 3 males and 8 females with both larval and pupal exuviae) and 16 fourth-instar larvae. Material collected in Rosetta was also colonized for behavioral/physiological studies. About 380 specimens were obtained from Cairo and Alexandria: some 64 males, 87 females, 151 pupal exuviae, 60 larval exuviae, and 20 fourth-instar larvae. In all, more than 1500 adults, approximately 90% with larval and/or pupal exuviae, and hundreds of fourth-instar larvae were obtained from 87 of 175 collections made in Egypt.

Detailed descriptions and illustrations of the adult, pupal, and larval stages of the neotype are provided. Characters which differ in the alloneotype are described, and some important adult sexual differences are illustrated. A description of diagnostic and variable characters for each life stage based on associated specimens is also included. Character measurements, setal counts, and setal branching counts were made on the neotype and alloneotype, and 10 specimens collected with them. The morphological terminology follows Harbach and Knight (1980), except that siphon indices were calculated using the basal width of the siphon rather than the width measured at midlength.

A translation of Forskål's original Latin description of *molestus* precedes the description of the neotype. It is included to show that the neotype and associated material conform to Forskål's concept of *molestus*. Additional evidence for this conformity is given in the discussion.

***Culex* (*Culex*) *molestus* Forskål**

Culex molestus Forskål 1775: 85.

"CULEX molestus; *antennae with whorls of pile; proboscis ash-colored, apex black, rather thick; dorsum dark, with six pale bands.*

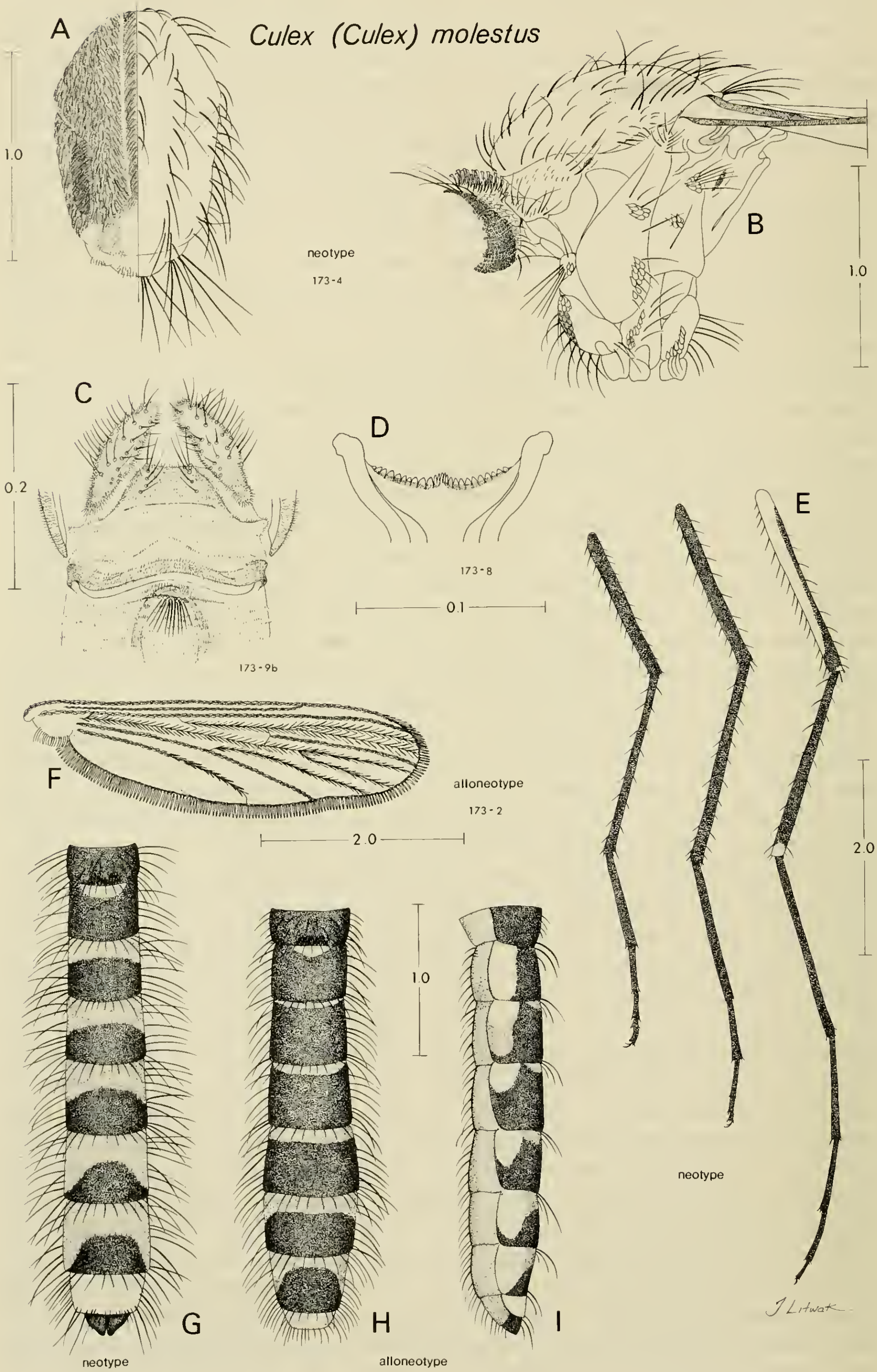
"Descr. *Size* and appearance of the *common Culex pipiens* [or perhaps, "*common twittering Culex*"]. *Eyes* greenish, consisting of numerous little globules. *Front* dark as well as the *Thorax. Proboscis* subclavate, that is thicker toward the apex and black; lower part ash-colored. *Antennae* setaceous, somewhat shorter than proboscis, furnished with large pilose whorls, about 13, as I would see them, base with a single segment. Bare indeed as perceived by the eyes, but poorly; because between them [pedicels?] are dense, erect, small hairs; one must use a microscope. *Lower thorax* and abdomen ashy-white. *Dorsum* dark, suture of segments 6 and 7 pale. Whole body and *Legs* pilose: femora ash-colored: tibiae dark. *Wings* dark, posterior margin ciliate. *Halteres* ash-colored, knob dark.

"*Rosetta, Cairo* and *Alexandria* tremendously abundant, bothers sleepers at night and difficult to avoid them unless with well-closed curtains."

Neotype (hereby designated): ♂ (173-4) with associated larval and pupal exuviae and genitalia on slides, Rosetta (= Rashid), Buhayrah Gov., Egypt, 6 May 83, ground pool with organic pollutants 2–3 m from open cesspit, Coll. Harbach/Gad. Deposited in the National Museum of Natural History, Washington, D.C., Type No. 101367.

Male (neotype) (Figs. 1, 2).—A medium-sized mosquito without striking features and special ornamentation. *Head:* Length of antennal flagellum 1.4 mm; flagellomeres 1–12 pale between whorls; flagellomeres 13 and 14 dark, length about 0.6 mm, approximately 0.4 of flagellum length; pedicel dark, paler laterally.

Proboscis without ventral cluster of setae near false joint; mainly black-scaled, with ventral patch of cream-colored scales 0.5–0.7 from base; length 2.1 mm, false joint 1.3 mm from base; labella yellowish. Length of maxillary palpus 2.5 mm, 1.2 of proboscis length, extending beyond tip of proboscis by nearly length of palpomere 5; palpus mainly dark-scaled, integument between palpomeres 2 and 3 pale; lateral surface of palpomere 3 with subtle stripe of creamy-white scales in middle, stripe bordered ventrally by row of long dark setae on distal 0.5 of palpomere, with ventromesal row of small antrorsely-curved pale setae along most of length; palpomere 4 with nearly complete ventral stripe of white scales tapering distally; base of palpomere 5 with small ventral patch of white scales; long lateral setae of palpomeres 4 and 5 longest at base of 4, gradually shortening to apex of 5. Forked scales of vertex rather short, dark, some paler medially; falcate scales narrow, pale yellow, paler laterally; lateral spatulate scales creamy white. Ocular setae dark reddish brown, curved anteriorly. Interocular space narrow, with few pale falcate scales continuous with those of vertex and 2 large, golden setae projecting ventrally over clypeus. *Thorax* (Fig. 1A, B): Pleural integument faded yellowish brown; scutal integument brown, paler laterally. Scutal scales fine, golden brown with slight reddish tint; scales finer on fossae and supraalar areas; integument and scales between supraalar and posterior dorsocentral setae noticeably darker, evident as pair of ovoid spots, particularly when viewed in dorsal aspect; pale yellow scales on margin of prescutellar area. Scutal setae dark reddish brown, prominent. Scutellum with narrow, pale yellow falcate scales; 5 large setae on each lateral lobe, 7 on median lobe. Antepronotum with pale yellow falcate scales and dark setae. Postpronotum with golden-brown falcate scales, paler posteriorly; with 6 dark setae on posterodorsal margin, longer posteriorly. Pleural setae golden brown, numbers on left side as follows: 13 upper proepisternal in more or less double row, 10 prealar, 4 upper mesokatepisternal, 6 lower mesokatepisternal, 6 upper mesepimeral and 1 lower mesepimeral. Pleural spatulate scales nearly white: few below upper proepisternal setae, patches on upper corner and lower posterior border of mesokatepisternum, anterior patch on mesepimeron at level of upper mesokatepisternal patch, and small patch before upper mesepimeral setae; without prealar and postspiracular scales. *Wing:* Length 3.1 mm; cell R_2 2.4 of R_{2+3}; subcosta intersects costa before furcation of R_{2+3}; cell M_1 0.7 of cell R_2; scales entirely dark. Dorsal scaling: squame scales on costa, subcosta, R, R_1, R_{4+5}, M_{3+4}, mcu and CuA; plume scales on R_s, R_{2+3}, R_2, R_3, M, M_{1+2} and distally on 1A; near-linear decumbent scales on M_1, M_2 and proximally on 1A; remigium with 2 distinct rows of scales, and 3 setae distally. Ventral scaling: squame scales on costa, subcosta, base of R_1, R_s, R_{2+3}, bases of R_2 and R_3, M, M_{1+2} and bases of M_1 and M_2; plume scales on other veins and parts of veins except CuA before mcu and proximal 0.75 of 1A which are without scales. *Halter:* Scabellum and pedicel yellowish brown, capitellum with black scales. *Legs* (Fig. 1E): Anterior surface of forecoxa mainly black-scaled, with small basal patch of yellowish scales, anterior surface also with many long, brown, ventrally-curved setae, apex with 3 shorter setae on posterior margin, most proximal seta more or less perpendicular to surface, others project ventrally; midcoxa with midlateral longitudinal row of 4 well-developed golden-brown setae and longitudinal patch of creamy-white spatulate scales on anterior side of setae, anterior surface with few black scales and several short ventrally-projecting setae at apex; posterolateral surface of hindcoxa with 7 golden-brown setae, anterolateral surface with narrow longitudinal row of creamy-white spatulate scales and 4 short ventrally-projecting setae at apex, mesal surface with 2 dark setae at apex. Trochanters with nearly white spatulate scales on posteroventral surface, anteroventral surface of fore- and midtrochanters with some black spatulate scales. Anterior surface of forefemur with black scales, posterior surface with off-white scales, apex with subtle narrow border of pale yellow scales dorsally; midfemur like forefemur but black scaling extended over dorsal surface distally; hindfemur with complete anterodorsal stripe of black scales, stripe gradually expanded distally onto anterior and posterior surfaces, apex with narrow border of pale yellow scales dorsally. Foretibia with black scales dorsally, gray scales ventrally; midtibia with black scales anteriorly, off-white scales posteriorly; hindtibia mainly with black scales, posteroventral surface with gray scales, anterodorsal surface with subtle spot of grayish-white scales at apex. Tarsi black-scaled, scales slightly paler ventrally, particularly on tarsomere 1. Pulvilli pale. Ungues black; anterior foreunguis longer than posterior one, both stout, anterior one with small ventral tooth near midlength, posterior one with small tooth nearer base; anterior midunguis like that of foreleg, posterior midunguis smaller, more slender, with tiny ventral tooth near midlength; hindungues very small, simple. *Abdomen* (Fig. 1G): Terga mainly black-scaled; tergum I golden setose, with some median black scales on posterior border; posterior margins of terga II–VII with row of golden setae, median setae nearly length of basal band of next tergum, lateral setae longer, about 0.75 of tergum length; lateral scale-free areas of terga II–VII with long laterally-projecting golden setae; tergum II with basomedian yellowish spot; terga III–VII with basal yellowish bands 0.4 of tergum length, bands produced posteriorly along lateral scale-free areas, particularly on terga V–VII, giving them a concave appearance; tergum VIII (ventral in position) with golden setae and yellowish scales, posterior margin slightly emarginate in middle with row of rather short setae on either side of emargination. Sterna II–VII pale (same color as basal bands of terga) with few median black scales; sternum VIII (dorsal in position) with dingy white scales; all sterna golden setose. *Genitalia* (Fig. 2C–H): Ninth tergal lobes small, with 8 and 10 unevenly-spaced setae on left and right lobes, respectively. Gonocoxite normal, ventrolateral setae strongly developed, these longer and stouter than lateral setae, mesal surface with 5 rows of small setae extending from base to level of subapical lobe; subapical lobe undivided, setae *a–f* in more or less straight row with gap between *c* and *d*, seta *g* immediately lateral to *d–f*, seta *h* lateral to *g*, *a–c* nearly straight, *a* and *b* stout, *c* more slender, apex of *a* blunt, apex of *b* and *c* hooked and pointed; *d–f* shorter than *a–c*, hooked apically, *d* and *e* slender, *f* laterally flattened and appearing broad in lateral view; *g* foliform, evenly rounded distally; *h* slender, bent distally. Gonostylus stout, curved and tapered distally, with 2 small, slender setae on distal 0.3 of slightly concave dorsal surface; gonostylar claw short, broadest apically, troughlike. Phallosome longer than broad with lateral plates and aedeagus of nearly equal length; lateral plate with definite dorsal, lateral and ventral arms, dorsal arm broad, apex nearly truncate, slightly sinuous in lateral aspect and diverging from its mate of the opposite side; lateral arm broad in lateral view, its posterior margin more or less trilobed, the ventral lobe more prominent than the others and bent ventrolaterally, base of lateral arm with thumblike dorsal process, base of this process continuous mesally with dorsal aedeagal bridge; ventral arm



Culex (Culex) molestus

narrow and curved with apex directed laterally. Aedeagus subcylindrical, narrowed distally; ventral aedeagal bridge relatively wide, joining aedeagal sclerites just beyond midlength. Proctiger without distinctive features; paraproct with small, conical basal lateral arm, crown dark with numerous short, spinelike spicules. Cercal sclerite elongate, irregularly shaped; 4 and 3 cercal setae on left and right sides, respectively. Tergum X rectangular, adjoining paraproct below basal lateral arm.

Alloneotype: ♀ (173-2) with associated larval and pupal exuviae and same data as neotype.

Female (Alloneotype).—Like neotype except as follows. *Head:* Length of antennal flagellum 1.9 mm, entirely dark, pedicel and flagellomere 1 with tiny white scales on mesal surface, mesal surface of pedicel also with tiny setae. Proboscis length 2 mm; proximal 0.7 of ventral surface with cream-colored scales. Maxillary palpus entirely black-scaled; length 0.4 mm, about 0.2 of proboscis length. Forked scales of vertex more numerous, entirely dark. *Cibarial armature* (Fig. 1D, described and illustrated from specimens collected with the alloneotype): Cibarial crest concave, slightly produced in middle; with about 25 short, blunt teeth, several teeth in middle narrower and longer. Cibarial dome nearly elliptical in dorsal outline, slightly produced anteriorly in middle; surface with imbrication of pointed scalelike markings. *Thorax:* Scutal and pleural scales and setae same as neotype except ovoid spots between supraalar and posterior dorsocentral setae indistinct; numbers of some pleural setae on left side differ as follows: 8 upper proepisternal, 8 lower mesokatepisternal and 7 upper mesepimeral. *Wing* (Fig. 1F): Length 3.7 mm; cell R_2 4.8 of R_{2+3}; subcosta intersects costa beyond furcation of R_{2+3}; cell M_1 0.8 of cell R_2; remigium with 3 setae on left wing, 2 on right wing. *Legs:* Like neotype except midcoxa with 5 setae in midlateral row; hindcoxa with 8 setae on posterolateral surface. Ungues very small, simple. *Abdomen* (Fig. 1H, I): Tergum I with median posterior pair of black scale-patches; tergum II with basomedian spot of yellowish scales and lateral patches of white scales; terga III–VII with basal bands of yellowish scales and rather large basolateral spots of white scales, bands 0.25 of tergum length, slightly convex on terga III and IV and not reaching spots, straight on terga V–VII and contiguous with spots; tergum VIII white-scaled. Sterna II–VII with yellowish scales, with few subtle dark scales in middle; sternum VIII with whitish scales on lateral margins, broad median area devoid of scales. *Genitalia* (Fig. 1C, described and illustrated from specimens collected with the alloneotype): Sternum VIII with rounded median posterior emargination. Tergum IX narrow, posterolateral margin of either side with irregular row of 7–13 setae. Upper vaginal lip narrow, distinct; lower vaginal lip and insula indistinct; 8–12 insular setae in dense transverse row. Upper vaginal sclerite distinct; U-shaped. Postgenital lobe short, apex slightly concave to rounded, row of 6–8 setae on either side of midline extending from dorsal to ventral surface over apex. Cercus

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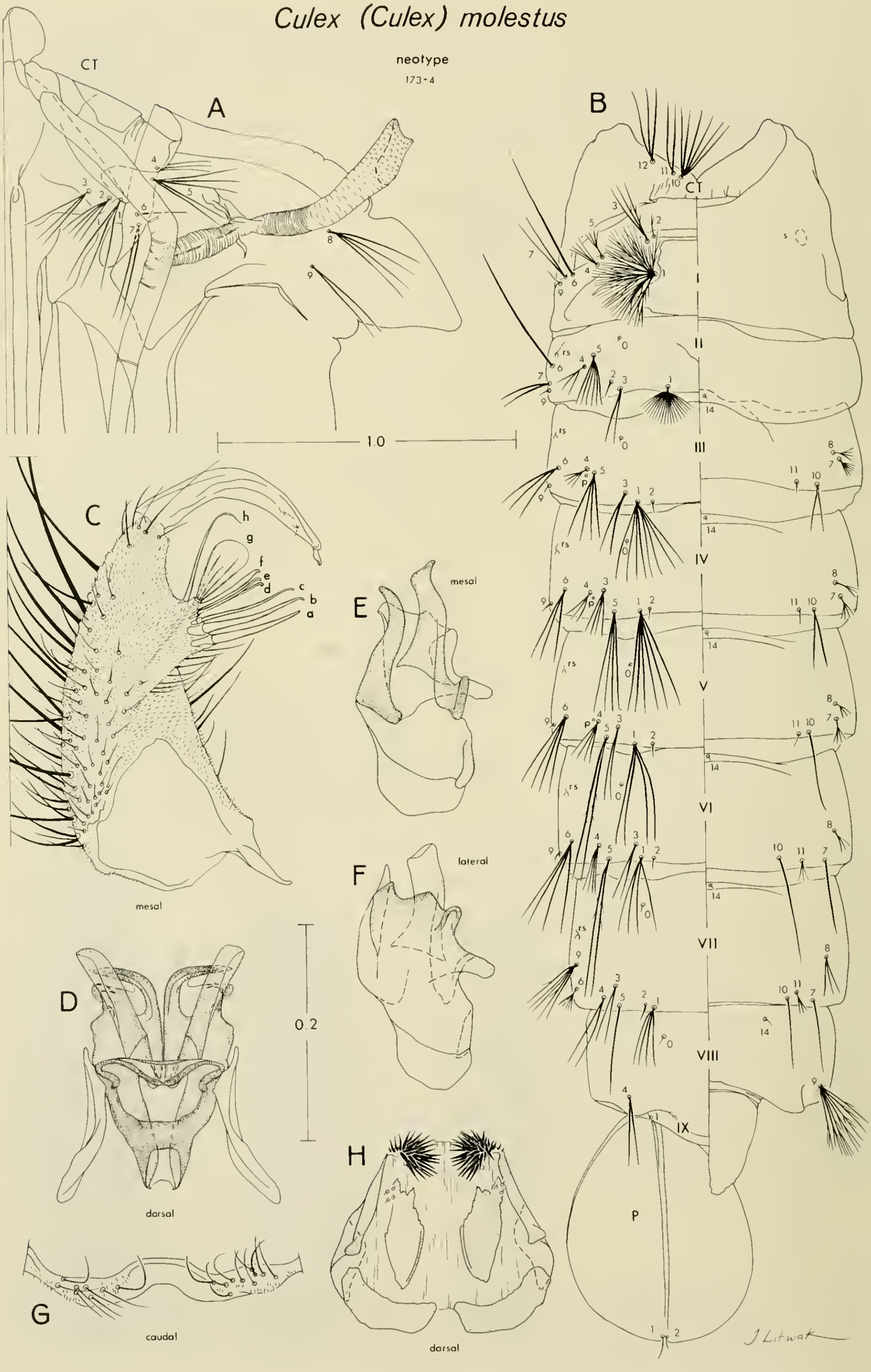
Fig. 1. *Culex* (*Culex*) *molestus* Forskål. A, Scutum of neotype male. B, Thorax of neotype male (left side). C, Female genitalia. D, Female cibarial armature. E, Legs of neotype male (anterior aspect of left legs). F, Right wing of alloneotype female (dorsal). G, Abdomen of neotype male (dorsal). H, I, Abdomen of alloneotype female (H, dorsal; I, left side). Scales in mm.

Culex (Culex) molestus



short, laterally compressed, broad in lateral view, apex bluntly rounded, lateral and ventral surfaces setose; cercus/dorsal postgenital lobe index 2.80–3.10.

The following variation was observed in specimens collected with the type-specimens. *Head:* Proboscis length 1.9–2.1 mm, mean 2.0 mm; length of maxillary palpus 0.4 mm in females (proboscis/palpus 5.0–5.3), 2.2–2.5 mm in males, mean 2.3 mm (palpus/proboscis 1.10–1.26, mean 1.18). *Thorax:* Ovoid spots of scutum often indistinct in females, when distinct, acrostichal and fossal scales sometimes equally dark and distinct; ovoid spots usually distinct in males. Postpronotum usually with 6 setae (5, 6); pleural setae: usually 8 or 9 upper proepisternal (7–15), 5–11 prealar, usually 4 upper mesokatepisternal (3–5), 5–8 lower mesokatepisternal, 4–9 upper mesepimeral. *Wing:* Length 3.6–3.7 mm in females, 2.8–3.1 mm in males; cell R_2/R_{2+3} 4.6–6.0 in females, 2.4–3.3 in males; subcosta intersects costa beyond furcation of R_{2+3} in females, at or before furcation in males; cell M_1/cell R_2 0.7–0.8. *Abdomen:* Basal bands of terga always yellowish, shape variable; basomedian spot of tergum I sometimes nearly or entirely lost; basal bands of terga III–VII either convex, straight or concave, bands of terga III and VII sometimes nearly or entirely lost in females; basal bands usually 0.20–0.25 length of terga in females, 0.25–0.30 in males. Sterna usually entirely pale-scaled.

Pupa (Neotype) (Fig. 2A, B).—Character and arrangement of setae as figured. *Cephalothorax:* Lightly tanned, legs and metathorax darker. *Trumpet:* Moderately tanned, almost cylindrical, gradually widened distally, index 5.0; tracheoid area darkened, extending 0.33 from base; pinna oblique, about length of tracheoid area. *Abdomen:* Lightly tanned, terga I–V darker in middle; length 3.2 mm. *Genital lobe:* Lightly tanned; length 0.4 mm. *Paddle:* Lightly tanned, midrib and buttress darker; midrib distinct except at apex; length 0.8 mm, width 0.6 mm, index 1.3.

The alloneotype resembles the neotype except as follows: trumpet index 6.2; abdominal length 3.3 mm; genital lobe length 0.2 mm; paddle 0.9 × 0.7 mm with same index.

Table 1 lists the range and modal number of branches for pupal setae observed in the types and associated specimens. Diagnostic and variable characters include the following. *Cephalothorax:* Seta 1-CT with 3 or 4 branches; 2-CT with 4 or 5 branches; 3, 4-CT usually with 3 branches (2–4); 6, 7, 9, 11-CT usually double; 10-CT with 5–13 branches, often with about 8. *Trumpet:* Index 4.9–6.2, mean 5.4. *Abdomen:* Setae 6-I, II single; 7-I, II usually double; 1-II multiple (14–24); 1-III–V frequently with at least 6 branches; 2-II, VII lateral to seta 1, 2-III–VI mesal to seta 1; 5-IV often with 4 branches, rarely double (2–5); 5-V, VI usually double; 6-III–VI usually with 3 or 4 branches. *Paddle:* Index 1.2–1.4, mean 1.3.

Larva (Neotype) (Fig. 3).—Placement and attributes of setae as figured. *Head:* Length 0.8 mm, width 1.1 mm; mainly lightly tanned, labiogula, posterior 0.5 of lateralia and posterior border of dorsal apotome moderately tanned; dorsal apo-

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Fig. 2. *Culex* (*Culex*) *molestus* Forskål, neotype male. A, B, Pupa (A, dorsolateral aspect of cephalothorax (left side); B, dorsal and ventral aspects of left side of metathorax and abdomen). C–H, Genitalia, aspects as indicated (C, gonocoxite; D, phallosome; E, F, lateral plate and aedeagal sclerite; G, tergum IX; H, proctiger). Scales in mm.

Table 1. Number of branches for pupal setae of *Culex* (*Culex*) *molestus* Forskål.[a]

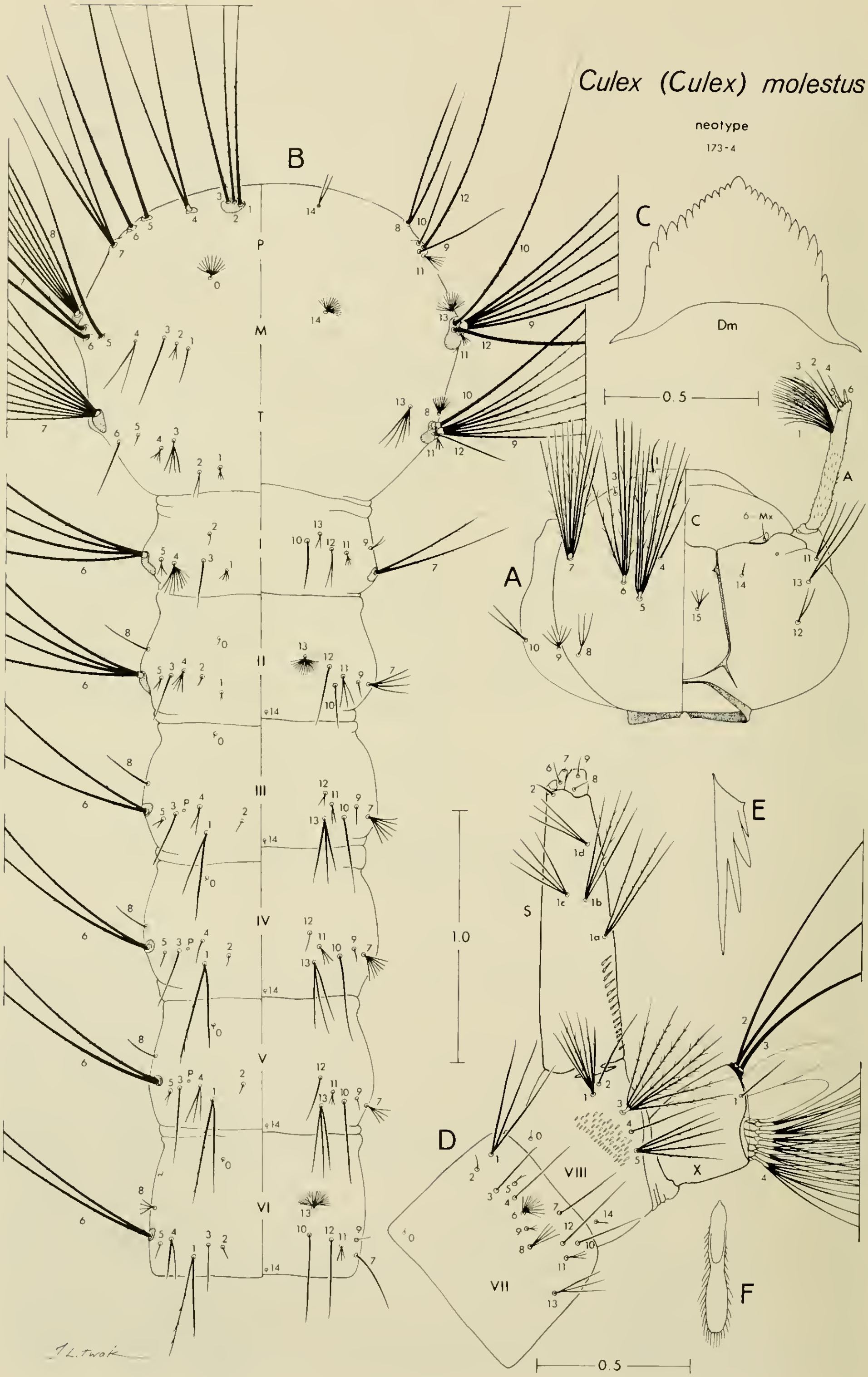
Seta Number	Cephalothorax CT	Abdominal Segments I	II	III	IV	V	VI	VII	VIII	IX	Paddle P
0	—	—	1	1, 2 (1)	1	1	1	1	1	—	—
1	3, 4 (4)[b]	36–75 (62)	14–24 (19)	5–9 (9)	5–9 (6)	4–7 (6)	3–7 (4)	3–5 (5)	—	1	1, 2 (1)
2	4, 5 (4)	1–4 (1)	1	1	1	1	1	1, 2 (1)	—	—	1
3	2–4 (3)	2, 3 (2)	2	2, 3 (2)	3–5 (5)	2, 3 (2)	2–4 (2)	1–3 (2)	—	—	—
4	2–4 (3)	4–8 (5)	2–7 (4)	4–8 (4)	2–5 (2)	3–6 (4)	2–6 (3)	1, 2 (2)	1–3 (2)	—	—
5	3–7 (6)	4–8 (5)	4–6 (5)	4–10 (5)	2–6 (4)	2, 3 (2)	1, 2 (2)	1–3 (2)	—	—	—
6	1–5 (2)	1	1	2–4 (3)	2–5 (3)	3–6 (4)	3–6 (4)	4–10 (5)	—	—	—
7	2, 3 (2)	2–4 (2)	2, 3 (2)	4–8 (5)	3–5 (3)	3–6 (5)	1	1	—	—	—
8	4–7 (4)	—	—	3–5 (3)	3, 4 (3)	2–4 (4)	2–4 (3)	2–5 (4)	—	—	—
9	1, 2 (2)	1, 2 (1)	1	1	1	1	1	4–6 (5)	6–11 (7)	—	—
10	5–13 (8)	a[c]	2, 3 (2)[d]	2, 3 (2)	2	1	1, 2 (1)	1	—	—	—
11	2, 3 (2)	1, 2 (1)	3, 5[e]	1	1	1, 2 (1)	1–3 (2)	1–4 (2)	—	—	—
12	2–4 (3)	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—
14	—	—	—	1	1	1	1	1	1, 2 (1)	—	—

[a] Based on counts made on the neotype, alloneotype, and 10 specimens collected with the type-specimens.
[b] Range (mode).
[c] Alveolus only.
[d] Occurring on one side in the alloneotype, and in 2 other specimens.
[e] Occurring with seta 10-II in 2 specimens.

tome with moderately tanned spots as follows: crescentic spot just anterior to each seta 8-C, small median spot immediately posterior to bases of seta 5-C, median transverse oval spot midway between bases of seta 5-C and posterior margin of head, latter with small spot on either side laterally. Median labral plate narrow but distinct, anterior margin slightly emarginate between insertions of seta 1-C. Labiogula longer than broad, broader posteriorly; hypostomal suture complete, extended posterolaterally from posterior tentorial pit to near collar. Collar moderately developed along lateralia, heavily tanned. Mouthparts developed for filter-feeding. Dorsomentum with 12 teeth on either side of median tooth. *Antenna:* Length 0.4 mm, 0.5 length of head; moderately tanned, mesal surface with dark spot at base; part proximal to seta 1-A with strongly-developed aciculae, distal part slender and smooth; seta 1-A 0.7 from base. *Thorax:* Integument hyaline, tubercles of all large setae moderately tanned; setae 1-3-P and 9-12-P, M, T on common tubercles. *Abdomen:* Integument hyaline, tubercles of setae 7-I, 6-I–VI and 1, 3, 5-VIII moderately tanned, tubercle of setae 2, 3-X heavily tanned. *Segment VIII:* Comb with 48 and 40 scales on left and right sides, respectively; scales short, evenly fringed on sides and apex, arranged in 4 irregular rows. *Siphon:* Index 3.35; imperceptibly sigmoid in lateral view, broadest at base; moderately tanned, darker at base and apex; acus attached, longer on posterior side of attachment. Pecten of either side with 14 spines, spines rather short, larger spines with 3 or 4 long basal denticles. Seta 1-S in 4 pairs, 1c-S almost directly anterior of 1b-S. *Segment X:* Saddle complete; moderately tanned, darker dorsally; posterodorsal area with minute spicules; length 0.3 mm, saddle/siphon index 3.60. 4-X with 1 unpaired and 6 paired setae, each seta arising from the grid. Anal papillae elongate, subacutely tapered; dorsal and ventral pairs of equal length, about length of saddle.

The alloneotype resembles the neotype except for the following principal differences: length of head 0.9 mm, width 1.2 mm; dorsal apotome moderately tanned, darker posteriorly, spots less distinct; length of antenna nearly 0.5 mm; comb with 43 and 46 scales on left and right sides, respectively; siphon index 3.65, pecten with 11 and 13 spines on left and right sides, respectively; length of saddle 0.4 mm, saddle/siphon index 3.53.

The range and modal number of branches of larval setae determined from the types and associated specimens are given in Table 2. A description of diagnostic and variable characters follows. *Head:* Seta 1-C slender, tapered distally, slightly bent mesad; 3-C distinct, 2-C absent; 4-C single, rather long; 5-C usually with 5 branches (4–7); 6-C commonly with 4 or 5 branches (3–6), more frequently with 4; 7-C resembles 5, 6-C, most often with 10 branches (8–13); 8-C usually double (2, 3); 10-C double; 11-13-C double or triple, more frequently double; dorsomentum frequently with 12 teeth (10–13) on either side of median tooth. *Thorax:* Setae 1-3-P all single, nearly of equal length; 4, 7, 8-P usually double, 4-P with 3 branches on right side of neotype only, 7-P with 3 branches on left side of neotype and in one other specimen examined, 8-P with 3 branches on left side of alloneotype only; 11-P usually with 4 or 5 branches (3–6). Seta 1-M single, about 0.5 of 3-M; 3-M single; 4-M double, single in alloneotype only. Seta 1-T short, 0.5 or less length of 2-T. *Abdomen:* Seta 3-I, VII usually single, occasionally double; seta 6-I–VI long, 6-I, II normally with 3 or 4 branches, 6-II double in one specimen examined, 6-III–VI usually double; 7-I usually double; 1-III–VI



Culex (Culex) molestus

neotype

173-4

usually double, one branch longer than the other. *Segment VIII:* Comb with 38–53 scales, mean 45; seta 3-VIII usually with 8 branches (7–9); seta 5-VIII usually with 4 branches (3–5). *Siphon:* Slightly S-shaped in lateral view; index 3.01–5.77, mean 3.96 (for 77 specimens from Rosetta, Alexandria, and Cairo); pecten with 11–18 spines, mean 14. *Segment X:* Saddle/siphon index 2.97–4.16, mean 3.54; seta I-X usually single (1, 2); 4-X with 6 paired setae, sometimes with an additional unpaired seta.

Behavior/physiology (observations by AMG).—Approximately 80% of the F_1 females obtained from specimens collected at Rosetta laid fertile autogenous eggs in the laboratory. Individuals mated freely in 30 × 30 × 30 cm cages and in glass cylinders 20 cm long and 10 cm in diameter. Most autogenous rafts were laid three days after the females had emerged, but some were laid up to two weeks after emergence. Females fed aggressively on the arm of a human following deposition of autogenous rafts.

DISCUSSION

There is no doubt that the neotype, alloneotype, and associated specimens are conspecific with the mosquito Forskål (1775) described and named *Culex molestus*. Forskål's diagnosis, description, and comments contain several critical clues that, when combined, eliminate the other species found in the type-localities of Rosetta, Cairo, and Alexandria. The clues are: (1) proboscis dark above, ash-colored below; (2) dorsum [abdomen] dark, with 6 pale bands; (3) size and appearance like *Cx. pipiens* Linnaeus; (4) tibiae dark; (5) wings dark; (6) tremendously abundant in all three type-localities; (7) bothers sleepers at night [i.e., bites man]; and (8) difficult to avoid unless with well closed curtains [i.e., inside homes].

Of 25 mosquito species confirmed from Egypt west of the Gulf of Suez, there are 13 (other than *molestus*) that could have been collected by Forskål which we must compare with the clues listed above. Two *Aedes* species can be eliminated quickly. *Aedes* (*Ochlerotatus*) *caspius* (Pallas) and *Ae.* (*Och.*) *detritus* (Haliday) have extensive pale scales on the proboscis, legs, wings, and abdomen. Furthermore, *Ae. caspius* has distinct pale tarsal bands and *detritus* has never been collected near Cairo. *Culiseta* (*Allotheobaldia*) *longiareolata* (Macquart) is very abundant in all three type-localities, but is very large, has pale scales on the wings, pale longitudinal stripes on the legs and does not bite man. *Culex* (*Lasiosiphon*) *adairi* Kirkpatrick and *Cx.* (*Neoculex*) *deserticola* Kirkpatrick are small pale species only collected infrequently in desert rock pools/wells, and never recorded biting man or from the Nile Delta. *Culex* (*Barraudius*) *pusillus* Macquart is a small dark species without pale bands on the abdomen, having only pale lateral patches. Apparently, *Cx. pusillus* is entirely autogenous, as it has not been observed feeding and could not be induced to bite (Kirkpatrick, 1925). *Culex* (*Cux.*) *mimeticus* Noé, *Cx.* (*Cux.*) *poicilipes* (Theobald), and *Cx.* (*Cux.*) *tritaeniorhynchus* Giles all possess a very distinct pale band on the proboscis, besides, only *poicilipes* has

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Fig. 3. *Culex* (*Culex*) *molestus* Forskål, neotype male, larva. A, Head (dorsal and ventral aspects of left side). B, Thorax and abdominal segments I–VI (dorsal and ventral aspects of left side). C, Dorsomentum. D, Abdominal segments VII–X (left side). E, Pecten spine. F, Comb scale. Scales in mm.

Table 2. Number of branches for setae of the fourth-instar larva of *Culex* (*Culex*) *molestus* Forskål.[a]

Seta Number	Head	Thorax			Abdominal Segments								
	C	P	M	T	I	II	III	IV	V	VI	VII	VIII	X
0	1	9–19 (16)[b]	—	—	—	1	1	1	1	1	1	1	—
1	1	1	1	2–4 (3)	3–5 (4)	1–3 (2)	1–3 (2)	2	1, 2 (2)	2	3, 4 (3)	4–7 (6)	1, 2 (1)
2	—	1	2–5 (3)	1–3 (2)	1	1	1	1	1	1, 2 (1)	1	1	2
3	1	1	1	3–5 (4)	1, 2 (1)	1, 2 (1)	1	1, 2 (1)	1	1	1, 2 (1)	7–9 (8)	1
4	1	2, 3 (2)	1, 2 (2)	2–4 (4)	8–12 (10)	3–7 (4)	1–4 (2)	1	3, 4 (3)	1–3 (2)	1	1	5–10 (6)
5	4–7 (5)	1	1	1	2–7 (5)	1, 2 (2)	1–3 (2)	1, 2 (2)	1–3 (2)	1–4 (3)	1–3 (2)	3–5 (4)	—
6	3–6 (4)	1	1	1	3, 4 (3)	2–4 (3)	2, 3 (2)	2	2	2	10–17 (12)	1a–S	—
7	8–13 (10)	2, 3 (2)	1	7–10 (10)	2, 3 (2)	3–5 (4)	5–9 (6)	6–10 (7)	4–8 (7)	1	1	2–4 (3)	—
8	2, 3 (2)	2, 3 (2)	5–9 (7)	9–18 (11)	—	1	1	1	1, 2 (1)	2–5 (3)	2–5 (4)	1b–S	—
9	3–7 (5)	1	5–8 (6)	5–9 (7)	2–5 (2)	1	1	1	1	1	3–8 (3)	2–4 (3)	—
10	2	1	1	1	1	1	1	1	1	1	1	1c–S	—
11	2, 3 (2)	3–6 (4)	2–4 (2)	1–3 (2)	3–10 (5)	2–5 (2)	1, 2 (2)	2, 3 (3)	1–3 (3)	2–4 (3)	2–4 (2)	1–4 (3)	—
12	2, 3 (2)	1	1	1	1–3 (2)	1, 2 (2)	1–3 (2)	1, 2 (1)	1	1	1	1d–S	—
13	2, 3 (2)	—	15–27 (23)	4–6 (4)	1–3 (2)	10–23 (15)	2–4 (3)	2, 3 (3)	2, 3 (3)	22–43 (28)	2, 3 (3)	2–4 (2)	—
14	1	1, 2 (1)	15–26 (20)	—	—	—	1	1	1	1	1	1	—
15	3–5 (3)	—	—	—	—	—	—	—	—	—	—	—	—

[a] Based on counts made on the neotype, alloneotype, and 10 specimens collected with the type-specimens.
[b] Range (mode).

been collected (infrequently) in the Delta of Egypt. *Culex mimeticus* has distinct pale scaling on the wings and is known in Egypt only from the far western oases, while *tritaeniorhynchus* is known only from the southwestern oases. *Culex* (*Cux.*) *perexiguus* Theobald is somewhat similar to *molestus* and seasonally common in the Delta, but is darker, has a pale stripe on the hindtibia, and normally feeds on birds. *Culex* (*Cux.*) *theileri* Theobald is a large pale species that is not very common in the Delta and has pale longitudinal stripes on the femora, tibiae, and first tarsomeres. *Culex* (*Cux.*) *laticinctus* Edwards is morphologically similar to *molestus* except for much broader pale bands on the abdomen. However, *Cx. laticinctus* is not known to bite man or enter houses and is uncommon in the Delta. We did not find this species during 30 days of collecting all over the Delta, but did see several specimens in collections that were made near Alexandria in the 1920's. Next to *molestus, Cx.* (*Cux.*) *antennatus* (Becker) was the most common *Culex* encountered in the Delta. This species bites man, but prefers large domestic animals. It is exophilic and easily separated from *molestus* by the absence of pale abdominal bands and the presence of pale lateral patches on only the more posterior terga.

As seen from the above, only one species presently occurs in the Nile Delta of Egypt and in the three type-localities that conforms to Forskål's description. This is the species called *pipiens* by Kirkpatrick (1925) and Knight and Abdel Malek (1951). It is the most abundant mosquito in the three type-localities, it avidly bites man and is difficult to keep out of houses and even hotels. This is the species we collected, reared, and selected to serve as the neotype, alloneotype, and associated specimens of *Culex molestus.*

Morphological variation.—*Culex molestus* Forskål was regarded as a junior synonym of *Culex pipiens* Linnaeus until Marshall and Staley (1937) revived the name for strains exhibiting autogeny, anthropophily, and stenogamy. Subsequently, specimens looking like *pipiens,* but exhibiting these behavioral/physiological traits, especially autogeny, have been treated under the name of *molestus,* either as a species, subspecies, or infraspecific form.

Morphological differences between man-biting and man-ignoring forms of *pipiens* were first noted by Ficalbi (1890) who observed that adults of the former were lighter in general coloration and lacked prominent pale spots at the apices of the femora and hindtibia. In 1896, Ficalbi noted differences in the length of the maxillary palpi of males as compared to the length of the proboscis. Much later, Marshall and Staley (1935a, b, 1937), Jobling (1938), and Christophers (1951) described additional adult characters, and a number of egg and larval characters, by which the autogenous form (*molestus*) could be distinguished from the anautogenous one (*pipiens*). These characters have proven to be so variable that most workers are unwilling to regard these forms as distinct species, or even subspecies. In fact, we made detailed comparisons between Egyptian specimens and a significant number of specimens of *Cx. pipiens* reared from larvae collected in a rural area near Veberöd, Sweden, and were unable to detect any constant morphological differences. Reference is made to this comparison in the paragraphs which follow.

Specimens conforming to the neotype of *molestus* were reared from larvae collected in all of the areas surveyed in Egypt. However, a small number of relatively dark adults were obtained from larvae collected in more or less rural areas. These specimens, mostly females, are characterized by having the basal bands of the abdominal terga reduced and/or indistinct, but are otherwise indistinguishable from the typical form. We also collected a small number of larvae in which the head and siphon were darker than usual. These were always collected with typical larvae from which they differed only in their more swarthy appearance. Some of the dark larvae developed into dark adults. We found neither dark larvae nor dark adults in the urban areas that were surveyed—including Aswan, Cairo, Alexandria, Rosetta, Port Said, and Suez. Knight and Abdel Malek (1951) also did not find dark adults in the Cairo area. The examination of hundreds of specimens resembling the neotype has shown that morphological variation is fairly constant and random for this form in Egypt. For this reason, the dark specimens appear to be nothing more than sporadic variants.

In general, adults examined from Egypt were scarcely paler than specimens from Sweden. Similarly, Lewis (1945) reported that individuals of *molestus* occurring between Khartoum and the Egyptian frontier were not appreciably paler than specimens of *pipiens* from Ethiopia and Sudan. Pale spots were always seen at the apices of the femora and the hindtibia, but varied considerably in distinctness. Knee spots are apparently weakly developed and normally cannot be seen with the unaided eye in specimens from purely autogenous strains (cf. Marshall and Staley, 1937; Jobling, 1938; and Christophers, 1951).

The abdominal sterna of specimens traditionally identified as *pipiens* usually, but not always, have prominent median patches of dark scales. This is true of specimens examined from Sweden. On the other hand, in specimens commonly recognized as *molestus*, the sterna are usually entirely pale or have a few indistinct dark scales in the middle. This is the case with specimens from Egypt. Overall, the sternal scaling is not too variable: the dark scales are usually either present or entirely absent, or nearly so, with few specimens exhibiting an intermediate condition. There appears to be a definite selection for entirely pale sterna in autogenous strains and populations occurring in arid areas.

Various authors maintain that the most reliable distinction between adults of *molestus* (autogenous strains) and *pipiens* (anautogenous strains) is the length of the maxillary palpi relative to the length of the proboscis in males. In *pipiens*, palpomeres 1–4 are said to be longer than the proboscis, and in *molestus* they are supposedly shorter than the proboscis. Christophers (1951) attributed this difference to the greater length of palpomere 4 in *pipiens*. He found that the length of palpomere 4 relative to that of palpomeres 1–3 was 2.71 in specimens he recognized as *pipiens* and 3.21 in specimens he called *molestus*. The variability of this character, however, is clearly evident in specimens from Egypt and Sweden. In males from Cairo, palpomeres 1–3 were found to be 2.75 to 3.87 times the length of palpomere 4 (Knight and Abdel Malek, 1951), while the palpi of males from Sweden often extend beyond the tip of the proboscis by less than the length of palpomere 5. Service (1968) found palpomere 4 was 2.95 ± 0.38 times as long as palpomeres 1–3 in British *pipiens*. According to Vinogradova and Fomenko (1968), this character is unreliable for separating specimens from Uzbekistan, USSR, and pointed out that it was useful "only in combination with biological criteria."

Jobling (1938) noted another difference in the maxillary palpi of males. He described palpomere 3 as being "almost straight" in *pipiens* and "usually curved" in *molestus.* We have examined numerous specimens from many localities in northern Africa, southwestern Asia, and Europe, and have found that palpomere 3 is usually straight or only slightly curved in lateral view.

Marshall and Staley (1938) and Marshall (1938, 1944) characterized the basal pale bands of the abdominal terga as being convex or bilobed in anautogenous females (*pipiens*) and straight in autogenous ones (*molestus*). Christophers (1951) remarked that the bands "strikingly differentiate the forms," but did not describe their appearance. Jobling (1938) also compared the tergal bands in autogenous and anautogenous females and found that they were of no diagnostic value. We have noted that the bands are always yellowish in color, but vary considerably in size and shape, sometimes also from terga to terga in a single specimen.

Neither the male nor female genitalia offer characters for the separation of individuals from autogenous and anautogenous strains. Differences have been noted in the number of setae on the ninth tergum in both sexes, but this character is too inconstant to be of diagnostic value (cf. Marshall and Staley, 1935b, 1937; Jobling, 1938; Christophers, 1951; and Knight and Abdel Malek, 1951). Christophers (1951) indicated that the dorsal arms of the male phallosome may possibly be more truncate in *pipiens* than *molestus.* The tips of the dorsal arms, however, frequently exhibit minor structural differences, although they are always blunt, and their appearance is easily influenced by positioning and the posture of the phallosome. Measurements of DV/D (Sundararaman, 1949) have not been studied in males from purely autogenous and anautogenous strains. Knight and Abdel Malek (1951) found DV/D ratios to vary from −0.14 to +0.02 (mean −0.07) in specimens from Cairo, while Service (1968) obtained a mean ratio of −0.10 ± 0.02 in males from Brownsea Island and elsewhere in Britain. Using the method of Barr (1957), we obtained DV/D ratios ranging from −0.19 to zero (mean −0.09) for males from Sweden.

Marshall (1944) stated that the pupae of *pipiens* are indistinguishable from those of *molestus,* but provided no comparative data. Apparently, little or no attention has been given to pupal characters. We were unable to find any morphological distinctions between pupae from Sweden and the type-locality of *molestus.* The chaetotaxy and various character measurements were virtually identical. Trumpet indices ranged from 4.9 to 6.2 (mean 5.4) in Egyptian specimens, and from 4.8 to 6.9 (mean 5.5) in pupae from Sweden. Paddle indices varied from 1.2 to 1.4 (mean 1.3) in the former, and from 1.2 to 1.6 (mean 1.4) in the latter.

Egyptian specimens exhibited the greatest amount of variation in the length of the larval siphon. This is evident from the range of siphon indices calculated for specimens from the three type-localities listed by Forskål: 27 specimens from Rosetta yielded indices between 3.01 and 4.15 (mean 3.61), indices obtained from 24 specimens collected in Alexandria ranged from 3.80 to 5.07 (mean 4.50), and indices for 26 larvae from Cairo varied from 3.20 to 5.77 (mean 3.82). Overall, these values (3.01–5.77, mean 3.96) are higher than those previously obtained by Knight and Abdel Malek (1951) who found indices ranging from 2.7 to 4.7 (mean 3.7) in 98 specimens from the Cairo area. Kirkpatrick (1925) stated that the siphon index of Egyptian specimens was usually about 4.5 but varied from about 4.0 to about 5.2. Jobling (1938) and Lewis (1945) recorded indices varying from 3.5 to 4.7 (mean 3.9) and 3.5 to 5.3 (mean 4.3) in specimens from Palestine and the

Sudan, respectively. For comparison, we measured the siphons of 106 *pipiens* larvae from the aforementioned Swedish population and obtained an average index of 4.99 with values ranging between 3.80 and 5.87. Simple *t*-test comparisons showed that the means from the Egyptian and Swedish larvae were significantly different ($P < 0.005$), yet there is considerable overlap in the range of indices. A large overlap was also observed for another index of siphon length, the saddle/siphon index, but a significant difference was likewise found between the means—Egyptian specimens showed a mean of 3.54 for indices ranging from 2.97 to 4.16, while specimens from Sweden had a mean of 4.04 with indices between 3.48 and 4.63. Despite the differences noted here, the character of the larval siphon is too inconstant over the whole range of *pipiens* to reflect specific or subspecific differences. Particularly illustrative of this is the mean siphon index of 4.06 ± 0.24 and the mean saddle/siphon index of 3.27 ± 0.18 that Service (1968) obtained from measurements made on larvae of *pipiens* from Britain. These values are undoubtedly significantly lower than those obtained from Swedish larvae, and the saddle/siphon index is considerably, if not significantly, lower than that obtained from the Egyptian specimens. Compare also the siphon indices obtained by Callot (1957) for specimens of *pipiens* and *molestus* (as *autogenicus* Roubaud) from France: mean of 3.8 for *pipiens* versus 3.2 for *molestus*.

No other significant differences were found between the Egyptian and Swedish larvae. The chaetotaxy was found to be indistinguishable with many setae exhibiting the same modal number of branches. Similarly, there was essentially no difference in the form or number of comb scales or pecten spines. The comb of Egyptian specimens frequently possessed 45 scales, but the number ranged from 38 to 53. Swedish specimens had 37 to 57 scales per comb with a modal number of 44. The modal number of pecten spines for both populations was 14 and the ranges were nearly identical, 11 to 18 for Egyptian larvae and 11 to 17 for those from Sweden. In 1951, Knight and Abdel Malek found almost exactly the same range and average number of pecten spines in specimens from Cairo: minimum 11, maximum 19 and 14.2 for the mean. Natvig (1948) recorded ranges of 28 to 60 (mean 41) and 12 to 18 (mean 15) for the number of comb scales and pecten spines, respectively, in specimens of *pipiens* examined from Scandinavia and Finland. Natvig, however, could not differentiate the larvae of *pipiens* and *Cx. torrentium* Martini and considered all larvae studied to be *pipiens*.

Jobling (1938) noted slight differences in the number of dorsomental teeth in specimens he recognized as *pipiens* and *molestus*. He observed 14 to 24 teeth, with a mean of 18, in the former and 18 to 24 teeth with a mean of 21 in the latter. Comparison with specimens from Egypt and Sweden indicates that the number of dorsomental teeth is quite variable. Egyptian specimens examined by us had 20 to 26 teeth with a modal number of 24, while Knight and Abdel Malek (1951) reported that specimens from Cairo had between 16 and 26 teeth with an average of 20.4. In larvae from Sweden, the number of teeth varied from 16 to 22 and the mode was 20. Therefore, the Swedish specimens had slightly more teeth than the English larvae which Jobling (1938) treated under the name of *pipiens*, and more closely resembled his specimens of *molestus* with respect to this character.

The number of branches for setae 1-S and 4-X, the length of the anal papillae, and the shape of the siphon, spiracular apodeme, and spiracular valves have been used to distinguish larvae of *molestus* and *pipiens,* but all have been found to be much too variable for this purpose.

No discrete or significant differences have been found in the size or structure of eggs obtained from autogenous and anautogenous strains (cf. Roubaud, 1935; Christophers, 1945; Cervone, 1957; Idris, 1960; Lincoln, 1965; and Hinton, 1968). Differences, however, have been reported in the size and shape of the egg rafts. Rafts obtained from anautogenous females are generally larger, usually containing 150–300 eggs, but the number of eggs varies considerably, e.g., Jobling (1938) examined rafts containing 77–505 eggs. Rafts deposited by autogenous females are generally smaller, containing 7–125 eggs (as reflected in the combined data of Marshall and Staley, 1935b and Jobling, 1938). Anautogenous rafts are usually elongate oval in shape (boat-shaped). Autogenous rafts are commonly oval, but may assume a variety of shapes: circular, oblong, square, rectangular, triangular, ribbonlike, or irregular. For comparison, studies on the Cairo population (Knight and Abdel Malek, 1951) revealed that over 40% of the rafts obtained from either autogenous or anautogenous females were boat-shaped. Furthermore, rafts obtained from blooded females contained 5–162 eggs (5–148 with human blood; 20–162 with pigeon blood), while those obtained from unfed females contained only 12–85 eggs. Considering that only a very small percentage of the females from the Cairo population lay autogenous rafts (0–4% depending on the collection site, mean 1.1%), the size of rafts obtained from blooded females is small when compared to the size of those reported for anautogenous populations from Europe.

Taxonomic status.—The current status of *molestus* as a species is based on Knight (1978), who elevated the name because of evidence for premating behavioral isolation in attempted crosses between *molestus* and *quinquefasciatus* (as *Cx. fatigans* Wiedemann) in Australia (Miles, 1977a, b). Miles followed Drummond (1951) in ascribing the name *molestus* to a member of the *pipiens* complex in Australia that exhibited autogeny, stenogamy, and anthropophily. He also assumed that the morphological differences described by Marshall and Staley (1937) to differentiate *molestus* from *pipiens* were decisive. These morphological "differences" are no longer recognized as valid for many populations of *molestus* and *pipiens.* Furthermore, autogeny and stenogamy are now recognized as genetic traits (Roubaud, 1929; Knight, 1951; Spielman, 1957; Aslamkham and Laven, 1970). In fact, autogeny is known to occur in many mosquito species that also exhibit anautogeny (Rioux et al., 1975). Such behavioral/physiological traits can be very useful in defining populations within species, or occasional sibling species; however, they should not be used as *carte blanche* criteria for differentiating species.

We feel the use of the name *molestus* by Miles (1977a, b), and Miles and Paterson (1979) for the aforementioned Australian population was unwarranted because an autogenous, stenogamous, and anthropophilic population is nothing more than a behavioral/physiological variant of *pipiens.* Accordingly, the crosses conducted by Miles (1977a, b) were between *pipiens* and *quinquefasciatus* and the premating isolation barrier he detected lends no support to the name *molestus,* but does support the elevation of *quinquefasciatus* to species status by Sirivanakarn (1976). Past crosses between members of populations called *molestus* and *pipiens* on the basis of behavioral/physiological criteria usually resulted in interfertility (Knight, 1951), with infrequent reports of non-fertility (Marshall and Staley, 1937; Spielman, 1967). Most of the negative crosses are now attributable to incompatibility between strains of the rickettsial symbiont, *Walbachia pipientis* Hertig, or an absence of the symbiont in one side of the cross (Yen and Barr, 1973), which may be influenced further by environmental pressure during colonization or maintenance in the laboratory (Irving-Bell, 1983). Other negative crosses may reflect genetic premating barriers which are more pronounced in certain isolated populations, but are incomplete in others (Spielman, 1979; Bullini, 1982). Even populations having fairly pronounced genetic premating barriers do not exhibit the Nei's genetic distances that typify mosquito sibling species (Bullini, 1982). Accordingly, we cannot accept species status for *molestus,* or even subspecies status, since as pointed out by Barr (1981) autogenous-stenogamous populations and anautogenous-eurygamous populations that are sympatric and called subspecies do not agree with Mayr's (1963) definition of subspecies. Autogenous, stenogamous, and anthropophilic populations or individuals should be identified as behavioral/physiological variants of *pipiens,* without using another name.

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TWO NEW SPECIES OF CECIDOMYIIDAE (DIPTERA) FROM HONEYLOCUST, *GLEDITSIA TRIACANTHOS* L. (FABACEAE), IN EASTERN UNITED STATES

RAYMOND J. GAGNÉ AND KARL VALLEY

(RJG) Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % U.S. National Museum of Natural History, NHB 168, Washington D.C. 20560; (KV) Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania 17110.

Abstract.—Two new species of Cecidomyiidae (Cecidomyiinae: supertribe Lasiopteridi) on honeylocust, *Gleditsia triacanthos* L. (Fabaceae), in eastern United States are described: *Meunieriella* ***aquilonia*** Gagné from spot galls on leaflets and *Neolasioptera* ***brevis*** Gagné from swollen twigs. Biological observations on both species are reported. *M. aquilonia* is the first record of its genus north of El Salvador.

Arthropods in increasing variety are being shown to damage honeylocust, *Gleditsia triacanthos* L. (Fabaceae), a tree species once considered relatively pest free. The mimosa webworm (Webster and St. George, 1947), the honeylocust pod gall midge (Schread, 1959), a honeylocust spider mite (English and Snetsinger, 1957), and the honeylocust plant bug (Wheeler and Henry, 1976) cause heavy damage. In 1982–83 two new species of Cecidomyiidae (Cecidomyiinae: supertribe Lasiopteridi: subtribe Alycaulina) were collected and reared from native and ornamental honeylocust in Pennsylvania, bringing to three, with *Dasineura gleditchiae* (Osten Sacken), the number of gall midges associated with the tree.

The two new species of Cecidomyiidae are described in this paper. One of them, *Neolasioptera brevis* Gagné, was noticed previously but was listed only as an undescribed species of *Neolasioptera* (Felt 1911, 1940). It causes twig swellings and usually prevents further growth beyond the galls. This species is univoltine, and adults emerge in early spring from the previous year's galls. We have no data to indicate its effect on honeylocust, but a heavy infestation could result in terminal dieback and affect the appearance of a tree.

The other new species, *Meunieriella aquilonia* Gagné, forms a spot gall on leaflets and is especially interesting because it is the first species of the large genus *Meunieriella* reported north of El Salvador. Further, unlike all its congeners which live as inquilines in galls formed by other cecidomyiids, this species forms its own galls. *Meunieriella aquilonia* appears at least by late spring and is multivoltine. We are uncertain of its economic status, largely because we became aware of this species only in 1982. The sudden and widespread appearance of this gall midge in central Pennsylvania is rather interesting considering that Pennsylvania Department of Agriculture (PDA) plant inspectors examine nursery stock annually in the State and that PDA entomologists have collected extensively on honeylocust since 1975. Leaf drop resulting from this fly appears negligible. Most spot galls are small and the necrosis produced remains confined to the gall and its perimeter.

Neolasioptera brevis Gagné, NEW SPECIES

Figs. 1–5

Scale color pattern of dried specimens.—Dorsoposterior surface of head dirty white; anterior corners of scutum, hind edge of scutellum, and pleura white; remainder of scutum and scutellum dirty white; leading edge of wing dark brown except white at base of C and at juncture of C and R5; legs dark except white on coxae and apices of femora and tibiae; abdominal tergum 1 white, terga 3–6 mostly black with white apically, pleura black, sterna white.

Head.—Eye bridge about 6 facets long. Antennae: those of ♂ lost; ♀ with 23–26 flagellomeres, each slightly wider than long. Frontoclypeus with mixed setae and scales. Palpi 4-segmented. Labella hemispherical in frontal view.

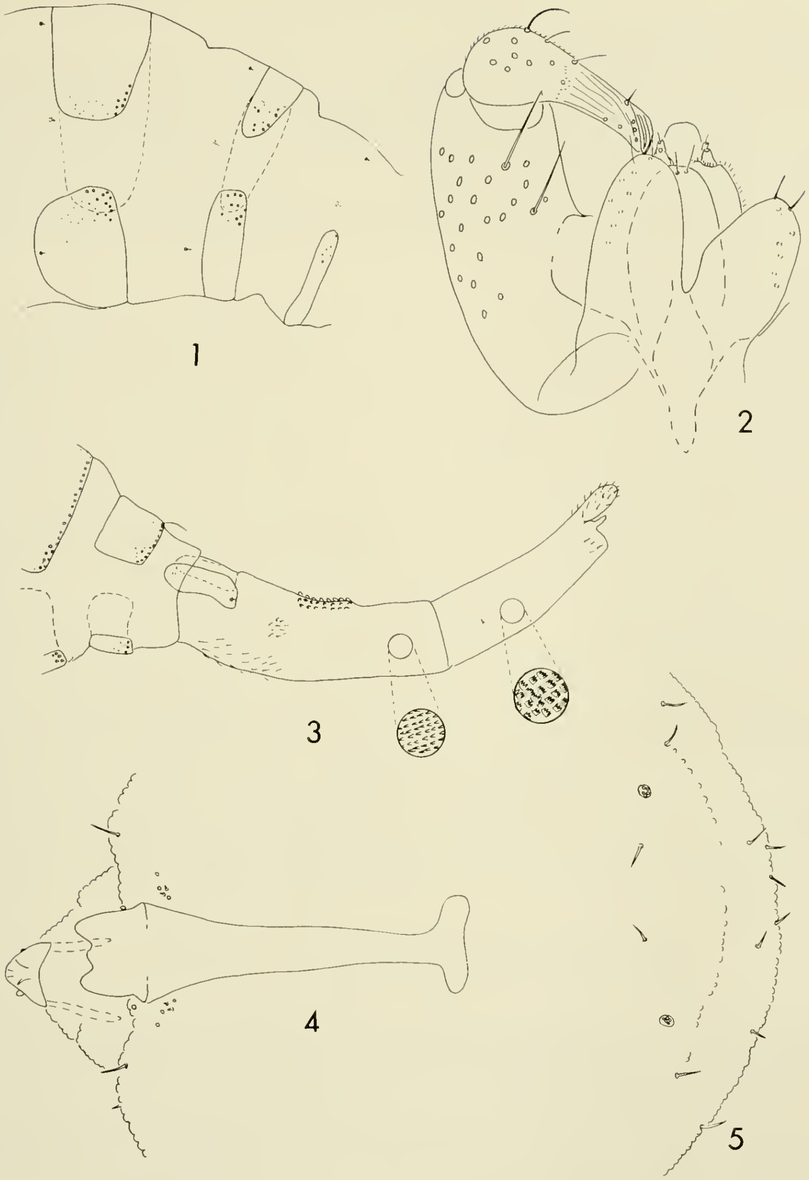
Thorax.—Scutum with scales covering surface except anterolaterally between lateral and dorsocentral setal rows, posteriorly just lateral to dorsocentral setal row, and anteromesally and posteromesally. Anepisternum with scales on top half only. Anepimeron with vertical row of setae and a few intermixed scales. Katepisternum with a few scales ventrally. Wing: ♂, 2.0 mm; ♀, 2.0 mm; R5 attaining 0.55 length wing.

Male abdomen (Figs. 1–2).—Tergites 1–6 rectangular, very wide, with 1 row of caudal setae, 0 lateral setae, a basal pair of trichoid sensilla on cephalic margin (except on tergite 6 on which they are placed just anterior to margin), and elsewhere covered with scales. Tergite 7 less than half as long as preceding, vestiture as for tergite 6 except pair of trichoid sensilla much anterior to sclerite. Tergite 8 not evident except for trichoid sensilla. Sternites 2–6 square, less strongly sclerotized in center than elsewhere, with about 2 rows of caudal setae, a horizontal group of setae at midlength, 1 or 2 basal trichoid sensilla (closely approximated if 2), and elsewhere covered with scales. Sternite 7 very short, with 2 rows of caudal setae and several scales, and 1 trichoid sensillum somewhat cephalad of sclerite. Sternite 8 very short, with 2 rows of caudal setae, trichoid sensilla not evident. Terminalia as in Fig. 2.

Female abdomen (Fig. 3).—Tergites 1–6 and sternites 2–6 as for male, but tergite 6 with trichoid sensilla situated on sclerite and all sternites with 2 trichoid sensilla. Tergite 7 much narrower and shorter than tergite 6, with vestiture only on posterior ½ except for 2 basal, trichoid sensilla. Tergite 9 weakly divided into 2 long tergites, with 2–4, short, caudal setae and subbasal pair of trichoid sensilla. Sternite 7 as for 6. Sternite 8 shorter than sternite 7, vestiture on posterior ⅔ except for basal trichoid sensilla. Length of tergites 6–8 (from trichoid sensilla to posteriormost setae) and distal half ovipositor as 32-18-20-82. Cerci ovoid.

Larva (Figs. 4–5).—Length, 3.0–3.5 mm. Spatula robust, tridentate. Integument pebbled. Full complement of Alycaulina papillae present except for loss of 2 terminal papillae.

Holotype, ♀, ex twig gall on 'Sunburst' honeylocust, *Gleditsia triacanthos* L., coll. 30-III-1983, emerged 12-IV-1983, E. Harrisburg Cemetery, Harrisburg, Dauphin Co., Pa., K. R. Valley, deposited in U.S. National Museum of Natural History, Washington, D.C. Paratypes (all ex twig galls on native *Gleditsia tria-*



Figs. 1–5. *Neolasioptera brevis.* 1, Male abdominal segments 6–8 (ventrolateral). 2, Male terminalia. 3, Female postabdomen. 4, Larva, anterior (ventral). 5, Larva, posterior (dorsal.

canthos; one ♀ and one ♂ deposited in the Pennsylvania Department of Agriculture Collection, Harrisburg, the remainder in USNMNH): 2 larvae, collected 14 March 1983, and ♂, ♀, emerged 25 and 28 March 1983, respectively, Mid. Paxton Township, Rt. 225, 0.4 mi N. Clark Creek, Dauphin Co., Pa.; ♀, same data except emerged 4 May 1983 from galls collected 29 April 1983; ♂, 5 ♀, emerged 6 April 1976, Warren Co., Ohio, R. L. Powell and K. Roach. Other specimens in poor condition: 3 ♀, em 22-IV-1882, Kirkwood, Mo. These last were probably the basis for the records in Felt (1911, 1940).

Neolasioptera brevis somewhat resembles but is distinct from *Neolasioptera cassiae* (Felt), also reared from a caesalpinaceous plant, *Cassia nictitans* L. (Fabaceae), in Arizona. The female could be mistaken for *N. brevis,* except that the ovipositor is slightly shorter. The males of the 2 species are distinct: tergites 6 and 7 of *brevis* are very different in size; those of *cassiae* are of equal length and breadth. Also, male *cassiae* have longer gonostyli and a bilobed instead of simple hypoproct. The new species is named *brevis* for the shortened sclerites of male abdominal segments 7 and 8.

Irregular twig swellings of about twice the normal diameter were first noticed by one of us (KV) on 2-VIII-1982 in Dauphin Co., Pa. Galls then contained second instars of cecidomyiid larvae assumed to belong to *Neolasioptera.* Because most neolasiopteras are univoltine and overwinter in the galls, the remaining galls were left on the trees until mid-March, 1983. Galls were found on ornamental 'Sunburst' honeylocust and on wild specimens. Inside the galls were short tunnels about 6 mm long, each usually aligned with the long axis of the twig, but curved slightly at the exit, which was covered either by a thin outermost layer of plant epidermis or particulate matter that appeared to be stuck together by webbing. The latter tunnels produced *N. brevis* adults and parasitic wasps; the tunnels with ends covered by the thin layer of epidermal tissue produced only wasps. In mid-March the tunnels contained full grown cecidomyiid larvae or hymenopterous larvae, or were apparently empty. A dead, shriveled second instar of *N. brevis* was found in one of the apparently empty but closed tunnels. Several adult *N. brevis* were reared in March and April as were many parasitic Hymenoptera belonging to 3 species: a *Platygaster* sp. (Platygastridae), evidently an internal parasite of *N. brevis* because it emerged from tunnels containing empty but still inflated *N. brevis* larval skins; a *Eurytoma* sp. (Eurytomidae), from tunnels with deflated, crumpled *N. brevis* skins; and a *Pediobius* sp. (Eulophidae).

Meunieriella aquilonia **Gagné, New Species**

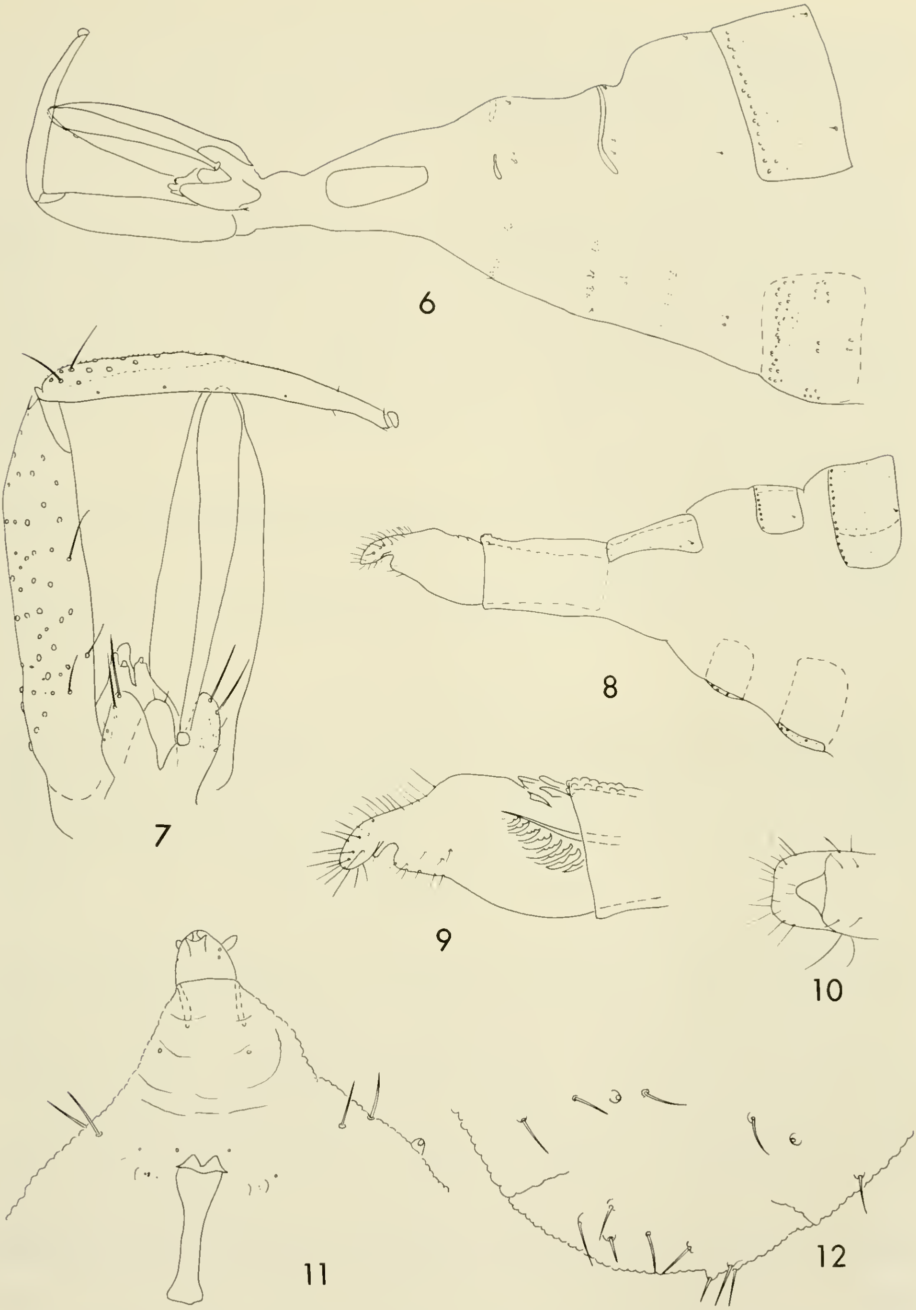
Figs. 6–12

Scale color pattern of dried specimens.—Dorsoposterior surface of head and thorax golden brown, lateroposterior surface of head white, leading edge of wing all dark brown, legs yellow except for brown tarsi, abdomen brown.

Head.—Eye bridge about 6 facets long. Antennae: ♂ with 20 flagellomeres, each about as wide as long; ♀ with 21–23 flagellomeres, each slightly wider than long. Frontoclypeus with mixed setae and scales. Palpi 4-segmented. Labella short, hemispherical in frontal view.

Thorax.—Scutum with scales covering surface except anterolaterally between the lateral and dorsocentral setal rows, posteriorly just laterad of dorsocentral setal row, and anteromesally and posteromesally. Anepisternum with scales on top half only. Anepimeron with vertical row of setae and 0 scales. Katepisternum bare. Wing: ♂, 1.3 mm; ♀, 1.2–1.3 mm; R5 attaining 0.50 length wing.

Male abdomen (Figs. 6–7).—Tergites 1–5 rectangular with a single row of caudal setae, 0 lateral setae, 2 basal trichoid sensilla, and covered elsewhere with scales. Sternites 2–5 rectangular, with a single row of caudal setae on sternites 2–4, and a double row on sternite 5, these sternites with a discontinuous horizontal row



Figs. 6–12. *Meunieriella aquilonia.* 6, Male posterior abdominal segments (dorsolateral). 7, Male terminalia (dorsal). 8, Female postabdomen (lateral). 9, Ovipositor (lateral). 10, Cercus and hypoproct (ventral). 11, Larva, anterior (ventral). 12, Larva, posterior (dorsal).

of setae at midlength, a basal pair of closely approximated trichoid sensilla and elsewhere covered with scales, these less numerous just anterior of caudal setal row. Segments 6–8 weakly sclerotized, tergites and sternites evident only by slight sclerotization anteriorly and by presence of 2 basal, trichoid sensilla on each tergite and sternite. Segment 9 with rhomboid sclerotized area anterior to terminalia. Terminalia as in Fig. 7.

Female abdomen (Figs. 8–10).—Tergites 1–6 and sternites 2–5 as for tergites 1–5 and sternites 2–5 of male. Tergite 7 much smaller than tergite 6, with vestiture only on posterior half except for basal trichoid sensilla. Tergal area between tergites 7 and 8 slightly sclerotized, tergite 8 longer and narrower than 7, with basal trichoid sensilla and a few, short setae laterally and posteriorly, sternite 7 smaller than 6, vestiture concentrated posteriorly. Lengths of tergites 6–8 (from trichoid sensilla to caudal setae) and distal half of ovipositor about as 20-12-24-73. Ovipositor: setulae on distal half of ovipositor very large laterally and dorsally; cerci short, flattened dorsoventrally, blunt-tipped.

Larva (Figs. 11–12).—Length, 2.3 mm. Spatula clove-shaped. Integument pebbled except spinulose anteroventrally on abdominal segments. Full complement of Alycaulina papillae present.

Holotype, ♀, from larva ex *Gleditsia triacanthos* leaf blister gall collected 15-VII-1982, emerged 30 July 1982, 0.4 mi. N. Clark Creek, Rt. 225, Mid. Paxt. Township, Dauphin Co., Pa., K. Valley, deposited in U.S. National Museum of Natural History, Washington, D.C. Paratypes (all associated with leaf spot galls on *G. triacanthos*; 2 ♀ and a ♂ deposited in the Pennsylvania Department of Agriculture Collection, Harrisburg, the remainder in USNMNH): 1 larva, same pertinent data as holotype; ♀, same data as holotype; ♂, 2 ♀, collected 2-VIII-1982, emerged 16–17-VIII-1982; ♀, collected 7-VII-1982, emerged 23-VII-1982; ♀, collected 15-VII-1982, emerged 1-VIII-1982; ♂ collected 5-VIII-1982, emerged 16-VIII-1982, E. Harrisburg Cemetery, Harrisburg, Dauphin Co., Pa.; ♀, emerged 25-VIII-1983, its larva collected 11-VIII-1983, Pt. Matilda, Centre Co., Pa.

M. aquilonia is the first published record of *Meunieriella* north of El Salvador, thus the specific name, an adjective meaning "northern." Two males in the USNMNH of a different, undescribed species were caught in a Malaise trap in eastern Maryland. They are generally similar to *aquilonia* but their gonocoxites are more robust. Three species are known from Brazil (Gagné, 1968, under *Dolicholabis*), 12 from El Salvador (Möhn, 1975), and 3 from Colombia (Wünsch, 1979). All those species are inquilines in galls caused by a variety of other cecidomyiids. The difficulty in further comparing the new species with those previously described is that many abdominal details noted and illustrated here for *aquilonia* are undescribed in the others. The claspettes and aedeagus of *aquilonia* are shorter in relation to gonopod length than those illustrated for the neotropical species.

The genus *Meunieriella* was not included in the key to Nearctic genera of Cecidomyiidae in Gagné (1981). The additional couplet and changes that follow will serve to key this genus. Change couplet 91 to 91a; on the last line of that couplet change 92 to 91b. Add the following new couplet 91b:

91b. Male gonopod extremely narrow and elongate; gonocoxite more than twice length of aedeagus. Female cercus dorsoventrally flattened; points of lateral setulae on distal half of ovipositor directed dorsally .... *Meunieriella* Kieffer

– Male gonopod broad; gonocoxite not much longer than aedeagus. Female cercus cylindrical or bulbous; points of lateral setulae on distal half of ovipositor directed posteriorly 92

Females of *M. aquilonia* deposit eggs on either the upper or lower epidermis, the latter apparently preferred. Of 34 mines examined where empty eggs were found, 25 had been deposited on the lower epidermis. The spot galls are circular to oval, usually measuring 2–3 mm in greatest diameter. Initially the spot is whitish, but gradually turns brown after the larva abandons the leaflet. Only one gall was found per leaflet in all but two of 51 leaflets examined and only one larva was found in every gall, except in one that contained two. The pupal period for two flies reared from field-collected larvae lasted 10 days for one, 11 for the other.

This gall midge appears to be widespread in central Pennsylvania. It was collected on wild honeylocust in Dauphin Co.; at a garden center in Lancaster Co.; in nurseries in Centre, Columbia, and York counties; and in a cemetery in Dauphin Co. where thornless cultivars of honeylocust were infested. The collection of larvae from late June through mid-September suggests the midge has several generations per year.

ACKNOWLEDGMENTS

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EPHEDRODOMA, A NEW GENUS OF ORTHOTYLINE MIRIDAE (HEMIPTERA) FROM WESTERN UNITED STATES

DAN A. POLHEMUS AND JOHN T. POLHEMUS

(DAP) Department of Biology, University of Utah, Salt Lake City, Utah 84112; (JTP) 3115 S. York St., Englewood, Colorado 80110.

Abstract.—**Ephedrodoma** n. gen. and *Ephedrodoma* **multilineata** n. sp. are described. The new genus is compared with *Argyrocoris* Van Duzee. The new species occurs in California, Nevada, Utah, Arizona, New Mexico, and Texas. Host plants are *Ephedra trifurca* and *Ephedra aspera.*

Our collections of Miridae in western United States over the past several years have revealed a species of Orthotylinae that inhabits *Ephedra* (Mormon Tea) and cannot be placed in any described genus. We thus propose a new genus, *Ephedrodoma,* for this insect.

Specimens treated in this paper are held in various collections with abbreviations as follows; we are indebted to the curators or individuals as noted for permission to study their collections. Gary M. Stonedahl Collection, Oregon State University (GS); R. T. Schuh, American Museum of Natural History (AMNH); J. T. Polhemus Collection (JTP).

Ephedrodoma, NEW GENUS

Description.—Head broad, short, triangular when viewed from above; eyes protrusive, large; vertex wide, more than twice the dorsal width of an eye; vertex with distinct carina, occasionally obscure medially; antennae long, slender, segments III and IV somewhat thinner than preceding two. Pronotum large, convex, posterior angles acute; calli not prominent. Mesoscutum well exposed; scutellum flat. Hemelytra long, macropterous, extending to tip of abdomen. Legs long, slender; femora robust; claws large, parempodia minute, pulvilli large, convergent. Rostrum long, extending past hind coxae. Male genitalia of orthotyline-type; right clasper club shaped, small, with 1–3 spinose projections apically; left clasper small, spatulate, with long curving projection on lower margin. Pubescence distinctive, consisting of black bristle-like hairs interspersed with patches and longitudinal lines of silvery scale-like hairs.

Discussion.—Superficially, *Ephedrodoma* n. gen. resembles *Argyrocoris* Van Duzee (1912). Both genera are placed in the subfamily Orthotylinae on the basis of genitalia and pretarsal structure, and both possess longitudinal lines of silvery scales on the head and pronotom. The major point of separation between the two genera lies in the structure of the head. In *Ephedrodoma* the head is strongly produced vertically, with the gena extending below the eye for a distance equal to the vertical height of the eye, in contrast to *Argyrocoris* where the head is essentially horizontal and the gena barely evident. In *Argyrocoris* the antennal socket contacts the inner margin of the eye, while in *Ephedrodoma* the socket is separated from the eye by a distance equal to the width of the second antennal segment. The head of *Ephedrodoma* is strongly carinate basally, and the eyes extremely protrusive; in *Argyrocoris* the head is nearly acarinate basally and the eyes, though bulging, are not strongly protrusive. The antennae of female *Ephedrodoma* possess long, pilose setae, a character lacking in *Argyrocoris*.

The two genera may also be separated on the basis of habitus, *Argyrocoris* having a narrower, more elongate form and uniformly pallid coloration (see figure in Carvalho and Schaffner, 1973 for comparison). The erect pubescence of the hemelytra of *Argyrocoris* is fine and pallid, in contrast to *Ephedrodoma* where it is stout, black, and bristle-like.

Within the Orthotylinae, *Ephedrodoma* appears to belong in the tribe Orthotylini; in Knight's (1968) key it runs to *Hadronema,* from which it may be immediately separated by its pale legs and antennae, and by the distinctive scaly pubescence on the dorsum.

Etymology.—The name *Ephedrodoma* (Gr., L.) is derived from *Ephedra,* the host plant, and *domus* meaning house, with change of ending. The gender is feminine.

***Ephedrodoma multilineata,* NEW SPECIES**
Figs. 1–2

Description.—*Male:* Of moderate size, ovate; length 3.86 mm; maximum width 1.26 mm. Head black; lorum, gena, and gula reddish, eyes red, antennae pallid; frons set with fine pallid setae, tylus not anteriorly produced, frons with parallel lines of flattened silvery hairs, one pair (1 + 1) extending from inner edges of eyes to bases of antennae, another pair (1 + 1) reaching from outer margins of vertex across frons and jugae, a longitudinal median line on frons extending onto tylus split posteriorly to form a V enclosing vertex; a pair (1 + 1) of lines of silvery hairs extending from genae to lorae; another pair of silvery hair patches (1 + 1) on buccula; vertex wide, .51 mm, exceeding twice the dorsal width of an eye; eyes protrusive, dorsal width .20 mm. Antennae pallid, segment I stout, set with pallid setae equal in length to diameter of segment, interspersed with several longer, stouter, upright pallid setae; segment II slender, with short, pallid, recumbent setae; segments III and IV dusky, with fine, recumbent, pallid setae; lengths of antennal segments I–IV (in mm): .31; 1.23; .74; .37.

Pronotum black; basalar plate, epimeron, and area surrounding ostiolar peritreme pallid, propleura reddish; collar narrow; lateral margins weakly concave, posterior angles acute, posterior margin weakly sinuate; calli indistinct; surface set with stout black bristles, with five longitudinal lines of scaly silvery hairs, one pair (1 + 1) along margins, another pair (1 + 1) extending caudad from margins of vertex, one single line medially; a fringe of silvery hairs also present along posterior margin; a single stout setae present at each anterior angle; pleural region with two longitudinal lines of flattened silvery hairs, one extending from middle of posterior eye margin across propleura to base of fore coxa, the other originating near bottom of eye and extending across lower propleuron and episternum to bases of coxae, contiguous with similar line on head. Scutellum black, lighter laterally; mesoscutum well exposed, covered with flattened silvery hairs; scutellum

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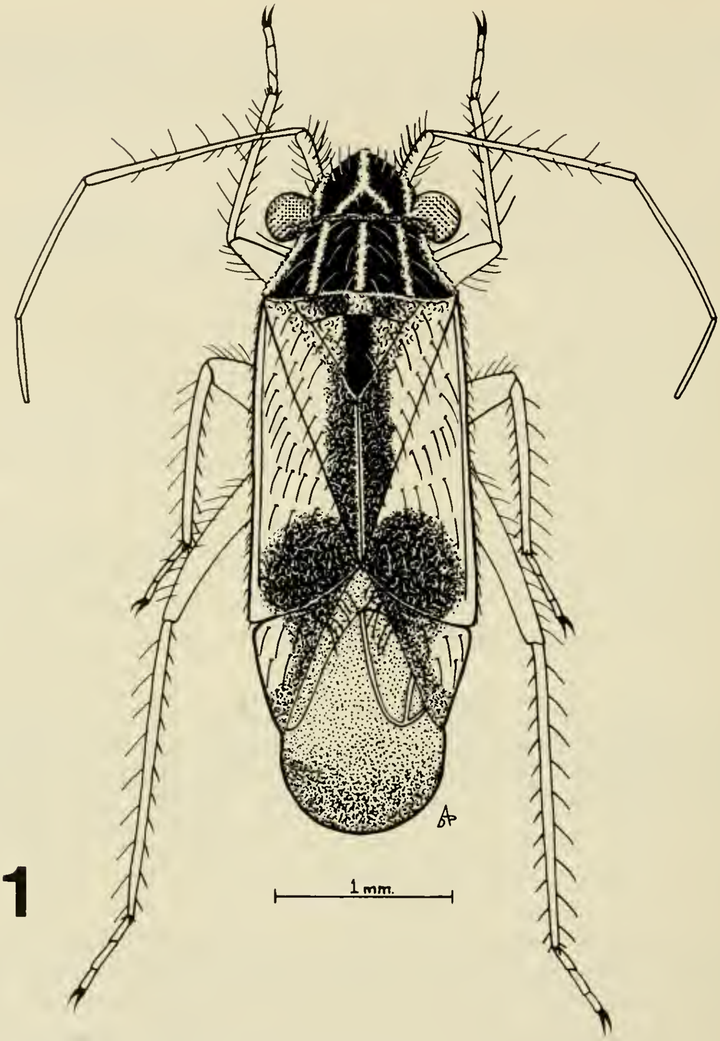


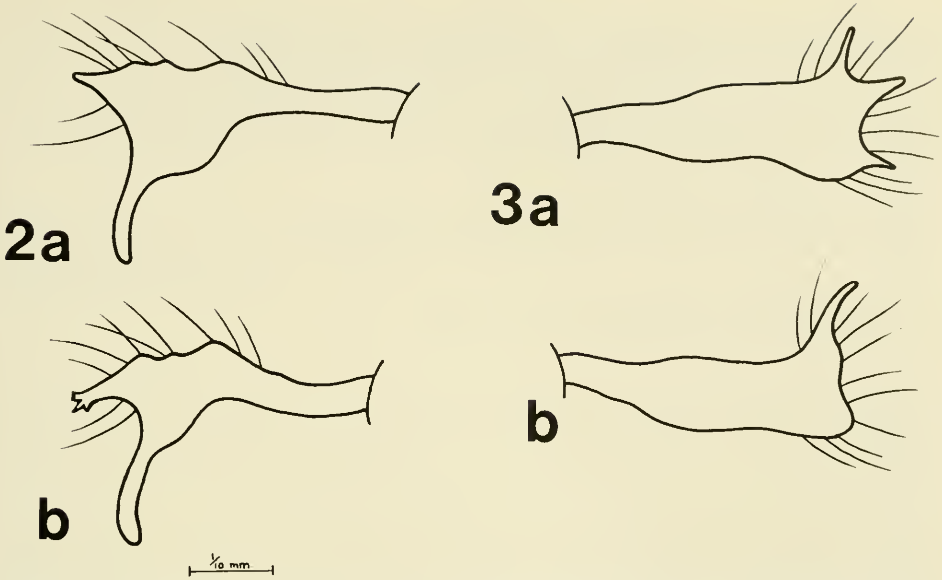
Fig. 1. *Ephedrodoma multilineata* n. sp., dorsal habitus.

with flattened silvery hairs medially and bordering clavus, also with scattered black bristles.

Hemelytra pallid, claval commissure and distal area of corium infuscated, cuneus mottled with red at least along inner margin; surface set with stout black bristles, interspersed with silvery scale-like hairs along claval commissure, basal and distal area of corium, and base of cuneus; cuneus with fine pallid setae; membrane orange, often infuscated on distal half; veins red.

Venter red, covered with fine pallid setae; abdomen covered with slender scaly white hairs. Legs pallid, coxae red basally, tips of tarsi infuscated; all segments covered with fine pallid setae, tibiae with pallid spines; tarsal joints subequal in length. Rostrum pallid, infuscated at tip, length 1.29 mm, reaching beyond hind coxae.

Genital segment with slender, pointed tergal process above base of left clasper;



Figs. 2–3. *Ephedrodoma multilineata* n. sp., male parameres, showing range of intraspecific variability. 2a–b, Left paramere. 3a–b, Right paramere.

claspers small, variable; right clasper club-like, with one to three spinose projections apically (see Figs. 3a, b); left clasper spatulate, with elongate, blunt process extending ventrally from bottom margin and a shorter process dorsally near apex with one to three small lobes at tip (see Fig. 2a, b).

Female: similar to male in coloration and structure; length 3.79 mm; antennal segment II also with long pilose hairs of length subequal to three times the diameter of the segment.

Discussion.—*Ephedrodoma multilineata* n. sp. inhabits *Ephedra* (Mormon Tea) growing on the outwash plains below desert mountain ranges. The insects are uncommon, with at most one or two specimens ever taken on a single plant. A notable feature of this species is the variability of the male claspers. The differences in structure between extremes in a population are equivalent to those that define many species, yet within a series of specimens a continuous intergradation of forms may be seen. Another notable feature is the sexual polymorphism involving pilose hairs on the antennae; these structures are present only in the females and perhaps serve as pheromone receptors.

Etymology.—The name *multilineata* refers to the color pattern of the insect.

Material examined.—Type, male, and allotype, female: NEVADA, Clark Co., Mount Charleston 5500″, VII-19-82, J. T. Polhemus (JTP). Paratypes: NEVADA; 3 ♂♂, 5 ♀♀, same data as types (JTP). CALIF.; 1 ♂ Inyo Co., along California Hwy. 141 nr. 9 Mile Canyon, NW of Inyokern, CL 1631, VII-15-82, J. T. Polhemus (JTP); 4 ♂♂, Inyo Co., 2 mi. E of Westgard Pass summit, 2072 m (6800′), VII-12-80, G. M. Stonedahl (GS). UTAH; 1 ♂, 17 ♀♀, Washington Co., 3.5 mi. E of LaVerkin, VI-25-80, R. T. Schuh (AMNH); 3 ♂♂, 8 ♀♀, Millard Co., 23.5 mi. E of Nevada border on U.S. 50, 1981 m (6500′), VII-18-80, G. M. Stonedahl (GS). ARIZ.; 9 ♂♂, 25 ♀♀, Cochise Co., .5 mi. E of Portal, 1450 m (4757′), VI-13-80,

R. T. Schuh, K. & R. Schmidt (AMNH); 1 ♂, 6 ♀♀, Mojave Co., Purgatory Can., .35 mi. S of m.p. 24 on I-15, along Virgin Riv., 792 m (2600′), V-24-81, M. D. Schwartz (AMNH). N. MEX.; 1 ♂, 4 ♀♀, Hidalgo Co., 2 mi. N of Rodeo, 1300 m (4265′), VI-11-80, R. T. Schuh, K. & R. Schmidt (AMNH). TEXAS, 3 ♂♂, 2 ♀♀, Brewster Co., Pine Canyon, Big Bend Nat. Park, V-1-82, D. A. & J. T. Polhemus (JTP).

Host plants.—*Ephedra aspera, Ephedra trifurca.*

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SYNOPSIS OF NEARCTIC AZOTINAE (HYMENOPTERA: APHELINIDAE)

D. Christopher Darling[1] and Norman F. Johnson

(DCD) Department of Entomology, Cornell University, Ithaca, New York 14853; (NFJ) Department of Entomology, 1735 Neil Avenue, The Ohio State University, Columbus, Ohio 43210.

Abstract.—Four species of the Azotinae (Hymenoptera: Aphelinidae) have been described from the Nearctic: *Ablerus clisiocampae* (Ashmead); *Azotus perspeciosus* (Girault); *Azotus americanus* (Girault), 1916 new combination; and *Azotus* ***dozieri*** new name for *Azotus americanus* Dozier, 1928. A lectotype is designated for *Azotus perspeciosus.* The original rearing record of *Ablerus clisiocampae* from the eggs of *Malacosoma americanum* (F.) (Lepidoptera: Lasiocampidae) is confirmed; the host range of this species also includes armored scale insects (Homoptera: Diaspididae). The presence of *Azotus atomon* (Walker) in the Nearctic is unsubstantiated.

Yasnosh (1976) has proposed a reclassification of the Aphelinidae (Hymenoptera: Chalcidoidea) which recognizes seven subfamilies: Aphelininae, Aphytinae, Azotinae, Calesinae, Coccophaginae, Physcinae and Prospaltellinae. The subfamily Azotinae is a small group, with only 82 described species. According to Yasnosh (1973), species are secondary parasitoids attacking Diaspididae, Coccidae, Aleurodidae (Homoptera), and are also known to emerge from the eggs of Cicadellidae (Homoptera) and Lepidoptera. Hayat (1983) has recently published a key that can be used to identify genera of the subfamily. In this paper we bring together published information on the taxonomy of Nearctic Azotinae, document nomenclatorial changes and discuss the host associations of *Ablerus clisiocampae* (Ashmead).

Azotinae

Azotinae Nikol'skaya 1966, in Nikol'skaya and Yasnosh 1966: 232.
Azotinae: Yasnosh, 1976: 167.

Diagnosis: antennae 7-merous; third flagellomere short, ringlike in male; clava unsegmented; pronotum entire; prepectus consisting of 2 separate sclerites; fore wings sparsely pubescent; with elongate radial vein and marginal fringe; abdominal tergites 9 and 10 separated; sternite 7 trapeziform, nearly reaching apex of abdomen; male genitalia with short, broad phallobase; basal ring present; parameres and digiti absent (Yasnosh, 1976).

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[1] Present address: Department of Entomology, Oregon State University, Corvallis, Oregon 97331.

Only two genera are included in the subfamily: *Ablerus* Howard and *Azotus* Howard. These may be distinguished on the basis of (1) the shape of the apex of the stigmal vein: narrowed and linear in *Ablerus* (Fig. 3), expanded and rounded in *Azotus* (Figs. 4–7); and (2) the discal setae on the fore wing: all of uniform length in *Ablerus* (Fig. 2), with patches of distinctly longer setae in *Azotus* (Fig. 1) (see also Hayat, 1983).

NEARCTIC SPECIES OF *ABLERUS*

Ablerus Howard, 1894: 7. Type species: *Centrodora clisiocampae* Ashmead by monotypy.

A study of the types of all species of Azotinae recorded in North America indicates that *Ablerus clisiocampae* is the only described representative of this genus in the Nearctic region. The species *americanus* and *perspeciosus*, originally described in *Ablerus*, are referred to *Azotus* (q.v).

1. ***Ablerus clisiocampae*** **(Ashmead)**

Figs. 2, 3

Centrodora clisiocampae Ashmead, 1894: 10. Type locality: Jacksonville, Florida. Host: Egg of *Malacosoma americanum* (F.) (Lepidoptera: Lasiocampidae).
Ablerus clisiocampae: Howard, 1894: 8.
Ablerus clisiocampae: Mercet, 1912: 133.
Ablerus clisiocampae: Peck, 1951: 436.
Ablerus clisiocampae: Peck, 1963: 269.
Ablerus clisiocampae: Gordh, 1979: 899.
Ablerus clisiocampae: Yasnosh, 1978: 494.
Ablerus clisiocampae: DeSantis, 1979: 319.

Type material: USNM No. 65475 [examined]. Two females. **LECTOTYPE** (*here designated*): Female, mounted on rectangular card; labels: "Type" [printed]; "Centrodora clisiocampae Ashm." [in Ashmead's handwriting]; "Lectotype *Centrodora clisiocampae* Ashmead, desig. Darling and Johnson." Paralectotype with same pertinent data as lectotype.

There has been considerable confusion concerning the host of *Ablerus clisiocampae.* Ashmead (1894) originally described the species on the basis of specimens reared from the eggs of the eastern tent caterpillar, *Malacosoma americanum* (then classified in the genus *Clisiocampa*). L. O. Howard (1894) redescribed the parasitoid from material reared from the scurfy scale, *Chionaspis furfura* (Fitch) (Homoptera: Diaspididae). Howard added that the specific name *clisiocampae* was unfortunate because "in my opinion, the true host is Chionaspis, and not the egg stage of Clisiocampa" (p. 6).

Girault (1907) also claimed that Ashmead's record was "undoubtedly incorrect"

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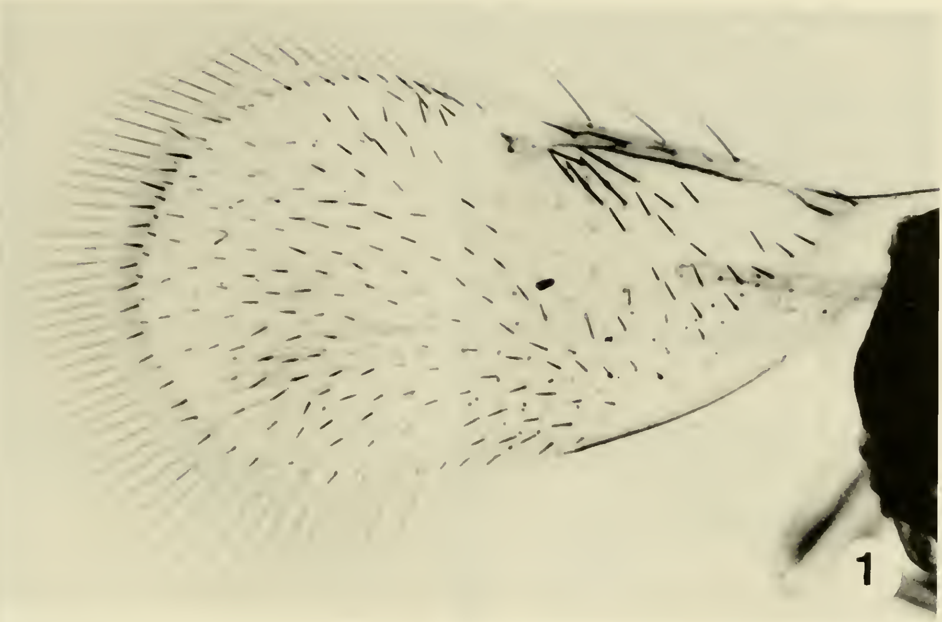
Figs. 1–3. Fore wings of Azotinae. 1, *Azotus marchali*, holotype male, showing differentiated discal setae. 2, *Ablerus clisiocampae*, female, reared from egg of *Malacosoma americanum*, showing uniform discal setae. The infuscate basal portion of the wing is found only in the female. 3, *Ablerus clisiocampae*, detail of narrowed stigmal vein.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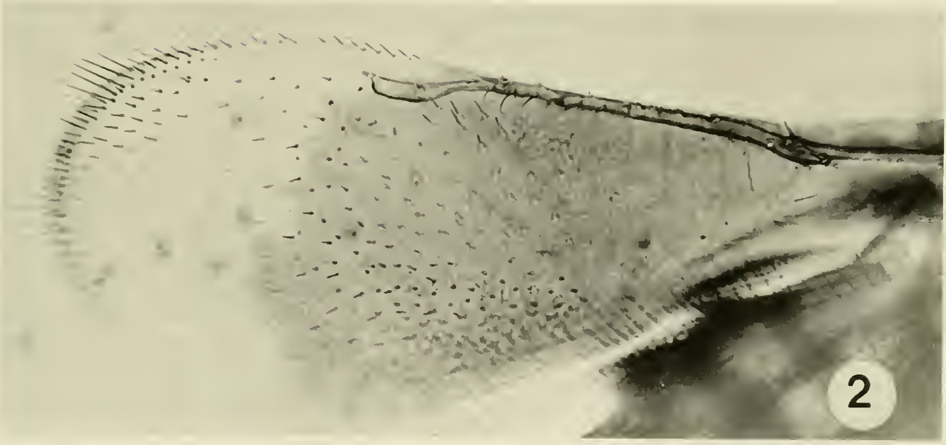
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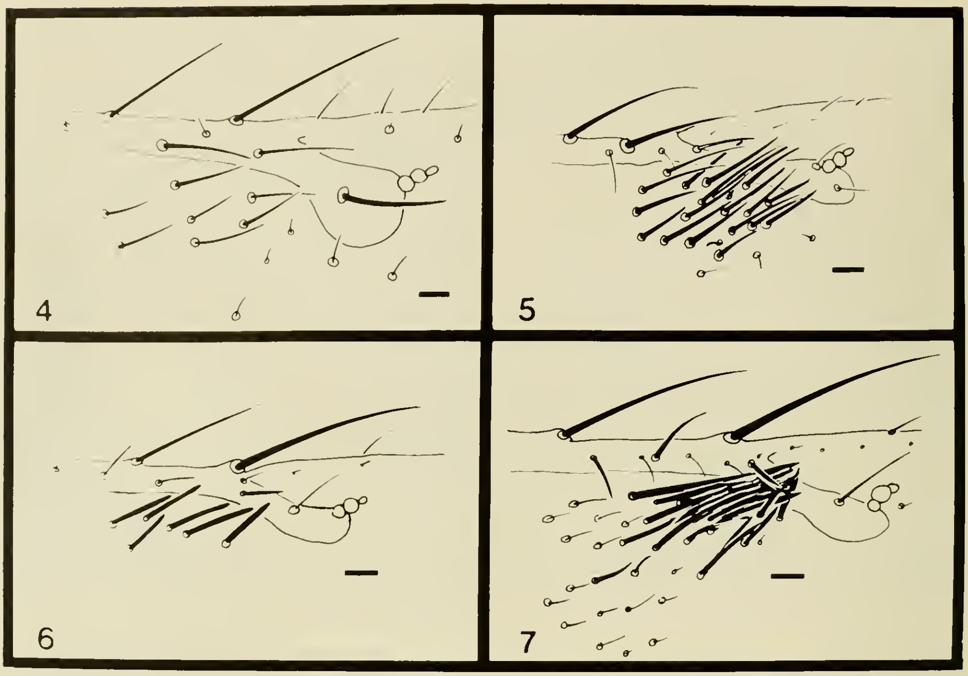

Figs. 4–7. Stigmal region of fore wings of *Azotus*. 4, *Azotus marchali*, holotype male. 5, *Azotus perspeciosus*, lectotype female. 6, *Azotus dozieri* (= *americanus* Dozier), holotype female. 7, *Azotus americanus*, holotype female. Scale line = 0.01 mm.

(p. 27). Ashmead's reported host, however, was corroborated by Williams (1916). He carefully removed *Malacosoma* egg masses from twigs in order to avoid possible contamination of the sample with scale insects. Porter (1917) also excluded scales and recovered *Ablerus* from *Malacosoma* eggs. More recent studies have reported *A. clisiocampae* in rearings of armored scales (Diaspididae) (Baker, 1933; Muma, 1959; Hughes, 1960). Peck (1951) listed both homopteran and lepidopteran hosts. Later (1963), he expressed doubt concerning the earlier *Malacosoma* records. In the most recent edition of the Catalog of Hymenoptera of America North of Mexico (Gordh, 1979) all reference to *Malacosoma* eggs as a host of *Ablerus clisiocampae* were deleted.

We have reared specimens of both sexes of *Ablerus clisiocampae* from the eggs of *Malacosoma americanum* (Darling and Johnson, 1982). We are confident that the specimens emerged from eggs and not from scale contaminants because each individual wasp was associated with a moth egg containing a larval parasitoid meconium. We have also examined Ashmead's syntypes of *Centrodora clisiocampae* (the series was not lost as reported in Peck, 1963). We have compared the types with both our reared material and specimens reared from the armored scales *Chionaspis furfura* and *Melanaspis obscura* (Comstock) (specimens from the collection of the U.S. National Museum of Natural History, Washington). We conclude that the lepidopteran and homopteran forms represent a single species, *Ablerus clisiocampae*. However, the Aphelinidae are known for the common occurrence of sibling species (see, e.g., Rosen, 1978; Rosen and DeBach, 1979).

Only detailed biological studies can determine whether this is a single polyphagous species, or two species attacking different host orders and life stages.

The wide host range for *Ablerus clisiocampae* is not unique. A comparable shift between Homoptera and insect eggs has also been reported in *Azotus* (Yasnosh, 1979). Kozlov (1972) has cited this as an example of morphotypical specialization, i.e., cases in which host range of a parasitoid is determined by general morphological similarities of potential hosts rather than, for example, specialization on a phylogenetic group. The shift of generations or individuals of *Ablerus clisiocampae* from one host order to the other has not been observed. The conclusion that they do is based upon a morphological comparison of adult wasps reared from the different hosts.

Nearctic Species of *Azotus*

Azotus Howard, 1898: 138. Type species: *Azotus marchali* Howard, by monotypy.
Dimacrocerus Brèthes, 1914: 4. Type species: *D. platensis* Brèthes by monotypy and original designation. Synonymized by Mercet (1922: 197).

[?] 1. ***Azotus atomon*** **(Walker)**

Encyrtus atomon Walker, 1847: 229. Type locality: Kollar, Austria. Host: unknown.
Azotus marchali Howard, 1898: 139, fig. 11. Type locality: uncertain. Host: *Diaspis osteaeformis* Signoret (Homoptera: Diaspididae) on pear.
Azotus pinifoliae Mercet, 1912: 141. Type locality: Madrid, Spain. Host: *Chionaspis pinifoliae* (Fitch) (Homoptera: Diaspididae) on *Pinus austriaca.*
Azotus mokrzeckii Nowicki, 1926: 108. Type locality: Bobrowa, Poland. Host: unknown.
Azotus marchali: Peck, 1951: 436.
[?]*Azotus marchali:* Peck, 1963: 271.
Azotus atomon: Ferrière, 1965: 105.
Azotus atomon: Nikol'skaya and Yasnosh, 1966: 237.
Azotus marchali: Gordh, 1979: 900.
Azotus atomon: Yasnosh, 1979: 494.

We have examined the type material of *Azotus marchali,* USNM No. 3647 (Figs. 1, 4). The material is slide mounted along with the type material of *Archenomus bicolor* Howard. Only a single specimen of *Azotus* is on the slide, the holotype male. We have indicated this specimen with an arrow (note: a specimen of *A. bicolor* is circled on the same slide).

The presence of *Azotus atomon* in North America is uncertain. There are no specimens of this species in the USNM that have been collected in North America, although the Hymenoptera Catalogs (Peck, 1951, Gordh, 1979) record it from the District of Columbia, Maryland and Virginia.

2. ***Azotus perspeciosus*** **(Girault)**

Fig. 5

Ablerus perspeciosus Girault, 1916a: 292. Type locality: Nishigahara, Japan. Host: *Pseudaulacaspis pentagona* (Targ.-Tozz.) (Homoptera: Diaspididae).
Azotus silvestrii Compere, 1926: 9, fig. 3. Type locality: Shanghai, China. Host:

Chrysomphalus aonidum (Linn.) (Homoptera: Diaspididae), on *Aucuba japonica* Thunberg (Cornaceae). Synonymized by Gahan (1942: 47).
Ablerus perspeciosus: Peck, 1951: 436.
Azotus perspeciosus: DeSantis, 1953: 74.
Azotus perspeciosus: Tachikawa, 1958: 62.
Ablerus perspeciosus: Peck, 1963: 271.
Azotus perspeciosus: Ferrière, 1965: 108, fig. 45.
Azotus perspeciosus: Nikol'skaya and Yasnosh, 1966: 236.
Ablerus perspeciosus: Gordh, 1979: 899.

The type material of *A. perspeciosus* is housed in the USNM: four females mounted on a slide, USNM No. 19930. **LECTOTYPE** (*here designated*): female, circled specimen in upper half of slide, centrally located (Fig. 5).

Specimens from Washington, D.C. [USNM] reared from *P. pentagona* and *Melanaspis obscura* (Comstock) closely agree with the type material and probably belong to this species.

3. *Azotus americanus* (Girault), NEW COMBINATION

Fig. 7

Ablerus americanus Girault, 1916b: 44. Type locality: Washington, D.C. Host: *Diaspidiotus uvae* (Comstock) (Homoptera: Diaspididae) on grape.
Ablerus americanus: Peck, 1951: 435.
Ablerus americanus: Peck, 1963: 269.
Ablerus americanus: Gordh, 1979: 899.

The type material consists of a single female specimen, slide mounted, in excellent condition (USNM No. 20004). This species is referred to *Azotus* on the basis of the rounded stigmal vein and the differentiated discal setae on the fore wing (Fig. 7).

4. *Azotus dozieri* Darling and Johnson, NEW NAME

Fig. 6

Azotus americanus Dozier, 1928: 36, fig. 1. Secondary homonym, preoccupied by *Azotus americanus* (Girault), 1916. Type locality: Newark, Delaware. Host: *Quadraspidiotus perniciosus* (Comstock) (Homoptera: Diaspididae) on *Sorbaria stellipila* (Rosaceae).
Azotus americanus: Peck, 1951: 436.
Azotus americanus: Peck, 1963: 271.
Azotus americanus: Gordh, 1979: 900.

This species is very similar to *A. atomon,* but has narrower wings. The marginal setae of the fore wing are not lengthened along the outer, lower margin as in the original description and figure. Dozier (1928) suggested that this species is a secondary parasite attacking *Prospaltella perniciosi* Tower (Aphelinidae).

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A NEW SPECIES OF *HYALOMYZUS* (HOMOPTERA: APHIDIDAE) FROM *HYPERICUM PROLIFICUM* IN ILLINOIS

DAVID VOEGTLIN

State Natural History Survey, Illinois Institute of Natural Resources, Natural Resources Building, 607 E. Peabody, Champaign, Illinois 61820.

Abstract.—The five morphs of *Hyalomyzus* **triangulatus** new species are described. Host records for all species of *Hyalomyzus* are given and the life cycle patterns within the genus are discussed.

Hyalomyzus mitchellensis Smith recently was described from *Hypericum mitchellianum* on Mt. Mitchell in North Carolina (Smith, 1982). At first it appeared that a previously unnamed species of *Hyalomyzus* collected in southern Illinois now had a name. However, closer examination of the specimens revealed distinct differences between the Illinois material and *H. mitchellensis*. Descriptions of the various morphs of this new species from Illinois are presented below with a review of some interesting biological aspects of *Hyalomyzus*. Measurements for all morphs are given in Table 1. Measurements in the text and Table 1 are in mm.

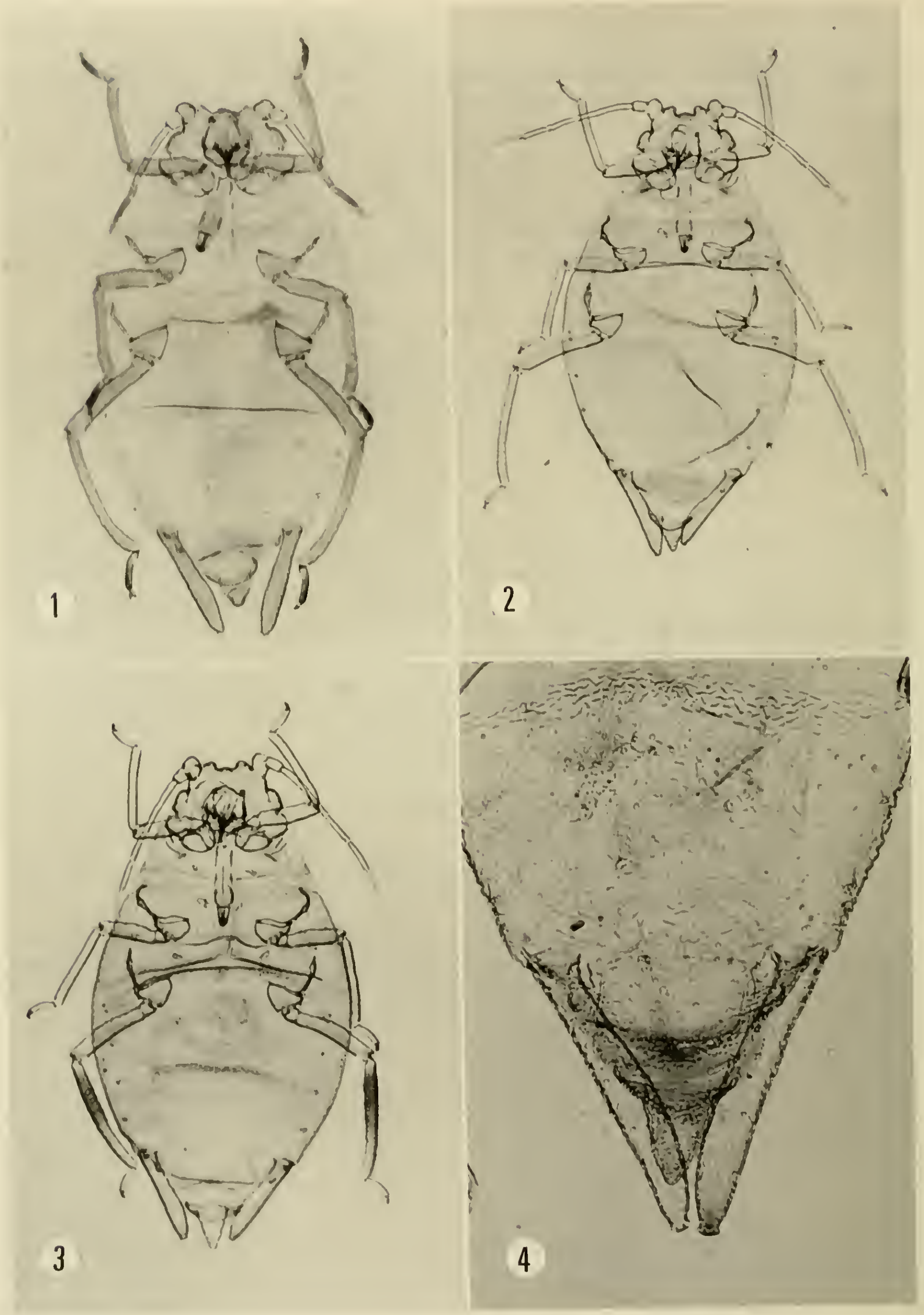
Hyalomyzus triangulatus Voegtlin, NEW SPECIES

Fundatrices.—Color in life: Pale yellow to green yellow throughout. Eyes and distal half of second tarsal segments dark. Eyes of embryos visible as red dots through abdominal dorsum.

Cleared specimens (Fig. 1): Very little sclerotization with distal half of antennal segment IV, segment V, tarsal segments I and II, siphunculi and cauda slightly darker than body. Subgenital plate pale and difficult to delineate.

Morphology: Front W-shaped, rugose, with median frontal tubercle shorter than the diverging lateral frontal tubercles. Vertex with irregular ridges. Antennal segment I scabrose on median surface, segment II smooth, segments III–V becoming increasingly imbricated distad. Rostrum short, reaching second coxae. Dorsum of abdomen faintly sculptured, appearing wrinkled at 250×. Siphunculi lightly sculptured on proximal ⅓ with distal ⅔ reticulate dorsally and imbricated ventrally, swelling asymmetrically over basal ⅔ then tapering rapidly to a narrowed tip with slight flange, lateral margin as observed in slide preparations almost straight, the swelling a function of the curved median margin, angled toward median line. Stigmal pori of abdominal segments VI and VII with large, nodulose operculum, much larger than those on segments I–V. Cauda almost parallel sided on basal ⅔ then tapering rapidly to tip.

Setation: Body, vertex and antennae with few very short setae (<.006). Legs with longer setae (.006–.009). Subgenital plate with 8–10 setae on posterior margin



Figs. 1–4. *Hyalomyzus triangulatus.* 1, Fundatrix, slide 80-3-3. 2, Apterous vivipara, holotype, slide 82-216-4. 3, Ovipara, slide 82-216-1. 4, Abdomen of apterous viviparous female showing elongate siphunculi forming triangle, slide 82-31-3.

and one pair near median line on anterior margin. Last rostral segment with no accessory setae. First tarsi all with 3 setae. Cauda with 5 setae.

Material examined: Two fundatrices, on *Hypericum prolificum,* 4 km S.E. of Eddyville, Pope Co., Illinois, 3-V-80.

Apterous viviparae.—Color in life: Spring and early summer specimens much like the fundatrices. Fall specimens with darker yellow-green abdomen and yellow head and thorax. Appendages pale yellow.

Cleared specimens (Fig. 2): As in fundatrices. Some specimens almost transparent, others with sclerotized area considerably darkened. Subgenital plate lightly sclerotized and distinctly visible.

Morphology: Front and frontal tubercles rough, nodulose, lateral frontal tubercles with parallel to converging inner margins, exceeding median frontal tubercle. Vertex irregularly ridged. Antennal segment I scabrose on inner margin, segment II smooth, segments III–VI increasingly imbricated distad. Antennae of 5 or 6 segments. Dorsum of thorax and abdomen often strongly rugose, intensity of roughness varies but always distinctly more visible than in fundatrices and alatae. Siphunculi lightly sculptured on upper surface, lower, medial and lateral surface coarsely imbricated, swelling asymmetrically as in fundatrices and usually longer, angled toward median line, in life appearing to touch posterior to cauda. Stigmal pori on abdominal segments VI and VII with large nodulose operculum. Subgenital plate oval. Cauda evenly tapered from base to tip.

Setation: Body, vertex and antennae with few short setae (<.006). Legs, front and frontal tubercles with longer setae (.006–.016.). Last rostral segment without accessory setae. Abdominal tergum VIII with 2–4 setae. Subgenital plate with 5–9 setae on posterior margin and 2–5 on anterior margin. First tarsi all with 3 setae. Cauda with 4 setae.

Material examined: 46 specimens, all taken on, or progeny of specimens from, *Hypericum prolificum,* 4 km S.E. of Eddyville, Pope Co., Illinois. Field collection dates: 3-V-1980, 16-V-1982, 25-V-1980, 12-X-1982. Lab reared collection dates: 23-VI-1982, 10-XI-1982, 18-XI-1982, 20-XII-1982.

Alate viviparae.—Color in life: Yellow to greenish yellow. Darker green areas include head, pterothorax and antennae beyond base of segment III. Antennal I, II and base of III greenish yellow. Siphunculi darkening distad. Cauda deeper yellow than abdomen. Femora with basal ½ pale; distal ½ of femora, all tibiae and tarsi evenly dark green.

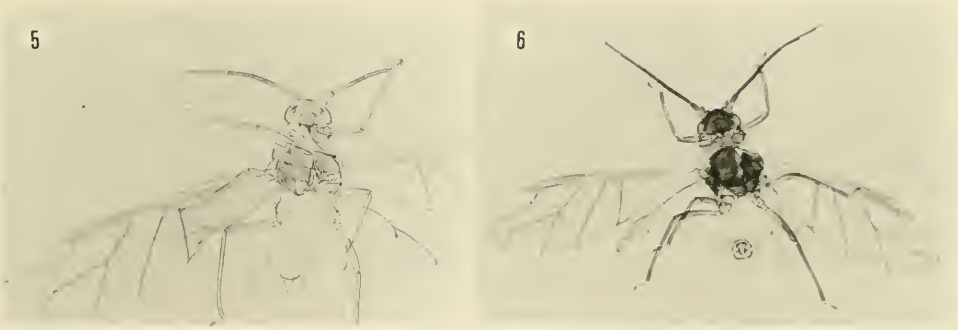
Cleared specimens (Fig. 5): Sclerotization pattern corresponds to dark areas indicated in living specimens. All sclerotized areas equally dark. Subgenital plate indistinct. Anal vein in forewings often lightly bordered on proximal edge. Other veins not bordered.

Morphology: Vertex and front relatively smooth, frontal tubercles slightly rugose with median frontal tubercle subequal to the diverging lateral frontal tubercles. Antennal I and II scabrose on inner margin, segments III–VI evenly imbricated, segments III–V with secondary sensoria. Dorsum of abdomen smooth. Siphunculi smooth to maximally swollen region then slightly imbricated, swelling and distal taper not as pronounced as in apterous forms. Stigmal pori on abdominal segments VI and VII with nodulose operculum, not as large or nodulose as in apterae. Cauda tapering evenly from base to tip.

Table 1. Measurements for the five morphs of *Hyalomyzus triangulatus*. All measurements are in mm. The symbol * refers to specimens having five antennal segments, in this case the third segment is considered to be a combination of antennal segments three and four. The abbreviation n.m. means the character could not be measured. For fundatrices and oviparae the last two segments are under columns V and VI even though they are segments IV and V. This allows the last antennal segment base and process terminalis to remain in line on the table.

specimen #	body length	antennal segments								length of					number of setae on cauda
		length of					secondary sensoria on								
		III	IV	V	VI b	VI pt	III	IV	V	last rostral segment	hind tibiae	hind tarsal II	siphunculi	cauda	
Fundatrices															
80-3-3	1.54	-*.166 -		.090	.077	.051	-	-	-	.064	.435	.096	.320	.130	5
80-3-1	1.32	-*.134 -		.077	.083	.051	-	-	-	.058	.367	.096	.320	.122	-
Apterous Viviparae															
80-3-4	1.47	-*.237 -		.115	.086	.083	-	-	-	.064	.448	.109	.384	.130	-
80-3-2b	1.10	.115	.096	.102	.096	.090	-	-	-	.064	.467	.105	.358	.115	4
80-3-2t	1.52	.128	.109	.109	.096	.090	-	-	-	.065	.480	.109	.384	.134	4
80-14-R3	1.25	-*.160 -		.096	.090	.086	-	-	-	.058	.384	.083	.301	.102	4
80-14-R1	1.47	.115	.109	.115	.102	.096	-	-	-	.064	.474	.109	.371	.118	4
82-31-1l	1.76	.122	.109	.115	.102	.090	-	-	-	.064	.480	.102	.403	.141	4
82-31-1r	1.32	-*.173 -		.090	.080	.077	-	-	-	.058	.410	.096	.339	.115	4
82-31-2l	1.61	.134	.122	.115	.096	.090	-	-	-	.064	.493	.109	.358	.134	4
82-31-2r	1.41	.109	.090	.102	.096	.093	-	-	-	.058	.422	.096	.352	.122	4
82-31-3l	1.61	-*.224 -		.128	.102	.090	-	-	-	.064	.506	.102	.390	.141	4
82-31-3r	1.38	.115	.096	.109	.090	.090	-	-	-	.064	.435	.096	.352	.115	4
82-31-4l	1.43	-*.198 -		.102	.096	.083	-	-	-	.058	.422	.102	.416	.115	4
82-31-4r	1.30	-*.166 -		.090	.090	.077	-	-	-	.058	.384	.090	.339	n.m.	4
82-216-2b	1.43	-*.166 -		.096	.090	.083	-	-	-	.064	.397	.096	.288	n.m.	4
82-216-3	1.45	-*.198 -		.102	.093	.077	-	-	-	.064	.378	.086	.301	.110	4
82-216-4	1.51	-*.198 -		.109	.096	.083	-	-	-	.064	.403	.086	.320	.128	4
82-216-5	1.51	-*.186 -		.096	.100	.083	-	-	-	.064	.422	.090	.320	.122	4
82-196-1	1.14	-*.134 -		.077	.080	.073	-	-	-	.058	.314	.077	.269	.102	4
82-222-7t	1.34	-*.205 -		.122	.109	.096	-	-	-	.064	.467	.096	.346	.141	4
82-222-7m	1.36	-*.192 -		.115	.096	.093	-	-	-	.064	.416	.090	.307	n.m.	4
82-78-1t	1.21	-*.141 -		.090	.083	.077	-	-	-	.058	.346	.077	.275	.096	4
82-78-1m	1.38	-*.160 -		.096	.093	.093	-	-	-	.058	.384	.083	.320	.102	4
82-78-1b	1.30	-*.134 -		.083	.096	.083	-	-	-	.055	.333	.077	.275	.109	4?
Alate Viviparae															
80-14-3t	1.43	.269	.179	.160	.115	.109	17	10	6	.061	.627	.102	.275	.134	4
80-14-3b	1.38	.282	.166	.134	.102	.102	17	8	5	.062	.602	.109	.275	.128	4
80-14-1	1.56	.301	.175	.141	.109	.109	19	10	4	.064	.652	.109	.301	.141	4
80-14-2t	1.36	.282	.166	.141	.102	.109	16	9	5	.064	.614	.105	.275	.122	4
80-14-2b	1.52	.262	.169	.154	.115	.112	17	7	3	.061	.614	.102	.275	.131	4
80-14-R3	1.16	.243	.147	.115	.090	.096	11	10	4	.054	.493	.090	.211	.115	4
82-31-1	1.61	-*.397 -		.141	.109	.104	-*26 -		6	.060	.621	.106	.275	n.m.	4
82-31-2	1.34	.250	.176	.134	.090	.109	18	7	3	.061	.582	.100	.256	n.m.	4
82-31-3	1.54	.288	.179	.154	.090	.090	18	8	6	.064	.621	.109	.282	.128	4
82-31-4	1.41	.275	.154	.134	.112	.122	18	9	5	.060	.595	.105	.269	n.m.	4
82-31-5	1.47	.269	.160	.141	.102	.090	16	8	4	.061	.582	.096	.262	.109	4
82-31-6	1.12	.262	.147	.128	.077	.073	17	6	3	.058	.544	.096	.250	.109	4
Ovipara															
82-216-1	1.35	-*.192 -		.102	.102	.083	-	-	-	.067	.410	.090	.320	.141	4
82-216-2	1.45	-*.212 -		.102	.109	.070	-	-	-	.064	.416	.090	.320	.128	4
82-216-3	1.54	-*.198 -		.102	.102	.077	-	-	-	.064	.410	.096	.358	.109	5
82-216-6	1.33	-*.166 -		.096	.096	.083	-	-	-	.064	.358	.083	.262	.102	4
82-222-6	1.32	-*.179 -		.102	.102	.077	-	-	-	.064	.397	.090	.294	.115	6
82-224-2	1.48	-*.173 -		.096	.093	.070	-	-	-	.061	.365	.090	.282	.128	4
82-224-3	1.41	-*.186 -		.105	.102	.083	-	-	-	.064	.390	.090	.282	.128	4
82-224-4	1.41	-*.179 -		.102	.102	.083	-	-	-	.068	.403	.093	.275	.122	4
82-224-6	1.36	-*.198 -		.109	.099	.083	-	-	-	.064	.403	.090	.320	.115	5
82-224-10	1.52	-*.179 -		.109	.102	.077	-	-	-	.068	.410	.090	.282	.131	5
Males															
82-196-2	1.18	.307	.179	.147	.128	.122	17	10	4	.070	.506	.090	.198	.096	4
82-196-1	1.21	.269	.163	.138	.122	.109	15	9	4	.064	.493	.090	.192	.083	4

Setation: Body, vertex and antennae with few short setae (<.006). Setae on frontal tubercles and mid dorsal region of tibiae longer (.006–.009). Setae on ventral region of tibiae approximately twice as long as that on dorsal region. Last rostral segment without accessory setae. Subgenital plate with 8–10 setae along posterior margin and 4–7 scattered near anterior margin. Abdominal tergum VIII with 4 setae. First tarsi all with 3 setae. Cauda with 4 setae.



Figs. 5–6. *Hyalomyzus triangulatus.* 5, Alate viviparous female, slide 80-14-2a. 6, Male, slide 82-196-2.

Material examined: 11 specimens, all taken on *Hypericum prolificum,* 4 km S.E. of Eddyville, Pope Co., Illinois. Collection dates: 14-V-1980, 16-V-1982.

Oviparae.—Color in life: Head and thorax yellow as in apterae and fundatrices, abdomen dark yellow to green. Frontal tubercles dark on inner margin. Appendages pale yellow, except for proximal ⅔ of hind tibiae which are dark yellow green.

Cleared specimens (Fig. 3): Body pale throughout, siphunculi and proximal ⅔ of hind tibiae darker. The darker region of the hind tibiae contains the pseudosensoria.

Morphology: Front and frontal tubercles rough, nodulose, lateral frontal tubercles with approximately parallel inner margins, median frontal tubercle small. Vertex moderately rugose. Antennal segment I nodulose on inner margin, segment II smooth, segments III–V increasingly imbricated distad. Dorsum of thorax and abdomen through tergum V heavily rugose, terga VI–VIII smooth to lightly rugose. Siphunculi as in apterae. Cauda tapering evenly from base to tip. Stigmal pori on abdominal segments VI and VII with large nodulose operculum. Hind tibiae with pseudosensoria confined mostly to ventral half on proximal ⅔.

Setation: Body, vertex and antennae with few short setae (<.007). Legs and front with longer setae (.006–.016). Abdominal tergum VIII with 6 setae. Subgenital plate with 10–12 setae along posterior margin and 10–12 scattered on anterior half. Last rostral segment without accessory setae. First tarsi all with 3 setae. Cauda with 4–6 setae.

Material examined: 25 specimens, all progeny of specimens taken on *Hypericum prolificum,* 4 km S.E. of Eddyville, Pope Co., Illinois. Lab reared collections: 10-XI-1982, 18-XI-82, 20-XII-82.

Males.—Color in life: Head medium green. Thorax lighter than head but darker than the pale yellow green abdomen. Distal ⅔ of femora, distal ¼ of tibiae, tarsi, antennal segments I and II concolorous with head. Antennal segments III–VI and tip of siphunculi dark green.

Cleared specimens (Fig. 6): Sclerotization pattern follows dark areas of living specimens. Antennal segments III–VI darker than all other areas, cauda and siphunculi pale. Wing veins dark not bordered. Abdomen transparent.

Morphology: Vertex and front smooth. Inner margin of frontal tubercles slightly scabrose, median frontal tubercle subequal to lateral frontal tubercles. Antennal segment I slightly scabrose on inner margin, segment II smooth, segments III–VI increasingly imbricated distad, segments III–V with secondary sensoria. Abdom-

Fig. 7. Antennae of the five morphs of *Hyalomyzus triangulatus*. A, Fundatrix, slide 80-3-1. B, Apterous vivipara, slide 80-14-R1; C, Alate vivipara, slide 80-14-3b. D, Ovipara, slide 82-16-6. E, Male, slide 82-196-2. All drawn to the same scale using a camera lucida.

inal terga smooth. Distal tapered area of siphunculi with scattered fine imbrications, not as strongly swollen as in apterae, with small flange. Operculum on stigmal pori of segments VI and VII not as large or nodulose as in other forms.

Setation: As in all other forms, with few short setae (<.006) everywhere except on legs, front and cauda. Abdominal tergum VIII with 4 setae. Setae on tibiae shorter on dorsal surface as in alatae. First tarsi all with 3 setae. Last rostral segment without accessory setae. Cauda with 4 setae.

Material examined: 2 specimens, both reared from 4th instar alatoid nymphs taken on *Hypericum prolificum,* 4 km S.E. of Eddyville, Pope Co., Illinois. 12-X-1982.

Type locality.—All field collected specimens taken 4 km S.E. of Eddyville, Pope Co., Illinois.

Types.—Holotype apterous vivipara on slide 82-216-4, progeny of specimen taken on *Hypericum prolificum,* 4 km S.E. of Eddyville, Pope Co., Illinois 10-XI-1982, David Voegtlin. Deposited at the Illinois Natural History Survey. Paratypes deposited in the United States National Museum, the British Museum of Natural History, the Canadian National Collection and with D. Hille Ris Lambers. All other paratypes deposited at the Illinois Natural History Survey.

Diagnosis.—*Hyalomyzus triangulatus* can be separated from all other species of *Hyalomyzus* by the very short process terminalis (Fig. 7) (<1.1 × base of last antennal segment) and in the apterous morphs by the siphunculi extending beyond

Table 2. The species of *Hyalomyzus* are shown with their primary and secondary hosts as given in the literature. Placement of species known from only one host species or genus is under the secondary host column to show the similarity of the hosts of these species to the secondary hosts of the species with host alternation. Citations for the host records are shown below the hosts for each species.

Species	Primary Host	Secondary Host
eriobotryae (Tissot)	*Eriobotrya japonica* *Pyrus malus* *Crataegus uniflora* (Rosaceae) (Tissot, 1935)	*Lycopus virginicus* (Labiatae) (Smith, 1960)
collinsoniae (Pepper)	*Pyrus augustifoliae* (Rosaceae) (Smith, 1982)	*Collinsonia canadensis* (Labiatae) (Pepper, 1950)
monardae (Davis)		*Monarda fistulosa* *Monarda* sp. (Labiatae) (Davis, 1911) (Mason, 1940)
tissoti Nielsson & Habeck	*Crataegus vicana* *Crataegus praeformosa* (Rosaceae) (Nielsson & Habeck, 1971)	*Drosera capillaris* *Drosera* sp. (Labiatae) *Isnardia intermedia* (Onagraceae)
jussiaeae Smith		*Jussiaea angustifolia* (Onagraceae) (Smith, 1960)
sensoriatus (Mason)	*Crataegus crusgalli* (Rosaceae) (Mason, 1940)	*Hypericum* sp. (Guttiferae) (Nielsson & Habeck, 1971)
mitchellensis Smith		*Hypericum mitchellianum* (Guttiferae) (Smith, 1982)
triangulatus Voegtlin		*Hypericum prolificum* (Guttiferae)

and nearly touching distad of cauda (Fig. 4). The following couplet will separate *H. triangulatus* from all other species in the genus and can be used in conjunction with the keys to apterous and alate viviparae prepared by Smith (1982).

– Process terminalis <1.1 × base of last antennal segment. On *Hypericum prolificum*. Siphunculi in apterous morphs extending beyond tip of cauda, almost touching in mounted specimens and in life. .... *Hyalomyzus triangulatus* Voegtlin

– Process terminalis >1.6 × base of last antennal segment. Not found on *Hypericum prolificum*. Siphunculi in apterous morphs not often exceeding cauda or touching on mid line .... other *Hyalomyzus* spp.

Etymology.—The trivial name is taken from the triangle formed by the siphunculi in the apterous morphs, which when viewed dorsally encloses the cauda and posterior abdominal segments (Fig. 4).

Biology.—*Hyalomyzus triangulatus* was never found to be abundant in the field. Specimens can be found in the leaf axils of *Hypericum prolificum* L. (sensu Svenson, 1952), a small shrub often found in abundance in abandoned fields in southern Illinois. This is considered to be the only host of *H. triangulatus* since both oviparae and males developed on it. Alate viviparae were collected only in the spring, a similar pattern to that observed for *H. mitchellensis* (Smith, 1982). Although I have collected this species in only one locality, I expect that it will have a wide distribution given the extensive distribution of its host plant (Utech and Iltis, 1970).

BIOLOGY OF *HYALOMYZUS*

Smith (1982) lists seven species of *Hyalomyzus*. These species and their host plants, as given in the literature, are listed in Table 2. Nielsson and Habeck (1971) synonymized *H. collinsoniae* with *H. eriobotryae,* but this was not accepted by Eastop and Hille Ris Lambers (1976), and Smith (1982) separated them in his keys. Published collection dates for these two species are as follows; *H. eriobotryae* has been collected in December, February and April in Florida (Tissot, 1935) and in May and June in Pennsylvania (Pepper, 1965); whereas *H. collinsoniae* has been collected in August in Florida (Pepper, 1950) and August and September in Pennsylvania (Pepper, 1965). Unpublished records on slides in the United States National Museum have *H. collinsoniae* collected in August and September and *H. eriobotryae* collected in April, May, June, November and December. These collection dates seem to support the conclusion of Nielsson and Habeck that *collinsoniae* is the summer form of *eriobotryae.* One of the characters used by Smith (1982) to separate the alatae of these two species is the presence or absence of a distinct bordering of the anal vein of the forewing, this being absent in *eriobotryae.* I examined two paratypes of this species and found the anal vein bordered in both. The holotype, an alate vivipara, however, does not show this distinct fuscos bordering of the anal vein. Tissot (1935) in the original description of *eriobotryae* stated "the anal and basal portion of the cubitus narrowly bordered with brown shading." These two species, if not synonymous, are obviously very closely related biologically as well as being morphologically similar.

Table 2 presents the host plants known for this genus, under the headings primary and secondary hosts. There is no indication in the literature that any of the species shown to have primary and secondary hosts actually had been transferred experimentally. These published host alternation patterns are apparently based on morphological similarities between specimens found on different hosts. Host transfer tests would resolve the taxonomic status of *collinsoniae* as well as verify the other life cycles.

The sequence in Table 2 is to show common host plant affinities. The first four species are associated with rosaceous shrubs as primary hosts with plants in the Labiatae or Onagraceae as secondary or only hosts. The next species is known only from Onagraceae and exists anholocyclicly in Puerto Rico. The last three are associated with *Hypericum* as the only or secondary host, and one has a rosaceous shrub as its primary host.

If we assume these life cycles are correct, they show some interesting evolutionary patterns within *Hyalomyzus*. *H. tissoti* can spend its entire life on the primary host (Nielsson and Habeck, 1971), while at the other extreme, *H. mitch-*

ellensis has apparently transferred its entire life cycle to *Hypericum,* a secondary host for this genus, and has developed wingless males, effectively eliminating the possibility of host alternation. *Hyalomyzus monardae* has been collected only from Labiatae. However, collection records from specimens in the United States National Museum and the Illinois Natural History Survey are all from June and July. Palmer (1952) recorded collections from May through early November, but fundatrices, oviparae or males are not indicated. The type of *H. monardae* was collected on May 24 and is an alate vivipara accompanied by nymphs. This suggests that *H. monardae* may alternate hosts.

I suspect that host transfer tests will confirm these proposed life cycles. Hopefully someone, in the geographic region of the species in question, will undertake the experimental work necessary to prove them.

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NEW SPECIES OF HYDROPTILIDAE (TRICHOPTERA) FROM ALABAMA

S. C. Harris and R. W. Kelley

(SCH) Environmental Division, Geological Survey of Alabama, P.O. Drawer O, University, Alabama 35486; (RWK) P.O. Box 522, Clemson, South Carolina 29633.

Abstract.—Three new species of Hydroptilidae (Trichoptera) from Alabama, *Hydroptila* ***alabama,*** *Hydroptila* ***recurvata,*** and *Ochrotrichia* ***tuscaloosa*** are described and illustrated.

In the course of a premining assessment study of Tyro Creek and two of its tributaries (Harris et al., 1983), several undescribed species of Trichoptera were collected with black light traps. Tyro Creek is a small, rocky stream located in the Cumberland Plateau in north Tuscaloosa County, Alabama. Two of the species are possibly restricted to the Black Warrior basin, of which the Tyro Creek drainage is a part, but the third species was subsequently collected throughout Alabama. These new species are described below and their affinities noted.

Hydroptila alabama Harris and Kelley, New Species

Fig. 1

This species is a member of the *tineoides* group (Marshall, 1979) most closely resembling *H. wyomia* (Denning). The species differs from *H. wyomia* and other members of the group in the structure of the aedeagus. In *H. wyomia* the bulbous portion of the aedeagus narrows to a beak-shaped apex, while in *H. alabama* it narrows to a thin, sharply angled apex (Fig. 1). When the bulbous portion of the aedeagus does not protrude beyond the tenth tergite, the new species is easily confused with *H. hamata* (Morton).

Male.—Antennae 29-segmented. Length 2.0–3.0 mm. Color brown in alcohol. Seventh sternum with a long apicomesal process extending beyond margin of eighth sternite. Lateral lobe of ninth segment slender with both dorsal and ventral setal clusters; internally ninth segment bearing a lightly sclerotized forked structure (the bilobed process of Marshall, 1979) tipped with stout setae at apices. Claspers short, sharply curved ventrad in lateral view, apices heavily sclerotized and contigious along meson in ventral view; midlaterally on each clasper arises a tubular process curved dorso-anteriorally bearing a prominent setae at apex. Tenth tergite lightly sclerotized, posterior portion slightly emarginate in dorsal view, in lateral view anterior portion domed, sloping to a blunt apex. Aedeagus long, tubular, nearly straight with only a narrow neck, lacking titillator; near base of apical portion arises a slender acuminate filament; distal portion bulbous then narrowing to an apex which is sharply bent at a right angle; straight process of ejaculatory duct also arising from bulbous portion.

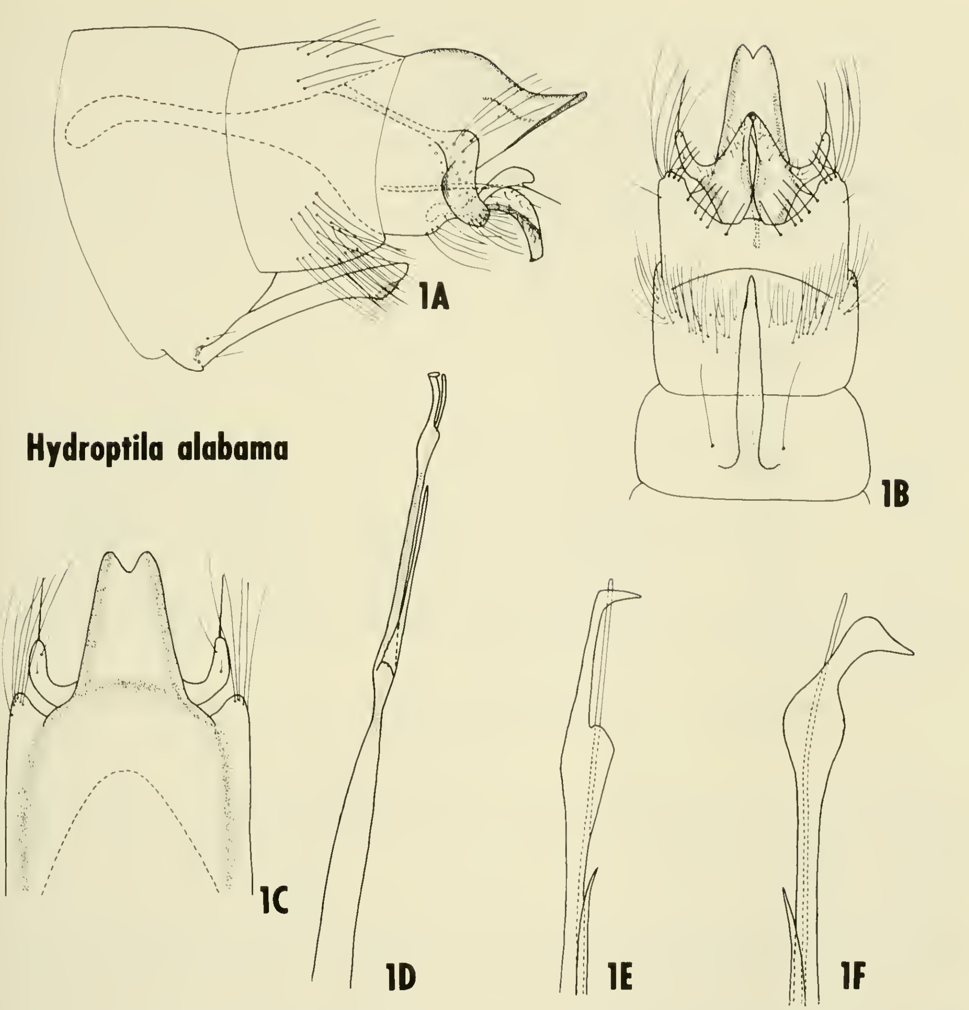

Fig. 1. *Hydroptila alabama* n.sp., male genitalia. 1A, lateral view. 1B, ventral view. 1C, dorsal view. 1D aedeagus. 1E, distal portion of aedeagus. 1F, *Hydroptila wyomia* Denning, distal portion of aedeagus (redrawn from paratype).

Female.—Unknown.

Holotype, male.—ALABAMA, Escambia County, Little Escambia Creek at Hwy. 31, 6 Aug. 1982, O'Neil. The holotype is deposited in the National Museum of Natural History, Washington, D.C.

Paratypes.—ALABAMA, Baldwin County, Turkey Creek at Hwy. 59, 11 May 1982, 1 ♂, Harris and McCullough; Bibb County, Six Mile Creek at Hwy. 25, 13 May 1982, 3 ♂, Harris and O'Neil; Schultz Creek, 4 miles north of Centreville, 25 Aug. 1981, 1 ♂, Harris and O'Neil; Butler County, Pigeon Creek at Hwy. 110, 4 Sept. 1982, 1 ♂, Harris; Calhoun County, Nances Creek at Piedmont, 6 Sept. 1981, 2 ♂, Harris and Handley; Tallassehattchee Creek, 1.5 miles northwest of Jacksonville, 7 Sept. 1981, 1 ♂, Harris and Handley; Choctaw County, Middle Tallawampa Creek at Co. Hwy. 23, 16 May 1982, 5 ♂, Harris; Tallawampa Creek at Co. Hwy. 23, 16 May 1982, 5 ♂, Harris; Cleburne County, Chulafinnee Creek at Co. Hwy. 24, 1 mile east of Abel, 22 May 1981, 2 ♂, Harris and O'Neil; Shoal Creek at Shoal Creek Campground, Talladega National Forest, 6 Sept. 1981, 9 ♂, Harris and Handley; Covington County, Yellow Creek at Co. Hwy. 4, 12 June 1982, 2 ♂, Harris; DeKalb County, Mush Creek at Porterville Gap, 8 miles south of Fort Payne, 22 June 1981, 1 ♂, Harris; Escambia County, Burnt Corn Creek, 5 miles northwest of Brewton, 13 June 1982, 46 ♂, Harris; Etowah County, Little Wills Creek at Hwy. 227, 17 July 1982, 2 ♂, Harris; Fayette County, Tyro Creek, 2.5 miles southeast of Berry, 18 May 1982, 3 ♂, Harris and O'Neil; Jefferson County, Cahaba River at Camp Coleman, 24 May 1981, 1 ♂, Harris and O'Neil; Mobile County, Little Creek, 4 miles southeast of Citronelle, 4 Aug. 1982, 1 ♂, Harris and O'Neil; Monroe County, Beaver Creek at Hwy. 41, 15 May 1982, 13 ♂, Harris; Tuscaloosa County, Tyro Creek, 4.5 miles east of New Lexington, 21 July 1981, 31 ♂, Harris and O'Neil; Tyro Creek, 3.5 miles south of Berry, 18 May 1982, 9 ♂, Harris and O'Neil; Wallace Branch, 5 miles southeast of Berry, 18 May 1982, 5 ♂, Harris and O'Neil; Big Sandy Creek, 4 miles south of Coaling, 9 June 1982, 1 ♂, Harris; Washington County, Bates Creek at Hwy. 43, 4 Aug. 1982, 1 ♂, Harris and O'Neil. Two paratype series are deposited in the National Museum of Natural History; the remaining paratypes are deposited at the Illinois Natural History Survey, Clemson University, Royal Ontario Museum, Geological Survey of Alabama, and collections of the authors.

Hydroptila recurvata **Harris and Kelley, New Species**

Fig. 2

This species can be placed in the *waubesiana* group (Marshall, 1979) on the basis of the long forked tenth tergum, and is closely related to *H. waubesiana* Betten. It differs primarily in the structure of the claspers which are long and sharply recurved.

Male.—Antennae 24-segmented. Length 2.4 mm. Color brown in alcohol. Seventh sternum with short apicomesal process. Eighth segment with numerous, long, heavily sclerotized spines on ventral and apico-lateral surface. Ninth segment retracted into eighth and posterior portion of seventh segment. Tenth tergum arises from ninth segment as a narrow, parallel-sided, lightly sclerotized process; forking near apex, each fork ending in a prominent spine. Claspers converging in ventral view, sharply bending anterio-laterally near apex and narrowing; with a heavily sclerotized projection near midlength; rounded at base with a pair of slender spines on apico-lateral margin. Aedeagus narrowly constricted at midlength and apex; titillator slender, arising near neck, spiraling anteriorly one revolution; ejaculatory duct arising near basal constriction and protruding at apex.

Female.—Unknown.

Etymology.—Latin: "bent back" referring to the distinctive claspers.

Holotype, male.—ALABAMA, Tuscaloosa County, Wallace Branch, 5 miles southeast of Berry, 15 June 1982, Harris and O'Neil. The holotype is deposited in the National Museum of Natural History.

Paratypes.—ALABAMA, same as above, but 25 July 1983, 1 ♂. Tuscaloosa County, Tyro Creek, 4 miles southeast of Berry, 23 Aug. 1983, 1 ♂, Harris and O'Neil; Fayette County, Tyro Creek, 2.5 miles southeast of Berry, 25 July 1983,

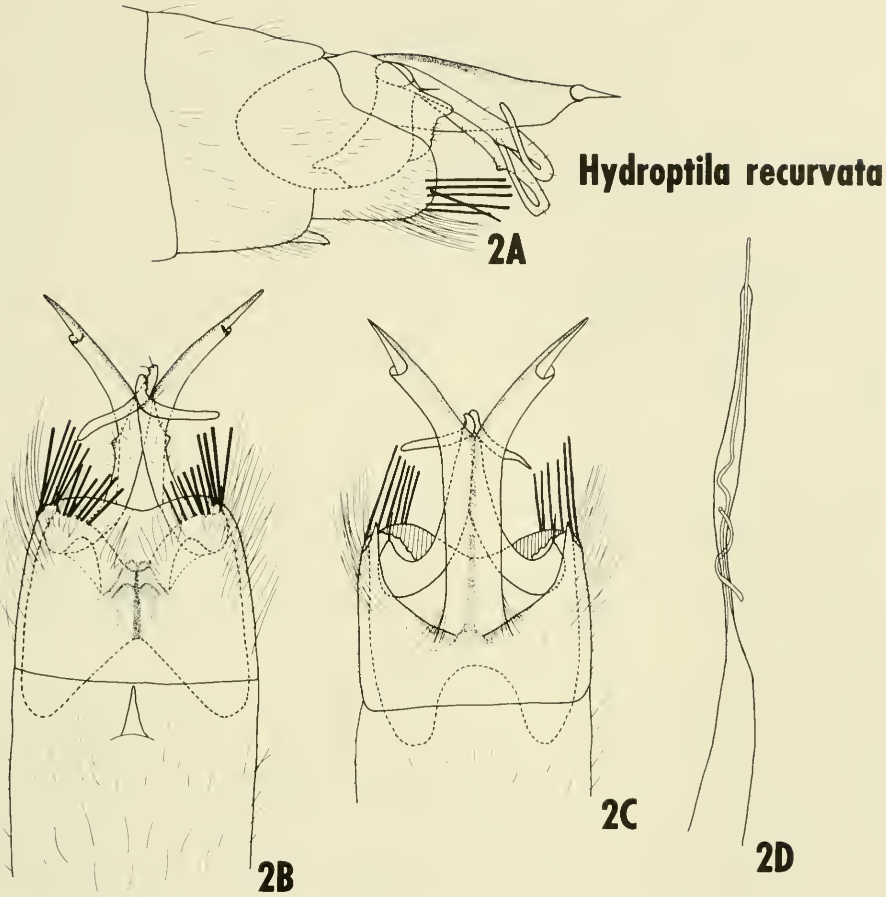

Fig. 2. *Hydroptila recurvata* n.sp., male genitalia. 2A, lateral view. 2B, ventral view. 2C, dorsal view. 2D, aedeagus.

1 ♂, Harris and O'Neil. Paratypes are deposited in the National Museum of Natural History and the Illinois Natural History Survey.

Ochrotrichia tuscaloosa Harris and Kelley, New Species
Fig. 3

This species appears to be a member of the *shawnee* group of Blickle (1979) with affinities to both *O. denningi* (Blickle and Morse) and *O. contorta* (Ross). It can be distinguished from other species in the group on the basis of the sclerite configuration of the tenth tergum.

Male.—Antennae 31-segmented. Length 3.0–3.5 mm. Color brown in alcohol. Ninth segment annular, with dorsum incised on meson to accommodate tenth tergum. Tenth tergum divided into several sclerotized processes (designated after Ross, 1944). Sclerite F coiled near apex, forming a spring-like structure; sclerite C slender, angled at base extending to midlength of sclerite D; sclerite D slender,

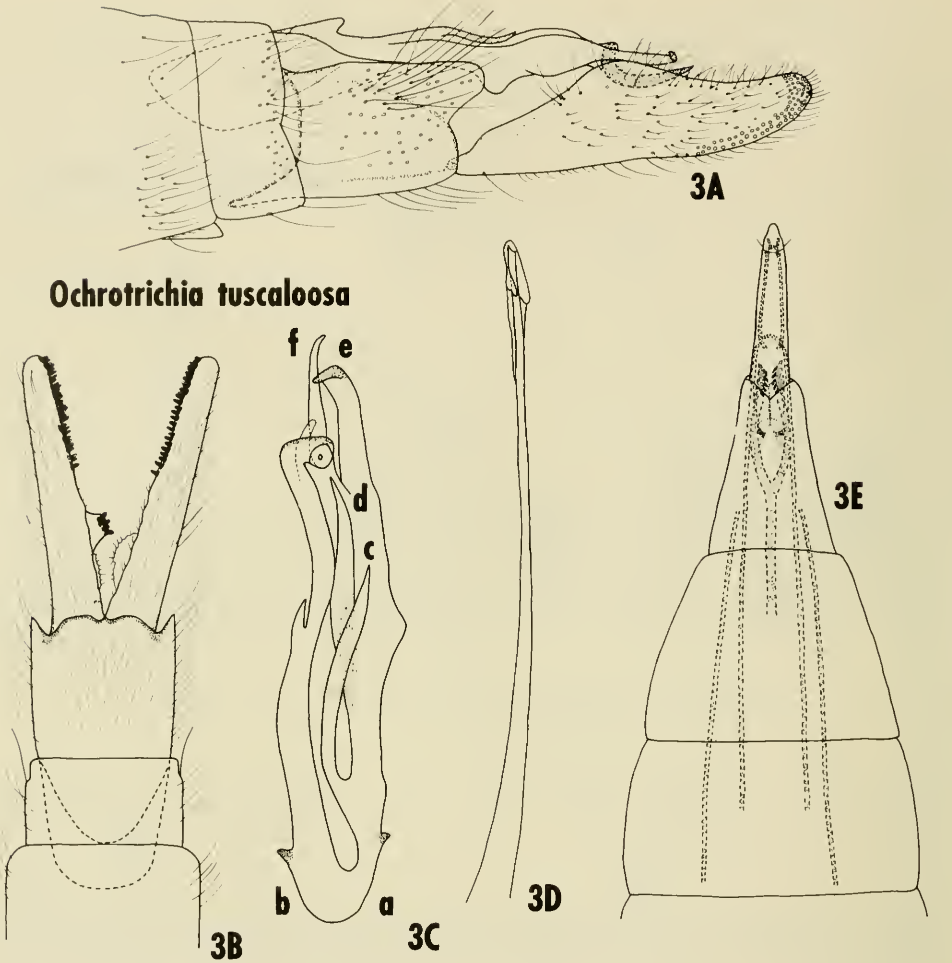

Fig. 3. *Ochrotrichia tuscaloosa* n.sp., male genitalia and female terminalia. 3A, lateral view, ♂. 3B, ventral view of claspers. 3C, tenth tergite, dorsal view, ♂. 3D, aedeagus. 3E, dorsal view, ♀.

reaching to near base of spiral of sclerite F, but separated at least by width of sclerite; sclerite E sharply angled and sclerotized at apex, shouldered near base. Pair of sclerotized denticles at base of tenth tergum. Claspers in lateral view similar in shape to *O. felipe* Ross; parallel-sided in ventral and dorsal views with peg-like denticles on the ventral-mesal surface. Aedeagus simple and tubular, typical for genus.

Female.—Identical to male in general appearance. Antennae 25-segmented. Length 3.1–3.3 mm. Seventh and eighth segments fused. Eighth tergum with deep, posteromedian emargination. Eighth segment with lateral apodemes extending into fifth segment. Ninth segment, membranous and extensile, with two apodemes extending anteriorly into posterior portion of fifth segment, apodemes connected by sclerotized arch at base and apex of the segment. Tenth segment short and conical, with pair of internal rods, lacking cerci. Internal apparatus with spermathecal sclerite protruded anteriorly; a pair of serrate, sclerotized rods posteriorly.

Etymology.—Tuscaloosa is the Choctaw word for "black warrior," the river basin in which the species was collected.

Holotype, male, and allotype.—ALABAMA, Tuscaloosa County, Tyro Creek, 4 miles southeast of Berry, 18 May 1982, Harris and O'Neil. The holotype and allotype are deposited in the National Museum of Natural History.

Paratypes.—ALABAMA, Tuscaloosa County, Tyro Creek, 4.5 miles east of New Lexington, 18 May 1982, 2 ♂, 1 ♀, Harris and O'Neil; Tyro Creek as above, but 14 June 1982, 1 ♂, Harris and O'Neil; Wallace Branch, 5 miles southeast of Berry, 18 May 1982, 2 ♂, Harris and O'Neil. Paratypes are deposited in the National Museum of Natural History, the Illinois Natural History Survey, and Clemson University.

ACKNOWLEDGMENTS

We thank Patrick O'Neil of the Geological Survey of Alabama for assistance in the field collections; Dr. Donald Denning, Moraga, California, for the loan of paratypes of *Hydroptila wyomia*; and Sabra Rager for typing the manuscript. The study was supported in part by a grant (no. AA851-CT1-49) from the U.S. Department of the Interior, Bureau of Land Management.

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A NEW SPECIES OF NEMOURIDAE (PLECOPTERA) FROM THE GREAT DISMAL SWAMP, VIRGINIA, USA

BORIS C. KONDRATIEFF AND RALPH F. KIRCHNER[1]

(BCK) 422 Florida Ave., New Ellenton, South Carolina 29809; (RFK) Department of the Army, Huntington District Corps of Engineers, Water Quality Section, 502 Eighth Street, Huntington, West Virginia 25701.

Abstract.—A new species of Nearctic Nemouridae, *Prostoia* ***hallasi*** n. sp. is described and figured from specimens collected from the Great Dismal Swamp in southeastern Virginia. Characters separating this species from other *Prostoia* are illustrated by drawings and scanning electron micrographs. Other Nemouridae associated with the new species are reported and comments are made on its atypical habitat.

The Great Dismal Swamp is situated in the Coastal Plain Physiographic province in southeastern Virginia and northeastern North Carolina. Very few points of the Swamp rise above 8 m in relief. Lake Drummond, a 1287 ha freshwater lake is located almost centrally in the Swamp. The predominant vegetation is mixed hardwoods.

Matta (1979) recently listed the aquatic insects known from the Dismal Swamp. He recorded seven orders: Ephemeroptera, Odonata, Hemiptera, Neuroptera, Trichoptera, Coleoptera, and Diptera; absent were the Plecoptera. Matta (1973) reviewed the aquatic habitats of the Dismal Swamp. The "ditches" or canals and their feeding streams apparently provide the only suitable habitats for stonefly immatures. The ditches were built by land companies for drainage and transporting lumber from the Dismal Swamp. The Washington Ditch (built in the late 1700's) was named after its presumed surveyor, George Washington. However, many of the ditches (i.e., Jericho, Lynn) have a low pH (3.5–5.5) that limits aquatic life. As Matta (1973) pointed out, ditches which have their primary drainage from the Suffolk Escarpment, such as Washington Ditch are much less acidic (pH 6–7) and have good diversity of aquatic insects.

We made several collecting trips into the Dismal Swamp and collected three species of Nemouridae, including a new species of the Nearctic genus *Prostoia* Ricker. The taxonomy of this genus has been well reviewed by Ricker (1952) and Baumann (1975). *Prostoia* presently includes three common species (Baumann, 1975). The western *P. besametsa* (Ricker) is an early spring stonefly of creeks and smaller rivers of the Coast, Cascade, Rocky and Sierra Nevada Mountains (Baumann et al., 1977, Ricker, 1964). The eastern species, *Prostoia completa* (Walker)

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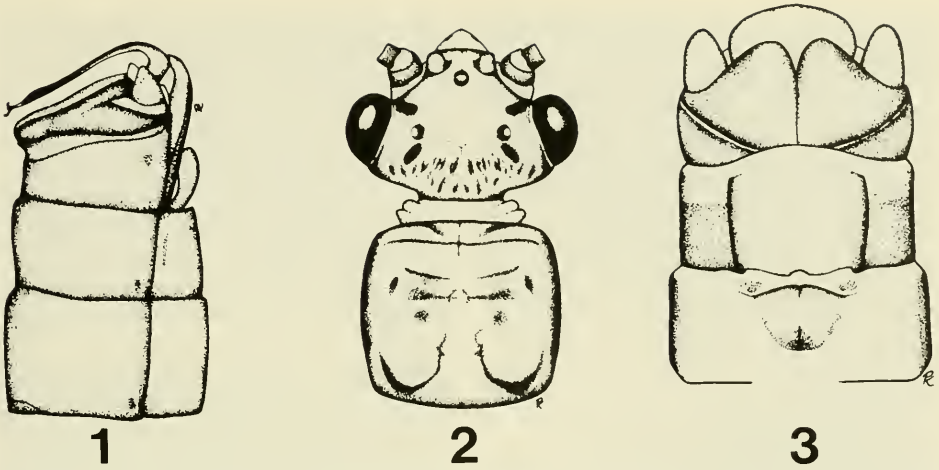
[1] The views of the author do not purport to reflect the position of the Department of the Army or the Department of Defense.



Figs. 1–5. *Prostoia hallasi.* 1, Male terminalia, lateral. 2, Adult head and pronotum. 3, Female terminalia, ventral.

and *P. similis* (Hagen) emerge during late winter or early spring and occur in small streams to large rivers. Morphological terms of the description follow Baumann (1975).

Prostoia hallasi **Kondratieff and Kirchner** NEW SPECIES

Figs. 1–6

Adult.—Length of body 5–7 mm. Macropterous, length of forewings 6–7 mm, venation typical for genus; wings hyaline with fumose stripe downward from cord. Head light brown with rugosities darker brown (Fig. 2); body brown, legs yellowish-brown; abdomen with a reddish-brown tinge.

Male: Hypoproct sclerotized, broad at base, tapering to narrow apex, extending to and covering part of base of epiproct; vesicle present; paraprocts unmodified. Epiproct completely sclerotized, ventral sclerite directed upward and recurved dorsally, narrow, with sides almost parallel with stout marginal and submarginal spines dorsally and ventrally, with middorsal groove (Figs. 1, 4 and 5), apex terminating in club-like process, apex also with pair of dorsally and ventrally directed processes (Figs. 1, 4 and 6); club-like process with an opening ventrally. Dorsal sclerite without well-developed lateral arms (Figs. 1 and 5). Tenth tergum with trough-like depression beneath ventral sclerite.

Female: Seventh and eighth sterna appearing fused at midline. Subgenital plate with a small median lightly sclerotized area and notch (Fig. 3).

Nymph: Typical for the genus as described by Baumann (1975) and no reliable characters were found to consistently separate the nymph from the other two eastern species.

Specimens examined.—Holotype, allotype, 25 paratype males, 28 paratype females, Virginia: City of Suffolk, Washington Ditch, Washington Ditch Road, March 2, 1983, B. C. Kondratieff. Additional paratypes: 4 males, 2 females, same location, nymphs collected 8 February 1983 emerged 12–18 February 1983, R. F. Kirchner and B. C. Kondratieff; 2 females, same location, 17 April 1983, B.

Figs. 4–9. Scanning electron micrographs. 4, *Prostoia hallasi,* epiproct, dorsal aspect. 5, *Prostoia hallasi,* epiproct, basal view. 6, *Prostoia hallasi,* epiproct, apex. 7, *Prostoia completa,* epiproct, dorsal aspect. 8, *Prostoia completa,* epiproct, posterior view. 9, *Prostoia similis,* epiproct, dorsal aspect. All scale lines are 100 micrometers long.

C. Kondratieff and R. F. Kirchner; 1 male, Washington Ditch between Lynn and Jericho Ditches, 17 April 1983, B. C. Kondratieff and R. F. Kirchner.

Holotype (USNM TYPE #101149), allotype and several paratypes deposited in the U.S. National Museum of Natural History. Other paratypes deposited in the collections of R. W. Baumann, Brigham Young University, R. F. Kirchner, C. H. Nelson, University of Tennessee-Chattanooga, B. P. Stark, Mississippi College, and Virginia Polytechnic Institute and State University.

Etymology.—The specific name honors Dr. Laurence E. Hallas, Monsanto Agricultural Products Co., St. Louis, Missouri, a life-long friend and supporter of the senior author.

Diagnosis.—*Prostoia hallasi* is easily distinguished from all other *Prostoia* by the following characters: (1) the shape of the ventral sclerite and ornamented apex of the epiproct, (2) the lack of well-developed lateral arms of the dorsal sclerite, (3) the shape of the hypoproct, and (4) the subgenital plate of the female. *Prostoia similis* has long and slender lateral arms of the dorsal sclerite of the epiproct (Fig. 9) and lacks the ornamented apex of the epiproct. *Prostoia completa* and *P. besametsa* have a simple glabrous ventral sclerite and the lateral arms of their dorsal sclerites are represented by small curved processes (Figs. 7 and 8).

Ecological notes.—*Prostoia hallasi* was collected along the Washington Ditch to just beyond the intersection of Lynn Ditch (see Matta (1973) Fig. 1). Other species of Nemouridae occurring commonly with *P. hallasi* were *Shipsa rotunda* Claassen and *Amphinemura nigritta* (Provancher). Two caddisflies, *Polycentropus crassicornis* Walker (Polycentropodidae) and *Rhyacophila* sp. near *ledra* Ross (Rhyacophilidae) were also abundant. The immatures of these taxa were found among leaf packs, debris and aquatic moss in Washington Ditch. Adults of Nemouridae were commonly collected on bald cypress knees and other tree trunks in the early morning. All these taxa apparently emerge very early in the year (February–April) taking advantage of seasonal cool water and air temperatures and much higher, sustained stream flows. Water quality and flow of Washington Ditch deteriorates rapidly during the summer, factors that probably eliminate additional taxa.

ACKNOWLEDGMENTS

We thank the personnel of the Great Dismal Swamp National Wildlife Refuge, especially the Refuge Biologist, Mary Keith Garrett, and Cherly Briley for their kind assistance; Dr. Oliver S. Flint, Jr., U.S. National Museum for examining the caddisflies; Penny F. Kondratieff for the illustrations; and Lily K. Fainter, College of Veterinary Medicine, VPI & SU for helping with the scanning electron micrographs.

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A SYNOPTIC REVISION OF THE GENUS *ACIURINA* CURRAN, 1932 (DIPTERA, TEPHRITIDAE)

GEORGE C. STEYSKAL

Cooperating Scientist, Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % U.S. National Museum of Natural History, Washington, D.C. 20560.

Abstract.—The genus *Aciurina* is concisely defined, reasons for separating it from *Tephrella* are cited, the host plants of the species are concisely cited, and one new species, *Aciurina* ***idahoensis,*** is described from Idaho. The following are cited as new synonyms of *Aciurina bigeloviae* (Cockerell), 1890: *Trypeta bigeloviae* var. *disrupta* Cockerell, 1890; *Tephrella semilucida* Bates, 1935; *Aciurina trixa* Curran, 1932.

Among North American genera of Tephritidae, *Aciurina* may be recognized by the following combination of characters: Humeral, dorsocentral, and scutellar setae present; apex of cell *bcu* (former anal cell) closed by inwardly bent *Cu2* causing lower apex of *bcu* to be acute; dorsocentral seta anterior to halfway point between supra-alar and acrostichal setae; scutellum neither inflated nor polished; posterior upper frontorbital seta reclinate or absent; width of front greater than that of one eye; only one pair of scutellar setae present; cell *r5* of wing with bulla; abdomen polished; tip of wing in cell *r5* not hyaline with V-shaped dark mark, but wholly dark or with narrow apical dark seam in full width of cell; occipital setae stubby, whitish.

Hering (1947) has distinguished a tribe Tephrellini apart from Aciurini under a subfamily Aciurinae by the possession of stubby pale occipital setae, but Hardy (1974, p. 228–229) states, "I do not see justification for treating Aciurinae as a subfamily and am treating Tephrellini as a tribe under the subfamily Tephritinae on the basis of the head bristles and by having the 6th abdominal tergum of ♀ slightly longer than 5th." This latter character was introduced by Hering (1947) as a primary character separating the subfamily Tephritinae from the Trypetinae, which have sharply pointed black occipital setae. This has been accepted by most workers on Tephritidae. The genus *Aciurina* consequently, as Hardy states, is tephritine, while *Aciura* is trypetine. A satisfactory division of these two subfamilies into tribes has not yet been proposed and a sharp distinction of the greater part of the family into these two subfamilies alone on a worldwide basis may not be feasible.

The species of *Aciurina* have been reported outside of the continental United States only from Mexico (see *A. mexicana*).

All *Aciurina* species whose biology is known are gall-formers on plants of the family Asteraceae (Compositae). These host plants have been listed by Wasbauer

(1972), the relationships of gall-form on *Chrysothamnus nauseosus* (Pall.) Britt. to the taxonomy of the plants has been discussed by McArthur et al. (1979), and Wangberg (1981) discussed the species of *Aciurina* relative to the galls they form on *Chrysothamnus* species. However, the relationship of species of *Aciurina* and their specific or subspecific taxonomy to that of the host plants is not yet clear. It is hoped that this paper will provide a firmer basis for such study than has been so far available.

ACIURINA SPECIES AND THEIR HOST PLANTS

The recorded host plants of *Aciurina* species, as far as is known at present, are tabulated below. Some additional detail is to be found in Wasbauer (1972) and in this paper under the various species. The plant names have been checked by Harold E. Robinson, Department of Botany, U.S. National Museum of Natural History. The taxonomy of plants below the rank of species in several of the listed genera is apparently somewhat unsettled, and is not considered in this list.

It may be noted that the hosts of *Aciurina* species include genera of four tribes of Asteraceae: *Artemisia* of Anthemideae; *Baccharis, Chrysothamnus, Gutierrezia, Haplopappus,* and *Solidago* of Astereae; *Bebbia* of Heliantheae; and *Senecio* of Senecioneae.

Aciurina aplopappi (Coq.)—*Gutierrezia sarothrae* (Pursh) Britt. & Rusby; *Haplopappus pinifolius* Gray.
A. bigeloviae (Cockerell)—*Artemisia tridentata* Nutt.; *Bebbia juncea* (Benth.) Greene; *Chrysothamnus nauseosus* (Pall.) Britt.; *C. parryi* (Gray) Greene; *C. viscidiflorus* (Hook.) Nutt. Syn. *A. semilucida*—*Artemisia* sp.; *Chrysothamnus nauseosus* (Pall.) Britt. Syn. *A. trixa*—*Artemisia tridentata* Nutt.; *Chrysothamnus nauseosus* (Pall.) Britt. *C. parryi* (Gray) Greene; *C. viscidiflorus* (Hook.) Nutt.
A. ferruginea (Doane)—*Chrysothamnus nauseosus* (Pall.) Britt.; *C. viscidiflorus* (Hook.) Nutt.; *Haplopappus bloomeri* Gray; *Solidago* sp.
A. idahoensis, n. sp.—*Chrysothamnus viscidiflorus* (Hook.) Nutt.
A. lutea (Coq.)—*Chrysothamnus viscidiflorus* (Hook.) Nutt.
A. maculata (Cole)—? *Amelanchier* sp.; *Chrysothamnus nauseosus* (Pall.) Britt.; *Senecio douglasii* DC.
A. mexicana (Aczél)—*Baccharis sarothroides* Gray.
A. notata (Coq.)—*Chrysothamnus nauseosus* (Pall.) Britt.
A. opaca Curran—*Chrysothamnus nauseosus* (Pall.) Britt.
A. thoracica Curran—*Baccharis emoryi* Gray; *B. pilularis* DC; *B. sarothroides* Gray.
A. trilitura Blanc & Foote—*Chrysothamnus nauseosus* (Pall.) Britt.

HOST PLANTS OF *ACIURINA* SPECIES

All are Asteraceae (Compositae), except the questionable record of *Amelanchier* (Rosaceae).

? *Amelanchier* sp.—*Aciurina maculata* (Cole).
Artemisia tridentata Nutt.—*A. bigeloviae* (Cockerell).
Baccharis emoryi Gray—*A. thoracica* Curran.
B. pilularis DC.—*A. thoracica* Curran.

B. sarothroides Gray—*A. mexicana* (Aczél); *A. thoracica* Curran.
Bebbia juncea (Benth.) Greene—*A. bigeloviae* (Cockerell).
Chrysothamnus nauseosus (Pall.) Britt., and subtaxa—*A. bigeloviae* (Cockerell); *A. maculata* (Cole); *A. notata* (Coq.); *A. opaca* (Coq.); *A. trilitura* Blanc & Foote.
C. parryi (Gray) Greene—*A. bigeloviae* (Cockerell).
C. viscidiflorus (Hook.) Nutt., and subtaxa—*A. bigeloviae* (Cockerell); *A. ferruginea* (Doane); *A. idahoensis*, n. sp.; *A. lutea* (Coq.).
Gutierrezia sarothrae (Pursh) Britt. & Rusby—*A. aplopappi* (Coq.).
Haplopappus bloomeri Gray—*A. ferruginea* (Doane).
H. pinifolius Gray—*A. aplopappi* (Coq.).
Senecio douglasii DC.—*A. maculata* (Cole).
Solidago sp.—*A. ferruginea* (Doane).

Terminology of Wing Venation

Inasmuch as the terminology of the wing venation used here differs somewhat from that used in most current work on the family, some explanation is called for. The venation of the higher Diptera, roughly about half of the species of the Order, is a consistent reduction of the pattern found in the lower Diptera, and is quite uniform from family to family and in the Dolichopodidae, a large brachyceran (lower) family, as well. A more detailed explanation is planned, but it should suffice to state here that I am in agreement with McAlpine (1981) in recognizing that the name of the old "anal" cell is inconsistent with that of the other cells. I cannot, however, call it cell *cup* (posterior cubital) because I am convinced that vein *Cup* is not actually a vein, but, like the spurious vein of the Syrphidae, it is no more than a furrow and therefore a part of the system of convex and concave furrows of the wing. The furrow is never fully developed in the Diptera, and in the higher Diptera is is greatly reduced or even wholly lacking. Vein *CuP* is therefore considered to be the claval furrow, some trace of which is found in most insect wings, and should not be considered the posterior cubital vein. Abbreviations are used for compound veins, such as R_5 for $R_{4\text{-}5}$. "Basal cubital cell" (*bcu*) is adopted for the old anal cell in line with McAlpine's use of basal radial and basal medial for the cells costad of those veins.

Key to Species of *Aciurina*

1 (2). Wing as in Fig. 2, with complete dark crossband through *Ta*, bifurcate between R_3 and *C*, one branch running to pterostigma, the other to *C*. apicad of R_1; complete crossband also through *Tp*; cell *2c* with broad median dark area .... *A. idahoensis*, new species

2 (1). With such crossbands, if almost so (as in some specimens of *A. bigeloviae* with reduced pattern), then dark mark in cell *2c* narrow or lacking.

3 (4). Wing as in Fig. 3, cell r_1 with 3 hyaline spots along *C*, the apical one just before end of R_3; cell r_5 uniformly dark brown, except for small roundish hyaline spot adjacent to vein *M* close to apical one of 3 separate hyaline spots in cell *am*; bulla large, last section of R_5 strongly bowed costad; abdomen wholly shining black .... *A. trilitura* Blanc and Foote

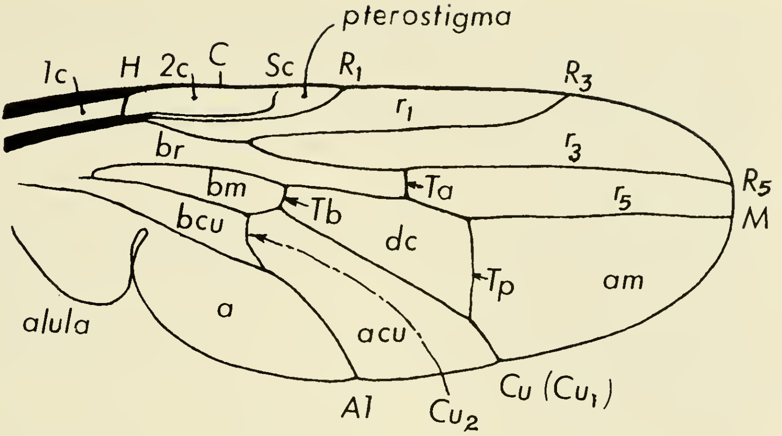


Fig. 1. Terminology of wing veins and cells in Tephritidae. Abbreviations of veins in capital and lower case letters, those of cells with all lower case letters, and all in italics. Names and equivalents in other systems: A_1—1st anal vein, anal vein, 1A + CuA_2; *a*—anal cell (undifferentiated cell a_1 and a_2), 4th posterior cell; *acu*—apical cubital cell, 3rd posterior cell, CuA_1; *am*—apical medial cell, 2nd posterior cell, m, 2nd m_2; *bcu*—basal cubital cell, anal cell, cup, medial cell; *bm*—basal medial cell, 2nd basal cell, radial cell; *br*—basal radial cell, 1st basal cell; *C*—costal vein, costa; *1c*—1st costal cell, basal costal cell; *2c*—2nd costal cell, costal cell; *Cu*—cubital vein (Cu_1), cubitus, CuA_1 5th vein, $M_3 + Cu_1$; Cu_2—branch of cubitus, CuA_2, basal crossvein; *dc*—discal cell, cell dam, 1st m_2; *H*—humeral crossvein; *M*—medial vein, medius, 4th vein, M_{1+2}; R_1—1st radial vein, 1st vein; r_1—1st radial cell marginal cell; R_3—vein R_{2+3}, 2nd vein; r_3—cell r_3 (r_{2+3}), submarginal cell; R_5—vein R_{4+5}, 3rd vein; r_5—cell r_5 (r_{4+5}), 1st posterior cell; *Sc*—subcostal vein, subcosta; *Ta*—anterior crossvein, r-m; *Tp*—posterior crossvein, dm-cu, im, M; *Tb*—basal crossvein, M_3, bm-cu.

4 (3). Cell r_1 with only 2 hyaline spots along *C* or with markings in cells r_5 and *am* otherwise.

5 (14). Wing (Figs. 4 to 8) with cell *1c* dark brown, similar to dark areas of other parts of wing.

6 (7). Wing as in Fig. 4, with cell r_5 crossed gby obliquely transverse preapical hyaline band; cell *am* with small subapical and large subbasal hyaline indentations, latter sometimes V-shaped by presence of marginal brown spot .... *A. maculata* (Cole)

7 (6). Wing with cell r_5 wholly brown or with 1 or 2 small round hyaline spots; otherwise differing.

8 (9). Alula hyaline or yellowish; cells *am* and *acu* (Fig. 5) each with very large subbasal hyaline blotch and small subapical hyaline spot, latter sometimes lacking in cell *acu* .... *A. lutea* (Coquillett)

9 (8). Alula brown, sometimes with central hyaline spot . . Aplopappi Group

10 (11). Wing as in Fig. 6, cells r_3 and r_5 apicad of *Tp* with at most 1 paler brown spot in dark brown area, cell *acu* with basal hyaline spot as well as at least 3 roundish hyaline spots apicad thereof, cell *am* with 2 hyaline indentations, cell *al* with 3 to 5 round hyaline spots. . . . . *A. aplopappi* (Coquillett)

11 (10). Wing as in Fig. 7 and 8, cells r_3 and r_5 apicad of *Tp* with several small, round paler brown spots, cell *acu* with 1 or 2, rarely 3, hyaline

areas, cell *am* with 1 or 2 hyaline indentations or spots; cell *am* with 1 to 3 minute marginal hyaline spots and sometimes 1 similar central spot.

12 (13). Wings as in Fig. 7, call *am* with broad, roughly parallel-sided median stripe and subbasal hyaline indentation extending halfway from wing margin to *M*. .... *A. thoracica* Curran

13 (12). Wing as in Fig. 8, cell *am* with median hyaline stripe cuneate or broken, broadest anteriorly and strongly tapering toward wing margin, subbasal indentation or spot usually lacking, at most short-oval .... *A. mexicana* (Aczél)

14 (5). Wing (Figs. 9 to 16) with cell *1c* with at least central hyaline area, sometimes wholly hyaline and sometimes yellowish and decidedly paler than dark areas of other parts of wing.

15 (16). Wing as in Fig. 9, cell r_5 wholly brown or with small roundish hyaline spot near wingtip adjacent to *M*; cell *2c* broadly hyaline distally, with transverse median brown bar; *dc* with preapical hyaline spot not extending to veins at sides of cell .... *A. ferruginea* (Doane)

16 (15). Wing with cell r_5 with preapical hyaline mark occupying at least half of width of cell, sometimes with additional subbasal mark, and sometimes largely hyaline.

17 (18). Wing as in Fig. 10, cell *2c* brown in distalhalf, a little pale apically in very pale specimens; uniform parallel-sided hyaline band extending from *C* at midlength of cell r_1 to lower third of *dc* .... *A. opaca* (Coquillett)

18 (17). Wing as in Figs. 11 to 15, cell *2c* hyaline at tip, with median transverse brown bar or even wholly hyaline, if complete transverse brown band is present through *Tp*, there is also marking apicad thereof in addition to costal marking.

19 (20). Wing as in Figs. 11 and 12, pterostigma along *C* no more than 1.5 times as long as greatest width, *Tp* nearly straight, lower apical angle of *dc* about 60°, wing predominantly hyaline ... *A. notata* (Coquillett)

20 (19). Wing as in Figs. 13 to 16, highly variable in extent of dark markings; pterostigma at least twice as long as greatest width; *Tp* usually bowed apicad, lower apical angle of *dc* seldom less than 80° .... *A. bigeloviae* (Cockerell)

The male postabdomen conforms closely to the general type shown in Fig. 18A–C, all of which have been considered as referable to *A. bigeloviae*. Specimens taken at the same time and place and with identical wing pattern, etc., were found to have as much variation in the length and outline of the epandrial process, profile of epandrium, size of cerci, size and shape of prensistae, etc., as shown in the three figured specimens. A careful, extensive study of single populations may lead to recognition of useful differences, and therefore to finer taxonomic distinctions, but none were found in this study.

It was at first thought that the ovipositor and associated structures of the female would also contribute little to species recognition and distinction. The size and outline of the ovipositor of most species is quite similar, and the tip is simply aciculate (Figs. 23A, B, D–J). The ovipositor of *A. opaca* (Fig. 23C) differs greatly from other species of *Aciurina* and is unique in known North America Tephritidae in completely lacking an extended, more or less pointed tip. Besides revealing the distinctness of *A. opaca,* it was later found with more careful examination of additional slide-mounted preparations that the female ovipositor complex yielded excellent characters, even better than in some other genera, although in different parts.

The most characteristic part of the *Aciurina* ovipositor in most species is to be seen in the soft flaps on the lower side of the ovipositor at each side of the mesal line where the egg emerges. In most Tephritidae the tissue at this point is simple, but in several species of *Aciurina* there is more or less wrinkling and development of ridges, teeth, or both. There is also considerable difference in the development of the rasper and the shape and size of its teeth. These characters are figured for most species and some description is given under each species heading, although the characters are not used in the key.

The terminology of the ovipositor complex is as in Fig. 17. The term taenia (dorsobasal and ventrobasal; pl. taeniae) has not been used previously in this sense. The dorsobasal and ventrobasal taeniae are two pairs of flexible strips of more or less darkened tissue at the base of the ovipositubus, reinforcing and supporting the tubus during retraction within the sheath and during extension when the rasper teeth are gnawing at the host epidermis.

Genus *Aciurina* Curran

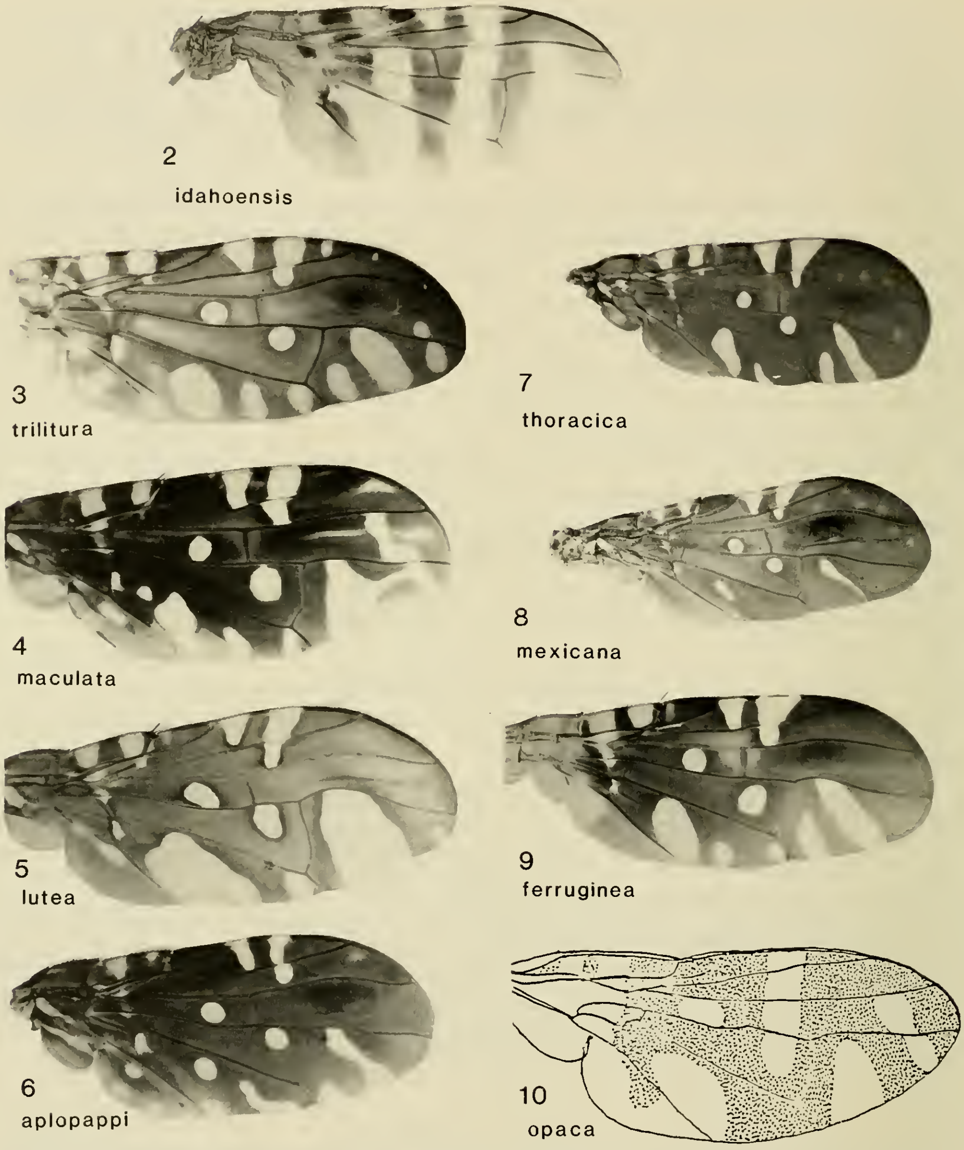
Aciurina Curran, 1932: 9. Type-species, *Aciurina bigeloviae* (Cockerell), as *A. trixa* Curran, by original designation.

Some species of *Aciurina* have been referred (Bates, 1935) to the genus *Tephrella* Bezzi, 1913. This is an Asiatic genus, which does indeed strongly resemble *Aciurina,* but its generitype, *T. decipiens* Bezzi, 1913, and *T. heringi* Hardy, 1970 have a wing pattern differing from that of *Aciurina* in that the basal one of the 2 costal hyaline wedges immediately apicad of the pterostigma extends to vein R_5 and cell *br* (basal radial) is wholly dark. *Aciurina* species have the hyaline wedge extending to R_5 only occasionally in specimens with very reduced wing pattern and there is always at least a small round subapical hyaline spot in the basal radial cell or in specimens with reduced pattern the cell may be mostly hyaline.

APLOPAPPI GROUP

Three species are so similar in general appearance and wing venation that at least two of them (*aplopappi* and *mexicana*) may eventually prove to be phenotypical variations of one species. The three species are *A. aplopappi* (Coquillett, 1894), *A. thoracica* Curran, 1932, and *A. mexicana* (Aczél, 1953). Inasmuch as *aplopappi* is the senior name under which the other species must be synonymized in case that course may be taken, it is proper that the group be called the *Aplopappi* group. *A. aplopappi* is so far known to feed on *Haplopappus pinifolius* (whence its name) and *Gutierrezia sarothrae* in the larval stages; the other two species feed on species of *Baccharis.*

The group is also distinguished by lack of surface specialization on the ventral side of the ovipositor, which is 0.9 to 1.0 mm long; taeniae of ovipositubus very

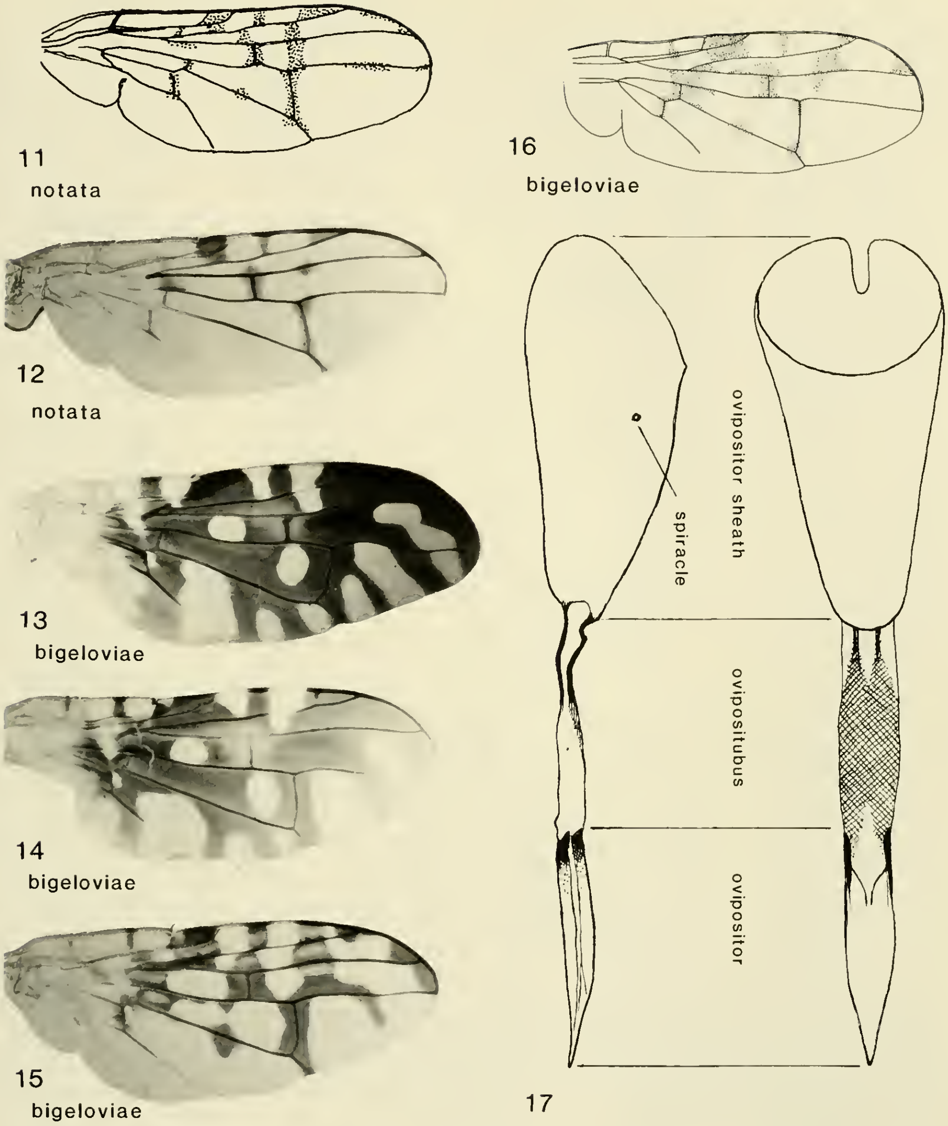


Figs. 2–10. *Aciurina* species, wings. 2, *A. idahoensis* Steyskal, n. sp., a variation found in ♂ specimens, 3, *A. trilitura* Blanc and Foote. 4, *A. maculata* (Cole). 5, *A. lutea* (Coquillett). 6, *A. aplopappi* (Coquillett). 7, *A. thoracica* Curran. 8, *A. mexicana* (Aczél). 9, *A. ferruginea* (Doane). 10, *A. opaca* (Coquillett), holotype.

short; less than ¼ of length of ovipositubus; rasper teeth more or less acute; and similar outline of ovipositor in all three species.

***Aciurina aplopappi* (Coquillett)**
Figs. 6, 23F

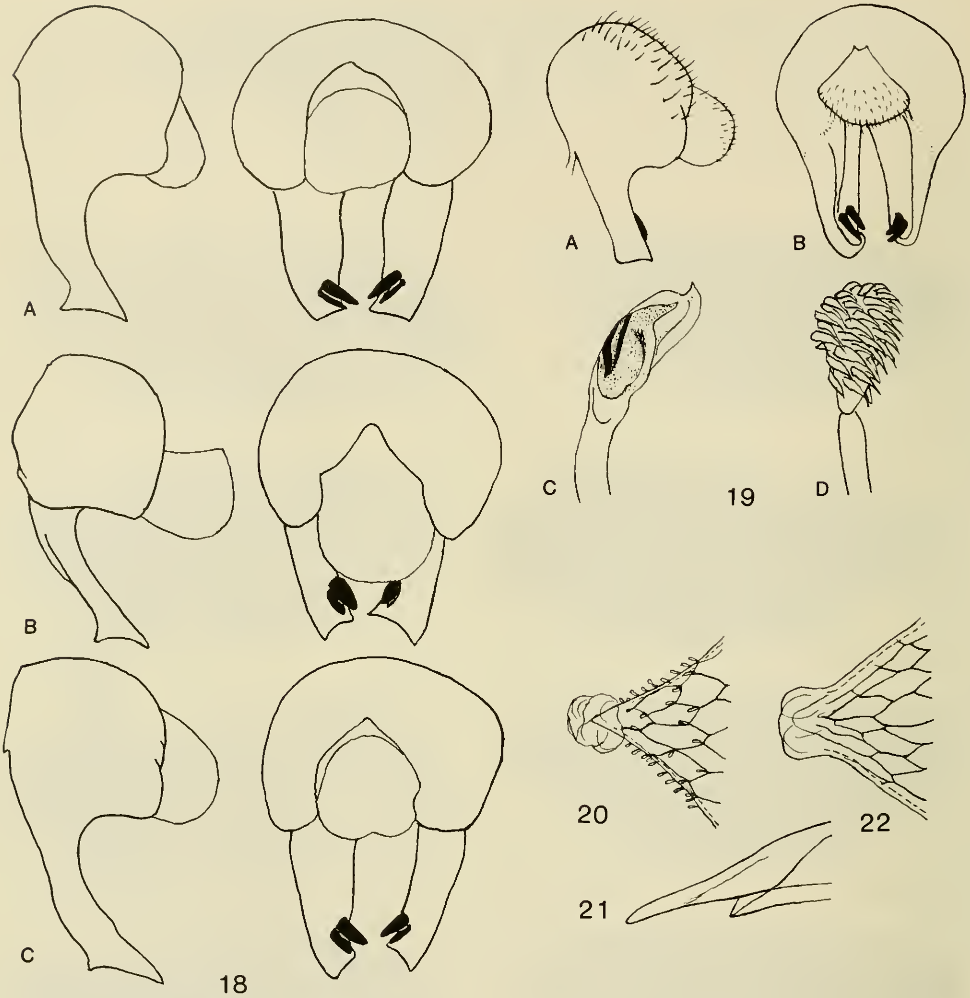
Trypeta (*Aciura*) *aplopappi* Coquillett, 1894: 72.
Aciurina aplopappi (Coquillett) Foote and Blanc, 1963: 7.



Figs. 11–17. *Aciurina* species, wings and (17) female postabdomen. 11–12, *A. notata* (Coquillett). 14–16, *A. bigeloviae* (Cockerell), illustrating variation (Fig. 16 copied from Bates, 1935, *semilucida*). 17, *A. ferruginea* (Doane), extended postabdomen, diagrammatic.

Ovipositor as in Fig. 23F, rasper teeth acute, largest at midlength of ovipositubus.

This species differs externally from the 2 other members of the group, as shown in the key, only in details of the wing pattern. The food plants, *Haplopappus pinifolius* and *Gutierrezia sarothrae,* as known so far, are different from the other species of the group, which feed on *Baccharis* species. Specimens have been examined only from California (Los Angeles County: "Los Angeles County" and



Figs. 18–22. *Aciurina* species, various details. 18, *A. bigeloviae* (Cockerell) ♂, postabdomen, diagrammatic: A–C, profile and posterior views of outer parts to illustrate variation. 19, *A. idahoensis* Steyskal, n. sp.: A, profile and B, posterior view of ♂ postabdomen; C, glans of aedeagus; D, spermatheca. 20, *A. notata* (Coquillet), micropilar end of egg. 21, same, profile of tip of ovipositor. 22, *A. bigeloviae* (Cockerell), micropilar end of egg.

Claremont; Riverside County: Blythe and Riverside; Santa Clara County). A male from "Los Angeles Co." in USNM is herewith designated lectotype. The few dates associated with these specimens indicate that adults appear in March and April.

Aciurina mexicana **(Aczél)**

Figs. 8, 23G

Tephrella mexicana Aczél, 1953: 194.
Aciurina mexicana (Aczél) Foote and Blanc, 1979: 161.

The ovipositor and associated structures are virtually the same as those of *A. aplopappi.*

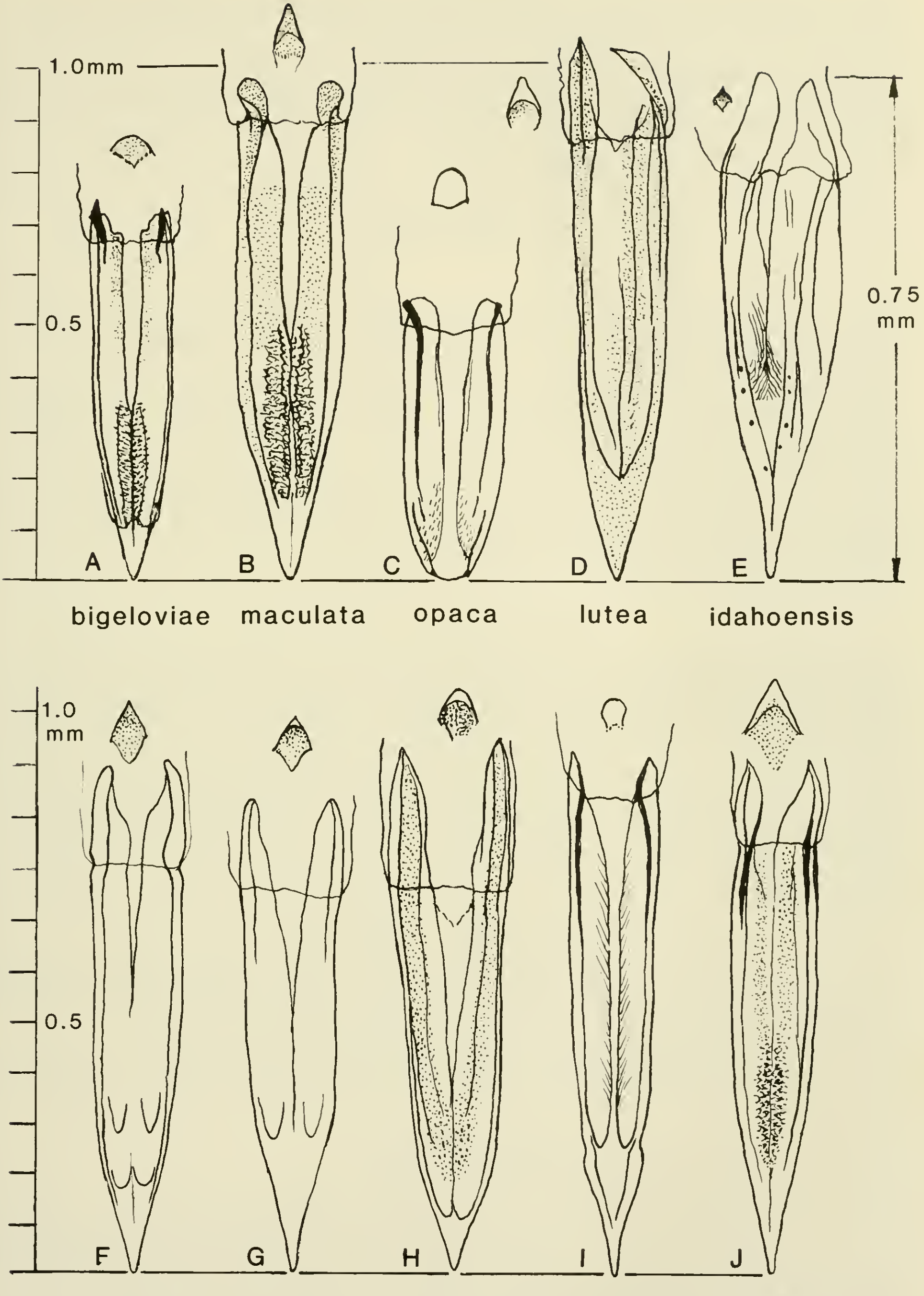


Fig. 23. *Aciurina* species, ventral views of ovipositors with more enlarged view of typical larger rasper tooth (all at same magnification for size comparison. A, *A. bigeloviae* (Cockerell). B, *A. maculata* (Cole). C, *A. opaca* (Coquillett). D, *A. bigeloviae* (Coquillett). E, *A. idahoensis* Steyskal, n. sp. (somewhat lateral). F, *A. aplopappi* (Coquillett). G, *A. mexicana* (Azcél). H, *A. thoracica* Curran. I, *A. trilitura* Blanc and Foote. J, *A. ferruginea* (Doane).

This species was described from Nogales, Veracruz, Mexico. Foote and Blanc recorded it from Phoenix and Catalina Mountains, Arizona. I have seen the type specimens and those reported from the Catalina Mountains, as well as others from Nogales, Arizona; Santa Maria, Santa Barbara County, California; and Cantillas Canyon, Sierra Juarez, Baja California (Norte). Adults have been found from the latter half of April to the first half of June.

Aciurina thoracica **Curran**

Figs. 7, 23H

Aciurina thoracica Curran, 1932: 11.

The ovipositor (Fig. 23H) with preapical sides more rounded; rasper teeth semiacute, largest ones at about basal ⅓ of ovipositubus.

This species was described from San Diego County, California. I have seen it from several localities in California (Cajon, Martinez, Otay, Stanford University, and Truckee), as well as from Bernalillo County, New Mexico, and Rockwell, Utah. Foote (1965: 670) recorded the species from Arizona; he informs me that the record is based upon a specimen from Scottsdale determined by him. That specimen was taken on February 22, which is the earliest date of occurrence; other dates extend from 9 April to 3 August.

Remainder of Genus

The remaining species of *Aciurina,* exclusive of the Aplopappi Group, may eventually be divided into further species groups, but they do not seem as distinct as the Aplopappi Group, and all are known to feed upon plants of the genus *Chrysothamnus,* as well as a few other genera, but not upon *Baccharis* species. Nor is any other species than *A. aplopappi* known to feed upon *Gutierrezia* and only *A. ferruginea* besides *A. aplopappi* is known to feed upon a species of *Haplopappus.* The remainder of the genus may therefore be considered as a single, typical group.

Aciurina bigeloviae **(Cockerell)**

Figs. 13 to 16, 22, 23

Trypeta bigeloviae Cockerell, 1890a: 75 (March, gall only); 1890b: 324 (December, adult) (cf. Sabrosky, C. W., 1971, Bull. Entomol. Soc. Am. 17: 85).
Trypeta b. var *disrupta* Cockerell, 1890b: 324. N. SYN.
Eurosta (Trypeta) *bigeloviae* Townsend, 1893: 49–52. Synonymy stated in footnote, p. 52.
Aciurina trixa Curran, 1932: 11. N. SYN.
Tephrella semilucida Bates, 1935: 111. N. SYN.
Aciurina bigeloviae (Cockerell) Foote and Blanc, 1963: 8.

The ovipositor (Fig. 23A) is rather short, 0.70 to 0.86 mm long; flaps finely erose along mesal edges, at each side of which are numerous short rows of minute denticles, the most apical of which are closer to extreme tip of ovipositor than in other species; rasper teeth small, semicircular; ventrobasal taeniae well separated at base, converging apicad and usually more or less fusing, extending almost half of length of ovipositubus.

An egg found in the abdomen of a specimen whose ovipositor was being prepared is cancellate at and near micropilar end (Fig. 22).

The only statements, although validly establishing the species-name, in the original description are: ". . . the white, woolly, conspicuous *galls* of *Trypeta bigeloviae,* n. sp., produced in abundance at West Cliff, Colorado, on *Bigelovia,* and yet apparently not injuring the plant seriously at all." West Cliff, Colorado, is in Custer County and the paper by Cockerell is dated January 12, 1980. It is not known whether Cockerell preserved any of these galls. If he did, one of them must be designated as lectotype, with or without the maker of the gall inside it. If he did not preserve galls on which the description was based, a neotype would have to be selected from material collected from the proper plant at the type locality, now known as Westcliffe.

Two of the named forms listed above as synonyms are founded upon minor variations in the wing pattern. The variety *disrupta* is characterized by having "the V-shaped hyaline mark divided into two by the obliteration of its apex." The mark (in cell *am*) has been found to be highly variable. As Cockerell stated, it is sometimes divided by the extension of the mark making it V-shaped, but that mark may also be entirely reduced, leaving a triangular hyaline space instead of a V-mark. This latter condition is present in the form Curran called *Aciurina trixa* in a paper in which no mention was made of *A. bigeloviae.* Many populations have been seen in which the wing pattern is further reduced to various degrees; I believe that *Tephrella semilucida* Bates is no more than *A. bigeloviae* with strongly reduced wing pattern.

A. bigeloviae is the most widely distributed and most variable of all the *Chrysothamnus*-feeding species, that is, the typical group of *Aciurina.* As noted above, the type (as well as the var. *disrupta*) is from Custer County Colorado. The type locality of *Tephrella semilucida* is Riparia, Whitman County, Washington, and that of *Aciurina trixa* is Stansbury Island, Great Salt Lake, Utah; this latter is no longer an island but a part of Tooele County near the edge of the lake. I have seen specimens from the eastern half of Washington, eastern ⅔ of Oregon, southern half of California, all parts of Idaho except the northernmost 5 counties, Nevada (Humboldt, Lander, and Washoe Counties), all parts of Utah, western ⅔ of Colorado, Arizona (Apache, Cocino, and Yavapai Counties), New Mexico (Bernalillo, Otero, Rio Arriba, and Taos Counties), Wyoming (Albany County), and North Dakota (Billings County). It will probably be found wherever its chief host, *Chrysothamnus nauseosus,* occurs.

Adults have been taken from the last week of March until the middle of September, but the great majority of them appear in May and June.

***Aciurina ferruginea* (Doane)**

Figs. 9, 17, 23J

Aciura ferruginea Doane, 1899: 182.
Aciurina ferruginea (Doane) Curran, 1932: 10.

The ovipositor is as in Figs. 17, 12J, the flaps with zones of mesally directed teeth, very acutely tipped, broadly based, and with concave sides, roughly triangular, area of occurrence rather short and well behind extreme tip of ovipositor; ovipositubus with dorsobasal taeniae only about ¼ of total length of tubus and near base separated by about 2.5 times their width; rasper teeth acutely triangular, largest ones a little basad of middle of tubus and larger than in other species, teeth lacking for considerable distance at each end of tubus.

The type is from "Washington." I have seen specimens from Washington (Adams, Benton, Grant, and Yakima Counties), Oregon (Crook, Deschutes, and Malheur Counties), California (Inyo and Mono Counties), Nevada (Ormsby County, now Carson City), Idaho (Cassia, Franklin, Idaho, Oneida, and Twin Falls Counties), Utah (Grand, Salt Lake, Summit, Uintah, and Weber Counties), Wyoming (Sweetwater County), Colorado (Summit County) and New Mexico (McKinley County).

Available dates of capture of adults run from 7 July to 21 September, indicating a season somewhat later than that of some other species.

Aciurina idahoensis Steyskal, New Species

Figs. 2, 19, 21, 23E

The very characteristic pattern of the wing, as described below and in the key and shown in Fig. 2, readily distinguishes this species from any other. The strongly scaphoid ovipositor is reminiscent only of that of *A. notata*, a species with quite different and very reduced wing pattern.

Male.—Length of wing 2.8–3.5 mm, average 3.07 mm.

Color of body largely yellowish, following parts blackish to piceous: central part of occiput (usually hidden); dorsum of thorax (exclusive of humeri, notopleura, and more or less of margin of scutellum); postscutellum and metanotum; variable amount of parts of posterior pleura (broad dorsal border of sternopleuron usually yellowish); most of abdominal tergites, including epandrium (paler specimens may have more or less of tergites yellowish starting at posterior margin and in palest specimens leaving only pairs of mesally pointed wedges of dark color). Head and legs wholly yellowish. Wing with venation and dark brown pattern as in Fig. 2, but with apicocostal band usually separated from transverse band through *tp*. All setae and hairs yellowish to whitish.

Integument subshining, lightly tomentose, to shining in a few places.

Antenna with 3rd segment 1.6 to 1.8 times as long as basal width. Upper front half total width of head. Cheek (lower edge of eye to oral margin) 0.153 to 0.18 of height of eye.

Genitalia as in Fig. 19A–C; epandrium black, shining, remainder yellowish; prensisetae black.

Female.—Length of wing 3.1 to 3.7 mm, average 3.45. Similar to mate in coloration, but black usually less extensive; abdominal tergites mostly yellowish, usually with black wedges or lateral spots and o-2 disjunct piceous spots; basal tergite usually mostly black; ovipositor sheath wholly black; mesonotum sometimes with 4 longitudinal black stripes, mesal pair discontinued well before scutellum, which then is wholly yellowish dorsally.

Wing as in Fig. 2, apicocostal band always broadly connected with transverse band through *tp*; one specimen has been seen with latter band connected along vein Cu and posteriorly to wing margin with band through *ta*.

Ovipositor (Fig. 23E) from 0.75 to 0.85 mm long; strongly scaphoid, convex above, flat to concave below; small area above flaps with minutely crenulate oblique ridges well before acute tip; dorsobasal taeniae narrow, about ⅓ length of ovipositubus; rasper teeth small, about 0.025 mm wide, fingernaillike, absent for short distance at each end of ovipositubus.

Holotype ♂, allotype ♀, and 9 ♂ and 11 ♀ paratypes, IDAHO, Murphy, Owyhee County, 8.VI.1967, 241-23A (E. J. Allen), ex pine-cone-like bud galls on *Chrys-*

othamnus viscidiflorus (in USNM). Other paratypes (all from Idaho and in the University of Idaho Collections): 3 ♀ 10 mi S Gilmore, Lemhi County, 24.VII.1959 (H. C. Manis), Chrysothamnus; 1 ♀, 6 mi SE Malta, 16.VI.1973 (J. K. Wangberg); 1 pair, 8.3 mi NW Mackay, Custer County, 21.V.1973 (J. K. Wangberg); 1 ♂, 20 mi NE Howe, Butte County, 29.V.1973 (J. K. Wangberg); 1 ♂, 7 mi E Howe, Butte County, 20.VI.1973 (J. K. Wangberg); 1 ♀, 2 mi W Carey, Blaine County, 22.V.1973 (J. K. Wangberg).

Note: Both Sp. A and Sp. B of Wangberg (1981) are likely *A. idahoensis.*

Aciurina lutea **(Coquillett)**

Figs. 5, 23D

Aciura lutea Coquillett. 1899: 264.
Aciurina lutea (Coquillett) Curran, 1932: 10.

Ovipositor (holotype) Length 10.05 mm; dorsal taeniae about 0.4 of length of tubus, separated by about their width; largest rasper teeth just basad of midlength of tubus, small, acute; flaps without specialization, pointed, ending well basad of tip.

The type is from Pareah, Utah. This locality does not appear on many modern maps, but it is on the Southwest section of the National Geographic Society's series entitled Close-Up: U.S.A. (October, 1977) and on some of the more recent official maps of the State of Utah as "Old Paria." I first found it in the Atlas section, volume X, of the Century Dictionary and Encyclopedia (1898) as Pareah. It is in Kane County 35 mi ENE of Kanab and on the Paria River.

The species is scarce; the only records besides that of the type are from Idaho (Blaine County, Carey; Jefferson County, Terreton; Oneida County, Holbrook, 17.VI.1973; all in University of Idaho), Nevada (Ormsby County, July 6, collected by Baker, with 3 smooth stem galls, in USNM), and New Mexico (Bernalillo County, 4 mi N San Isidro, 29.III.1981, collected by Gary Dodson, from "woolly" galls on *Chrysothamnus* sp. The Idaho specimens were reared from *Chrysothamnus viscidiflorus* and the smooth galls were described and figured by Wangberg (1981). It is unfortunate that the species of *Chrysothamnus* on which the "woolly" galls were formed is unknown.

Aciurina maculata **(Cole)**

Figs. 4, 23B

Aciura maculata Cole, in Cole and Lovett 1919: 252.
Aciurina maculata (Cole) Curran, 1932: 10.
Aciurina pacifica Curran, 1932: 10; synonymy by Bates, 1935: 108.

Ovipositor Length 0.95 to 1.0 mm; taeniae nearly half length of tubus; rasper teeth relatively large, acute, largest teeth about at midlength of tubus; broad basal zone bare, but small teeth extend to ovipositor; flaps on mesal margins with series of scalelike projections, each with 3 sharp apical teeth; similar projections on surface for some distance each side of mesal margin, but with fewer teeth.

The holotype of *A. maculata* is from Jackson County, Oregon and that of *A. pacifica* is from Yakima, Washington. I have determined material as this species from California (Yosemite Park, Mariposa County), Oregon (Jackson and Malheur Counties), Washington (Yakima County), Idaho (Blaine, Butte, Custer, Elmore, and Owyhee Counties), and Nevada (Glenbrook, Douglas County). Dates are from 16 March (Idaho) to 7 July (Oregon).

Aciurina notata **(Coquillett)**

Figs. 11, 12, 20, 21

Trypeta notata Coquillett, 1899: 262.
Aciurina notata (Coquillett) Foote, 1960: 254.

As shown in the foregoing key, the wing pattern and most characters are very like those of *A. bigeloviae* with strongly reduced wing pattern. The pterostigma, however, is much smaller than in *A. bigeloviae.* The ovipositor (Fig. 21) is almost round in section and gently curving to the tip; a preparation showing a ventral view was not feasible with the available material; length 0.7 mm; flaps with a few triangular teeth on surface; tubus shorter than ovipositor; taeniae about half as long as tubus; rasper teeth largest at midlength of tubus, paraboloid, largest about 0.018 mm wide; tubus bare between most of taeniae. An egg, recovered from the abdomen of the specimen from which Fig. 21 was made, shows numerous minute appendages at the corners of the reticulations at the micropilar end (Fig. 20).

The type is from Albuquerque, Bernalillo County, New Mexico, in USNM. The only other records are from Sante Fe, Sante Fe County, New Mexico, in USNM; a rearing from *Chrysothamnus* sp. in Bernalillo County, New Mexico, 3–11 May, by Gary Dodson; and one of caught specimens in that same county on 29 April.

Aciurina opaca **(Coquillett)**

Figs. 4, 23B

Aciura opaca Coquillett, 1899: 263.
Aciurina opaca (Coquillett) Curran, 1932: 10.
Acidia johnsoni Thomas, 1914; synonymy by Foote, 1965: 670.

The very unusual ovipositor, with smoothly and roundly rounded tip, suggests habits considerably different from other species of the genus. Neither R. H. Foote nor I am aware of any other American Tephritidae with such a blunt ovipositor but Hardy (1973) figures a few with quite bluntly tipped ovipositors; however little to indicate details of their habits is associated with those species. Ovipositor length 0.55 mm; tip rounded; flaps widely separated, without obvious surface modification; tubus nearly 1.5 times as long as ovipositor; taeniae widely separated at base, bearing a few large, clawed, dark rasper teeth at their apices; membrane of tubus bare between taeniae, elsewhere covered with small, pale scalelike teeth.

The type of *A. opaca* is from Elko, Nevada and that of *Acidia johnsoni* is from "Colo." Only a few additional records are available: Arizona (White Mountains, collected by Parker, in USNM; Idaho (Fremont and Oneida Counties, 18 March to 27 May, in University of Idaho); and Utah (Paiute and Panguitch Counties), 1–19 June, in University of Utah).

The host of *A. opaca* is cited as *Chrysothamnus nauseosus* by Wangberg (1981).

Aciurina trilitura **Blanc and Foote**

Figs. 3, 23I

Aciurina trilitura Blanc and Foote, 1961: 73; Foote and Blanc, 1963: 10.

Ovipositor length 1.0 mm; taeniae narrow, dorsal ones only about their width apart and only about ¼ length of tubus; rapser teeth very small, semicircular, absent in most of basal intertaenial space, but becoming very small apically and extending to ovipositor; mesal parts of flaps very finely obliquely wrinkled, but with small, shallow mesal emargination.

The type is from San Bernardino County, California. Several additional California records were cited by Foote and Blanc (1963), including Inyo, Kern, Los Angeles, and San Bernardino Counties. Since that time the following extra-Californian records have accumulated: Idaho (Holbrook, Oneida County, 6.VI.1974, in University of Idaho); Utah (Bear Valley, Iron County, 9.VI.1966, and Ogden, Weber County, 10.VI.1965, in University of Utah). Capture of adults in California extends from 26 April to 26 June. The species is distinctive in both wing pattern and ovipositor characters.

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A NEW SPECIES OF *PHERBELLIA* FROM MONTANA (DIPTERA: SCIOMYZIDAE)

R. E. Orth

Department of Entomology, Division of Biological Control, University of California, Riverside, California 92521.

Abstract.—*Pherbellia* **spectabilis,** n. sp. is described from northwestern Montana. Illustrations of the head and terminalia are included.

The species described below, *Pherbellia spectabilis,* is known only from 5 miles W of Browning, Montana. Browning is located in the northwestern part of the state just east of the continental divide. The holotype is the only identified specimen of this species.

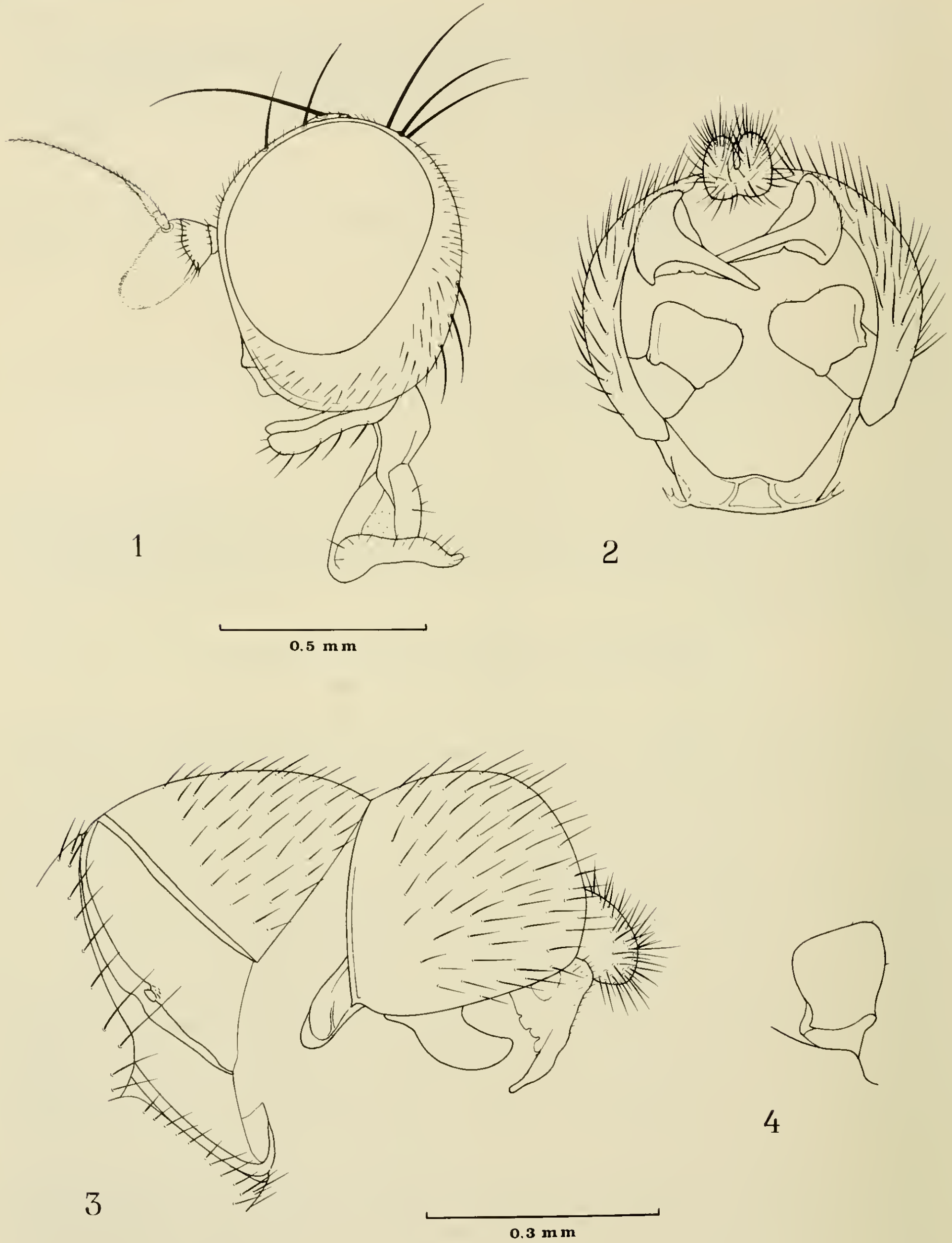
Pherbellia spectabilis **Orth,** New Species
Figs. 1–4

Holotype male.—Height of head ⅝ width. Medifacies, parafacies, and cheeks whitish tomentose with a tinge of yellow. Frons yellowish, lighter anteriorly. Midfrontal stripe poorly defined, extending approximately ½ distance from anterior ocellus to anterior margin of frons. Ocellar triangle and orbital plates brownish tomentose. Orbital plates tapered anteriorly, extending beyond midfrontal stripe. Orbito-antennal spot lacking; narrow strip of whitish tomentum along upper orbital margin. Two pairs of fronto-orbital bristles, anterior pair nearly as long as posterior pair; ocellar, postocellar, and inner and outer vertical bristles well developed. Occiput tannish, tomentose. Short black setae on lower ½ of cheeks and parafacies, on anterior area of frons, between ocellar and postocellar bristles, along outer parts of orbital plates, and in midcervical patch. Lateral occipital margins with stronger setae and bristles. Antennae testaceous, segment 3 elongate oval. Arista blackish with relatively short hairs. Palpi yellowish, labium and labella yellowish brown.

Thorax tannish brown, tomentose, with indistinct blackish longitudinal stripes. Pleura brownish, tomentose. Mesopleuron bare. Pteropleuron on left side with cluster of 5 bristles situated below and anterior to the vallar ridge. In this specimen, only 1 bristle complete; bases of all 5 approximately same size. Pteropleuron on right side covered by point-mount. Sternopleuron with fine bristles or setae over dorsal and central surface, well-developed bristles ventrally. Prosternum bare.

Coxae yellowish white, tomentose. Legs yellowish, except distal ⅓ of forefemur, distal ¼ of foretibia, and foretarsus, which are infuscated.

Wing length 3.6 mm. Membrane greyish yellow, hyaline; costal margin and wing veins yellowish, area around crossveins not clouded. No stump veins; anterior crossvein slightly oblique, first vein not surpassing level of anterior cross-



Figs. 1–4. *Pherbellia spectabilis.* 1, Head. 2, Terminalia, ventral view. 3, Terminalia, sinistral view. 4, Anterior surstylus, viewed in broadest aspect. 2–4, Same scale.

vein; anal vein reaching wing margin. Halter, squama, and squamal ciliae yellowish.

Abdominal segments dorsally infuscated; light brown ventrally. Terminalia as in Figs. 2–4.

Female.—Not known.

Holotype.—USA, Montana, Glacier Co., 5 mi W of Browning, 19 July 1967 (S. Whitney). Deposited in the National Museum of Natural History, Washington, D.C. The type was from the B. A. Foote collection, Kent State University, Kent, Ohio prior to my receipt of it in 1981. At that time I acquired it and a few additional male *Pherbellia* from Foote that he felt were new species. He said *in litt.* "Please feel free to do whatever you wish with these specimens, including using them in new species' descriptions if they are truly new." I here acknowledge thanks to Ben A. Foote for graciously allowing me to describe this species.

Etymology.—The species name *spectabilis* is an adjective of Latin derivation and means worth seeing or notable.

Diagnosis.—Externally this small *Pherbellia* keys most closely to *P. aloea* Orth and members of the *P. propages* group. Common diagnostic characters shared by the above species and *P. spectabilis* are: (1) frons with median stripe less than ⅔ as long as distance from ocellus to frontal margin; (2) mesopleuron entirely bare; (3) wings not patterned; (4) halteres yellowish or whitish; (5) first vein not surpassing level of anterior crossvein. Apart from some color differences *P. spectabilis* differs from *P. aloea* in the following features: (1) arista with relatively short hairs in *P. spectabilis* (arista bare in *P. aloea*); (2) first vein at the level of or just short of anterior crossvein in *P. spectabilis* (first vein distinctly surpassing level of anterior crossvein in *P. aloea*); (3) *Pherbellia spectabilis* is also slightly smaller than *P. aloea.* Members of the *P. propages* group exhibit some color differences as well as being smaller than *P. spectabilis. Pherbellia spectabilis* further differs from *P. propages* group as follows: (1) sternopleuron with only fine dorsal setae in *P. spectabilis* (sternopleuron with fine setae and 2 well developed bristles dorsally in *P. propages* group); (2) anterior and posterior fronto-orbital bristles approximately the same length in *P. spectabilis* (anterior fronto-orbital bristle ½ length of posterior fronto-orbital bristle in *P. propages* group). The terminalia of *P. spectabilis* do not resemble those of either *P. aloea* or *P. propages* group as illustrated by Orth (1982, 1983); they are distinct from any described species of *Pherbellia.*

ACKNOWLEDGMENTS

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THE NYMPHS OF *CALOPTERYX AMATA* AND *C. ANGUSTIPENNIS* (ODONATA: CALOPTERYGIDAE)

K. J. Tennessen

1949 Hickory Ave., Florence, Alabama 35630.

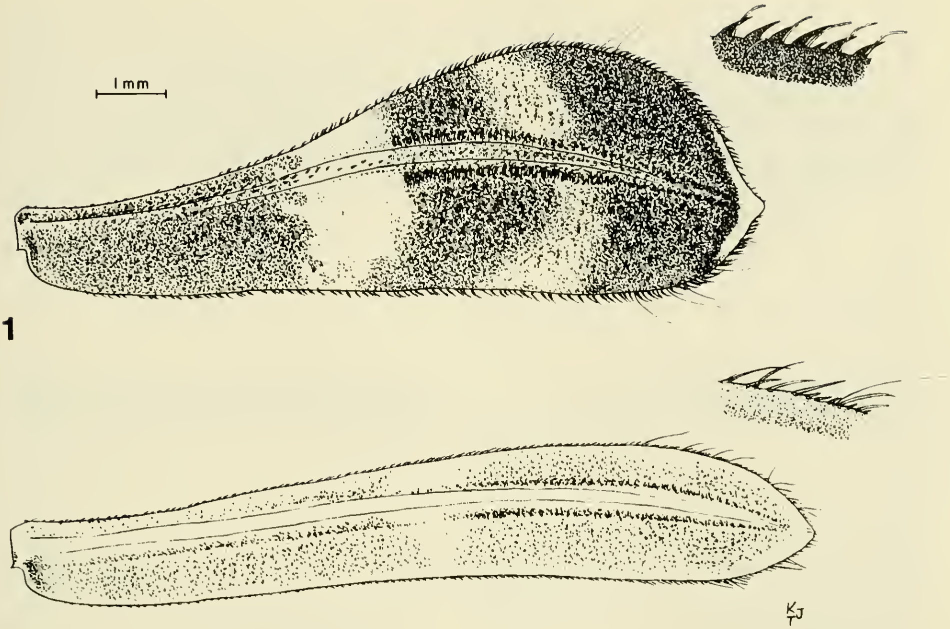
Abstract.—Reared specimens of *Calopteryx angustipennis* (Selys) prove Needham's early supposition (1911) of its nymph was correct. The nymph of *C. amata* Hagen is described for the first time, from reared specimens. A key to the nymphs of the five Nearctic species of *Calopteryx* is given.

Calopteryx nymphs are unique in the North American zygopteran fauna with the combination of antennal segment 1 longer than the remaining 6 segments, triquetral lateral gills, prementum cleft about halfway to base, and lateral carinae of abdominal segments 9 and 10 without a terminal spine. They are restricted to lotic waters ranging from first-order tributaries to medium-sized rivers. Though adults of the five North American species are readily distinguished (Johnson, 1974), nymphs are very similar morphologically. Nymphs of three species are known with certainty, viz. *maculata* (Beauvois), *aequabilis* Say (see Needham, 1903), and *dimidiata* Burmeister (see Wright, 1946—supposition, but subsequently confirmed by several workers). Martin (1939) gave additional differences between *maculata* and *aequabilis.* Needham (1911) described a single immature nymph from Kentucky as *angustipennis* (Selys) by supposition. The nymph of *amata* Hagen has remained unknown.

The purposes of this paper are to show that Needham's supposition of the nymph of *angustipennis* was correct, to describe the nymph of *amata* from reared specimens, and to give characteristics by which the nymphs of the five species may be distinguished.

Nymph of ***Calopteryx angustipennis*** (Selys)

The median gill and the ratio of antennal segment 1 : head width shown by Needham (1911) for his nymph match characteristics of *angustipennis* nymphs I reared in Alabama and Tennessee. Measurements from 18 final instar nymphs are given to supplement Needham's description: total length 24.5–32.0 mm, head width 4.03–4.35 mm, abdomen length (excluding gills) 16–22 mm, hind femora length 8.7–11.2 mm, median gill length 8.4–10.9 mm, antennal segment 1 length 3.85–4.90 mm. The ratio of the length of antennal segment 2 to segment 1 ranged from 0.21 to 0.23. The shape of the median gill appears to be the most distinguishing characteristic of this species. This gill is widened abruptly beyond the basal third (Fig. 1), and in final instars is 0.6 to 0.7 times the length of the lateral gills; its width is ca. ⅓ its length. The dorsal and ventral margins have prominent,



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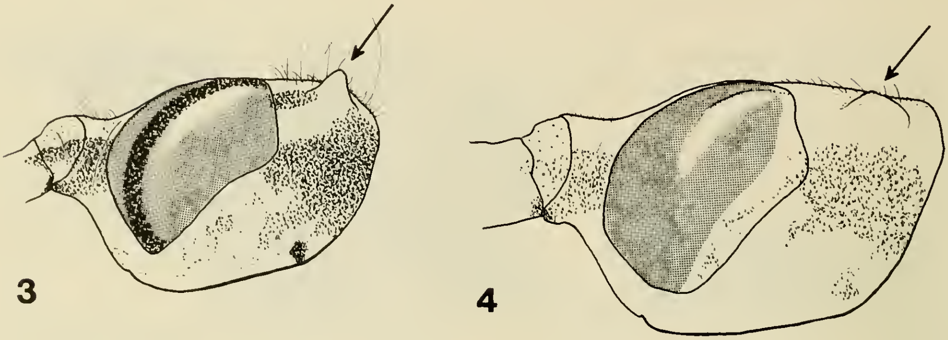
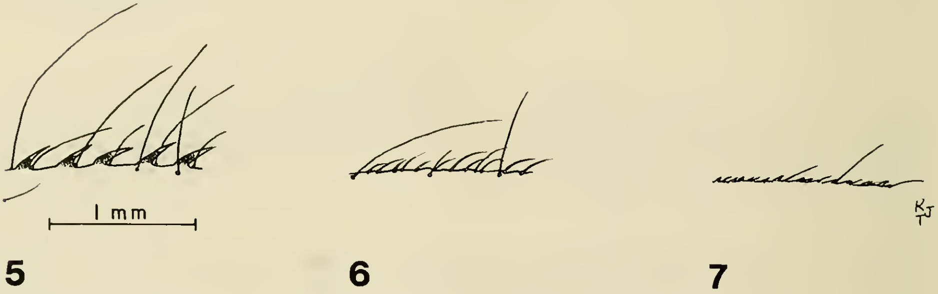
Figs. 1–2. Median gills with detail of marginal spines and setae. 1, *C. angustipennis*. 2, *C. amata*.

stout, curved spines their entire length (Fig. 1). Immediately posterior to each spine is a slender, pale seta; each margin has 4 to 6 much longer hairlike setae beyond midlength. The ventral margin is straight until curved dorsally to the tip. The triquetral lateral gills also have spines along the three margins. The median gill has 3 pale transverse bands, the basal band most evident, the apical band very narrow (Fig. 1).

Material examined.—ALABAMA: Lauderdale Co., Butler Creek, 14 April 1978, KJT, 5 nymphs (2 reared); Winston Co., Sipsey Fork, Bankhead National Forest, 24 April 1981, KJT, 1 nymph. SOUTH CAROLINA: Laurens Co., Durbin Creek, 5 May 1980, KJT, 1 nymph. TENNESSEE: Marshall Co., Duck River, 29 April 1980, KJT, 1 nymph (reared); Maury Co., Duck River, 9–14 May 1980, 5 May 1981, KJT, 8 nymphs (1 reared). WEST VIRGINIA: Mineral Co., Patterson Creek, Burlington, 26 May 1973, P. D. Harwood, 1 nymph (reared); Hampshire Co., Ice Mountain, Slanesville, 26 May 1973, P. D. Harwood, 1 nymph. The West Virginia specimens are in the Florida State Collection of Arthropods.

Five of the *C. angustipennis* nymphs from Duck River, Maury Co., TENN., had 1–9 larvae of *Rheotanytarsus* (Chironomidae) on the exoskeleton. Larval cases were attached to the gills, wing pads, dorsum of abdominal segment 2, femora, dorsum of head, venter of neck, and antennae. These attachments probably are phoretic in nature, as no damage or sign of feeding on the nymphs could be discerned. Very few such examples of a relationship between chironomids and odonates have been reported (see White and Fox, 1979).





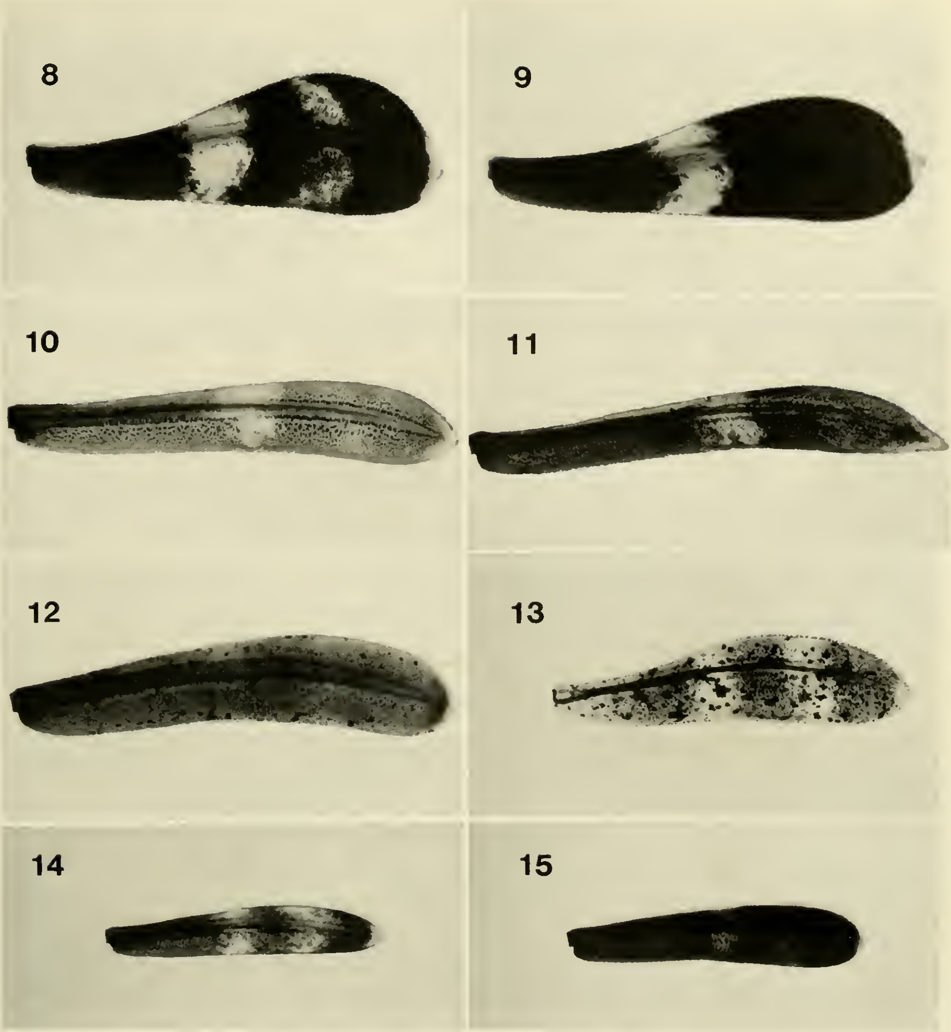
Figs. 3–4. Lateral view of head of nymphs. 3, *C. dimidiata*. 4, *C. amata*.
Figs. 5–7. Marginal setae and spines of median gills. 5, *C. dimidiata*. 6, *C. maculata*. 7, *C. aequabilis*.

Nymph of ***Calopteryx amata*** Hagen

Total length 30.5–33 mm, head width 4.18–4.26 mm, abdomen length (excluding gills) 21–23 mm, hind femora length 10.1–11.6 mm, median gill length 11.3–12.4 mm, antennal segment 1 length 4.6–5.2 mm.

General body color light brown, dorsolateral margins of thorax darker brown. Antennal segment 1 length 1.1 to 1.2 times width of head across eyes; segment 2 length 0.23 to 0.26 times the length of segment 1; segments 1 and 2 light brown, apical ⅓ or ¼ of segment 2 darker brown, remaining segments yellowish-tan to yellow. Tubercle posterior to each eye not elevated above eye level. Prementum similar to *angustipennis*, but each slender lobe with 2 prominent setae, the distal seta smaller.

Tips of wing pads extended to posterior of abdominal segment 4 in last instar. Apical and preapical brown band on legs separated by pale band. Lateral margins of abdominal segments 9 and 10 with ca. 10–14 small, stout, dark brown spines posteriorly, among which are numerous longer and thinner curved yellow setae. Median gill of nearly equal width along entire length, ca. ⅙ as wide as long; dorsal and ventral margins upcurved slightly, with slender spines and setae interspersed in posterior third by 6 to 10 long hairlike setae (Fig. 2); general color light brown with dark brown spots, a pale area near midlength and at apex. Median gill 0.7 to 0.8 times the length of the lateral gills. Coloration and marginal setae of lateral gills similar to median gill.



Figs. 8–15. Photographs of median gills. 8 & 9, *C. angustipennis.* 10 & 11, *C. amata.* 12, *C. aequabilis.* 13, *C. dimidiata.* 14 & 15, *C. maculata.*

Material examined.—PENNSYLVANIA: Huntingdon Co., Laurel Run, Whipple Dam State Park, 1 May 1960, G. H. & A. F. Beatty, 2 nymphs (reared). WEST VIRGINIA: Randolph Co., Cheat Bridge, Shavers Fork, 22 May 1972, P. D. Harwood, 3 nymphs (1 reared); Tucker Co., Sinks of Gandy, 14 Oct. 1975, P. D. Harwood, 1 nymph. All specimens deposited in Florida State Collection of Arthropods.

KEY TO NEARCTIC *CALOPTERYX* FINAL INSTAR NYMPHS

1. Tubercles behind eyes prominent and acute, raised above level of eyes (Fig. 3); antennal segment 1 length 0.8–0.85 times maximum width of head across eyes; hind femora 7.5 mm or less 2

– Tubercles behind eyes low and rounded, not raised above level of eyes

(Fig. 4); antennal segment 1 length 0.95–1.22 times maximum width of head across eyes; hind femora 8.2 mm or more 3

2. Stout, dark spines on posterior portion of lateral carinae of abdominal segments 9 and 10; margins of median gill with stout spines and many long, hairlike setae (Fig. 5); each premental lobe with one stout seta ... . *dimidiata*

– No stout spines on lateral carinae of abdominal segments 9 and 10; margins of median gill with thin, short setae, few long hairlike setae, and no stout spines (Fig. 6); each premental lobe with 2 stout setae .... *maculata*

3. Length of median gill 3 to 3.5 times width, at most; margins of gills with large stout spines (Fig. 1); antennal segment 2 length 0.21–0.23 times antennal segment 1 length .... *angustipennis*

– Length of median gill 5 to 6 times width; margins of gills with or without small stout spines; antennal segment 2 length 0.23–0.26 times antennal segment 1 length 4

4. Median gill about 5 times as long as wide, with small stout spines (only 3 or 4 times as long as basal width) and a few pale curved setae on dorsal and ventral margins (Fig. 7); hind femora 8.0–9.3 mm long ...... *aequabilis*

– Median gill about 6 times as long as wide, with many curved setae (at least 10 times as long as wide) and no stout spines on margins (Fig. 2); hind femora 10.1–11.6 mm long .... *amata*

DISCUSSION

Photographs of the median gill of each species are shown in Figs. 8–15 to supplement the key. The amount of dark pigmentation varies within some species, especially *maculata,* more than is shown here. Regenerated gills can cause problems in identification, but with experience such gills can be recognized by their shorter length and paler coloration. The couplets contain character states of other structures in case of missing or regenerated gills.

The key to the nymphs does not reflect the same affinities as shown by Johnson (1974) in his keys to adult males and females. The shape of the median gill and the configuration of its marginal setae indicate that *amata* and *aequabilis* had a common ancestor, and that *dimidiata* may be more closely related to *angustipennis* than would be surmised from adult appearance. Use of other characters, however, complicates these apparent relationships, and the combination of characters which best depicts the phylogeny of the group is unknown.

Calopteryx amata and *C. angustipennis* appear to have different habitat requirements. *C. amata* has been found almost exclusively on rapidly flowing, smaller streams where large rocks predominate. *C. angustipennis* generally occurs at riffles of slower flowing, larger streams where gravel and sand predominate. The two species have been collected at two localities on Penns Creek in Pennsylvania (in Centre County at Poe Paddy, and in Union County near Weikert) (Shiffer, personal communication). This stream has both types of habitat.

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HABITATS, DISTRIBUTIONAL RECORDS, SEASONAL ACTIVITY, ABUNDANCE, AND SEX RATIOS OF BOREIDAE AND MEROPEIDAE (MECOPTERA) COLLECTED IN NEW ENGLAND

CHRIS T. MAIER

Department of Entomology, The Connecticut Agricultural Experiment Station, 123 Huntington Street, New Haven, Connecticut 06504-1106.

Abstract.—Descriptions of habitats, new distributional records, seasonal activity, abundance, and sex ratios are given for adults of *Boreus brumalis* Fitch and *B. nivoriundus* Fitch from Connecticut and Vermont and for adults of *Merope tuber* Newman from Connecticut. Sticky traps and Malaise traps were highly effective in capturing boreids and meropeids, respectively. Based on trapping in Connecticut, adults of *Boreus* spp. were active from November–April, and those of *M. tuber* were flying from June–October. Systematic sampling with a Malaise trap indicated that the abundance (or activity) of *M. tuber* fluctuated annually and monthly. The mecopteran sex ratios derived from collections were biased in all 3 species. There was a preponderance of males of *B. brumalis* and *B. nivoriundus* in collections from moss and of females in collections from the snow surface. Females of *M. tuber* outnumbered males in Malaise traps and represented the majority of the individuals captured between August and October.

The boreids *Boreus brumalis* Fitch and *B. nivoriundus* Fitch and the meropeid *Merope tuber* Newman are intriguing because their biology is not well known. In New England, these species are poorly represented in most insect collections even though their woodland habitats abound. The scarcity of boreid adults in collections can be attributed to their unusual winter activity and to a lesser extent to their small size and brachyptery. Unlike the predaceous adults of bittacids and panorpids, they consume mosses (e.g., Byers and Thornhill, 1983). The few records of *M. tuber* from New England reflect entomologists' ignorance of its biology. Both the feeding habits and the immature stages await discovery. Distributional records summarized by Byers (1973) indicate the nocturnal adults of *M. tuber* tend to inhabit forests associated with a permanent stream or other water source. Recently, Sanborne (1982), Scarbrough (1980), and Thornhill and Johnson (1974) have reported large collections made with Malaise traps. Sanborne (1982) used live specimens obtained in a Malaise trap to describe the stridulatory behavior of adults.

My principal objectives in this paper are to provide additional records of boreid and meropeid adults from New England and to demonstrate that these insects can be collected abundantly with specialized collecting equipment. The life history and the host plants of the 2 boreids will be presented in detail in a forthcoming paper.

MATERIALS AND METHODS

Boreid adults were collected by aspirating them from moss and snow and by trapping them on horizontal sticky plates on moss. Sticky traps, which were constructed of 2 × 12-cm pieces of tempered hardboard, were coated on the upper surface with Tack Trap®. To determine the period of seasonal activity of boreid adults, sticky traps were placed on various mosses in forests in Connecticut and were then checked weekly from September–May. In all, 25 sticky traps were used at Cockaponset St. Forest (Middlesex Co.) during 1979–1980, and 45 were used at Sleeping Giant St. Park (New Haven Co.) during 1980–1981 and at West Rock Park (New Haven Co.) during 1981–1982. The mean number per trap per day was calculated for the period from the first to the last capture of each species. This abundance measure was also calculated for another set of 25 traps at the above 3 sites and for 25 traps at Sharon (Litchfield Co.). These four sets of traps were monitored during two 1–3 week periods, one between December 1979 and January 1980 and one between March and April 1980.

Most of the adults of *M. tuber* were captured in horizontal Malaise traps (D. Focks and Co., P.O. Box 12852, Gainesville, Florida 32608), which were each suspended between 2 trees in either a regrowth forest or an apple orchard from 1977–1982. The collection drums of the Malaise traps were charged with Vapona® or KCN. Between April and October of 1980–1982, one trap was operated in the same location in a regrowth forest and was emptied every two days. The mean number of adults captured per day (for the period from the first to last capture) was calculated for each of the three years.

Voucher specimens of each species of Mecoptera will be deposited in collections at The Connecticut Agricultural Experiment Station, the Illinois Natural History Survey, and the Peabody Museum of Yale University.

RESULTS AND DISCUSSION

Description of collecting sites.—Boreids inhabited regrowth forests which had one or more of the mosses upon which they fed. Typically, adults of *B. brumalis* frequented *Dicranella heteromalla* (Hedw.) Schimp. and *Atrichum* spp. moss mats that grew on disturbed soil along woodland paths, at the base of fallen and standing trees, and on eroded hillsides. Adults of *B. nivoriundus* occurred on *Atrichum* spp. that grew in the aforementioned areas and on *Polytrichum ohioense* Ren. and Gord. and *P. commune* Hedw. that developed at the base of large, upright trees and along partially exposed rocky ledges (Maier, unpublished data). Both species of boreids occasionally visited other species of moss or crawled across snow. Dominant overstory trees at major sites were *Quercus alba* L. and *Q. prinus* L. (e.g., Cockaponset St. Forest and West Rock Park, Connecticut) or were *Q. alba* and *Betula* spp. (Ludlow, Vermont). Small stands of *Tsuga canadensis* (L.) Carr. were sometimes intermixed with the deciduous trees. In Edgewood Park, New Haven, Connecticut, *B. brumalis* developed in *D. heteromalla* at the bases of *Fagus grandifolia* Ehrh. and *Q. rubra* L. or under thickets of *Kalmia latifolia* L. near these trees.

The principal collecting site for *M. tuber* was a regrowth forest located at Lockwood Farm in Mount Carmel, Connecticut. This forest (ca. 1 hectare in size) was bordered to the north by an old field, to the east by an apple orchard, to the south

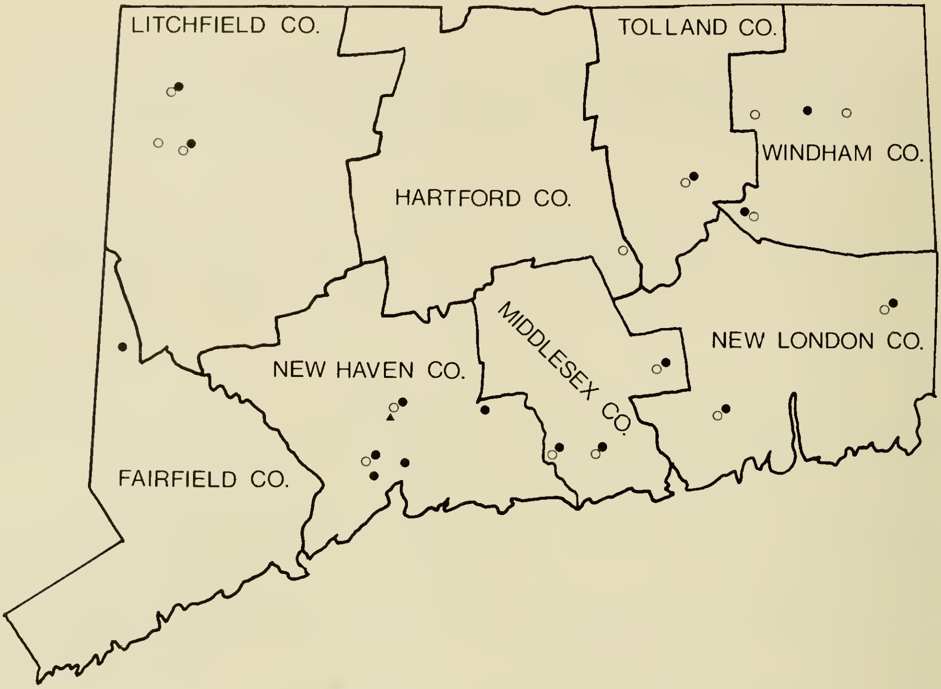

Fig. 1. New distributional records for *Boreus brumalis* (solid circles), *B. nivoriundus* (hollow circles), and *Merope tuber* (solid triangle) collected in Connecticut. More precise distributional data can be obtained from the author.

by a corn field, and to the west by a wet area with trees and shrubs and by a *Pinus resinosa* Ait. plantation. Within 0.5 km of the woodlot was an extensive forest dominated by *Quercus* spp. Characteristic trees at the collecting site were *Acer saccharum* Marsh., *Betula lenta* L., *Fraxinus americana* L., *Q. alba,* and *Q. rubra.* According to records kept since 1950, the woodland has been periodically disturbed. In the 1950's, many of the trees were removed or girdled to facilitate the growth of the *Castanea* spp. in an experimental plot. In the 1960's, shrubby growth was reduced by cutting and use of chemicals. Old stumps in the forest had diameters ranging up to 80 cm.

A Malaise trap was placed in the center of the woodlot in 1979 and between the same two trees in the southwestern corner of the woods from 1980–1982. The southwestern corner was dominated by *A. saccharum* (up to 50 cm in diameter) and by *F. americana* (up to 40 cm in diameter). The elevation at this trapping site was 43 m. The soil had a texture of sandy clay loam and a pH of 5.3 at a depth of 15 cm. The ground sloped about 5 m from the eastern to western edge of the woodlot. An underground rivulet reached the soil surface directly underneath the Malaise trap and flowed into the depression in the adjacent swampy area to the west. The water flow was greatest in winter and spring when a large pool covered about 75% of 0.3-hectare wet area. Several *Q. bicolor* Willd. trees (40–50 cm in diameter) formed a discontinuous canopy in the swampy area. *Cornus* spp., *Lindera benzoin* (L.) Blume, and *Toxicodendron radicans* (L.) Ktze.

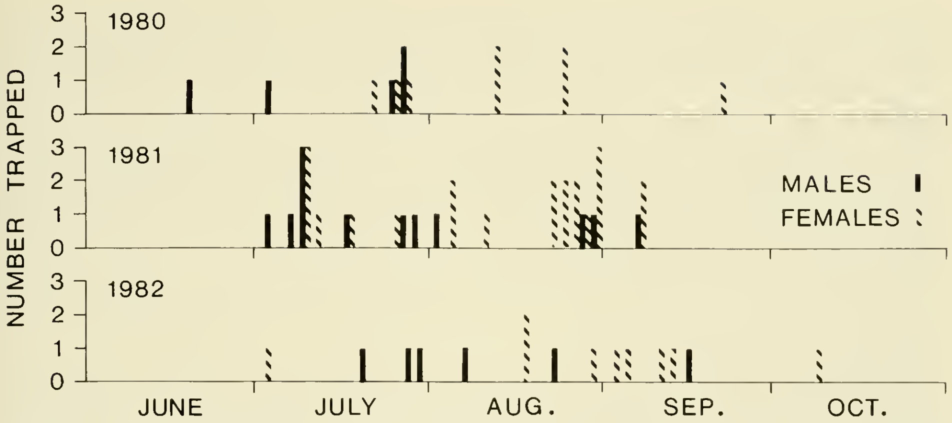

Fig. 2. Seasonal distribution of adults of *Merope tuber,* which were captured between 1980 and 1982 in a horizontal Malaise trap located in a regrowth forest in Mount Carmel, Connecticut.

formed a thicket in the understory. Numerous decaying logs occurred within 100 m of the spot where the rivulet surfaced.

Distributional records.—Each species of *Boreus* was captured at one or more sites in 7 of 8 counties in Connecticut (Fig. 1) and at Ludlow, Windsor Co., Vermont. These collections represented new distributional records that were not included in recent monographs discussing boreids (Penny, 1977; Webb et al., 1975).

The capture of *M. tuber* in New Haven Co. (Fig. 1) provided the second record of this species in Connecticut. Engelhardt (1915) previously collected 3 females at lights in Litchfield Co.

Seasonal activity and abundance.—In Connecticut, the adult activity of *B. brumalis* and *B. nivoriundus* extended from November–April. Webb et al. (1975) and Penny (1977) found that these boreids had a similar period of activity in other areas.

Trapping with sticky plates was a successful new technique for capturing boreid adults. Overall, 77% of the adults of *B. brumalis* (n = 673) and 84% of those of *B. nivoriundus* (n = 839) were collected on sticky traps placed on various mosses. During three consecutive seasons of trapping between November and April, the mean number of adults per trap per day was 0.02 (range 0.01–0.02) for *B. brumalis* and 0.02 (range 0.01–0.03) for *B. nivoriundus.* At four trapping locations used during 1979–1980, the average number captured per trap per day increased from the first sampling period in December–January to the second one in March–April. In the first period, the mean values were 0.03 (range 0.01–0.05) for *B. brumalis* and 0.14 (range 0.04–0.38) for *B. nivoriundus*; in the second period, the means were 0.08 (range 0.04–0.11) and 0.26 (range 0.06–0.57) for these respective species. The increase from winter to spring was correlated with a rise in temperature and, therefore, in adult activity.

Based on samples from a Malaise trap, the flight period of *M. tuber* lasted from June to October (Fig. 2). Although this flight period resembled that reported by Byers (1954), it is the longest recorded from one locale. Captures in the Malaise trap from June–October of 1980–1982 indicated that a disproportionate number of adults were trapped each month. Monthly captures (represented as % of total caught) were 1.6% in June, 41% in July, 41% in August, 14.8% in September, and 1.6% in October. Caron (1967) made the only other capture in October (one female).

My total catch of *M. tuber* (n = 69) between 1977 and 1982 ranked second to the phenomenal capture of more than 100 adults by Needham (Carpenter, 1932). Annual abundance measured at the same location between 1980 and 1982 varied considerably, being 13 (21.3% of 3-year total) in 1980, 33 (54.1%) in 1981, and 15 (24.6%) in 1982. Over these three years, the average number trapped per day was 0.26 (range 0.15–0.49). Data presented by Scarbrough (1980) also showed a fluctuation in annual abundance of *M. tuber* captured in a Malaise trap.

Sex ratios.—Biased sex ratios characterized the entire collection of each mecopteran species. Males significantly outnumbered females in *B. brumalis* (465 ♂, 208 ♀; $P < 0.001$, chi-square analysis) and in *B. nivoriundus* (608 ♂, 231 ♀; $P < 0.001$). Although males predominated in the whole collection aspirated from moss (51 ♂, 20 ♀ *B. brumalis*; 77 ♂, 30 ♀ *B. nivoriundus*; both *P*'s < 0.001) and trapped on sticky plates on moss (378 ♂, 138 ♀ *B. brumalis*; 518 ♂, 177 ♀ *B. nivoriundus*; both *P*'s < 0.001), females exceeded males in number on the surface of the snow (36 ♂, 50 ♀ *B. brumalis*, $P < 0.25$; 13 ♂, 24 ♀ *B. nivoriundus*, $P < 0.10$). Cooper (1974) found that the sex ratio of pupae of *B. brumalis* and *B. nivoriundus* did not depart significantly from equality. However, Cooper (1974) and Shorthouse (1979) collected more males than females in the field. A review of the sex ratios observed in Boreidae (see Cooper, 1974) showed that males do not consistently outnumber females in collections. Certainly, the sex ratio could be influenced by the collecting technique and time and by the sexual difference in boreid behavior.

For the entire collection of *M. tuber*, females outnumbered males (26 ♂, 43 ♀; $P < 0.05$). Systematic sampling with the Malaise trap between 1980 and 1982 did exhibit a preponderance of females (23 ♂, 38 ♀) although the departure from a 1:1 sex ratio was not significant ($P < 0.10$). Female-biased sex ratios also characterized the collections that Scarbrough (1980) and Sanborne (1982) made with Malaise traps. Comparison of monthly captures from 1980–1982 indicated males dominated in June (1 ♂) and July (15 ♂, 10 ♀) and females dominated in August (5 ♂, 20 ♀), September (2 ♂, 7 ♀), and October (1 ♀).

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I thank Lewis J. Stannard, Jr. (retired) and Donald W. Webb (Section of Faunistic Surveys and Insect Identification, Illinois Natural History Survey) for introducing me to the study of boreids and meropeids. David Wagner assisted with many of the field collections. Harold Robinson (Department of Botany, National Museum of Natural History, Smithsonian Institution) identified a reference collection of mosses. Richard Jaynes (Department of Forestry and Horticulture, The Connecticut Agricultural Experiment Station) provided valuable details about the principal collecting site for *M. tuber.*

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A NEW *CAUTETHIA* FROM THE BAHAMAS (LEPIDOPTERA: SPHINGIDAE)

TIM L. MCCABE

New York State Museum, Cultural Education Center, Albany, New York 12230.

Abstract.—*Cautethia* ***exuma*** n.sp. is described and illustrated. It is closely related to *C. grotei* Henry Edwards. The caterpillar is described and illustrated. The known host plant is *Erithalis fruticosa* (Linnaeus) (Rubiaceae).

When Grote (1867) proposed *Cautethia* as a replacement name for *Oenasanda* Walker (1856b) (preoccupied by *Oenasanda* Walker, 1856a) he included only one species from Cuba, which he identified as *C. noctuiformis* Walker (1856b). Henry Edwards (1882) pointed out that the *Cautethia* species that Grote had from Cuba was actually *C. grotei* Henry Edwards. Jordan (1940) also made note of the misidentified Cuban species when he described two new races of *C. grotei* from the Cayman Islands.

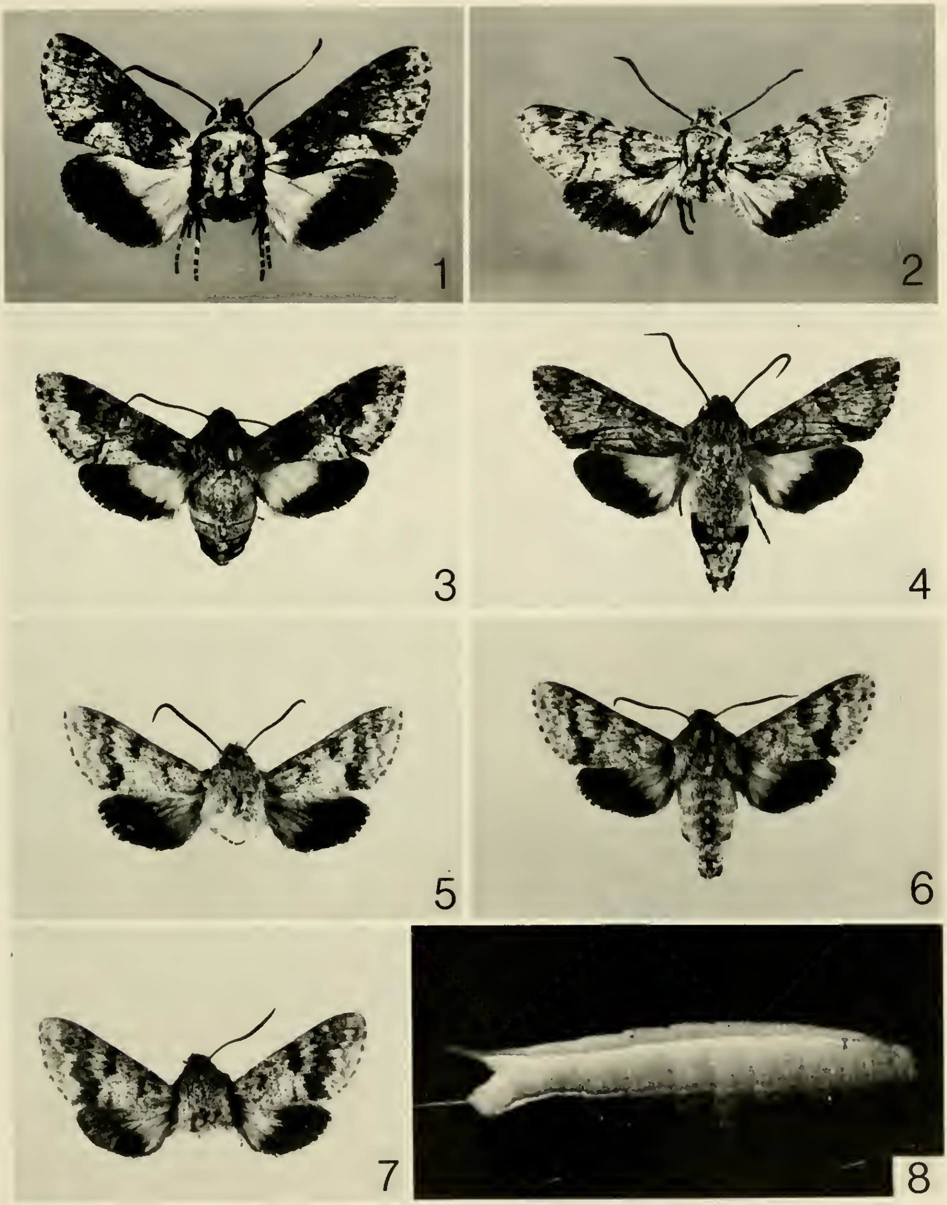
The genus *Cautethia* includes six species of small-sized moths. *Cautethia grotei* occurs in Cuba, the Cayman Islands, and the Bahamas. *Cautethia noctuiformis* is found in Puerto Rico, the Virgin Islands, and a few of the Lesser Antilles, and Cary (1971) recently described a race from Antigua (Fig. 2). The remaining species of *Cautethia* are: *C. spuria* Boisduval (1875) (Mexico) (male genitalia figured in Hodges, 1971), *C. simitia* Schaus (1932) (Columbia) and *C. yucatana* Clark (1919) (Mexico). The species described herein is, at present, known only from Great Exuma in the Bahamas.

Cautethia exuma McCabe, NEW SPECIES

Adult.—Wingspan 27–32 mm; forewing light-gray irrorated with dark gray or black scales; AM line, when traceable, strongly angled at cubitus, then directed basally to anal vein, then even more steeply angled basally to inner margin; reniform diffuse, with white scaling proximally and diffuse black patch distally; PM double and shallowly scalloped on veins, slightly darker in anal area; terminal line diffuse; forewing ventrally uniform gray; hindwing yellow brown in basal ⅖ths and brownish-black in distal ⅗ths; hindwing ventrally with basal yellow-brown restricted to base of anal area. Thorax and abdomen same shade of light gray as forewing; abdomen with weak tufts on abdominal segments 2, 3, 4, & 5. Male and female similar.

Male genitalia (Fig. 11). Gnathos straight, broad, and heavily chitinized at apex; uncus large, straight and blunt tipped; valves broad and upturned, with undifferentiated cucullus; process present at base of valve, ⅓ length of valve; aedeagus (Fig. 12) with simple vesica marked by right-angle bend.

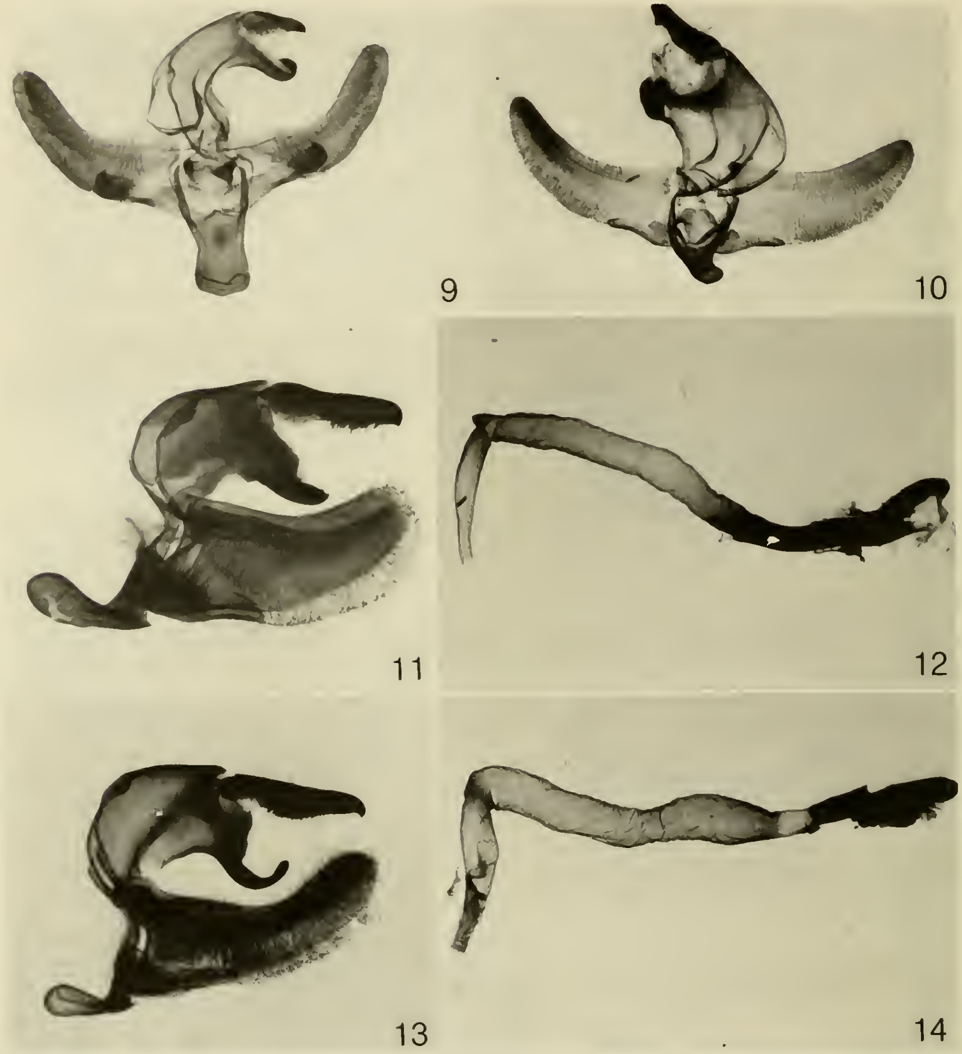
Female genitalia (Fig. 15). Bursa copulatrix very long-stalked and bulbous at



Figs. 1–8. 1, *Cautethia yucatana* male. 2, *Cautethia noctuiformis bredini* Cary (Holotype). 3, *Cautethia grotei* male. 4, *Cautethia grotei* female. 5, *Cautethia exuma* male (Holotype). 6, *Cautethia exuma* male (Paratype). 7, *Cautethia exuma* female (Paratype). 8, *Cautethia exuma* ultimate instar larva at rest on host, *Erithalis fruticosa* (L.).

anterior end, without signa, but with large appendix bursa subequal in size to bulbous portion of bursa copulatrix.

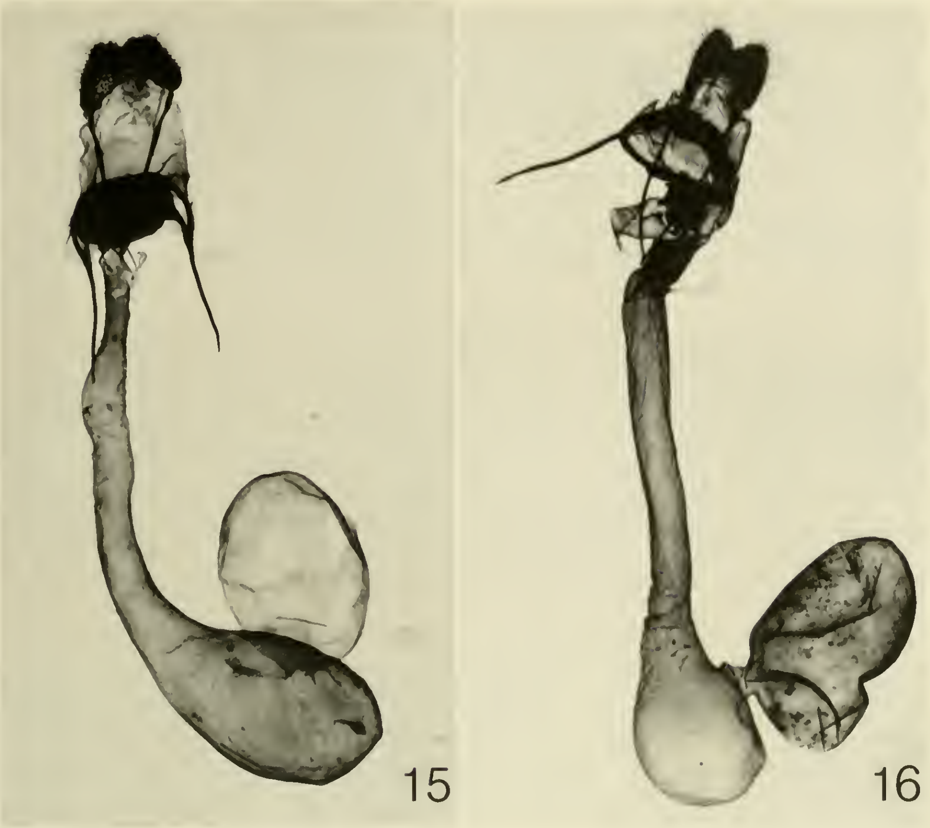
Full grown larva. Length 36 mm; head green with pair of faint longitudinal greenish-white stripes; body green with subdorsal white stripe running length of



Figs. 9–14. 9, *Cautethia noctuiformis bredini* valves. 10, *Cautethia yucatana* valves. 11, *Cautethia exuma* (Holotype) valves. 12, *Cautethia exuma* (Holotype) vesica. 13, *Cautethia grotei* valves. 14, *Cautethia grotei* vesica.

body to base of horn; no dorsal line or pattern; dorsum slightly darker green than sides, both with raised white rugosities; spiracles yellow; yellow subspiracular line present from anal proleg forward to last abdominal proleg, then fading to white and not traceable anterior to abdominal prolegs; horn green, apex pale, projecting from an enlarged base; anterior end of body and thoracic legs raised at rest; thoracic legs held parallel (directed forward) to body when at rest; head retractable; body somewhat swollen anteriorly.

The larva of *Cautethia exuma* differs from Dyar's (1896) description of *C. grotei* in several respects: Abdominal prolegs 3 & 4 are not used when at rest in *C. grotei*; in *C. exuma* all prolegs are used when at rest; geminate dorsal line



Figs. 15–16. 15, *Cautethia exuma* female genitalia. 16, *Cautethia grotei* female genitalia.

present in *C. grotei*, dorsal line absent in *C. exuma*; subdorsal line pale yellow at upper border in *C. grotei*, that of *C. exuma* is white; spiracles white with median red band, that of *C. exuma* yellow with median reddish band; sides marked by dark green chevrons in *C. grotei*, that of *C. exuma* uniform light green and unmarked; subspiracular line white, yellow, and marked with pink in *C. grotei*, that of *C. exuma* is yellow and white, no pink.

Holotype ♂ (Figs. 5 & 11).—Bahamas, Great Exuma, Simon's Point, 23.31.50N 75.47.30W, 11 January 1980, deposited in New York State Museum.

Paratypes.—1 ♀, 30 ♂. All with the same data as holotype except dates range from 26 December to 22 January. Paratypes are to be distributed among the U.S. National Museum of Natural History, American Museum of Natural History, Cornell University Insect Collection, Canadian National Collections, British Museum of Natural History, Museum für Naturkunde der Humboldt-Universität, New York State Museum, and various other collections.

DIAGNOSIS

Cautethia exuma males differ from the males of all other known *Cautethia* species in lacking a dark patch of scales in the tornus of the forewing; *Cautethia* *exuma* lack the sexual dimorphism of the other *Cautethia* species. *Cautethia grotei* is larger, has a deeply scalloped postmedial line, more extensive and brighter basal orange on the hindwing, differing gnathos (compare Fig. 11 to Fig. 13) and female genitalia with an appendix bursa larger than the bursa copulatrix (subequal in *C. exuma*, see Figs. 15 & 16). *Cautethia simitia* (type in USNM) has been examined, but not dissected. It is very similar to *C. grotei* as well as to *C. yucatana* and might prove conspecific with the latter. The species described in this paper has been named after the island of Great Exuma. The name is to be treated as a noun in apposition.

Biology

Knowing that the related *C. grotei* feeds on *Chiocca alba* (L.) A. Hitch. (Rubiaceae), I conducted an intensive search for sphinx larvae on the most abundant rubiaceous plant on Exuma, *Erithalis fruticosa* (Linnaeus) and discovered the larva of *C. exuma*. The single larva pupated, but the fully formed moth died within the pupal shell. Color photographs were taken of the larva and the black and white figure is reproduced from one of them (Fig. 8). All adult specimens were collected at a 15 watt ultra-violet light. One adult was observed feeding at the blossoms of Strongback, *Bourreria ovata* Miers (Boraginaceae), at dusk.

Acknowledgments

I thank Sidney Russell of the Bahamian Ministry of Agriculture and Fisheries for granting permission to collect Lepidoptera on Exuma. Assistance from curators R. W. Hodges and R. W. Poole, Systematic Entomology Laboratory, USDA, and M. Honey and A. Watson, British Museum, was most appreciated. J. Barnes kindly reviewed the manuscript. My sincerest thanks to Margaret Stedman for providing lodging on Exuma.

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FOUR SPECIES OF *OMMATIUS* WIEDEMANN (DIPTERA: ASILIDAE) FROM PUERTO RICO AND THE VIRGIN ISLANDS

A. G. Scarbrough

Department of Biological Sciences, Towson State University, Baltimore, Maryland 21204.

Abstract.—Four species of *Ommatius* Wiedemann, *O. vitreus* Bigot, *O.* ***monensis*** Scarbrough new species, *O.* ***falcatus*** Scarbrough new species, and *O. marginellus* (Fabricius), are reported from Puerto Rico and the Virgin Islands. The last 3 species are described and illustrated. A key to the species is also included, and *O. tibialis* Say is removed from the list of Caribbean Asilidae.

Presently *Ommatius marginellus* (Fabricius) is listed from Cuba, southward through the Lesser Antilles, from eastern South America (Martin and Papavero, 1970), and from the Galapagos Islands (Linsley and Usinger, 1966). However, a re-evaluation of the species suggests a more restricted distribution to the middle Caribbean Islands. Farr (1965) found in museums at least three different species labeled *O. marginellus.* Upon examination of over 100 museum specimens labeled *O. marginellus,* I also found numerous errors in the identification of the species. The problems in identification apparently originate from the brief original description (Fabricius, 1781) of the species and recent references (Curran, 1928; Bromley, 1929) to the presence of marginal scutellar bristles. Until recently (Farr, 1965; Scarbrough, in press), *O. marginellus* was the only species in the Caribbean region stated to have marginal scutellar bristles. It seems likely then that any species with this character was immediately identified and labeled as such.

Through a loan from the Universitetet Zoologiske Museum, Copenhagen, Denmark, I was able to examine the male holotype of *O. marginellus.* The type is in poor condition, and consists of only the thorax, wings and parts of the foreleg. The scutellum is without marginal bristles or any evidence (scars or basal sockets) that they were present earlier. Unfortunately, the original description and later modifications of it (Fabricius, 1781; 1787; 1805) do not refer to this character. In order to clarify the confusion of the identity of *O. marginellus,* I have selected specimens (♂, ♀ homotypes) from a series collected in the Virgin Islands (type locality) that closely resemble the holotype to construct a more thorough description of the species. Two undescribed species of *Ommatius* from Puerto Rico are also described and illustrated, and a third species (*O. vitreus* Bigot) is reported from Mona Island, Puerto Rico, for the first time.

KEY TO SPECIES FROM PUERTO RICO AND THE VIRGIN ISLANDS

1. Femora wholly dark 2
– Femora dark in part only 3

2. Small slender specimen (11.0–14.0 mm); forecoxal bristles wholly white to pale yellow; epandrium deeply divided apically; costal margin straight (Mona Island & Hispaniola) .... *O. vitreus* Bigot
– Large robust species (13.0–18.0 mm); most forecoxal bristles black; epandrium not divided apically; (Fig. 5); costal margin noticeably protruding (Mona Island) .... *O. monensis* new species
3. Epandrium with apical ⅓ slender and sickle-shaped (Fig. 6); marginal and submarginal cells and halter yellowish (Puerto Rico) .... *O. falcatus* new species
– Epandrium with apical ⅓ broad and more angular below; apical margin somewhat subtruncate (Fig. 3); marginal and submarginal cells clear; halter yellowish brown to brown (Puerto Rico & Virgin Islands) .... *O. marginellus* (Fabr.)

***Ommatius marginellus* (Fabricius)**

Figs. 1–4

Asilus marginellus Fabricius, 1781: 464; 1787: 178. Type locality Virgin Islands, St. Croix.

Dasyopogon marginellus: Wiedemann, 1821: 213.

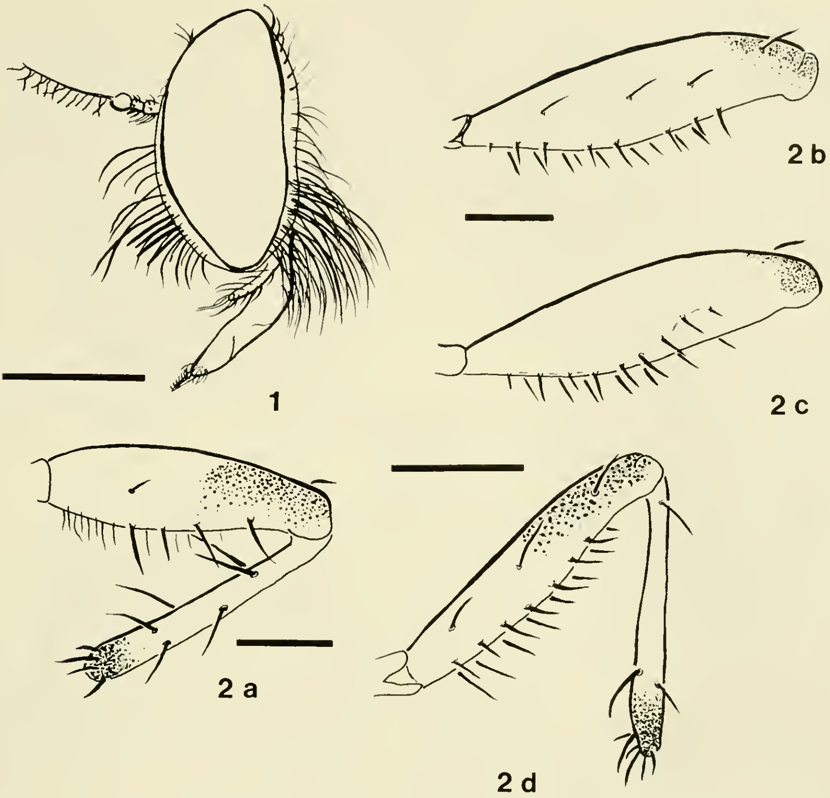
Ommatius marginellus: Coquillett, 1910: 579. Type species designated; Wolcott, 1948: 453; Hull, 1962: 434–436.

Male (Fig. 1).—Length 14.0 mm. Head dark brown; face and front grayish yellow tomentose, tomentum of occiput yellowish white. Bristles of face and front yellow to orangish, beard white; 2 long ocellar and several postocular bristles brown, the latter slightly curved forward near tips. Antennal segments each about same length, style almost twice length of 3 segments combined; 3rd segment ovate with style inserted slightly above middle and 1–3 short hairs dorsally; bristles of antennal segments mostly short and dark, those below on 1st segment pale yellow.

Thorax brown to dark brown. Scutum with yellowish to brownish white pollen in grooves along lateral margins, on prescutellar region and scutellum; pollen lightest in color in prescutellar region, golden to brownish yellow behind humeral callus. Pleural pollinosity yellowish with brown on upper half. Chaetotaxy: 2 notopleurals, 1 supraalar and 1 postalar; 2–3 weak, pale prescutellar dorsocentral hairs; pleural row of bristles pale yellow. Thoracic pile pale and weak, most abundant on prothorax, humeral callus and scutellum, sparse elsewhere. Strong marginal scutellar bristles absent. Halter yellowish brown to orangish.

Wings hyaline, costal margin moderately bulging, anterior cells with slight brownish tint. Veins dark brown apically, lighter basally. R-m crossvein before middle of discal cell. Second posterior cell somewhat constricted beyond its middle.

Legs (Fig. 2a–c) mostly orangish yellow; black on apical ¼ to $^1/_5$ anteriorly on fore- and midfemora; black band on apical ¼ of hindfemur and hind tibia; bases of basal tarsomeres of tarsi yellow to yellowish brown, the remaining segments brown. Coxae yellowish gray pollinose with yellowish bristles and pile. Bristles of femora and tibiae primarily yellow to orangish, black at apices of tibiae with 3–4 additional ones on mid- and hindtibiae; midfemur with 4 black bristles on anterior surface (2 anteroventral, 2 more apical and slightly above the former) and 1 posteroapical; hindfemur with 6 black bristles in posteroventral row. Fore-



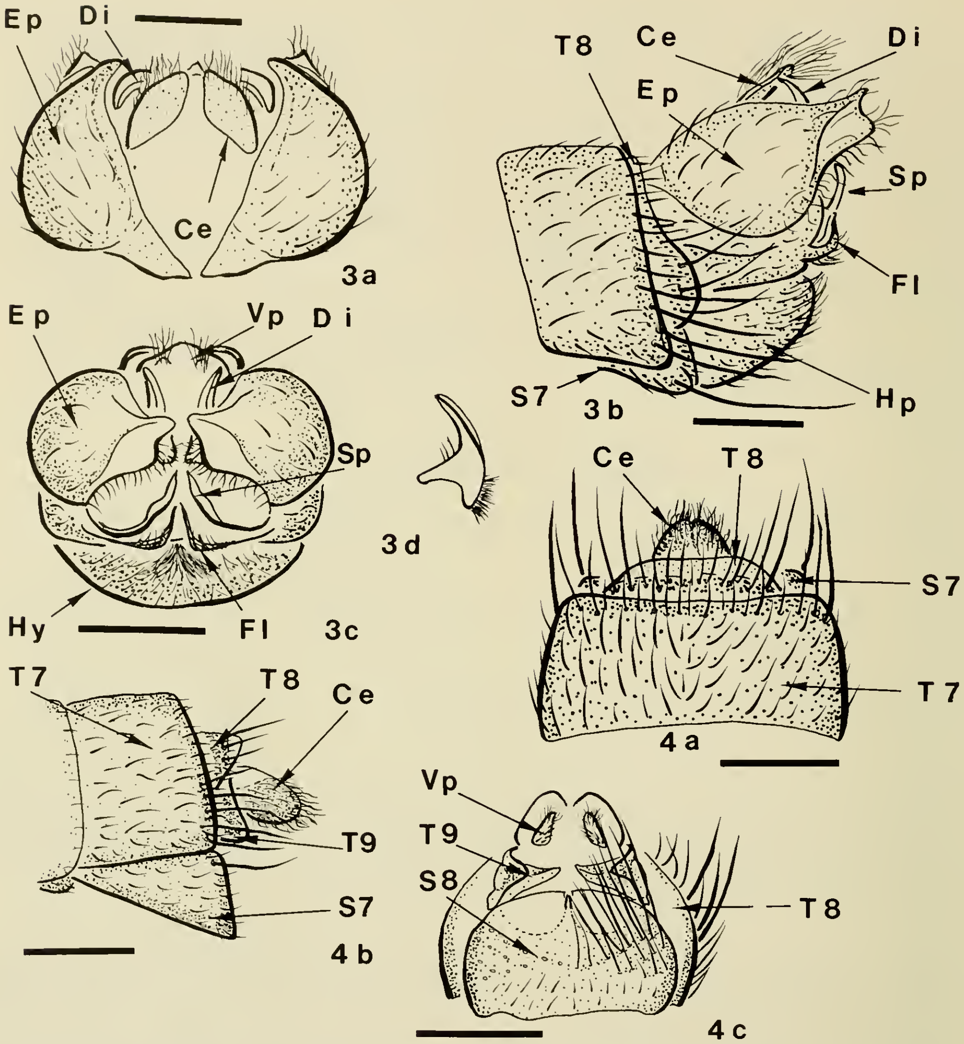
Figs. 1–4. *Ommatius marginellus* (Fabricius). 1, Head, lateral view. 2, Typical leg chaetotaxy and color patterns: (a) male midleg, front view; (b) male left hindfemur, front view; (c) male left hindfemur, posterior view; (d) female left hindleg, front view. (Horizontal bar = 1.0 mm.)

tarsi with 4 pale yellow bristles, the remaining ones black. Legs with primarily yellowish pile, black in dark areas; tibiae with black setulae and a few long, thin black hairs ventrally on foretibia.

Abdomen brown with yellow pollen and appressed setae; pile pale yellowish. Swellings of tergite 1 with 4–5 pale orangish bristles and numerous slender hairs. Tergites 7–8 somewhat shiny, the latter and much of tergite 6 with brown hairs; apical corners of tergites 3–6 with 1–2 short, bristly, pale yellowish hairs.

Terminalia (Fig. 3) primarily dark brown; lower surface, cercus and apical tips of epandrium orangish to reddish. Pile and hairs of lighter areas yellowish, some dark brown to black pile in dark areas. Epandrium swollen on basal ⅔ or more, flattened and abruptly narrowed near apex; apical margin slightly projecting dorsally, somewhat angular or subtruncate below. Hypandrium somewhat inflated. Dististylus slender, slightly curved forward, gently tapered to apex. Basistylus with a spinelike projection and a thin basal flange. Cercus short, about ⅓ length of epandrium; fused plates below cercus with 2 apical swellings and long, pale pile.

Female (Figs. 2d, 4).—Other than sexual differences, the female closely resembles the male. Length 14.0 mm. Wings without costal bulge, r-m crossvein beyond middle of discal cell, constriction of second posterior cell less apparent than in male; halter reddish. Legs darker orange with more black at apices. Leg bristles



Figs. 3–4. *Ommatius marginellus* (Fabricius). 3, Male terminalia: (a) dorsal, (b) lateral, (c) apical views; (d) left dististylus. 4, Female terminalia: (a) dorsal, (b) lateral, and (c) ventral views. Abbreviations: Ce = cercus, Ep = epandrium, Di = dististylus, Ba = basistylus, Hy = hypandrium, T = tergite, S = sternite, Sp = spine of basistylus, Fl = flange, Vp = ventral plates. Horizontal bar = 0.5 mm.

orange except for 4 black ones on midfemur, 1 on fore- and 5 on mid-tibiae. Bases of basal tarsomeres of mid- and hindtarsi light brown; 1 orangish foretarsal bristle. Abdominal segment 7 with mostly yellow setae and hairs, some dark setae above and 1 long, bristly, brown hair in apical corners. Segment 8 and tergite 9 short, retracted into segment 7. Sternite 8 with numerous brown hairs and a small, median, subapical point with a shallow depression to each side; apical margin without protuberances. Apical corners of tergite 9 slightly projecting posteriorly and wrapping around base of cercus, almost touching below.

Variation.—Length 10.0–15.5 mm. Tomentum, pollen and chaetotaxy are typically more yellowish to yellow in males, especially in males from the Virgin

Islands. Darker specimens have 1–3 additional black leg and tarsal bristles than lighter specimens. Puerto Rican specimens have darker legs than those from the Virgin Islands, with darker orange and more extensive black markings. For example, black extends the full length and width of the anterior surface of the forefemur, the apical ½ or more of the anterior surface of the midfemur, and the apical ¼ to ⅔ of the hindfemur. In addition, the black apical bands are present on the mid- (narrow) and hindtibiae (apical ¼ to ½) and the basal tarsomeres are sometimes light brown, usually dark brown. Specimens from the Virgin Islands have black markings rarely (1 male) extending beyond the apical ½ of the forefemur; apical bands on the tibiae are either absent (fore) or occur as a narrow clouded band (middle); the basal ½ of the basal tarsomeres of the posterior 2 tarsi are usually yellowish brown.

Material examined.—♂ holotype, VI; ♂ homotype 6 Aug. 1980, Brewers Bay, St. Thomas, VI (M. A. Ivie): ♀ homotype 25 Jul. 1979, Perserverance Bay, St. Thomas, VI (M. A. Ivie). VIRGIN ISLANDS (St. Thomas & St. Johns Islands) 6 ♂, 2 ♀; PUERTO RICO 18 ♂, 8 ♀.

The holotype male is in the collection of the Universitetet Zoologiske Museum, Copenhagen, Denmark. The homotypes are deposited in the USNM, Washington, D.C.; additional specimens are located in the USNM; MCZ, Cambridge University; AMNH, New York; Museum of University of Puerto Rico, Mayaguez; Universitetet Zoologiske Museum, Copenhagen, Denmark; The Museum of Entomology, University of Puerto Rico, Rio Piedras; the collections of Mike Ivie, Ohio State University, Columbus, and the author.

Discussion.—*Ommatius marginellus* is recognized by yellow to orangish facial bristles and hairs; yellow abdominal pollen; an absence of marginal scutellar bristles; tibiae and femora primarily orangish yellow to orange with black apically; epandrium with apical margin slightly projecting dorsally, subtruncate apically and angular below; basistylus with a single leglike process and basal flange; dististylus only slightly curved forward. In Farr's key (1965), *O. marginellus* runs to *O. jamaiciensis* Farr but differs from that species by the absence of white facial and pale brown leg bristles and brown tibiae, and the presence of yellow abdominal pollen, a yellowish orange halter and a slightly curved dististylus.

Ommatius monensis **Scarbrough, New Species**

Fig. 5

Male.—Length 18.0 mm. Head black with white to gray tomentum. Hairs and bristles of face and most of those of occiput white or whitish; ocellar and a few dorsal postocular bristles black. Mystax with abundant long and shorter hairs and bristles, hairs weaker and less abundant above. Most postocular bristles straight or nearly so, inner 2–3 strongly proclinate above eyes; 2 long ocellar bristles and 3–4 shorter ones. Antenna black, segments of about equal lengths; style slightly more than twice length of all segments; third segment slightly longer than wide; hairs primarily white on segment 1 with a few black ones above and all hairs black on segment 2.

Thorax black. Scutum with a brown pollinose patch behind humeri; brownish or yellowish gray to gray pollen in grooves, on sides above wings and in prescutellar region; light brown pollen on postalar callus. Pleural pollinosity gray, upper half of anepisternum with some yellow or brown mixed with gray. Thoracic pile weak

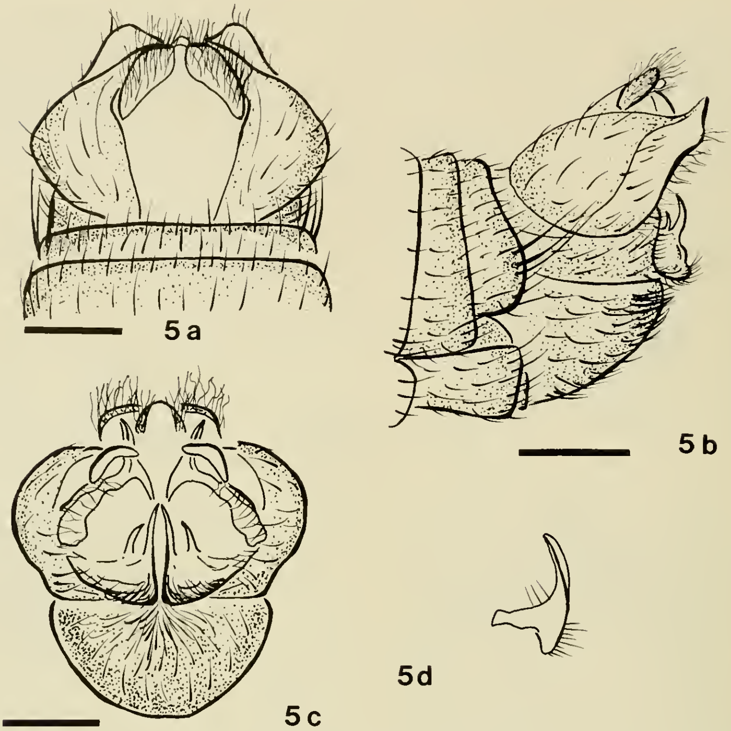


Fig. 5. *Ommatius monensis* n. sp., male terminalia: (a) dorsal, (b) lateral, and (c) apical views; (d) left dististylus. See Figures 1–4 for parts of terminalia. Horizontal bar = 0.5 mm.

and whitish; pile most abundant on prothorax, humeral callus, anepisternum, katepisternum and laterotergite, sparse or absent on remaining pleurites. Chaetotaxy: 2 notopleurals, 1 supra-alar and 1 postalar; several pale, weak dorsocentrals in prescutellar region; pleural row of bristles white to pale brownish white. Scutellum with gray to yellowish gray pollen and long whitish pile; pile along margin not noticeably different from that on dorsum. Halter brown.

Wings hyaline, veins reddish brown basally, dark brown apically, costal margin greatly swollen, marginal and submarginal cells with strong ripples and some brown adjacent veins; r-m crossvein before middle of discal cell.

Legs.—Coxae black with gray pollen and whitish pile; forecoxa with several strong black bristles and 1 or 2 white ones; mid- and hindcoxae without black bristles. Femora swollen, shiny black with apical margins brownish; tibiae brownish orange, foretibia lightest; fore- and midtibia with a small brown apical spot; hintibia with a narrow apical brown band. Tarsi dark brown, basal segments light brownish to brownish orange. Femora pile generally white, sparse posteriorly on fore- and midfemora, abundant elsewhere; pile longer below and basally on all femora and posteriorly on hindfemur. Forefemur with whitish bristles, 2 on anterior surface and a row of stiff bristles below, extending almost the full length of segment; midfemur with several whitish bristly hairs below and 5–6 bristles on anterior surface, 3–4 of latter bristles and 1 posteroapical bristle black. Hindfemur with anteroventral row and 3–4 bristles on anterior surface whitish, bristles of posterior row and 1 anterior preapical bristle black. Tibiae with yellowish white pile and sparse black setulae; tibial and tarsal bristles black except 3 on foretarsus, 4 on foretibia and 1 on midtibia; foretibia with black bristles restricted to apex; fore- and midtibiae with long, thin black hairs in a row below.

Abdomen dark brown to black, apical margins of segments slightly lighter; grayish pollen laterally on segments with traces of brown. Whitish pile on lighter areas of segments, long on basal 3 segments; dark short setae on dark areas of tergites; tergite 1, apical corners of sternite 8, tergites 7 and 8 with one or more pale or whitish bristly hairs or bristles.

Terminalia (Fig. 5a–d) reddish brown to black with short black pile basally, longer pale pile and bristly hairs apically. Cercus dark brown; epandrium greatly swollen on basal ⅔ and black, tapered apically and reddish. Hypandrium and gonopod brown to reddish, the former slightly swollen, its apical margin almost straight in apical view; hypandrium with bristly pale hair and pile concentrated at middle of apical ⅓. Basistylus with a thick fold basally on each side and abundant pale bristly hair and pile; 4 long, slightly curved spines, 2 on each side of middle, inner one slightly longer and arising more basally. Dististylus reddish, slender, slightly curved forward. Apical lobes of plates below cercus slightly projecting.

Female.—Unknown.

Variation.—The specimens in the type series differ little, primarily in size (13.5–18.0 mm) and by having 1 or 2 additional white bristles on the hindfemur.

Holotype.—♂ "lights," Camp Capresi, Mona Is., Puerto Rico, Oct. 1956 (W. H. Cross). The holotype is deposited in the USNM collection. Paratypes. ♂ same data; ♂ Mona Is., P.R. 17–28 Apr. 1954 (J. Maldonado Capriles), deposited in the USNM collection and that of the author. A male in poor condition is in the Museum of Entomology, University of Puerto Rico, Rio Piedras. The latter was previously listed as *O. marginellus* from Mona Island, P.R. (Ramos, 1946; Wolcott, 1948).

Discussion.—*Ommatius monensis* is recognized by the white to gray tomentum of the head; white facial hairs and bristles, 2–3 long black proclinate postocular bristles; a strong bulge in the costal margin of the wings of males; black femora, brownish tibiae; black forecoxal bristles; mostly whitish leg vestiture; hind femur with a posterior row of black bristles; basistylus with 4 long, slightly curved spines and an absence of scutellar bristles.

Ommatius monensis is greatly different from the other reported species from the Caribbean area. Its black, robust body, black forecoxal bristles, strong costal bulge of the wing, whitish leg vestiture and terminalia readily separates this species from others.

Etymology.—The species is named after the island on which it was found.

Ommatius falcatus Scarbrough, New Species

Fig. 6

Male.—Length 16.5 mm. Head brown to dark brown; tomentum of face yellow to golden brown, front more brown, occiput light brownish white. Bristles and hairs of face pale yellow to brownish yellow, bristles darkest; proclinate postoculars, ocellars and most antennal bristles brown, those of lower half of antennal segment 1 pale brown; beard and remaining occipital vestiture white. Postoculars straight or curve forward slightly near tips. Antennal segments about same length,

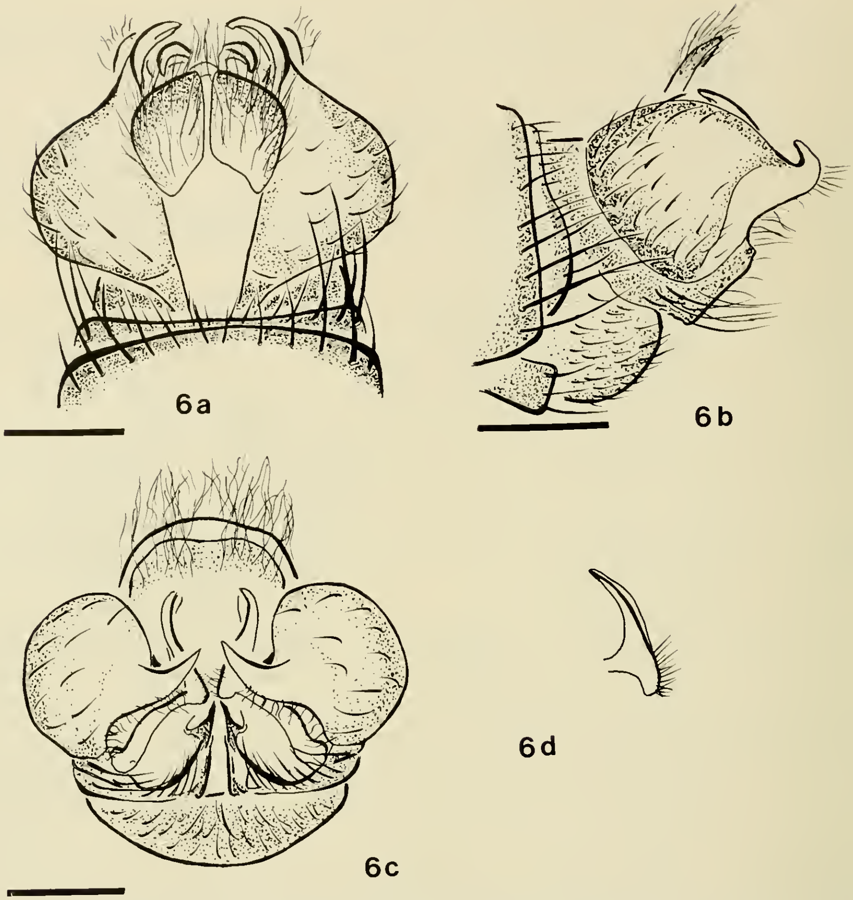


Fig. 6. *Ommatius falcatus* n. sp., male terminalia: (a) dorsal, (b) lateral, and (c) apical views; (d) left diststylus. See Figures 1–4 for parts of terminalia. Horizontal bar = 0.5 mm.

third slightly longer than wide, style slightly more than twice length of all segments combined.

Thorax brown.—Scutum with brown pollen; grooves, sides, prescutellum and scutellum pollinosity yellow to brownish yellow. Pile of thorax pale yellowish to white, most abundant on prothorax and humeral callus, sparse on pleuron, between dorsocentrals and on scutellum. Chaetotaxy: 2 notopleurals, 1 supraalar and 1 postalar; 2–3 pale, weak prescutellar dorsocentrals; row of pleural bristles pale brownish yellow. Marginal scutellar bristles absent. Halter yellow.

Wings hyaline with a moderate costal bulge anteriorly. Marginal and submarginal cells brownish, costal and subcostal cells somewhat yellowish. Crossvein r-m before middle of discal cell; second posterior cell somewhat constricted beyond middle.

Legs.—Coxae brown with yellowish pollen, pile, and bristles. Femora orangish yellow to orange with black as follows: apical halves along anterior and dorsal surfaces of fore- and midfemora, apical ½ of hindtibiae, apical ⅘ of hindfemur, and narrow apical band on midtibiae; tarsi mostly dark brown or black with basal tarsomeres of fore- and midtarsi brownish yellow to orange. Bristles of femora and tibiae primarily orangish, slightly lighter on forelegs; tibial apices with black bristles, 3 additional black ones before apices on mid- and hindtibiae; midfemur with 4 black bristles on anterior surface and 1 on posteroapical surface; hindfemur with 3 black bristles in anteroventral row and 7–8 in posteroventral row. Tarsal bristles black except for 2–3 orangish ones on foretarsus. Legs with fine yellowish pile, some black in black areas; tibiae with short appressed black setulae and a few thin, long black hairs ventrally on foretibia.

Abdomen brown, lightest along apical margins of segments, with brownish to yellow pollen, lightest pollen laterally and ventrally on segments. Bristles and pile primarily yellowish with a few pale brown bristles on tergite 1; brown setae and a few bristly hairs and several longer yellow hairs on apical corners of tergites 6–8. Tergite 8 short, only partially exposed; sternite 8 concealed by sternite 7.

Terminalia (Fig. 6) mostly dark brown with lower surface and apex of epandrium reddish. Epandrium greatly swollen on basal ⅔ or more, tapering abruptly and becoming sickle-like apically; the distal margin with long fine hairs along much of its length, stronger dark hairs basally. Hypandrium slightly swollen and with yellow hairs. Basistylus with a somewhat circular basal ridge, forming a sharp finger-like spine. Dististylus slender, slightly curved forward and narrowed toward tip; cercus brownish, short and with pale yellow pile.

Female.—Unknown.

Holotype.—♂ Maricao, Puerto Rico, Nov. ?. 1956 (C. Valarques). The type is deposited in the USNM collection, Washington, D.C.

Discussion.—*Ommatius falcatus* is recognized by the pale yellow to brownish yellow facial hairs and bristles, yellow to golden brown facial tomentum, a moderate costal bulge in the wing, brownish marginal and submarginal cells yellowish costal and subcostal cells, a slight constriction in the second posterior cell, an epandrium with apical ⅓ sickle-shaped, dististylus slightly curved forward, and the absence of scutellar marginal bristles.

Ommatius falcatus is similar to the Puerto Rican *O. marginellus* but is easily recognized by a slightly larger body, yellow halter, yellowish costal and subcostal cells, and the sickle-shaped apical ⅓ of the epandrium.

Etymology.—The species is named after the sickle-shaped apical portion of the epandrium.

Ommatius vitreus Bigot

Ommatius vitreus Bigot, 1895: 246, type locality: Haiti, Type ♀; Martin and Papavero, 1970: 60, removed from synonymy.
Ommatius marginellus: Hull, 1962: 435, listed *O. vitreus* as a synonym.

Scarbrough (in press) redescribed the female lectotype and described the male.

A single female specimen captured on Mona Island (Los Pinas 23 Oct. 1955, W. H. Cross) differs from specimens reported from Hispaniola in that the facial hairs are wholly white rather than 4–6 hairs being dark brown to black; the facial tomentum and abdominal pollen are white to gray rather than the typical yellowish white; hairs and bristles of the legs are white rather than yellowish.

Ommatius tibialis Say

Ommatius tibialis Say, 1923: 49 (1859: 63), type locality: U.S.A. Pennsylvania, ♂, ♀; Martin and Papavero, 1970: 60.

Although Martin and Papavero (1970) list this species from Puerto Rico and the Virgin Islands, it is doubtful that it actually occurs there or elsewhere in the Caribbean. Its nearest reported locality is Florida (U.S.A.). Males of *O. tibialis* are easily recognized by having the epandrium excavated on the apical ⅓ to ½ of its dorsal surface and by an absence of marginal scutellar bristles. Unfortunately, the male terminalia were not used until recently to separate species in the Caribbean. Furthermore, *O. marginellus* was the only species in the area thought to have marginal bristles, and thus specimens without this character were arbitrarily identified as *O. tibialis.* However, none of the specimens which I have examined from the middle Caribbean Islands or southward has an excavated epandrium or other diagnostic characters of *O. tibialis.* Thus I propose to remove *O. tibialis* from the list of Caribbean Asilidae.

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PROC. ENTOMOL. SOC. WASH.
86(3), 1984, pp. 630–634

A NEW SAND-DUNE-INHABITING *NOVELSIS* (COLEOPTERA: DERMESTIDAE) FROM CALIFORNIA AND NEVADA

R. S. Beal, Jr.

Department of Biological Sciences, Northern Arizona University, Flagstaff, Arizona 86011.

Abstract.—Adult and larval stages of *Novelsis sabulorum,* n. sp., from California and Nevada sand deserts are described. The fossorial adaptations of the species are unique among the Dermestidae.

In the course of investigating beetles inhabiting California sand dunes, Fred G. Andrews of the Insect Taxonomy Laboratory of the California Department of Food and Agriculture found a new unusual larva by sifting sand at the Algodones Dunes near Glamis, Imperial County. The adult exhibits tibial structures apparently developed for digging in sand. Fossorial adaptations are unknown in any other Nearctic dermestid species. Andrews, Hardy and Giuliani (1979) speculated that this species is a sand obligate. This seems to be confirmed by the discovery of additional specimens in Nevada, all from sandy desert areas. The adult and mature larva of the species are described herewith.

Novelsis sabulorum Beal, New Species

Adult male.—Integument of head dark brown; integument of pronotum medium brown; integument of elytra medium brown at basal ⅕ becoming light tan on apical ⅘; ventral surfaces, legs and antennal club medium brown. Pubescence of head brownish black, subrecumbent. Pubescence of pronotum brownish black on disc, recumbent; pubescence on pronotal lobe, posterior margin and lateral margins pale golden white; hairs of margins projecting (although hairs of holotype somewhat unnaturally glued down by collecting fluid), long, some longer than length of front tibia. Pubescence of elytra of recumbent and suberect hairs; hairs on basal ⅕ subrecumbent, brownish black with some intermingled pale hairs; hairs on apical ⅘ mostly subrecumbent pale golden white with many fewer intermingled subrecumbent and suberect brownish black hairs; some black hairs arranged in poorly defined rows; hairs on lateral margins all suberect, pale golden white, long at elytral base becoming shorter toward apex. Eye rounding and not emarginate above base of antenna but with very small emargination behind base of antenna. Antenna (Fig. 2) 11-segmented, extending in repose to about middle of abdominal segment 1; flagellar shaft ⅔ as long as segment 1 of club, ⅛ as long as total length of club; ratio of length of terminal segment to combined length of pronotum and elytra 1:3.6. Channel in front of eye for reception of flagellar shaft very slightly concave; anterior margin forming short, low, threadlike carina not visibly projecting from side of head when seen from front; carina terminating before base of maxilla. Pronotum with lateral carina becoming evanescent around anterolateral angle; basal lobe very little produced and broadly and slightly emarginate at apex. Scutellum narrow, slightly prominent. Ventral surfaces covered with long, pale golden white hairs. Hypomeron slightly inflated, not contiguous with hind margin of lateral lobe of prosternum so that trochantin well exposed. Prosternum with posterior margin of lateral lobe slightly reflexed; posterior process extending posteriad almost to apex of front coxae when coxae in repose; apex of process not expanded; disc without longitudinal carina, without distinct lateral carina before anterior margin and without median anterior denticle. Epipleuron indistinctly formed, scarcely apparent beyond middle of lateral margin of metasternal episternum. Ventral plate of hind coxa not forming tooth but length of plate from point of insertion of trochanter diminishing more or less gradually for entire width; plate extending behind metasternal episternum but not quite attaining metasternal epimeron. Legs covered with long, pale golden white hairs; length of longest hairs ⅔ length of hindfemur. All tibiae with long outer and somewhat shorter inner apical spines; longer spine on front leg extending to apex of tarsal segment 2 (Fig. 3). Foretibia not carinate on dorsal margin. Midfemur with ventral surfaces somewhat flattened but without crural cavity.

Length (of pronotum and elytra): 3.9 mm; width (across humeri): 1.8 mm.

Adult female.—Unknown.

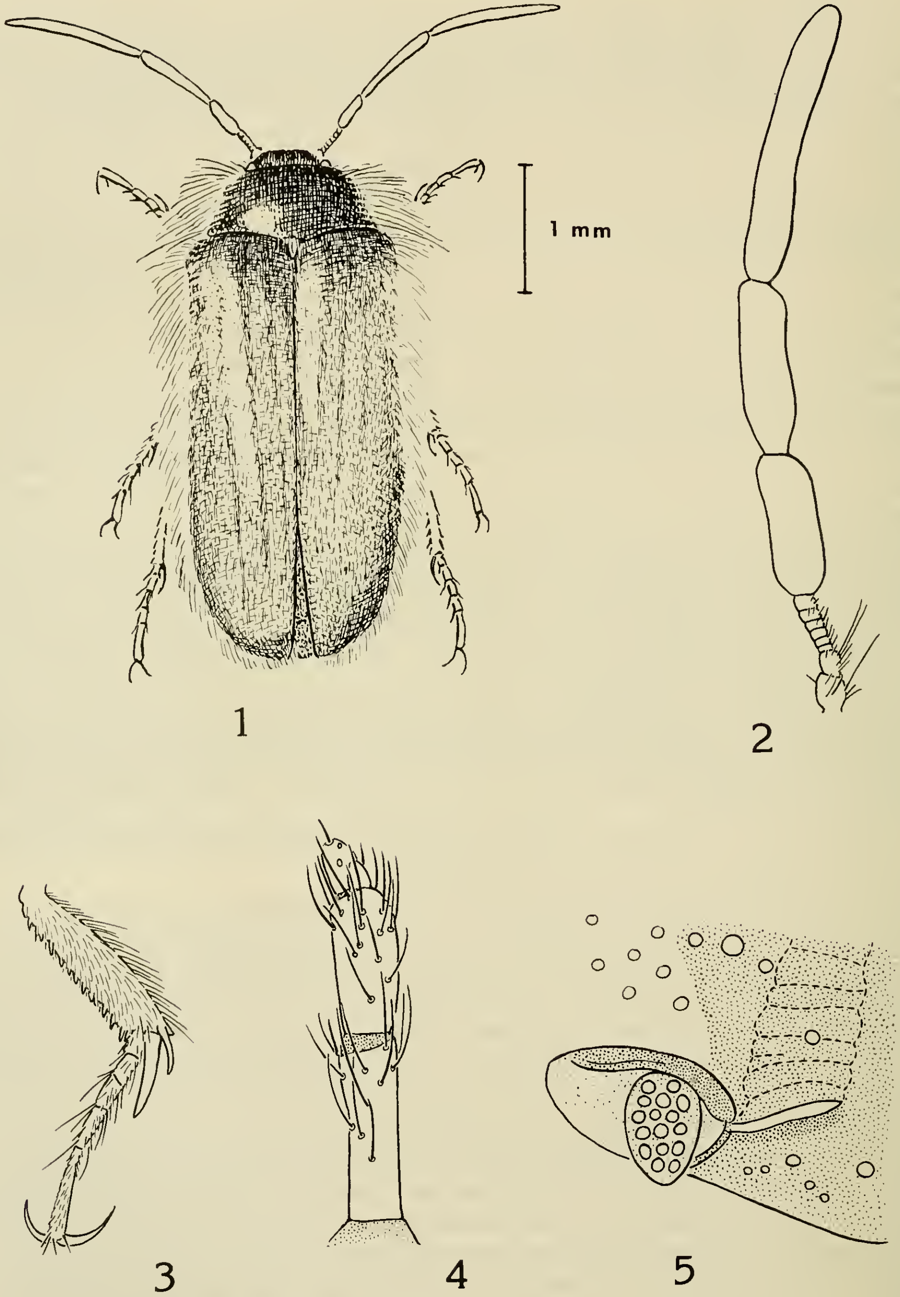
Range of observed variations.—Elytra with or without darkly colored integument at basal ⅕; pubescence of all pale hairs to almost equal number of dark and pale hairs. Length varying from 3.6 to 4.5 mm. Ratio of width to length varying from 1:2.10 to 1:2.36.

Mature larva.—Integument of head and dorsal surfaces yellowish; color of setae (based on appearance of exuviae) light golden.

Head: Antenna (Fig. 4) with ratio of length of segment 3 to segment 2 1:2.3; ratio of length of segment 3 to segment 1 1:3.2; accessory papilla entirely terminal, ½ as long as segment 3; segment 2 with numerous setae inserted from basal ⅓ to apex; terminal seta about ½ as long as length of segment 3. Epipharynx with proximal series of 17 sensory pits, middle series of 6 sensory papillae and distal series of 2 widely separated sensory pits. Maxillary palpus with 4 setae inserted on segment 3. Labium with 11 simple setae inserted on dorsal surface of each lobe of ligula; palpus without setae on basal segment.

Body setae: Margins of all setae smooth. Anterior part of terga with fine, simple setae varying in length from ¼ to subequal to length of tergum. Terga without submarginal erect setae; disc rather densely clothed with long, fine setae, some 3 times length of tergum, and with numerous linear-lanceolate setae ½ to ⅔ as long as length of sclerotized area of tergum; linear-lanceolate setae faintly and minutely longitudinally ribbed with smooth margins; posterior margin of tergum with row of numerous linear-lanceolate setae. Sterna with long, simple setae on anterior part of each segment, intermingled simple and linear-lanceolate setae on disc and dense row of linear-lanceolate setae along posterior margin.

Spiracle and associated structures: Spiracle closed behind by tergum; opening slit-like; anterior margin more or less straight; posterior margin somewhat thickened; slit connecting laterally with emargination formed in tergum for reception



Figs. 1–5. *Novelsis sabulorum.* 1, Adult male habitus. 2, Antenna of adult male. 3, Front view of left tibia and tarsus of adult male. 4, Antenna of larva. 5, Spiracle and spiracular sclerite from abdominal segment 3 of larva. Circles represent points of insertion of setae; the size of the circle is roughly proportional to the size of the seta.

of spiracular sclerite. Spiracular sclerite ovate, not enclosed by tergum; 12 to 20 setae inserted in sclerite. Area of tergum in front of spiracular sclerite forming sclerotized ridge projecting somewhat laterad of tergum so that spiracular sclerite and ridge appear partially separated from tergum (Fig. 5).

Terga and abdomen: All segments of body without antecostal suture. Abdominal tergum 9 about ¾ as long as tergum 8. Distinct sclerites not apparent in sternum of abdominal segment 9.

Legs: Femur of foreleg about 2 times as long as wide. Two pair of longer stout setae on ventral side of tibia about ⅔ as long as length of pretarsal claw. Setae at base of pretarsus slender, subequal in width and length, extending to about middle of claw.

Type specimens.—Holotype ♂ and 2 ♂ paratypes, Blow Sand Mountains, T 15 N, R 20 E, Churchill County, Nevada, August 2, 1979 (R. C. Bechtel, L. M. Hanks, D. L. Horton, R. W. Rust). Additional paratypes as follows: 5 ♂, Indian Lake-sand, Churchill County, Nevada, "VIII–23/11–13 1980" (J. B. Knight); 1 ♂ with 2 larval skin casts, Glamis, Imperial County, California, as larva April, 1968, reared August, 1969 (Fred G. Andrews). Holotype and 1 paratype deposited in the California Academy of Sciences. Additional paratypes deposited in the collections of the Nevada Insect Survey, Nevada State Department of Agriculture, the National Museum of Natural History, and the author.

Etymology.—*Sabulorum* is a Latin genitive plural neuter noun meaning "of the sands."

Diagnosis.—Adults of this species are distinguished from all other known Attagenini by the long spine at the apex of each tibia, which on the forelegs extends to the apex of tarsal segment 2. An additional character, which separates *N. sabulorum* from other described species of *Novelsis,* is the exceptionally long setae of the body and legs, some hairs of the hind legs being ⅔ the length of the femur. In *N. picta* Casey, which bears longer hairs on the legs than any other previously described species, the longest hairs are no more than ⅕ the length of the hind femur.

Larvae are easily distinguished from all other described larval Attagenini by the lack of an antecostal suture on all thoracic and abdominal segments. In the key to known mature larvae of Nearctic Attagenini published by Beal (1970), this character could be run in before the first couplet to separate *N. sabulorum* before considering other species. Additionally, this species has a large number of setae inserted on antennal segment 2, a character shared among known larvae of Attagenini only by *Attagenus fasciatus* (Thunberg).

Comments.—The systematic position of this species needs further investigation, a need that in this author's opinion will be fully satisfied only with a world-wide generic revision of the tribe. Adults, at least superficially, seem to be close to other species of *Novelsis.* The elongated shape of the antennal club and the elongated shape of the body seem to place the species in the group that includes *N. horni* Jayne, *N. andersoni* Beal, *N. picta* Casey, and *N. timia* Beal. On the other hand, the exposed foretrochantin and lack of a tooth on the metacoxal plate associate the species with *N. athlophora* Beal and *A. bicolor* Harold. In contrast, larval characters point to a closer alignment with a group of species clustered around *Attagenus pellio* (L.), the type species for *Attagenus.* In common with *A. pellio* the epipharynx possesses a distal set of 2 sensory cups, which are lacking in *N. horni, N. andersoni* and *N. uteana* Casey. The broad dorsal setae with smooth margins and numerous longitudinal ribs are more like those of *A. pellio* than species of *Novelsis*. Conceivably the species might be removed to a separate genus along with *A. bicolor* and *N. athlophora* or even a new monotypical genus established for it.

Andrews reared the larva he collected to maturity on a diet of dead mealworms, suggesting that the species is a scavenger on dried protein materials, as are other species of *Novelsis* for which the larval habitats are known (Beal, 1954). Beyond this, one can only speculate on the possible habitats of the larvae. It is possible they live in the nests of sand-burrowing wasps or bees.

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I extend my best thanks to Fred G. Andrews, Systematic Entomologist, Division of Plant Industry, California Department of Food and Agriculture, and Robert C. Bechtel, Survey and Systematic Entomologist, Division of Plant Industry, Nevada Department of Agriculture, for the loan of specimens used in this study. I also thank Fred G. Andrews for a critical reading of the manuscript.

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A NEW GENUS AND TWO NEW SPECIES OF BLENNOCAMPINAE (HYMENOPTERA: TENTHREDINIDAE) FROM JAPAN AND TAIWAN

Ichiji Togashi

Ishikawa Prefecture College of Agriculture, Suematsu, Nonoichi-machi, Ishikawa Prefecture, 921, Japan.

Abstract.—A new genus, ***Esehabachia,*** with two new species, *E.* ***luteipes*** from Japan and *E.* ***satoi*** from Taiwan, are described.

Recently, I found a few sawflies that belong to the subfamily Blennocampinae. After examination of these specimens and comparisons with the descriptions of the genera and species, I concluded that they belong to two new species for which a new genus must be erected. These are described in this paper. All type specimens are deposited in the National Science Museum (Natural History), Tokyo.

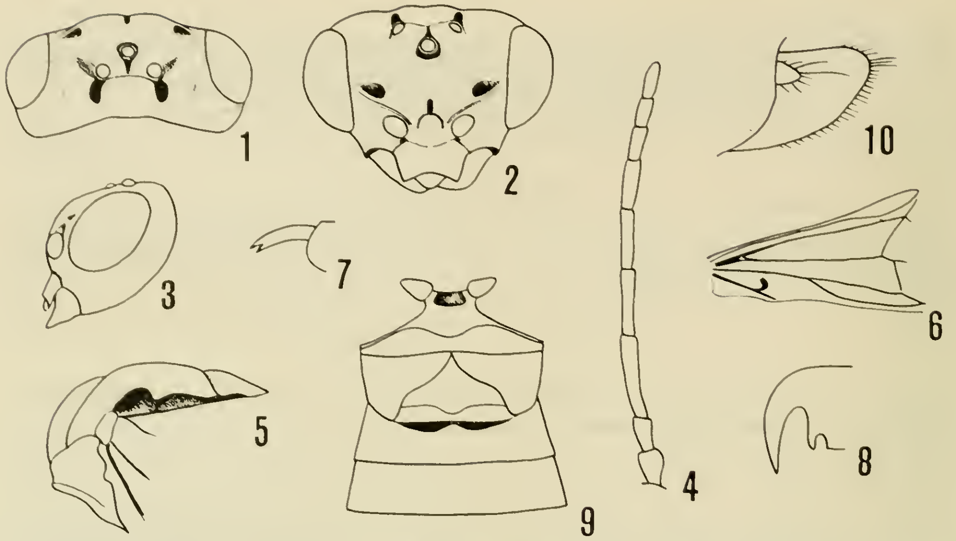
Esehabachia **Togashi, New Genus**

Description.—Body rather slender. Labrum short and rounded; clypeus shallowly emarginate; malar space wide, about 1.5× diameter of front ocellus; postorbital groove absent; postgenal carina absent; antenna filiform, pedicel about 2× longer than apical width, 3rd segment slightly longer than 4th, apical 3 segments with ventral pale areas; prepectus absent; posterior margin of propodeum triangularly emarginate; sawsheath broad in lateral view. First cubital crossvein of forewing absent; 3 cubital cells; stub of analis of forewing furcate at apex; hindwing without a middle cell. Inner spur of foretibia furcate at apex; claw with small tooth and basal lobe.

Type-species.—*Esehabachia luteipes* sp. nov.

Distribution.—Eastern Asia (Japan and Taiwan).

Remarks.—This new genus is closely allied to the subgenus *Veratra* Smith of the genus *Rhadinoceraea* Konow from North America, but it is distinguished from the latter by the form of the claw (in *Veratra,* the claw is simple); by the clypeus (in *Veratra,* the front margin of the clypeus is truncate); and by the absence of the first cubital crossvein of the forewing (in *Veratra,* the first cubital crossvein of the forewing is present). From *Habachia* Takeuchi from Japan, it is separated by the small and short labrum (in *Habachia,* the labrum is large and long); by the stub of the analis of the forewing (in *Habachia,* the stub of the analis is straight); and by the absence of the postorbital groove (in *Habachia,* the postorbital groove is present). In Okutani's (1972) key to Japanese Blennocampinae, *Esehabachia* keys to *Periclista* Konow, but in *Periclista* the stub of the analis of the forewing is curved up, the malar space is short, and the propodeum is not emarginate. The combination of the inner tooth and basal lobe of the tarsal claw, the furcate stub



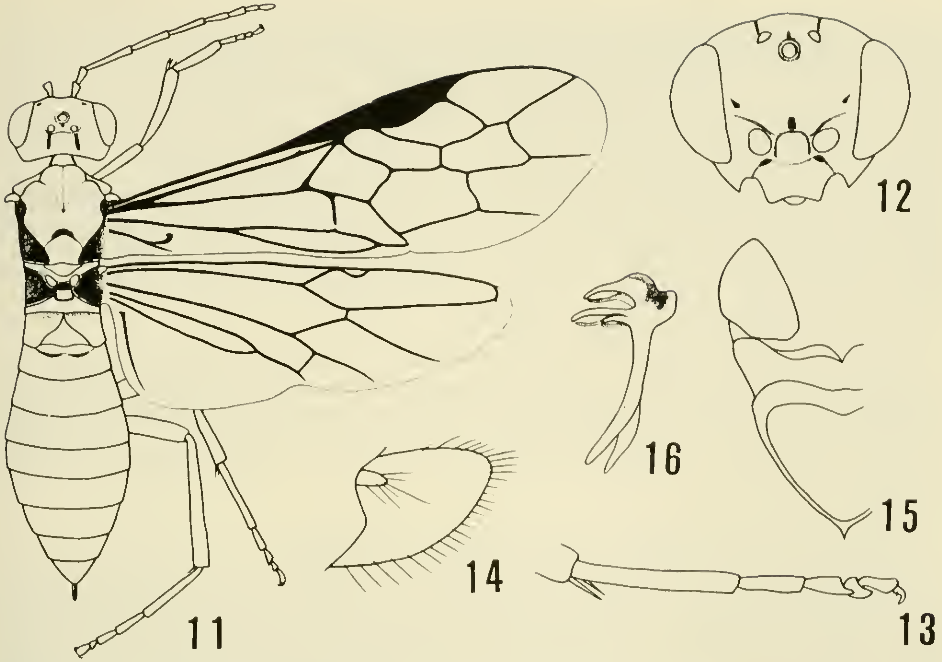
Figs. 1–10. *Esehabachia luteipes.* 1, Head, dorsal view. 2, Head, front view. 3, Head in profile. 4, Antenna. 5, Pro- and mesonotum, lateral view. 6, Basal portion of forewing. 7, Inner spur of front tibia. 8, Claw. 9, Cenchri and propodeum. 10, Sawsheath, lateral view.

of the analis and absence of the first cubital crossvein of the forewing, the absence of cell M in the hindwing, the long malar space, and the deeply emarginate propodeum will separate this genus from all other genera of Blennocampinae.

Esehabachia luteipes Togashi, New Species
Figs. 1–10

Female.—Length 5 mm. Body black with the following parts pale yellow: inner and hind orbits, genae, face below frontal crest, supraclypeal area, clypeus, labrum, malar space, mandible except for reddish-orange apex, palpi, latero-posterior portion of pronotum, tegulae, parapteron, cenchri, cerci, and lower ⅔ of sawsheath. Antenna mostly black, venter brown. Wings slightly yellowish hyaline; costa and stigma of forewing pale yellow, other veins brown. Legs mostly pale yellow, basal portion of coxae dark brown.

Head seen from above transverse, narrowing behind eyes; eyes large, about 4× as long as temples in dorsal view; OOL : POL : OCL = 1.3:1.0:1.1; postocellar area transverse, gently convex; lateral furrows distinct and deep; postocellar furrow linear; interocellar furrow rather shallow; circumocellar furrow distinct; area just in front of front ocellus depressed and connected with the frontal portion of circumocellar furrow; frontal area gently elevated, nearly flattened; median fovea elongate and deep; lateral foveae large and deep, situated on lateral sides of frontal area; supraclypeal area slightly convex and surrounded by suture, but lower margin absent; malar space wide, about 1.5× as wide as diameter of front ocellus; clypeus slightly convex, anterior margin slightly emarginate; labrum small, rounded apically. Antenna filiform, slightly shorter than costa of forewing (ratio between them about 0.9:1.0), relative lengths of segments about 0.9:1.0:2.4:1.9:1.8:1.5:0.9:0.9:1.0; pedicel long, about twice as long as apical width.



Figs. 11–16. *Esehabachia satoi.* 11, Dorsal view. 12, Head, front view. 13, Hind tarsus, lateral view. 14, Sawsheath, lateral view. 15, Male genitalia, left half. 16, Penis valve.

Thorax: frontal portion of prescutum convex anteriorly in lateral view; mesoscutellum slightly convex. Wings: apex of costa of forewing dilated; anal cell of hindwing with long petiole. Legs: hindbasitarsus nearly as long as following segments combined.

Abdomen: sawsheath broad in lateral view; cerci broad in lateral view.

Head minutely and densely punctured, rather opaque; mesonotum and mesoscutellum minutely and coarsely punctured, shining; posttergite, metascutellum and metanotum nearly impunctate, shining; under thorax covered with minute and scattered punctures, shining; abdominal tergites shagreened.

Male.—Unknown.

Distribution.—Japan (Honshu).

Holotype.—♀, Chugu Spa, foot of Mt. Hakusan, Ishikawa Prefecture, June 25, 1974, I. Togashi leg.

***Esehabachia satoi* Togashi, New Species**

Figs. 11–16

Female.—Length 5.4 mm. Head and thorax dark brown with following parts pale yellow: face below frontal crest, clypeus, labrum, malar space, mandible except for red apex, pronotum, tegulae, parapteron, and cenchri. Abdomen pale yellow with following parts brown to dark brown: propodeum, tergites 2 and 7–9, and sawsheath. Antenna dark brown though scape and venter of apical 3 segments pale reddish yellow. Wings slightly yellowish hyaline; stigma and veins brown. Legs entirely pale yellow.

Head seen from above transverse, narrowing behind eyes; eyes large, about 2.8 × as long as temples in dorsal view; OOL : POL : OCL = 1.2:1.0:1.1; postocellar area transverse, nearly flattened; lateral furrows distinct and deep; postocellar furrow slightly depressed; interocellar furrow distinct but short; circumocellar furrow distinct; frontal area slightly convex; median fovea depressed; lateral foveae distinct, situated on lateral sides of face; supraclypeal area nearly flattened; frontal margin of clypeus slightly emarginate; malar space slightly longer than diameter of front ocellus. Antenna filiform, shorter than costa of forewing (ratio between them about 1.0:1.2), relative lengths of segments about 1.4:1.0:3.3:3.0:2.6:1.9: 1.3:1.0:1.4; pedicel about 2 × as long as apical width.

Thorax and abdomen as in *E. luteipes.*

Head and thorax covered with minute and scattered punctures, shining; propodeum nearly impunctate, polished; tergites 2–9 nearly impunctate, shining.

Male.—Length 5 mm. Coloration and structure similar to those of female except for sexual segments. Apical margin of subgenital plate nearly truncate. Genitalia as in Figs. 15 and 16.

Distribution.—Taiwan.

Holotype.—♀, Mt. Arisan, May 27, 1929, K. Sato leg.

Paratype.—1 ♂, same locality as holotype.

Remarks.—This new species and *E. luteipes* are separated by the coloration of the abdomen (in *luteipes,* the abdomen is black), by the punctuation of head (in *luteipes,* the head is covered with dense and minute punctures), and by the length of the malar space (in *luteipes,* the length of the malar space is 1.5 × as long as the diameter of front ocellus).

The left wings of the holotype are missing. I believe the wings were removed by Mr. K. Sato himself for study, but they have not been found in his collection.

ACKNOWLEDGMENTS

I express my hearty thanks to Y. Kurosawa and M. Owada of the National Science Museum, Tokyo, for their fine cooperation in allowing me to study the Sato collection, and to David R. Smith, Systematic Entomology Laboratory, USDA, Washington, D.C., for his kind advice and review of the manuscript.

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A NEW SPECIES OF *TRIPUDIA* GROTE (LEPIDOPTERA: NOCTUIDAE) FROM WESTERN TEXAS

André Blanchard and Edward C. Knudson

(AB) 3023 Underwood, Houston, Texas 77025; (ECK) 808 Woodstock, Bellaire, Texas 77401.

Abstract.—*Tripudia chihuahua* is described. Male and female imagines, genitalia, and male wing venation are figured. The species occurs in the Chihuahuan desert of western Texas.

This new species is well known to the authors because it is not uncommon in the Chihuahuan desert habitat of west Texas, especially in Big Bend National Park. It has remained undescribed for many years, and in some collections was probably misidentified as *Tripudia inquaesita* (Barnes & Benjamin) due to superficial similarity to that species.

Tripudia chihuahua **A. Blanchard & E. Knudson,** New Species

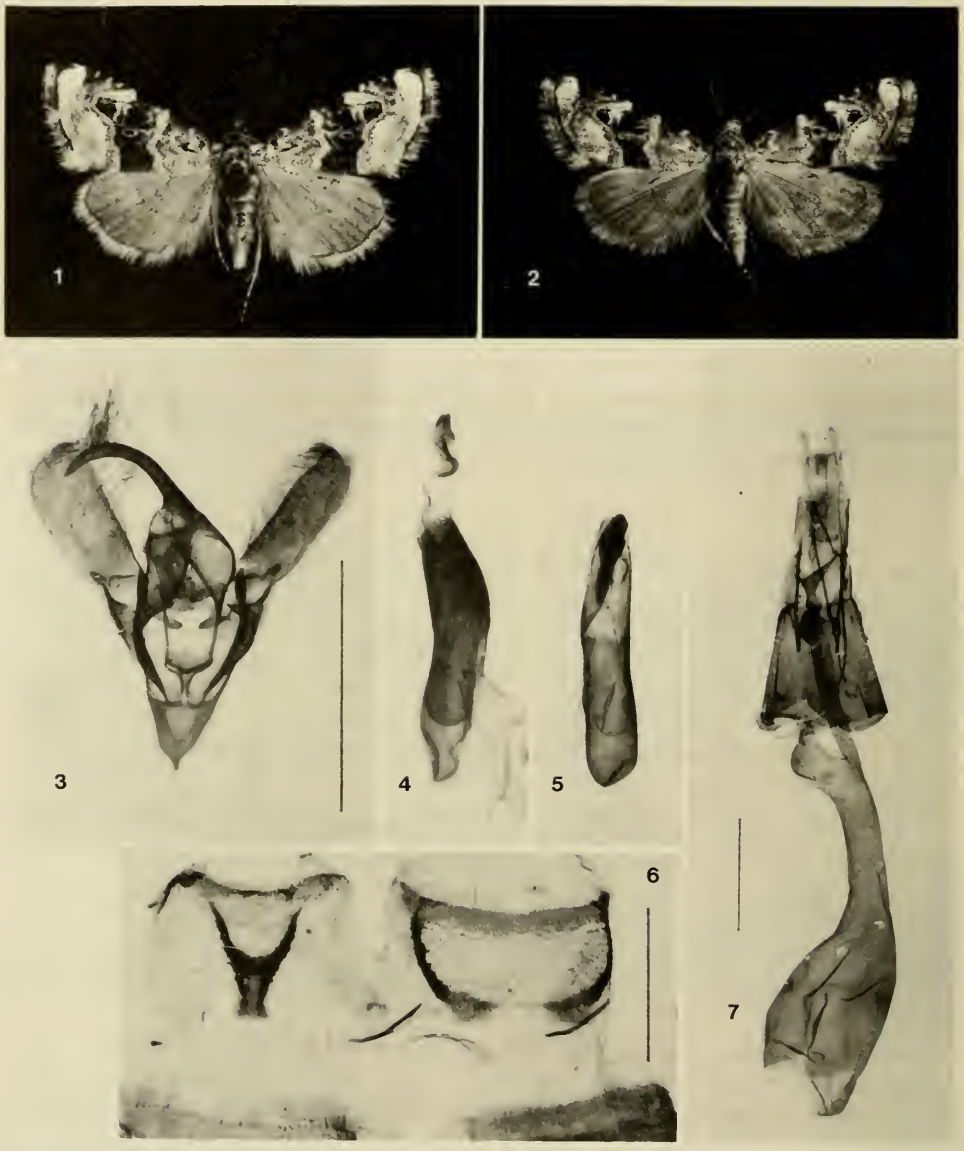
Figs. 1–9

Head.—Front rounded, slightly protruding, smooth scaled, cream color with a few blackish brown scales laterally. Vertex clothed with anteriorly directed rows of scales, slightly erect between antennal bases, cream color, with some blackish brown scales between antennal bases. Labial palpi upcurved to slightly above eye; cream color with some blackish brown scales on lateral surface. Ocelli present. Antennae simple, light brown dorso-laterally, minutely setose ventrally, scape whitish.

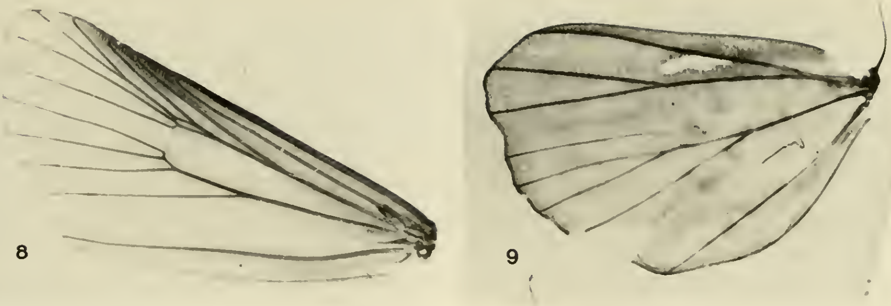
Thorax.—Tegulae, patagia, and mesonotum cream color with variable irroration of blackish brown. Posterior tuft light brown, relatively flattened and smooth. Legs with femora and tibiae mainly whitish, tarsi dark brown with whitish bands at the joints.

Abdomen.—Cream color with brown bands at anterior margins of segments dorsally, entirely cream color ventrally. Small flat mid-dorsal tufts on 1st and 2nd segments; slightly larger raised dorsal tuft on 3rd segment.

Forewings.—Multicolored in various shades of brown, gray, black, pink, and white. Antemedial band extending from costa at inner ⅖, slightly outwardly angled below cell, joining dorsal margin at inner ⅓; outer line black, inner line medium brown, enclosing a pale center, which is pinkish near costa and light brown over median area to dorsal margin. Basad of the antemedial band, ground color is mainly brown, becoming darker toward costa, interrupted by a wavy basal half line, which is whitish, and 2 black spots below cell. Median area contrastingly dark brown, with patches of black scales between orbicular and reniform, and



Figs. 1–7. *Tripudia chihuahua.* 1, Holotype male, Big Bend Nat'l. Park, Texas, Chihuahuan Desert near Nugent Mt., 8-X-69, A. & M. E. Blanchard coll. 2, Paratype female, same data as holotype. 3, Male genitalia of paratype, aedeagus removed, on slide ECK 755, Culberson Co., Texas, 10 miles N. of Van Horn, 2-IX-79, E. Knudson coll. 4, Aedeagus with manica intact, same specimen as Fig. 3. 5, Aedeagus with manica removed, from slide ECK 762, same locality as holotype, 13-IX-82, E. Knudson coll. 6, Sclerotizations of 8th abdominal segment of male, slide ECK 754, Culberson Co., Texas, 10 mi N. of Van Horn, 2-IX-79, E. Knudson coll. 7, Female genitalia of paratype, on slide ECK 657, same locality as holotype, 13-IX-82, E. Knudson coll. The segment in Figs. 3, 4, 5, and 7 represents 1 mm, in Fig. 6, it represents 0.5 mm.



Figs. 8–9. Wing venation of male. 8, Forewing venation of male, slide AB 2769, same locality as holotype, 10-IV-67, A. & M. E. Blanchard coll. 9, Hindwing venation of male, same specimen as Fig. 8.

patch of steely gray scales near near dorsal margin. Orbicular ovoid, blackish, ringed with white. Reniform quadrangular, slightly constricted near middle, brown, spotted with black and ringed with white. Subreniform displaced inward, barely touching orbicular and similar to it in form and color, although smaller and paler. Postmedial band extending from costa at outer ⅖; outwardly rounded well beyond reniform and thence nearly vertical to dorsum at outer ⅖; inner line black, outer line brown, enclosing a paler center, which is pinkish near costa and light brown over median portion to dorsum. Outer ⅖ of wing mainly white, with a dark brown subapical wedge at costa, including three short white costal dashes, and merging with a variable patch of light brown and gray scales above and at tornus. Terminal line black, narrow, usually continuous. Fringe white speckled with brown and with a broad brownish inner band, which is usually interrupted by white scales at apex, near middle, and at tornus. Undersurface fuscous, except for costa, which is whitish, irrorated with fuscous. Postmedial line faint, dark fuscous, terminal line well defined, blackish.

Hindwing pale fuscous, with darker median line faintly indicated or obsolete; terminal line blackish; fringe whitish. Undersurface whitish, irrorated with fuscous, with faint darker medial line and dark terminal line.

Venation (Figs. 8, 9).—Forewing: Accessory cell small; R$_1$ free, R$_2$ from near base of accessory cell; R$_{3-4}$ stalked for about ½ their length, arising near, but not connate with R$_5$, at the apex of accessory cell. M$_1$ arising from near upper angle of cell. Hindwing: M$_2$ nearly as strong as M$_3$ and Cu$_1$, arising from discocellular vein ¼ the distance from lower angle; M$_3$–Cu$_1$ very short stalked.

Length of forewing.—Males: (N = 20) 8.5–6.8 mm, average 7.8 mm. Females: (N = 20) 8.7–6.8 mm, average 8.0 mm.

Male genitalia (Figs. 3–6).—Fig. 3 is of genitalia with aedeagus removed. Uncus a long curved hook, not expanded at its apex. Valvae with well sclerotized costa basally only, lacking costal process. Sacculus short, moderately expanded, with clavus. Clasper present, with broad ampullary portion. Valvula unmodified, cucullus undifferentiated. Juxta fork-like, with lateral processes extending to near base of tegumen. Fig. 4 is of aedeagus with densely spined manica intact, vesica partially extruded, showing S shaped cornutus. Fig. 5 is of aedeagus with manica removed, vesica not extruded. Fig. 6 is of 8th abdominal segment.

Female genitalia (Fig. 7).—Papillae anales narrow, widely separated, lightly setose. Apophyses posteriores twice the length of apophyses anteriores. Sterigma with genital opening funnel shaped, membranous; ostial chamber constricted and densely scobinate posteriorly, partially sclerotized anteriorly. Ductus bursae ⅓ the length of corpus bursae, lightly scobinate. Corpus bursae with appendix bursae posteriorly, bearing ductus seminalis; globular anteriorly, membranous, except for signa, which consists of a small cluster of scobinations.

Holotype (Fig. 1).—Male, Brewster Co., Texas, Big Bend Nat'l. Park, Chihuahuan desert near Nugent Mt., 8-X-69, collected by A. & M. E. Blanchard and deposited in the National Museum of Natural Histoy History, Washington, D.C.

Paratypes.—Same data as holotype, 6 ♂, 7 ♀; same locality as holotype, 6-IV-67, 1 ♂; 10-IV-67, 3 ♂, 2 ♀; 1-X-67, 3 ♂, 2 ♀; Big Bend Nat'l. Park, Oak Spring, 30-VI-65, 1 ♂, 1 ♀; Dugout Wells, 2-VII-65, 1 ♂; Presidio Co., Texas, Shafter, 9-IX-69, 2 ♂, all collected by A. & M.E. Blanchard. Same location as holotype, 28-IX-81, 1 ♂, 1 ♀; 13-IX-82, 2 ♂, 6 ♀; Big Bend Nat'l. Park, Dugout Wells, 13-IX-82, 1 ♂, 2 ♀; Gov't. Spring, 12-IX-82, 1 ♂; Terrel Co., Texas, Sanderson, 25-IV-81, 2 ♀; Culberson Co., Texas, 10 miles N. of Van Horn, 2-IX-79, 3 ♂, all collected by E. Knudson.

REMARKS

This new species is placed in the genus *Tripudia* Grote for several reasons. Although the male genitalia are unlike any of the seven North American species studied by the authors, the interspecific differences within *Tripudia* are no less than the differences between *chihuahua* and other *Tripudia.* The wing venation agrees with *Tripudia, Cobubatha* Walker, and some species of *Ozarba* Walker. The abdominal tufts are more like those of *Tripudia* than either *Cobubatha* or *Ozarba.* The maculation of the adult is most similar to *Tripudia inquaesita* (B. & Benj.), from which it differs in several respects. In *inquaesita,* the antemedial band is less distinct, with little contrast between the median and basal areas of the wing; the orbicular and subreniform are absent; the subterminal area is not mainly whitish. The genitalia of *inquaesita* also differ greatly from *chihuahua.* Both species occur in Big Bend Nat'l. Park, but *inquaesita* is much less common.

ACKNOWLEDGMENTS

The authors are extremely grateful to J. G. Franclemont and R. W. Poole, for lending specimens for comparison and for reviewing the MS. We are also grateful to E. L. Todd for his prior examination of some of the specimens and his helpful comments and suggestions. Finally, we thank the U.S. National Park Service for providing access to collecting sites in Big Bend National Park.

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NOTES ON TABANIDAE (DIPTERA) OF THE ORIENTAL REGION II. DISTRIBUTION RECORDS OF SOME TABANIDAE FROM SOUTHEASTERN PAKISTAN AND A LIST OF SPECIES FROM PAKISTAN AND ADJACENT AREAS[1]

John F. Burger

Department of Entomology, University of New Hampshire, Durham, New Hampshire 03824.

Abstract.—A recent collection of horse flies from southern Pakistan indicates that this country is a complex transition area between Ethiopian-Eurasian arid-adapted species in the west and south, central Asian montane species in the north and Oriental species in the east. A list of species known to occur in or potentially occurring in Pakistan is given, based on studies in adjacent countries.

Although Pakistan is nominally placed within the Oriental Region, a recent collection of horse flies from the southeastern part of that country indicates that it is, in fact, a complex transition zone between Oriental, southern Palearctic and Ethiopian-Arid Desert species ranges. Since virtually nothing is known of the horse fly fauna of Pakistan, some recent collection records are cited below and a list of species occurring or possibly occurring there is given to facilitate identification of specimens and to stimulate interest in this zoogeographically complex area. Specimens will be deposited in the U.S. National Museum, Washington, D.C. and the collection of the author.

Tabanus dorsilinea Wiedemann

Tabanus dorsilinea (as *T. macer* Bigot) was recorded from Rawalpindi by Senior-White (1927), as well as from several areas in India. Burger (1981) discussed the distribtuion of this species in Sri Lanka and indicated that it is probably specifically distinct from specimens identified as *dorsilinea* by Burton (1978) from Thailand. Burton summarized the synonymy of this species. *Tabanus dorsilinea* is most common in the southern and western parts of India, probably reaching its limit of distribution in western Pakistan, and therefore is clearly part of the Oriental fauna.

Material examined.—1 ♀, PAKISTAN: Sind Prov. Lake Haleji, near Thatta (Tatta), 22 Sept. 1976, G. F. Hevel & R. E. Dietz IV, Collectors.

Tabanus laetitinctus Becker

This species has not previously been reported from Pakistan. It is a southern Palearctic species characteristic of montane-steppe areas in the southern part of

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[1] Scientific Contribution Number 1230 from the New Hampshire Agricultural Experiment Station.

the Soviet Union (southern Turkmenia, Tadzhikstan, Uzbekistan and Kirghizia) (Olsufjev, 1977). It is also recorded from Afghanistan, Iran, Iraq and Turkey. Olsufjev (1977) stated that the larvae are found in irrigation ditches, springs and rivers, from data of Kadyrova (1972). The male from Pakistan is the paler nominative subspecies, *T. laetitinctus laetitinctus* as stated by Olsufjev (1977).

Material examined.—1 ♂, PAKISTAN: Sind Prov., Miani Forest, near Hyderabad, 24 September 1976, Coll. G. F. Hevel & R. E. Dietz IV.

Tabanus sufis **Jaennicke**

Tabanus sufis is widely distributed in the arid and semi-arid parts of northern and northeastern Africa through the Middle East to Pakistan, and appears to be well adapted to arid environments. Excellent taxonomic descriptions of this species are given by Oldroyd (1954) and Efflatoun Bey (1930) and the distribution of this species has been discussed for Africa (Oldroyd, 1954), Egypt (Efflatoun Bey, 1930) and Iran (Abbassian-Lintzen, 1961, 1964). Jezek (1980) has mapped its entire known range from Africa to Pakistan. Senior-White (1927) records a specimen from Punjab in the British Museum (Natural History) collection. Strictly speaking, this species should be considered southern Palearctic, but adventive into semi-arid parts of the Ethiopian Region.

Material examined.—3 ♂, 1 ♀, PAKISTAN: Sind Prov., Miani Forest, near Hyderabad, 24 September 1976, Coll. G. F. Hevel & R. E. Dietz IV.

Discussion

Pakistan can be considered a transition area for Tabanidae, with montane-steppe Palearctic species to the north, Ethiopian-Eurasian arid-adapted species to the west and widely distributed Oriental species to the east. Nothing is known of possible precinctive species in Pakistan. For biogeographic purposes, that part of Pakistan east of the Indus River can be considered part of the Oriental Region, where species from that Region would be expected to occur, with Palearctic adventive elements from the west and north also present. The area west of the Indus River and bordering Iran would support those arid-adapted species commonly found in southeastern Iran. Northern areas adjacent to Afghanistan, the USSR, China and Kashmir are difficult to characterize accurately but species of *Hybomitra* and *Tabanus* known from Afghanistan, the southern USSR and western China would be most likely to occur there.

Based on collection records from areas adjacent to Pakistan, a list of species known to occur or possibly occurring in Pakistan is presented below for future reference. This list is based on records from Iran (Abbassian-Lintzen, 1961, 1964; Jezek, 1980, 1981b; Moucha, 1976), Afghanistan (Moucha & Chvala, 1961, 1963), the USSR (Olsufjev, 1977), India (Ricardo, 1911; Stone, 1975; Stone & Philip, 1974) and general biogeographic information on Palearctic species by Leclercq (1966). As pointed out by Jezek (1981a), it is difficult to ascertain the potential distribution of horse flies without information about the biology and habitat preferences of immature stages, since it is these stages that are most demanding of favorable habitat for development and most limited by arid environment. Until such information is available, only thorough collecting in all suitable biotopes will provide the data necessary to characterize accurately the biogeographic relationships of the horse fly fauna of Pakistan.

LIST OF TABANIDAE OCCURRING IN OR EXPECTED TO OCCUR IN PAKISTAN

Palearctic species.—*Mediterranean-Arid Steppe species:*

Nemorius irritans (Ricardo)
Chrysops flavipes askahabadensis Szilady
Chrysops flavipes gedrosianus Abbassian-Lintzen
Chrysops flavipes punctifer Loew
Haematopota pallens Loew
Atylotus pulchellus (Loew)
Atylotus quadrifarius (Loew)
Hybomitra acuminata (Loew)
**Tabanus ansarii nigrinervis* Abbassian-Lintzen
Tabanus autumnalis brunnescens Szilady
Tabanus canipalpis Bigot
**Tabanus gedrosiae* Abbassian-Lintzen
**Tabanus hashemii* Jezek
Tabanus laetitinctus Becker
Tabanus leclercqi Abbassian-Lintzen
Tabanus leleani Austen
**Tabanus mistschenkoi* Olsufjev
Tabanus mofidii mofidii Leclercq
Tabanus regularis Jaennicke
Tabanus sabuletorum Loew
Tabanus semenovi Olsufjev
Tabanus tinctus Walker
Tabanus unifasciatus Loew
**Tabanus zeirii* Jezek
Tabanus zimini Olsufjev

Boreal-Asian species:

Hybomitra caucasica (Enderlein)
Hybomitra hunnorum (Szilady)
Hybomitra kuhlhorni Leclercq
Hybomitra olsufjeviana olsufjeviana (Moucha & Chvala)
Hybomitra olsufjeviana pseudozonata (Moucha & Chvala)
Hybomitra paulisseni Leclercq
Hybomitra peculiararis var. *kashmirensis* (Szilady)

Ethiopian-Eurasian species:

Tabanus gratus Loew
Tabanus mordax boroumandi Jezek
Tabanus sufis Jaennicke

Oriental species.—*Indo-Malaysian and Widespread species:*

Chrysops dispar Fabricius
Hippocentrodes striatipennis (Brunetti)
Haematopota crossi Stone & Philip
Haematopota fulvipes Stone & Philip
Haematopota kashmirensis Stone & Philip

Atylotus virgo (Wiedemann)
Tabanus dorsilinea Wiedemann
Tabanus flavimedius Schuurmans Stekhoven
Tabanus jucundus Walker
Tabanus nemocallosus Ricardo
Tabanus orientis Walker
Tabanus rubidus Wiedemann
Tabanus striatus Fabricius

*These species are quite local in distribution and would occur in Pakistan only if suitable larval breeding sites are available.

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PROC. ENTOMOL. SOC. WASH.
86(3), 1984, p. 647

NOTE

Two name changes for Neotropical Streblidae (Diptera)

In 1976 (Wenzel, R., Brigham Young Univ. Sci. Bull., Biol. Ser. 20(4): 1–177), I proposed the name *Phalcophila* for a new genus of batflies collected during a survey of Venezuelan mammals and ectoparasites (Smithsonian Venezuela Project). I thereby created a homonym, for, by a most unusual coincidence, Brennan and Reed (1973, J. Parasitol. 59: 706–710) had proposed the same generic name for a new chigger mite collected on that survey. A new name is proposed for the streblid taxon as follows:

Phalconomus Wenzel, NEW NAME

Phalcophila Wenzel, 1976: 15 (Type-species: *Phalcophila puliciformis* Wenzel, *loc. cit.*, p. 16) not *Phalcophila* Brennan and Reed, 1973: 708 (type-species: *Phalcophila antica* Brennan and Reed, *loc. cit.*).

In my 1976 paper (p. 127), I also described a new species of *Speiseria,* which I named *S. peytoni,* for Patricia Peyton Johnson. I here emend the trivial name to ***peytonae*** to give the correct ending for this patronymic, which I had inadvertently formed in the masculine gender.

Rupert L. Wenzel, *Field Museum of Natural History, Chicago, Illinois 60605.*

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86(3), 1984, pp. 648–652

A NEW *DIPLOPERLA* FROM WEST VIRGINIA (PLECOPTERA: PERLODIDAE)

Ralph F. Kirchner[1] and Boris C. Kondratieff

(RFK) Department of the Army, Huntington District Corps of Engineers, Water Quality Section, 502 8th Street, Huntington, West Virginia 25701; (BCK) 422 Florida Ave., New Ellenton, South Carolina 29809.

Abstract.—*Diploperla kanawholensis,* n. sp., is described from Braxton and Lewis Counties, West Virginia. The diagnostic features of the adult male and female, egg, and mature nymph are presented. Ecological notes, physical-chemical data, and other associated species of Perlodinae are also given.

While preparing a manual on the stoneflies of Virginia we studied also those from the surrounding states. We collected and reared a new species in the family Perlodidae from the Little Kanawha River in West Virginia.

The eastern Nearctic genus *Diploperla* Needham and Claassen has been reviewed by Stark and Gaufin (1974) and Kondratieff et al. (1981). The new species described here is presently included in the genus *Diploperla* because (1) the presence of well-defined lobes on both the seventh and eighth abdominal sterna of the adult male, and (2) the absence of a long setal fringe on the dorsum of the nymphal cerci. However, the male shares with the Nearctic genus *Cultus* an epiproct being nearly equal to or exceeding the lateral stylets in length. The egg is tortoise shaped as is typical for *Diploperla* and *Cultus.* Conclusive generic placement will have to await future studies on the phylogenetic relationshps among *Diploperla, Cultus,* and related perlodine genera.

Diploperla kanawholensis **Kirchner and Kondratieff** New Species

Figs. 1–10

Adult.—Macropterous. Body length, male 15–16 mm; female 16–18 mm. Forewing length, male 14–15 mm; female 16–18 mm. General color yellow. Head yellow with dark brown markings in ocellar triangle, on clypeus, and behind compound eyes (Fig. 1). Antennae brown. Prothorax and sides of meso- and metapleura brown; prothorax with median yellow stripe. Wings hyaline, veins brown. Legs brown, distal apex of femora and tibiae yellow. Abdomen yellow, darker laterally. Cerci brown.

Male: Seventh and eighth abdominal sterna with well-defined lobes (Fig. 5).

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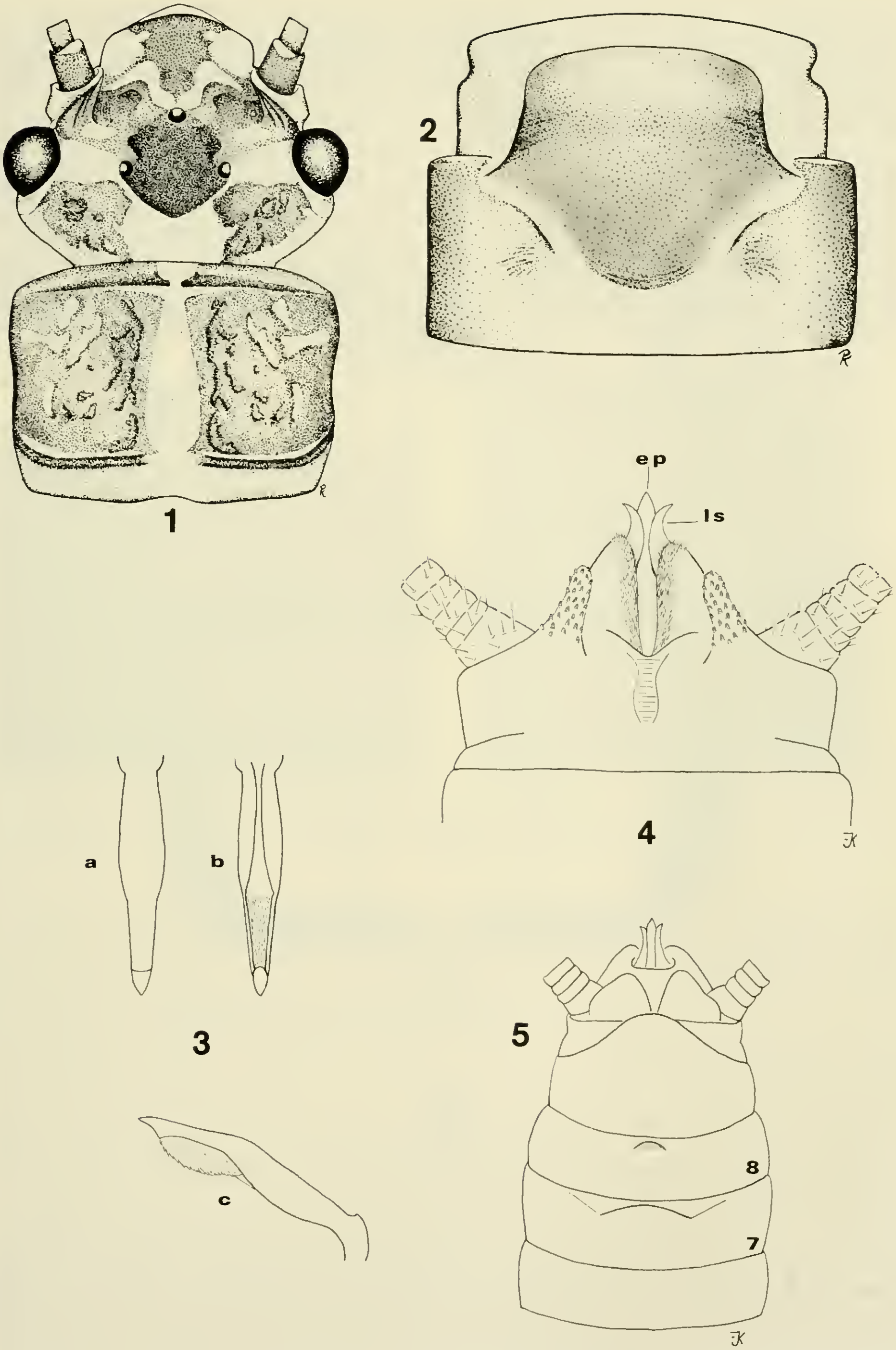
[1] The views of the author do not purport to reflect the position of the Department of the Army or the Department of Defense.



Figs. 1–5. *Diploperla kanawholensis.* 1, Adult head and pronotum. 2, Female subgenital plate, ventral. 3, Male epiproct: a. dorsal, b. ventral, c. lateral. 4, Male terminalia, dorsal (*ep* = epiproct; *ls* = lateral stylets). 5, Male terminalia, ventral.

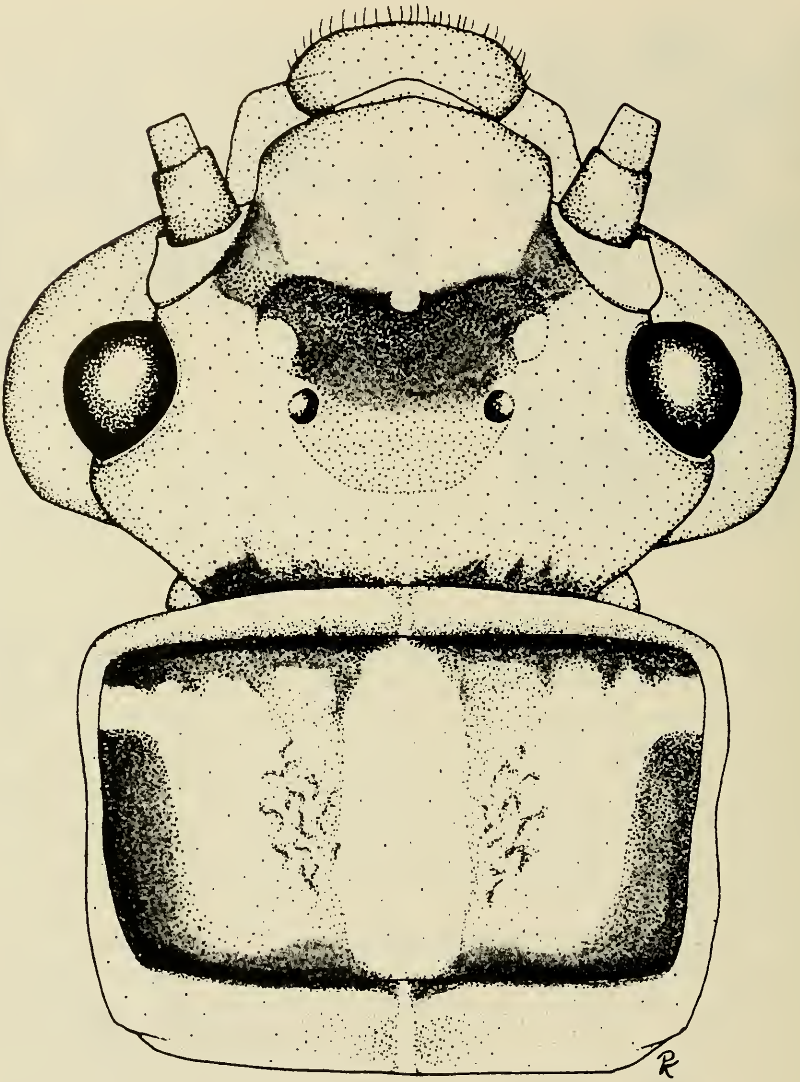


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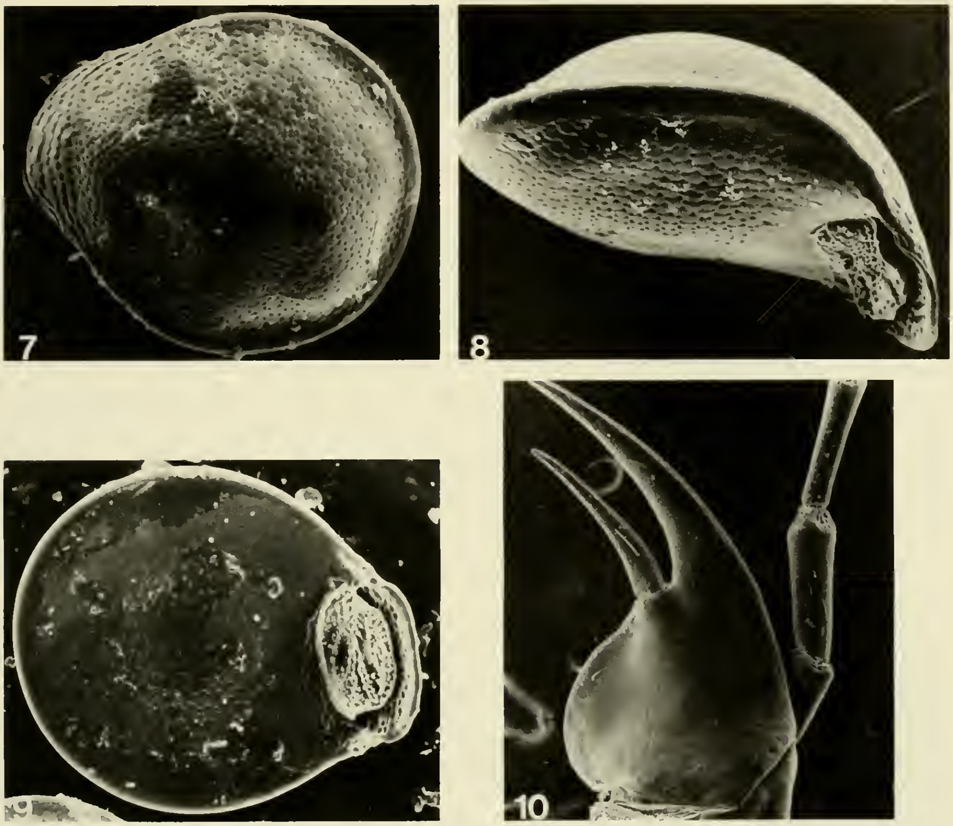
Fig. 6. *Diploperla kanawholensis.* Nymphal head and pronotum.

Tenth tergum cleft behind with long, raised spinulose lobes. Lateral stylets shorter in length than epiproct, tips acute (Fig. 4). Epiproct sclerotized, prominent, long and slender in dorsal view (Fig. 3a); excavated ventrally enclosing an extrudable spinose membrane (Figs. 3b and 3c).

Female: Subgenital plate dark brown, produced over most or all of ninth sternum (Fig. 2), sides nearly parallel, apical margin broadly rounded to nearly truncate.



Figs. 7–10. *Diploperla kanawholensis,* scanning electron photomicrographs. 7, Egg, dorsal, 200×. 8, Egg, lateral, 260×. 9, Egg, ventral, 200×. 10, Mature nymph, left lacinia, 42×.

Egg.—General shape oval, cross section semicircular (Figs. 7–9). Chorion with visor-like extension covering collar (Figs. 7–9). Chorionic punctations in hexagonal pattern ventrally and dorsally, visor coarsely punctate (Figs. 7 and 9). Lateral margin of chorion slightly thickened (Fig. 8).

Nymph.—Length of mature nymph 14–18 mm. General body color yellow. Head with a transverse dark brown band enclosing ocellar triangle (Fig. 6). Base of lacinia rounded mesally with 1–4 small hairs (Fig. 10). Pronotum margined in dark brown. Femora with dark brown longitudinal streak. Anterior margin of abdominal terga dark brown. Cerci dark brown, without dorsal fringe of setae.

Material.—Holotype male, allotype, and paratype male: West Virginia, Braxton County, Little Kanawha River, at Falls Mill, U.S. 19, 4 May 1982, R. F. Kirchner and J. I. Fox. Paratypes: same locality as holotype 1 male, 2 females, 7 May 1982, R. F. Kirchner; 6 females, 8 May 1981, R. F. Kirchner; Braxton-Lewis County Line, Little Kanawha River, 1 mi. SW of Wildcat, 13 males, 7 females, 29 April 1983, R. F. Kirchner and B. C. Kondratieff.

The holotype, allotype, and paratypes will be deposited in the National Museum of Natural History, Washington, D.C. (Type number # 100888). Other paratypes will be deposited in the collections of the Illinois Natural History Survey, Champaign; Virginia Polytechnic Institute and State University, Blacksburg; B. P. Stark, Mississippi College, Clinton; C. H. Nelson, University of Tennessee, Chattanooga; P. P. Harper, University of Montreal; and R. F. Kirchner.

Etymology.—The specific epithet, *kanawholensis,* is a New Latin adjective meaning "found in the Little Kanawha River." The name is formed from the New Latin noun, Kanawhole (= Little Kanawhola = Little Kanawha) and the suffix, ensis.

Diagnosis.—The adult male of *D. kanawholensis* is readily distinguished from all other species of *Diploperla* by the prominent epiproct and the long spinulose lobes of the tenth tergum. In *D. duplicata* (Banks), *D. robusta* Stark and Gaufin, and *D. morgani* Kondratieff and Voshell, the epiproct is greatly reduced and the spinulose lobes are short and rounded or blunt. The adult female of *D. kanawholensis* is similar to *D. morgani* in general appearance, but is distinguished by the shape of the subgenital plate (see Kondratieff and Voshell, 1982, Fig. 35). *Diploperla morgani* has the plate evenly tapered and the apical margin usually emarginate medially whereas in *D. kanawholensis,* the plate is nearly parallel sided and the apical margin broadly rounded or truncate.

The mature nymphs of *D. kanawholensis,* and *D. morgani* are very similar in morphology and color pattern and can not be separated satisfactorily at this time.

Remarks.—The Little Kanawha River at the type locality is a fourth order stream with a width of 34 m and a gradient of 2.2 m/km. The substrate consists of pebble, cobble, large boulders, and scattered beds of water-willow, *Justicia americana* (L.) Vahl. (Acanthaceae). The following physical-chemical data for the stream were provided by the Army Corps of Engineers from their water quality monitoring station at Falls Mill: 1–25°C; specific conductance, 3–49 μmho/cm; dissolved oxygen, 7–13 mg/l; pH, 5.6–7.4; alkalinity as $CaCO_3$, 2–26 mg/l; and total hardness as $CaCO_3$, 1–18 mg/l. Other Perlodinae associated with *D. kanawholensis* include *D. duplicata* (Banks), *Isogenoides hansoni* (Ricker), and *Helopicus subvarians* (Banks).

ACKNOWLEDGMENTS

We thank Bill P. Stark, Mississippi College, Clinton, for examining specimens and providing suggestions and Penelope F. Kondratieff, VPI & SU, for assisting with the illustrations (Figs. 1, 2 and 6). Thomas O. MacAdoo, Department of Foreign Languages, VPI & SU, verified the etymology and construction of the specific epithet.

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A NEW SPECIES OF *PYROTA* FROM ARGENTINA (COLEOPTERA: MELOIDAE)

ANTONIO MARTÍNEZ AND RICHARD B. SELANDER

(AM) Investigador de Carrera, Consejo Nacional de Investigaciones Científicas y Técnicas en INESALT, Rosario de Lerma, Salta, Argentina; (RBS) Professor, Departments of Genetics and Development and of Entomology, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801.

Abstract.—*Pyrota* **horacioi,** new species, is described from adults from Salta, Argentina. The species is structurally similar to *P. muelleri* Borchmann, presently known from the states of Pernambuco and Bahia, Brazil, but is easily distinguished from it and other species of *Pyrota* in possessing a quadrivittate elytral color pattern.

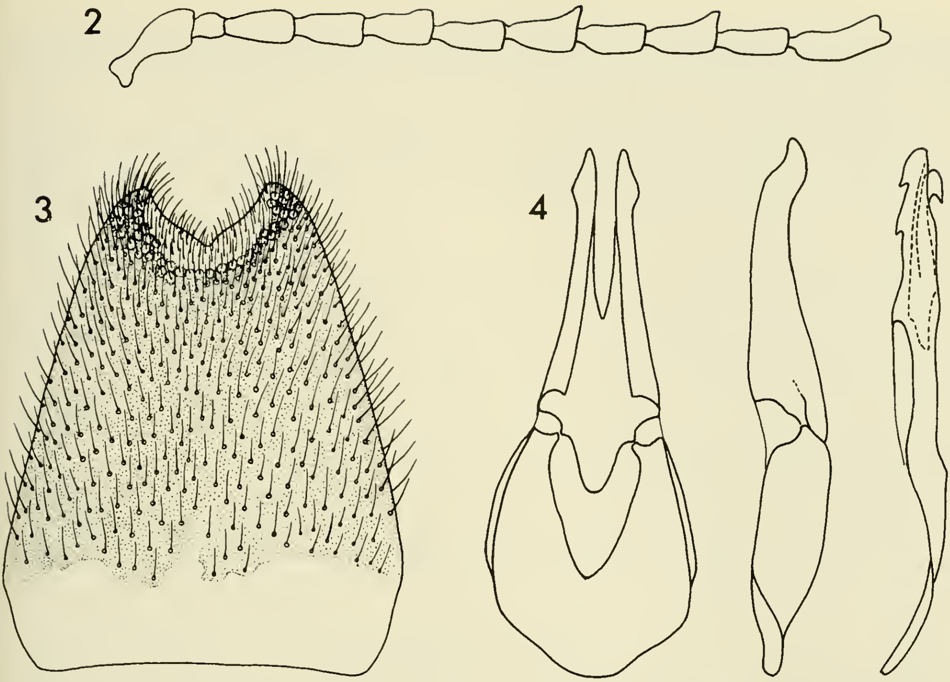
Several years ago in the northwestern province of Salta, Argentina, Dr. Horacio Martínez collected at light three adult blister beetles which are structurally similar to adults of *Pyrota muelleri* Borchmann (1927) but distinctive in coloration. *Pyrota muelleri* was described from the state of Pernambuco on the northeastern coast of Brazil and, as far as we know, has since been taken only once, in the adjacent state of Bahia, Brazil (Selander, in preparation). Although the distance between Pernambuco/Bahia and Salta is about 3000 km, we do not discount the possibility that geographically intermediate populations exist and that Dr. Martínez' specimens may ultimately prove to represent a western race of *P. muelleri*. At the same time, in the absence of any indication of intergradation between the two known populations in available material (we have examined 11 specimens of *P. muelleri*), we are inclined to treat the Salta population as a separate species, which we have the pleasure of dedicating to its discoverer.

***Pyrota horacioi,* NEW SPECIES**
Figs. 1–4

Adult.—Head, pronotum, and elytra largely bright medium orange. Front of head with heavy black streak on each side, distinctly separated from ocular margin, extending from level of middle of eye to frontoclypeal suture and then continuing onto sclerotized portion of clypeus, where it expands to cover lateral ⅓; vertex with large brown postocular spot on each side, reaching ocular margin and extending more than halfway to dorsal margin of head; underside of head with smaller brown spot on anterior margin next to base of maxilla, this spot produced laterally as brown suffusion encompassing antennal socket. Labrum orange, variably marked laterally with dark brown. Antenna black with segments I–II or I–III bright orange; IV sometimes suffused with orange basally. Maxilla dark brown except palpal segment II orange. Labium orange with fine lateral margin of mentum

Fig. 1. *Pyrota horacioi,* male.

and entire palpal segment III dark brown. Pronotum with pair of elongate brown discal spots centered in apical ⅓, these about 2 × as long as wide, tapered apically and basally, less than ½ as long as pronotum, separated from each other by about width of one spot, extending to basal ⅓ of pronotum. Elytron with four long,



Figs. 2–4. *Pyrota horacioi,* male. 2, Antenna. 3, Sixth (visible) abdominal sternum. 4, Genitalia (ventral and lateral views of gonoforceps and lateral view of aedeagus).

narrow, brown vittae separated by costulae; space between lateralmost costula and lateral elytral margin lacking a vitta; inner pair of vittae arising from base of elytron, with innermost vitta weakened or broken near base; outer pair arising behind humerus; near apex of elytron, where costulae disappear, inner pair of vittae fuse together, as do lateral pair, without reaching apex (fusion of inner pair incomplete on one elytron in one specimen). Venter dark brown except for prosternum, which is yellow brown. Coxae dark brown. Trochanters orange, with black basal spot. Femora orange with apical ¼ dark brown. Tibiae largely or entirely dark brown; midtibia may be lightened to chestnut medianly on posterior surface; hindtibia distinctly lightened medianly on posterior surface, just appreciably so on anterior surface. Tarsi dark brown. Setae of body golden yellow; setae of legs golden yellow on orange areas, piceous on brown areas. Length: 16 mm.

Head, pronotum, and elytra smooth, waxy, very shiny, appearing impunctate (or nearly so) and glabrous under low magnification; venter of body and the legs finely punctate, conspicuously pubescent.

Head with length (to base of labrum) $1\frac{1}{10}\times$ width across eyes, which is nearly 2½× interocular distance (ID); dorsal margin above eyes less evenly rounded than in *P. muelleri,* tempora weak but distinct; eye large, prominent, width about ⅔ length, nearly $\frac{9}{10}$ ID; front weakly convex between antennae, with deep lateral depression on each side between eyes, not reaching ocular margin; vertex with few scattered, very fine punctures, each bearing an extremely short seta, elsewhere punctures a little denser and setae longer and more conspicuous. Labrum quadrate, with a shallow emargination on anterior margin. Mandible curved in apical third. Neck with rugose punctures and short, erect setae except for smooth, glabrous area ventromedianly.

Pronotum narrow, ⅔ as wide as long; sides parallel for basal ½, then moderately convergent to apex; apical margin little more than ½ as wide as basal margin; anterior ½ of pronotum deeply depressed, evenly concave; disk with median impression at base; cuticle as on vertex.

Elytra with humerus well marked but not prominent; apex well rounded; four costulae present, only weakly elevated but conspicuous because of color; surface between costulae flat, rather sparsely micropunctate and with evenly, very sparsely scattered, fine punctures, each bearing a minute erect seta.

Venter of thorax with each puncture bearing a moderately long, conspicuous seta; abdominal sterna with fine punctures or fine transverse striae (transversely torn punctures) bearing setae like those of thoracic venter.

Legs long, slender; midfemur 5 × as long as wide. Orange portions of femora very sparsely punctate and setate except for relatively densely punctate and setate area in posterior basal ⅖ of forefemur. Hindtibial spurs similar to each other in form, widened, obliquely truncate; truncature a little longer than wide, acute apically. Tarsi clothed ventrally with dark setae, lacking pads of pale setae.

Male.—Antenna slender, reaching one segment beyond base of pronotum; segments lacking ventral edge; segment I with length about ⅘ ID, reaching about ⅓ across eye; II ½ as long as I; III–X each ⁷⁄₁₀ as long as I, about 2 × as long as wide, moderately compressed, with anterior face flattened or slightly concave; XI slightly longer than I; VII, IX, and XI strongly produced anteroapically to distinct point; V swollen anteroapically but not drawn to point. Maxillary and labial palpi normal, not expanded or otherwise modified; maxillary palpal segment IV 3 × as long as wide. Foretarsus normal, not expanded or distorted. Pygidium with posterior margin broadly curved, with small notch medianly. Fifth (visible) abdominal sternum feebly emarginate; sixth with deep V-shaped emargination, margin rather widely membranous, closely set with long setae, with some even longer setae on lateral apices. Genitalia with gonostylus (paramere) in ventral view relatively slender, expanded laterallly at apex to form large, fleshy "foot," in ventral view rather thick, curved abruptly dorsad at apex, which is obtuse; surface of apical region of gonostylus densely microspinose dorsally, sparsely so laterally; distal separation of gonostyli narrow; gonocoxal (basal) piece with deep, V-shaped emargination that extends beyond middle, emarginate area partly filled by tongue-like extension of basal margin of fused gonostyli; aedeagus slender, straight except at base, with two well-develoepd ventral hooks of nearly equal size; dorsal hook strongly recurved, not spinose.

Female.—Unknown.

Type material.—Holotype male and two paratype males from Pichanal, Departamento de Orán, Provincia de Salta, Argentina, March 1968, Horacio Martínez. Holotype and one paratype in Martínez collection, Buenos Aires; one paratype in Selander collection, Urbana, Illinois.

Discussion.—The species is immediately distinguished in the adult stage from all other species of *Pyrota* Dejean by its quadrivittate elytral color pattern. The metasternum is somewhat less densely punctate and setate than in *Pyrota muel-*

leri, the membranous posterior marginal area of the male sixth abdominal sternum is wider and more densely setate, the gonostylus of the male genitalia is thicker in lateral view and more strongly curved dorsad apically, and the emargination of the gonocoxal piece is much deeper. Due, evidently, to the more quadrate form of the vertex of the head, the eye appears to be slightly smaller and less prominent. By actual measurement, however, the two species do not differ appreciably in our small samples in either the ratio of width of eye to ID or that of width of head across eyes to width just above eyes.

Pyrota muelleri is more extensively melanistic on the head, pronotum, and legs, and the dark color is commonly more nearly black than brown. The head is entirely black except for a median orange spot of variable size on the vertex; antennal segments I–II or I–III are only suffused with orange, not a pure, bright orange; the labrum, maxilla, and labium are dark brown or black. The pronotal spots are black and extend to near the apical and basal margins; typically each has near the middle a lateral branch projecting onto the deflexed side. The elytron is a light brownish yellow, rather than orange, and lacks vittae, although there is usually a brown suffusion at the very base. The femoral orange area is limited to no more than the basal ½ of the segment, and there is no lightly colored area on either the mid- or hindtibia.

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86(3), 1984, pp. 658–659

TEXAPONIUM, A NEW GENUS FOR *CRYPTADIUS TRIPLEHORNI* BERRY (COLEOPTERA: TENEBRIONIDAE)

Donald B. Thomas, Jr.

U.S. Livestock Insects Laboratory, USDA, P.O. Box 232, Kerrville, Texas 78028.

Abstract.—A new genus, ***Texaponium,*** is described for *Cryptadius triplehorni* Berry. The shape of the prosternum, scutellum, and lateral elytron provide the important distinguishing characters.

In the course of a revisionary study of *Cryptadius* LeConte, it became apparent to me that *C. triplehorni* Berry differs from the other species in the genus to a degree that requires its elevation to a separate genus. Berry's (1974) figures and original description of *triplehorni* accurately distinguish this unique species from the other forms of *Cryptadius.* These characters include the finely punctate, almost granular surface of the frontovertex and pronotal disc, vs the coarse punctation of the other species; the long dense epipleural setae, vs short and sparse or setae absent; the minute and sharply pointed scutellum, vs the larger and rounded scutellum (figures in Berry, 1974); and the overall small size (4.7–5.4 mm length) and convexity of *C. triplehorni.* In addition, although Berry mentioned that the lateral elytra were markedly convex, he failed to emphasize the difference between this species and other *Cryptadius.* While the epipleural carina is present in all species, in *Cryptadius* the epipleural fold is strongly developed so that it divides the lateral elytra basally into distinctly dorsal and ventral surfaces. In *triplehorni* the epipleural fold is so weak that the elytra laterally are nearly continuously convex. Another important character unnoticed, or at least not mentioned by Berry, is that the prosternum is quite distinct in *triplehorni.* Behind the procoxae the prosternum is produced into a tumescent keel with an angular apex. In *Cryptadius* the prosternum is not produced but is strongly declivent behind the coxae, follows their contour, and has its apex broadly rounded.

Based on these distinctive characters I erect a new genus, *Texaponium,* for *triplehorni,* and provide the following diagnosis for its separation from the other genera in the tribe Eurymetopini.

Texaponium, New Genus

Type species.—*Cryptadius triplehorni* Berry.

Diagnosis.—A eurymetopine without hind wings; body strongly oval, convex. Protibiae strongly produced at apex. Supraorbital carina present. Scutellum minute, triangular. Epipleural fold obsolescent basally, epipleural carina present at base but elytra nearly continuously convex laterally, not folded. Prosternum produced behind coxae into tumescent, wedge-shaped keel with angular apex.

Cryptadius spp. are found on the sandy coastal strands of California, the Baja California peninsula, and the gulf coast of Sonora. Their true affinities among the Eurymetopini seem to lie with *Telaponium* and *Stictodera,* genera with which it is sympatric on the Baja peninsula. *Texaponium triplehorni* was described from Big Bend National Park, Texas, and is so far known only from that locality. Berry (1974) gives further notes on the habitat. *Cryptadius* and *Texaponium* are fossorial and found in loose, sandy substrates. It is likely that the convexity of the body and the spatulate protibiae are adaptations to this habitat and may be convergent in character, rather than indicative of close relationship.

The tribe Eurymetopini contains a group of tightly knit genera, some of which are distinguished by rather subtle characters (key in Arnett, 1971). In some cases the genera are separated by the relative lengths of the tarsomeres, or even the length of the tarsal setae. *Texaponium* and *Cryptadius* will key to couplet 5 in Arnett (1971) along with *Telaponium*. The shape of the prosternum will separate *Texaponium* from both genera.

ACKNOWLEDGMENTS

I thank D. H. Kavanaugh of the California Academy of Science and R. L. Aalbu of Ohio State University for the loan of *Cryptadius triplehorni* types. I am also grateful to C. A. Triplehorn, R. L. Berry and R. L. Aalbu for reviewing the manuscript and for their advice on relationships in the Eurymetopini.

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PROC. ENTOMOL. SOC. WASH.
86(3), 1984, pp. 660–663

THE PUPAL COCOON OF THE CAT FLEA, *CTENOCEPHALIDES FELIS* (BOUCHÉ) (SIPHONAPTERA: PULICIDAE): A BARRIER TO ANT PREDATION

Jules Silverman and Arthur G. Appel

Department of Entomology, University of California, Riverside, California 92521.

Abstract.—The pupal cocoon of the cat flea, *Ctenocephalides felis,* serves as a protective barrier to predation by the Argentine ant, *Iridomyrmex humilis.* The ants readily foraged on exposed eggs, larvae and pupae. However, intact pupal cocoons constructed of sand, soil or cotton fibers provided protection from foraging ants. The pupal cocoon itself is not air or water tight or repellent, indicating physical protection rather than a chemical barrier.

Many holometabolous insects, including fleas, construct pupal cocoons that are thought to protect the pupae from natural enemies, temperature and moisture extremes, and physical damage (Chapman, 1982; Richards and Davies, 1977). Those functions, however, have not been supported by adequate data.

The cocoons of Siphonaptera, constructed by the third-instar larvae, are typically composed of silk and debris. Cocoons of the cat flea, *Ctenocephalides felis* (Bouché), may be located in soil, on vegetation, under rocks and on a number of man-made substrates such as carpet, furniture fabrics, and animal bedding. The cocoon surrounds the third-instar larvae, prepupae, pupae and pre-emergent adult for up to 122 days (Silverman et al., 1981), but development can proceed without the cocoon (Silverman, 1981).

The present study was initiated following observations of predation on eggs, larvae, and unenclosed pupae of *C. felis* by the Argentine ant, *Iridomyrmex humilis* (Mayr), in an outdoor test. Ant predation has been shown to cause significant reductions in prey populations including ticks (Harris and Burns, 1972; Butler et al., 1979), scale insects (Bartlett, 1961), houseflies (Pimentel, 1955), rootworm eggs (Risch, 1981), boll weevils (Sterling, 1978) and at least 32 other arthropod species (Risch and Carroll, 1982). Herein we document the protective function of the cat flea pupal cocoon against ant predation and examine some possible mechanisms to account for this phenomenon.

Materials and Methods

Fleas were obtained from laboratory cultures maintained as described by Silverman et al. (1981). Eggs; second instar larvae; pupae dissected from their cocoons; pupae in partially opened cocoons; and pupae completely enclosed in cocoons composed of cotton fibers, sand or soil, were used in the experiments.

Fleas, empty cocoons and cocoon-size cotton fiber, sand or soil models were presented to trailing *I. humilis* workers on or ca. 4 cm away from a main trail. The interval between the time when the flea or model was presented to the ants and when it was picked up was recorded. If the flea or model was not picked up or moved away from the trail within 15 min, it was scored as a non-response.

The effectiveness of the cocoon in preventing ant predation by random foraging and subsequent worker recruitment was determined by presenting fleas near the ant nest. On each of 5 days over a 2 week period, 20 specimens of each flea stage were placed inside 6-cm-diam × 2-cm tin containers 1.5 m from the entrance of an *I. humilis* colony. The number of specimens of each stage or variable remaining in each container after 24 hours was recorded.

RESULTS AND DISCUSSION

Cat flea eggs, larvae and naked pupae were picked up along a foraging trail of *I. humilis* workers within one minute and taken into the ant colony (Table 1). Up to 6 ant workers required nearly 5 min to remove pupae from partially opened cocoons. None of the 3 types of cocoons (cotton, sand or soil) which contained pupae were picked up by the ants within 15 min. Similarly, ants ignored or discarded models the size and color of cocoons.

All exposed stages placed 1.5 m from the ant nest entrance were removed by the ants on each of the 5 test days. No pupae in cocoons constructed of cotton fibers, sand or soil were removed during the first 3 test days, but on the last 2 days all sand cocoons were removed. We subsequently discovered that sand cocoons presented during the first 3 days were constructed exclusively of sand and silk while cocoons presented to the ants on days 4 and 5 were composed of sand and silk in addition to larval rearing media containing beef blood, Wheast® and dog chow. When the test was repeated comparing 100 cocoons constructed of sand or sand and media, 61% of the cocoons made of sand and media were removed while cocoons made with sand were left intact.

Several mechanisms to explain the protection afforded by the cocoon were considered. Visual camouflage was probably not important since the color and form of the cocoon contrasted sharply with the substrate. Since ants aggregated around partially opened cocoons while attempting to remove pupae but ignored cocoons placed directly on a trail it is unlikely that the cocoon contained a chemical repellent. Silverman (1981) showed that the pupal cocoon of *C. felis* is permeable to air and water vapor suggesting that the cocoon does not mask possibly attractive odors of the enclosed pupae. Ants ignored or discarded intact cocoons and similar size cocoon models. Cocoons constructed of sand and larval media were removed because the ants perceived food incorporated into the case of the cocoon, not because of the presence of a pupa. Larval media particles the size of cocoons were removed from ant trails as rapidly as naked pupae.

The cocoon of *C. felis* affords the pupae protection from *I. humilis* and possibly other ant predators. Whether the pupal cocoons of *C. felis* and other Siphonaptera evolved in response to attack by ants or other predators is unknown. Although ants and fleas often occur in the same location, the relationship between these two groups has received very little study. Fox and Garcia-Moll (1961) reported attack of adult and larval oriental rat flea, *Xenopsylla cheopis* (Rothschild), by the

Table 1. Response of *I. humilis* workers to immature fleas and cocoon models placed on or near a foraging trail.

Stage and Condition or Model	No. Minutes ($\bar{x}$ ± SD)[a] Until Removed by Ants
Egg	0.5 ± 0.3
Larva	0.6 ± 0.2
Naked pupa	0.9 ± 0.7
Pupa in partially opened cocoon	4.7 ± 2.1
Pupa/cotton fiber cocoon	Ignored or discarded[b]
Pupa/sand cocoon	Ignored or discarded
Pupa/soil cocoon	Ignored or discarded
Cocoon size cotton, sand or soil model	Ignored or discarded

[a] Mean and standard deviation based on $n = 20$.
[b] Ignored for at least 15 min or removed up to 10 cm from the trail.

crazy ant, *Paratrechina longicornis* (Latreille). They found *P. longicornis* in 43% of rat nests and speculated that ant predation might be partly responsible for periodic reductions in rat flea poulations in Puerto Rico and a concomitant reduction in the incidence of murine typhus.

When considering the adaptive significance of the cocoon relative to ant predation, the location of the cocoon is critical. If pupation occurs in areas inaccessible to ants, then a cocoon providing defense from ants would be unnecessary. We found that of 93 third-instar larvae placed on 2.5-cm-diam plugs of hybrid bermuda turf, 50 pupated on or between the blades above ground level (accessible to ants) while the remainder pupated in the soil between the roots. Every pupa was enclosed within a cocoon. Silverman et al. (1982) found the dauerlarvae of the soil-dwelling entomogenous nematode, *Neoaplectana carpocapsae* Weiser, readily penetrated *C. felis* cocoons and infected both prepupae and pupae placed in moist soil. Pupation in soil may therefore be more hazardous to the flea than pupation above ground where *I. humilis* workers normally forage.

Although not necessary for the development of *C. felis,* the cocoon is an important factor contributing to the survival of the cat flea and perhaps other flea species in at least two respects. The cocoon conceals its inhabitant from ants and possibly other macropredators, and by its protective nature allows for pupation in a number of locations not suitable for many micropredators.

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NOTE

A new host for *Perilampus hyalinus* Say (Hymenoptera: Perilampidae)

Perilampus hyalinus Say (det. E. E. Grissell, Systematic Entomology Laboratory, USDA) was reared as a hyperparasite from puparia of *Senotainia trilineata* (Van der Wulp) and *S. vigilans* Allen (Diptera: Sarcophagidae:Miltogrammini) from cells of *Tachysphex terminatus* (Smith) and *Tachytes validus* Cresson (Hymenoptera: Sphecidae) at two central New York sites in 1981 and 1982. *P. hyalinus,* either as a primary or secondary parasite, may represent a species complex rather than a single species (Burks, in Krombein et al. 1979, Catalog of Hymenoptera in America North of Mexico, Vol. 2 (Aculeata), Smithsonian Inst. Press: 768–835). Host records on Miltogrammini exist only for *Perilampus* sp. and *P. hyalinus* on *S. trilineata* (Frisch, J. G. 1936. Psyche 43: 84–85; Frisch, 1938. Am. Midl. Natur. 19: 673–677; Medler, J. F. 1965. Ann. Entomol. Soc. Am. 58: 137–142). Thus *S. vigilans* is a new secondary host for *P. hyalinus.*

Margery G. Spofford and Frank E. Kurczewski, *Department of Environmental and Forest Biology, SUNY College of Environmental Science and Forestry, Syracuse, New York 13210.*

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AN INTERESTING NEW GALL-FORMING *OPHIOMYIA* SPECIES (DIPTERA: AGROMYZIDAE) ON *ATRIPLEX* (CHENOPODIACEAE) IN SOUTHERN CALIFORNIA

Kenneth A. Spencer and Bradford A. Hawkins

(KAS) Exwell Farm, Bray Shop, Callington PL17 8QJ, Cornwall, England; (BAH) Department of Entomology, Texas A&M University, College Station, Texas 77843-2475.

Abstract.—*Ophiomyia atriplicis* new species (Diptera: Agromyzidae), which forms bud galls on *Atriplex polycarpa* (Chenopodiaceae), is described. The male genitalia are illustrated and an account is given of the fly's biology.

Ophiomyia is a relatively large, cosmopolitan genus of agromyzid flies, with over 150 described species. Twenty five species are now known from California (Spencer, 1981). The majority of species form stem mines, although a few mine leaves or feed on seeds. Several species are pests of economically important plants.

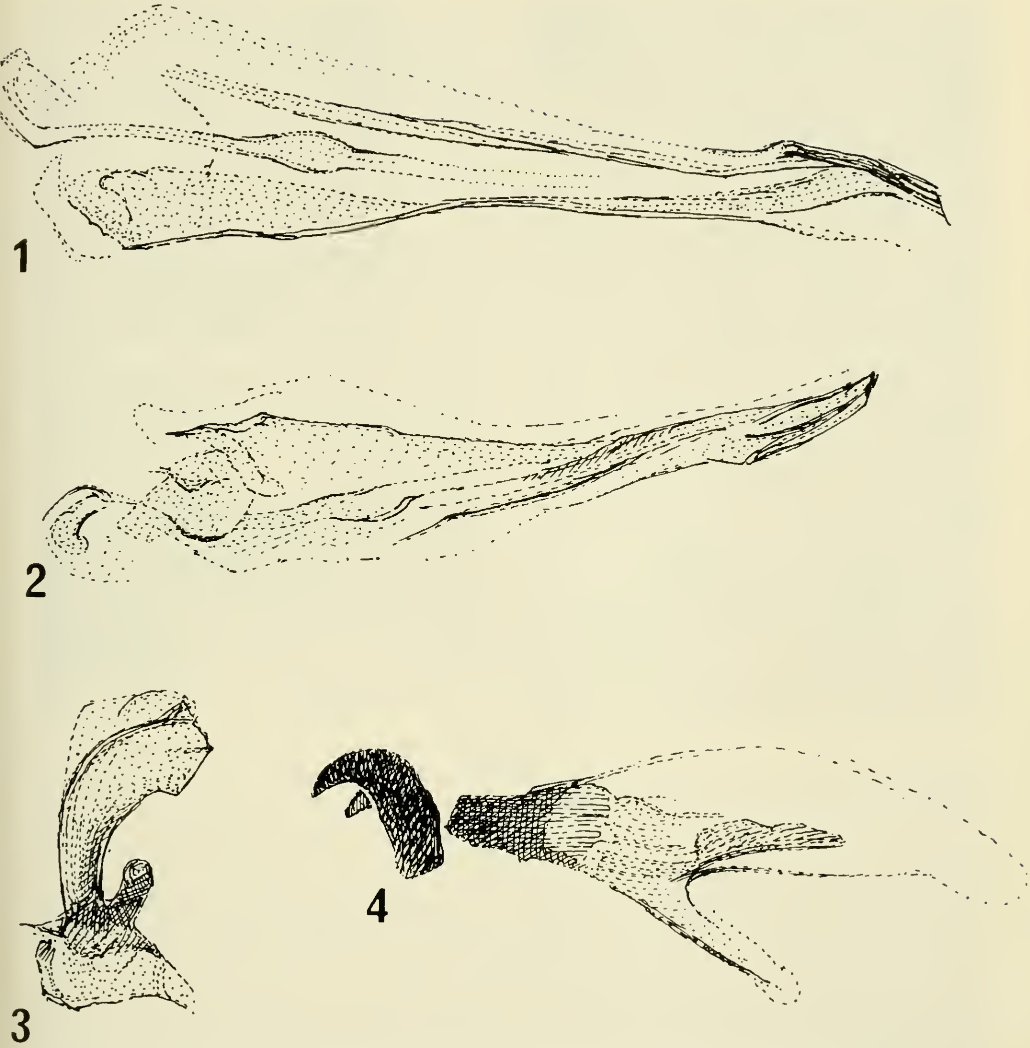
Ecological studies by one of us (BAH) on the galls of *Atriplex* spp. have revealed an undescribed species of *Ophiomyia* forming bud galls on *A. polycarpa* (Torrey) Watson. In this paper the species is described and data are provided illustrating its development and the structure of its gall.

Atriplex polycarpa is a woody, perennial shrub ca. 1 m tall that is widespread in the deserts of western North America. It is a component of several desert plant communities, e.g., Creosote Bush Scrub, Shadscale Scrub and Sagebrush Scrub, and is an indicator species of the Alkali Sink Scrub Community in which it is usually the dominant perennial (Munz and Keck, 1959).

Ophiomyia atriplicis **Spencer, New Species**
Figs. 1–4

Head.—Frons broad, from 2 to almost 3 × eye width, distinctly projecting above eye in profile; orbital bristles conspicuously slender, somewhat irregular both in number and inclination, both upper and lower orbitals normally inclined and slightly reclinate, more rarely more proclinate, varying from 2 to 3 upper and 2 to 3 lower; orbital setulae numerous, arranged irregularly in 2 rows, all reclinate; orbits well differentiated from frons, slightly broader above and narrowing towards base of antennae; ocellar triangle varying from moderately to brilliantly shining, broad above but extending narrowly to level between lower orbitals; gena deepest in center below eye; 3rd antennal segment small, rounded, arista swollen at base, then finely tapering, only minutely pubescent, appearing bare; base of antenna divided by narrow raised keel, without any central furrow; vibrissal margin with up to 12 short bristles in both sexes, no trace of vibrissal fasciculus in male; inner and outer vertical bristles widely diverging, low; post ocellars distinctly proclinate.

Legs.—No bristles on mid- or fore-tibiae.



Figs. 1–4. *Ophiomyia atriplicis.* 1, Aedeagus, dorsal aspect. 2, Aedeagus, lateral aspect. 3, Sperm pump, drawn from paratype from Torres Martinez Ind. Res. 4, Larval cephalopharyngeal skeleton.

Wing.—Length from 1.8 to 2.0 mm, female normally larger; C extending to apex of vein M_{1+2}; last section of M_{3+4} generally slightly longer than penultimate but varying from 1.06 to 1.50×.

Color.—Generally black; frons mat, contrasting with the orbits which are more shining adjoining eye margin and narrowly paler, almost brownish, towards frons; cheeks shining black, gena brownish black; scutum weakly shining black, abdomen more shining, with no trace of metallic coloration; wings pale, whitish, veins pale brown; squamae and fringe white, margin scarcely differentiated, at most pale brown; halteres black.

Male genitalia.—Aedeagus (Figs. 1, 2) with very long basal sclerites which extend beyond base of distiphallus, this in the form of a single weakly sclerotized ventrally

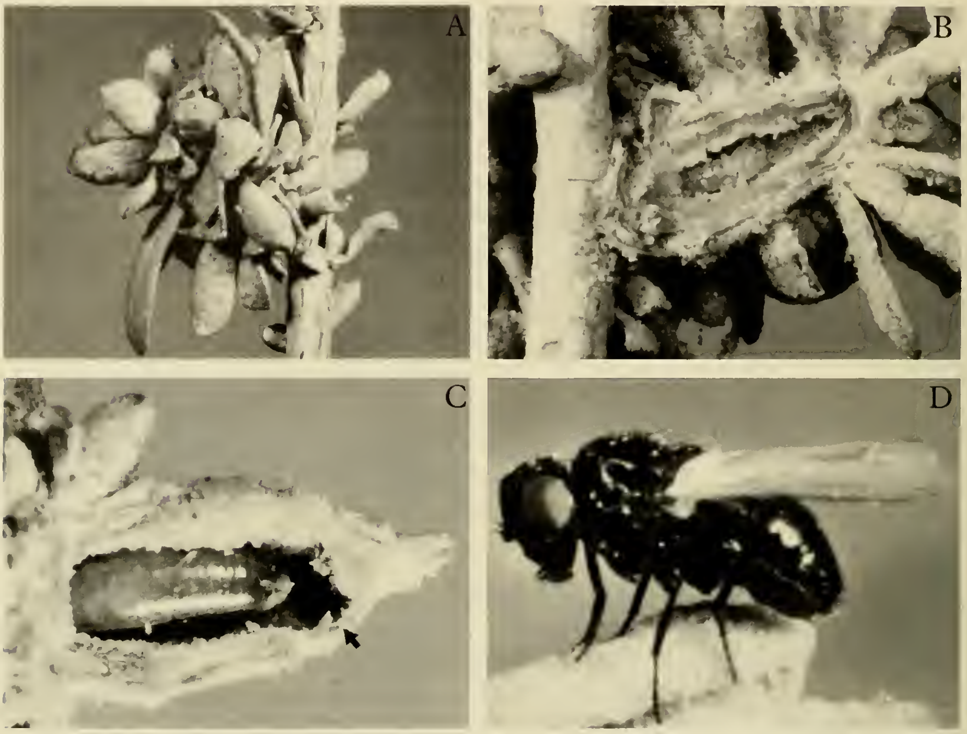


Fig. 5. *Ophiomyia atriplicis* and its gall. (A), Gall. (B), Larva in central feeding chamber. (C), A pupa (Leaves have been removed to show gall shape. Adult will emerge through the pre-formed emergence window (arrow)). (D), Adult male.

directed tubule; hypandrium elongate, side-arms narrow, with slightly extended apodeme; sperm pump minute, with asymmetrical blade (Fig. 3).

Larva.—Length up to 3.4 mm, white, segment boundaries little differentiated; mouth hooks with 2 strong teeth, the upper larger (Fig. 4); anterior spiracles on short projections, each with an ellipse of minute pores, anal segment blunt, extending beyond spiracles, these each with an ellipse of normally 3 pores; puparium pale brown.

Holotype.—Male, California, Riverside Co., Mecca, 14/II/1983, B. A. Hawkins. Paratypes: Mecca, 3 ♂, 2 ♀, 14/III/1982; California, Riverside Co., Torres Martinez Ind. Res., 3 ♂, 1 ♀, 30/III/1982. All material collected and reared from bud galls on *Atriplex polycarpa* by B. A. Hawkins. Holotype and paratypes deposited in the National Museum of Natural History, Washington, D.C.

BIOLOGY

Fig. 5 pictures the development of *O. atriplicis.* The mature gall is ca. 6 mm long and is covered with and hidden by a dense cluster of slightly elongated leaves (Fig. 5A). The leaves of *A. polycarpa* are clustered on axillary buds along the stems, and the adult female inserts a single egg into the stem at the base of a bud. Following eclosion the first instar occupies a small chamber formed in the stem beneath a bud until gall development begins. As the gall develops into its characteristic cone shape, the larva moves into the gall where it feeds and develops in an elongate, central chamber which it excavates with its mouth hooks (Fig. 5B). As larval development proceeds, the gall changes from green and succulent to brown and woody. Prior to pupariation the mature larva scrapes a window near the distal end of the gall wall (Fig. 5C). Pupariation occurs in the gall (Fig. 5C) with the head oriented distally. The adult (Fig. 5D) emerges from the puparium and leaves the gall through the pre-formed emergence window. The leaves on empty galls gradually die and turn brown. These empty galls may persist for several months, but are no longer present by the following season.

Gall development may be initiated anytime from late fall to early spring. In 1980 and 1982, galls first appeared in early January, from which all adult flies had emerged by late March. Simultaneous with adult emergence from the first generation a second generation of galls appeared, the adults from which emerged in May. During the following season, however, galls were first observed in November, 1982, resulting in 3 generations in the 1982–1983 season rather than the 2 generations observed the previous years.

It is not known how or where *O. atriplicis* diapauses. Old galls do not support larvae or pupae over the summer, and no galls have been found on other plant species sympatric with *A. polycarpa*. It is assumed that diapause occurs as eggs or first instars implanted in stem tissue at the base of buds, similar to that found by Silverman and Goeden (1980) with a gall-forming tephritid, *Procecidochares* n. sp., attacking *Ambrosia dumosa* (Gray) Payne (Asteraceae) in southern California.

DISCUSSION

This is the first known case of an *Ophiomyia* sp. forming bud galls. Only 2 other gall-forming species are known in the genus. *Ophiomyia fici* Spencer and Hill (1976) forms leaf galls on *Ficus microcarpa* L. (Moraceae) in Hong Kong, and a species which will be described shortly forms long stem mines with the formation of some gall tissue on *Abutilon theophrasti* Medic. (Malvaceae), known in the United States from Minnesota to Mississippi (Spencer and Steyskal, in press).

This new species lacks the male vibrissal fasciculus which was originally considered to be an essential generic character, but a number of such species are now known in the genus. The raised facial keel and especially the form of the posterior larval spiracles confirm the generic position in *Ophiomyia*. The male genitalia are unique within the genus, confirming the isolated position of this interesting species.

In all of the genera normally included in the subfamily Agromyzinae, the larval cephalopharyngeal skeleton bears a double upper arm, each arm being distinctly and separately sclerotized. The only other case in which the double upper arm is more generally sclerotized, thus giving the appearance of a single broad arm, is in *Melanagromyza paederiae* Sasakawa from Japan (Sasakawa, 1954).

Ophiomyia atriplicis can be included in the senior author's key to California *Ophiomyia* species (Spencer, 1981) by the addition of the following couplet:

couplet 3, first alternative, for 4 read 3A

3A(3) Squamae and fringe silvery white .... *atriplicis* new species
– Squamae and fringe dark, brown or black 4

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NOTE

Lectotype designation for *Rhamphomyia abdita* Coquillett (Diptera: Empididae)

In response to a request from Howard E. Evans, Colorado State University, for determination of a small series of an empidid fly, I was somewhat taken aback when the specimens arrived and they turned out to be a species of the huge genus *Rhamphomyia.* The latest comprehensive key to this genus is by Coquillett (1895, Proc. U.S. Natl. Mus. 18: 387–440). Surprisingly enough, determinations may frequently still be made with this key if synonymy, etc., are checked in the latest catalog (Stone, A. et al., eds., 1965, Agr. Handbook No. 276). Evans' specimens ran rather easily to *R. abdita* Coquillett (ibid, pp. 430), which is now cataloged as a synonym of *R. sociabilis* (Williston). Melander (1902, Trans. Am. Entomol. Soc. 28: 195) stated the synonymy of these 2 species, both of which are based on specimens of the same series taken by C. V. Piper at Pullman, Washington. Although Coquillett in his description of *R. abdita* cited one male and 3 females as "types" with USNM nos. 3223 and 3224, no type labels remain with specimens now in the USNM collection. There is, however, one male specimen from the original Piper lot in good condition bearing a determination label "Rhamphomyia abdita Coq." in Coquillett's handwriting. I have added thereunto a red label "Lectotype Rhamphomyia abdita Coq., G. Steyskal, 1984." Comparison of this specimen with numerous other Piper specimens determined as either *R. abdita* or *R. sociabilis* leaves no doubt that they are all of the same species first described as *Empis sociabilis* Williston. Complete references to descriptions, etc., may be found in Stone, A. et al., eds., 1965, A Catalog of the Diptera of America North of Mexico (reprinted by Smithsonian Press, 1983).

George C. Steyskal, *Cooperating Scientist, Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA,* % National Museum of Natural History, Washington, D.C. 20560.

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PERISTENUS HENRYI (HYMENOPTERA: BRACONIDAE, EUPHORINAE), A NEW SPECIES PARASITIC ON THE HONEYLOCUST PLANT BUG, *DIAPHNOCORIS CHLORIONIS* (HEMIPTERA: MIRIDAE)

A. G. WHEELER, JR. AND C. C. LOAN

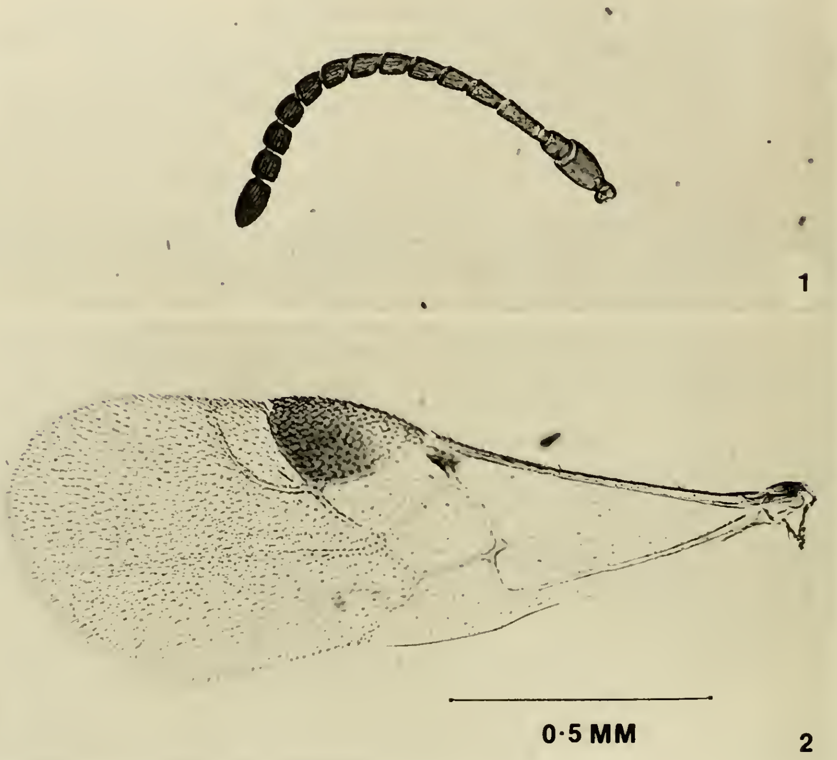
(AGW) Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania 17110; (CCL) Ottawa Research Station, Agriculture Canada, Ottawa, Ontario K1A 0C6.

Abstract.—The euphorine braconid *Peristenus henryi* Loan, a parasite of the plant bug *Diaphnocoris chlorionis* (Say), is described as a new species from Pennsylvania and compared with *P. reidi* Loan. Notes are given on parasite biology and on parasitism of honeylocust plant bug populations. The euphorine *Leiophron maculipennis* (Ashmead), also reared from *D. chlorionis* in Pennsylvania, is listed as a new state record.

The honeylocust plant bug, *Diaphnocoris chlorionis* (Say), is a univoltine, orthotyline mirid restricted to honeylocust, *Gleditsia triacanthos* L. Wheeler and Henry (1976) studied its life history in ornamental plantings and nurseries in southcentral Pennsylvania. Eggs overwinter in 2- or 3-year-old stems. Their hatch the following spring is well synchronized with leaf flush of host trees, beginning from early to late April in Pennsylvania. Nymphal development requires 4–5 weeks, with adults appearing as early as the second week of May. Peak numbers of adults occur from late May to early June; they usually die off by late June or early July. Plant bug feeding produces severe discoloration and distortion of leaflets, premature leaf fall and, in heavy infestations, defoliation.

Wheeler and Henry (1976) reported large populations of the honeylocust plant bug during 1975–76 (as many as 2500 nymphs and adults on the terminal 36 cm of 4 branches on each of 2 trees). Parasitism was not mentioned in the paper, although a euphorine braconid found parasitizing nymphs of *D. chlorionis* in 1976 appeared responsible for the population crash observed the following year (Wheeler and Henry, unpublished data). Until recently, problems in breaking diapause precluded the rearing and identification of the parasite,.

The braconid was not identified until reared specimens were submitted to CCL, who found that the series contained not only *Leiophron maculipennis* (Ashmead), the only euphorine previously known to parasitize *D. chlorionis* (Loan 1974, 1980) but also an undescribed species of the related genus *Peristenus* Foerster. The new species, *P. henryi,* is described and illustrated here, and notes are given on its biology.



Figs. 1–2. *Peristenus henryi.* 1, Antenna of female. 2, Forewing of female.

Peristenus henryi **Loan, New Species**
Figs. 1–2

Female.—Holotype about 2.2 mm long. Reddish black. Clypeus, front legs light tawny, mid and hind legs dark testaceous. Head about as long as width of pronotum, 1.3 times as wide as long. Eyes distinctly convergent on face, temple very weakly receding behind eye. Face in profile view even, without protuberance by clypeus, 0.8 times and temple 0.7 times as wide as eye. Lateral ocelli about in line with posterior margins of eye, POL (postocellar line) = OOL (ocular-ocellar line). Malar space not as long as basal width of mandible. Flagellum as long as head combined with pronotum, short and widened distally, 12–13 articles, with articles 8–12 subquadrate (Fig. 1). Frons finely punctate.

Scutum with shallow punctures, moderately setose. Mesepisternum finely sculptured above and below, medially smooth and polished between front and rear margins. Forewing (Fig. 2): stigma deep with proximal margin a little longer than distal. Hindwing nervellus about as long as basal abscissa of basella.

Tergite 1 with discrete, subparallel striae, nearly as long as midfemur, 0.6 times as long as hindtibia.

Male.—Essentially as for female apart from secondary sexual characters. Flagellum with 14–16 articles.

Table 1. Characters distinguishing *Peristenus henryi* from *P. reidi.*

Peristenus henryi	*Peristenus reidi*
Flagellar articles 12–13 (♀), 14–16 (♂)	Flagellar articles 13–14 (♀), 15–17 (♂)
Face between eyes not as wide as eye (♀)	Face between eyes wider than eye (♀)
First abscissa of radius obsolete	First abscissa of radius short but discrete
Radial cell at wing margin about 0.5 times as wide as length of stigma	Radial cell at wing margin 0.7–0.8 times as wide as length of stigma
Fuscous habitus with face above clypeus usually dark and coxa III usually infuscated	Testaceous habitus with face above clypeus and coxa III light tawny

Material examined.—Holotype: ♀, USA, PA: York Co., Shiloh Nurs., Emigsville; ex *Diaphnocoris chlorionis* taken on *Gleditsia triacanthos,* deposited in Canadian National Collection, Ottawa (CNC); mirid nymph coll. 5 June 1981, wasp emerged in lab. 30 Mar. 1982, J. F. Stimmel and A. G. Wheeler, Jr. collectors. Paratypes: (deposited in Canadian National Collection, Ottawa, and National Museum of Natural History, Washington, D.C.): 3 ♀, 3 ♂, same data as holotype, adult wasps emerged 29 Mar.–2 Apr. 1982; 1 ♀, 2 ♂, PA: Dauphin Co., Harrisburg, East Hbg. Cemetery, 21–28 April 1976, K. Valley collector.

Etymology.—The name *henryi* is a patronym to recognize and honor the mirid systematist Thomas J. Henry (Systematic Entomology Laboratory, USDA, Washington, D.C.).

Remarks.—The short flagellum with fewer than 15 articles separates both *Peristenus reidi* and *P. henryi* from other described Nearctic species. This genus is remarkably homogeneous, but the flagellum and other characters, especially venation and landmarks of the face, eyes, and first tergite, permit identification. *P. henryi* differs from *reidi* by the characters listed in Table 1.

Biological notes.—Three adults of *Peristenus henryi* were collected during studies of the mirid complex of honeylocust (Wheeler and Henry, 1976); they were taken on 21–28 April 1976 when the population of *D. chlorionis* consisted mainly of 2nd- and 3rd-instar nymphs. The braconid may have begun to emerge slightly earlier because *Peristenus* spp. parasitize 1st or 2nd instars (Loan, 1974).

By mid- to late May, parasitized 5th instars were common in samples. They were distinguishable externally by the distended, often distorted and discolored (dark brown) abdomens. When parasitized nymphs were dissected, the larva usually was found coiled in the host abdomen, the U-shape taking somewhat different configurations. Of more than 400 nymphs dissected, only 1 contained 2 parasite larvae. Euphorine development is solitary with supernumerary eggs dying or 1st-instar larvae remaining moribund (Loan, 1974).

In the laboratory, the mature larva emerged laterally from the abdomen of a 5th instar (no larvae were found in teneral adults), dropped to the substrate, and spun a cocoon a few cm deep in potting soil. A few cocoons were uncovered in mid-summer and observed to contain adult parasites. Because adults overwinter within cocoons, the rearing technique of Loan (1974) was used to break diapause and to obtain adults. Of the eight specimens that were reared, seven proved to be the new species *P. henryi,* whereas one represented *Leiophron maculipennis,* known previously from Florida (type locality) and Belleville, Ontario (see Loan, 1974, 1980). Although *P. henryi* may have been the dominant parasite, the relative contribution of the two species cannot be separated in the discussion of parasitism that follows.

An estimate that braconid parasitism of honeylocust plant bug was 75% or more in 1976 was based on field observations when adults outnumbered nymphs 3 or 4:1. Parasitized nymphs take longer to develop, and assessments of nymphal parasitism based on even large numbers of these "stragglers" will be biased. A more accurate estimate of parasitism was made using 4th and 5th instars collected before adults were present. In a sample chosen at random from the weekly collections for 12 May (see Wheeler and Henry, 1976 for details of the sampling technique), parasitism of 100 nymphs on each of two trees was 17 and 21%, respectively. Although numbers of the honeylocust plant bug were much lower the following year (unpublished data), the parasites' contributions to mortality could not be evaluated.

Observations made on native honeylocust suggest that parasitism may have considerable impact on plant bug populations. On heavily damaged trees at Emigsville (York Co.), Pennsylvania, on 5 June 1981, nearly all remaining late instars were parasitized. The following year, 100 late instars were collected at random from the same trees on 19 May before adults had appeared; 93 were parasitized.

The honeylocust plant bug has 2 braconid parasites: *Leiophron maculipennis* and *Peristenus henryi,* described herein from Pennsylvania. These apparently species-specific euphorines at times are important natural enemies of *D. chlorionis* on ornamental honeylocust. Loan (1980) reported that *L. maculipennis* parasitized 65% of 81 nymphs collected 12 June 1970 at Belleville, Ontario. In one collection of 100 nymphs in Pennsylvania, *P. henryi* was responsible for an even higher rate of parasitism (93%). A thorough study of these parasites is needed to clarify details of the life history and the relationship of parasitism to host density.

Acknowledgments

We thank James F. Stimmel, Bureau of Plant Industry, Pennsylvania Department of Agriculture, for helping rear the braconid, and Priscilla S. MacLean (BPI, PDA) for dissecting nymphs of the mirid. K. Valley (BPI, PDA) and G. Stuart Walley (Winding Way, Nepean, Ontario) kindly reviewed the manuscript.

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THE NEOTROPICAL PREDACEOUS MIDGES OF THE GENUS *ALLUAUDOMYIA* (DIPTERA: CERATOPOGONIDAE)

GUSTAVO R. SPINELLI AND WILLIS W. WIRTH

(GRS) Instituto de Limnologia, Museo de La Plata, La Plata, Argentina; (WWW) Systematic Entomology Laboratory, IIBIII, Agric. Res. Serv., USDA, % U.S. National Museum, Washington, D.C. 20560, USA.

Abstract.—This study treats the 17 known Neotropical species of the predaceous midge genus *Alluaudomyia* Kieffer. Fourteen new species are described and illustrated: ***amazonica, caribbeana, catarinensis, distispinulosa, estevezae, fittkaui, leei, nubeculosa, plaumanni, punctiradialis, sexpunctata, tenuiannulata, tripunctata,*** and ***youngi.*** A diagnosis is given for the genus and a key is presented for the recognition of species. New Neotropical distribution records are given for *A. bella* (Coquillett) and *prima* Clastrier.

The small, pale, conspicuously marked, predaceous midges of the genus *Alluaudomyia* Kieffer are well represented in all the major biogeographic regions of the world. There are 23 described Palearctic species, 9 Nearctic, 39 Afrotropical, 31 Oriental, and 27 Australasian species. By contrast, the Neotropical species have been neglected, and only two species have been previously described: *A. prima* Clastrier (1976) and *A. schnacki* Spinelli (in press). In this study we present descriptions of 14 new species and record the Nearctic species, *A. bella* (Coquillett), from Mexico and Grand Cayman, bringing the total number of Neotropical species to 17.

This study is based primarily on the collections of the National Museum of Natural History in Washington, where the holotypes and allotypes of the new species are deposited. Paratypes as available will be deposited in the following collections: British Museum (Natural History), London; California Academy of Sciences, San Francisco; Canadian National Collection, Agriculture Canada, Ottawa; Museo de La Plata, La Plata, Argentina; Museu de Zoologia, Universidade de São Paulo, Brazil, and Museum National d'Histoire Naturelle, Paris. The senior author acknowledges financial support from the Consejo Nacional de Investigaciones Científicas y Técnicas de La República Argentina.

For general terminology of the Ceratopogonidae see Wirth (1952a), Wirth et al. (1977), and Downes and Wirth (1981). The last 2 references contain keys to genera by which the genus may be identified.

Genus *Alluaudomyia* Kieffer

Alluaudomyia Kieffer, 1913: 12. Type-species, *Alluaudomyia imparunguis* Kieffer (monobasic).

Neoceratopogon Malloch, 1915: 310. Type-species, *Ceratopogon bellus* Coquillett (original designation).

Prionognathus Carter, Ingram, and Macfie, 1921: 309. Type-species, *Priono-*

gnathus marmoratus Carter, Ingram, and Macfie (original designation). Preocc. by LaFerte-Senectère, 1851.

Thysanognathus Ingram and Macfie, 1922: 244. New name for *Prionognathus* Carter, Ingram, and Macfie.

Isoecacta Garrett, 1925: 9. Type-species, *Isoecacta poeyi* Garrett (original designation) = *bella* (Coquillett).

Diagnosis (after Wirth, 1952b; Debenham, 1971; Wirth and Delfinado, 1974; Wirth and Grogan, 1981).—Small, moderately hairy midges with slender body. Eyes bare or hairy, contiguous or narrowly separated. Antenna 15-segmented; female with segments 3–10 long, 11–15 more so; male antenna with plume. Palpus 5-segmented; 3rd segment slender with small sensory pit. Wing with 1st radial cell obsolete, 2nd radial cell well developed; membrane without microtrichia, macrotrichia numerous on distal part of wing; usually 1 to 15–20 small dark spots present and sometimes with grayish streaks along veins. Legs slender, more or less hairy; female claws long, slightly unequal on fore and mid legs, very unequal on hind leg. Female with 1 or 2 spermathecae; genital segments with characteristic sclerotization for each species, an internal furca (9th sternite) usually present. Male terminalia highly modified; 9th tergite always long, usually with well-developed apicolateral processes; gonocoxite and gonostylus simple; aedeagus arched with large distal process. Parameres separate, shape varying with species; slender anterolateral apodeme present.

Immature stages.—Remm and Glukhova (1971) gave a good description and figures of the larva and pupa of *A. pentaspila* Remm and Glukhova; Glukhova (1977) figured the head, pharyngeal comb, and last body segment of the larva of *A. quadripunctata* (Goetghebuer). Grogan and Bystrak (1976) described the larva and pupa of *A. parva* Wirth; Grogan and Messersmith (1976) described the larva and pupa of *A. paraspina* Wirth; and Thomsen (1937) gave figures and a short description of the larva and pupa of *A. bella* (Coquillett) and *A. needhami* Thomsen. Glukhova (1979) described and illustrated the larva of *A. quadripunctata, A. pentaspila,* and *A. splendida* (Winnertz) in the U.S.S.R. and gave a key for their recognition. Wirth and Grogan (1981) described the immature stages of *A. bella, A. footei* Wirth, *A. megaparamera* Williams, *A. needhami, A. paraspina,* and *A. parva* in Maryland, and gave notes on larval habits. The larvae of *A. needhami* were observed to be predators of the larvae of *Atrichopogon* spp. at the water line on the emergent stems of aquatic shrubs. Spinelli (in press) described and illustrated the immature stages of *A. schnacki* Spinelli, and gave notes on the larval habits.

KEY TO NEOTROPICAL SPECIES OF ALLUAUDOMYIA

1. Wing with only 2 large, distinct, black spots, one at r-m crossvein, the other at tip of costa (Fig. 2); faint distal or posterior markings may also be present 2
– Wing with more than 2 large, distinct, black spots (Fig. 1, 5) 11
2. Wing with faint distal and posterior markings in addition to the 2 distinct black spots at r-m crossvein and tip of costa (Fig. 8) 3
– Wing without faint distal or posterior markings (Fig. 2) 4
3. Wing with only 3 faint distal markings, in cells R5, M1, and M2 .. .. *prima* Clastrier

– Wing with 10 faint distal and posterior markings, 1 at wing margin and a 2nd submarginally, in each of cells R5, M1, M2, M4, and anal cell (Fig. 8) .... *nubeculosa* n. sp.
4. Pattern of leg markings with many small brown rings and punctures; male genitalia elongate, distal portion of paramere with group of spinules (Fig. 4, 10) 5
– Pattern of legs without these markings; male genitalia not elongated, distal portion of paramere without group of spinules 6
5. Wing with small brown punctures along radius; bases of femora pale; caudal membrane of sternite 9 not spiculate (Fig. 10) .... *punctiradialis* n. sp.
– Wing without small brown punctures along radius; bases of femora brown; caudal membrane of sternite 9 spiculate (Fig. 4) .... *distispinulosa* n. sp.
6. Large species; wing length 1.3 mm or more 7
– Small or medium-sized species; wing length less than 1.2 mm 8
7. Legs with pale rings on femora and tibiae; claws unequal on all legs (Fig. 3) .... *catarinensis* n. sp.
– Legs uniformly dark brown; tarsal claws subequal on all legs (Fig. 9) .... *plaumanni* n. sp.
8. Fore and hind femora with bases broadly pale; aedeagus with basal arch reaching ¼ of total length; tergite 9 with very long apicolateral processes; paramere expanded distally .... *schnacki* Spinelli
– All femora dark at bases, hind femur with or without narrow subbasal pale ring; aedeagus with basal arch reaching nearly ¾ of total length; tergite 9 with poorly developed apicolateral processes or none; paramere not expanded distally 9
9. Fore and hind tibiae brown at least on distal halves; male paramere slender, well sclerotized, with subapical process directed ventrally (Fig. 14) .... *youngi* n. sp.
– All tibiae with narrow subapical pale rings; paramere stout or if slender, are poorly sclerotized with terminal filament 10
10. Broad pale bands present subapically on mid femur and sub-basally on mid and hind tibiae; male paramere very slender, poorly sclerotized (Fig. 2) .... *caribbeana* n. sp.
– These bands narrow; male paramere very stout and straight, distal portion abruptly recurved subterminally (Fig. 12) . . *tenuiannulata* n. sp.
11(1). Wing with more than 6 distinct black spots (Fig. 5) 12
– Wing with 6 or less distinct black spots (additional obscure black streaks sometimes present near apices of medial and cubital branches) (Fig. 1) 13
12. Wing with 12–13 distinct black spots; male paramere with distal portion tapering to sharp point; legs brownish with pale rings (Fig. 5) . ... *estevezae* n. sp.
– Wing with 8–10 distinct black spots; male paramere swollen club-shaped distally; legs yellow with brown bands .... *bella* (Coquillett)
13. Wing with 6 distinct black spots (Fig. 11) .... *sexpunctata* n. sp.
– Wing with 3–5 distinct black spots or streaks (Fig. 1) 14

14. Wing with 4–5 black spots or streaks; hind tarsal ratio not more than 3.1; aedeagus longer than broad at base (Fig. 1) 15
– Wing with 3 black spots; hind tarsal ratio 3.4; aedeagus about as long as broad at base (Fig. 13) .... *tripunctata* n. sp.
15. Extreme base of fore and hind femora brownish; sternite 9 without caudomedian excavation; tergite 9 without apicolateral processes; gonostylus with an anterior subrectangular process projecting posteriorly; paramere not very long (Figs. 6, 7) 16
– Extreme base of fore and hind femora pale; sternite 9 with caudomedian excavation; tergite 9 with apicolateral processes; gonostylus without anterior subrectangular process projecting posteriorly; paramere very long (Fig. 1) .... *amazonica* n. sp.
16. Wing with black streaks near apices of veins M1, M2, M3 + 4, and Cu1; wing length not less than 1.05 mm; mid tibia with distinct subapical pale ring; hind tibia with broad median brown band; brownish species (Fig. 7) .... *leei* n. sp.
– Wing without black streaks at apices of veins M1, M2, M3 + 4, and Cu1, at most these veins slightly infuscated; wing length 0.85 mm; mid tibia with faint subapical pale ring; hind tibia with narrow median brown ring; yellowish brown species (Fig. 6) ....*fittkaui* n. sp.

***Alluaudomyia amazonica* Spinelli and Wirth, NEW SPECIES**

Fig. 1

Female.—Wing length 1.05 (1.00–1.10, n = 3) mm; breadth 0.41 (0.37–0.43), n = 3) mm.

Head: Pale brown. Eyes bare, nearly contiguous. Antenna with lengths of flagellar segments in proportion of 26-17-16-16-16-18-20-20-25-25-27-25-33; antennal ratio 0.92 (0.90–0.95, n = 3). Palpus (Fig. 1b) with lengths of segments in proportion of 11-16-17-12-21; 3rd segment with distal sensory area, without well-developed pit; last 3 segments more brownish than proximal 2. Mandible with 16 teeth.

Thorax: Yellowish brown, with small dark brown mottlings. Legs (Fig. 1d) brownish; fore coxa pale; narrow pale rings present on bases of fore and hind femora, subapically on all femora, and subbasally and subapically on tibiae; knees of fore and mid legs pale; tarsi pale brown except hind basitarsus dark brown; hind tarsal ratio 2.59 (2.55–2.62, n = 3); claws (Fig. 1c) slender, unequal on all legs. Wing (Fig. 1a) nearly identical with that described for *Alluaudomyia leei*; costal ratio 0.63. Halter pale.

Abdomen: Pale brown; genital sclerotization as in Fig. 1f. One subspherical spermatheca (Fig. 1e) with conical neck; measuring 0.072 (0.065–0.076, n = 3) mm long × 0.057 (0.053–0.060, n = 3) mm broad.

Male.—Wing length 0.82 (0.75–0.85, n = 4) mm; breadth 0.34 (0.30–0.35, n = 4) mm. Similar to female, with usual sexual differences. Antenna with lengths of flagellar segments in proportion of 48-20-18-18-17-17-17-17-20-27-40-38-45; antennal ratio 0.98 (0.97–1.00, n = 4). Palpus with lengths of segments in proportion of 9-17-17-15-23. Costal ratio 0.52 (n = 4). Hind tarsal ratio 2.2 (2.15–2.25, n = 4).

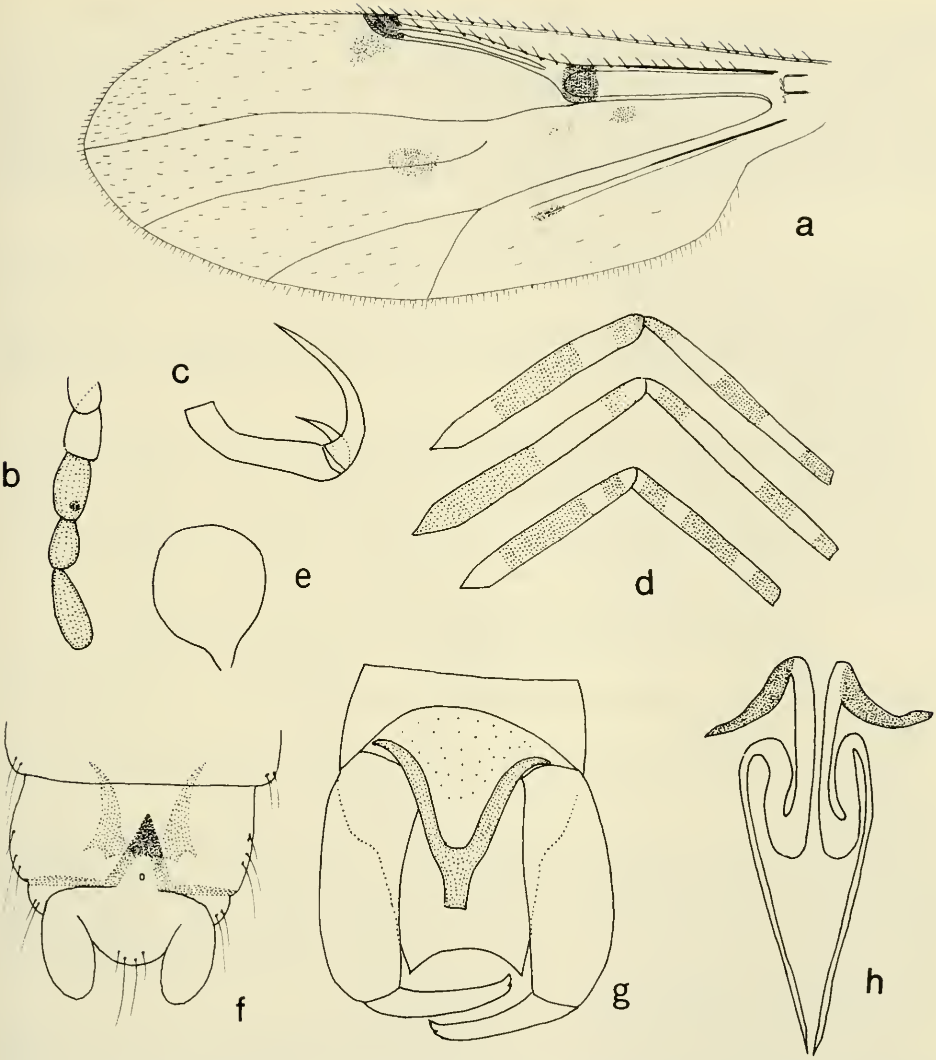

Fig. 1. *Alluaudomyia amazonica*; a–f, female; g–h, male: a, wing; b, palpus; c, claws of all legs; d, femora and tibiae of (top to bottom) hind, mid and fore legs; e, spermatheca; f, genital sclerotization; g, genitalia; h, parameres.

Genitalia (Fig. 1g): short; sternite 9 with deep caudomedian excavation, posterior membrane spiculate; tergite 9 with truncate posterior margin and slender, well-developed apicolateral processes. Gonocoxite moderately slender, gonostylus nearly straight, with distinct apical tooth. Aedeagus longer than basal breadth, basal arch extending about ⅔ of total length. Parameres (Fig. 1h) nearly identical with those of *A. leei* (Fig. 7h), but the mid portion with the bulbous process more developed and distal portion longer and straighter.

Distribution.—Brazil.

Types.—Holotype ♀, allotype ♂, Brazil, Amazonas, Manaus, 21.ix.1969, H. A. Wright. Paratypes, 2 ♀, 3 ♂, as follows: BRAZIL: Same data as holotype, 2 ♂; Rio

Amazon, Ilha Parintius, 11.ix.1969, Wright, 2 ♀; Rio Solimões, 15.ix.1961, E. J. Fittkau, 1 ♂, at light.

Discussion.—The wing markings of *Alluaudomyia amazonica* are nearly identical with those of *A. leei* (Fig. 7a), but *amazonica* differs in the pale bases of the fore and hind femora, the male gonocoxites lack the heavily sclerotized mesal process at the base, and the slender tips of the male parameres are much longer.

Alluaudomyia bella **(Coquillett)**

Ceratopogon bellus Coquillett, 1902: 87 (male; District of Columbia; holotype in USNM).

Alluaudomyia bella (Coquillett); Wirth, 1952a: 195 (combination; Calif.; redescribed; figs.); Wirth and Grogan, 1981: 9 (redescribed; pupa; biology; distribution; figs.).

Distribution.—North America; common from Alaska to California and east to Nova Scotia and Florida; Bahamas, Cayman Islands, Mexico.

New records.—BAHAMAS: South Bimini I., v.1951, M. Cazier and W. Gertsch, 1 ♀, 1 ♂, CAYMAN ISLANDS: Grand Cayman, xii.1973, J. E. Davies, 2 ♂. MEXICO. Veracruz, Fortin de Flores, iv.1965, H. V. Weems, 1 ♂.

Aluaudomyia caribbeana **Spinelli and Wirth, New Species**

Fig. 2

Alluaudomyia needhami Thomsen; Wirth, 1952a: 196 (misident.; male; figs.; Calif.).

Female.—Wing length 1.02 (0.90–1.10, n = 10) mm; breadth 0.40 (0.37–0.48, n = 10) mm.

Head: Brownish. Eyes bare, contiguous for a distance equal to diameter of 1.5 ommatidial facets. Antenna brownish, bases of segments 3–10 pale; lengths of flagellar segments in proportion of 22-14-14-16-20-20-23-23-25-27-33-38-34; antennal ratio 0.93 (0.90–0.97, n = 10). Palpus (Fig. 2b) brownish; lengths of segments in proportion of 10-17-17-14-20; 3rd segment with distal pit bearing a very long sensillum. Mandible with 13–14 teeth.

Thorax: Brownish; scutellum paler. Legs (Fig. 2d) brownish, with pale rings subbasally on tibiae and subapically on femora and tibiae; knees pale on all legs; tarsi brownish except 4 distal tarsomeres on hind leg pale; hind tarsal ratio 3.00 (2.95–3.05, n = 10); claws (Fig. 2c) long and slender, unequal on all legs. Wing (Fig. 2a) membrane whitish; 2 black spots, one proximad of r-m crossvein, 2nd at end of costa in cell R5; costal ratio 0.55 (0.53–0.56, n = 10). Halter with knob infuscated.

Abdomen: Brownish. Genital sclerotization not pigmented. One elongated spermatheca (Fig. 2e), measuring 0.086 (0.080–0.093, n = 10) mm long × 0.061 (0.058–0.065, n = 10) mm broad.

Male.—Wing length 0.80 (0.70–0.85, n = 6) mm; breadth 0.31 (0.28–0.34, n = 6) mm; costal ratio 0.48 (0.46–0.50, n = 6). Similar to female with usual sexual differences. Antenna with lengths of flagellar segments in proportion of 45-18-18-16-16-15-16-16-17-18-43-37-40; antennal ratio 0.99 (0.97–1.03, n = 3). Palpus with lengths of segments in proportion of 10-16-15-13-21. Hind tarsal ratio 2.57 (2.43–2.70, n = 6).

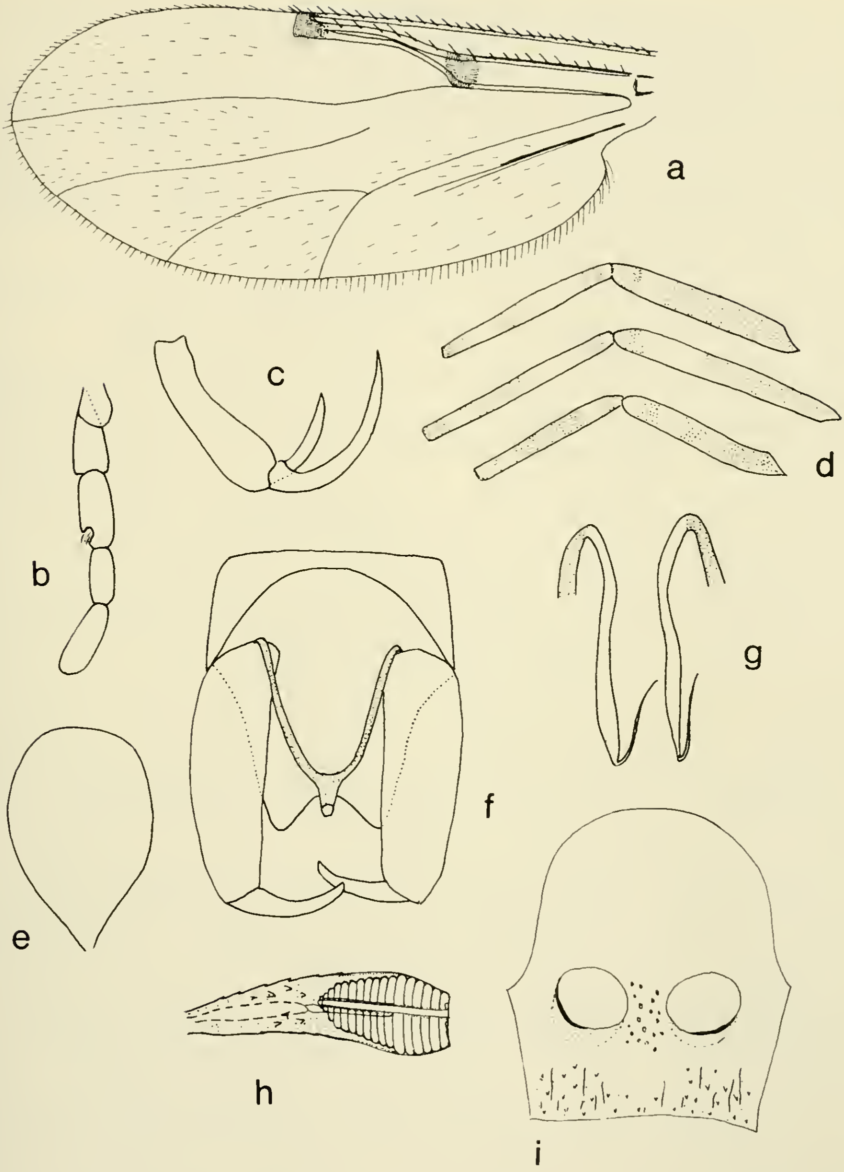

Fig. 2. *Alluaudomyia caribbeana*; a–e, female; f–g, male; h–i, pupa: a, wing; b, palpus; c, claws of all legs; d, femora and tibiae of (top to bottom) hind, mid and fore legs; e, spermatheca; f, genitalia; g, parameres; h, respiratory horn; i, operculum.

Genitalia (Fig. 2f): Elongated; sternite 9 with very broad and deep caudomedian excavation; tergite 9 moderately short, lateral margins parallel on distal ½, apicolateral processes short and blunt. Gonocoxite elongated; gonostylus short with pointed tip. Aedeagus with very high basal arch, distomedian process short and pointed, ventrally bent. Parameres (Fig. 2g) each with well-sclerotized, recurved, basal apodeme; main portion very elongate, slender, and nearly straight; distal portion very attenuated, bent ventrad, ending in slender filament.

Pupa.—Exuviae yellowish. Length about 3 mm. Respiratory horn (Fig. 2h) 3 × as long as greatest breadth, expanded distally; surface with scale-like tubercles; distal portion with double row of 14–15 spiracular openings. Operculum (Fig. 2i) slightly longer than greatest breadth, with rounded anterior margin; central portion with pair of sublateral, circular, raised areas, without *a.m.* setae; surface of posterior margin slightly spiculate, and a few tubercles present between the raised areas. Remaining structures not suitable for description.

Distribution.—U.S.A. (California to Texas, Florida); circum-Caribbean from Mexico to Colombia, Venezuela, Puerto Rico, Haiti, and Jamaica.

Types.—Holotype ♀, allotype ♂, Belize, Nattieville, 8.vii.1968, W. L. Haase, at light. Paratypes, 56 ♀, 54 ♂, as follows: ARIZONA: Coconino Co., Oak Creek at Chavez Crossing, 26.vii.1978, M.W. Sanderson, UV trap, 1 ♂. Yavapai Co., Clarkdale, spring near Josephine Tunnel, 6.x.1980, Sanderson, UV trap, 6 ♂; Oak Creek at Cornville, 10.vi.1977, Sanderson, UV trap, 2 ♂; Fossil Creek, Rte. 708 SE Camp Verde, 3.vi.1981, Sanderson, UV trap, 1 ♂, BELIZE: Same data as types, 3 ♀, 5 ♂; same data except 7–8.vii.1968, black light, 12♀; Mile 15, Western Highway, 9.vii.1968, Haase, black light, 1 ♂; Cayo District, Western Highway MP 66, vi.1969, W. & D. Haase, light trap, 1 ♀; Punta Gorda, 1.5 mi W, 31.vii.1968, Haase, black light, 1 ♀. CALIFORNIA: Death Valley, Saratoga Springs, 30.v.1953, J. N. Belkin, 1 ♀; same, vi–vii.1954, Belkin and McDonald, at light, 1 ♀, 4 ♂, Riverside Co., Blythe, 8.iv.1949, W. W. Wirth, at light, 1 ♂. COLOMBIA: Meta, Pto. Lopez, 7.ix.1971, C. J. Marinkelle, light trap, 1 ♀. COSTA RICA: San Jose, San Isidro del General, 30.vii.1964, 1 ♂; Palmar Sur, ix.1962, F. S. Blanton, 1 ♀. EL SALVADOR: Sonsonata, Armenia, viii–xi.1966. Blanton, 1 ♀; San Vicente, viii.1967, Blanton, 1 ♂. FLORIDA: Dade Co., Kendall, 6.viii.1977, W. W. Wirth, light trap, 1 ♀. HONDURAS: Comayagua, Siguatepeque, viii.1964, Blanton, 3 ♀, 2 ♂; same data except ix.1966, 5 ♀, 5 ♂; same except viii.1967, 1 ♀, 1 ♂; Comayagua, Comayagua, 17.v.1966, J. F. Matta, 1 ♂. Copan, Santa Rosa, 15.vi.1966, Matta, 1 ♀; same except 26.vi.1966, 1 ♂, 28.vi.1966, 1 ♂; 10.vii.1966, 1 ♂; 4.viii.1966, 1 ♂; Santa Rosa, iii–v.1964, Blanton, 1 ♂; same except x.1966, 2 ♀, 4 ♂. Zamorano, Francisco Morazan, 15.vi.1966, Matta, 1 ♀. HAITI: Chou Chou Vaie, 8.vi.1978, C. Raccurt, swept, 2 ♀. JAMAICA: Clarendon Parish, Milk River Bath, 19.xi.1968, R. E. Woodruff, black light, 2 ♀. St. Catherine, Twickenham Park, 28.iv.1970, E. G. Franworth, light trap, 3 ♀. MEXICO: Morelos, El Salto Falls, 17.vi.1969, W. & D. Haase, light trap, 1 ♂. Sinaloa, 20 mi E Villa Union, 31.i.1964, E. I. Schlinger & M. E. Irwin, at light, 1 ♀. PANAMA: Chiriqui, El Volcan, 22.vii.1966, A. Broce, 1 ♀. Darien, Santa Fe, ii–xi.1967, Broce, 2 ♀. Canal Zone, Mojinga Swamp, i.1952, F. S. Blanton, 1 ♀, 4 ♂. PUERTO RICO: Mayaguez, Univ. Puerto Rico Campus, 9.i.1969, Walker & Drummond, light trap, 1 ♂. TEXAS: Gillespie Co., Fredericksburg, 30.vi.1967, Blanton & Borchers, light trap, 1 ♀; Pedernales River, 4.iv.1955, W. W. Wirth, reared stream margin, 1 ♀ with pupal exuviae, Kerr Co., Kerrville, 10–11.viii.1953, L. J. Bottimer, light trap, 4 ♀, 6 ♂. VENEZUELA: Araq. Ocumare, 10.ii.1969, P. Spangler, 1 ♀. Guarico, 12 km S Calabozo, 6.ii.1969, P. & P. Spangler, light trap, 1 ♀. Zulia, El Tucuco, Sierra de Perija, 28.i.1978, J. B. Heppner, 1 ♂.

Discussion.—Among the Neotropical species with 2-spotted wings, *Alluaudo-*

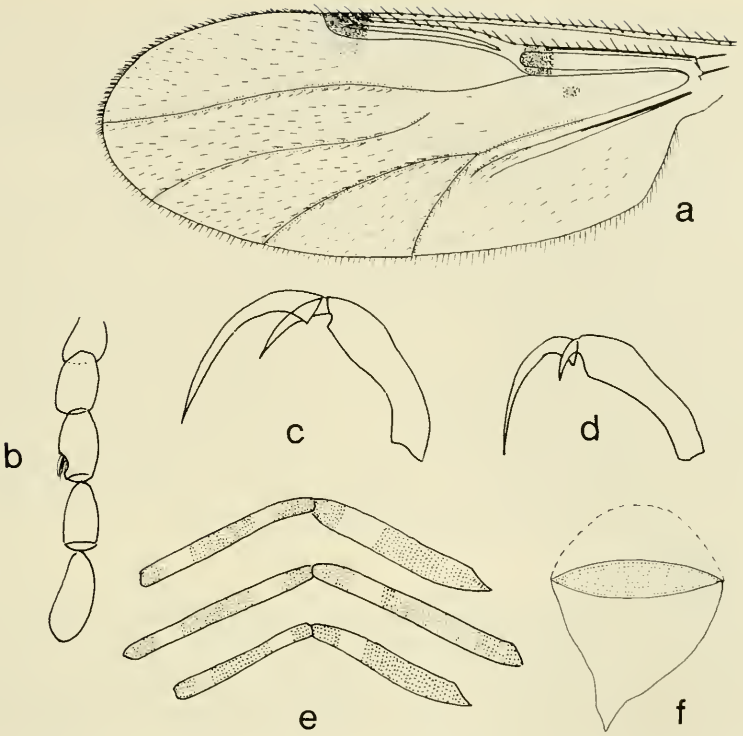

Fig. 3. *Alluaudomyia catarinensis,* female: a, wing; b, palpus; c, claws of fore and mid legs; d, claws of hind leg; e, femora and tibiae of (top to bottom) hind, mid and fore legs; f, spermatheca.

myia caribbeana resembles *A. schnacki* in the presence of subapical pale rings on the tibiae, but differs from that species in having the bases of all femora brown. It also differs from *A. schnacki* in the high arch of the male aedeagus.

Alluaudomyia wirthi Williams (1956) from Douglas Lake, Michigan, is very similar to *A. caribbeana* but differs in having 3 additional black streaks on the wing: a distinct one near the base of vein M2, an indistinct one toward the base of cell M2, and another at the tip of the anal vein. The genitalia of the unique holotype male of *A. wirthi* are mounted with the aedeagus folded back on itself, but the basal arch is apparently much shorter than in *A. caribbeana.*

The pupa of *Alluaudomyia caribbeana* differs from that of *A. bella* (Coquillett) by the small number of spiracular openings on the respiratory horn, and by the absence of microsetae in the midportion of the raised areas of the operculum. It differs from the pupa of *A. schnacki* Spinelli by the small number of spiracular openings of the respiratory horn, and by the scale-like tubercles on the surface of the horn; in addition the pupa of *A. schnacki* lacks the large raised areas on the operculum, but there are 2 small *a.m.* setae on each of these areas instead.

Aluaudomyia catarinenis **Spinelli and Wirth, New Species**

Fig. 3

Female.—Wing length 1.35 (1.30–1.40, n = 2) mm; breadth 0.58 (0.56–0.60, n = 2) mm.

Head: Brownish. Eyes bare, contiguous for a distance equal to diameter of 2 ommatidial facets. Antenna brownish, bases of segments 3–10 pale; lengths of flagellar segments in proportion of 25-20-18-19-20-20-22-22-25-27-30-30-40; antennal ratio 0.91 (n = 2). Palpus (Fig. 3b) brownish; lengths of segments in proportion of 15-20-20-15-25; 3rd segment with conspicuous distal pit bearing long hyaline sensilla. Mandible with 16 teeth.

Thorax: Uniformly brownish, very pilose; scutellum with 4 setae. Legs (Fig. 3e) brownish, with subapical pale rings on femora and tibiae, and subbasally on tibiae; tarsi brownish; hind tarsal ratio 2.87 (2.84–2.90, n = 2); claws (Fig. 3c, d) long, slender and greatly unequal on all legs, but short claw very much reduced on hind leg. Wing (Fig. 3a) gray, markedly infuscated along veins; 2 extensive conspicuous dark-brownish spots, one proximad of r-m crossvein between radius and media, the other covering end of costa and extending posteriorly across cell R5 over ½ way to vein M1; costal ratio 0.62 (n = 2). Halter pale.

Abdomen: Dark brown, last segment yellowish; genital sclerotization not pigmented. One spermatheca (Fig. 3f), collapsed and not measured in specimens examined, but appearing ovoid with tapering neck.

Male.—Unknown.

Distribution.—Brazil.

Types.—Holotype ♀, Brazil, Santa Catarina, Nova Teutonia, x.1967, F. Plaumann. Paratype, 1 ♀, same data except xi.1970.

Discussion.—This species is readily distinguished from the other Neotropical species of *Alluaudomyia* with 2-spotted wings by its large size (shared with *A. plaumanni*) and dark, pale-banded legs.

Alluaudomyia distispinulosa **Spinelli and Wirth, New Species**

Fig. 4

Female.—Wing length 1.10 (1.05–1.15, n = 2) mm; breadth 0.48 (0.47–0.49, n = 2) mm.

Head: Brownish. Eyes bare, contiguous for a distance equal to diameter of 3 ommatidial facets. Antenna brownish, bases of segments 3–10 pale; lengths of flagellar segments in proportion of 25-18-17-18-20-20-22-23-27-27-28-25-39; antennal ratio 0.89. Palpus (Fig. 4b) with lengths of segments in proportion of 12-15-16-13-25; 3rd segment with conspicuous distal pit. Mandible with 16 teeth.

Thorax: Brownish, with small dark mottlings; scutellum paler than mesonotum and postnotum. Legs (Fig. 4d) yellowish, coxae and trochanters dark brown; femora dark brown on proximal ½, with subapical pale ring on fore and mid legs; mid tibia with 4 narrow, equally separated, incomplete brown rings; fore tibia with subbasal and subapical pale ring; mid and hind tibiae brown at extreme base and apex, with narrow, equally separated, incomplete brown rings, 4–5 on mid tibia, 5–6 on hind tibia; tarsi brownish; hind tarsal ratio 3.3; claws (Fig. 4c) long and slender, unequal on all legs. Wing (Fig. 4a) with costal ratio 0.60 (0.58–0.62, n = 2); membrane whitish; 2 black spots, 1 proximad of r-m crossvein, the other over end of costa and extending into cell R5. Halter pale.

Abdomen: Pale brown, genital sclerotization not in position to study. One ovoid spermatheca (Fig. 4e) measuring 0.090 mm long × 0.055 mm broad.

Male.—Wing length 0.85 mm; breadth 0.34 mm. Similar to female with usual

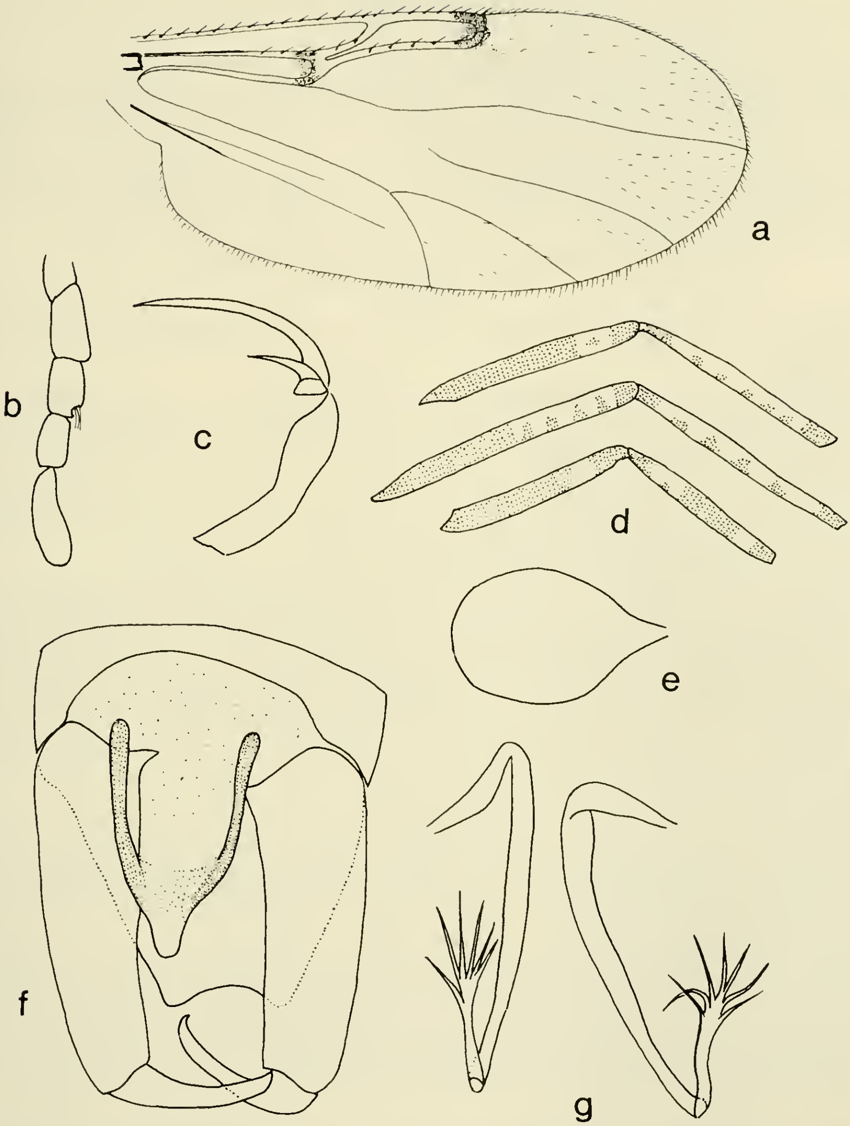

Fig. 4. *Alluaudomyia distispinulosa*; a–e, female; f–g, male; male: a, wing; b, palpus; c. claws of all legs; d, femora and tibiae of (top to bottom) hind, mid and fore legs; e, spermatheca; f, genitalia; g, parameres.

sexual differences. Antenna missing. Palpal segments with lengths in proportion of 8-18-16-14-26. Hind tarsal ratio 2.85. Costal ratio 0.50.

Genitalia (Fig. 4f): Learly identical with those of *A. punctiradialis,* but caudal membrane of sternite 9 spiculate; gonostylus without distinct apical tooth, and paramere (Fig. 4g) with spinules in a more compact group at tip.

Distribution.—Brazil, Colombia, Venezuela.

Types.—Holotype ♀, Brazil, Amazonas, Manaus, 21.ix.1969, H. A. Wright. Allotype ♂, Venezuela, Guarico, 12 km S Calabozo, 6.ii.1969, P. & P. Spangler, light trap. Paratype, COLOMBIA: Rio Raposo, iv.1964, V. H. Lee, light trap, 1 ♀.

Discussion.—The species takes its name from its distally spinulose male parameres, a character it shares with *A. punctiradialis* n. sp. The Oriental species of the *A. annulata* Group (Wirth and Delfinado, 1964) are also characterized by many narrow dark rings and punctations on the legs, and small dark punctures on the radius, but the Oriental species differ in having 7 additional posterior spots on the wings and parameres without the distal clump of sharp spinules.

Alluaudomyia estevezae **Spinelli and Wirth, New Species**

Fig. 5

Female.—Wing length 1.00 (0.95–1.05, n = 5) mm; breadth 0.45 (0.42–0.50, n = 5) mm.

Head: Brownish. Eyes bare, contiguous for a distance equal to diameter of 2 ommatidial facets. Antenna brownish, bases of segments 3-10 pale; flagellar segments with lengths in proportion of 28-16-16-17-17-18-18-20-22-22-25-23-31; antennal ratio 0.80 (0.78–0.82, n = 5). Palpus with lengths of segments in proportion of 12-15-20-15-25, last 3 segments darker than preceding 2; 3rd segment with 1 or 2 distal sensilla. Mandible with 15 teeth.

Thorax: Brownish with dark-brown mottlings; scutellum paler. Legs (Fig. 5e) brownish, with pale rings subapically on femora, subbasally and subapically on tibiae; tarsi pale brown; hind tarsal ratio 2.79 (2.60–3.00, n = 5); tarsal claws (Fig. 5c, d) moderately short and stout, unequal on all legs. Wing (Fig. 5a) with costal ratio 0.60 (n = 5); membrane whitish, with 12–13 black spots: 1 at end of costa extending into cell R5, 2nd proximad of r-m crossvein; 4 subapically in cells R5, M1, M2, and M4, 3 in anal cell, 1 on vein M1 + 2, 1 on vein M2, and 1 in cell M2 just above mediocubital fork. Halter pale.

Abdomen: Brownish, last segment whitish. Genital sclerotization (Fig. 5f) prominent, deeply sclerotized brownish, as figured. One subspherical spermatheca (Fig. 5g) with conical sclerotized neck, measuring 0.069 (0.067–0.072, n = 3) mm long × 0.057 (0.055–0.060, n = 3) mm broad.

Male.—Wing length 0.70 mm, breadth 0.32 mm; costal ratio 0.52. Similar to female with usual sexual differences. Antenna with lengths of flagellar segments in proportion of 42-18-18-17-14-13-12-13-13-14-34-30-36; antennal ratio 0.86. Palpal segments with lengths in proportion of 10-17-15-14-19. Hind tarsal ratio 2.3.

Genitalia (Fig. 5h): Elongated; sternite 9 short with deep, broad, U-shaped, caudomedian excavation, posterior membrane spiculate; tergite 9 short, tapering to long, narrowly pointed, apicolateral processes. Gonocoxite long and slender, ca. 4× longer than wide; gonostylus slender and curved. Aedeagus slightly longer than basal breadth, with high basal arch. Parameres (Fig. 5i) divergent caudad; each with short recurved basal apodeme; main portion moderately stout and sclerotized anteriorly, distal portion tapering, abruptly recurved ventrad, and tapering to slender sharp point.

Distribution.—El Salvador, Honduras, Mexico.

Types.—Holotype ♀, Mexico, Morelos, El Salto Falls, 17.vi.1969, W. & D. Haase, light trap. Allotype ♂, El Salvador, San Vicente, Santo Domingo, xi.1966, F. S. Blanton. Paratypes, 5 ♀, as follows: MEXICO, same data as holotype, 4 ♀. HONDURAS: Santa Rosa, iii–v.1964, F. S. Blanton, 1 ♀.

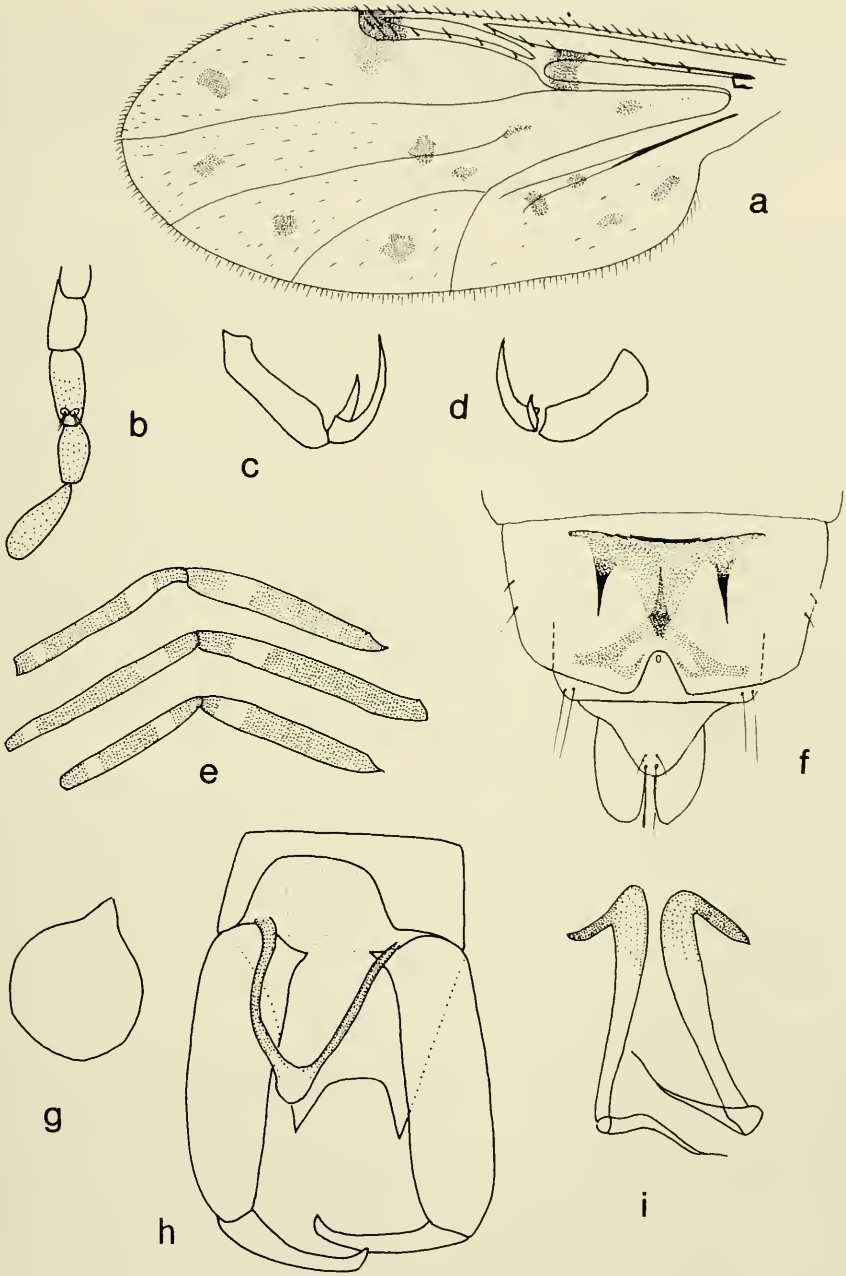

Fig. 5. *Alluaudomyia estevezae*; a–g, female; h–i, male: a, wing; b, palpus; c, claws of fore and mid legs; d, claws of hind leg; e, femora and tibiae of (top to bottom) hind, mid, and fore legs; f, genital sclerotization; g, spermatheca; h, genitalia; i, parameres.

Discussion.—The species is named for Lic. Ana L. Estevez of the Instituto de Limnologia de La Plata (ILPLA), República Argentina.

Alluaudomyia estevezae is similar to *A. bella* (Coquillett) in wing pattern, but consistently has 3 rather than 1 pale spots in the anal cell and 2 pale spots in the proximal ½ of cell M2 in line with the pale spot over the base of vein M2, the legs are dark brown with narrow pale bands, the spermatheca has a conical tapering neck, and the genital sclerotization is dark brown with 3 narrowly pointed posterior extensions. The male aedeagus and parameres of the 2 species also differ markedly.

Alluaudomyia fittkaui Spinelli and Wirth, New Species

Fig. 6

Female.—Wing length 0.85 (n = 7) mm; breadth 0.35 (n = 7) mm.

Head: Yellowish brown. Eyes bare, contiguous for a distance equal to diameter of 3 ommatidial facets. Antenna with lengths of flagellar segments in proportion of 17-12-12-13-14-15-18-19-19-21-26-23-32; antennal ratio 1.02 (1.00–1.07, n = 7). Palpus (Fig. 6b) with lengths of segments in proportion of 9-12-12-10-17; 3rd segment with sensory pit. Mandible with 11–12 teeth.

Thorax: Yellowish brown; scutellum with 2 setae. Legs (Fig. 6d) yellowish brown, with pale rings subapically on all femora and subbasally on fore and mid tibiae; hind tibia pale except narrow median and apical rings brown; tarsi pale brown except hind basitarsus dark brown; hind tarsal ratio 3.04 (2.96–3.12, n = 7). Tarsal claws (Fig. 6c) large and slender, unequal on all legs. Wing (Fig. 6a) with costal ratio 0.60 (n = 7); membrane whitish; 4 small black spots, one proximad of r-m crossvein, 2nd at end of costa extending into cell R5, 3rd lying near base of vein M2, and 4th near tip of vein Cu1. Halter pale.

Abdomen: Yellowish brown; genital sclerotization not pigmented. One pear-shaped spermatheca (Fig. 6e) measuring 0.057 (0.055–0.068, n = 7) mm long × 0.046 (0.045–0.051, n =7) mm broad.

Male.—Wing length 0.72 (0.70–0.78, n = 3) mm; breadth 0.31 (0.30, n = 3) mm; costal ratio 0.51 (0.50–0.52, n = 3). Similar to female with usual sexual differences. Antenna with lengths of flagellar segments in proportion of 42-18-18-18-18-17-17-16-16-25-46-41-39; antennal ratio 1.00 (0.98–1.03, n = 4). Palpus with lengths of segments in proportion of 8-13-14-10-15. Hind tarsal ratio 2.6 (2.43–2.71, n = 4).

Genitalia (Fig. 6f, g): Indistinguishable from those of *Alluaudomyia leei* (Fig. 7g, h).

Distribution.—Brazil, Ecuador.

Types.—Holotype ♀, allotype ♂, Brazil, Amazonas, Cachoeira San Antonio, 10.i.1963, E. J. Fittkau, at light. Paratypes, 229 ♀, 25 ♂, as follows: BRAZIL: Same data as types, 18 ♀; Amazonas, Rio Cueiras, iv.1961, Fittkau, at light, 2 ♀, 2 ♂; same data except 19.i.1961, 1 ♀, 1 ♂; Rio Cururu, Mission Cururu, i.1961, Fittkau, at light, 5 ♂; Rio Irapirapi, Cachoeira, 11.i.1963, Fittkau, at light, 34 ♀; same data except 13.i.1963, 2 ♀; Rio Marauia, xii-1962-ii.1963, Fittkau, at light, 78 ♀, 1 ♂; same data except 7.i.1963, 15 ♀; same data except 22.i.1963, sandy beach, 6 ♀; same data except 24.i.1963, near foothills, 8 ♀, 1 ♂; same data except i–ii.1963, 17 ♀, 1 ♂. Para, Rio Paru, 14.iii-22.iv.1962, Fittkau, 16 ♀, 2 ♂; same data except iii.1962, 3 ♀, 1 ♂; same data except iv.1962, 7 ♀. ECUADOR: Pastaza, Cononaco, 30.v.1976, J. Cohen, at light, 22 ♀, 11 ♂.

Discussion.—This species is named for Ernst J. Fittkau of the Zoologische Staatssammlung, München, West Germany, in recognition of his important contributions in the collection and study of Amazonian midges.

Alluaudomyia fittkaui belongs to a large group of species related to the North

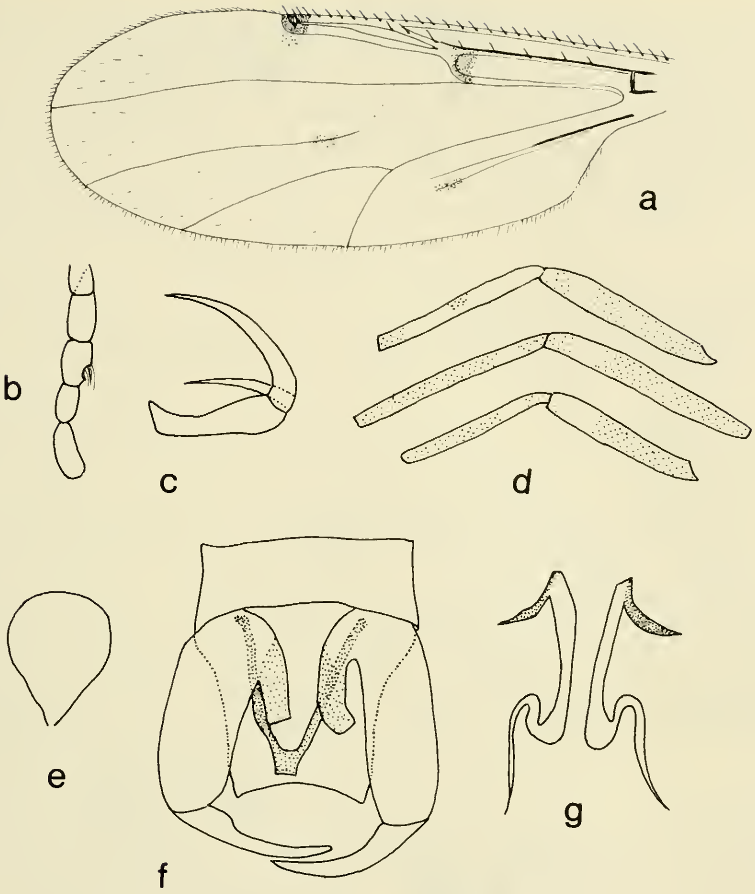

Fig. 6. *Alluaudomyia fittkaui*; a–e, female; f–g, male: a, wing; b, palpus; c, claws of all legs; d, femora and tibiae of (top to bottom) hind, mid and fore legs; e, spermatheca; f, genitalia; g, parameres.

American *A. megaparamera* Williams in which the marginal wing spots are few in number and the male parameres consist of a nearly straight proximal portion, abruptly swollen and reflexed in mid portion, and ending in a long, tapering, curved, pointed process. *A. megaparamera* is readily distinguished from *fittkaui* by the presence of 2 distinct anterior black spots and 7 indistinct black streaks posteriorly, more extensive pale leg markings, more elongate spermatheca, and more prominent and differently shaped genital sclerotization.

***Alluaudomyia leei* Spinelli and Wirth, NEW SPECIES**

Fig. 7

Female.—Wing length 1.12 (1.05–1.20, n = 6) mm; breadth 0.48 (0.45–0.50, n = 6) mm.

Head: Dark brown. Eyes bare, contiguous for a distance equal to diameter of 1.5 ommatidial facets. Anntenna brownish, bases of segments 3–10 pale; lengths of flagellar segments in proportion of 28-20-20-20-23-23-25-25-29-29-30-26-35; antennal ratio 0.86 (0.81–0.92, n = 8). Palpus (Fig. 7b) with lengths of segments

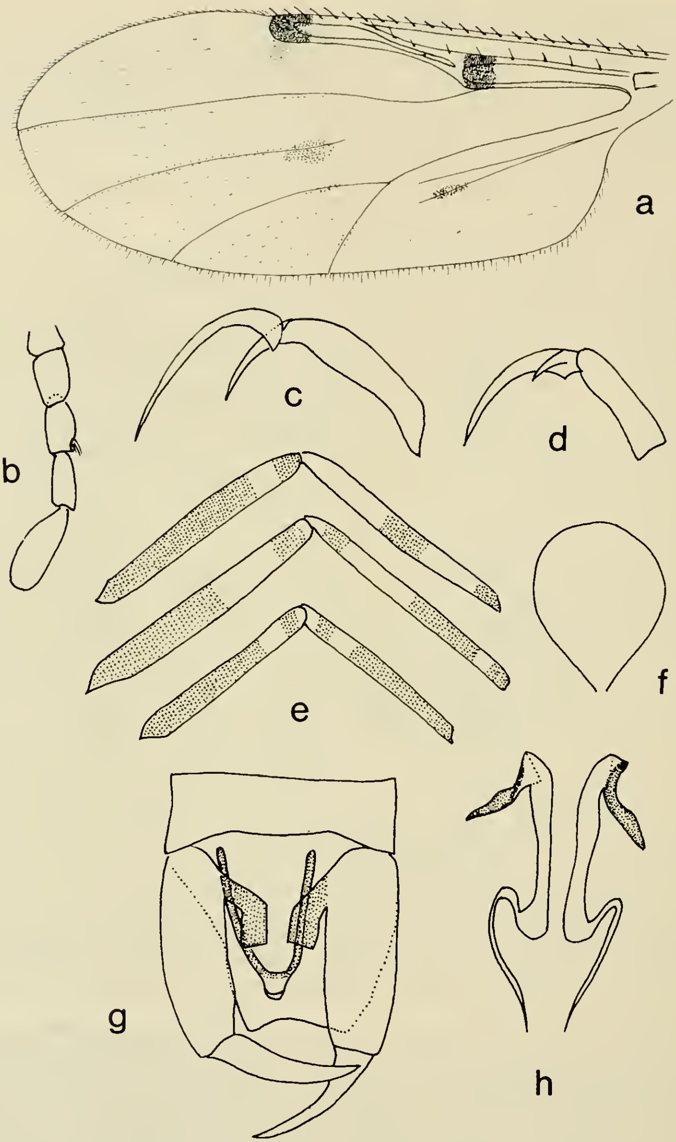

Fig. 7. *Alluaudomyia leei*; a–f, female; g–h, male: a, wing; b, palpus; c, claws of fore and mid legs; d, claws of hind leg; e, femora and tibiae of (top to bottom) hind, mid and fore legs; f, spermatheca; g, genitalia; h, parameres.

in proportion of 12-15-17-15-23; 3rd segment with sensory pit. Mandible with 13 teeth.

Thorax: Brownish, with dark brown mottlings. Legs (Fig. 7e) brownish; coxae and trochanters brown; femora and fore and mid tibiae with subapical pale rings; tibiae pale at bases, fore and mid tibiae with subbasal pale rings; tarsi light brown except hind basitarsus dark brown; hind tarsal ratio 2.75 (2.50–2.94, n = 7); tarsal claws (Fig. 7c, d) large and slender, unequal on all legs, the longer nearly as long as tarsomere 5, but short claw very much reduced on hind leg. Wing (Fig. 7a) with costal ratio 0.60 (0.58–0.63, n = 6); membrane whitish, faint dark streaks along veins; 4 black spots, one proximad of r-m crossvein extending from costa to media, 2nd at end of costa and extending in cell R5 about ½ way to vein M1, 3rd lying near base of vein M2, and 4th near tip of vein Cu1. Halter pale.

Abdomen: Brownish; genital sclerotization not pigmented. One subspherical spermatheca (Fig. 7f) with short neck, measuring 0.076 (0.075–0.080, n = 5) mm long × 0.060 (0.055–0.070, n = 5) mm broad.

Male.—Wing length 0.82 (0.75–0.85, n = 3) mm; breadth 0.31 (0.30–0.32, n = 3) mm; costal ratio 0.52 (0.50–0.56, n = 3). Similar to female with usual sexual differences. Antenna with lengths of flagellar segments in proportion of 48-18-18-16-18-14-14-14-14-26-46-38-40; antennal ratio 0.99 (0.97–1.02, n = 3). Hind tarsal ratio 2.5 (n = 3).

Genitalia (Fig. 7g): Short; sternite 9 broad, without caudomedian excavation; tergite 9 elongate, tapering distally with apicolateral processes reduced to obtuse angles. Gonocoxite moderately long, bearing an anteromesal subrectangular process projecting posteriorly; gonostylus slender, curved to pointed tip. Aedeagus longer than basal breadth; basal arch extending nearly to apex; distomedian process a short, ventrally bent point. Parameres (Fig. 7h) separate, nearly identical with those described by Wirth and Grogan (1981) for the Nearctic species *A. megaparamera* Williams; each with slender, recurved, and heavily sclerotized basal apodeme; straight and slender on proximal ½ of main portion, then abruptly swollen bulbously, abruptly recurved basad ventrolaterally, and less abruptly curved laterally and distally as a long, slender, tapering, pointed process.

Distribution.—Bolivia, Colombia.

Types.—Holotype ♀, Colombia, Meta, Finca Barbascal, 27–30.iv.1964, V. H. Lee, light trap. Allotype ♂, Colombia, Meta, Refugio Macarena, 10.i.1966, C. J. Marinkelle, light trap. Paratypes, 15 ♀, 3 ♂, as follows: BOLIVIA: Santa Cruz Pr., San Esteban Mayurina, 2–5.x.1959, R. E. Cummings, light trap, 4 ♀; Santa Cruz, Saavedra Agr. Exp. Sta., 3.i.1960, Cummings, light trap, 2 ♀; Santa Cruz, 2.i.1960, Cummings, 3 ♀. COLOMBIA: 6 ♀, 3 ♂, same data as holotype.

Discussion.—This species is named for Vernon H. Lee, who while a member of a Rockefeller arbovirus research team in Cali, Colombia, made extensive collections of Ceratopogonidae for the U.S. National Museum. *Alluaudomyia leei* differs from *A. fittkaui* and *amazonica*, the other 2 Neotropical species with 4–5 black wing spots, by the brown bases of all femora, and the presence of black streaks near the apices of veins M1, M2, M3 + 4, and Cu1. The male gonostyli of *A. leei* bear a strongly sclerotized mesal process at the base similar to that found in *A. fittkaui* (Fig. 6f), but lacking in *A. amazonica* (Fig. 1g).

Allaudomyia nubeculosa Spinelli and Wirth, New Species

Fig. 8

Female.—Wing length 0.90 (0.85–0.95, n = 6) mm; breadth 0.38 (0.35–0.40, n = 6) mm.

Head: Uniformly pale brown. Eyes bare, narrowly contiguous, about the distance of the diameter of 1 ommatidial facet. Antenna with lengths of flagellar segments in proportion of 20-15-15-16-18-18-20-20-24-24-28-26-34; antennal ratio 1.03 (0.96–1.10, n = 6). Palpus (Fig. 8b) with lengths of segments in pro-

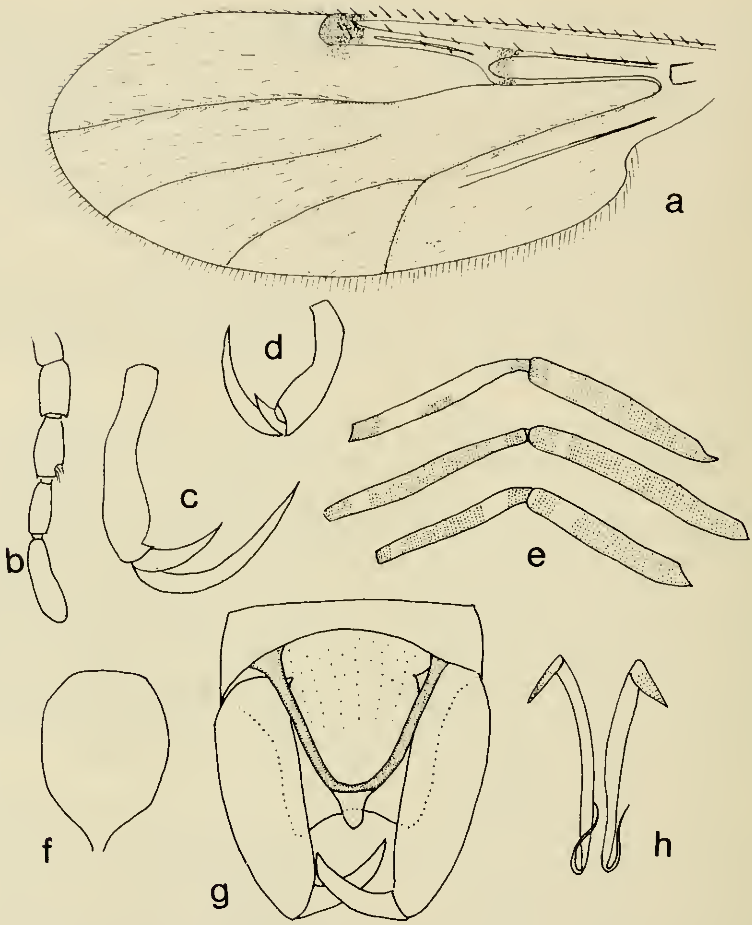

Fig. 8. *Alluaudomyia nubeculosa*; a–f, female; g–h, male; a, wing; b, palpus; c, claws of fore and mid legs; d, claws of hind leg; e, femora and tibiae of (top to bottom) hind, mid and fore legs; f, spermatheca; g, genitalia; h, parameres.

portion of 10-14-17-14-23; 3rd segment with distal sensory pit. Mandible with 14 teeth.

Thorax: Brownish; scutellum paler, bearing 4 central setae. Legs (Fig. 8e) brownish, with pale rings subapically on femora, subbasally and subapically on fore and mid tibiae; hind tibia with broad central pale band bearing a faint brownish ventral area in midportion; tarsi brownish except 4 distal tarsomeres on hind leg pale; hind tarsal ratio 3.52 (3.33–3.70, n = 6); claws (Fig. 8c, d) very unequal, the longer nearly as long as tarsomere 5, but short claw much reduced on hind leg. Wing (Fig. 8a) with costal ratio 0.55 (0.53–0.56, n = 6); membrane milky but infuscated along veins; 2 black spots, 1 proximad of r-m crossvein, 2nd at the end of costa and extending into cell R5; 10 fainter, cloudy markings, 2 each (1 at wing margin and 1 subapically) in cells R5, M1, M2, M4, and anal cell macrotrichia conspicuously long and dense. Halter pale with infuscated knob.

Abdomen: Pale brown; genital sclerotization a short median rodlike pigmented sclerite. One ovoid spermatheca (Fig. 8f) measuring 0.088 (0.085–0.090, n = 5) mm long × 0.059 (0.058–0.060, n = 5) mm broad, with short slender neck.

Male.—Wing length 0.70 (n = 4) mm; breadth 0.26 (n = 4) mm; costal ratio 0.50 (n = 4). Similar to female with usual sexual differences, wing pattern without distal markings. Antenna with lengths of flagellar segments in proportion of 48-16-16-15-15-14-14-15-16-20-44-36-37; antennal ratio 1.03 (1.00–1.08, n = 4). Palpus with lengths of segments in proportion of 8-16-14-14-20. Hind tarsal ratio 2.85 (n = 4).

Genitalia (Fig. 8g): Short; sternite 9 with low caudomedian excavation, posterior membrane spiculate; tergite 9 progressively narrowing distad, with 2 very short apicolateral processes. Gonocoxite short; gonostylus slender, curved. Aedeagus about as long as basal breadth, basal arch very high, distomedian process short. Parameres (Fig. 8h) each with well-developed basal apodeme; main portion slender, nearly straight and not well sclerotized, curving ventrad to simple, sharp, filamentous tip.

Distribution.—Brazil, Colombia.

Types.—Holotype ♀, allotype ♂, Brazil, Amazonas, Rio Solimões, 15.ix.1961, E. J. Fittkau, at light. Paratypes, 6 ♀, 3 ♂, as follows: BRAZIL: Same data as types, 2 ♀, 2 ♂; same data except 31.viii.1961, 1 ♀; Amazonas, Rio Madeira, Parana Madeirinha, 10.ix.1960, Fittkau, at light, 1 ♀. Para, Belem, ii.1970, T. H. G. Aitken, light trap, 1 ♀; same data except xi.1970, 1 ♂. COLOMBIA: Valle, Rio Raposo, iv.1963, V. H. Lee, light trap, 1 ♀.

Discussion—*Alluaudomyia nubeculosa* differs markedly in wing pattern from all other Neotropical species by the presence of a pair of cloudy markings one at wing margin and the other submarginally, in each of cells R5, M1, M2, M4, and CuA1.

Alluaudomyia plaumanni **Spinelli and Wirth, NEW SPECIES**

Fig. 9

Female.—Wing length 1.3 mm; breadth 0.55 mm.

Head: Dark brown. Eyes bare, contiguous for a distance equal to diameter of 2 ommatidial facets. Antenna uniformly dark brown; flagellar segments with lengths in proportion of 25-17-15-15-17-18-18-19-25-30-34-34-42; antennal ratio 1.15. Palpus (Fig. 9b) brown; lengths of segments in proportion of 15-18-18-15-25; 3rd segment with conspicuous distal pit. Mandible with 14 teeth.

Thorax: Uniformly dark brown; scutellum with 4 setae, 2 in midportion and 1 on each side. Legs (Fig. 9f) uniformly dark brown; hind tarsal ratio 3.0; tarsal claws (Fig. 9c, d, e) long and slender, subequal on fore leg, unequal on mid and hind legs. Wing (Fig. 9a) with costal ratio 0.58; membrane gray, infuscated along veins; 2 large black spots: 1 proximad of r-m crossvein between radius and media extending into cell M2, the other broadly covering end of costa and extending into cell R5. Halter deeply infuscated.

Abdomen: Same coloration as thorax. Genital sclerotization not in position to describe. One pear-shaped spermatheca (Fig. 9g) measuring 0.090 mm long × 0.070 mm broad.

Male.—Unknown.

Distribution.—Brazil.

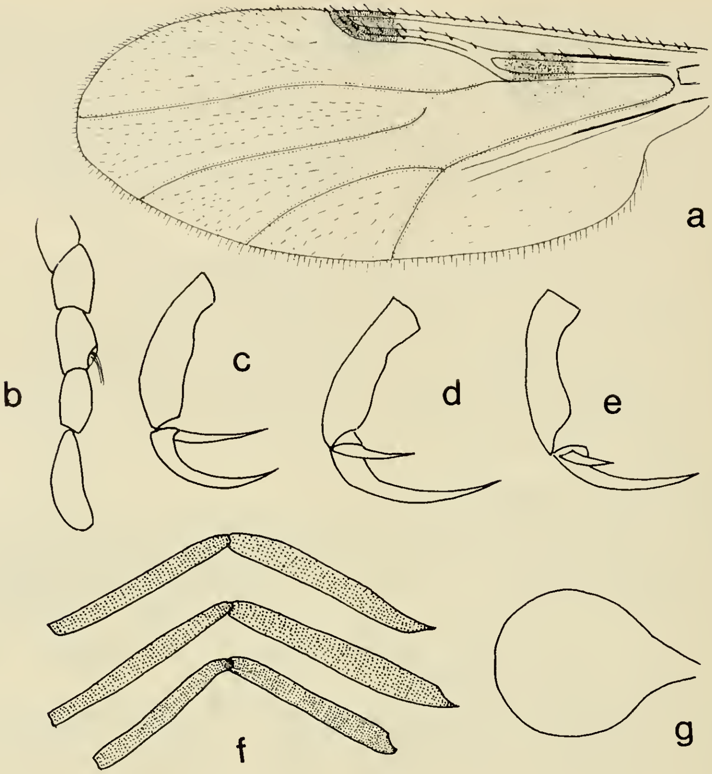

Fig. 9. *Alluaudomyia plaumanni,* female: a, wing; b, palpus; claws of c, fore; d, mid; and e, hind legs; f, femora and tibiae of (top to bottom) hind, mid and fore legs; g, spermatheca.

Type.—Holotype ♀, Brazil, Santa Catarina, Nova Teutonia, viii.1963, F. Plaumann.

Discussion.—This species is named for Fritz Plaumann, whose half century of collecting in Santa Catarina has added so much to our knowledge of the Brazilian insect fauna. *A. plaumanni* is readily distinguished from the other Neotropical *Alluaudomyia* with 2-spotted wings by its large size and uniformly dark brown body and legs.

Aluaudomyia prima Clastrier

Alluaudomyia prima Clastrier, 1976: 205 (female; French Guiana; figs.; holotype in Paris Mus.).

Distribution.—Holotype ♀ from French Guiana, Haut Maroni, Maripasoula.

New record.—PANAMA: Canal Zone, Mojinga Swamp, i.1952, F. S. Blanton, 1 ♀.

Aluaudomyia punctiradialis Spinelli and Wirth, New Species

Fig. 10

Female.—Wing length 1.08 (1.00–1.10, n = 5) mm; breadth 0.49 (0.46–0.50, n = 5) mm.

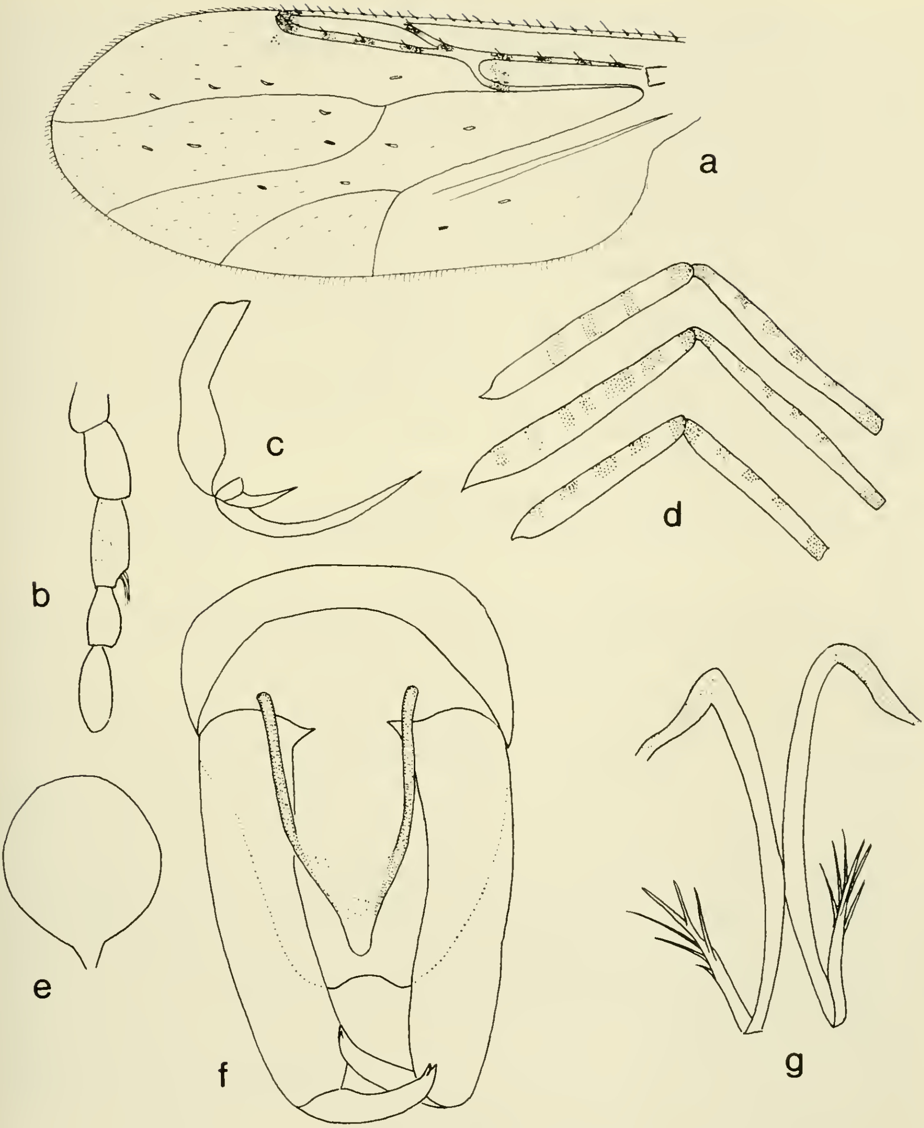

Fig. 10. *Alluaudomyia punctiradialis*; a–e, female; f–g, male: a, wing; b, palpus; c. claws of all legs; d, femora and tibiae of (top to bottom) hind, mid and fore legs; e, spermatheca; f, genitalia; g, parameres.

Head: Dark brown. Eyes bare, contiguous for a distance equal to diameter of 3 ommatidial facets. Antenna dark brown, bases of segments 3–10 pale; lengths of flagellar segments in proportion of 28-18-18-20-22-22-22-23-28-30-29-29-34; antennal ratio 0.87 (n = 3). Palpus (Fig. 10b) with lengths of segments in proportion of 13-20-20-16-25; 3rd segment with distal sensory pit and darker than others. Mandible with 14–15 subequal teeth.

Thorax: Dark brown, with small dark mottlings; scutellum with pale and dark bands alternately arranged. Legs (Fig. 10d) yellowish, with many narrow dark brown rings and punctations, coxae and trochanters brownish. Fore leg femur with 3–4 incomplete brown rings and brown apex, tibia brown at extreme base and apex, with 3 narrow, equally separated, incomplete brown rings in midportion, tarsus brownish, basitarsus infuscated at base and apex, tarsomere 2 infuscated at apex. On mid leg femur with 5–6 incomplete brown rings, apex brown; tibia brown at extreme base and apex and with 5 narrow, equally separated, incomplete brown rings; tarsus brownish, basitarsus infuscated at base, apex, and midportion; tarsomere 2 infuscated at apex. On hind leg femur with 3 complete brown rings and brown apex; tibia brown at extreme base and apex, and with 4 incomplete brown rings; tarsus brownish, basitarsus infuscated at apex; hind tarsal ratio 3.5 (3.38–3.60, n = 4). Tarsal claws (Fig. 10c) long and slender, unequal on all legs. Wing (Fig. 10a) with costal ratio 0.64 (0.63–0.67, n = 5); membrane milky white, infuscated along veins; 2 black spots, 1 proximad of r-m crossvein, the other over end of costa and extending into cell R5; 10 small brown punctures along radius; macrotrichia flattened into long narrow scales, mostly white but a few scattered ones are dark brown. Halter infuscated.

Abdomen: Dark brown, last segment white; genital sclerotization not pigmented. One subspherical spermatheca (Fig. 10e), measuring 0.085 mm long × 0.068 mm broad.

Male.—Wing length 0.80 (0.75–0.85, n = 4) mm; breadth 0.33 (0.31–0.35, n = 4) mm; costal ratio 0.56 (0.52–0.56, n = 4). Similar to female with usual sexual differences. Antenna pale brown, segments 14, 15, and base of 13 dark brown; flagellar segments with lengths in proportion of 58-19-19-19-19-17-17-17-20-30-54-40-44; antennal ratio 1.00 (n = 4). Palpus dark brown; lengths of segments in proportion of 12-17-17-12-22. Wing with the usual 2 black spots; radius with 4–5 small brown punctures. Hind tarsal ratio 2.95 (2.80–3.00, n = 3).

Genitalia (Fig. 10f): Elongated; sternite 9 with broad and deep caudomedian excavation, posterior membrane not spiculate; tergite 9 without well-developed apicolateral processes. Gonocoxite long and slender; gonostylus short with distinct apical tooth. Aedeagus with high basal arch, basal arms slender, distal process slender and simple. Parameres (Fig. 10g) each with well-developed, recurved, basal apodeme; main portion elongated and slightly curved, distal portion abruptly recurved ventrad and bearing numerous spinules on distal ½.

Distribution.—Brazil.

Types.—Holotype female, Brazil, Para, Belem. ii.1970, T. H. G. Aitken, APWG Forest, light trap. Allotype male, same data except xi.1970. Paratypes, 5 females, 25 males, same data except dates iv.viii,ix.1970.

Discussion.—This species is unique among the known Neotropical species in the presence of many small punctations along the length of the radius. The male of *A. distispinulosa* has parameres (Fig. 4g) very similar to those of *punctiradialis,* but *distispinulsoa* lacks the punctations along the radius and its femora are uniformly dark on the proximal halves (Fig. 4).

Alluaudomyia schnacki **Spinelli**

Fig. 14k

Alluaudomyia schnacki Spinelli, in press (all stages; figs.; Argentina; holotype in Mus. de La Plata).

Distribution.—Argentina.

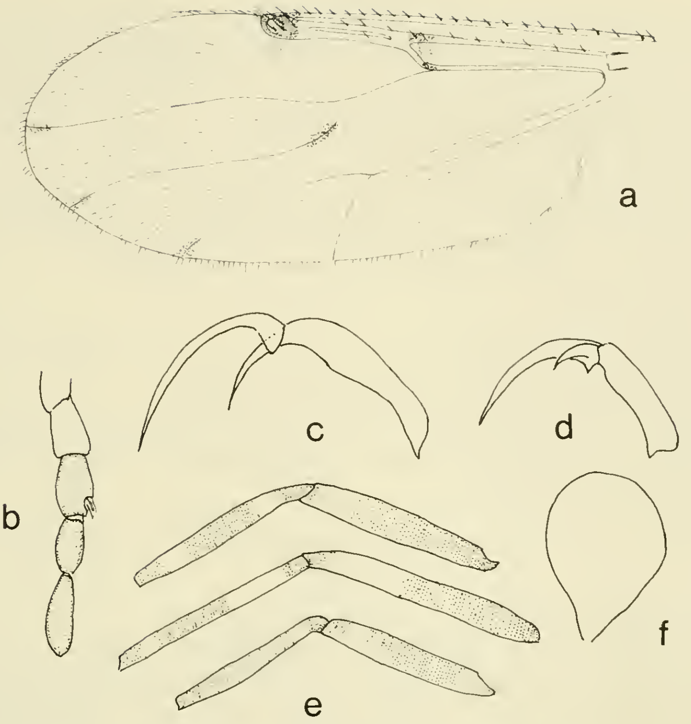

Fig. 11. *Alluaudomyia sexpunctata,* female: a, wing; b, palpus; c, claws of fore and mid legs; d, claws of hind leg; e, femora and tibiae of (top to bottom) hind, mid and fore legs; f, spermatheca.

Comment.—The original description gave all details necessary for comparison with the Neotropical species reported herein except for the details of the female genital sclerotization, which are illustrated in Fig. 14k. The species is known only from the type series collected by Spinelli 5.xi.1979, at Los Talas, Partido de Berisso, Buenos Aires Prov., Rep. Argentina. Adults were reared from larvae and pupae found associated with floating aquatic vegetation (*Azolla filiculoides*) forming the "pleuston community."

Alluaudomyia sexpunctata **Spinelli and Wirth, New Species**

Fig. 11

Female.—Wing length 0.92 (0.90–0.95, n = 3) mm; breadth 0.37 (0.35–0.40, n = 3) mm.

Head: Uniformly pale brown. Eyes bare, contiguous for a distance equal to diameter of 1 ommatidial facet. Antenna with lengths of flagellar segments in proportion of 25-18-18-20-22-22-24-24-26-30-34-32-40; antennal ratio 0.85 (0.78–0.93, n = 2). Palpus (Fig. 11b) with lengths of segments in proportion of 10-15-17-14-22; last 3 segments darker than other 2; 3rd segment with distal pit bearing a long hyaline sensillum. Mandible with 17 teeth.

Thorax: Light brown, with dark brown mottlings. Legs (Fig. 11e) brownish; coxae and trochanters brown; pale rings subapically on femora, subbasally on tibiae, and subapically on mid and hind tibiae; tarsi brownish except 4 distal tarsomeres pale on hind legs; hind tarsal ratio 3.3 (n = 2). Claws (Fig. 11c, d) long and slender, unequal, the longer nearly as long as tarsomere 5, but shorter claw much reduced on hind leg. Wing (Fig. 11a) with costal ratio 0.61 (0.58–0.62, n = 3); membrane whitish; 6 black spots: 1 proximad of r-m crossvein, 2nd at end of costa extending into cell R5, 3rd lying near base of vein M2, and the last 3 at the ends of veins M1, M2, and M3 + 4. Halter slightly infuscated.

Abdomen: Pale brown; pale yellowish distally, without pigmented genital sclerotization. One pear-shaped spermatheca (Fig. 11f) with conical sclerotized neck; measuring 0.075 (n = 3) mm long × 0.050 (n = 3) mm broad.

Male.—Unknown.

Distribution.—Colombia.

Types.—Holotype ♀, Colombia, Rio Raposo, vii.1965, V. H. Lee, light trap. Paratypes, 2 ♀, same data except iv.1963 and iv.1965.

Discussion.—The presence of 4 small but distinct black spots distally on the wing, in addition to the usual 2 large anterior spots, will serve to distinguish *Alluaudomyia sexpunctata.*

Alluaudomyia tenuiannulata Spinelli and Wirth, NEW SPECIES

Fig. 12

Female.—Wing length 1.1 mm; breadth 0.5 mm.

Head: Uniformly brownish. Eyes bare, contiguous for a distance equal to diameter of 2 ommatidial facets. Antenna with lengths of flagellar segments in proportion of 27-19-17-19-19-20-21-23-26-27-30-28-40; antennal ratio 0.87. Palpus (Fig. 12b) with lengths of segments in proportion of 10-17-17-13-21; 3rd segment with distal sensory pit. Mandible with 15 (?) teeth.

Thorax: Dark brown, scutellum paler. Legs (Fig. 12d) brownish, coxae and trochanters brown. Femora with subapical pale rings; tibiae with subbasal and subapical pale rings; tarsi brownish; hind tarsal ratio 2.9; claws (Fig. 12c) long, slender, and unequal on all legs. Wing (Fig. 12a) with costal ratio 0.57; membrane lightly brownish, especially along veins; only 2 conspicuous black spots, 1 extending proximad of r-m crossvein, the 2nd lying over apex of costa and not extending into cell R5. Halter pale.

Abdomen: Dark brown. Genital sclerotization as in Fig. 12f. Spermatheca (Fig. 12e) pear-shaped, with conical sclerotized neck; measuring 0.068 mm long × 0.060 mm broad.

Male.—Wing length 0.95 mm; breadth 0.42 mm; costal ratio 0.47. Similar to female with usual sexual differences. Antenna with lengths of flagellar segments in proportion of 57-19-17-17-16-15-15-15-15-20-47-39-37; antennal ratio 0.92. Palpus with lengths of segments in proportion of 10-16-19-18-18.

Genitalia (Fig. 12g): Short; sternite 9 with shallow caudomedian excavation, posterior membrane not spiculate; tergite 9 progressively narrowing distad, with 2 low, rounded, apicolateral lobes. Gonocoxite moderately stout; gonostylus nearly straight. Aedeagus short, basal arch extending about ⅔ of total length; distomedian process short and moderately stout with blunt tip. Parameres (Fig. 12h) each with detached basal apodeme; main portion very stout and straight, distal portion abruptly recurved ventrad and tapering to sharp point.

Distribution.—Costa Rica, Guatemala.

Types.—Holotype ♀, Guatemala, Acantenango, 2.vii.1951, Gibson and Ascoli,

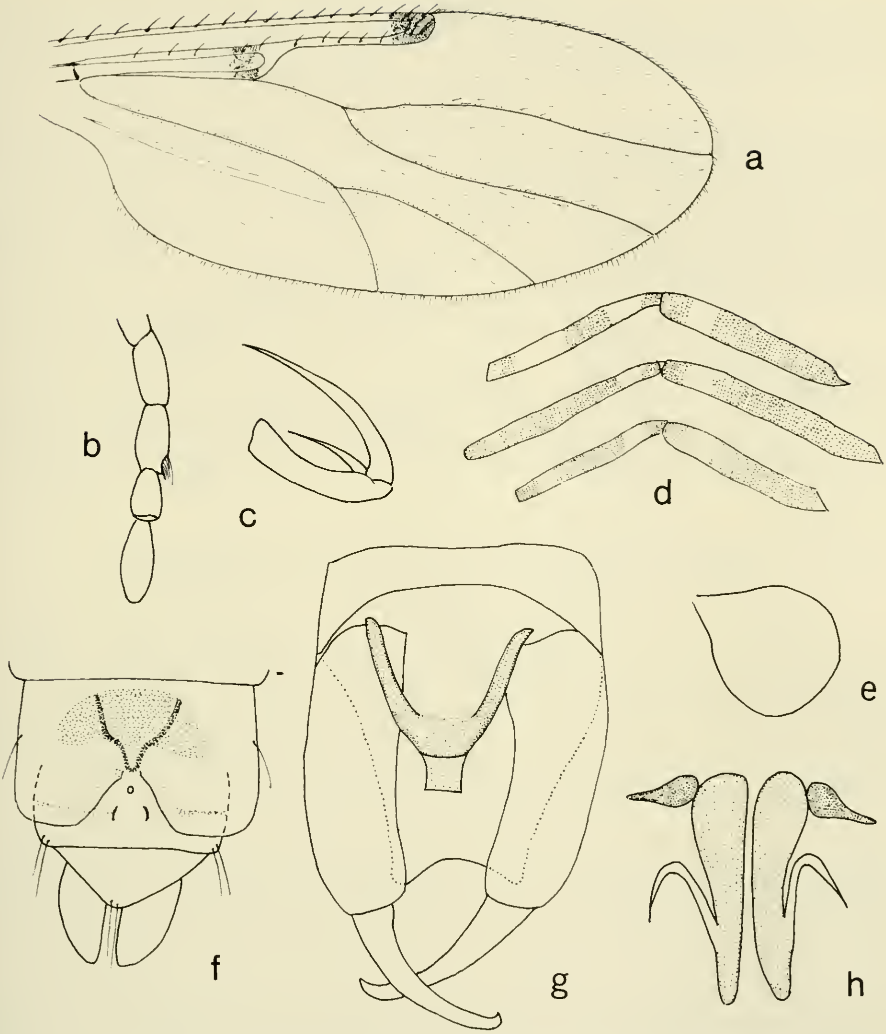

Fig. 12. *Alluaudomyia tenuiannulata*; a–f, female; g–h, male: a, wing; b, palpus; c, of all legs; d, femora and tibiae of (top to bottom) hind, mid and fore legs; e, spermatheca; f, genital sclerotization; g, genitalia; h, parameres.

light trap. Allotype ♂, Costa Rica, Puntarenas, Sabalito, viii.1953, F. S. Blanton, light trap.

Discussion.—The species takes its name from the conspicuous, narrow pale rings on the legs, differing from the other small Neotropical *Alluaudomyia* with 2-spotted wing, *A. caribbeana, schancki,* and *youngi,* in which the pale bands are much more extensive. The female genital sclerotization is shaped similar to that of *A. schnacki* (Fig. 14k).

Alluaudomyia tripunctata **Spinelli and Wirth, New Species**

Fig. 13

Female.—Wing length 0.87 mm; breadth 0.38 mm.

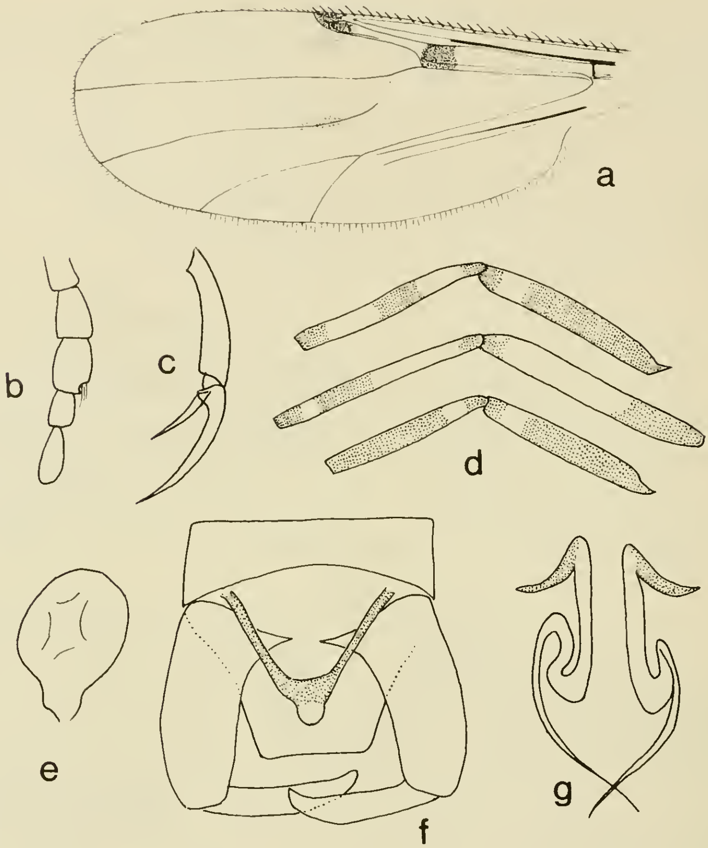

Fig. 13. *Alluaudomyia tripunctata*; a, f–g, male; b–e, female: a, wing; b, palpus; c, claws of all legs; d, femora and tibiae of (top to bottom) hind, mid and fore legs; e, spermatheca; f, genitalia; g, parameres.

Head: Light brownish. Eyes bare, contiguous for a distance equal to diameter of 2 ommatidial facets. Antenna brownish except bases of segments 3–10 pale; flagellar segments with lengths in proportion 20-15-14-17-18-18-20-20-20-24-27-25-33; antennal ratio 0.90. Palpus (Fig. 13b) with lengths of segments in proportion of 10-15-15-10-18; 3rd segment globose, with conspicuous distal pit bearing a long hyaline sensillum. Mandible with 12 teeth.

Thorax: Yellowish with dark brown mottlings; scutellum infuscated in midportion, bearing 4 setae. Legs (Fig. 13d) brownish, with pale rings subapically on femora and on mid and hind tibiae, and subbasally on all tibiae, the pale areas on each side of mid knee extensive; tarsi brownish; hind tarsal ratio 3.4. Claws (Fig. 13c) large, slender, and unequal on all legs. Wing (Fig. 13a) with costal ratio 0.56; membrane whitish; 3 black spots, 1 proximad of r-m crossvein, 2nd at end of costa, and 3rd smaller than the others, lying near base of vein M2. Halter with infuscated knob.

Abdomen: Yellowish; genital sclerotization not pigmented. One pear-shaped spermatheca (Fig. 13e), measuring 0.068 mm long × 0.046 mm broad.

Male.—Wing length 0.75 mm; breadth 0.29 mm; costal ratio 0.53. Similar to female with usual sexual differences. Antenna with lengths of flagellar segments in proportion of 40-17-15-15-15-15-15-15-15-20-40-35-45; antennal ratio 1.05. Palpus with lengths of segments in proportion of 7-15-14-9-12. Hind tarsal ratio 2.7.

Genitalia (Fig. 13f): Short and broad, sternite 9 with shallow caudomedian excavation, posterior membrane not spiculate; tergite 9 short and tapering, more or less rounded, without apicolateral processes. Gonocoxite moderately stout, basomesal corner produced mesad in an angular process; gonostylus nearly straight. Aedeagus about as long as basal breadth, basal arch extending ⅔ of total length; distomedian process short and bluntly rounded, poorly sclerotized. Parameres (Fig. 13g) nearly identical with those for *Alluaudomyia leei.*

Distribution.—Colombia.

Types.—Holotype ♀, Colombia, Rio Raposo, 10.vi.1964, V. H. Lee, light trap. Allotype ♂, same data except 28.vii.1964.

Discussion.—This species is readily distinguished from its Neotropical congeners by its 3-spotted wing.

Alluaudomyia youngi **Spinelli and Wirth, NEW SPECIES**

Fig. 14a–j

Female.—Wing length 1.0 mm; breadth 0.43 mm.

Head: Brownish. Eyes bare, contiguous for a distance equal to diameter of 2.5 ommatidial facets. Antenna brownish, bases of segments 3–10 pale; lengths of flagellar segments in proportion of 27-17-16-17-17-17-20-21-23-26-32-28-34; antennal ratio 0.94. Palpus (Fig. 14b) brownish; lengths of segments in proportion of 10-16-15-12-19; 3rd segment with conspicuous distal pit bearing a long hyaline sensillum. Mandible with 15–16 teeth, the distal 4 very strong.

Thorax: Uniformly light brown. Legs (Fig. 14f) brownish; coxae and trochanters brown; femora with pale rings subapically on fore and mid legs and distal ½ of hind leg; fore and mid tibiae with subbasal pale rings; hind tibia pale on proximal ⅓ and subapically; all knees pale; tarsi brownish; hind tarsal ratio 2.9. Tarsal claws (Fig. 14c–e) long and slender, subequal on fore leg, unequal on mid and hind legs. Wing (Fig. 14a) with costal ratio 0.54; membrane milky whitish; 2 black spots, one proximad of r-m crossvein, 2nd at end of costa and extending into cell R4 about ½ way to vein M1. Halter pale.

Abdomen: Light brown. Genital sclerotization prominent, as in Fig. 14h. One pear-shaped spermatheca (Fig. 14g) with conical sclerotized neck, measuring 0.068 mm long × 0.056 mm broad.

Male.—Similar to female with usual sexual differences. Antenna with lengths of flagellar segments in proportion of 46-16-15-14-13-12-12-12-13-15-38-41-46; antennal ratio 1.1.

Genitalia (Fig. 14i): Short; sternite 9 a narrow anterior band bordering a broad caudomedian excavation, posterior membrane spiculate; tergite 9 short, with rounded posterior margin without well-developed apicolateral processes. Gonocoxite short; gonostylus slender and curved, with distinct apical tooth. Aedeagus about as long as broad at base, basal arch very high, distomedian process short and bluntly rounded. Parameres (Fig. 14j) heavily sclerotized; each with long, slender recurved basal apodeme; mid portion a long, slender, curved blade; bearing

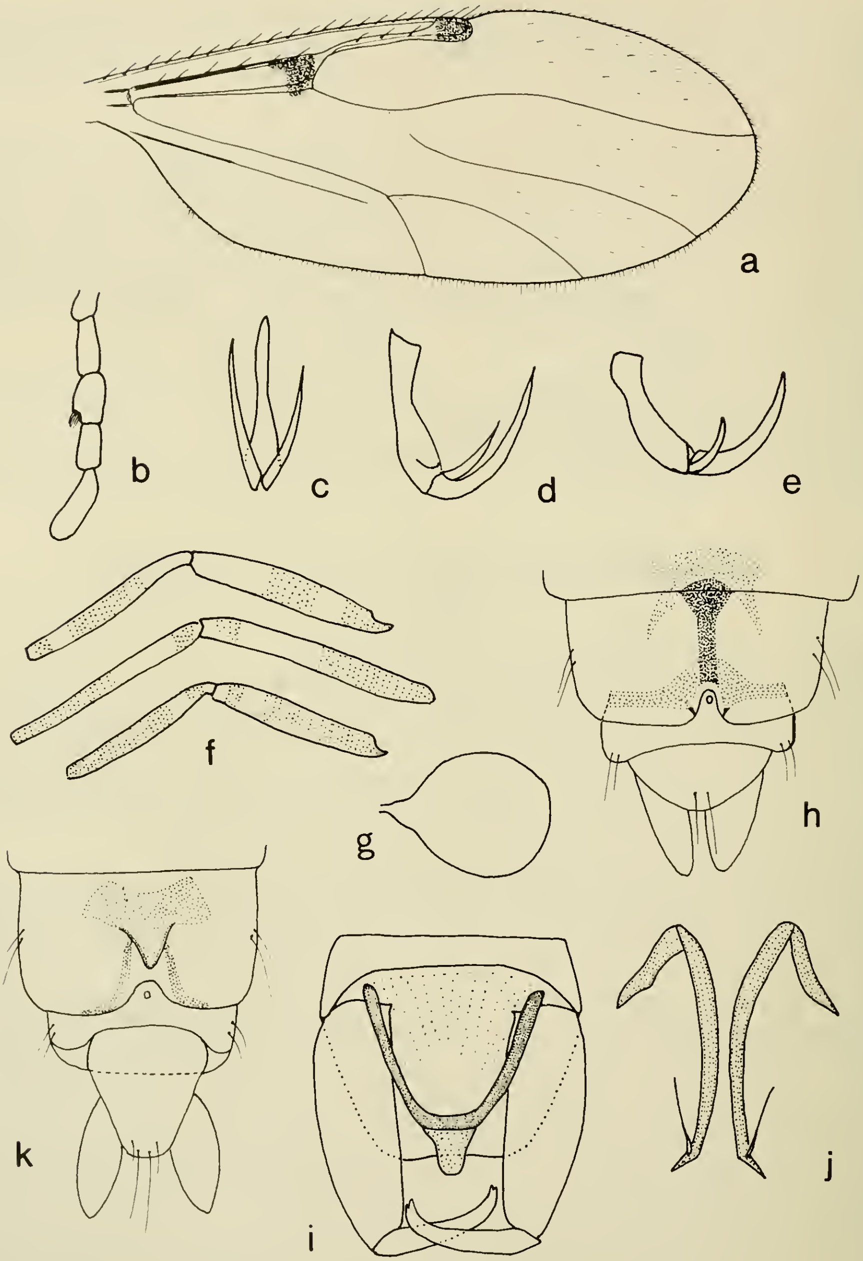

Fig. 14. *Alluaudomyia youngi,* a–j; *A. schnacki,* k; a–h, k, female; i–j, male: a, wing; b, palpus; claws of c, fore; d, mid, and e, hind legs; f, femora and tibiae of (top to bottom) hind, mid and fore legs; g, spermatheca; h, k, genital sclerotization; i, genitalia; j, parameres.

distally a short slender, filamentous process arising subapically and directed ventroproximad.

Distribution.—Colombia, Panama.

Types.—Holotype ♀, Colombia, Antioquia Dept., near Rio Anori, ix.1970, D. G. Young, blacklight trap in tropical rain forest. Allotype ♂, Panama, Canal Zone, Gamboa, Pipeline Rd., vii.1967, W. W. Wirth, light trap. Paratype, 1 ♂, same data as holotype.

Discussion.—This species is named for David G. Young of the University of Florida in Gainesville, in recognition of his important contributions to our knowledge of Neotroical Diptera, especially phlebotomine sand flies.

Alluaudomyia youngi can readily be distinguished from the other small Neotropical species of *Alluaudomyia* with 2-spotted wings by the broadly pale hind knees. The male parameres are easily distinguished by the subapical origin of the short, filamentous distal process.

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Note

Distribution of *Xylosandrus germanus* (Blandford) (Coleoptera: Scolytidae) in Maryland

Weber and McPherson (Great Lakes Entomol. 15:172–174, 1982) state that *Xylosandrus germanus* (Blandford) is apparently not established in Maryland. Specimens in the collections of E. J. Ford, USDA APHIS, and C. L. Staines, Jr. provide the following Maryland records:

Anne Arundel County: Edgewater, 1 May 1982; Gambrills, 28 June 1976. Baltimore City: Leakin Park, 11 May 1976, off beech (*Fagus* sp.) and dead *Carpinus* sp. Baltimore County: Butler, 25 April 1976, off sassafras (*Sassafras albidum*); Granite, 18 April 1973, off *Pinus* sp. Somerset County: Shelltown, 10 May 1969, from sugar trap. Talbot County: Wittman, 25 May 1974.

These records show that *X. germanus* is widely distributed in Maryland. The collection from Shelltown shows that *X. germanus* was established in Maryland before the 1971 detection at the port of Baltimore to which Weber and McPherson (1982) referred.

Specimens have been deposited in the U.S. National Museum.

C. L. Staines, Jr., *3302 Decker Place, Edgewater, Maryland 21037.*

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86(3), 1984, pp. 703–713

TAXONOMIC ANALYSIS OF *PSEUDOCOCCUS AFFINIS* (MASKELL), A SENIOR SYNONYM OF *PSEUDOCOCCUS OBSCURUS* ESSIG, AND A COMPARISON WITH *PSEUDOCOCCUS MARITIMUS* (EHRHORN) (HOMOPTERA: COCCOIDEA: PSEUDOCOCCIDAE)

Douglass R. Miller, Raymond J. Gill, and
Douglas J. Williams

(DRM) Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, Beltsville, Maryland 20705; (RJG) California Department of Food and Agriculture, Sacramento, California 95814; (DJW) Commonwealth Institute of Entomology, % British Museum (Natural History), London, SW7 5BD England.

Abstract.—Examination of type specimens of *Dactylopius affinis* Maskell, 1894, has demonstrated that it is the senior synonym of the obscure mealybug, *Pseudococcus obscurus* Essig, 1909; *P. affinis* now is the correct name for this taxon. A statistical analysis was made of the characters that best separate the pest mealybugs *Pseudococcus affinis* and *P. maritimus.* These characters are: the number of discoidal pores near the eye, the number and distribution of dorsal oral-rim tubular ducts, the length of the longest seta on the venter of abdominal segment VII, the number of translucent pores on the hind tibiae and femora, the number of multilocular pores on the venter of the thorax, the length of the apical setae, and the shape of the hind tibiae. These characters used in combination will allow accurate identification of these important agricultural pests for the first time. Lectotypes are designated for *P. obscurus, P. longispinus* var. *latipes* Green, *Dactylopius maritimus* (Ehrhorn), *P. bakeri* Essig, and *P. omniverae* Hollinger.

In 1900, Ehrhorn described *Pseudococcus maritimus* (Ehrhorn) from California. Between 1900 and 1961 several segregates of *P. maritimus* were described and synonymized and there was considerable confusion concerning the identity of the components of the complex. The United States National Museum of Natural History (USNM) contains approximately 1000 slides that were identified as *P. maritimus* between 1900 and 1961. This series contains no less than 10 different species, some of which are quite distinctive, but others that are very similar to one another.

In 1961 Wilkey and McKenzie studied a complex of species of *Pseudococcus* that they called the "*maritimus-malacearum* complex." Although several species were included, one important aspect of the research was that it provided the first basis for the separation of *P. maritimus* and *P. affinis* (Maskell) (= *P. obscurus* Essig). Although several characters were mentioned, the number of translucent pores on the hind femur and tibia was the basis of the separation. They briefly mentioned other differences but these characteristics were not used when separating species. In 1962 McKenzie mentioned the translucent pores again stating that *P. affinis* sometimes possessed fewer such pores than mentioned in his earlier paper with Wilkey. In 1967 McKenzie used the presence of discoidal pores near the eye as a primary couplet in his key to the North American species of *Pseudococcus* and separated *P. maritimus* and *P. affinis* (= *P. obscurus*) on that basis. In the description of *P. affinis* he mentioned his data on the translucent pores on the hind legs, but he did not discuss other differences. In 1966 Beardsley presented a key that included *P. maritimus* and *P. affinis* (= *P. obscurus*) and separated them by the number of translucent pores, the shape of the hind tibia, and the length of the labium. Gimpel (1983) completed a dissertation on the systematics of the *P. affinis* group and used the number and distribution of oral-collar tubular ducts on the ventral submargin to separate several species including *P. affinis* and *P. maritimus.*

The purpose of this paper is to reexamine the taxonomic characters of *P. maritimus* and *P. affinis,* to present more detailed information on the characters that were mentioned only briefly in Wilkey and McKenzie (1961) and Beardsley (1966), to discuss a few additional characters, and to draw attention to new synonymy of *P. affinis* and *P. obscurus.*

It seems of value at this point to emphasize that no single character can be used to separate *P. maritimus* and *P. affinis* in all specimens. It is necessary to look at a combination of characters and a series of specimens to make a decision concerning the identity of an unknown population. A similiar situation was demonstrated in *Pseudaulacaspis pentagona* (Targioni-Tozzetti) and *P. prunicola* (Maskell) (Davidson et al., 1983).

METHODS

Several hundred specimens were examined including type material of *P. affinis, P. capensis* Brain, *P. longispinus* var. *latipes* (Green), *P. malacearum* Ferris, and *P. maritimus.* Originally specimens were segregated to either *P. affinis* or *P. maritimus* based on the characteristics listed by Wilkey and McKenzie (1961), i.e., the occurrence of the tenth cerarius, the number of dorsal oral-rim tubular ducts, the size of the dorsal oral rims, the number of discoidal pores associated with each eye, the shape of the hind tibia, and the number of translucent pores on the hind tibia and femur. As stated by Wilkey and McKenzie, these characters are not always consistent with each other; therefore we grouped the specimens together if they possessed a majority, but not necessarily all, of the characteristics of one of the two species. After a preliminary analysis of each of the characters mentioned above, additional characters were added that appeared to conform to the original concept of the species. Some of the original characters were deleted because they were determined to be statistically identical. The data presented in Table 1 are based on 37 specimens of each species from a diversity of locations and hosts. The specimens are marked with a number and are deposited in the U.S. National Museum of Natural History (USNM). Terminology used in the text is that of McKenzie (1967) except that the cerarii are numbered from the posterior pair to the anterior pair with number one on the anal lobe and number 17 on the head. Abdominal segmentation follows that of Beardsley (1966) with the first visible segment being segment I and the segment containing the anal lobe being segment VIII.

Analysis of data was done using the Median Test, a nonparametric statistical test (Conover, 1971). Nonparametric statistical tests are used when the form of the sample distributions is not specified at the moment. The characters measured

Table 1. Comparison of characters of *Pseudococcus affinis* (aff.) and *P. maritimus* (mar.). For each character differences between species were detected with a median test. For each character significant differences were found. The symbol "n" represents the number of observations not the number of specimens.

Characters	Spp.	n	Range	Mean	Median	T Value	Signif. Level
No. discoidal pores	aff.	69	0–5	2.3	2	91.28	$P < .001$
near eye	mar.	71	0–2	0.4	0		
No. oral rims on	aff.	37	9–18	13.2	13	70.11	$P < .001$
dorsal abdomen	mar.	37	18–38	29.3	30		
Length longest seta	aff.	37	42–84	67.1	67	43.97	$P < .001$
on venter of VII	mar.	37	54–119	85.2	86		
No. translucent pores	aff.	37	47–137	82.3	75	42.41	$P < .001$
on hind tibia	mar.	37	15–68	34.7	30		
No. translucent pores	aff.	37	18–97	50.4	49	40.91	$P < .001$
on hind femur	mar.	36	2–73	23.5	24		
No. multilocular pores	aff.	37	0–8	1.5	1	14.67	$P < .001$
on venter of thorax	mar.	36	1–23	9.1	4		
Length of apical seta	aff.	31	106–153	128.2	128	8.75	$P < .005$
	mar.	30	128–173	150.1	153		

present several properties that preclude them from being normally distributed. One measure of a normal distribution is that the median and the mean are equal. Note in Table 1, that in *P. maritimus* the mean of the number of multilocular disk pores on the venter of the thorax is 9.1 and the median is 4. This difference may not seem large, however, an analysis of the frequency distribution of this character reveals that it is skewed to the lower values. The median is a more exact measure of central tendency. In *P. affinis* the discrepancy between the mean (82.3) and the median (75) numbers of translucent pores on the hind tibia is not as great in relative magnitude as the above mentioned character. A closer look at the frequency distribution, yields an extreme mode of 70, a slightly skewed distribution favoring the lower values, with a tendency to bimodality. Even those characters that have reasonably equal means and medians, at times present problematic distributions. For example, in *P. maritimus* for the number of translucent pores on the hind femur the values of the mean and the median are almost identical (23.5 vs 24.0), yet the frequency distribution consists of a clump of outliers for the larger values (45–73). This again may indicate the possibility of biomodality. With problems of this sort, the assumption of normality or the possibility of finding a perfect transformation in order to enforce normality, becomes less tenable. Therefore, nonparametric statistical tests for possible differences in the measured characters is the simplest resort.

RESULTS

We have found the following characters to be useful in combination (Table 1): (the number in parentheses in the following comparison is the mean rounded off to the nearest whole number) *Pseudococcus affinis* has 0–5(2) discoidal pores associated with each eye; 9–18(13) oral-rim tubular ducts on the dorsal abdomen; longest seta on the ventral area of segment VII 42–84(67) μ long; 47–137(82) translucent pores on the hind tibia; 18–97(50) translucent pores on the hind femur;

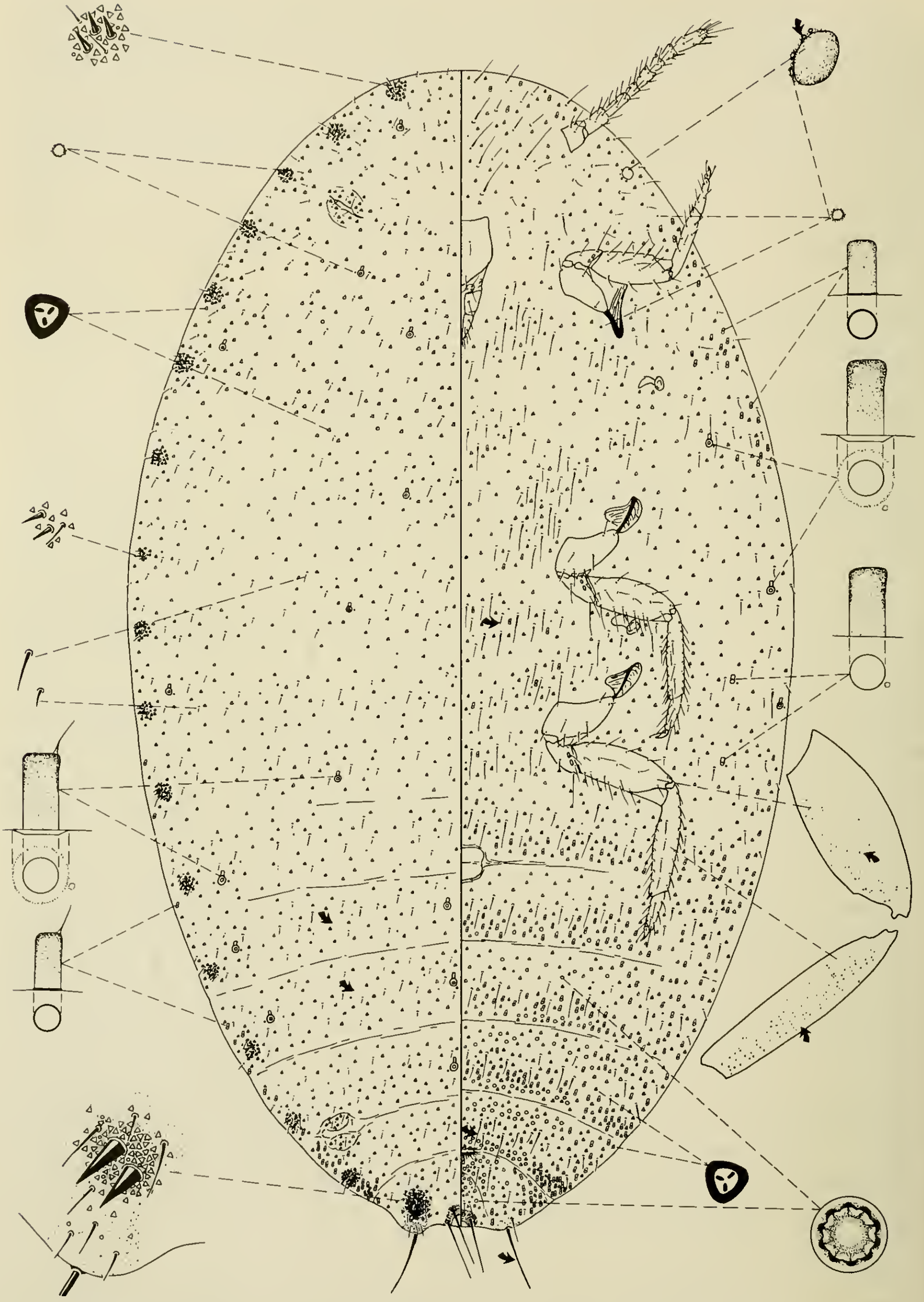

Fig. 1. *Pseudococcus affinis* (Maskell), Camberley, England, in greenhouse, November 10, 1916, on *Fuchsia* sp. Arrows point to diagnostic features.

0–8(2) ventral multilocular disk pores on the ventral thorax; longest anal-lobe seta 106–153(128) μ long (Fig. 1). *Pseudococcus maritimus* has 0–3(0) discoidal pores associated with each eye; 18–38(29) oral-rim tubular ducts on the dorsal abdomen; longest seta on the ventral area of segment VII 54–119(85) μ long; 15–68(35) translucent pores on the hind tibia; 2–73(23) translucent pores on the hind femur; 1–23(9) ventral multilocular disk pores on the ventral thorax; longest anal-lobe seta 128–173(150) μ long (Fig. 2).

We also examined the size and distribution of the oral rims on the abdomen, the occurrence and relative development of cerarius 10, the length of the labium, and the shape of the hind tibia. In *P. affinis* of the 37 specimens examined, only two possessed mediolateral oral rims on segment III, and mediolateral oral rims were absent from segments IV and V in all specimens. In *P. maritimus* the opposite was true; of the 37 specimens examined, three were without mediolateral oral rims on segment III, one was without mediolateral oral rims on segment IV, and five were without mediolateral oral rims on segment V, the remaining specimens had oral rims in these positions. We could detect no consistent difference in the relative sizes of the oral rims, although the border of the rims on *P. affinis* tended to be less evident than on *P. maritimus.* Differences were slight at best in the occurrence of the tenth cerarius. In *P. maritimus,* of 37 specimens, 29 had definite cerarii with two conical setae, seven had indefinite cerarii with a single conical seta or one or two slender setae, and one specimen lacked cerarii in this position. In *P. affinis,* of 37 specimens examined, 19 had definite cerarii, 10 had indefinite cerarii, and eight had no tenth cerarius. Although we measured the labium length of 36 specimens of each species, we could find no difference in the length of this structure ($P < 0.250$). The hind tibia of most specimens of *P. affinis* is swollen, while in *P. maritimus* it only occasionally is swollen. Unfortunately, this character could not be quantified sufficiently to demonstrate an obvious difference.

SYNONYMY

Pseudococcus affinis **(Maskell)**

Dactylopius affinis Maskell 1894:90.
Pseudococcus affinis (Maskell); Fernald 1903:97.
Pseudococcus obscurus Essig 1909:43 NEW SYNONYMY.

Based on our examination of primary types of both *P. affinis* and *P. obscurus* and on other pertinent specimens, we are confident that these species are synonyms. Both possess the diagnostic characters of the species including the unusual features of having few dorsal oral-rim tubular ducts and large numbers of translucent pores on the hind femur and tibia. The only feature that is different on the adult female syntype of *P. affinis* is that there are about 150 translucent pores on the hind tibia. We do not consider this to be sufficient to distinguish it from *P. obscurus* considering the large range of variation that we have observed in other material (47–137).

Pseudococcus capensis Brain 1912:182 NEW SYNONYMY.
Pseudococcus longispinus var. *latipes* Green 1917:264 NEW SYNONYMY.
Pseudococcus malacearum Ferris 1950:185 NEW SYNONYMY.
Pseudococcus latipes Green; Williams 1962:40 NEW SYNONYMY.

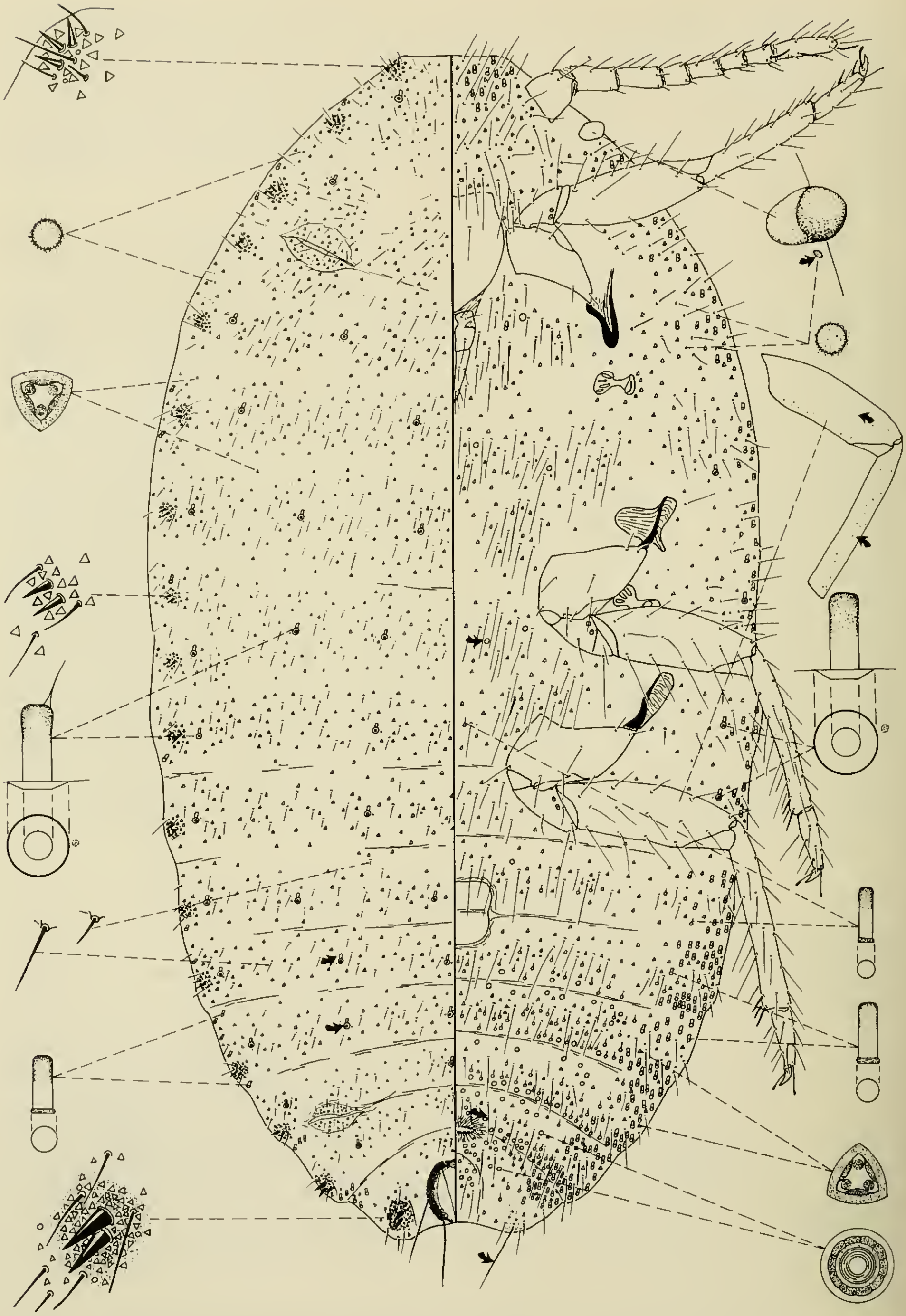

Fig. 2. *Pseudococcus maritimus* (Ehrhorn), Santa Cruz, California, July 1899, on *Eriogonum* sp. Arrows point to diagnostic features.

Pseudococcus maritimus (Ehrhorn)

Dactylopius maritimus Ehrhorn 1900:316.
Pseudococcus bakeri Essig 1910:339.
Pseudococcus omniverae Hollinger 1917:271.
Pseudococcus maritimus (Ehrhorn); Ferris 1918:48.

TYPES

1. *Dactylopius affinis* Maskell.—According to Deitz and Tocker (1980) there are three original slides of this species each containing a single specimen. We have examined these slides and under normal circumstances we would designate a lectotype. Unfortunately, the best specimen from the series has been misplaced by Miller at the facilities at Beltsville, and the remaining two specimens (an immature and a portion of the head of an adult female) are inappropriate for lectotype designation unless no other material is found. Therefore we have decided to delay designating a lectotype at this time. Two of us (Miller and Williams) have examined the lost adult female; in fact, Williams studied the specimen in his analysis of data for this paper while the specimen was still in London. Based on these observations, we have no doubt about the correct identity and characteristics of the type series of *Dactylopius affinis.* The specimens were collected in Australia on tubers of dahlia and potato by Mr. Olliff in 1893. The three slides are the property of the Department of Scientific and Industrial Research, Auckland, New Zealand Collection of Arthropods.

2. *Pseudococcus obscurus* Essig.—There are 16 syntype specimens on two slides that are deposited in the California Academy of Sciences, San Francisco (CAS). From the series we have selected as lectotype an adult female that is one of eight mounted on a slide. The lectotype is located on the bottom, right side of the coverslip. The slide has the right label "Pseudococcus/obscurus/CoTypes Essig"; left label "Cactus/Opuntia/sp."; on the back of the slide the right label gives a map showing the position of the lectotype and states "Pseudococcus/obscurus Essig/paralectotypes/Lectotype/designated 1984/Miller, Gill, Williams"; left label "California Academy/of Sciences/Entomology Type/No.11420." The remaining syntypes are considered to be paralectotypes.

3. *Pseudococcus capensis* Brain.—We have examined the holotype and four paratypes of this species. The holotype is in the USNM and has the right label under a square coverslip "*Pseudococcus/capensis* Brain./on *Phytolacca dioica*/ Piper./Rosebank. C. P./July, 1911./-Type-"; the left label is under a round coverslip "54./C.K.B." There are 3 additional paratypes from the same locality collected May 12, 1910 that are in the USNM. A single paratype from the same locality collected July 11, 1911 is in the British Museum (Natural History), London (BM).

4. *Pseudococcus longispinus* var. *latipes* Green.—There are five syntypes of this species mounted on a single slide deposited in the BM. From the series we have selected as lectotype an adult female that is the center specimen in the row of three specimens at the bottom of the coverslip. The slide has the right label "Pseudococcus/longispinus (longispinus is marked through with a pen)/maritimus Targ (Targ is marked through with a pen)/on Fuchsia/(underglass)/Camberley, Surrey/England. 10-XI-1916/ (see Journal p.ub.e)"; left label "Pseudococcus/lon-

gispinus var. latipes/Green/LECTOTYPE./PARALECTOTYPE" and a map showing the position of the Lectotype. The remaining syntypes are considered to be paralectotypes.

5. *Pseudococcus malacearum* Ferris.—The lectotype of this species was designated by Wilkey and M^{c}Kenzie (1961). This specimen originally was mounted on a slide with four other syntypes including four adult females and one immature. While preparing the 1961 paper, Wilkey remounted the specimens and placed each on a separate slide. The adults were numbered from one to four and the immature was labelled as "immature paratype." Unfortunately, we have been unable to locate the lectotype, but we have examined the remaining paralectotypes and it is clear to us that they are conspecific with *P. maritimus*. Presumably, the lectotype slide is number three and has a label identical with the paralectotypes excluding the type designation; therefore we are giving label information from one of the paralectotypes. The left label is as follows: "Pseudococcus/malacearum/Ferris/'*paratype*' #1/Det. by/*remounted from/type slide*/9-X-61 RFW C^4H^8O/Piccolyte"; right label "No. 46K 139 Cal. Dept. Agr./Loc. Santa Clara/California/21-X-1946/ex. pear/H. S. Smith coll." The lectotype, when found, should be deposited in UCD; an additional adult female paralectotype and the immature paralectotype are in UCD. The remaining two paratypes are deposited in the collections of the California Department of Food and Agriculture, Sacramento and the USNM.

6. *Dactylopius maritimus* Ehrhorn.—There are 10 syntypes deposited in the USNM and seven deposited in the BM. From the series we have selected as lectotype an adult female mounted alone on a slide. The slide has the right label "remounted from a/slide labeled as follows/Dactylopius maritimus/Ehrh/Type/on Eriogonum roots/Santa Cruz Cal/3 of 5 drawn"; left label "Pseudococcus/maritimus/(Ehrhorn)/Lectotype/designated by/Miller, Gill, and/Williams." The lectotype is deposited in the USNM and is one of five syntypes that originally was mounted on a slide containing five specimens; these syntypes were remounted and placed individually on separate slides.

7. *Pseudococcus bakeri* Essig.—There are four syntype specimens mounted on two slides deposited in the CAS. Slide number one contains three specimens; the specimen on the left is circled in red and is here designated as the lectotype. The slide has the right label "LECTOTYPE/1/Pseudococcus/bakeri/Co*Types Essig*/PARALECTOTYPE"; left label "*Eng. Walnut*/Juglans/regiae"; a label on the back of the slide states "California Academy/of Sciences/Entomology Type/No. 11419." Slide number two contains one specimen and has the same labels and data as given above except there is no left label.

8. *Pseudococcus omniverae* Hollinger.—One slide mounted specimen is the only type material known to us. The specimen is in good condition and is here designated as lectotype. The label on the right side of the slide states "*Pseudococcus/omniverae* Hol./On *Tilia/americana.*/Columbia, Mo/Aug. 1916/From A. H. Hollinger/Entomological Laboratory/Stanford University"; left label "LECTOTYPE." The lectotype slide is deposited in UCD.

Distribution

We have examined specimens of *P. affinis* from the following locations: Argentina, Australia, Azores, Belgium, Brazil, Canada, Canary Islands, Chile, Costa Rica, Denmark, Easter Island, Ecuador, England, France, Germany, Guatemala, Holland, Italy, Korea, Madeira Island, Mexico, Morocco, Netherlands, New Zealand, Panama, People's Republic of China, Portugal, Scotland, Sri Lanka, Spain, Sweden, South Africa, United States (California, Connecticut, Delaware, District of Columbia, Georgia, Hawaii, Illinois, Maryland, Massachusetts, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Virginia, Washington, Wisconsin), Uruguay, Venezuela.

We have examined specimens of *P. maritimus* from the following locations: United States (Arkansas, California, Connecticut, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Maryland, Massachusetts, Michigan, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Tennessee, Texas, Vermont, Virginia, Washington, West Virginia). Outside of the United States we have seen specimens of this species only from two collections from Mexico. We have been unable to substantiate the many literature records from the rest of the world and suspect that most of them are based on misidentifications.

KEY

The key presented by M^{c}Kenzie (1967) does not work for all specimens of either *P. affinis* or *P. maritimus.* The key should be modified as follows: (Items italicized are new modifications to the key).

6(5). *Femur of hind leg with translucent pores* 6a
– Femur of hind leg without translucent pores 7
6a(6). *Tibia of hind leg with 35–135(82) translucent pores; with 9–18(13) dorsal oral-rim tubular ducts on abdomen; dorsal oral rims usually absent from mediolateral areas of segments IV and V* .... *affinis (Maskell)(in part)*
– *Tibia of hind leg with 15–68(35) translucent pores; with 18–38(29) dorsal oral-rim tubular ducts on abdomen; dorsal oral rims usually present on mediolateral areas of segments IV and V* .... *maritimus (Ehrhorn)(in part)*
9(8). With not more than 7 oral-rim tubular ducts on dorsum of abdomen 10
– With at least *9* oral-rim tubular ducts on dorsum of abdomen 12
19(18). *Dorsal oral rims usually absent from mediolateral areas of segments IV and V* 20
– *Dorsal oral rims present on mediolateral areas of segments IV and/or V* .... *maritimus (Ehrhorn)(in part)*
20(19). *Without oral-collar tubular ducts in ventral submarginal cluster between cerarii 10 and 11, occasionally with 1 or 2 such ducts in this area* .... *affinis (Maskell)(in part)*
– *With cluster oral-collar tubular ducts in ventral submarginal area between cerarii 10 and 11* .... *kingii (Cockerell)*

DISCUSSION AND CONCLUSIONS

It seems clear to us that *P. affinis* is the senior synonym of *P. obscurus.* The type specimens of each name possess the unique characters that we believe are important in separating the species from the remaining members of the *P. affinis* complex.

We have no doubt that *P. affinis* is distinctive when compared with *P. maritimus.* Characteristics that distinguish them are the number of discoidal pores associated with the eye, the arrangement and number of dorsal oral-rim tubular ducts, the absolute length of the apical setae, the length of the longest ventral body setae on segment VII, the number of translucent pores on the hind tibia and femur, the number of multilocular disk pores on the ventral thorax, the development of the tenth cerarius, and the shape of the hind tibia. Unfortunately, no single character can be used to separate these species in all specimens. It is necessary to look at a series and to use a diversity of diagnostic characters.

Acknowledgments

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PROC. ENTOMOL. SOC. WASH.
86(3), 1984, p. 713

NOTE

An Overlooked Generic Name in Chloropidae (Diptera)

While scanning the volume "Indian Insect Life" (1909) by H. Maxwell-Lefroy, I chanced upon the generic name *Merochlorops* for a chloropid fly. This generic name has never been noticed by specialists in the family, nor in nomenclators.

Figure 4 on colored Plate LXVI, between pp. 616 and 617, shows the egg, larva, posterior spiracles, puparium, and the adult fly with wings spread so that the venation shows clearly. There is no description, but before 1931 the publication of a name "in connection with an illustration" is an "indication" sufficient to make the name available ("International Code of Zoologial Nomenclature," Art. 16a.vii). The appearance of the imago, thorax stocky and predominantly shining black with yellow scutellum and a yellow area on each side (probably notopleuron plus mesopleuron), long veins slightly concave anteriorly, discal cell strongly widened distad to the small (r-m) crossvein and the longer outer crossvein slightly oblique, and the short and broad abdomen, readily identify the species as belonging to the genus long known as *Formosina* Becker (1911), of which *Merochlorops* is the senior synonym (**N. syn.**).

No species name is given and the species cannot be identified positively from the figure, although it appears to be *Formosina ceylanica* Duda. I hereby designate *F. ceylanica* as the type species of *Merochlorops.* If the species figured is specific to or common in the recorded niche, it might some day be confirmed by rearing. The author comments (pp. 627–628) that "The larva lives in the watery tissue of the swathing leaves round the stem of plantain-trees and under sissoo bark." The only locality mentioned is "Pusa," i.e., Darbhanga, in Bihar State, in connection with his description of a native 'doctor's' use of the larvae.

The 18 specific names listed by Sabrosky (1977, in Delfinado and Hardy, "A Catalog of the Diptera of the Oriental Region," vol. III, pp. 309–310) become new combinations with *Merochlorops,* 10 with the same spelling and 8 changed to masculine endings (*atratus, ceylanicus, cinctus, impavidus, nigrolimbatus, ochraceus, perplexus,* and *tumidus*).

Curtis W. Sabrosky, *Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % U.S. National Museum of Natural History, Washington, D.C. 20560.*

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86(3), 1984, pp. 714–719

AN *IN VIVO* FLUORESCENT MARKER FOR SPERMATOZOA OF THE SCREWWORM (DIPTERA: CALLIPHORIDAE): A FIRST REPORT

RICHARD J. BRENNER

USDA-ARS, Screwworm Research Project, American Embassy–Mexico (Tuxtla), P.O. Box 3087, Laredo, Texas 78041.[1]

Abstract.—Acridine orange (AO) was used as a fluorescent marker for spermatozoa of the screwworm, *Cochliomyia hominivorax* (Coquerel). The chemical was ingested by adult sterile flies in carbohydrate solutions at a concentration of 1.0 mg AO/ml. When reproductive organs of both sexes were examined for fluorescence under longwave ultraviolet light on a Zeiss compound microscope, all reproductive tissues (testes, ovaries, seminal fluid glands, accessory glands, and spermathecae) were marked. Access to AO in 35% honey for 24–48 h was sufficient to mark sperm in the testes for up to 15 days in males (maximum value tested); heads and tails of sperm fluoresced a brilliant green. Neither male adult longevity nor propensity to mate were adversely affected by AO. Spermatozoa within the crushed spermathecae of unmarked females inseminated by marked males fluoresced brilliantly indicating that this technique can be used for mating preference tests. However, false positives were noted; fluorescence of marked spermathecae was transferred to unmarked sperm in the spermathecae soon after mating. Acridine orange at 1.0 mg/ml in the liquid diet of larval screwworms delayed growth in proportion to the duration of exposure; reproductive organs of resultant adults were strongly fluorescent. Fertile flies that fed on AO solutions as adults, mated and oviposited normally; neither sterility nor mutagenic effects were noted. The applications of this technique to the screwworm eradication program, and to biological research are discussed.

The success of the USA-Mexico joint program to eradicate the screwworm, *Cochliomyia hominivorax* (Coquerel), from Mexico north and west of the Isthmus of Teuantepec is dependent on the ability of mass reared sterile male flies to find and mate with native females. Since the conception of the program, the efficacy of any given release strain has been indirectly examined following its release in the field by measuring the proportion of sterile to fertile egg masses collected from sentinel animals.

Decisions on whether to change strains in the mass rearing facilities at Tuxtla Gutierrez, Chiapas, Mexico, have been made by comparing the field effectiveness of a recently produced candidate strain with that of the strain in production. The best available method for comparison involves the simultaneous release of both

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[1] Send reprint request % P.O. Box 267, Weslaco, TX 78596. Color transparencies provided with reprint.

strains in "ecologically similar" but separate areas; hence, the comparison is not one of direct competition. Also, factors such as differences in terrain, weather, animal husbandry practices, age structure of the target populations, and irregularities in fly-release flight lanes cannot be controlled. Consequently, the interpretation of data has been difficult and the significance of the results has been questionable.

If the sperm of sterile strains could be differentiated from each other and from that of native flies, these uncontrollable factors would be irrelevant. If their sperm were marked, two or more strains of sterile flies could be released simultaneously in the same region so that sterile males of the test strains would compete for virgin wild females under the same biotic and abiotic conditions. Wild females, trapped at oviposition sites, could be dissected and the sperm in the spermathecae examined to determine the source of male gametes. Thus far, the lack of an accurate method for differentiating irradiated sperm of screwworms from unirradiated (McInnis, 1984), and the lack of any method for differentiating the sperm of two sterile strains, have precluded execution of simultaneous and sympatric releases of sterile strains.

For our purposes, any technique for marking sperm of screwworms must be reliable, easily discernable with readily-available equipment, and usable in the field. Sperm of other insects has been marked using rare elements (Moss and Van Steenwyk, 1982) or radioactive isotopes (Lowe et al., 1974). However, such techniques require special care and equipment, and are thus unsuitable for field studies distant from well supplied laboratories. This paper reports the results of a project undertaken to test the hypothesis that known fluorescent compounds, easily detected in the field with a portable microscope, could be used as *in vivo* markers for spermatozoa of screwworms.

MATERIALS AND METHODS

Sterile adult screwworms (A-82 or 0-83 strains, originating from material collected in Arriaga, Chiapas and the state of Oaxaca, respectively), were mass reared on liquid medium at the sterile fly production plant in Tuxtla Gutierrez, Chiapas, Mexico, and irradiated as pupae by the standard cesium source. Flies were given continuous access to water and to a 10% sucrose solution (by weight in water) containing 0, 0.01, 0.1, or 1.0 mg of fluorescent compound per ml of solution from emergence through the first five days of adult life. Thereafter, separate containers of water and 10% sucrose were available. All flies were maintained at 23°–28°C in uncontrolled relative humidity under artificial light (10:14 L:D).

Flies were dissected from day four through day 15. Reproductive structures (ovaries or testes, accessory glands or seminal fluid glands, and spermathecae) and parts of the alimentary/excretory systems (midgut, hindgut, and rectal pads) from two males and two females per treatment were excised and placed individually in wells of a porcelain spot plate in 1 ml of physiological saline (Ephrussi and Beadle, 1936) and 10% glycerine. Each organ was then transferred to a clean drop of saline-glycerine solution on a microscope slide, covered with a glass cover slip, and examined for fluorescence at magnifications of 25, 160, and 400 diameters under longwave ultraviolet light (HBO 75W xenon light source) affixed to a Zeiss compound microscope.

Eight fluorescent compounds were screened as described above: ethidium bromide, propidium iodide, fluorescein isothiocyanate, rhodamine B, rhodamine B isothiocyanate, victoria blue, lissamine green, and acridine orange. Of these, only acridine orange (AO) imparted a strong fluorescent color to the reproductive tissues.

Carbohydrate solutions containing the various concentrations of AO were prepared by first dissolving the powder in 1 ml of 95% ethanol and then diluting this to the desired concentrations with the sucrose solution; flies were provided with cotton soaked in the carbohydrate-AO solutions.

In separate tests, larval screwworms were reared on a water-base medium (dried blood, dried milk, powdered egg in a 7:5:3 ratio, respectively, with 1.7 ml formol per liter) containing 0 or 1.0 mg AO/ml of diet. Larvae fed continuously on treated medium from eclosion, 24 h of age, or 48 h of age until the crawl-off stage (96–108 h). Each treatment was replicated 3 times with 75 larvae per replicate. Resultant adults were held at 23°–28°C and 55% relative humidity under artificial light (10:14 L:D) through day 3 of adult life with access to separate containers of water and pure honey. Dissections were made on day 4 of adult life.

Fertile screwworms (strain A-82, non-irradiated) were also fed 1.0 mg AO/ml of 35% honey for 48 h to determine if AO functioned as a chemosterilant. Crosses were made (treated male × untreated female, and untreated male × treated female) and resultant eggs were scored for fertility. Parous females were dissected to verify insemination.

RESULTS

All of the tissues examined were dyed with AO. Fluorescence was proportional to the concentration of the solution. At 0.01 mg AO/ml, fluorescence was barely perceptible at the highest magnification; whereas both the head and tail of spermatozoa from males that had fed on the 1.0 mg AO/ml of carbohydrate solution fluoresced a brilliant green under ultraviolet light at all magnifications used. Regardless of magnification, sperm from untreated males lacked fluorescent color under the same light source. All tests indicated that ingestion of AO at the highest concentration used did not adversely affect longevity (Table 1) nor inhibit mating (Table 2). Dissections through day 15 post-emergence (10 days post-treatment) indicated that the sperm in the testes continued to fluoresce without apparent loss of brilliance. This fluorescence did not appear to be light sensitive, as testes prepared 7–10 days previously still fluoresced. In further testing, similar results were obtained by feeding adults a solution of 1.0, 2.0 or 5.0 mg AO/ml of 35% honey, the standard carbohydrate used for feeding adults prior to aerial release in the eradication program. Results demonstrated that access to AO solutions for 24–48 h was sufficient to mark sperm in the testes for up to 15 days (maximum value tested) without affecting longevity nor propensity to mate.

Sperm in the spermathecae of both marked and unmarked females inseminated by marked males also fluoresced brilliantly. However, since all reproductive organs of treated females were strongly marked, further tests were conducted to determine the existence of "false positives"—i.e. whether sperm from untreated males could become marked by fluids in treated females. All possible crosses were made with marked and unmarked males and females. In blind tests, the source of sperm could easily be determined in crosses involving unmarked females, as sperm from treated males fluoresced brilliantly in females up to 12 days of age (4–6 days post

Table 1. Mortality of sterile adult *Cochliomyia hominivorax* fed 1.0 mg acridine orange per ml of 10% sucrose or 35% honey.

Age of cohort (days)	Mortality ($\bar{x}$% ± SD)[a]			
	Treated		Control	
	Male	Female	Male	Female
5	4.5 ± 4.5	1.8 ± 1.6	3.5 ± 2.4	3.0 ± 2.7
10	17.5 ± 12.0	25.0 ± 2.7	19.0 ± 3.0	15.3 ± 4.3

[a] n = 3 replicates per treatment with 30–60 males and 30–60 females per replicate.

copulation). Thereafter fluorescence was detected in less than 50% of the dissections. In untreated females 11 days old (3 to 5 days post-copulation), fluorescent sperm from marked males was light sensitive; the intensity diminished when tissues were exposed to ultraviolet light for 5–10 minutes. Regardless of pairings, sperm in marked females always fluoresced, thereby confirming the existence of false positives.

Studies on the effect of AO in the larval diet resulted in great variation in survival among replicates, even within controls. Therefore, results are discussed only in general terms. Acridine orange in the larval diet resulted in retardation of development in rates proportional to the time of exposure. Larvae with AO in their diet for the duration of larval development were smaller and required an additional 48–72 h to complete development and pupate. At the time of pupation, the integument of these larvae was characteristically orange. Exposure to AO beginning 24 or 48 h after eclosion resulted in nearly normal survival, slightly smaller pupae, and a total delay of development of 24 h, compared to controls. Resultant adults were dissected and all organs fluoresced, including muscles and pleural integument.

Fertile flies that fed on AO for 48 h post-emergence showed no aberrant behavior. Random samples of both crosses indicated that 96.4 ± 0.42% ($\bar{x}$ ± SD) mated, and 75.6 ± 5.16% of mated females oviposited; 90.2% of the egg masses were fertile.

DISCUSSION

While the entire potential and limitations for this technique are not yet fully evaluated, these studies have demonstrated that acridine orange is a useful vital

Table 2. Mating competence of sterile adult *Cochliomyia hominivorax* fed 1.0 mg acridine orange per ml of 10% sucrose or 35% honey.

Age of cohort (days)	No. inseminated/no. examined	
	Treated[a]	Control[b]
6	0/6	0/6
7	0/6	4/6
8	5/6	5/6
10	5/6	5/6
12	6/6	5/6
14	6/6	5/6

[a] Both sexes were treated.

[b] Neither sex was treated.

stain for research on the mating behavior of screwworms. This technique will be of immediate application to laboratory studies already in progress in our laboratory in Tuxtla Guiterrez and, at Fargo North Dakota, for assessing the mating behavior of both sterile and fertile screwworms. These include studies on mating aggressiveness versus time in colony, multiple matings and sperm displacement, and mating competitiveness of large versus small males.

In recent years, some of our research in southern Mexico has focused on developing methodologies to enable us to improve studies on the bionomics and ecology of both sterile and fertile screwworms in the tropical Americas. Field studies conducted in 1982 (Brenner, 1984) demonstrated that sterile screwworms could be ground released in relatively small areas to test mating competence and to collect precise data on the dispersion of sterile flies within the test area. In 1983, this technique was used to compare the effectiveness of two strains of sterile flies in the same test site (Brenner and MacVean, in prep.). While this experimental design reduced or eliminated many of the variables discussed previously, a direct comparison of competitiveness was still not possible since release of the second strain was delayed by a period of four to six weeks in order for the native population to "recover" from the challenge of the first strain. Hence, both weather conditions and the age structure of the target population may have been different when the second strain was released.

The problems inherent to a simultaneous release of 2 or more test strains may be resolved if AO can be shown to be stable and persistant in sterile released flies. A field study has already been designed to examine the limitations of using AO to directly compare the competitiveness of two sterile strains released simultaneously and sympatrically. The results of feeding AO to larvae are encouraging and suggest that large numbers of screwworms can be easily and uniformly marked in this manner. Unfortunately, the existence of false positives will preclude a testing of the hypothesis that sterile females "trap" a significant amount of sperm from native males. Such information would be desirable in assessing the worth of a "males-only" rearing and release program. Ongoing laboratory studies will continue efforts to define the minimum dosage for maximum persistence, while monitoring any deleterious effects on the behavior of marked flies.

Because the acridines bind generally to mitochondrial DNA, or DNA polymerase (Waring, 1968); Simpson et al., 1974; Morales et al., 1972), AO should have a broad applicability for behavioral research on other insects. The ease in marking large populations, in detecting fluorescence with relatively unspecialized portable equipment, the relatively low toxicity, apparent lack of mutagenicity and the ready availability of this inexpensive compound should encourage extensive use of this technology.

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NOTE

Notes on the Systematics and Natural History of *Dielocerus fasciatus* (Enderlein) and key to species of the genus (Hymenoptera: Argidae)

Dielocerus fasciatus (Enderlein) (new combination) was recently collected from a central Amazonian inundation forest near Manaus, Brazil. Up to now, this species has been represented by only two females from Ecuador and Peru. Notes are here given on its systematic position and natural history. The taxonomic work was done by D. R. Smith, the field and laboratory work by J. Adis. Specimens are deposited in the Institute Nacional de Pesquisas da Amazônia (INPA), Manaus, Brazil, and the National Museum of Natural History, Washington, D.C.

Systematics.—*Dielocerus fasciatus* was described by Enderlein (1919, Sber. Gesell. Naturf. Freunde Berlin, p. 117) as *Eriglenum fasciatum* from "Eucador, Cuvaray." Though Malaise (1941. Ent. Tidskr. 62: 133) placed it in his genus *Digelasinus,* its correct placement was doubtful until DRS examined the type in 1977 through the courtesy of E. Kierych. Polish Academy of Sciences, Institute of Zoology, Warsaw. Other than the type and material obtained from the rearing reported here, DRS has seen only one other specimen, that being from Pucallpa, Peru, X-2-1954, E. I. Schlinger and E. S. Ross, collectors (in the California Academy of Sciences, San Francisco). This rearing has provided associated males for the first time.

Dielocerus is a small genus, now with three species. Both sexes of *fasciatus* are very similar in structure to *formosus* and *diasi* (see illustrations of ovipositors and male genitalia in Smith. 1975. Proc. Ent. Soc. Wash. 77: 369–375), differing only by subtle differences in the shape of the genitalia of those species. The easiest way to separate *fasciatus* is by color as used in the following key to species. Larvae of all three are known to spin mass cocoons that are attached to the trunks of trees and shrubs, similar to that described by Dias (1976. Studia Entomol. 19: 461–501) for *diasi.* All distribution records given in the key are from specimens DRS has examined.

KEY TO SPECIES OF *DIELOCERUS*

1. Female 2
– Male 4
2. Mesonotum black, rest of thorax orange; hindtibia and hindtarsus black; less than 10 mm long (costa black, intercostal area infuscated black; apical wing margin even, without apical notch)(Brazil: Amazonas; Ecuador; Peru) (on *Sclerolobium paniculatum*) .... *fasciatus* (Enderlein)
– Thorax orange; hindtibia and/or hindtarsus with orange; 12–15 mm long 3
3. Costa black; intercostal area usually black infuscated; apical wing margin even, without notch; apical 4 hindtarsal segments usually black (Brazil: Minas Gerais, Rio de Janeiro, Espirito Santo, Bahia) (on *Inga* sp.) .... *formosus* (Klug)

– Costa white; intercostal area hyaline; notch on antero-apical margin of forewing near apex of radial cell (Fig. 1, Smith, 1975) (Brazil: Distrito Federal, Goias, Mato Grosso) (on *Sclerolobium aureum*) ...... *diasi* Smith
4. Head orange; mesoprescutum orange, rest of mesonotum black; costa whitish .... *diasi* Smith
– Head black above antennae; mesonotum black; costa black 5
5. Apical 4 hindtarsal segments black; orange on hind orbits restricted to lower ⅓; large, 12–13 mm long .... *formosus* (Klug)
– Hindtarsus orange; orange on hind orbits extends nearly to top of eye; small, less than 9 mm long .... *fasciatus* (Enderlein)

Natural history.—Central Amazonian inundation forests along black-water rivers, e.g., the Rio Negro, are annually inundated for 5–6 months (March/April to August/September), up to several meters in height. Six cocoons containing prepupae of *D. fasciatus* were collected in July 1979 during the receding water phase in one of these forests at Tarumã Mirím near Manaus (cf. Adis. 1981. Amazoniana 7(2): 87–173). They were found on tree trunks of *Sclerolobium paniculatum* (Leguminoseae, Caesalpinae) at about 2.5 m height. The cocoons had previously been flooded for 4–6 weeks, evident by the high-water mark on the trunks and by the brownish coating, which the receding waters left on the cocoons. Adults emerged in the laboratory in January and August 1981 as well as in January 1982. This is more than two years after cocoon formation. *Dielocerus fasciatus* apparently passes a diapause in the prepupal stage as already reported for *D. diasi,* a sawfly of the cerrado near Brasilia (Dias, 1976). The cells and silk web of the cocoon are impermeable to water, thus insensitive to flooding. Flood resistance is already known to occur in terricolous arthropods of black-water inundation forests, especially in small species, e.g., Acari (*Rostrocoetes foveolatus* Sellnick, Oribatidae; Beck. 1972. Pedobiologia 12: 133–148), Symphyla (*Ribautiella amazonica* Scheller, Scoloendrellidae; Scheller and Adis. *In press.* Amazoniana), and Diplopoda (Pyrogdesmidae; Adis, unpublished data), as well as in Coleoptera larvae (*Sisenopiras gounellei* Pic, Oedemeridae) found in decaying wood under water (Arnett and Adis, unpublished data).

David R. Smith, *Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % National Museum of Natural History, Washington, D.C. 20560, and* Joachim Adis, *Max-Planck-Institute for Limnology, Working Group: Tropical Ecology, Postfach 165, D-2320 Plön, in cooperation with Instituto Nacional de Pesquisas da Amazônia (INPA), c.p. 478, 69.000 Manaus/AM, Brazil (Convenio INPA/Max-Planck).*

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Note

A Warningly Colored Fly, *Stratiomys badius* Walker (Diptera: Stratiomyidae), Uses its Scutellar Spines in Defense

On two occasions adult males of *Stratiomys badius* Walker gave my thumb a painful prick with their sharp scutellar spines. In both instances I had grasped the fly with my thumb and index finger through the mesh of an aerial net, and I could feel it squirm slightly in my grasp as it drove the scutellar spine (s?) into the ball of my thumb. There was enough pain to make me withdraw my hand involuntarily—about equivalent to the prick of a fine insect pin. The spines might well have had a similar effect if the fly had been held in the bill of a bird or in the jaws of some other vertebrate.

The spines, sharp and about 1 mm long, jut up at an angle of about 60° from the caudal edge of the scutellum (Fig. 1). They occur in both sexes. I did not see the motion that drove the spine (s?) into my thumb, but it may have been a

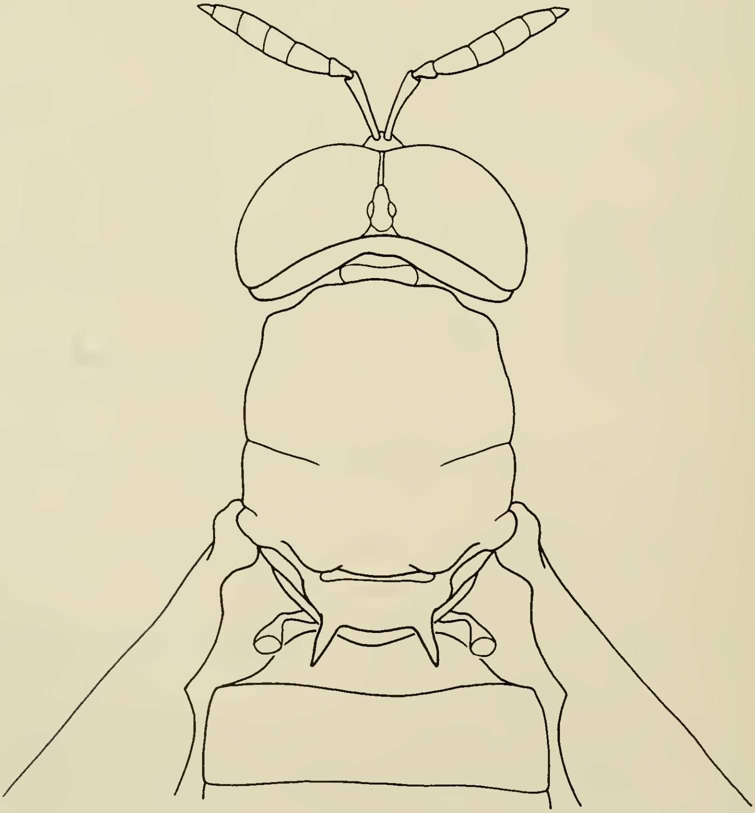

Fig. 1. Dorsal aspect of the head and thorax of *Stratiomys badius* showing the scutellar spines.

squirming of the entire body or a flexing of the thorax on the abdomen. These observations were made in Emmet County, Michigan, on 20 and 22 July of 1982.

Scutellar spines are not universally distributed in the Stratiomyidae, but they do occur commonly in members of the subfamily Stratiomyinae, mostly large and robust flies that are usually boldy marked with yellow or pale green stripes on a dark background. Not only boldy marked stratiomyids have scutellar spines but many of those that are would conventionally be considered generalized Batesian mimics of wasps. However, as indicated by the above observations, at least *S. badius* must be considered a Müllerian mimic of wasps and also of other Stratiomyinae if the latter also use their scutellar spines in defense.

S. badius is not alone among insects in its use of spines in defense against vertebrates. Townes (1972. Proc. Entomol. Soc. Wash. 74: 85–86) reported that diopsids (Diptera: Diopsidae) can also prick with their sharp scutellar spines. Freed (1982. Oecologia 53: 20–26) found that tree frogs repeatedly rejected *Euschistus* sp. (Hemiptera: Pentatomidae) after the humeral spines on the prothorax lodged between their jaws. Rothschild et al. (1970. Toxicon 8: 293–299) reported that adult *Acanthosphinx guessfeldtii* (Dewitz) (Lepidoptera: Sphingidae) can administer painful scratches with their tibial spurs. Smith (1884. Amer. Nat. 18: 727–728) described how a long-horned beetle (Coleoptera: Cerambycidae) of the New World tropics uses spines at the end of the antennae to deliver painful pricks when it is held in the fingers.

I thank the staff of the University of Michigan Biological Station for the use of their facilities. Dr. Donald W. Webb identified the stratiomyid. This material is based upon work supported by the National Science Foundation under Grant No. DEB 8202772.

G. P. Waldbauer, *Department of Entomology, University of Illinois, Urbana, Illinois 61801.*

Book Review

Notes on Neotropical Tabanidae (Diptera) XIX. The Tabanus lineola *complex.* By G. B. Fairchild. Miscellaneous Publications, Entomological Society of America, No. 57, 52 pp. $7.50, ESA Members $4.50.

This is a review of the species of the genus *Tabanus* that have banded eyes and striped abdomens commonly known as the "*lineola* complex." The group is redefined to include '28' valid species including two new species, *T. kwatta* and *T. wokei.* Previous to this work, 60 specific names had been used in this complex of difficult to distinguish species. Six names are discarded as unrecognized or as applying to non American species. *Tabanus wilkersoni* is proposed as a new name for that of an Amazon basin species, *T. despectus* Fairchild, that is preoccupied. A check list of names mentioned in the text, a synonymical list, and a table of frontal and divergence indices are given. The females and known males are keyed, and characters of the female antenna, palpus, frons, and eye pattern are figured for most of the species, as well as lateral views of the heads of certain males. Notes are given on each species that vary in extent from a few lines to more extensive presentations of supplemental information, to complete redescriptions of inadequately described species, to descriptions of two new species.

A quick check of the female key (males are rarely received for identification) using four of the six North American representatives of the group, showed that the key was relatively easy to use. However, a key is always easier to use by the person who produced it than it is for others to use it. I was hard pressed to make the pale median abdominal stripe of NMNH specimens fit the descriptions of this character for *similis* and *subsimilis.* On the other hand, *lineola* ran easily, as did specimens of *colombensis.* As a novice tabanidologist I shudder when characters such as frontal index and divergence index appear at the beginning of a couplet as they do at couplets 7, 20, 22, 25, and 31 of the female key, especially when the author states that these characters ". . . are not usually, taken alone, of definitive value in characterizing species." Such characters then, should be placed later in the couplet and not as the first or prime characters. One other inconvenience appears where one must turn to page 39 to find out what the figures are that are depicted on the plates. All caption material is better placed before the appropriate plate of figures. Despite these few minor criticisms, the paper generally is well written and should be useful to anyone who has to identify horseflies of the *T. lineola* complex.

B. V. Peterson, *Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % National Museum of Natural History, NHB-168, Washington, D.C. 20560.*

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Book Review

The Ultrastructure and Functioning of Insect Cells. Edited by H. Akai, R. C. King, and S. Morohoshi. The Society for Insect Cells Japan. Pp. xii + 195. Cost: US $28. Available from Business Center for Academic Societies of Japan, 4-16, 2 Chome, Yayoi, Bunkyo-ku, 113 Tokyo.

Insect Ultrastructure, Vol. 1. Edited by Robert C. King and Horomu Akai. New York, Plenum Press. Pp. xiii + 485. Cost: $55.

The symposium the first book reports was held in Sapporo in August, 1982. Thirty of the 47 papers are by Japanese, and the senior editor writes that the purpose of the symposium was to present Japanese scientists "with an opportunity to present their work in a congenial atmosphere, where they could acquire the feeling that they were members of a large international scientific community" (p. vii).

The papers range in subject from the isolation and characterization of cell organelles and macromolecules, to accounts of cellular and multicellular structures (e.g., egg chorions); much of the work is descriptive, whether molecular or fine-structural, and not experimental. The papers range in depth from brief research reports with little or no discussion to brief reviews of rather narrow topics. In this respect the volume conforms to most published symposia: some progress reports, some finished work, and a few papers of broad interest.

I find of particular interest the attempt by S. Morohoshi to review (in four scant pages [109–112] and several too-small diagrams) fifty years' work on the control of molting and diapause in the silk worm. A complex interaction exists between secretions of the brain and the corpora cardiaca, and between the latter and subesophageal glands; the result of this interaction affects (and effects) diapause. A similar antagonistic interaction occurs between juvenile hormone and molting hormone, and determines if the larvae will grow (molt) or develop (metamorphosis). These sets of interactions themselves interact, of course, and are under genetic control. Morohoshi presents the complexity of the system with remarkable clarity.

An earlier paper, by R. C. King (pp. 5–8), considers the process by which a single germarial cell becomes an oöcyte and its attendant nurse cells, a clone of cell-division products joined to one another by cytoplasmic bridges. These bridges are the arrested cleavage furrows, and through them extend the cytoplasmic remnants of the spindle fibers. It appears that the amount of this material determines which of the cells becomes the oöcyte. Study of the system has been much helped by a mutant in *Drosophila* which produces ovarian tumors by causing cytokinesis to go to completion. The story is an elegant one, but again (as with the Morohoshi paper), more space and better (in this case, any) figures should have been used to tell it. In the second volume reviewed here, the story is presented again, more fully and better illustrated.

Several other papers are as broadly interesting as these, and I single these out not as the best in this symposium, but as examples of the best.

The book concludes with a list of authors, a list of participants in the symposium, and five pages of (Japanese) advertisements from some of the companies thanked in the front of the book for financial support. It is because of this support that the cost of the book is relatively low.

Overall, the volume shows us where the study of insect fine-structure morphology now stands. Function in these papers derives from structure. Little work appears to be done studying function directly, that is, experimentally. Whether at the molecular or at the anatomical level, one examines how the parts are put together and infers therefrom what they do individually and collectively. A list of the general topics covered follows:

Oögenesis (5 papers, 20 pages)
Insect Chromosomes (6 papers, 20 pages)
Embryonic Development (7 papers, 28 pages)
Differentiation of Cells and Tissues (7 papers, 30 pages)
Structure and Function of Cells and Tissues (9 papers, 36 pages)
Structure and Function of Silk Glands (5 papers, 22 pages)
Defense Reactions of Cells and Tissues (6 papers, 24 pages)
Technical Advances in Electron Microscopy (3 papers, 13 pages)

The second volume reviewed here differs in several important ways. Although stimulated by discussions at the XVI International Congress of Entomology (Kyoto, 1980), it is not a symposium. Rather, an array of authors has been given sufficient space to present data and discuss ideas adequately, which is to say at length and in depth. Much original work is presented, but not merely for the sake of its presentation. The discussion of subjects under active study requires that unpublished data be included.

Again, most of the papers are descriptive, the results of fine-structural analysis of the cells of reproductive structures and of developing tissues. As in the first book, little truly experimental work is reported, and indeed most of the chapter titles mention "structure and development" not "structure and function" (true also of the forthcoming second volume). But the book is not an atlas of electron micrographs. Text greatly predominates, describing, discussing, speculating on origin and function, and bringing the reader up to date on some of the most exciting areas of cell biology and entomology. The papers here are without exception excellent. The authors present clearly sufficient detail to make their points, but not so much as to overwhelm the reader. Both entomologists and cell biologists can read the book with profit, and should do so. That two such different audiences can be well served by the same book, speaks well for the authors' ability to express themselves, and the editors' ability to enforce clarity (an editorial duty of the utmost importance, and one too often honored in the breach).

A second volume of *Insect Ultrastructure* is promised for June, 1984 (R. C. King, pers. commun.), and should be a fitting companion to the first. The contents of both are listed here:

Volume I

I. The Ultrastructure of Gametes
   The formation of clones of interconnected cells during gametogenesis in insects. (R. C. King, J. D. Cassidy, and A. Rousset; 29 pp.)

Relationships between germ and somatic cells in the testes of locusts and moths. (A. Szöllösi; 29 pp.)
The meiotic prophase in Bombyx mori. (S. W. Rasmussen and P. B. Holm; 25 pp.)
Morphological manifestations of ribosomal DNA amplification during insect oogenesis. (M. D. Cave; 32 pp)
The cell biology of vitellogenic follicles in Hyalophora and Rhodnius. (W. H. Telfer, E. Huebner, and D. S. Smith; 32 pp.)
Order and defects in the silkmoth chorion, a biological analogue of a cholesteric liquid crystal. (G. D. Mazur, J. C. Regier, and F. C. Kafatos; 49 pp.)

II. The Ultrastructure of Developing Cells
The cytoplasmic architecture of the insect egg cell. (D. Zissler and K. Sander; 33 pp.)
Morphological analysis of transcription in insect embryos. (V. Foe, H. Forrest, L. Wilkinson, and C. Laird; 25 pp.)
The morphogenesis of imaginal discs in Drosophila. (D. K. Fristrom and W. L. Rickoll; 34 pp.)

III. The Ultrastructure of the Development, Differentiation, and Functioning of Specialized Tissues and Organs
Fine structure of the cuticle of insects and other arthropods. (B. K. Fisher; 32 pp.)
The structure and development of insect connective tissues. (D. E. Ashhurst; 38 pp.)
The structure and development of the tracheal system. (C. Noirot and C. Noirot-Timothée; 31 pp.)
Structural and functional analysis of Balbiani ring genes in the salivary glands of Chironomus tentans. (B. Daneholt; 20 pp.)
Insect intercellular junctions: their structure and development. (N. J. Lane; 32 pp.)
Selectivity in junctional coupling between cells of insect tissues. (S. Caveney and R. Berdan; 28 pp.)

Volume II

(N.b.: This list differs somewhat from that given in Vol. 1; several titles are modified, one chapter is omitted, and three others have been added. This list, dated June, 1983, was supplied me by R. C. King.)

I. The Ultrastructure of Developing Cells.
The development and ultrastructure of the telotrophic ovary. (E. Huebner)
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Carl W. Schaefer, *Biological Sciences Group, University of Connecticut, Storrs, Connecticut 06268.*

PROC. ENTOMOL. SOC. WASH.
86(3), 1984, pp. 728–729

Book Review

Check List of the Lepidoptera of America North of Mexico. 1983. Edited by Ronald W. Hodges and others, E. W. Classey Limited and the Wedge Entomological Research Foundation, London. xxiv, 284 pp. Soft cover. Cost: $88.00.

It is virtually superfluous to state that this publication fills a long standing need. It is a checklist in the strict sense, citing only a serial number, name, author, and year of publication of each valid name, followed by synonyms. The serial numbers run up to 11,233 on p. 159. The remainder of the book consists of an alphabetical index of all names. The physical quality of the book is excellent.

As is a practical necessity at the present state of the systematics of such a large group of animals of such a large area, the authorship and editing are both cooperative. Hodges had 6 other outstanding lepidopterists working with him as editors. The following 16 authors contributed one or more families: F. Martin Brown; Charles V. Covell, Jr.; Donald R. Davis; W. Donald Duckworth; Douglas C. Ferguson; John G. Franclemont; John B. Heppner; Ronald W. Hodges; Alexander B. Klots; J. Donald Lafontaine; Lee D. Miller; Eugene Munroe; Jerry A. Powell; Eric L. Quinter; E. L. Todd; Christopher Wilkinson; Barry Wright. There is also a 4 page bibliography (p. xxi–xxiv) of major revisionary works. Such a roster of authors and editors assures the high scientific quality of the work.

There is only one feature of the work which I find disappointing, viz., names of the species group frequently do not follow the rules of the International Code of Zoological Nomenclature in regard to gender concord with their genus names. The Code states in Art. 11.g.i.1 that "a species-group name . . . must be or be treated as (1) an adjective in the nominative singular *agreeing in gender* with the generic name . . ." and that principle is also stated generally in Art. 30. I am told by several of the authors who contributed to this work that there was much discussion in editorial meetings concerning the belief of some workers that a species-group name should maintain the spelling given it when it was first proposed and that the gender-concord principle should be abrogated. Curtis W. Sabrosky, a long time member and Past President of the International Commission on Zoological Nomenclature, tells me that the gender-concord principle will be maintained with very little change in the forthcoming revision of the Code. My conversations with a few members of the Commission, as well as other systematists, lead me to believe that world-wide movement toward the original-spelling principle is at present rather small and mostly among workers who have easy access to most of the old literature.

No indication is given in the introduction to the Check List that any of the authors followed the principle of original spelling, nor is there any indication of the original generic combination of the names when the author's name and date are in parentheses. One feature of names of Lepidoptera that has caused a large part of the difficulties, especially with "micros," was instigated by Linnaeus when he named many species with a formalized ending such as *-ella, -ana,* and *-aria,* all of which form Latin words which most usually (except in diminutive nouns in *-ellus, -ella,* or *-ellum*) must agree in gender with the generic name.

Most, if not all, lepidopterists associated with the U.S. National Museum have definitely tried to follow the principle of gender-concord, as for example in the case of *Heliothis* (p. 158), where the adjectival species-names are cited in the their masculine form rather than in the long-used incorrect feminine form. Names in *-odes, -oides,* etc., should be masculine according to the Code (Art. 30), but in the Check List at least the following genera are treated as feminine: *Prolimacodes* (p. 66, *badia*), *Neoleucinodes* (p. 72, *prophetica*), *Steniodes (p. 73, mendica*), *Omiodes* (p. 74, *indicata*), and *Chesiadodes* (p. 91, *cinerea, morosata, fusca, curvata, longa*). The generic names ending in *-ma* (usually neuter) are also frequently treated as feminine.

George C. Steyskal, *Cooperating Scientist, Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % U.S. National Museum of Natural History, Washington, D.C. 20560.*

PROC. ENTOMOL. SOC. WASH.
86(3), 1984, pp. 730–732

INFORMATION FOR PREPARATION OF MANUSCRIPTS

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Publication in the *Proceedings* is generally reserved for members. Manuscripts should be in English and not be so lengthy that they would exceed 15 printed pages including illustrations (two typewritten pages are approximately equivalent to a printed page.) Manuscripts are reviewed before they are accepted. Acceptance of manuscripts is the responsibility of the Editor. Papers are published in the order they are received rather than in order of date of acceptance. This eliminates possible bias due to the varying length of time taken to review a paper. Notes and book reviews are published as space is available, usually in the next issue prepared. Immediate publication can be had for payment of full page charges, but this provision should be reserved for papers with some justification for expedited handling. These papers do not lengthen the waiting period of regular manuscripts because they are published in addition to the regularly budgeted number of pages.

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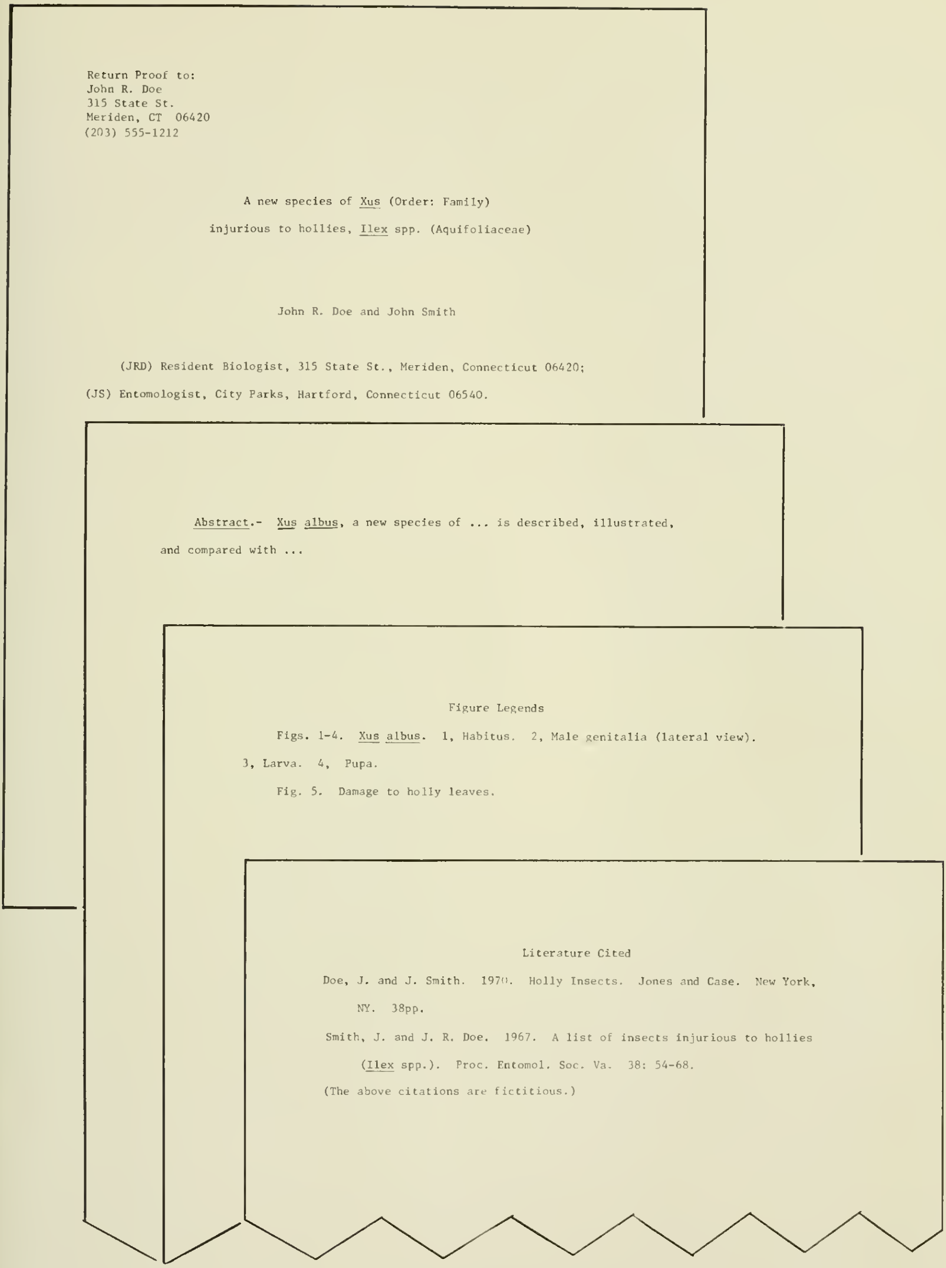

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A new species of *Xus* (Order: Family)
injurious to hollies, *Ilex* spp. (Aquifoliaceae)

John R. Doe and John Smith

(JRD) Resident Biologist, 315 State St., Meriden, Connecticut 06420;
(JS) Entomologist, City Parks, Hartford, Connecticut 06540.

Abstract.- *Xus albus*, a new species of ... is described, illustrated, and compared with ...

Figure Legends

Figs. 1-4. *Xus albus*. 1, Habitus. 2, Male genitalia (lateral view). 3, Larva. 4, Pupa.

Fig. 5. Damage to holly leaves.

Literature Cited

Doe, J. and J. Smith. 1970. Holly Insects. Jones and Case. New York, NY. 38pp.

Smith, J. and J. R. Doe. 1967. A list of insects injurious to hollies (*Ilex* spp.). Proc. Entomol. Soc. Va. 38: 54-68.

(The above citations are fictitious.)

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PROCEEDINGS
of the
NTOMOLOGICAL SOCIETY of WASHINGTON

CENTENNIAL VOLUME
PUBLISHED QUARTERLY

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IN CELEBRATION OF THE CENTENNIAL

ARTICLES

(*Continued on back cover*)

THE
ENTOMOLOGICAL SOCIETY
OF WASHINGTON

ORGANIZED MARCH 12, 1884

All correspondence concerning Society business should be mailed to the appropriate officer at the followin address: Entomological Society of Washington, c/o Department of Entomology, NHB 168, Smithsonian Institution, Washington, D.C. 20560.

MEETINGS.—Regular meetings of the Society are held in the Natural History Building, Smithsonian Institution on the first Thursday of each month from October to June, inclusive, at 8 P.M. Minutes of meetings are publishe regularly in the *Proceedings.*

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PROCEEDINGS.—Published quarterly beginning with January by the Society at Washington, D.C. Member in good standing receive the Proceedings of the Entomological Society of Washington. Nonmember subscription are $25.00 per year, domestic, and $27.00 per year, foreign (U.S. currency), payable in advance. All remittance should be made payable to *The Entomological Society of Washington.*

The Society does not exchange its publications for those of other societies.

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IN DAYS OF YORE

Curtis W. Sabrosky

Systematic Entomology Laboratory, IIBIII, ARS, U.S. Department of Agriculture, Washington, D.C. 20560.

[Author's note: This is the main part of the after-dinner address at the Centennial Banquet of the Entomological Society of Washington, March 12, 1984. In the delivery, occasional sentences or details were overlooked, or compressed, or rearranged, but the full text has been given here for the record.]

I cannot imagine a worse situation for a speaker, after an evening of drinking and feasting, than to have to step forward and give a talk on history. Perhaps if it were a history of pornography or of presidential peccadillos, it could be lively and interesting. But the history of an entomological society? Well, this is my assignment, and I might as well get on with it.

There are different kinds of history, one of dates and events, of facts and figures, of when and where and what. But history is also composed of people: of some who stand out from the crowd for what they were and what they did; of many who belonged and worked and served; of the long line that made the Entomological Society of Washington, which we honor here tonight. I shall try to do some justice to both kinds of history, to give you some facts and to tell you of some people, showing pictures of some, and reminiscing about some within my own memory. I first came to Washington, studying at the Museum, in 1935—almost a half century ago as I realize with a bit of shock—and many old timers were still working. But I am really a Johnny-come-lately on the history of the Society. I know of nine or ten histories, the most recent and one of the best by Ashley Gurney in 1976 at the time of the International Congress of Entomology here in Washington. I freely acknowledge my indebtedness to these. In particular, we are all indebted to Dr. L. O. Howard for four of these histories, in 1894, 1909, and 1934 on our 10th, 25th, and 50th birthdays, and in 1931. These are especially significant because Dr. Howard was one of the founders of the Society, and his memory of the birthpains and adolescence of the Society is the chief source of information about those early years.

Tonight, as we celebrate the 100th birthday, we should realize that we are not the oldest entomological society by any means, not even in the United States. The oldest continuous entomological society in North America is the American Entomological Society at Philadelphia, which celebrated its 125th anniversary a month ago, on February 15th. Representatives of that Society are here tonight. There are also two other older societies in this country. But our own Society, founded in 1884, is at least one of the oldest, and certainly one of the most active and successful of the entomological societies in America.

According to Howard, the idea for the Society was C. V. Riley's. In 1881, Comstock had returned to Cornell, leaving Riley, Howard and E. A. Schwarz as lonely entomologists in the Philosophical Society of Washington and the Biological

Society of Washington. Howard has written: "We were lonely, we wanted to talk with people who understood us." So these three put out a circular call for anyone interested in insects. The initial group met in Riley's home at 1700 Thirteenth St. NW, on February 29, 1884. That was a leap year, too, but luckily they did not formally organize until a later meeting; otherwise, we would be celebrating only our 25th! Howard himself, in his first three histories, said variously that there were 9, or 10, or 11 persons present. Take a number. Suffice it to say that he actually *named* ten in his first history, so that is my choice. Those first interested parties wasted no time. By March 12th, when 16 were present, they had a constitution and formally adopted it, and we date the birth of the Society from that meeting. These 16 are the real founding fathers, although some signed soon after and are counted among the 25 charter members.

Meetings.—After three preliminary meetings, all in Professor Riley's house, the regular meetings began in the Council Room of the old National Museum of the Smithsonian. Successive meetings for years were held in the homes of members, including one in Baltimore at the home of the amateur hemipterist, Dr. Phillip Uhler, Librarian at the Peabody Institute. Home meetings worked very well as long as the Society was small. In his first history, Howard recalled that the average attendance was 11, varying from 4—probably a snowy night!—to 27 when the speaker was a famous entomologist from Oxford, England. You will have noted the early association with the National Museum, which has continued to the present time. For many years, the Society met in old Room 43, off the foyer of the Natural History Building, or on special occasions even in the Auditorium of that building. When I came in 1946, the headquarters of the USDA entomologists was in the South Building of Agriculture, and Room 43 was well filled at almost every meeting, often including the top brass, now very rarely seen. Long before that time, and before the present Natural History Building was built, the Society held its meetings in rented halls, entertained by individual entomologists assisted by an "Entertainment Fund." Many such meetings were held in the old Saengerbund Hall at 314 C Street NW. Some were held at the Cosmos Club and other places. Finally, about 1920, the meetings were moved to the new Natural History Building, at a nominal rental for guard service, and later even this charge was dropped. At the early meetings, there was a program for about an hour, followed by an hour or more of conversation and refreshment, which apparently consisted of beer in quantity. I recall a memorial meeting at which this was mentioned, and Dr. Blake, botanist from Beltsville and husband of coleopterist Doris Blake, remarked that it is said of many people that their names were writ in water but of those old entomologists it could be said that their names were writ in beer. There is some evidence that the custom has been revived, or perhaps it never really died out.

May I quote a passage from Howard's 1909 history, both for the flavor of the meetings in the early days and the flavor of the writings and speeches of L. O. Howard. After saying that "In those early days entomology and beer went together," he pointed out the number of Germans in the Society, with names like Schwarz, Marx, Ulke, Heidemann, and others. And then this:

> "The after meetings of the Entomological Society were interesting: the conversation was good; the refreshments were unlimited in quantity but limited in

> kind; you could have light beer or dark beer, and that was about the extent of the variation. It was my custom to order two cases of beer, each of 24 bottles, for an average attendance of 7 or 8, and I always made the arrangement with the grocer to return those bottles which were not empty, as well as the empty ones, but it soon became a standing joke between us that it was unnecessary to make any provision concerning the unempty bottles. I am not sure that this custom, which no longer holds, was a good one. I am not sure that it was a very bad one. So far as I know, it never seriously affected the health of any of the members, but on the whole perhaps it was unfortunate and I am inclined to believe that the present method is the best. I should dislike to see some of the younger members of the Society drink as much beer as some of us did at their ages, and, while I would not vote the prohibition ticket as Banks does, I believe that Banks was about right when the Society met at his house for the first time and he gave us hot lemonade and cold lemonade and some very excellent raisin cake. It is true that a few glasses of beer will make a stupid remark sound witty, but there was no necessity for any such stimulus to the imagination in the old days, because all of the remarks were witty."

There was another characteristic of the old-time meetings. The dipterist J. M. Aldrich described a Society meeting in someone's apartment as "so full of tobacco smoke that at the conclusion of the meeting I was compelled to seek fresh air, without sharing the social air which was then an outstanding feature."

Officers.—A word about the officers. We are 100 years old, but there have been only 82 presidents, counting one who had been transferred—redeployed seems to be the currently popular word—to Florida and who came back and served for five minutes and then resigned. He did appoint a committee, which is about all some presidents accomplish anyway. For the first forty years, presidents usually served two terms, probably a tradition borrowed from the national scene. C. V. Riley served the first two years, declining a third term, although he did serve another two years after Howard, Schwarz, and George Marx (arachnologist) had their turns in office. Other than Riley, there have been no repeaters except when L. O. Howard was again honored in 1923, 36 years after his previous tour of duty. In the January issue of the Proceedings, Manya Stoetzel has gathered together pictures of all the presidents, a real effort, together with lists of the officers who served with them. I note that four women have been president, two of them, Louise Russell and Helen Sollers-Riedel, long before there was a campaign for ERA. Thirty-three of our 82 presidents are still alive; the earliest of these, Carl Muesebeck, was president in 1940. It would be easy to think of the Entomological Society of Washington as favoring taxonomists, especially because the Proceedings contain so many taxonomic papers. So I was interested to find that of the 74 presidents since 1900 there were 32 taxonomists and 42 non-taxonomists, i.e., economic entomologists, physiologists, information specialists, regulatory entomologists.

Riley and Howard loom large in the early history of the Society, but Howard has quoted with approbation a remark of one of the members that "The principal reason for the existence of the Entomological Society is E. A. Schwarz." Schwarz was a German, a coleopterist, and an early member of USDA's Division of Entomology as assistant to Riley. Howard said this of him: "There are volumes upon volumes of entomological knowledge packed away in his brain, and with tables of contents and elaborate indices prepared for instant use." And apparently used with a most kindly spirit and delightful sense of humor. Perhaps to many of you the name means little, but I would remind you that he is responsible for that famous biological generalization called "Schwarz's Law." During a survey of a crop plant—I believe it was on insects affecting corn—so many insects of no relevance whatever to corn were turned in for identification that Schwarz remarked in exasperation (underlined by his German accent) "Vell, they have to zit zomewhere!" And thus Schwarz's Law was born. Schwarz, who died in 1928 aged 84, served in USDA from 1878 to 1926, when he was retired for age and pensioned at the age of 82! Senator Pepper would have loved that.

Membership.—I have mentioned that the Society started out with ten interested people, or 16 founding fathers, or 25 charter members, take whichever number you choose. At the close of the 100th year, there were 629 members. We are a mighty healthy centenarian.

Proceedings.—There have been only 85 volumes, because early volumes covered several years each. In these 85 volumes, over 27,000 pages have been published—27,361 if you insist on details (if you don't insist, you get them anyway). For most of the time, the volumes were less than 250 pages. Our first 300-page volume was in 1945. In 1969, a special number for Carl Muesebeck had 600 pages, and after that 400- and 500-page volumes were regular. But listen to this: The last three volumes, 1981–83, have averaged 860 pages each, in spite of higher costs of printing.

Let me read a few titles to give you the flavor of the early years:

Sleeping trees of Hymenoptera (by Schwarz, coleopterist)
Some insects which brave the dangers of the pitcher plant
The insect-catching grass of Cuba
Some insects from the top of Pike's Peak, found on snow
How *Lysiphlebus* fastens its aphid host to the plant
Luminous Collembola (by coleopterist H. S. Barber)
Mosquitoes attacking a frog
Migrating armies of myriapods (again by H. S. Barber)
Dung-bearing weevil larvae (by Frederick Knab, a dipterist)
Notes on the respiration of entomologists [Smoke-filled rooms in the old days]

Remember that most of these were presented at the meetings, so it tells you the variety of papers and the keen observations by specialists of insects not in their specialty. And one can imagine the lively discussion that would follow. As I have looked through the pages of our Proceedings—and I would recommend this to anyone—I have been impressed by the amount of solid contributions, the impressive list of authoritative publications, by Snodgrass and Crampton on morphology, by Clausen and Harry Parker on biological control, by Dyar and Shannon on mosquitoes, and the outpouring of work on mosquitoes during and after World War II by Stone and Knight and Komp and many others, by Böving on coleopterous larvae, and on and on. Our journal has indeed made an impressive contribution to the literature of entomology.

In the early days, the Proceedings were handled by a Publications Committee of from 3 to 7 members, but in the 71 years and 71 volumes since the first elected

Editor, there have been only 14 editors, thanks to the dedication and durability of many of them, most notably W. R. Walton, who served for 16 years from 1927 through 1942. We who merely belong owe much to those who have served in this important but laborious office.

If some of you wish fascinating reading, try the Editorials, which were published from 1923 through 1926, often but not always by the Editor. A sample:

Walton, noting that C. H. T. Townsend had developed a system of abbreviations for the numerous bristles and areas of muscoid flies, commented that "Nothing [Dr. Townsend] has hitherto perpetrated on a long suffering scientific fraternity begins to approach in absurdity his most recent lapsus calami . . . . It amounts practically to a new, synthetic language which his prospective readers will be compelled to learn before they may be able to translate his recent paroxysms of taxonomy into the 'king's English.' . . . Dr. Townsend could not have adopted better means to limit his reading public had he written in the Eskimo language."

But the prize exchange was this one. In the December 1925 issue, editor Carl Heinrich commented on a paper on Lepidoptera that had appeared in the English journal, *The Entomologists' Record and Journal of Variation,* as follows: "With the freedom of an emancipated mind this author soars beyond the commonplace of facts, mounting from assumption to conclusion through the magic circles of hypothesis unto the dizzy empyrean of fiction pure and undefiled whence he views with clairvoyant eye the evolution of species, and reveals to us the meaning and the methods of their evolving. . . . From the illicit union of assumption and conclusion he litters a mongrel progeny of subspecies, races, varieties, forms and hybrids which he must needs legitimatize by nomenclatorial baptism, thus overburdening more an already overburdened synonymy. We can only wish that one who seems so susceptible to modern vagaries would suffer that last infirmity of scientific minds—eugenics—and practice a little birth control."

If you think that was strong, even though deftly worded, here was the reply of the editor of the English journal:

"One stands aghast at the apparent colossal ignorance of this American scientist. . . . Our critic (sic) does not criticise, he vituperates, he absolutely ignores the latest discoveries. . . . We are astonished that a worthy society allows its pages to be used to utter the low down scum of frothy journalism."

I can find no reply by Heinrich. What I did find is that he wrote no more editorials! In fact the practice of editorials ended suddenly that year, with a scattered exception or two.

Being a taxonomist, I could not close this first part of my talk without commenting on the many new genera and new species published in the Proceedings down through the years. I wonder how many there were? But who on earth would go through 85 volumes of Proceedings and count them? Well, an old taxonomist needing material for an after-dinner speech, that's who! Totals: 6071 new species and subspecies, and 724 new genera and subgenera, plus assorted new families, new tribes, new varieties, new combinations galore, and keys and classifications, and, as the King of Siam said in a famous old movie, "Et cetera, et cetera, et cetera." Then he died, and it's a good place for me to stop.

[The second part of the talk consisted of slides, with personal reminiscences of some of the entomologists shown.]

PROC. ENTOMOL. SOC. WASH.
86(4), 1984, pp. 738–744

AETHUS NIGRITUS (F.), A PALEARCTIC BURROWER BUG ESTABLISHED IN EASTERN NORTH AMERICA (HEMIPTERA-HETEROPTERA: CYDNIDAE)

E. RICHARD HOEBEKE AND A. G. WHEELER, JR.

(ERH) Department of Entomology, Cornell University, Ithaca, New York 14853; (AGW) Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania 17110.

Abstract.—Aethus nigritus (F.), a Eurasian burrower bug, was first collected in North America at single localities in Delaware in 1977 and in Connecticut in 1979; it is here reported from additional localities in Connecticut, and from New Jersey, New York and Pennsylvania. This introduced cydnid is briefly described, and its dorsal habitus, diagnostic external characters, and male genitalia are illustrated. The habitat and associated host plants are given, and North American locality records are listed and mapped. Several selected keys to North American genera of Cydnidae are modified to include *Aethus,* an Old World genus.

Aethus Dallas, an Old World genus comprised of at least 19 species (Stichel, 1961), is distributed throughout most of the Palearctic and a portion of the Oriental region. All North American species previously assigned to *Aethus* belong to the genus *Tominotus* Mulsant and Rey (Froeschner, 1960).

The burrower bug *Aethus nigritus* (F.) was detected recently in the Western Hemisphere (Hoebeke, 1978, 1980), based on specimens submitted (to ERH) for identification in support of the USDA-APHIS "High Hazard Pest Survey" program. A single adult male was taken in a soybean field at Townsend, Delaware (New Castle Co.), on 8 June 1977; a second male, from forage at Waterford, Connecticut (New London Co.), on 22 August 1979.

In this paper we confirm the establishment of *A. nigritus* in the eastern United States, give additional locality records from New England and the Middle Atlantic states, map its distribution, and briefly describe its habitat and associated host plants. An adult diagnosis and photographs of the adult habitus and other distinguishing adult characters are provided, and selected keys to North American Cydnidae (i.e., Froeschner, 1960; Slater and Baranowski, 1978; and McPherson, 1982) are modified to include *A. nigritus.*

Aethus nigritus (F.)

Aethus nigritus is a common Old World cydnid that ranges throughout most of Europe, the Soviet Union, and Asia (Stichel, 1961). Although its habits have not been well studied, this fossorial bug is generally found in sandy areas such as dunes and fields and is known to occur up to 15 cm deep (Otten, 1956) at the roots of weeds like *Artemesia campestris* L., *Achillea,* and *Calluna* (Stichel, 1925),

Fig. 1. Habitus of *Aethus nigritus*, dorsal aspect. Scale line = 1.0 mm.

and grasses, particularly *Corynephorus canescens* (L.) Beauv. (Stichel, 1961). Kerzhner (1967) characterizes *A. nigritus* as a "polyphagous" and "sometimes injurious" species. Adults overwinter about 5 cm deep in loose sand and become active on warm days in early spring (Schumacher, 1916). Mating occurs during April and May, and eggs are laid in loose clusters in the sand near their host plants (Hertzel, 1982). *A. nigritus* sometimes occurs in large numbers and occasionally injures crop plants, e.g., lupine, potatoes, and rye (Schumacher, 1916; Reclaire, 1936). Other *Aethus* species also cause sporadic crop damage—*A. indicus* (Westwood) to germinating corn in Indonesia (Kalshoven, 1950) and *A. laticollis orientalis* Ghauri to pearl millet, *Pennisetum typhoides* (Burm.), and to wheat in sandy areas in central India (Ghauri, 1975).

Aethus nigritus is the only species of *Aethus* known to be established in the

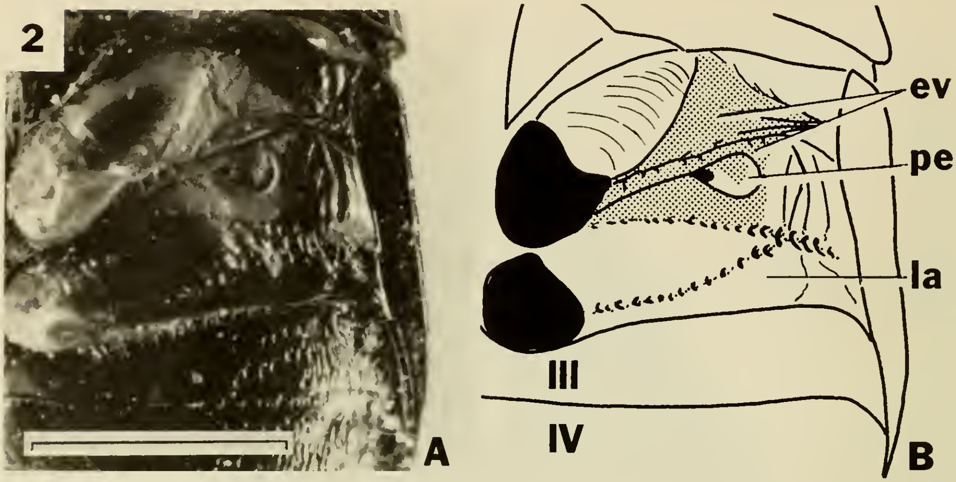


Fig. 2. Mesopleuron and metapleuron of *Aethus nigritus*, ventral aspect. A, photograph of area. B, line schematic of same, highlighting diagnostic structures. [ev, evaporatoria; pe, peritreme; la, lamella. Terminology after Froeschner, 1960.] Scale line = 1.0 mm.

Western Hemisphere. During 1978–79, *A. nigritus* was intercepted from a shipment of roots of *Glycyrrhiza* sp. (Leguminosae) from China that was destined for Pennsylvania (USDA, 1981). In addition, at least two other species of *Aethus* have been intercepted at U.S. ports of entry since 1944. *Aethus indicus*, widespread in Eurasia, has been intercepted on numerous occasions in cargo destined principally for Hawaii, California, Washington, Alaska, and the eastern U.S. (including Delaware, Maryland, New Jersey and New York) (USDA, 1946–1981), and during 1971–72, *A. pilosus* H.-S. was found in soil in a shipment from the Soviet Union and destined for New York (USDA, 1974).

Distribution and habits in North America.—In addition to the original collection of *A. nigritus* in Townsend, DE and Waterford, CT, we provide the following localities in eastern North America (Fig. 5), based on the examination of museum specimens and our own collecting.

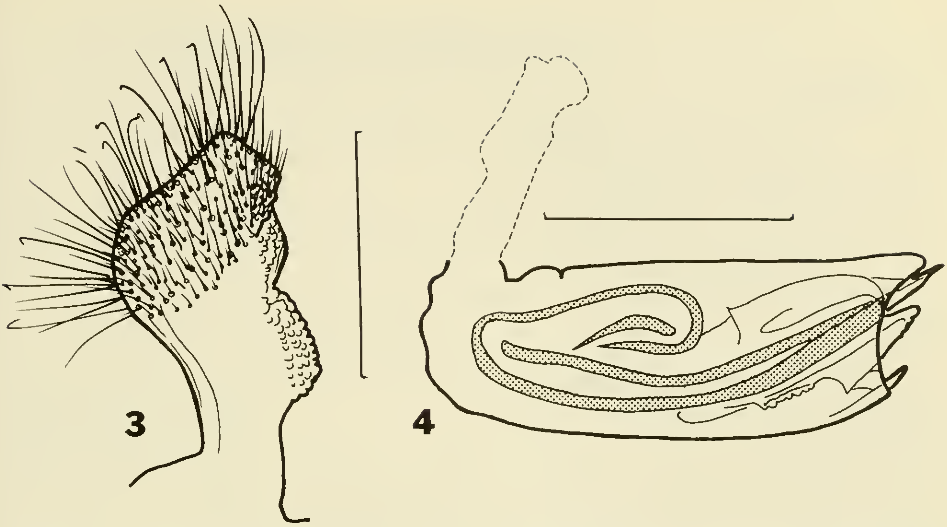
Connecticut: New London Co., Stonington, Barn Island, 12 August 1976, Slater, Ford, and O'Donnell. Tolland Co., Storrs, 30 May 1977, D. Leston; Storrs, Univ. of Conn. campus, 29 May 1983, ERH and AGW; Mansfield Center, 9 July 1979 and 25 April 1980, J. A. Slater. Middlesex Co., Old Saybrook, 28 May 1983, ERH and AGW.

New Jersey: Burlington Co., Lebanon State Forest, 4 mi. N of Chatsworth, 11 May 1969, G. C. and K. Eickwort.

New York: Nassau Co., Tobay Beach, 19 May 1975, G. C. Eickwort.

Pennsylvania: Dauphin Co., Harrisburg, 2 June 1983, AGW.

At a landfill at Old Saybrook, Connecticut, we collected more than 20 adults of *A. nigritus* under rocks of various sizes and in the gravelly, sandy soil up to several centimeters deep. Most of the cydnids were taken near roots of the dominant grasses present in the landfill, namely *Festuca capillata* Lam., *Panicum lanuginosum* Ell., and *P. clandestinum* L. Two adults of a native cydnid, *Amnestus spinifrons* (Say), also were collected under rocks at the same site.



Figs. 3–4. *Aethus nigritus.* Scale line = 0.25 mm. 3, Right clasper of male genitalia, mesal aspect. 4, Aedeagus of male genitalia, lateral aspect.

On the campus of the University of Connecticut (Storrs) specimens of *A. nigritus* were collected under mats of grasses overlying the edge of a sidewalk and were observed crawling across the sidewalk. The one Pennsylvania specimen collected also was observed running across a sidewalk; Gulde (1933) mentions a similar habit ("Wege laufend") for *A. nigritus* in Europe. The single specimens known from New Jersey (Pine Barrens) and New York (Tobay Beach on Long Island) probably were collected in sandy areas that appear typical for the species in the Old World.

Recognition.—Adults of *A. nigritus* (Fig. 1) closely resemble those of several native cydnids occurring in eastern North America (especially species of *Microporus* Uhler, *Tominotus,* and *Melanaethus* Uhler), but may be differentiated by the following diagnosis: Dark piceous-brown, with hemelytra often rufous-brown; body length 4.0–5.2 mm; anterior margin of head between eyes with a submarginal row of long setae and short, erect pegs (Fig. 1); peritreme of scent gland channel forming apically a large, nearly circular, partly polished loop (Fig. 2); metapleural evaporatorium (Fig. 2) extensive, occupying more than half of sclerite, and nearly reaching base of metapleural lamella posteriorly; and clasper and aedeagus of male genitalia as in Figs. 3 and 4.

We have modified several selected keys to the North American Cydnidae to include *A. nigritus.* The two regional works chosen contain updated keys, are popular among users, and encompass the fauna of eastern North America. In addition, the key in a monograph of the cydnid fauna of the Western Hemisphere is modified to reflect the presence of a newly introduced taxon in the hemisphere.

A key to the Cydnidae of the eastern United States by Slater and Baranowski (1978) has been modified, beginning with their couplet #6 (p. 36):

6. Scent gland channel forming a loop surrounding a ventrally visible pore, the outer end broadly rounded. Fig. 32, and Fig. 2 herein 8

Fig. 5. Distribution of *Aethus nigritus* in eastern United States. Map shows portions of New England, New York, Pennsylvania, New Jersey, Delaware, and Maryland.

6a. Scent gland channel not forming a loop, but subacute at outer end, pore visible posteriorly, not ventrally. Fig. 33 .... *Tominotus*

7. Terminal process of scent gland channel flat, expanded posteriorly as a partially polished flap. Fig. 34 .... *Melanaethus*

7a. Terminal process of scent gland channel neither expanded nor flat. Fig. 35 .... *Dallasiellus*

8. Metapleural evaporatorium very limited, just outlining peritreme, not approaching metapleural lamella posteriorly .... *Microporus*

8a. Metapleural evaporatorium more extensive, occupying more than half of sclerite, nearly reaching base of metapleural lamella posteriorly. Fig. 2 herein .... *Aethus*

McPherson's (1982) key to the Cydninae of Northeastern North America, starting with his couplet #2 (p. 29), is modified as follows:

2. Metapleural evaporative area just outlining peritreme, not approaching metapleural lamella posteriorly .... *Microporus* Uhler (p. 30)

2′. Metapleural evaporative area larger, occupying more than half of supporting plate and reaching metapleural lamella .... 2a.

2a. Head in front with submarginal row of long hairs and short, erect pegs (Fig. 1 herein) .... *Aethus* Dallas

2a′. Head in front with submarginal row of widely spaced hairs only .... *Melanaethus* Uhler (p. 31)

Finally, a key to the Cydnidae of the Western Hemisphere by Froeschner (1960) is altered to include *Aethus*; couplet #7 (p. 381) is modified to read:

7. Terminal process of peritreme scoop-shaped or auricular (Fig. 95), or nearly circular (Fig. 2 herein) 7a

– Terminal process of peritreme flat, simply expanded posteriorly as a more or less polished lobe (Figs. 96, 97), osteole opening posteriorly, not conspicuous ventrally .... *Melanaethus* Uhler (p. 421)

7a. Peritreme terminating apically in a free-edged, truncated auricle (Fig. 95), with osteole opening at its base .... *Onalips* Signoret (p. 415)

– Peritreme terminating in a large, differentiated, free-edged, circular loop (Fig. 2 herein), with osteole opening at its base .... *Aethus* Dallas

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We thank James A. Slater (Univ. of Connecticut) for bringing to our attention specimens in the University of Connecticut collection, and for accompanying us on a collecting trip to portions of coastal Connecticut in search of this introduced cydnid. We also acknowledge Robert J. Hill (Penn. Dept. of Agric., Harrisburg, PA) for identifying the grass species present in the Old Saybrook, CT landfill, one of the localities where *A. nigritus* was found.

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NOTE

Metrioptera roeseli (Hagenbach), a European Katydid Found for the First Time in Pennsylvania (Orthoptera: Tettigoniidae: Decticinae)

Metrioptera roeseli (Hagenbach, 1822) is a European decticine katydid accidently introduced into Canada sometime between 1945 and 1951. It was first reported in the vicinity of Montreal and Ville St. Laurent (Urquhart and Beaudry. 1953. Can. Entomol. 85: 78–9). Kevan et al. (Ann. Entomol. Soc. Quebec 7: 70–86, 1963) documented its further spread through eastern Canada and reported capture of *roeseli* for the first time in the United States (New York: Harrigan's Corners and Meacham Lake). Vickery (Ann. Entomol. Soc. Quebec 9: 165–71, 1965) mapped its distribution in Canada and the United States, and suggested that although collected only in New York State, *M. roeseli* probably would extend its range into Vermont and Pennsylvania. To date, however, no specimens have been reported from those states. This note documents the first capture of a single short-winged female in Pennsylvania. The specimen was collected in Wayne Co., 1.5 mi. N. of Newfoundland on VII-17-1982 by Gary Hevel and is in the collection of the National Museum of Natural History, Washington, D.C.

Metrioptera roeseli is similar in form to *Orchelimum* species but is brown with black and green markings on the lateral lobe of the pronotum. It occurs in both macropterous and brachypterous forms (in which the tegmina are only half as long as the abdomen). It is graminivorous, feeding especially on both wild and cultivated timothy grass (Vickery et al. 1974. Lyman Entomol. Mus. Res. Lab. Memoir 1: 1–204.) but is unlikely to be economically important as a pest.

David A. Nickle, *Systematic Entomology Laboratory, IIBIII, ARS, USDA, % National Museum of Natural History, Washington, D.C. 20560.*

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REDESCRIPTION OF *AGAPETUS AVITUS* EDWARDS (TRICHOPTERA: GLOSSOSOMATIDAE) WITH NOTES ON MORPHOLOGICAL VARIATION AND DISTRIBUTION

S. C. Harris

Department of Biology, University of Alabama, Tuscaloosa, Alabama 35486.

Abstract.—*Agapetus avitus* Edwards is redescribed and illustrated. Morphological variation present in the genitalia and distribution of the species is summarized.

In examining several collections of *Agapetus* (Trichoptera: Glossosomatidae) from northern Alabama, a number of specimens were tentatively identified as *Agapetus avitus* Edwards. These specimens could not be positively identified using

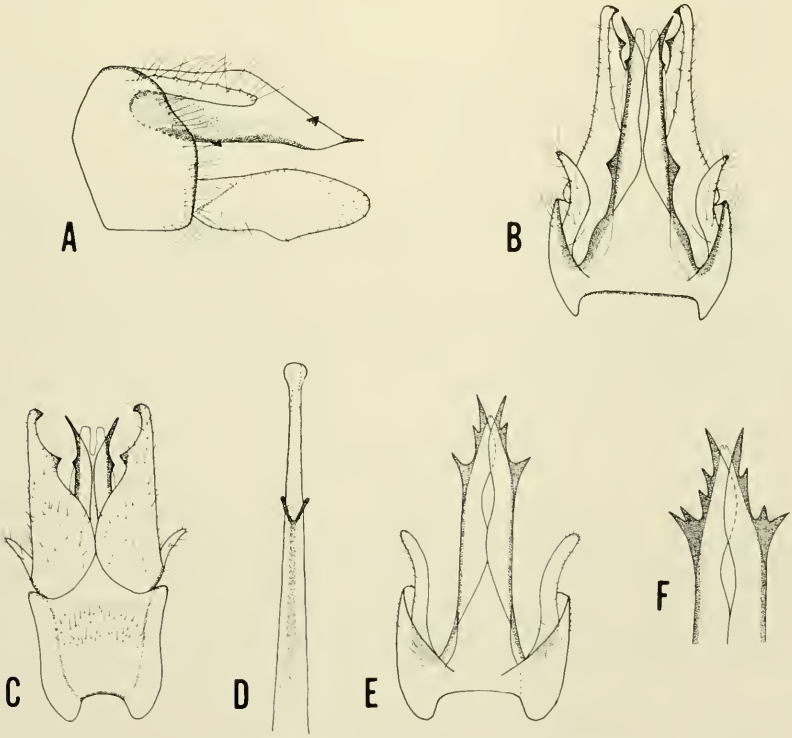

Fig. 1. *Agapetus avitus,* male genitalia. a–d, Redrawn from holotype. a, Lateral view. b, Dorsal view. c, ventral view. d, Phallus. e–f, Variation in genitalia; specimens from north Alabama. e, Tenth tergum, dorsal view. f, Apical portion of tenth tergum, dorsal view.

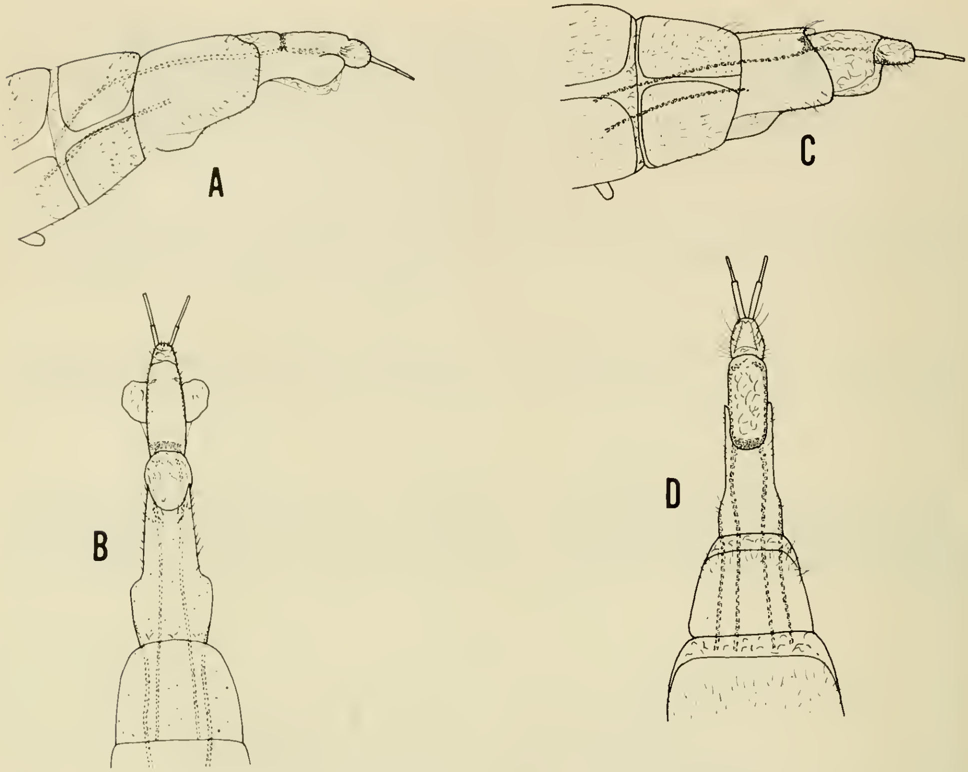

Fig. 2. *Agapetus avitus,* female terminalia. a–b, Redrawn from allotype. a, Lateral view. b, Dorsal view. c–d, Variation in terminalia, specimen from north Alabama. c, Lateral view. d, Dorsal view.

the original species description and illustrations of Edwards (1956). A final identification was made only after a comparison with the holotype and examining the extent of morphological variation in material from several locations in both Alabama and Tennessee. The redescription of *A. avitus* from the holotype and allotype of Edwards and the discussion of morphological variation which follows should simplify future identifications.

***Agapetus avitus* Edwards**

Figs. 1–2

Male (Fig. 1a–d).—Length 6 mm. Wings, legs, and abdominal segments brown; head and thorax dark brown. Antennal segments 28. Abdominal segment IX quadrate in lateral view, incised dorsally and continuous with tenth tergum. Preanal appendages (cerci) thin, in dorsal view gradually curving laterally, extending about half the length of segment X, fused basally with dorso-lateral edge of segment IX. Inferior appendages (claspers) in lateral view parallel sided basally, rounded distally; triangular ventrally with ventro-mesal edge bearing a heavily sclerotized spine apically and subapically. Tenth tergite elongate, wide basally tapering to apex; membranous dorsally with pair of lobes distally, ventral portion divided into two sclerotized arms, each heavily sclerotized at ventro-lateral margin and

Fig. 3. Distribution of *Agapetus avitus* in the southeastern United States.

terminating in a long, acute spine, with small spine subapically and broad spine near base. Phallus typical for genus, elongate, tapering distally, bulbous at apex.

Female (Fig. 2a–b).—In general, appearance similar to male. Length 6 mm (pharate adult). Antennal segments 28. Abdominal segment VII quadrate and lightly sclerotized, ridged ventro-laterally, incised dorsally on distal margin; pair of apodemes extending from midsegment anteriorly to segment V. Segment VIII tubular, membranous, and often retracted into VII; pair of apodemes extending from distal portion of segment anteriorly to segment V margin. Segment IX rectangular, membranous, with lateral wing-like lobes; pair of sclerotic rods at dorso-lateral margin connected anteriorly by heavily sclerotized dorsal bridge. Segment X membranous, rounded distally with pair of two-segmented cerci.

Morphological variation.—The species varies in size from 5.8–6.6 mm with males and females similarly sized. Coloration varies little in the species. Most of the variation in the 84 specimens examined from Tennessee and Alabama occurred in features of the genitalia. In the males, this variation appears restricted primarily to the shape and structure of the tenth tergum. In females, the appearance of abdominal segment IX is variable.

In the holotype, the tenth tergum, in dorsal view, is wide at its base with the ventral arms possessing two pair of spines apically and another pair basally (Fig. 1b). In examined specimens, the tenth tergum is often narrow and parallel sided (Fig. 1e), although intermediates between the two extremes exist. The spinal arrangement of the arms varies from 4 to 10 spines distally (Fig. 1e and 1f). The heavy spines present basally on the holotype were absent in all specimens I examined. Unfortunately, the paratype series denoted by Edwards (1956) was destroyed in an accident (S. Edwards, personal communication) making further analysis of this character impossible.

In females, the membranous, wing-like lateral lobes of the ninth abdominal segment (as seen on the allotype (Fig. 2b)) are closely appressed in most specimens (Fig. 2c and 2d). The specimen designated as allotype by Edwards (1956) was a pharate adult. These laterally extended lobes were also present in other pharate females I examined. Evidently, the lobes become more laterally appressed as specimens mature.

Distribution.—*Agapetus avitus* appears to be limited in range to a small portion of the southeastern United States in Tennessee and Alabama (Fig. 3). In Alabama, the species has been collected in Lauderdale County; in Tennessee records exist for Bedford, Coffee, Hardin, Perry, and Wayne counties. The species occurs in spring runs and in small, swift streams with rocky substrates. Adults have been collected from April through June.

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My thanks to John Unzicker and David Etnier for the loan of Alabama and Tennessee specimens, respectively. Dr. Etnier also reviewed the manuscript and provided many records from Tennessee. Oliver S. Flint, Jr. provided the types of *Agapetus avitus*. I also thank Sabra Rager for typing the manuscript and Ruth Turner for producing the plates.

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SHORE FLY (DIPTERA: EPHYDRIDAE) COMMUNITY STRUCTURE IN A XERIC GRASS HABITAT

Bruce A. Steinly

Department of Entomology, University of Illinois, 320 Morrill Hall, Urbana, Illinois 61801.

Abstract.—Analysis of a xeric terrestrial grass shore fly population found the community composed of 17 species. In addition to the 14 species previously listed from southern Ohio terrestrial grass, *Parydra breviceps* Loew, *Hyadina binotata* (Cresson), and *H. pruinosa* (Cresson) were collected. *Leptopsilopa atrimana* (Loew) was dominant during the collection period. The consistent presence of *L. atrimana* adults and gravid females suggested the species has encountered physical and biological conditions satisfying minimum reproductive requirements. Quantitative parameters including species diversity (H′), evenness (J′), richness (s), and relative abundance (RA) were calculated for xeric terrestrial grass. A comparison of terrestrial quantitative parameters with aquatic grass shore and limnic wrack suggests fundamental differences in species composition. Also, low indices of similarity in addition to physical and biological observations substantiate the designation of xeric terrestrial grass as a new shore fly habitat.

The Ephydridae are considered one of the most diverse families of cyclorraphous Diptera. Of the 404 Nearctic species (Deonier, 1979), most are semi-aquatic as adults and aquatic in the immature instars. Adults are frequently found in wetland habitats, and many species survive the rigors of thermal springs (Brues, 1932; Tuxen, 1944; Wirth and Mathis, 1979), alkaline springs (Brock and Brock, 1968; Lindroth, 1931; Wirth and Mathis, 1979), inland saline pools and lakes (Aldrich, 1912; Ping, 1921; Scheiring and Foote, 1973), coastal salt marshes (Dahl, 1959; Simpson, 1976a), crude oil pools (Crawford, 1912; Thorpe, 1930), and urine-soaked wood (Oldroyd, 1964). Additionally, several unusual larval microhabitats have been reported. Larvae have been collected under a human cadaver and pig droppings (Bohart and Gressitt, 1951), reared from decaying crayfish (Runyan and Deonier, 1979), and marine mussels (Steinly and Runyan, 1979), associated with decaying land snails (Berganstamm, 1864), reared from aquatic snails (Wirth, 1971), preying on the developing eggs of a marsh-inhabiting spider (Becker, 1926; Scheiring and Foote, 1973), developing frog eggs (Bokermann, 1957), and mining leaves (Meijere, 1947). Although these microhabitats were unusual, the shore flies were located in close proximity to aquatic or marine habitats.

The first comprehensive ecological, distributional, and behavioral investigation of the Ephydridae was accomplished in Scandinavia (Dahl, 1959). Later, Deonier (1965) reported the results of his studies on the ecology and distribution of the Iowa fauna. Deonier (1965) collected more than 100 shore fly species from 12 aquatic habitats. Scheiring and Foote (1973) reported 68 species found in 12 aquatic habitat types located in northeastern Ohio. The Iowa and northeastern Ohio populations were later analyzed for spatial and temporal patterns in shore fly diversity (Scheiring, 1974; Scheiring and Deonier, 1979a). In southern Ohio, Regensburg (1976) investigated 12 wetland habitats from which were recorded 65 shore fly species (Deonier and Regensburg, 1978). The final phase of the Ohio study yielded 104 species of Ephydridae from 13 northern Ohio aquatic habitats (Steinly, 1979; Steinly and Deonier, 1980). Also, Zack (1979) reported 45 species from aquatic habitats in Mount Rainier National Park. The Nearctic investigations have focused extensively on the ecology and distribution of the ephydrids within aquatic habitats. These habitats in Iowa, Ohio, and Washington were characterized by vegetation types and/or substrate constitution in various physiographic regions.

Several recent publications have focused on shore fly life cycle requirements and natural history. These studies have confirmed the aquatic or semi-aquatic nature of most ephydrid species (Eastin and Foote, 1971; Foote and Eastin, 1974; Simpson, 1975, 1976b; Busacca and Foote, 1978; Deonier and Regensburg, 1978; Zack and Foote, 1978; Runyan and Deonier, 1979; Deonier, Mathis and Regensburg, 1979; Thier and Foote, 1980; Foote, 1981a, b; Mathis and Simpson, 1981; Foote, 1982; Zack, 1983a, b).

Although ephydrid association with aquatic habitats has been extensively documented, only a few species have been reported from dry (xeric) habitats. One early reference to a distinctly xeric species described the dependence of *Mosillus subsultans* Fabricius on dry sand substrate into which the organism digs rapidly when shaded (Latreille, 1805; Schiner, 1863). Rapp (1942) identified three Palearctic shore fly species in dry habitats (biotopes). In a recent ecological investigation of moist, half dry, and dry grassland habitats, Bahrmann (1978) reported the largest numbers of 8 Palearctic ephydrid species from half dry to dry habitats dominated by grasses. These species were rarely collected in moist grassland habitats.

In the Nearctic region, Sturtevant and Wheeler (1954) reported the collection of *Nostima scutellaris* Cresson, *Hydrellia griseola* (Fallén), *Psilopa varipes* Coquillett, *P. compta* (Meigen), and *Philygria* (*Hydrina*) *debilis* (Loew) from a city lawn and garden. Additionally, *H. griseola,* a leaf miner, has been recorded from the leaves of oats, strawberries, sagebrush (Deonier, 1971) and late-sown barley (Lilljeborg, 1861; Grimshaw, 1925). In a discussion of the life history of *Leptopsilopa atrimana,* Steinly and Runyan (1979) reported 14 shore fly species over a grass lawn located some distance from any typical freshwater habitat. Furthermore, the authors suggested that terrestrial habitats may contain aquatic microhabitats utilized by some ephydrids. During laboratory rearing, *L. atrimana* appeared to be consuming saprophytic microorganisms trapped in the surface film on decaying grass blades (Steinly and Runyan, 1979). Similarly, Scheiring and Foote (1973) suggested the abundant decaying organic matter of the limnic wrack habitat provided a suitable substrate for the proliferation of bacteria, yeast, and unicellular algae.

Selection by shore flies of low humidity regions was experimentally verified by Dahl (1959). Also, Dahl maintained a few species at low humidity, and these species withstood desiccation. These xerophilists reached greatest predominance within the dry Hockenye and dune heath biotopes (Dahl, 1959). The dry Hockenye and dune heath biotopes are transitional beach areas with distinctive vegetation communities and are not inundated by tides or storms. Drought and temperature resistance may enable certain Ephydridae to colonize terrestrial habitats having aquatic microhabitats.

In this paper, I compare shore fly species diversity, evenness, and richness of selected aquatic and terrestrial habitats. Shore fly species temporal and abundance patterns are described for the Nearctic terrestrial habitat.

Description of Study Area

On July 4, 1978, a shore fly community was discovered over a grass lawn and garden area. These collecting localities were located 4 km north of Oxford, Ohio. The habitats were not in close proximity to surface water and not subject to irrigation. The nearest permanent surface water, an abandoned gravel pit, was located 0.5 km to the west. No shore flies were associated with ephemeral woodland seepage areas 150 m to the west.

The grass lawn collecting site included substantial accumulations of mowed grass clippings in various stages of decomposition. The lawn was mowed infrequently depending upon the growth rates of the vascular plant cover. Plant species commonly encountered in the lawn included: *Festuca elatior* Linnaeus (meadow fescue), *Cyperus esculentis* Linnaeus, *Digitoria sanguinalis* (Linnaeus) Scopoli (crabgrass), *Setaria faberi* Herrman (nodding foxtail), *S. lutescens* (Weigel) Hubbard, *Medicago lupulina* Linnaeus (hop or black medick), *Muhlenbergia schreberi* J. Gmelin and *Oxalis* sp. Linnaeus (wood sorel).

I located a garden area 100 m south of the grass lawn with a path, approximately 50 m long on the west side. The path was in frequent use and was characterized by intermittent hard packed barren soil areas and patches of *Digitoria sanguinalis.* Although the garden path was devoid of extensive vascular plant growth, the soil areas retained moisture during periods of low and high precipitation. Soil moisture was renewed by the heavy morning dew. The garden vegetation to the east and trees in close proximity to the west shaded the exposed soil during the major portion of the day. These areas of exposed soil were covered sparsely with dried plant debris. Adjacent vegetation included *Setaria faberi,* and cultivated garden varieties of *Lycopersicon esculentum* P. Miller (tomato), and *Capsicum* sp. Linnaeus (bell pepper).

These sites were situated on a ridge sheltered by a dense tree line to the west. The ridge area was well drained, since the slope prohibited surface accumulation of precipitation.

Methods and Materials

Shore flies were collected with a modified aerial sweep net (Regensburg, 1977) from July 4 through November, 1978. Additional sampling was continued in February, 1979 through June, 1979 over the grass lawn. Although begun in February, 1979, collecting had to be terminated over the garden area in April, because the area was brought into cultivation. Sampling was done weekly over the mowed lawn and garden path.

Adult Ephydridae were selectively aspirated from samples collected over both localities. These adults were isolated in 7 dram vials in the field. The remaining insects in the collecting bags, including specimens of *Leptopsilopa atrimana,* were immediately killed with ethyl acetate at the site. Dead specimens of *Leptopsilopa atrimana, Paralimna punctipennis* Wiedemann, *Philygria debilis, Nostima scutellaris, Hydrellia formosa* Loew, and *Hyadina albovenosa* Coquillett were examined to ascertain reproductive condition.

The percent relative abundance of each species was calculated within the terrestrial localities. The percentage ranges (Scheiring and Foote, 1973; Regensburg, 1976; Deonier and Regensburg, 1978; Steinly, 1979) were characterized as follows: 1–2% rare (r); 3–8% occasional (occ); 9–14% common (c); 15–25% abundant (a); and 26–100% very abundant (va).

The Shannon-Wiener diversity index (H′) (Scheiring, 1974) was calculated because it incorporates species richness (s) and evenness (J′). Diversity was calculated by: $H' = - \Sigma p_i \log_{10} Pi$ where p_i is n_i/N, n_i is the number of individuals of the ith species of the habitat being considered, and N is the total number of individuals per habitat. Although Wilhm and Dorris (1968) and Olive and Dambach (1973) have stated that H′ is essentially dimensionless and not affected by sample size (N), Sanders (1968), Pielou (1969), Fager (1972), and Simberloff (1972) have shown that this index is sensitive to sample size in many instances. However, no mathematically or conceptually acceptable alternative has been proposed (Scheiring, 1974). Habitats were sampled for the same approximate amount of time and differences in sample size reflect biological differences among the habitats. Evenness (J′) (Scheiring, 1974) was calculated by: $J' = H'/\log_{10} s$ where s is the species richness (species number) per habitat. H′, J′, and s values for the aquatic grass shore and limnic wrack habitats (Scheiring and Foote, 1973; Scheiring, 1974; Scheiring and Deonier, 1979b) were compared with calculated values for the terrestrial grass lawn and garden localities.

The community composition of the infrequently mowed grass lawn was compared by means of the Sorenson index of similarity (I) with aquatic grass shore and limnic wrack data compiled by Regensburg (1976), Steinly (1979), and data reported by Scheiring and Foote (1973), Scheiring (1974), and Scheiring and Deonier (1979b). The similarity index was calculated with the formula $I = 2C/A + B$ where I is the index of similarity, C is the number of species shared, A is the number of species in habitat A, and B is the number of species in habitat B (Scheiring and Deonier, 1979b). The aquatic grass shore was compared with the terrestrial habitats, because these habitats were dominated by similar vascular vegetation. The limnic wrack was compared with terrestrial sites because these ephydrid populations appear to have similar larval food resources. Shore fly larvae seem to be feeding on microorganisms in terrestrial and limnic wrack habitats. The value of the Sorenson index ranges from 0 when there is no similarity (no species shared) between habitats to 1 when there is complete similarity (all species shared).

Results

Relative abundance and community structure.—The dominant species of Ephydridae on the grass lawn were *Leptopsilopa atrimana* (va) and *Hydrellia formosa* (occ) (Table 1). *L. atrimana* was very abundant (Table 2) during all months of the investigation. *L. atrimana* accounted for 87.7% of the total population (Table 3) over the grass lawn. Scheiring and Foote (1973) did not report *L. atrimana* from the grass shore habitat in northeastern Ohio, but found the

Table 1. Ephydridae (Diptera) found in xeric terrestrial habitats in southeastern Ohio.

Species	Grass		Garden	
	Number N	Relative Abundance R.A.	Number N	Relative Abundance R.A.
Allotrichoma simplex	6	r	—	—
Discocerina obscurella	14	r	11	occ
Ditrichophora exigua	3	r	3	r
Hyadina albovenosa	11	r	—	—
H. binotata	2	r	1	r
H. pruinosa	2	r	1	r
Hydrellia formosa	153	occ	18	occ
H. griseola	7	r	1	r
H. ischiaca	4	r	1	r
H. tibialis	4	r	—	—
Leptopsilopa atrimana	1870	va	64	a
Limnellia anna	—	—	1	r
Nostima scutellaris	16	r	14	occ
Ochthera mantis	—	—	1	r
Paralimna punctipennis	15	r	217	va
Parydra breviceps	1	r	—	—
Philygria debilis	17	r	6	r
Psilopa dupla	3	r	—	—
Trimerina madizans	—	—	1	r
Typopsilopa atra	4	r	—	—
	Total = 2132		Total = 340	

species common (c) in the limnic wrack. Steinly (1979) and Regensburg (1976) did not encounter *L. atrimana* in the limnic wrack of northern and southern Ohio, but found the species rare (r) in the grass shore, marsh reeds, mud shore, sand shore, sedge meadow, and stagnant woodland pool habitats. Scheiring and Deonier (1979b) reported *Hydrellia griseola* and *H. tibialis* Cresson the dominant species from Iowa grass shore habitat while *Discocerina obscurella* (Fallén), *H. griseola,* and *Notiphila scalaris* Loew were dominant in northeastern Ohio.

The most numerous species over the garden area included *Paralimna punctipennis* (va), *Nostima scutellaris* (occ), *Discocerina obscurella* (occ), and *Hydrellia formosa* (occ). *P. punctipennis* accounted for 63.8% of the total specimens collected at the garden locality. The remaining species at both terrestrial localities were rare (r) (Table 1). *P. punctipennis* specimens were rarely collected in southern Ohio floating algal mat, floating vegetation, freshet seep, periphytose stream rocks, sedge meadow, terrestrial shoreline vegetation, and occasionally (occ) in limnic wrack and mud shore habitats (Regensburg, 1976). A single specimen was collected in northern Ohio from floating vegetation habitat (Steinly, 1979). Previously, *Parydra appendiculata* Loew was reported from Iowa, and *D. obscurella* and *Dichaeta caudata* (Fallén) were reported from northeastern Ohio as the dominant shore flies in the limnic wrack (Scheiring and Deonier, 1979b).

The limnic wrack, grass shore, and garden area shore fly populations were compared with the terrestrial grass species assemblage by means of the Sorenson

Table 2. Temporal patterns of shore fly species in terrestrial grass and garden habitats. Species collected from both habitats (B), collected from grass lawn only (L), and collected from garden area only (P).

	Month—1978						Month—1979			
Species	July	Aug.	Sept.	Oct.	Nov.		Mar.	Apr.	May	June
Allotrichoma simplex			L	L		II				
Discocerina obscurella	L	L	B	B		II				
Ditrichophora exigua			L	B		II				
Hyadina albovenosa	L	L				II				
H. binotata					P	II	L			
H. pruinosa	L		B			II				
Hydrellia formosa	L	L	B	B	L	II			L	
H. griseola			L	B		II				
H. ischiaca		L	B			II				
H. tibialis	L		L	L		II				
Leptopsilopa atrimana	L	L	B	B	L	II	L	L	L	L
Limnellia anna	P					II				
Nostima scutellaris	B	L	B		P	II	B			
Ochthera mantis						II	P			
Paralimna punctipennis	P	P	B	B	P	II			L	
Parydra breviceps	L					II				
Philygria debilis	B	L	B		B	II	B		L	
Psilopa dupla	L					II				
Trimerina madizans		P				II				
Typopsilopa atra	L		L			II				

index of similarity (Table 4). The garden path and grass lawn had the greatest index of similarity. The similarity values for northeastern, northern, and southern Ohio grass shore and limnic wrack habitats were low. The index values for the limnic wrack were generally lower than the values calculated for the aquatic grass shore. These values suggest a fundamental difference in the composition of the ephydrid communities, particularly in the limnic wrack habitat.

Diversity.—The overall values for habitat diversity (H′), evenness (J′), and richness (s) are given in Table 5. The H′ and J′ were lowest for the terrestrial grass lawn due to the predominance of *Leptopsilopa atrimana* in the population. The aquatic habitats, including grass shore and limnic wrack, have relatively high H′, J′, and s values (Scheiring and Deonier, 1979b). The only exceptions were the values for H′ in the Iowa grass shore and for s in the limnic wrack of northeastern Ohio (Scheiring and Deonier, 1979b). The consistent disparity between the aquatic and terrestrial H′, J′, and s values suggests a fundamental difference in shore fly community structures. In addition, the lack of J′, low s and % relative abundance for the grass lawn suggests that *L. atrimana* is the only species in the population adapted to the terrestrial habitat.

Seasonal distribution.—*Leptopsilopa atrimana* was collected consistently in large numbers during warmer months from the grass lawn. During November of 1978 and March and April of 1979, *L. atrimana* was not encountered in large numbers, but the species comprised the largest percentage of the shore flies collected (Table 3). The consistent abundance of *L. atrimana* suggests that the species was a relatively permanent inhabitant of the grass lawn. The examination and dissection

Table 3. Monthly percent relative abundance (R.A.) of *Leptopsilopa atrimana* on the grass lawn habitat.

Month	R.A.	Total Number of *L. atrimana*	Total Number of Shore Flies
July, 1978	0.910	546	600
August	0.913	306	335
September	0.821	418	509
October	0.869	345	397
November	0.625	10	16
March, 1979	0.600	9	15
April	1.000	11	11
May	0.875	168	192
June	1.000	57	57
	Total = 0.877	Total = 1870	Total = 2132

of *L. atrimana, Philygria debilis, Nostima scutellaris, Paralimna punctipennis, Hyadina albovenosa,* and *Hydrellia formosa* revealed gravid females. Gravid *L. atrimana* were encountered from April to mid September. All gravid species, except *P. punctipennis,* were associated with the grass lawn. The presence of gravid females suggests that the minimum reproductive requirements for the species were being satisfied in the terrestrial habitat. One *L. atrimana* larva was collected from grass clippings on the grass lawn.

The presence of *Leptopsilopa atrimana, Paralimna punctipennis,* and *Discocerina obscurella* during September and October in lawn and garden may be attributed to immigration. *Philygria debilis* and *Nostima scutellaris* were collected often in both localities, suggesting that these species were residents and/or moved between habitats. *Typospilopa atra* Loew, *Psilopa dupla, Parydra breviceps, Hydrellia tibialis, Hyadina albovenosa,* and *Allotrichoma simplex* (Loew) were collected only in the grass lawn habitat, while *Trimerina madizans* (Fallén), *Ochthera mantis* (De Geer), and *Limnellia anna* Cresson were found exclusively associated with the garden path. Previously, *Hyadina binotata, H. pruinosa,* and *Parydra breviceps* were not reported from terrestrial grass habitat.

DISCUSSION

The seasonal persistence of ephydrids in large numbers in dry terrestrial grass, the dissimilarity of the comparative parameters, and the observed physical, biological, and population differences all support the contention that grassland is a hitherto unreported habitat for ephydrids. Moreover, the collection of Palearctic shore fly species in xeric grassland biotopes (Bahrmann, 1978) suggests the presence of the Ephydridae in a Nearctic dry terrestrial habitat is not a biological anomaly. Preliminary experimental evidence concerning drought and temperature resistance (Dahl, 1959) has substantiated the capacity of certain Ephydridae to withstand the physiological stresses associated with desiccation.

The presence of a reproductive shore fly population over a dry terrestrial grass habitat has been confirmed in the Nearctic region. *Leptopsilopa atrimana* was the dominant ephydrid species and very abundant during all months. Although *L. atrimana* was collected on March 3, 1979, adult overwintering was not confirmed.

Table 4. Similarity of shore-fly habitats to terrestrial grass.

Habitat	Index of Similarity (I)		
Garden area, Present Study	0.7097		
Grass shore NE Ohio[1] (Scheiring and Foote, 1973)	0.3333	Limnic wrack[1]	0.3750
Grass shore northern Ohio[2] (Steinly, 1979)	0.4615	Limnic wrack[2]	0.2500
Grass shore southern Ohio[3] (Regensburg, 1976)	0.5581	Limnic wrack[3]	0.2632

Comparison of the quantitative parameters H′, J′, s, and I strongly indicate fundamental differences in the ephydrid populations associated with aquatic and terrestrial grass habitats. Low H′, J′, and s values for the grass lawn, low indices of similarity, and high monthly relative abundance of *Leptopsilopa atrimana* supports the designation of a new terrestrial habitat for the Ephydridae. The low H′ and J′ for terrestrial grass suggests that *L. atrimana* has adapted to the intrinsic physical and biological conditions in the habitat. Even though the garden area quantitative parameters were not similar to the aquatic grass shore and limnic wrack, the designation of a new habitat (terrestrial soil) is not warranted. Although *Paralimna punctipennis* was dominant over the garden path, a relatively high similarity value suggests that the ephydrid community structure was comparable to the population within the terrestrial grass.

The gross similarities in dominant vascular vegetation are not indicative of subtle biological and physical differences encountered in the aquatic grass shore and terrestrial grass habitats. In particular, vegetation growth rate and condition on the grass shore are often regulated and/or altered by one or more of the following: the length and number of times the habitat is submerged; the intensity of flushing and scouring; the amount of habitat area flooded and subjected to flushing; and the amount and type of sediment deposition.

During laboratory rearing, *Leptopsilopa atrimana* larvae were unable to escape or survive entrapment in large areas of condensation on the vial walls (Steinly, unpubl.). Although larvae continually probed the internal condensation surface, individuals were not able to break the surface tension and expired in 4–6 hours. *L. atrimana* larval entrapment suggests the species is not well adapted to submersion.

Feeding observations suggested that *Leptopsilopa atrimana* larvae consume microorganisms on decaying vegetation surfaces (Steinly and Runyan, 1979). During flood, grass shore decaying vegetation was removed or coated with sediment (Steinly, unpubl.). The terrestrial grass habitat was not subjected to flood. The terrestrial availability of microorganisms and ephydrid oviposition sites may facilitate habitat colonization by *L. atrimana*.

Limnic wrack, composed of decaying organic matter, provides ample substrate for microorganism proliferation (Scheiring and Foote, 1973). The transient limnic wrack is subjected to physical stresses that include rapid desiccation (thermal and wind), periodic inundations, and severe wave action. These physical stresses and bird predation, in all probability, precluded the colonization and development of many ephydrid species. *Leptopsilopa atrimana* was reported common (c) from northeastern Ohio limnic wrack (Scheiring and Foote, 1973), but was encountered rarely (r) by Regensburg (1976) and Steinly (1979). Limnic wrack habitat disrup-

Table 5. Diversity, evenness, and richness values for Ephydridae in Nearctic habitats.

Ephydrid Habitats	Diversity (H')	Evenness (J')	Richness (s)
Terrestrial grass[1] (Present Study)	0.252	0.205	17
Garden area[1]	0.535	0.467	14
Grass shore NE Ohio[2] (Scheiring and Deonier, 1979b)	0.9	0.70	19
Grass shore, Iowa[2]	0.42	0.31	24
Limnic wrack, Ohio[2]	0.817	0.76	12
Limnic wrack, Iowa[2]	1.36	0.82	45

tion may interrupt the relatively long life cycle (17–27 days) of *L. atrimana* (Steinly and Runyan, 1979).

Leptopsilopa atrimana utilization, colonization and oviposition of terrestrial habitats may depend on the stability of decaying vegetation. The stable terrestrial grass microhabitat (decaying vegetation) provides a substrate for microorganism proliferation (Steinly and Runyan, 1979). In terrestrial grass, *L. atrimana* is not subjected to the disruptive forces common in aquatic habitats. Although adults remain in the same general area of pupation, Scheiring (1974) was convinced that the species in a habitat were determined by larval adaptation. Deonier (1965) and Scheiring (1974) have suggested that most ephydrid larvae have more specialized habitat and food requirements than the adults.

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DESCRIPTION OF THE LARVA AND PUPA OF *ARGYRIPA LANSBERGEI* (SALLÉ) WITH NEW DISTRIBUTIONAL RECORDS FOR THE GENUS AND A KEY TO NEW WORLD GYMNETINI LARVAE (COLEOPTERA: SCARABAEIDAE: CETONIINAE)

Miguel Angel Morón and Brett C. Ratcliffe

(MAM) Instituto de Ecología, Apdo. Postal 18-845, México, D. F. 11800, MEXICO; (BCR) Systematics Research Collections, University of Nebraska State Museum, W436 Nebraska Hall, University of Nebraska, Lincoln, Nebraska 68588-0514 U.S.A.

Abstract.—The third instar larva and pupa of *Argyripa lansbergei* (Sallé) are described and illustrated based on specimens from Mexico. New records are given for *A. anomala* (Mexico), *A. gloriosa* (Ecuador), and *A. lansbergei* (Mexico). A key to the larvae of New World Gymnetini is provided.

Ratcliffe (1978) revised and illustrated the four species of the cetoniine genus *Argyripa* which ranged from Chontales, Nicaragua, to Portoviejo, Ecuador. During recent collecting near the Tacana Volcano, Chiapas, Mexico, Morón found larvae that, after being laboratory reared, emerged as *Argyripa lansbergei* adults. In addition, Luis González-Cota collected two adult specimens of *A. anomala* (Bates) in Veracruz and Oaxaca states, Mexico. Lastly, Ratcliffe found additional Mexican specimens of both of these species in the collections of the Museum für Naturkunde in Berlin. These new records clearly indicate the presence of this Neotropical genus in Mexico, about 1200 km to the NW of its previously known occurrence.

Descriptions

Six larvae of *A. lansbergei* were preserved in the field upon collection in March 1982. The remaining ten specimens were placed in individual plastic containers with 250 grams of organic bedding composed of equal portions of black soil, milled rotten wood, and pulverized dry cow dung. The rearing containers containing larvae were maintained at 20 ± 3° C for seven months until all the adults had emerged. One third instar larva collected on 9 March reached the adult stage on 3 May. The remaining eight larvae formed pupal cells from 30 June to 11 September. One specimen died. The egg-shaped pupation cells constructed by the larvae remained intact for 60–105 days after which the adults began to emerge (Fig. 14). From lab reared, third stage larvae, adults were recovered in May (one specimen), August (one specimen), September (one specimen), and October (four specimens).

Technical terms and abbreviations used in the text and figures are those of

Ritcher (1966). The larvae and adults studied in this project are deposited in the M. A. Morón Collection/Museo de Historia Natural de la Ciudad de México, and in the B. C. Ratcliffe Collection.

Argyripa lansbergei (Sallé)

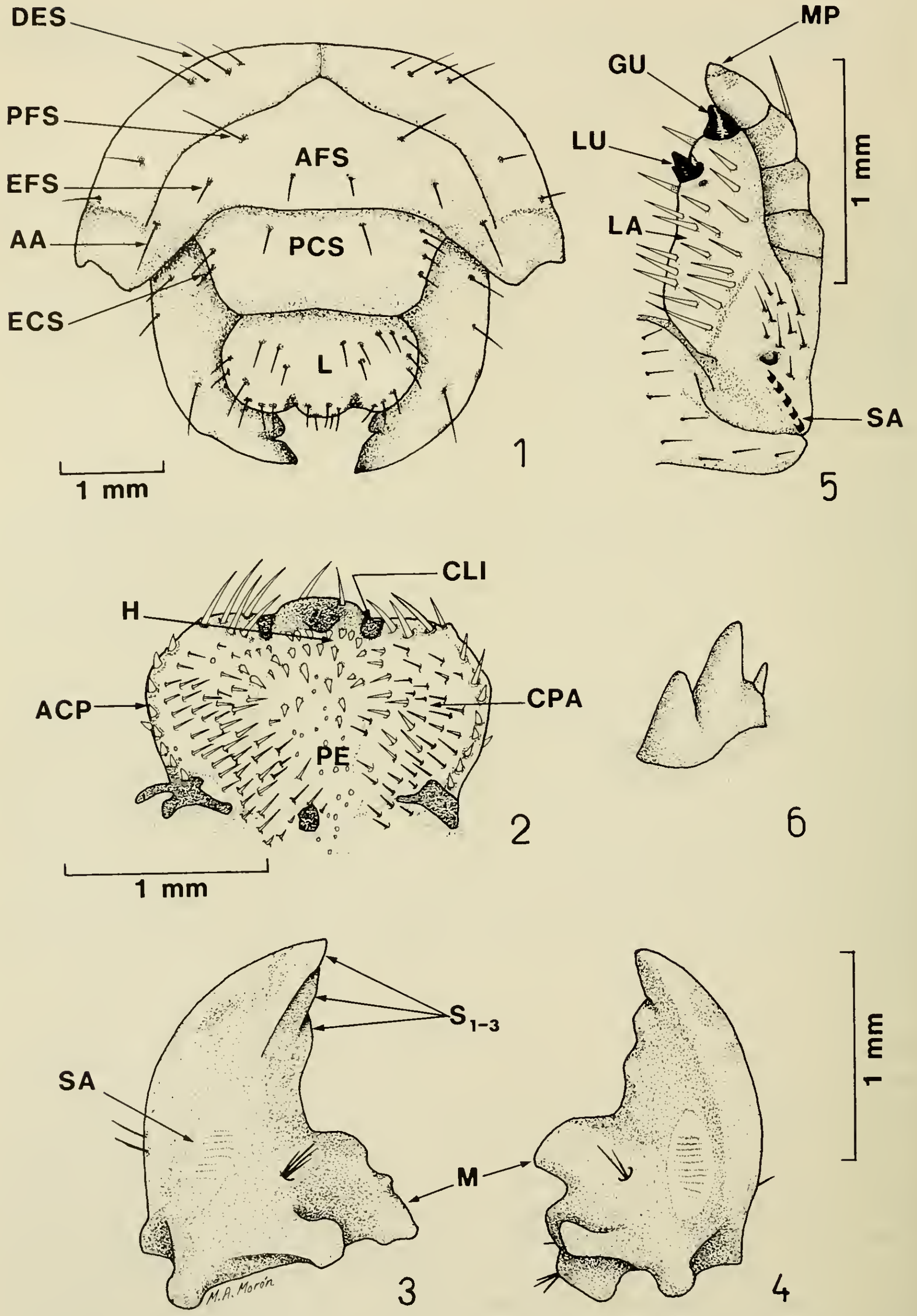
Figs. 1–13

Third instar larva.—This description is based on the following material: six third instar larvae, two cast skins of third instar larvae reared to the pupal stage, and seven cast skins of third instar larvae reared to the adult stage. All 15 larvae collected in MEXICO: State of Chiapas, Cacaohatán Municipality, Finca San José de la Victoria, 9-III-1982, M. A. Morón & R. Terrón, in rich organic soil under rotten log of *Bursera simaruba* (L.) Sarg. (coffee-cacao plantation surrounded by tropical rain forest, 430 m altitude).

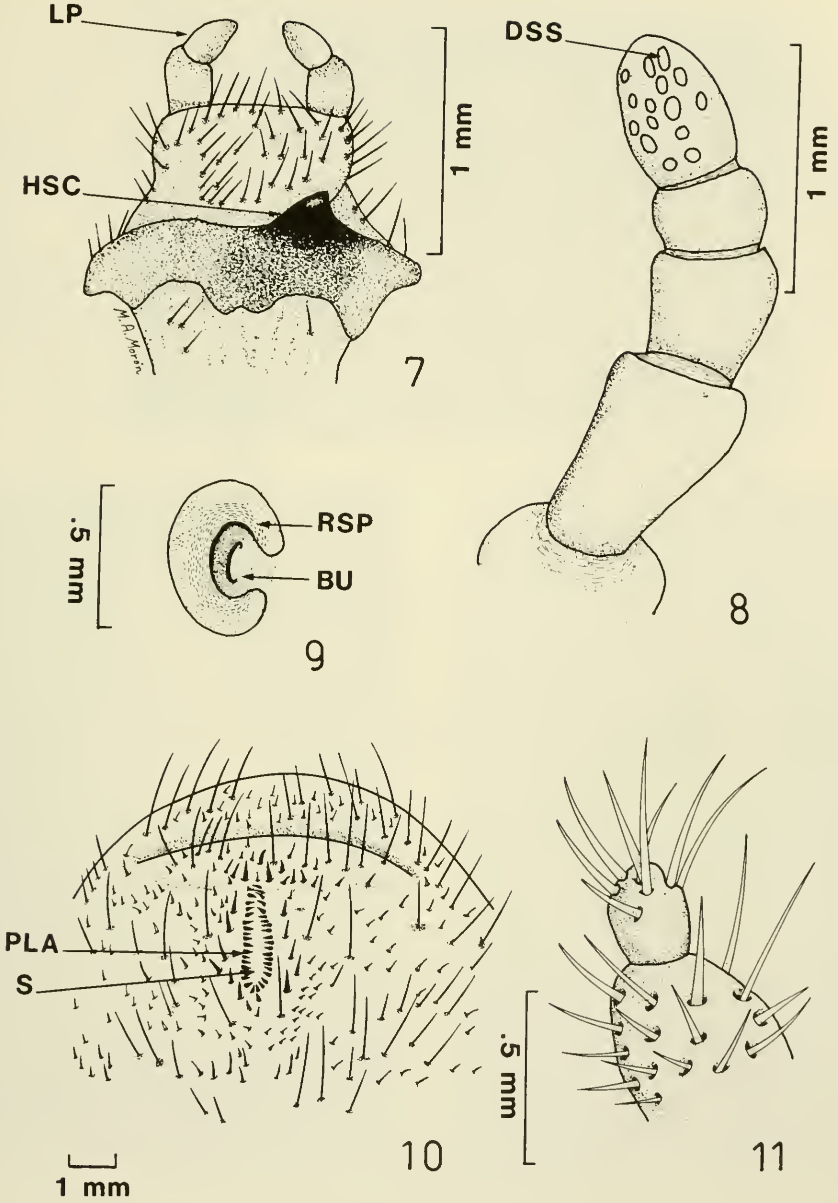
Head (Fig. 1): Maximum width of head capsule 4.0–4.3 mm. Surface of cranium smooth to slightly roughened, yellowish. Frons with one posterior frontal seta, one exterior frontal seta, one anterior frontal seta, and one anterior angle seta on each side. Dorsoepicranial seta consisting of 2 large and 1–4 small setae on each side. Clypeus with one posterior clypeal seta and 2–4 exterior clypeal setae on each side. Labrum (Fig. 2) trilobed, with 8–11 large setae on each side; clithra present. Haptomeral region of epipharynx with transverse row of 7–8 conical setae below haptomeral transverse process. Right chaetoparia with 15–18 large median setae and 30–36 slender external setae. Left chaetoparia with 12–15 large median setae and 21–25 slender external setae. Pedium with 8–12 sensilla and 4–7 conical setae. Left acanthoparia with 9–10 conical setae. Right acanthoparia with 8–9 conical setae. Acroparia with 5–7 long stout setae on each side. Each mandible (Figs. 3–4) with 3 scissorial teeth, bilobed molar areas well developed, and small oval stridulatory areas poorly marked by very fine ridges. Maxillary stridulatory area (Fig. 5) consisting of a row of 5 curved teeth with anteriorly projecting points and an anterior truncate process. Lacinia of maxilla (Fig. 6) with 2 terminal unci fused basally, dorsal uncus much larger, dorsobasal expansion with a conical seta that often appears as third uncus (Fig. 6). Galea with large, terminal uncus. Hypopharyngeal sclerome (Fig. 7) heavily sclerotized, with right process moderately developed. Last antennal segment (Fig. 8) with 10–15 dorsal sensory spots.

Thorax: Spiracles (Fig. 9) 0.51–0.56 mm long, 0.29–0.37 mm wide. Respiratory plate with maximum of 36 very small, externally irregular, internally slit-shaped "holes" along any diameter; holes not in definite rows. Distance between two lobes of respiratory plate slightly less than dorsoventral diameter of bulla.

Abdomen: Spiracles 1–8 similar in size. Dorsum of abdominal tergum 7 divided into 3 annulets; dorsum of tergum 8 with 2 annulets. Each annulet covered with short, stiff setae and fringed posteriorly with long setae. Segments 9–10 fused dorsally, covered with short, stiff setae and long setae mixed (fused tergum 9 with 2–3 transverse rows of long setae clearly defined). Venter of tenth abdominal segment (Fig. 10) posteriorly with paired palidia and tegilla. Each palidium with 23–26 stout, moderately long, somewhat compressed pali in a single, slightly irregular, longitudinal curved row. Pali separated from each other by space equal to or less than width of palus at its base. Septula elongated, occasionally open posteriorly, always closed anteriorly. Lower anal lip with 10–12 long setae.



Figs. 1–6. *Argyripa lansbergei.* 1, Frontal view of head of third instar larva (AA—anterior angle seta; AFS—anterior frontal seta; DES—dorsoepicranial seta; ECS—exterior clypeal setae; EFS—exterior frontal seta; L—labrum; PCS—posterior clypeal seta; PFS—posterior frontal seta). 2, Epipharynx (ACP—acanthoparia; CLI—clithrum; CPA—chaetoparia; H—haptomerum; PE—pedium). 3–4, Ventral aspect of right and left mandibles, respectively (M—molar lobes; SA—stridulatory area: S_{1-3}—scissorial teeth). 5, Dorsal aspect of right maxilla (GU—uncus of galea; LA—lacinia; LU—unci of lacinia; MP—maxillary palpus; SA—stridulatory area). 6, Unci of right lacinia, enlarged.

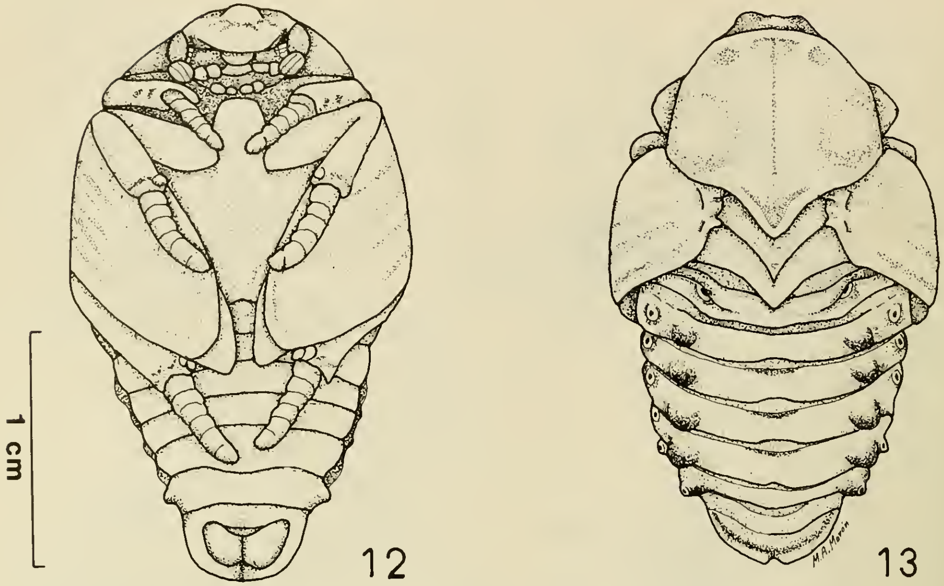


Figs. 7–11. *Argyripa lansbergei.* 7, Ventral view of labium and hypopharyngeal sclerome (HSC—hypopharyngeal sclerome; LP—labial palpus). 8, Right antenna, dorsal view (DSS—dorsal sensory spots). 9, Left thoracic spiracle (BU—bulla; RSP—respiratory plate). 10, Venter of tenth abdominal segment (PLA—palidia; S—septula). 11, Lateral view of claw of metathoracic leg.

Claws (Fig. 11) cylindrical, rounded apically, bearing 8–9 long setae.

Approximate body length: 23 to 39 mm.

Remarks.—The dorsum of abdominal segment seven with three annulets, the monostichous elliptical palidia combined with the 10–15 dorsal sensory spots on the last antennal segment, and the presence of a haptomeral transverse process



Figs. 12–13. *Argyripa lansbergei,* ventral and dorsal view, respectively, of pupa.

on the epipharynx will serve to separate *Argyripa* larvae from those of *Cotinis mutabilis* (G. & P.), *Cotinis nitida* (L.), *Gymnetina cretacea* (LeC.), and *Gymnetis flavomarginata sallei* Schaum.

Pupa.—The following description is based on one pupa and one advanced prepupa reared from third stage larvae collected in the same location and date cited in the larval description.

Length 18.0–23.6 mm. Shape subovate, stout, exarate. Color cream-white to yellowish; color becoming reddish as eclosion approaches. Head glabrous, bent downward, mouthparts directed downward. Eyes, antennae, mandibles, and palps clearly discernible; clypeus large, apex broadly rounded. Surface of frons with slight depressions, slightly swollen at vertex.

Pronotum glabrous, subheptagonal in shape, widest posteriorly, basal margin distinctly bisinuated, center base projecting posteriorly as in adult. Pronotal disc slightly convex, much swollen at basal angles, weakly depressed at anterior angles. A narrow, median, longitudinal sulcus extending from apex to near base. Meso- and metascutella acute, projecting posteriorly. Mesosternal process clearly discernible. Elytra closely appressed, curved ventrally around body, extending posteriorly to third abdominal segment, surface with 4 longitudinal sulci.

Abdominal spiracles clearly exposed, last pair situated on rounded tubercles. Each abdominal tergum at side with a distinct, rounded tubercle, most developed on visible terga 3–6.

Legs glabrous. Fore- and mesofemora extend at approximately 70°–90° from longitudinal axis of body; metafemora covered by elytra and wings. Tarsomeres and pretarsus distinct.

Remarks.—The pupa is remarkable because of the presence of pronotal swellings and dorsolateral tubercles on the abdominal segments. The abdominal tubercles

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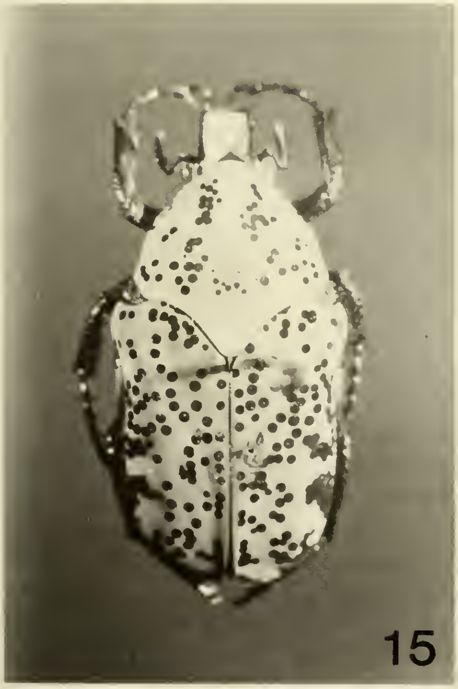

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Figs. 14–16. 14, *Argyripa lansbergei*, adult female emerging from pupal cell. 15, *Argyripa lansbergei*, adult male from Chiapas, Mexico. 16, *Argyripa anomala*, adult male from Oaxaca, Mexico.

are particularly interesting because they have not been previously reported in New World Gymnetini. The swellings and/or tubercles may serve to support the pupa within the pupal chamber as has been noted for some *Onthophagus, Copris, Liatongus*, and *Coprophanaeus* (Edmonds and Halffter, 1978), *Termitodius araujoi* Reyes-Castillo and Martínez (Reyes-Castillo and Martínez, 1979), and *Trichillum adisi* Ratcliffe (Ratcliffe, 1980).

Fig. 17. Distribution of the species of *Argyripa.*

New Distribution Records and Biogeographical Notes

The revised and expanded distribution for the species of *Argyripa* is shown in Fig. 17. This pattern of distribution is characteristic of Halffter's (1976) "typical Neotropical dispersal pattern" wherein South American taxa have recently (post-Pliocene, less than 5.7 million years before the present) penetrated into the Mexican Transition Zone via Central America. Dispersal northward by tropical taxa into Mexico has been limited largely, though not exclusively, to areas of humid forests (100–2000 meters in elevation) south of the Transverse Volcanic System (approx. 18–19°N latitude) and in the coastal plains of both Mexican coastlines. Rain forests of tropical Mexico contain a low percentage of endemic taxa, and the majority of these are of Central American origin (Rzedowsky, 1962 in Toledo (1982)).

Argyripa lansbergei (Sallé)

Argyripa lansbergei was previously known only from Colombia and Ecuador (Ratcliffe, 1978). It is here reported from Mexico for the first time. These new records are: "MEXICO: Chiapas, Cacaohatán, Finca San José de la Victoria, III-9-1982, M. Morón & R. Terrón." Fifteen specimens in the collections of Miguel Morón, Brett C. Ratcliffe, and the Museo de Historia Natural de la Ciudad de México. "MEXICO: Chiapas, Hidalgo San Antonio." One specimen in the collections of the Museum für Naturkunde, Berlin.

The Mexican occurrence of *Argyripa lansbergei* places this species in Mesoamerica and represents a considerable disjunction in range from its previously known occurrence in NW South America. This discovery is even more surprising when one considers that much of Central America has been intensively, albeit selectively, collected over the past half century. We believe that, in view of the current data, it is not unreasonable to expect new records for this taxon in other areas of Central America where suitable habitat still exists. Alternatively, the Chiapas specimens may be indicative of a relictual distribution resulting from Pleistocene forest refugia in Mexico. Toledo (1982) has found two such presumed refugia in Chiapas based on phytogeographic evidence. Further data are needed to corroborate such a hypothesis.

***Argyripa anomala* (Bates)**

This species is known from Panama, Costa Rica, and Nicaragua (Ratcliffe, 1978). We report its occurrence in Mexico: "MEXICO: Veracruz, Santiago Tuxtla, Cerro El Vigía, IX-17-1982, 400 m, L. González-Cota." One specimen in the collection of B. Ratcliffe. "MEXICO: Oaxaca, Chiltepec, El Naranjal, VI-21-1982, 105 m, L. González-Cota." One specimen in the collection of M. Morón. "MEXICO: Chiapas, Tumbala." One specimen in the collections of the Museum für Naturkunde, Berlin. "MEXICO: Chiapas, Ocosingo, VII–IX-1947, 1200 m, M. del Toro." One specimen in the collection of Antonio Martínez.

As with *A. lansbergei,* the Mexican records represent a large range expansion for this species. It seems likely that *A. anomala* may also occur in suitable areas of Central America between Mexico and Nicaragua.

***Argyripa gloriosa* Ratcliffe**

Argyripa gloriosa was described from Colombia. We record it from Ecuador for the first time. Two specimens, lacking any further data than "Ecuador," are in the Francisco Campos collection in the Museum of Natural History, Quito, and in the Phillip Marshall collection in Cave Creek, Arizona. This species remains tantalizingly obscure. Only four specimens are known (despite its vivid metallic coloration), and all of these are females. The male is yet to be described.

Key to the Known Third Stage Larvae of New World Gymnetini

(Adapted from Ritcher, 1966 and Monné, 1969)

1\. Palidia present 2
– Palidia absent .... *Gymnetina cretacea* (LeC.)
2\. Raster with each palidium consisting of 2 or more irregular rows of pali. Last antennal segment with 3–7 dorsal sensory spots. Haptomeral process absent .... *Cotinis* 3
– Palidia monostichous. Other characters not as above 4
3\. Raster with inner row of each palidium set with pali only slightly larger than those in outer row .... *C. nitida* (L.)
– Raster with inner row of each palidium having 7–10 pali much stouter and larger than other pali .... *C. mutabilis* (G. & P.)
4\. Dorsum of abdominal segment 7 with 2 annulets. Haptomeral process absent. Last antennal segment with 2–6 dorsal sensory spots 5

– Dorsum of abdominal segment 7 with 3 annulets. Transverse haptomeral process present. Last antennal segment with 10–15 dorsal sensory spots . . . . *Argyripa lansbergei* (Sallé)

5. Maxillary stridulatory area with a row of 3–5 teeth. Claws bearing 10–12 setae . . . . *Gymnetis flavomarginata sallei* Schaum

– Maxillary stridulatory area with 6 or more teeth. Claws with less than 10 setae 6

6. Maxillary stridulatory area with a row of 7 teeth. Claws bearing 6–7 setae . . . . *Blaesia atra* Burm.

– Maxillary stridulatory area with a row of 9 teeth. Claws bearing 5–6 setae . . . . *Marmarina tigrina* (G. & P.)

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A NEW SPECIES OF *NEODAVISIA* BARNES AND McDUNNOUGH (LEPIDOPTERA: PYRALIDAE) FROM SOUTHERN TEXAS

Douglas C. Ferguson, André Blanchard, and Edward C. Knudson

(DCF) Systematic Entomology Laboratory, IIBIII, USDA, % U.S. National Museum of Natural History, Washington, D.C. 20560; (AB) 3023 Underwood, Houston, Texas 77025; (ECK) 808 Woodstock, Bellaire, Texas 77401.

Abstract.—A new species of pyralid moth from southern Texas is assigned to the subfamily Pyralinae, tribe Endotrichini, and described as *Neodavisia* ***melusina.*** It is the second known species of this genus. The adult, genitalia, and wing venation are illustrated.

This new pyralid is described from specimens collected by the two junior authors in extreme south Texas and from additional examples collected by Dr. James E. Gillaspy at Kingsville, Texas. Its assignment to the correct subfamily, tribe, and genus presented problems because it belongs to a group that is poorly represented and poorly known in the Western Hemisphere. The distinctive hindwing venation and typically pyraline male genitalia show that it belongs somewhere in the Pyralinae. The presence of chaetosemata, even if poorly developed, the obsolescence of Rs where it closely approximates Sc in the basal half of the hindwing, and well-developed maxillary palpi preclude association with the Chrysauginae, which are the next most closely related subfamily. The male genitalia hardly differ from those of *Pyralis* L., *Herculia* Walker, and *Aglossa* Latreille, except that these genera of the tribe Pyralini always seem to have a single large cornutus in the vesica. With some reservation, we assign the new species to the tribe Endotrichini.

The Endotrichini are characterized by a well-developed tongue, the presence of maxillary palpi and chaetosemata, forewing venation with R_5 stalked with R_4 and R_3, and hindwing venation with Rs anastomosing with Sc + R (Whalley, 1961: 733), a combination with which this species seems to agree fairly well. However, R_4 of the forewing is lost, or rather fully united with R_3 so that the radius is 4-branched, unlike the 5-branched radius of most other Endotrichini. Also, Rs of the hindwing appears to be free but largely obsolescent, rather than anastomosed with Sc where they are closely parallel.

The two described American genera to which the new species is most closely related are *Neodavisia* Barnes and McDunnough (1914: 31) and *Taboga* Dyar (1914: 321), both of which are monotypic. The male genitalia of all are so alike that on that basis the three species might be regarded as congeneric. *Neodavisia singularis* (Barnes and McDunnough, 1913: 179, fig. 5) has a normal, 5-branched radius. *Taboga inis* Dyar (1914: 321) has a 4-branched radius, but a very different hindwing venation in which R and Sc meet and coalesce for a short distance beyond the cell (as in the Pyralini). The chaetosema is small but clearly apparent

Figs. 1–2. *Neodavisia melusina.* 1, Holotype male, Roma, Starr Co., Texas, 4-IV-78, A. & M. E. Blanchard. 2, Male genitalia of holotype, slide A. B. 4667, USNM slide 56,612. Line in Fig. 2 represents 1 mm.

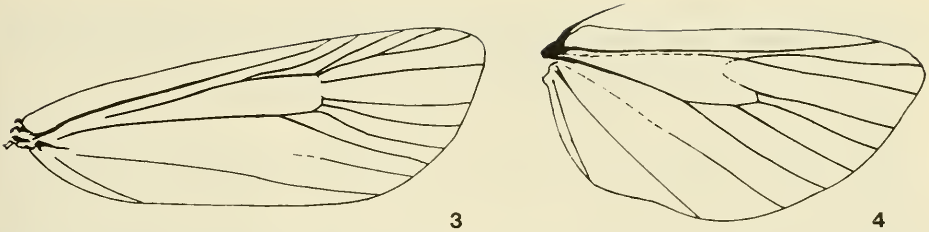
in *Taboga inis* and *Neodavisia singularis* and has about 18 bristles. That of the new species appears to be further reduced, having no more than 7–8 bristles. The new species has one unique feature that we have not seen elsewhere. The antennae of both sexes, in addition to being scaled above and ciliate beneath in the usual way, have conspicuous transverse bands of scales on the ciliate surfaces between the segments, repeated intersegmentally for most of the antennal length. These scales appear to be attached at the distal margin of each antennal segment and to overlap the base of the next segment.

Rather than propose a new genus based on differences of uncertain significance, we think it best for the present to assign the new species to what seems the most appropriate existing genus. Despite the curious antennae and union of R_3 and R_4, it fits best in *Neodavisia.* The pattern and color are similar except for the presence of an angled, whitish antemedial band that is lacking in *N. singularis,* and a more outwardly convex postmedial band. *Taboga inis* is more gray than reddish brown, has less regular bands, and a less acute forewing. *Parachmidia fervidalis* (Walker), from the island of Hispaniola, is possibly in this group, but according to Hampson's description of the genus (1896: 495), its venation is different. No other closely related New World species have been described, but the collection of the U.S. National Museum contains old material of at least two undescribed neotropical species that may be related. The few Endotrichini that occur in the Western Hemisphere and those Pyralini that resemble them need proper revision, based on adequate material, but these moths are very rare in collections. For example, *N. singularis* was described from Florida in 1913 but is still known from no more than 10 specimens, as far as we are aware.

Neodavisia melusina Ferguson, Blanchard, & Knudson, New Species

Figs. 1–4

Head.—Front flat, smooth scaled, reddish brown. Vertex reddish brown, rough scaled with median dorsal crest or tuft of scales. Labial palpi exceeding front by 1 eye diameter, 2nd segment 1½ times length of 3rd segment, with short ventral brush. Both 2nd and 3rd segments ochreous with brownish scales laterally. First



Figs. 3–4. *Neodavisia melusina*. 3, Forewing venation of paratype, slide ECK 791 (drawing by Blanchard), Santa Ana Natl. Wildlife Refuge, Hidalgo Co., Texas, 5-IV-80, E. C. Knudson. 4, Hindwing venation of paratype, same specimen and data as for Fig. 3.

segment whitish. Maxillary palpi filiform, exceeding front by ½ eye diameter, ochreous brown. Tongue well developed. Small chaetosemata present. Antennae with basal tuft of ochreous and reddish-brown scales; shaft compressed, scaled above and finely ciliate beneath, with unusual bands of scales intersegmentally on ciliate surfaces as discussed above. Collar whitish.

Thorax.—Brownish, clothed with ochreous scales having dark-brown apices.

Abdomen.—Ochreous brown dorsally with segments 3 and 4 darker. Laterally, segments 2, 3, and 4 are dark brown with row of white scales on posterior margins. Segments 5, 6, and 7 orange brown with white posterior margins. Terminal tuft pale orange.

Wings.—Forewing smooth scaled. Most conspicuous feature is a nearly straight, oblique line just before middle of wing, running from inner margin at ⅓ distance from base to near middle of costa, and sharply dividing median space into darker brown proximal part and light-brown distal part. Forewing also with thin, white, well-defined antemedial and postmedial bands, the former acutely angled at 1st anal fold, the latter deflected outwardly opposite discal cell in a rounded convexity that almost reaches outer margin. Basal area buff to orange brown except for a few scattered dark scales and a dark-brown area between radial stem and costa, separated from paler basal area by thin, longitudinal whitish bar on radial stem; thin, whitish, basal band present but only near costa. Median space traversed by oblique, dark-brown/pale-brown interface mentioned above and marked by a small, double, dark discal spot halfway between interface and postmedial band; also shaded with dusky to reddish-brown scaling that intensifies distally toward postmedial band, beyond which wing is variably shaded with dark-brown to reddish-brown scales. First anal fold from base to apex marked by a vague, diffuse, pale orange-brown streak. Terminal line represented by an incomplete band of dark-brown scales. Hindwing a nearly uniform dusky brown except for traces of a diffuse, whitish postmedial band near and parallel to outer margin and, in female, a dash of orange in 1st anal fold just before postmedial band. Fringes of both wings light yellowish to gray brown or whitish. Underside dusky brown, faintly flushed at costa of both wings with buff in male, more extensively with red in female, and unmarked except for traces of pale postmedial bands.

Venation (Figs. 3–4).—Forewing with 4 radial veins. Sc free; R_2 from before anterior outer angle of cell; $R_3 + R_4$ completely fused; R_5 stalked with $R_3 + R_4$ for half its length; 1st A absent. Hindwing with Sc free from base; Rs in basal half of hindwing apparently not fused with Sc but obsolescent; Rs and M_1 diverging from common point at anterior outer angle of cell; M_2 and M_3 arising separately from outer end of cell.

Length of forewing.—Males (N = 5): 4.8–5.6 mm; average, 5.1 mm. Female (N = 1): 5.8 mm.

Male genitalia (Fig. 2).—These differ from male genitalia of *N. singularis* in having shorter uncus, shorter process on gnathos, and much shorter aedeagus, which is decidedly shorter than distance from end of saccus to tip of uncus; aedeagus with numerous small cornuti near distal end; valve tapered to rounded end. In *N. singularis,* aedeagus is long and slender, at least as long as distance from end of saccus to tip of uncus, lacks the cornuti, and valve is not tapered, being about as wide toward end as near base. *Taboga inis* differs from both in having an expanded uncus, slightly constricted near its base, and a short but slender aedeagus (without cornuti). Its valve is tapered like that of *melusina.*

Female genitalia.—Papillae anales narrow, well separated, lightly setose; posterior apophyses slightly shorter than anterior apophyses; ostium bursae elongate, tubular, sclerotized; bursa copulatrix membranous, without signum.

Types.—Holotype ♂ (Figs. 1, 2), Roma, Starr County, Texas, 4 April 1978, A. & M. E. Blanchard, genitalia slide AB 4667. Paratypes: 1 ♂, Santa Ana National Wildlife Refuge, Hidalgo County, Texas, 5 April 1980, E. Knudson; 1 ♂, Kingsville, Kleberg County, Texas, 9 September 1976, J. E. Gillaspy; 1 ♂, same locality and collector, 4 July 1980, genitalia slide ECK 809; 1 ♂, same locality and collector, 13 June 1980; 1 ♀, same locality and collector, 18 June 1978, genitalia slide ECK 807. Holotype in collection of U.S. National Museum of Natural History; paratypes retained by collectors.

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OVIPOSITION AND EGGS OF AN AUSTRALIAN ROBBER FLY, *NEOARATUS ABLUDO* DANIELS (DIPTERA: ASILIDAE)[1]

FRED A. LAWSON AND ROBERT J. LAVIGNE

Entomology Section, University of Wyoming, Box 3354, University Station, Laramie, Wyoming 82071.

Abstract.—The Australian robber fly, *Neoaratus abludo* Daniels, deposited eggs within or on the glumes of shattered seed heads of wild wheat, *Avena barbata.* Oviposition occurred mostly between 1100–1200 h, at temperatures from 23.5° to 30°C (mean 27.3°C). The mean length of 157 eggs was 1.19 mm; the mean width, 0.39 mm. SEM photos of eggs reveal a finely, densely striate surface over a slightly elevated, coarsely reticulated network of sculpturing. Small, rounded to elongate oval bodies cover much of the surface but are intermixed with larger, dome-like projections which have sloping sides, striated basal and lateral areas, smooth apical surface, and rounded to slit-like openings in each. Sperm tails are present in the micropyle of some eggs.

The Australian robber fly, *Neoaratus abludo* Daniels, oviposited in shattered seed heads of wild wheat, *Avena barbata,* at a site near Aldinga, South Australia; one to nine eggs per head (mean 3.5) were deposited per seed head. Most eggs were laid singly, usually in rows, on the surface of, or within, empty glumes. Some were cemented directly to the stalk. One female, observed for a period of ca. 15 minutes, deposited 28 eggs on or within seven shattered seed heads. She visited an additional three seed heads without depositing eggs. Another female probed the flower heads of catsear, *Hypochoeris radieata,* but no eggs were recovered. Some *N. abludo* females grasped the pedicel at the base of the seed head, faced down the stem, and curled the ovipositor so that eggs were placed near the base. One female grasped a glume near the middle and took a crosswise position while ovipositing.

Daniels (1983) reported that a female *N. abludo* (at Cudal, N.S.W.) deposited one egg on a seed head of wheat at 9:00 A.M.; other plants had as many as 5 eggs, including some on the stem.

Oviposition records for other *Neoaratus* spp. are scarce. Hardy (1927) discovered a female *N. inglorius* (Macleay) placing eggs in parallel rows on a leaf of a garden shrub at Edgecliff, Sydney; larvae emerged seven days later and dropped to the ground. In the same city, eggs deposited by a female *N. hercules* (Wiedemann) in an inverted glass tumbler hatched after six days (Irwin-Smith, 1923).

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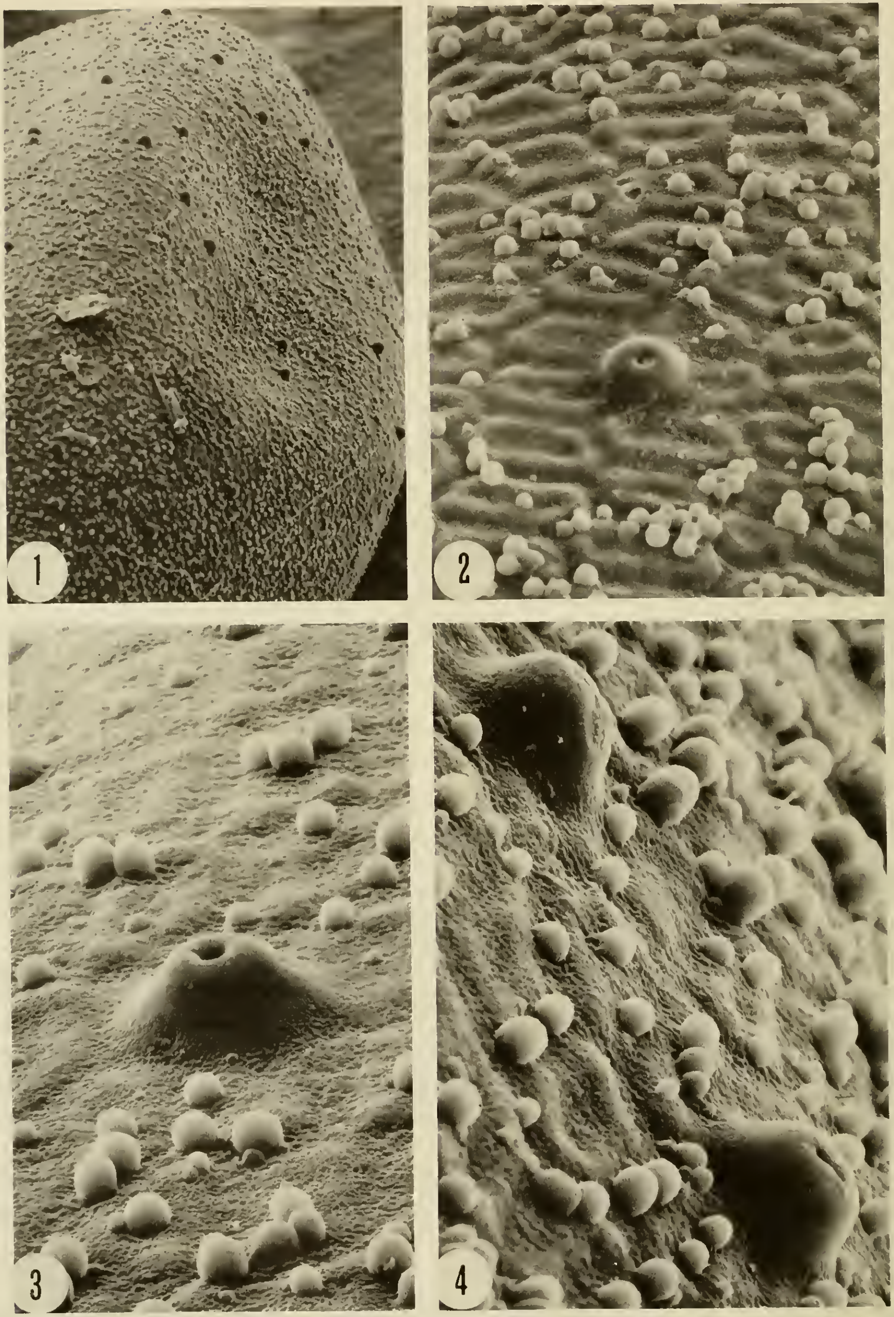
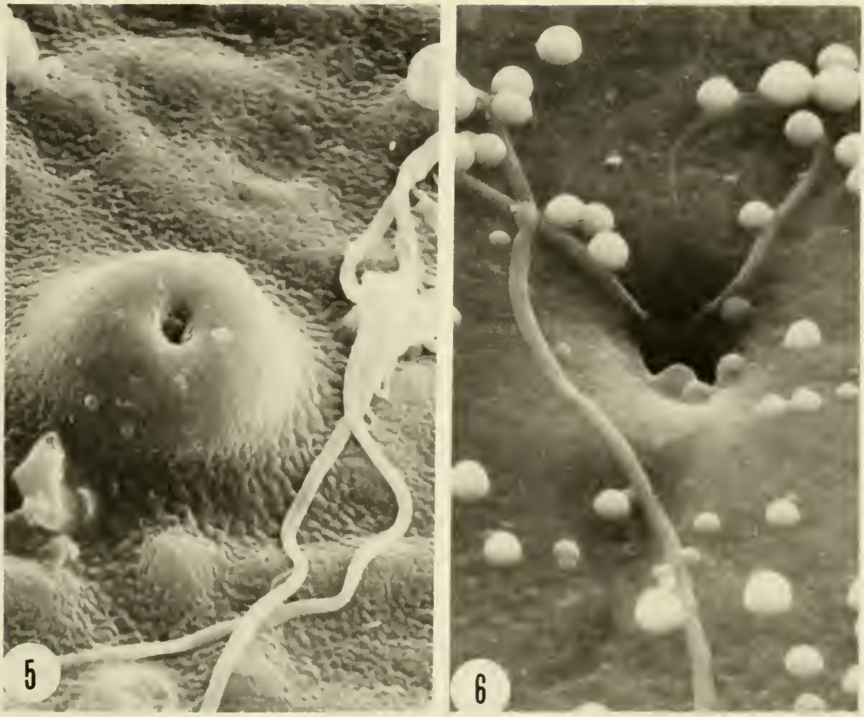


Figs. 1–4. Eggs of *Neoaratus abludo* Daniels (SEM). 1, General view, one end, ×200. 2, Surface; elevated bodies and reticulated sculpturing, ×1000. 3, Elevated bodies and striated surface, ×2000. 4, Elevated bodies and striated surface, ×2000.



Figs. 5–6. Eggs of *Neoaratus abludo* Daniels (SEM). 5, Surface: striations, elevated bodies, sperm tails, ×4000. 6, Micropyle and sperm tails, ×4000.

The light cream colored eggs, which changed to yellowish brown, and the first instar larvae were described.

Oviposition by *N. abludo* was observed between 0930 and 1310 h, with 42% occurring between 1100–1200 h. Time of oviposition varied with temperature; on days with heavy overcast or light rain, oviposition occurred at a later time. Temperatures at oviposition levels (45–76 cm) ranged from 23.5° C to 30° C (mean 27.3° C) when eggs were deposited.

Out of 157 eggs collected, 35 (22%) were placed inside glumes, 4 on the pedicel, and 118 (75%) on the ribbed outside surface of the glumes. These eggs were light brown when deposited. The lengths of the 157 eggs ranged from 0.90 mm to 1.25 mm (mean 1.19 mm); the widths, 0.38 mm to 0.40 mm (mean 0.39 mm).

Eggs for the SEM were soaked briefly in liquid detergent, washed, sonicated in water, and dehydrated. They were mounted on specimen stubs with silver paint, vacuum coated once with carbon and twice with gold, and examined in a JEOL SM35C.

The eggs of *N. abludo* had the outer surface (Fig. 1) densely set with very small, rounded projections and scattered larger bodies irregularly distributed within a coarsely reticulated sculpturing of low ridges (Fig. 2). The ultimate external surface of the egg shell (Figs. 3, 4) is minutely, finely striate.

The smaller of the surface projections (Figs. 2–4) appear solid; they are firmly attached, round to elongate oval structures with smoothly curved apices. The scattered larger projections (Figs. 1–5) are rounded on top, have gently to steeply sloping sides, and are widened at the base. The apical area is smooth, but the sides, to a varying degree upward, have fine striations continuous with those of the flatter surfaces of the egg (Figs. 3–5). The top of each of these dome-like elevations has a single, median, rounded to slit-like opening which may lead to a hollow interior (Figs. 2–5). These medium, rounded openings are similar in appearance to those in SEM photos of *Machimus fimbratus* (Meigen) eggs (Musso, 1981) although the surface reticulation is considerably different.

Some of these eggs were evidently deposited (and collected) soon after they were fertilized (Figs. 5, 6). A micropyle opening is pictured in Fig. 6, with two sperm tails extending from the interior of the egg. Tangled sperm tails are present also on the egg in Fig. 5.

ACKNOWLEDGMENTS

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RECONSTITUTION OF THE DIAPERINI OF NORTH AMERICA, WITH NEW SPECIES OF *ADELINA* AND *SITOPHAGUS* (COLEOPTERA: TENEBRIONIDAE)

JOHN T. DOYEN

University of California, Berkeley, California 94720.

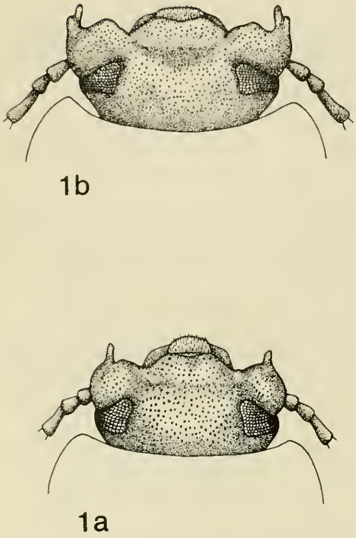
Abstract.—The tenebrionid tribe Diaperini is redefined on the basis of larval and adult features, and the tribe is reconstituted for North America. A key to genera is provided. *Adelina* ***latiramosa*** and *Sitophagus* ***alveolatus*** are newly described and a key is provided for the North and Central American species of *Sitophagus.*

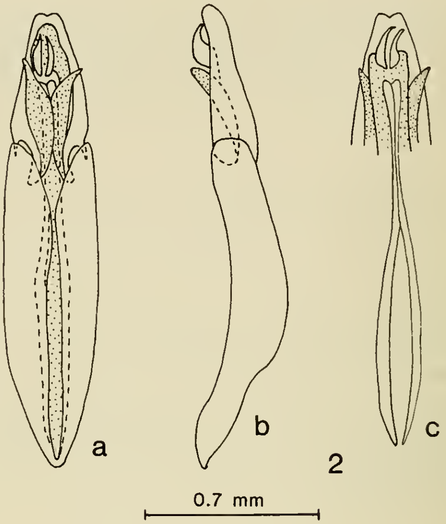
Adelina Dejean (= *Doliema* Pascoe; Spilman, 1973) and *Sitophagus* Mulsant are closely related genera presently included in the tenebrionid tribe Ulomini. *Adelina* has been recently revised by Ardoin (1977), but several new species, including one described here, occur in the New World Tropics. *Sitophagus* has never been revised and includes an undescribed North American species. Despite their superficial similarity to *Tribolium* and other members of Ulomini, *Adelina* and *Sitophagus* are similar in all important taxonomic features to Diaperini (Tschinkel and Doyen, 1980; Doyen and Tschinkel, 1982). The purposes of the present report, aside from proposing names for the new species, are to clarify the relationships of *Adelina* and *Sitophagus* and to reorganize the tribe Diaperini to reflect the results of recent morphological and phylogenetic analyses.

Adelina latiramosa, NEW SPECIES
Figs. 1–2

Male.—Strongly flattened, elongate oval, medium brown. Cranium (Fig. 1) dorsally with punctures much smaller than eye facets, separated by about 1–2 puncture diameters; epistomal suture strong, impressed medially, dark with depressed lateral extremities reaching clypeal margin; clypeus prominent, truncate or weakly indented in middle; genae expanded as foliaceus processes extending anterolaterad of eyes and terminating as slender, downcurved horns (Fig. 1a), bifid in large individuals (Fig. 1b). Antennae subfiliform, with segments longer than broad; segment length ratios as follows: 2.0:1.0:1.9:1.5:1.6:1.6:1.7:1.7:1.8: 1.6:1.9. Eyes strongly emarginated by genal canthus; ventral lobe about twice size of dorsal. Mentum subquadrate, broader than long, with slender, sharply pointed projection in middle. Gular sutures confluent anteriorly.

Pronotal disk sculptured as cranium, finely margined except anteromedially, basal and apical widths subequal; anterior angles rounded, basal angles barely acute; posterior margin weakly, concavely bisinuate; hypomeron with punctation slightly denser, coarser; prosternal process nearly twice as broad behind as between coxae, sides nearly straight, apex broadly rounded.





Figs. 1–2. *Adelina latiramosa.* 1a, Dorsal aspect of head, small male; 1b, dorsal aspect of head, large male. 2, Aedeagus, a, ventral; b, lateral; c, detail of median lobe.

Elytral disk very weakly convex, 8th interstria angulate, with lateral portion subvertical; strial punctures subequal to eye facets in diameter, regularly separated by about one puncture diameter; interstriae very finely, moderately densely punctate. Mesosternum shallowly but distinctly concave; metasternum set with punctures nearly as large as eye facets, these becoming slightly larger and denser on metepisternum, abdominal sternites finely punctatorugulose. Femora strongly clavate, flattened; protibiae with dorsal margins bearing row of closely set, short, blunt spines; outer tibial spurs much larger, stouter than inner; meso- and metatibiae with dorsal edges bearing fine, irregular, crenulate ridge; inner spurs slightly larger than outer.

Aedeagus as in Fig. 2, with clavae fleshy, penis with sclerotized rods converging anteriorly, apex fleshy with paired, dorsally directed laciniae.

Elytral length, 3.9–4.5 mm; greatest elytral width, 2.4–2.6 mm; median pronotal length, 1.1–1.3 mm; greatest pronotal width 2.1–2.4 mm.

Female.—Unknown.

Holotype ♂ (California Academy of Sciences) and 2 paratypes from Mexico, Puebla, 45 mi. N Acatlan, July 30, 1963, J. T. Doyen.

Adelina latiramosa is similar to *A. bifurca* (Champion) in the shape of the genal projections. It differs from *bifurca* and all other described species in its strongly projecting, truncate clypeus (Fig. 1). It has the 8th elytral interstria angulate (carinate in *bifurca*).

The following modification in Ardoin's key (1977: 15) will accommodate *latiramosa.*

3. Elytral disk completely flat, the transition to the marginal, subvertical part marked throughout its length by a sharp carina. Fossae at the base of the pronotum large and deep 4

– Elytral disk slightly convex, the transition to the marginal subvertical part rounded, with a feeble carina apparent only behind the humerus. Fossae at the base of the pronotum reduced 3a

3a. Anterior margin of head bearing a pair of arcuate, anterodorsally directed horns arising just lateral to the clypeus; clypeus rounded .... *angustata* Champion

– Anterior margin of head expanded anterolaterally before the eyes as horizontal, foliaceous processes; clypeus truncate or medially indented. .... *latiramosa* new species

***Sitophagus alveolatus*, New Species**

Figs. 3–4

Male.—Moderately flattened, elongate oval, medium to dark brown. Cranium (Fig. 3) dorsally with punctures about half eye facet diameter, separated by about one puncture diameter on frons, slightly sparser on clypeus; epistomal suture distinct, lateral arms meeting medial portion at nearly right angles; clypeus deeply, broadly emarginate medially, prominent laterally, subhorizontal and curved slightly inward; labroclypeal membrane broadly exposed. Antennae filiform at base, becoming serrate apically, with segments 7–10 about as broad as long; antennal length ratios as follows: 1.6:0.7:1.9:1.2:1.2:1.2:1.2:1.2:1.0:0.9:1.1. Eyes strongly emarginated by epistomal canthus; ventral lobe slightly larger than dorsal. Mentum trapezoidal, broader than long, convex with strong tumescence just behind anterior border bearing minute apical pore. Gular sutures confluent anteriorly.

Pronotal disk more finely, sparsely punctate than cranium, finely margined except anteromedially; apical width distinctly less than basal; lateral margins arcuate, more strongly so in anterior half; anterior angles rounded; posterior angles very narrowly rounded, barely obtuse; posterior margin distinctly bisinuate. Hypomeron and sternum finely punctatorugulose; prosternal process slightly wider behind than between coxae, declivous, rounded apically.

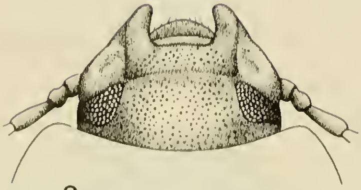
Elytral disk weakly convex, lateral margins evenly rounded; strial punctures slightly larger than eye facets, separated by about one puncture diameter; interstriae weakly convex, finely, sparsely punctate. Mesosternum moderately concave medially; metasternum with punctures as large as eye facets, separated by 1–2 puncture diameters, becoming nearly confluent on metepimeron; abdominal sternites anteriorly with punctures about as large as eye facets, separated by about one puncture diameter, becoming finer, sparser near posterior margin, and on 5th sternite. Femora strongly clavate, slightly flattened; protibiae bearing fine, crenulate ridge on dorsal face; tibial spurs subequal on all legs.

Aedeagus as in Fig. 4, with clavae fleshy with few extremely fine setae; penis with subparallel, sclerotized rods slightly downcurved at apex.

Elytral length, 4.3–4.8 mm; greatest elytral width, 2.3–2.6 mm; median pronotal length, 1.2–1.4 mm; greatest pronotal width, 2.1–2.3 mm.

Female.—Clypeus not produced laterally, moderately and narrowly emarginate medially, barely exposing labroclypeal membrane; mentum simply convex without anterior tumescence. Elytral length, 4.4–4.6 mm; greatest elytral width, 2.5–2.6 mm; pronotal length, 1.2–1.3 mm; greatest pronotal width, 1.9–2.2 mm.

Holotype ♂ (California Academy of Sciences) from Arizona, Cochise County, Rustler Park, Chiricahua Mountains, 8–9000 ft., July 27, 1927. Van Dyke Col-



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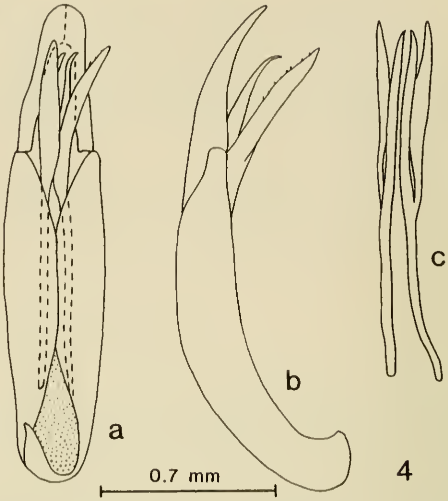

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Figs. 3–4. *Sitophagus alveolatus*. 3, Dorsal aspect of head of male. 4, Aedeagus; a, ventral; b, lateral; c, detail of median lobe.

lection. Paratypes as follows: Arizona, Rose Canyon, V-5-1963 (1 ♀); Cochise County, Chiricahua Mountains, 8500 ft., V-4-1969 (2 ♂♂); 6200 ft., VI-20-1928, A. A. Nichol (1 ♀); IX-14-1938, D. J. & J. N. Knull (1 ♂); 8000 ft., X-6-1974, K. Stephan (1 ♀); Huachuca Mountains, 9000 ft., VII-1929, H. H. Wenzel (1 ♀). Graham County, Graham Mountains, V-18-1969, K. Stephan (2 ♂♂); Navajo County, Springerville, IX-15-1972, K. Stephan (1 ♂, 1 ♀). Pima County, Rincon Mountains, IV-11-1976, K. Stephan (2 ♂♂); Santa Catalina Mountains, VII-1936, E. Ross (1 ♂); VII-1938, Bryant (3 ♂♂, 2 ♀♀); 7000 ft., XI-9-1974, K. Stephan (1 ♂); 8500 ft., IV-12-1969 (1 ♀); 7000 ft., IV-5-1967 (1 ♀); Mt. Lemon, IV-25-1970, K. Stephan (2 ♂♂).

Sitophagus alveolatus is similar to *fuliginosus* Champion in having the clypeus broadly, truncately emarginate. It differs in the subhorizontal clypeal processes, with the antennal orbits nearly flat (processes upturned, orbits raised in *fuliginosus*).

KEY TO ADULT *SITOPHAGUS* OF NORTH AND CENTRAL AMERICA

1. Head convex between eyes 2
– Head excavated between eyes (Fig. 5) . . . . *dilatifrons* Champion
2(1). Clypeus truncate between lateral projections (Fig. 3) 3
– Clypeus convex between lateral projections (Fig. 6) . . . . *hololeptoides* Laporte
3(2). Antennal orbits swollen, upturned; lateral clypeal projections upcurved; body shining black . . . . *fuliginosus* Champion
– Antennal orbits nearly flat; lateral clypeal projections subhorizontal; body medium to dark brown . . . . *alveolatus* new species.

TAXONOMIC POSITION OF *ADELINA* AND *SITOPHAGUS*

Adults of *Adelina* and *Sitophagus* are strikingly modified for living beneath tightly adherent bark of dead trees. The broad body is strongly flattened, often with a distinct, subvertical epipleuron defined by a fine carina just medial to the 8th stria. The antennae are unusually long for Tenebrionidae, reaching well beyond the pronotal base in most *Adelina*. Superficially these beetles resemble Cucujidae and, especially, Laemophloeidae, with which they are frequently found in collections that have not been examined by specialists. Both genera show strong sexual dimorphism. The epistomal region of the male is variably produced as foliaceous or horn-like expansions, and the frons and vertex are modified in some species.

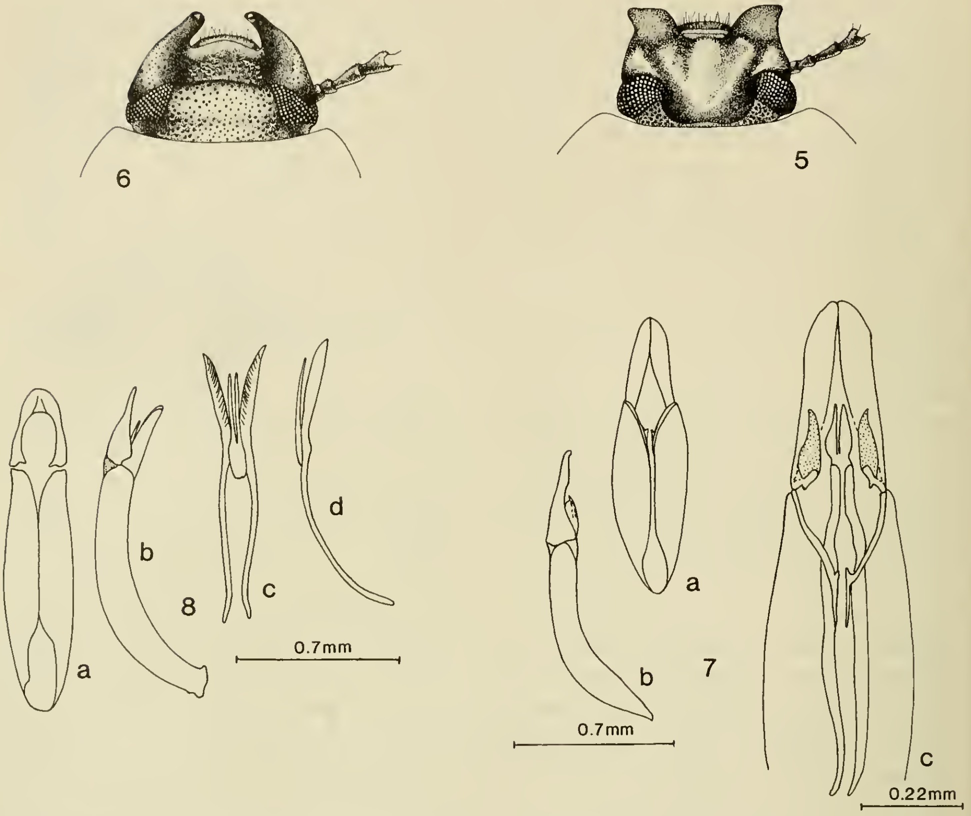
The phyletic relationships of *Adelina* and *Sitophagus* have never been properly interpreted, probably because of the morphological peculiarities mentioned above. LeConte (1862) placed *Adelina* in his Adelinini, which was an assemblage of remotely related genera. Lacordaire (1859) included *Sitophagus* in his tenebrionides vrais (= Tenebrionini) and this placement was later accepted by Horn (1870) and LeConte and Horn (1883). Horn (1870) included in *Sitophagus* the species properly belonging in *Adelina*. Champion (1886) recognized two genera, *Doliema* (= *Adelina*) and *Sitophagus*, which he transferred to the Ulomini without specifying why. Subsequent cataloguers have accepted that position, and in the only recent papers dealing explicitly with these genera (Spilman, 1967, 1973; Ardoin, 1977) phyletic relationships were not addressed.

Tschinkel and Doyen (1980) noted that in three species of *Adelina* the structure of the female reproductive tract and defensive glands were similar to those of Diaperini. Based on this evidence and on similarities to Diaperini in wing configuration and venation, metendosternite structure and tentorial shape, Doyen and Tschinkel (1982: 182) suggested that *Doliema*, *Gnatocerus*, and perhaps other genera included in Ulomini should be transferred to Diaperini. The important characters supporting this placement are summarized in the following section.

Adelina and *Sitophagus* share a strikingly apomorphic aedeagal structure (Figs. 2, 4, 7, 8). The basal piece is much shorter than the parameres. The median lobe consists of a median structure which appears to be the intromittant organ and a pair of lateral lobes which move ventrolaterally when the organ is protruded from the aedeagal sheath. These structures are here termed the penis and clavae, respectively. Both penis and clavae vary in detail. In *Sitophagus alveolatus* the penis consists of a pair of sclerotized, lateral struts with slightly downturned apices (Fig. 4). The clavae are simple, membranous but rigid processes. In *S. hololeptoides* the clavae are setose (Fig. 8), and in *Adelina quadridentata* Champion they are secondarily attached to a baculus that hinges against the aedeagal sheath (Fig. 7). In *A. latiramosa* the apex of the penis is membranous with a pair of stout, upturned laciniae (Fig. 2).

Variation in male genitalia was noticed by Ardoin, who provided simplified diagrams of the aedeagi of *Adelina* species. Spilman (1967) had previously recognized the unusual nature of these structures, giving detailed descriptions of their configuration in *Doliodesmus* and *Doliopines* as well as some species of *Adelina* and *Sitophagus*. Further comparisons by me have shown that the same genitalic structure is shared by three other genera, *Cynaeus*, *Alphitophagus* and *Gnatocerus*. It may be expected that the morphologically similar *Iccius* Champion and *Sicinus* Champion have male genitalia of the same type.

This group of genera evidently forms a monophyletic lineage within the Diaperini. The most specialized genera are *Adelina* and *Gnatocerus*. *Alphitophagus*, which has traditionally been included in Diaperini, and *Cynaeus* are the most primitive in external features. Ecologically these beetles seem less specialized than



Figs. 5–8. 5, Dorsal aspect of head of *Sitophagus dilatifrons*. 6, *S. hololeptoides*. 7, Aedeagus of *Adelina quadridentata* Champion; a, ventral; b, lateral; c, detail of median lobe. 8, Aedeagus of *S. hololeptoides*; a, ventral; b, lateral; c, dorsal aspect of median lobe; d, lateral aspect of median lobe.

most other Diaperini, which largely feed on polypore fungi. The subcortical area of relatively old dead trees is the natural habitat of most, but *Alphitophagus* and *Cynaeus* now occur in stored grain, where they apparently feed on fungi. Because of its morphological and ecological distinctness, nomenclatural recognition at the subtribal level is appropriate for this lineage. The proper name appears to be Adelinina LeConte (1862: 237). At present the remaining genera should be kept in a single subtribe, Diaperina, which may eventually need to be subdivided.

Reconstitution of Diaperini

In terms of internal structures the diaperine lineage (Doyen and Tschinkel, 1982) is one of the most distinctive and uniform groups of Tenebrionidae. The most important features characterizing the diaperine group are as follows: 1) The ovipositor has relatively large gonostyles, with the 4th coxite lobes relatively large and free. The 1st coxite lobe is small and folded under the second; 2) The internal female reproductive tract retains a bursa copulatrix. The basal portion of the spermathecal accessory gland is modified as a characteristic capsular spermatheca. In Diaperini the bursa copulatrix usually bears a circle of stiff, transparent cuticle; 3) The defensive gland reservoirs bear annular foldings in their walls; 4) The

Table 1. Distribution of important taxonomic characters among North American diaperine genera which have been examined in detail.

	Apsida	Metaclisa	Scaphidema	Adelina	Sitophagus	Gnatocerus	Alphitophagus	Doliopines	Doliodesmus	Cynaeus	Phayllus	Cosmonota	Platydema	Liodema	Palembus	Neomida	Pentaphyllus	Diaperis
Diaperine ♀ tract and ovipositor				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X[3]
Tentorium looped			[2]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Glands with helical folds				X	X	X	X	X	X	X	X	X	X[4]	X	X	X	X	
Labroclypeal membrane exposed	X		X	X	X	X	X			X	X	X	X	X	X	X	X	X
Mala without uncus			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Meso-, metatibia ridged				X	X[1]	X	X	X		X	X	X	X	X	X	X	X	X
Wing membrane elongate; recurrent cell reduced			X	X	X	X	X	X	X	X	X	X	X[4]	X	X	X	X	X
Coelometopine ♀ tract and ovipositor	X																	
Tenebrionine ♀ tract		X																
Nonheteromeran trochanters			X															
Larval antenna 2-segmented			X															

[1] Present in *S. dilatifrons.*

[2] Absent.

[3] Ovipositor strongly aberrant.

[4] Sometimes intermediate.

tentorium has the bridge located anteriorly and looped far dorsally (Doyen and Tschinkel, 1982: Figs. 2–3); 5) The wings have the apical membranous portion relatively long, with the recurrent cell reduced or absent (Doyen and Tschinkel, Figs. 33–34). Two additional important apomorphies characterizing Diaperini were pointed out by Triplehorn (1965). First, the labroclypeal membrane is exposed. Second, the metatibia bears on its external (dorsal) surface a fine, crenulate longitudinal ridge. A similar ridge is often more strongly developed on the mesotibia.

This suite of characters is distributed among North American genera as shown in Table 1. Included are taxa traditionally but erroneously placed in Diaperini as well as taxa formerly in Ulomini but properly placed in Diaperini. The most important changes suggested by these data are as follows:

1) The group of genera constituting the subtribe Adelinina are undisputed members of Diaperini, sharing all or nearly all important features. The Ulomini, in which all of these genera except *Alphitophagus* were previously placed, differ fundamentally in all of the features described above (see Doyen and Tschinkel, 1982: 161–163). Their elongate, flattened body shape and specialized male genitalia differentiate Adelinina from Diaperina.

2) The genera *Phayllus* Champion and *Cosmonota* Blanchard show all the

important diaperine features, but lack the male genitalic specializations of the Adelinina. They are placed in the Diaperina. External characters suggest that *Lelegis* Champion, *Paniasis* Champion, and *Loxostethes* Triplehorn, which have not been dissected, certainly belong in Diaperini. Their relationships are discussed by Triplehorn (1962). *Stenoscapha* Bates is very similar to *Liodema* Horn of the Diaperina. *Saptine* Champion appears to be very similar to *Platydema,* but the type of the former lacks the head and prothorax.

3) The genus *Apsida* Lacordaire belongs to the coelometopine lineage of Doyen and Tschinkel, probably to Cnodalonini. *Apsida* shows the very distinctive ovipositor and female reproductive tract of the coelometopine lineage (Doyen and Tschinkel, 1982: 164–165), and conforms in wing, tentorial and defensive gland configuration. As in other coelometopines and cnodalonines the tarsae bear densely setose pads and the tibiae are apically setose. *Gonospa* Champion belongs near *Apsida* in Coelometopini, but I have not made dissections.

4) *Metaclisa,* excluded from Diaperini by Arnett (1960) and Triplehorn (1965) belongs to the tenebrionine lineage of Doyen and Tschinkel, where it fits conveniently into the Tenebrionini.

5) *Scaphidema* has traditionally been placed in Diaperini, but with reservations because of its atypical external structures such as widely separated meso- and metacoxae. The internal female reproductive tract and defensive glands deviate from the diaperine pattern, and the ovipositor is more primitive, with the large 4th coxite lobes entirely free. These characters are shared with the Australian *Spiloscapha* Bates. Both genera have anterior trochanters which are not overlapped laterally by the femora (nonheteromeran trochanters of Watt, 1974), and lack the tentorial bridge. Their larvae have distinct urogomphi and antennae with the 3rd segment greatly reduced, without a strip of cuticle between the antennal base and mandible. These and other characters indicate that *Scaphidema* and *Spiloscapha* are the most primitive members of the tribe Nilionini, which will be treated in more detail in the future (Doyen and Lawrence, in prep.).

Uloporus Casey and *Menimopsis* Champion, included in Diaperini in previous classifications, have previously been removed to the Archeocrypticidae (Lawrence, 1977; Triplehorn and Wheeler, 1979) and Gnathidiini (Doyen and Lawrence, 1979), respectively. Kaszab (1981) subsequently synonymized *Uloporus* under *Enneboeus* (Waterhouse).

Even after the removal of the Adelinina, the tribe Ulomini remains composite. *Uloma* and its relatives are strongly differentiated in external as well as some internal characters. Ulomini should be restricted to this group, represented in North America by *Uloma* Laporte, *Eutochia* LeConte, *Alegoria* Laporte, *Uleda* Laporte, *Antimachus* Gistel and possibly *Ulosonia* Laporte. *Tribolium* McLeay, *Palorus* Mulsant, *Latheticus* Waterhouse, *Lyphia* Mulsant & Rey, *Mycotrogus* Horn and *Tharsus* LeConte are phenetically more similar to *Tenebrio,* and should be provisionally moved to Tenebrionini. That tribe is presently composite, containing many members of Coelometopini and Cnodalonini. Limits of these tribes will be specified in future work (Doyen, in prep.).

The rearrangements proposed above will make present keys to tribes inadequate. It may be pointed out that Diaperini cannot be keyed to tribe in Arnett (1960). In the key to tribes of Tenebrionini, couplet 2b, presence of an external labroclypeal membrane, would lead to couplet 21 and thence to the tribes Helopini or

Strongyliini. Because of the numerous rearrangements still required in tribes such as Tenebrionini it is premature to construct a new key at present. The following minor change in Arnett's key will accommodate most Diaperini.

2 (1). Epistoma without a membranous margin or a membranous band between it and labrum 3
– Epistoma with a membranous margin or a membranous band between it and labrum 2a
2a(2). Middle and hind tibiae bearing a longitudinal, finely crenulate carina on the outer (dorsal) margin .... Diaperini
– Middle and hind tibiae lacking carina on outer margin 21

Tribe Diaperini, new sense

Diaperales Latreille, 1802: 161.
Diaperides Redtenbacher, 1845: 128; Lacordaire, 1859: 298.

Adult.—Small to moderate (2–15 mm), elongate to subglobular, flattened to convex. Eyes large, anteriorly emarginate, or occasionally small, entire; antennae gradually enlarged or bearing distinct 5–8 segmented club; apical 5–7 segments bearing large, stellate sensoriae; labrum strongly transverse, basal membrane almost always exposed; mandible with mola finely, transversely striate, rarely flat or highly modified; lacinia finely setose, without uncus; palp subcylindrical or weakly triangular; tentorium with bridge anterior, strongly arched dorsad. Apical membrane at least 33% wing length; recurrent cell much reduced or absent; meso- and metatibiae bearing fine, crenulate ridge on outer (posterior) surface, or rarely smooth; mesocoxal cavities closed by mesepimeron or meso- and metasterna; metendosternite with arms usually expanded as apical muscle disks. Ovipositor with gonostyles terminal, moderate in size; coxite with basal lobe reduced, folded under second lobe; or ovipositor highly modified (*Diaperis*). Internal female reproductive tract with bursa copulatrix, capsular spermatheca at base of accessory gland. Defensive reservoirs without common volume; reservoir walls usually with annular folding; secretory tissue drained by basal line of ducts or few large collecting ducts. Aedeagus with tegmen dorsal; median lobe free or occasionally adnate, or aedeagus highly modified.

Larva.—Cylindrical or subcylindrical, slender to moderately stout, tapering somewhat posteriorly, moderately sclerotized and pigmented to weakly sclerotized, cream colored; ocelli present or absent.

Antennae 3 segmented; second segment about twice length of basal, bearing C-shaped sensorium near apex; third segment a digitate process, less than half length of second and bearing a single long and several short setae at apex. Labrum about as wide as long to distinctly transverse, with semicircular anterior margin; tormae submedial, projecting strongly backward; epipharynx with asymmetrical masticatory processes. Mandibles asymmetrical; right mola lacking transverse ridges, developed at apex as blunt prominence; left mola set with fine transverse ridges, apical surface receding. Maxillae with mala rounded, without uncus or indentations, setose or spinose on medial surface. Labium with subtrapezoidal hypopharyngeal sclerome set behind setose prominence; ligula short to moderate, bearing 2–4 apical setae. Thoracic legs slender, similar in size and structure, bearing slender setae. Ninth abdominal tergite much larger than sternite, with projecting, acutely rounded or pointed apex, or shorter, bluntly rounded with median, bifid tubercle (*Diaperis*); anus subterminal; pygopods moderate to large, glabrous or very finely, sparsely setose. Spiracles simple annular or with peripheral air tubes (*Diaperis*).

Subtribe Adelinina

Adelinini LeConte, 1862: 237.
Doliemini Reitter, 1917: 58, Kwieton, 1982: 98.
Gnatocerini Skopin, 1978: 228.

Flattened, elongate oval beetles, antennae gradually enlarged; eyes narrower than frons across epistomal canthus (exception, *Alphitophagus*); mesocoxal cavities closed by sterna; epipleuron abruptly narrowed near anterior margin of 5th abdominal sternite; aedeagus with clavae.

Included North American genera: *Adelina* Dejean; *Sitophagus* Mulsant; *Gnatocerus* Thunberg (including *Sicinus* Champion); *Iccius* Champion; *Alphitophagus* Stephens; *Doliopines* Horn; *Doliodesmus* Spilman; *Cynaeus* LeConte.

Described members of this lineage are native to the New World, with the exception of *Doliema turcica* Redtenbacher, *nitidula* Macleay, *ferruginea* Kaszab, *platisoides* Pascoe and *tenuicornis* Fairmaire. The type of *platisoides* (the generitype) is very similar in general appearance to the New World species of *Adelina.* It bears serrulate ridges on the hind tibiae and compound sensoria on the apical 6 antennomeres. On this basis it is provisionally included in Adelinina. However, *nitidula* lacks ridges on the hind tibiae, has simple antennal sensoria, and shows none of the diagnostic internal features of Diaperini. It properly belongs to *Platycotylus* Olliff, originally described in Cucujidae, but probably close to *Lorelus* (Tenebrionidae; Lagriinae) (Doyen and Lawrence, in preparation). The remaining species have not been examined. The name *Doliema* should be retained for the Old World species (except *nitidula*) until more detailed comparisons have been made, especially of internal structures.

Subtribe Diaperina

Diaperales Latreille, 1802: 161.
Diaperides Redtenbacher, 1845: 128; Lacordaire, 1859: 298.

Globular or short oval beetles. Antennae gradually enlarged or with distinct 5–8 segmented club; eyes exceeding epistomal canthi; mesocoxal cavities closed by mesepimeron (exception, *Pentaphyllus*); epipleuron gradually narrowed to elytral apex (exception, *Diaperis,* some *Neomida*); adeagus without clavae.

Included North American genera: *Diaperis* Müller; *Pentaphyllus* Dejean; *Neomida* Latreille; *Palembus* Casey; *Liodema* Horn; *Platydema* LaPorte & Brullé; *Lelegis* Champion; *Paniasis* Champion; *Loxostethes* Triplehorn; *Phayllus* Champion; *Saptine* Champion; *Stenoscapha* Bates.

This subtribe is nearly cosmopolitan and includes the Old World genera *Basanus* Lacordaire, *Ischnodactylus* Chevrolat, *Ceropria* Laporte & Brullé, and probably most other names presently included in Diaperini.

The variation in antennal form, epipleuron shape and in larval 9th segment configuration (see Hayashi, 1966) suggests that Diaperina is composite. Two groups of genera are apparent. *Diaperis, Pentaphyllus, Neomida,* and *Loxostethes* are strongly convex, with the antennae distinctly clubbed. *Platydema, Liodema stenoscapha, Lelegis, Paniasis, Phayllus* and *Saptine* are less convex, with the antennae gradually enlarged. *Palembus* seems intermediate, with weakly convex body but distinctly clubbed antennae. *Diaperis,* especially, is aberrant. Its peculiarities have been discussed by Watt (1974: 405–407) and Doyen and Tschinkel (1982: 163).

KEY TO THE GENERA OF ADULT DIAPERINI NORTH OF MEXICO

1\. Antennae with terminal 5–8 segments enlarged as distinct club ... 2
– Antennae gradually enlarged to apex, or subfiliform ... 5
2(1). Antennal club of 6–8 enlarged segments; eyes emarginate anteriorly ... 3
– Antennal club of 5 segments; eyes round, not at all emarginate ... *Pentaphyllus* Dejean
3(2). Ventral distance between eyes greater than width of oral fossa; epipleuron usually narrowed abruptly near anterior margin of 5th sternite ... 4
– Ventral distance between eyes less than width of oral fossa; epipleuron narrowing gradually to elytral apex ... *Palembus* Casy
4(3). Body broadly oval, strongly convex; without frontal horns; body length greater than 4 mm ... *Diaperis* Müller
– Body elongate oval, subcylindrical; males with frontal horns, females with tubercles; body length less than 5 mm ... *Neomida* Latreille
5(1). Mesocoxal cavities closed by meso- and metasterna ... 7
– Mesocoxal cavities bordered laterally by mesepimeron ... 6
6(5). Mesosternum concave between middle coxae ... *Platydema* LaPorte & Brullé
– Mesosternum projecting anterad as prominent, horizontal lobes ... *Liodema* Horn
7(5). Epipleuron narrowed abruptly near anterior margin of 5th sternite; dorsum glabrous ... 8
– Epipleuron narrowed gradually to elytral apex; dorsum setose ... *Alphitophagus* Stephens
8(7). Posterior pronotal corners angulate, sharp ... 10
– Posterior pronotal corners broadly rounded ... 9
9(8). Antennal segment 4 about 1.5 times length of 2; meso- and metatibiae with outer surface evenly convex ... *Doliodesmus* Spilman
– Antennal segment 4 about 2.5 times length of 2; meso- and metatibiae bearing fine, crenulate ridge on outer surface ... *Doliopines* Horn
10(8). Elytra with 8th interval simply convex or nearly flat; antennae with segments 8–10 at least as wide as long ... 11
– Elytra with 8th interval sharply angulate, usually weakly carinate; antennae with segments 8–10 longer than wide ... *Adelina* Dejean
11(10). Posterior pronotal border bisinuate; mandible normal ... 12
– Posterior pronotal border evenly convex, mandibles of males bearing dorsal horns ... *Gnatocerus* Thunberg
12(11). Pronotal disk evenly convex; anterior corners angulate ... *Cynaeus* LeConte

– Pronotal disk flat medially, declivous laterally, especially near front margin; anterior corners rounded .... *Sitophagus* Mulsant

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NOTE

A New Synonym in *Hexagenia* (Ephemeroptera: Ephemeridae)

The common burrowing mayfly, *Hexagenia limbata* (Serville), has recently been shown in field and laboratory experiments by McCafferty and Pereira (1984. Ann. Entomol. Soc. Am. 77: 69–87) to be highly variable, with the source of much of this variability being attributable to temperatures of the developmental environment. That study also showed that the range of variability included all of the color pattern characteristics previously associated with *Hexagenia munda* Eaton, with particular reference to the abdomen but also including the lack of costal crossvein margination and the color of the costal membrane, both of which were used by Spieth (1941. Amer. Midl. Nat. 26: 239) to key *H. munda* from *H. limbata.* The shape of the penes has also been proposed as a distinguishing specific character. After many years of identifying *Hexagenia* from throughout North America (*H. limbata* and *H. munda* are reportedly sympatric over most of eastern N.A., McCafferty, 1975. Trans. Am. Entomol. Soc. 101: 470), I have found these possible penes differences indiscernible. B. C. Kondratieff (pers. comm., 1983) has also not been able to discern supposed penes differences and has seriously doubted the validity of *H. munda.* Differences in curvature of the penes drawn by Spieth (1941: 278) are miniscule and can be duplicated in many *limbata* specimens by a slight rotation, or by the angle of view in a slide mount. Even if such differences occur, they would appear to represent only slight intraspecific variability, particularly in light of the extreme range of variability of other characters of *H. limbata.*

Underlying abdominal color pattern of the adults that has been used to attempt to distinguish larvae of *H. munda* expresses only a known variation of *H. limbata.* I have also determined that tusk length varies considerably in *H. limbata* larvae and includes size differences previously suspected of being specific for some *H. munda.*

On the basis of the above I designate *H. munda* Eaton as a NEW JUNIOR SYNONYM of *H. limbata* (Serville). Fourteen specific epithets are now referable to *H. limbata,* including seven that have been synonymized with *H. munda.*

W. P. McCafferty, *Department of Entomology, Purdue University, West Lafayette, Indiana 47907. Purdue Exp. Stat. Journal No. 9846.*

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SEASONAL HISTORY, HABITS, AND IMMATURE STAGES OF *BELONOCHILUS NUMENIUS* (HEMIPTERA: LYGAEIDAE)

A. G. Wheeler, Jr.

Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania 17110.

Abstract.—The seasonal history of the orsilline lygaeid *Belonochilus numenius* (Say) was studied in southcentral Pennsylvania during 1976–81. Eggs overwintered in fruiting heads of London plane, *Platanus* × *acerifolia* (Ait.) Willd., and began to hatch in early to mid-April; nymphs developed in old fruits persisting on the trees or in fallen fruits beneath the hosts. Adults of the first generation began to appear in late May, those of the second generation during early July. A third (and perhaps fourth) generation was produced during August–September. Nymphal development in the laboratory required an average of 28.8 days at 20° C. The egg is described and the fifth instar is described and illustrated; brief descriptions and comparative measurements are provided for the other four instars.

Belonochilus numenius (Say), originally described in *Lygaeus* in 1831 and known from the New England states south to Louisiana and west to California and Mexico, is the only North American member of the genus (Slater, 1964). Before its food plant was known, this orsilline lygaeid was considered "very" or "extremely rare" (Uhler, 1871, 1878). Van Duzee (1894) recorded *B. numenius* from goldenrod, but the actual host was not discovered until Heidemann (1902) found nymphs of all stages on leaves of sycamore or American plane trees (*Platanus occidentalis* L.). Additional collecting allowed Heidemann to associate nymphs with the sycamore fruits. In California, Van Duzee (1914) also recorded nymphs from sycamore fruits, and in the laboratory Ashlock (1967) observed nymphs and adults feeding on seeds of sycamore. Heidemann (1911) described and figured the egg and reported that it is this stage that overwinters, rather than adults as he earlier suggested (Heidemann, 1902). Blatchley (1926), having collected an adult under a log in late April, suggested that adults overwinter in the latitude of Indiana. Torre-Bueno (1946) stated that adults hibernate under bark, probably basing his opinion on observations he had made in Arizona (Torre-Bueno, 1940). In Mexico (Tamaulipas) adults have been taken under bark during autumn (U.S. National Museum collection).

Except for Heidemann's (1902, 1911) fragmentary, somewhat confusing sketch of life history, *B. numenius* has remained largely unstudied; sycamore and the western *Platanus racemosa* Nutt. and *P. wrighti* S. Wats. have been merely confirmed as the principal hosts (Torre-Bueno, 1940, 1946). Apparently this lygaeid develops occasionally on other plants. In Missouri, Froeschner (1944) observed nymphs on giant ragweed, *Ambrosia trifida* L., and on hackberry, *Celtis occiden-*

talis L.; nymphs and teneral adults have been collected in Maryland on willow, *Salix* sp. (USNM).

Here, I summarize the seasonal history of populations studied on London plane, *Platanus* × *acerifolia* (Ait.) Willd., in southcentral Pennsylvania and report developmental times for the nymphal stages based on laboratory rearing. The egg is described and the fifth instar described and illustrated; diagnoses are given for the second through fourth instars.

METHODS

Seasonal history at Harrisburg, Pennsylvania, was studied by collecting *Belonochilus numenius* from a street planting of mature London plane trees. Beginning April 1, 1978, the pistillate heads or fruits, both fallen and those persisting on trees, were collected and examined in the laboratory for the hatching of overwintered eggs. Once eggs had begun to hatch (about April 10), fruits were collected every 7–10 days through mid-July and every 2–4 weeks through early November. Under a stereoscopic microscope, all stages of the lygaeid present were counted and recorded (almost always 10 individuals and usually more). To supplement the data on seasonality of *B. numenius* obtained from dissecting sycamore fruits in 1978, a less time-consuming technique was used in 1981. From 1–5 fruits were collected weekly from late April to early June and biweekly from late June to early September, placed in a Berlese funnel, and all nymphs (adults were counted in the field and removed) falling in the container beneath were sorted to stage and counted. The number of nymphs obtained varied from 0 to more than 50 (average 15/sample). Collections made irregularly during 1976–77 and 1979–80 provided additional information on early- and late-season activity.

In the laboratory developmental times were determined by rearing nymphs at 20° C with natural photoperiod. Nymphs were assigned numbers, placed with a water source in individual petri dishes containing several coriaceous nutlets from fruiting heads of London plane, and checked daily for ecdysis. Owing to a high rate of mortality in the laboratory cultures, the developmental times reported are based on the determination of instars for field-collected, first generation nymphs of various stages.

BIOLOGY

Seasonal history.—Eggs overwintered mainly within fallen fruiting heads of London plane; only a few fruits remained on the trees during winter 1977–78. Eggs usually were inserted singly between nutlets, flush with the fruit surface or slightly protruding (Fig. 1), or in loose clusters of 2–10 in cavities near the base of the peduncle. Overwintered eggs began to hatch during April 10–11, 1978, and continued to hatch until early May (in 1979 first instars were common on fallen fruits by April 5). Early instars fed deep within the heads and could be seen clustered around the core after nutlets had been removed.

In the May 1, 1978, sample, second through fourth instars were found in nearly equal numbers. Fifth instars were observed by May 8, and the first adults appeared in the sample of May 20. This first generation developed beneath host trees on fallen fruits that had broken into clusters of nutlets. A smaller percentage of the population developed on the few heads of the previous season that remained on host trees.

Fig. 1. Egg of *B. numenius* (at arrow) in fruiting head of London plane, *Platanus* × *acerifolia.*

First generation adults became common during the last week of May, and soon eggs were deposited on the small, green current-season fruits. Females also oviposited in the few old fruits remaining on the trees, but no eggs were found in fallen fruiting heads. First instars of the second generation were present by early June along with fourth and fifth instars of the first brood. Second generation nymphs developed mainly on immature fruits of the current season and fed on the surface or at the base of peduncles since they could not penetrate the interior of these harder, more compact fruits. The overlapping of generations became increasingly evident; by June 20 all nymphal stages of the second generation were present, plus a few first generation adults, which continued to mate and oviposit.

On July 7, 1978, fourth and fifth instars and teneral adults were observed, with first generation adults still present. Although the overlapping of broods made it more difficult to interpret phenology during the remainder of the season, an increase in numbers of adults in the early August sample, coupled with laboratory data showing that at 20° C the nymphal period requires an average of 28.8 days (Table 1), indicated the development of a third generation. A fourth generation may have been completed during the remainder of August and into late September–early October, but the infrequency of late-season sampling precluded documentation of a fourth brood. Although mating pairs were found on fruiting heads as late as early November, early instars were absent in samples taken during late September through October 1978. This suggests that eggs deposited by third or fourth generation females represented the overwintering stage. At the sample site, adults have been taken under bark of London plane trees during November,

Table 1. Duration (in days) of the nymphal stadia of *B. numenius* reared at 20° C under natural photoperiod.

Stage	No. individuals	Duration		
		Range	Mean ± SE	Cumulative mean age
Nymphal stadia				
1st	12	4–8	6.2 ± 0.32	6.2
2nd	13	4–7	4.7 ± 0.29	10.9
3rd	15	3–8	4.4 ± 0.32	15.3
4th	16	4–9	5.2 ± 0.32	20.5
5th	7	6–10	8.3 ± 0.47	28.8

but only eggs have been found to survive until spring. Adults, however, may overwinter in more southern latitudes.

Sampling in 1981 gave a similar picture of early-season phenology. Adults of the first generation first appeared in the May 20 sample, first instars of the second generation were numerous on June 8 (30 of 36 nymphs sorted), and first instars of a third generation appeared in the August 5 sample. No nymphs were obtained in an early September collection, but a single first instar obtained from the early October sample may have indicated the presence of a fourth (and perhaps partial) generation.

Belonochilus numenius thus is a multivoltine lygaeid that feeds on immature and mature fruits of *Platanus* spp., with the elongated labium an adaptation for this specialized mode of feeding. Although in some years the first generation develops mainly on fallen fruits and scattered clusters of nutlets from disintegrated heads, this species should be considered an arboreal rather than terrestrial seed predator. Brachypterous morphs, so common in populations of litter-inhabiting lygaeids (Slater, 1977), are absent. Adults disperse actively, with those of the first generation moving from fallen fruits to host trees where they mate and oviposit on immature heads or old fruits from the previous season.

DESCRIPTIONS

Egg (n = 10).—Length 1.34–1.56 mm, $\bar{x} = 1.44$; width 0.28–0.32 mm, $\bar{x} = 0.30$. Elongate, slightly tapering toward posterior pole; pale yellow when deposited, becoming brownish before eclosion, smooth, hexagonal sculpturing faint. Aeromicropyles 5–7 encircling anterior pole, stalked and bearing inward-directed cup-like processes (see Heidemann, 1911, Pl. 10, Fig. 1).

Fifth instar (in alcohol, n = 9) (Fig. 2).—Oblong–oval, widest across middle of abdomen, length 4.58–6.08 mm, $\bar{x} = 5.38$; general color testaceous, marked with reddish brown and fuscous, intensity of darker markings variable. Head porrect, nondeclivent, longer than wide, tylus extending nearly to middle of antennal segment II, length 1.20 mm, width 1.04 mm, interocular space 0.64 mm; fuscous stripes on either side of midline from near apex of tylus to base, reddish to fuscous lateral stripes visible from antennal bases to base of head; labium elongate, extending to middle or base of abdomen, length of segments variable, I, 0.90–1.20 mm; II, 0.90–1.34; III, 1.10–1.52; IV, 0.64–0.90; antenna testaceous, segment IV stout, reddish brown or fuscous, length of segments, I, 0.26 mm; II, 0.70; III,

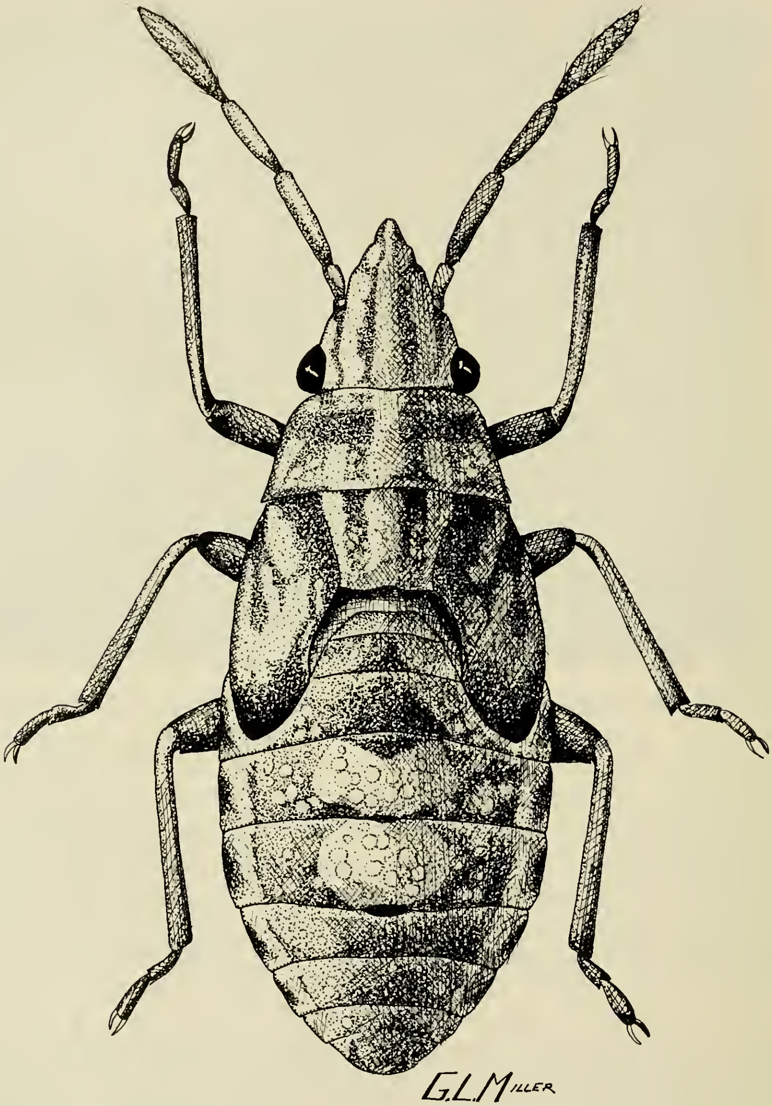

Fig. 2. *B. numenius,* fifth instar.

0.56; IV, 0.66, total antennal length 2.18 mm. Pronotum trapeziform, anterior margin shallowly concave, truncate posteriorly, lateral margins carinate, length 0.72 mm, width 1.56 mm; testaceous, median line pale, bordered by fuscous stripes, sometimes an additional fuscous stripe visible midway between midline and edge, lateral edge pale, bordered by narrow fuscous line, calli irregularly mottled with brown; scutellum testaceous, margined with fuscous, median line pale; wing pads testaceous, margins fuscous and basal half mottled with fuscous, apices nearly reaching posterior margin of abdominal tergite III. Abdominal tergites reddish brown to fuscous (tergite II sometimes testaceous), broken by numerous pale spots, marginal areas of segments testaceous; dorsal abdominal scent gland openings between tergites 4–5 and 5–6, rims thin, darkened, broad pale areas visible anterior to scent gland openings (appearing darker in some specimens); venter uniformly testaceous; a reddish-brown to fuscous stripe along pleural areas of thorax, broken by paler spots along edge of abdomen. Legs pale testaceous, sides of femora sometimes with faint brown spots, fore femora incrassate with short, blunt spine near apex.

Fourth instar (in alcohol, n = 5).—Similar in form and color to 5th instar. Dark markings on head, pronotum, and wing pads less intense; large, clearly defined red areas anterior to abdominal scent gland openings in most specimens; wing pads reaching abdominal segment I.

Length, 3.60–4.20 mm, $\bar{x} = 3.89$. Head, length 0.80–0.84 mm, $\bar{x} = 0.81$; width 0.66–0.70 mm, $\bar{x} = 0.68$; interocular space 0.46–0.52 mm, $\bar{x} = 0.49$. Protergal length 0.42–0.44 mm, $\bar{x} = 0.43$; humeral width 0.82–0.88, $\bar{x} = 0.86$. Antennal lengths I, 0.16 mm; II, 0.32–0.34; III, 0.24–0.28; IV, 0.42–0.44. Labial lengths I, 0.56–0.64 mm; II, 0.58–0.68; III, 0.60–0.84; IV, 0.44–0.52.

Third instar (in alcohol, n = 5).—Similar in form and color to 4th instar. Dark markings on head generally less intense; mesothoracic wing pads distinct, slightly overlapping metanotum. Note: labium in one specimen examined was extremely long, reaching beyond apex of abdomen.

Length, 2.64–3.28 mm, $\bar{x} = 2.86$. Head, length 0.60–0.80 mm, $\bar{x} = 0.68$; width 0.52–0.54 mm, $\bar{x} = 0.54$; interocular space 0.36–0.40 mm, $\bar{x} = 0.38$. Protergal length 0.26–0.34 mm, $\bar{x} = 30$; humeral width 0.62–0.70 mm, $\bar{x} = 0.66$. Antennal lengths I, 0.12–0.14 mm; II, 0.18–0.28; III, 0.16–0.24; IV, 0.30–0.38. Labial lengths I, 0.36–0.70 mm; II, 0.36–0.84; III, 0.38–1.00; IV, 0.36–0.70.

Second instar (in alcohol, n = 5).—Similar to 3rd instar, but head and pronotum nearly uniformly dusky.

Length, 1.88–2.10 mm, $\bar{x} = 1.95$. Head, length 0.40–0.46 mm, $\bar{x} = 0.44$; width 0.38–0.44 mm, $\bar{x} = 0.41$; interocular space 0.30 mm. Protergal length 0.18–0.20 mm, $\bar{x} = 0.18$; humeral width 0.42–0.52 mm, $\bar{x} = 0.46$. Antennal lengths I, 0.08–0.12 mm; II, 0.14–0.16; III, 0.12–0.18; IV, 0.20–0.28. Labial lengths I, 0.26–0.36 mm; II, 0.28–0.40; III, 0.26–0.40; IV, 0.26–0.36.

First instar (in alcohol, n = 5).—Similar to 2nd instar but more elongate.

Length, 1.26–1.60 mm, $\bar{x} = 1.43$. Head, length 0.34–0.40 mm, $\bar{x} = 0.37$; width 0.30–0.32 mm, $\bar{x} = 0.31$; interocular space 0.20–0.26 mm, $\bar{x} = 0.22$. Protergal length 0.12–0.16 mm, $\bar{x} = 0.14$; humeral width 0.34 mm. Antennal lengths I, 0.06–0.08 mm; II, 0.08–0.12; III, 0.08–0.12; IV, 0.20–0.24. Labial lengths I, 0.16–0.26 mm; II, 0.22–0.26; III, 0.22–0.30; IV, 0.20–0.28.

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REVISION OF THE NEARCTIC SPECIES OF THE *TRISSOLCUS FLAVIPES* GROUP (HYMENOPTERA: SCELIONIDAE)

NORMAN F. JOHNSON

Department of Entomology, 1735 Neil Avenue, The Ohio State University, Columbus, Ohio 43210.

Abstract.—Four species of the *Trissolcus flavipes* group are recognized in the Nearctic: *T. brochymenae* (Ashmead) [southern USA, Mexico], *T. edessae* Fouts [southeastern USA west to Kansas, Texas], *T. euschisti* (Ashmead) [widespread] and *T. strabus* new species [widespread]. The names *Trissolcus murgantiae* Ashmead and *Trissolcus rufiscapus* Ashmead are synonymized with *T. brochymenae*; *Trissolcus podisi* Ashmead and *Trissolcus rufitarsis* Kieffer are synonymized with *T. euschisti*. Lectotypes are designated for *T. euschisti* and *T. rufitarsis*. An identification key is provided; known host and distribution data are summarized.

The genus *Trissolcus* Ashmead (= *Asolcus* Nakagawa, *Microphanurus* Kieffer) is one of the two main groups within the subfamily Telenominae (Hymenoptera: Scelionidae). All species of the genus are egg parasitoids of bugs of the superfamily Pentatomoidea (Heteroptera). Many of these hosts are economically important pests, and, as a result, there has been interest in species of *Trissolcus* as biological control agents.

Species of *Trissolcus* may be recognized using the keys of Masner (1976, 1980). Most of the abbreviations and morphological terms used in this revision are defined in Masner (1980). The *hyperoccipital carina* (*hc,* Fig. 5), a term introduced by Masner (1979), refers to a carina that, in the Telenominae, runs continuously across the vertex from one eye to the other, behind the lateral ocelli, and merging with the outer orbit of the eye without joining the occipital carina. The inner orbit of most species of the group discussed in this paper is bounded by a distinct furrow that expands in width ventrally; this is referred to as the *orbital furrow* (*of,* Fig. 3). Above the base of the mandibles in many species of *Trissolcus* is a large, sometimes poorly-defined puncture, into which one or a few setae are inserted; this is the *pleurostomal puncture* (*p,* Fig. 2). *Sublateral setae* refer to one or more pairs of posteriorly directed setae near the sides of the first metasomal tergite, not the laterally directed setae near the laterotergite line of flexion.

The descriptions represent summaries only of character states distinguishing the hypothesized species and refer to both sexes unless specifically indicated otherwise. As such they are based on the series of specimens, not a single specimen. Because of the inadequacy of Ashmead's 1893 key for identification I have not cited host data published in the literature. The sections summarizing host information refer only to specimens that I have seen.

This revision is based upon material from the following institutions and persons (with acronyms used in the text in parentheses): California State Department of Food and Agriculture, Sacramento, CA; Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, ONT (CNC); Cornell University Insect Collection, Ithaca, NY; Florida State Collection of Arthropods, Gainesville, FL (FSCA); Kansas State University, Manhattan, KS; Los Angeles County Museum, Los Angeles, CA; Mississippi Entomological Museum, Mississippi State, MS; Museum of Comparative Zoology, Harvard University, Cambridge, MA (MCZ); The Ohio State University, Columbus, OH; Texas A&M University, College Station, TX; U.S. National Museum of Natural History, Washington, DC (USNM); University of California, Riverside, CA; and the collections of D. C. Darling (Ithaca, NY) and the author (NFJ).

The *flavipes* group of *Trissolcus* was first recognized by Kozlov and Lê (1976). They characterized the group as those species with notauli, a strongly convex frons, and a hyperoccipital carina. The diagnosis of the *flavipes* group can be expanded as follows: hyperoccipital carina present (*hc,* Fig. 5, Figs. 6–8), rarely interrupted medially (Fig. 4); frons with large setigerous punctures at least laterally (Figs. 3, 5, 7); frons strongly bulging between antennal insertions and inner orbits; orbital furrow usually strongly expanded ventrally (*of,* Fig. 3; Figs. 1, 5); radicle of antenna light in color, concolorous with or lighter than scape, never darker; genal surface rounded from malar sulcus to occipital carina, with no carina extending from base of mandibles dorsad; notauli well-developed (*n,* Fig. 11; Fig. 9); central longitudinal keel between notauli usually present; sublateral setae on T1 usually absent (Figs. 16–20).

The *Trissolcus flavipes* group is worldwide in distribution. It is, however, most diverse in the New World, and, in particular, in the Neotropics. This paper deals only with the Nearctic representatives of the group. Four species are recognized: *T. brochymenae* (Ashmead), *T. edessae* Fouts, *T. euschisti* (Ashmead), and *T. strabus* new species. *Trissolcus brochymenae* is a southern species whose range extends well into the Neotropics; it can be found as far north as Missouri, Kansas and New Jersey. It is sympatric throughout its Nearctic range with *T. euschisti,* but only the latter species can be found in the northern states and Canada. *Trissolcus edessae* is a southeastern U.S. species and may also be found in the West Indies; *T. strabus* is widespread in the Nearctic, but is rare.

The expression of many characters of the species of this group appears to be strongly affected by the size of the individual. Masner reported this phenomenon in *Trissolcus* in 1959. He noted that the development of frontal sculpture, mesoscutal sculpture, the central keel on the mesoscutum, and the length of antennomeres may be highly variable. In addition to these characters, I have found that the number of setae on the lateral margins of T1, above the mid coxae, and on S1, and the extent of the sculpture on T2 are variable and appear to be related to size. This is especially a problem in *T. euschisti,* here interpreted as a polyphagous and geographically widespread species.

KEY TO NEARCTIC SPECIES OF THE *TRISSOLCUS FLAVIPES* GROUP

1. Orbital furrow narrow ventrally (Figs. 7, 8); scutellum rugulose (Figs. 11, 12) . . . . *strabus*

– Orbital furrow strongly expanded ventrally (Figs. 1, 3, 5); scutellum with shallowly impressed coriaceous sculpture (Fig. 10) or smooth (Fig. 9) 2

2(1′). Mesopleural carina absent (Fig. 15); female antennal flagellum abruptly bicolored: A1–A6 yellow, A7–A11 dark brown .... *edessae*

– Mesopleural carina present (*mc*, Fig. 13; Figs. 1, 14); female antennal flagellum infuscate throughout 3

3(2′). Ventral portion of mesepisternum anterior to mesopleural carina rugulose (Fig. 13) .... *brochymenae*

– Ventral portion of mesepisternum anterior to mesopleural carina smooth or with shallowly impressed coriaceous microsculpture (Fig. 14) .... *euschisti*

SPECIES DESCRIPTIONS

Trissolcus brochymenae

Figs. 1, 2, 13, 16

Telenomus Crochymenae Ashmead, 1881: 193. Type locality: Jacksonville, Florida. Host: *Brochymena arborea* (Pentatomidae). Lectotype No. 2855 (examined) in USNM.

Trissolcus brochymenae: Ashmead, 1893: 164.

Trissolcus murgantiae Ashmead, 1893: 163. Type locality: Baton Rouge, Louisiana. Host: *Murgantia histrionica* (Pentatomidae). **New synonymy.** Lectotype No. 2231 (examined) in USNM.

Trissolcus rufiscapus Ashmead, 1893: 163. Type locality: Washington, D.C. Host unknown. **New synonymy.** Holotype No. 2232 (examined) in USNM.

Trissolcus murgantiae: Kieffer, 1926: 128.

Trissolcus brochymenae: Kieffer, 1926: 129.

Trissolcus rufiscapus: Kieffer, 1926: 129.

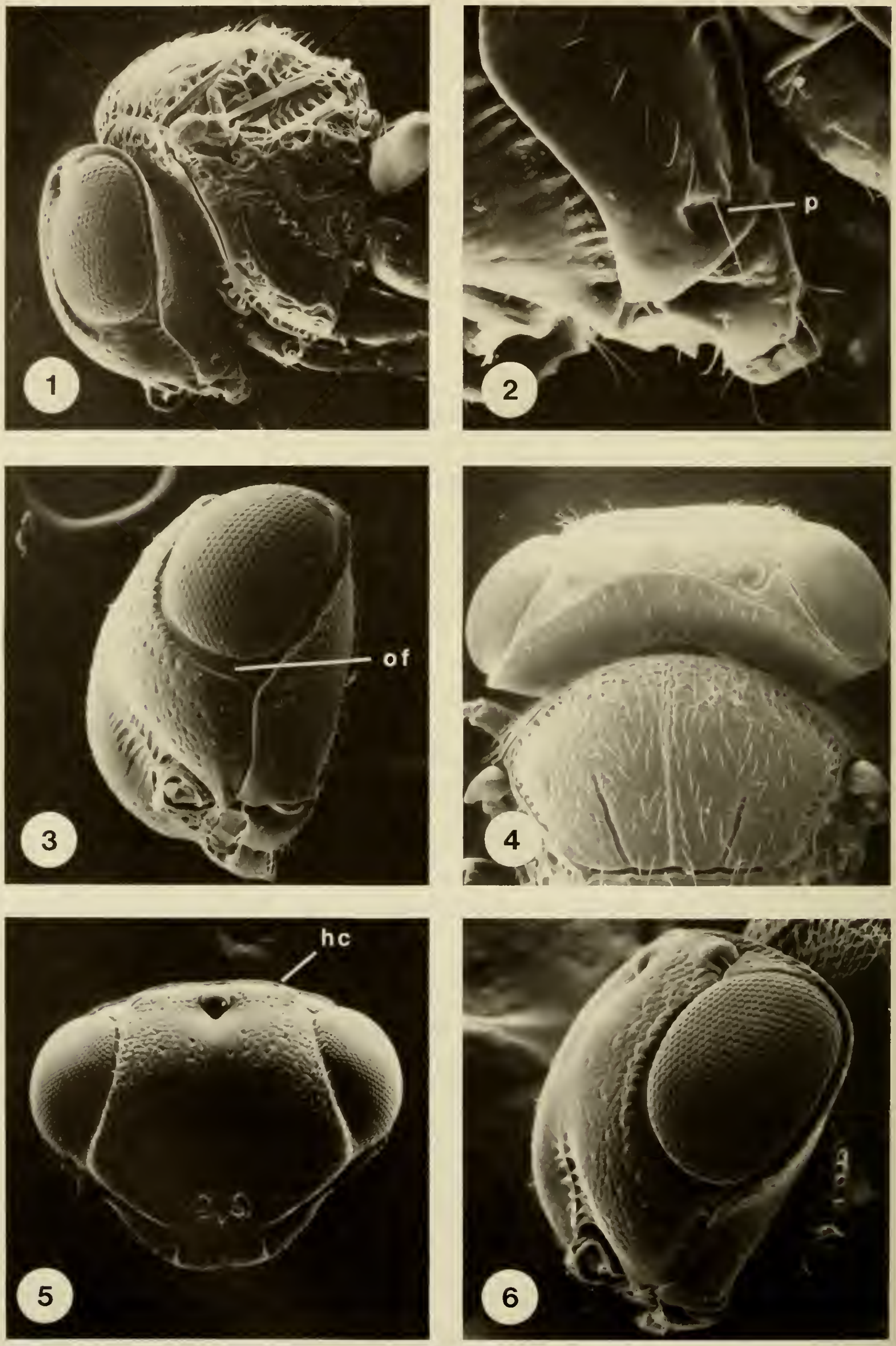
Trissolcus brochymenae: Masner and Muesebeck, 1968: 72 (lectotype designation).

Trissolcus murgantiae: Masner and Muesebeck, 1968: 73 (lectotype designation).

Length: 1.1–1.3 mm; orbital furrow expanded ventrally (Fig. 1); hyperoccipital carina present, sometimes low medially, but head at least sharply angled at vertex; female antennal flagellum not abruptly bicolored, A3–A11 dark brown to black; genae above mandibles smooth, pleurostomal puncture present (*p*, Fig. 2); mesoscutum with coriaceous microsculpture throughout, irregularly longitudinally rugulose anteriorly; scutellum with effaced coriaceous microsculpture, sometimes smooth; dorsellum excavate ventrally; ventral portion of mesepisternum anterior to mesopleural carina strongly rugulose (Figs. 1, 13); femora and tibiae usually yellow, sometimes (especially in arid regions and in Neotropics) infuscate; mesopleural carina present (*mc*, Fig. 13); metasoma (Fig. 16): no sublateral setae on T1; T2 smooth beyond basal costae; T2 with short transverse subapical setal band, few setae along T2-laterotergite line of flexion.

Hosts: Acrosternum hilare, Murgantia histrionica, Nezara viridula (Heteroptera: Pentatomidae).

Distribution: Arkansas (Phillips, Pike Co.), *California* (Humboldt Co., Orange Co., San Diego Co., Santa Clara Co.), *Florida* (Alachua Co., Baker Co., Duval Co., Pinellas Co.), *Georgia* (Cobb Co.), *Kansas* (Cherokee Co.), *Louisiana* (E. Baton Rouge Parish), *Maryland* (Anne Arundel Co., Montgomery Co., Prince



Figs. 1–2. *Trissolcus brochymenae.* 1, Head and mesosoma, lateral view. 2, Detail of lower part of head, lateral view; *p*: pleurostomal puncture. Figs. 3–4. *T. edessae.* 3, Head, fronto-lateral view; *of*: orbital furrow. 4, Head and mesosoma, dorsal view. Figs. 5–6. *T. euschisti,* head. 5, Frontal view; *hc*: hyperoccipital carina. 6, Fronto-lateral view.

Georges Co.), *Mississippi* (Oktibbeha Co., Pontotoc Co.), *Missouri* (Boone Co., Wayne Co.), *New Jersey* (Burlington Co.), *North Carolina* (Wake Co.), *South Carolina* (Florence Co., Richland Co.), *Tennessee* (Anderson Co., Blount Co.), *Texas* (McLennan Co.), *Virginia* (Shenandoah Co.). Mexico: *Baja California Sur, Nuevo Leon, Sonora.*

Remarks.—*Trissolcus brochymenae* is most similar to *T. euschisti* and may be distinguished from it by the strongly rugulose ventral portion of the mesepisternum anterior to the mesopleural carina (Fig. 13). This species is also similar to *T. euschisti* in that it shows a great deal of variability, presumably in association with its wide geographic distribution and host range.

Trissolcus edessae

Figs. 3, 4, 15, 17

Trissolcus edessae Fouts, 1920: 65. Type locality: New Orleans, Louisiana. Host: *Edessa bifida* (Pentatomidae). Holotype No. 22797 (examined) in USNM.

Orbital furrow expanded ventrally (Fig. 3); hyperoccipital carina effaced medially, vertex there rounded (Fig. 4); female antennal flagellum abruptly bicolored, A1–A6 yellow, A7–A11 dark brown; genae above mandibles coriaceous except for narrow strip at base of mandibles (Fig. 3), pleurostomal puncture present; disc of mesoscutum coriaceous; scutellum with coriaceous microsculpture anteriorly, otherwise smooth; dorsellum excavate ventrally; anteroventral portion of mesepisternum coriaceous, with few irregular rugae (Fig. 15); legs beyond coxae yellow; mesopleural carina indicated only by short raised keel ventrally (Fig. 15); metasoma (Fig. 17): no sublateral setae on T1; T2 smooth beyond basal costae; T2 with short, subapical band of setae, 3–4 setae along T2-laterotergite line of flexion.

Host: Acrosternum hilare, Edessa bifida (Heteroptera: Pentatomidae).

Distribution: Florida (Dade Co., Stock Is.); *Georgia* (Cobb Co.); *Kansas* (Cherokee Co.); *Louisiana* (E. Baton Rouge, Orleans Parish); *Mississippi* (Panola Co.); *South Carolina* (Darlington Co.); *Texas* (Galveston Co.).

Remarks.—*Trissolcus edessae* may be easily recognized among the species of the *flavipes* group dealt with here by the abruptly bicolored female antennae and the lack of a well-developed mesopleural carina.

Trissolcus euschisti

Figs. 5, 6, 9, 10, 14, 18, 19

Telenomus euschristus Ashmead, 1888: ii. Type locality: Manhattan, Kansas. Host: "Pentatomid eggs, which apparently belong to some species of *Euschristus* or an allied form." (Pentatomidae). Lectotype (designated below) in collection of Kansas State University.

Trissolcus euschisti: Ashmead, 1893: 162.

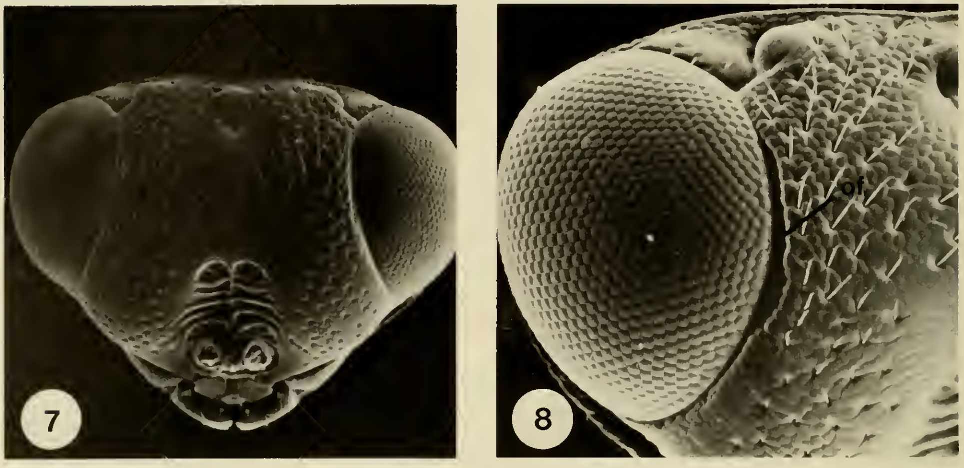
Trissolcus podisi, Ashmead, 1893: 162. Type locality: Philadelphia, Pennsylvania. Host: *Podisus spinosus* (Pentatomidae). **New synonymy.** Lectotype No. 2229 (examined) in USNM.

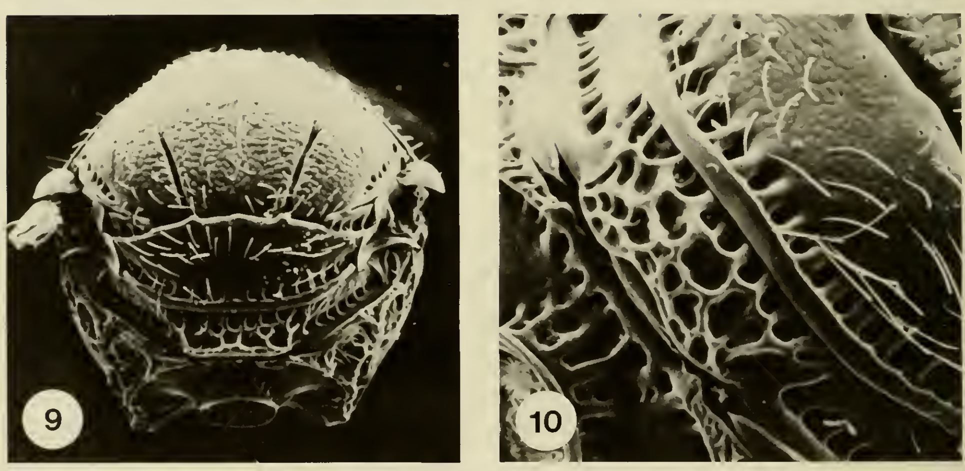
Trissolcus rufitarsis Kieffer, 1905: 262. Type locality: Ormsby, Nevada. **New synonymy.** Lectotype (designated below) in Cornell University Insect Collection.

Trissolcus euschisti: Kieffer, 1926: 129.

Trissolcus podisi: Kieffer, 1926: 129.

Trissolcus podisi: Masner and Muesebeck, 1968: 73 (lectotype designation).





Figs. 7–8. *Trissolcus strabus,* head. 7, Frontal view. 8, Detail of orbital furrow; *of:* frontal view. Figs. 9–10. *T. euschisti.* 9, Mesosoma, dorsal view. 10, Scutellum and dorsellum, postero-dorsal view. Figs. 11–12. *T. strabus.* 11, Mesosoma, dorsal view; *n:* notaulus. 12, Scutellum and dorsellum, postero-dorsal view.

Orbital furrow distinctly expanded ventrally (Figs. 5, 6); hyperoccipital carina present (Figs. 5, 6, *hc*); female antennal flagellum darkened throughout, not abruptly bicolored; genae above mandibles smooth, pleurostomal puncture present (Fig. 5); mesoscutum with coriaceous microsculpture throughout (Fig. 9), rugulose anteriorly; scutellum with coriaceous microsculpture (Fig. 10), smooth in small specimens; dorsellum excavate ventrally; ventral portion of mesepisternum anterior to mesopleural carina smooth or with shallowly impressed coriaceous microsculpture (Fig. 14); femora and tibiae infuscate medially; mesopleural carina usually present, sometimes poorly developed anteriorly (especially in large specimens, Fig. 14); metasoma (Figs. 18, 19): no sublateral setae on T1; large specimens with longitudinal wrinkles on T2 beyond basal costae (Fig. 19), smaller forms with T2 smooth beyond costae (Fig. 18); T2 setation limited to short transverse subapical band, few setae along T2-laterotergite line of flexion.

Hosts: Acanthosomatidae sp., probably *Elasmostethus cruciatus*; *Acrosternum hilare*; *Banasa dimidiata*; *Brochymena quadripustulata*; *Brochymena sulcata*; *Brochymena* sp.; *Cornifrons ebutalis*; *Euschistus* sp.; *Murgantia histrionica*; *Perillus ocularis*; *Perillus* sp.; *Podisus maculiventris*; *Podisus sereiventris*; *Podisus* sp.; *Tetyra bipunctata.*

Material examined.—*Telenomus euschisti* lectotype female (*here designated*). Label data: "Riley Co Ks, Marlatt; 763; Lectotype female Telenomus euschisti Ashmead, desig. N. Johnson." The egg mass is also pinned. The lectotype is deposited in the collection of the Kansas State University. Ashmead (1888) specified that the description was based upon two specimens labelled 763. Later (1893) he stated that the types were located both in Kansas State and in his collection, which is now in the USNM. The lectotype is the only specimen I have found with the 763 label. At least two other specimens have only a "Riley Co, Ks, Marlatt" label. Since I cannot determine which one Ashmead may have used in the original description, I have not designated a paralectotype.

Trissolcus rufitarsis lectotype female (*here designated*). Label data: "Ormsby Co. Nev, July. Baker; 105; Paratype Cornell U. No. 388.1; Trisolcus [sic] rufitarsis K, Paratype." Lectotype deposited in Cornell University. Masner (1976) reported that the types of Kieffer's species from the Baker collection were transferred from Pomono College to the California Academy of Sciences (San Francisco), and that some syntype material was obtained by Cornell University through exchange. Dr. Wojciech Pulawski (CAS) has, however, informed me (in litt.) that the type of *T. rufitarsis* is not in that collection. Accordingly, I have designated the Cornell specimen as the lectotype.

Many other specimens were examined from the following areas: *Arizona* (Cochise Co., Coconino Co.); *Arkansas* (Garland Co.); *California* (Alameda Co., Merced Co., Sacramento Co., San Diego Co., Santa Clara Co., Shasta Co., Yolo Co.); *Connecticut* (Fairfield Co.); *Florida* (Alachua Co., Baker Co.); *Georgia* (Peach Co.); *Idaho* (Owyhee Co.); *Indiana* (Greene Co., Martin Co.); *Iowa* (Woodbury Co.); *Kansas* (Riley Co.), *Louisiana* (Beauregard Parish); *Maryland* (Baltimore Co., Montgomery Co.); *Massachusetts* (Middlesex Co.); *Michigan* (Oscoda Co.); *Mississippi* (Oktibbeha Co.); *Missouri* (Wayne Co.); *New Mexico* (Dona Ana Co., Valencia Co.); *New York* (Dutchess Co., Greene Co., Tompkins Co.); *North Carolina* (Buncombe Co., Macon Co., Wake Co.); *North Dakota* (Burleigh Co.); *Ohio* (Hocking Co., Tuscarawas Co., Wayne Co.); *Oklahoma* (McIntosh Co.); *Pennsylvania* (Franklin Co.); *South Carolina* (Anderson Co., Barnwell Co.); *South*

Figs. 13–14. Ventral portion of mesepisternum, antero-lateral view, legs removed. 13, *Trissolcus brochymenae*; *mc*: mesopleural carina. 14, *T. euschisti*.

Dakota (Pennington Co.); *Tennessee* (Henderson Co., Shelby Co.); *Texas* (Brewster Co., Brown Co., McLennan Co., Uvalde Co.); *Utah* (Cache Co., Davis Co.); *Virginia* (Fairfax Co., Frederick Co.); *West Virginia* (Kanawha Co.); *District of Columbia.* Canada: *British Columbia*; *Ontario*; *Quebec.* Mexico: *Jalisco, Morelos, Vera Cruz.*

Remarks.—*Trissolcus euschisti* may be distinguished from the similar *T. brochymenae* by the smooth or shallowly impressed sculpture on the ventral portion of the mesepisternum anterior to the mesopleural carina (Fig. 14). The smaller specimens of what I take to be *T. euschisti* are often quite distinct from the larger ones in the following characters: number of lateral setae on T1, extent of fine wrinkles on T2, extent of wrinkles on S2, extent of S1 setation, number of setae on the mesopleuron above the mid coxae, sculpture of the upper portion of the frons, extent of transverse striae within the antennal scrobes, and the presence of a shallow groove below the median ocellus. Ashmead's species *Trissolcus podisi* represents the small form, *T. euschisti* the large. The two extremes in size may be rather easily separated on the basis of these characters, but intermediate forms also exist, although they are much less common. The larger form seems to be more common in the south and the smaller one in the north, but both extremes and intermediates may be found throughout the range cited above. I therefore hypothesize that they belong to the same, geographically widespread and polyphagous species. It is upon this basis that I have synonymized the names *T. podisi* and *T. rufitarsis.*

Yeargan (1982) discussed some aspects of the reproductive biology of *Trissolcus euschisti.* He noted that the fecundity of a single female was generally sufficient to parasitize all of the eggs within a mass of such hosts as *Podisus maculiventris* and *Euschistus servus.* He indicated, however, that both *T. euschisti* and *Telenomus podisi* were capable of successfully parasitizing bug eggs up to the seventh day of host embryonic development (with eclosion of nymphs occurring on day 8 or 9). This extended period of parasitization capability is unusual in the Telen-

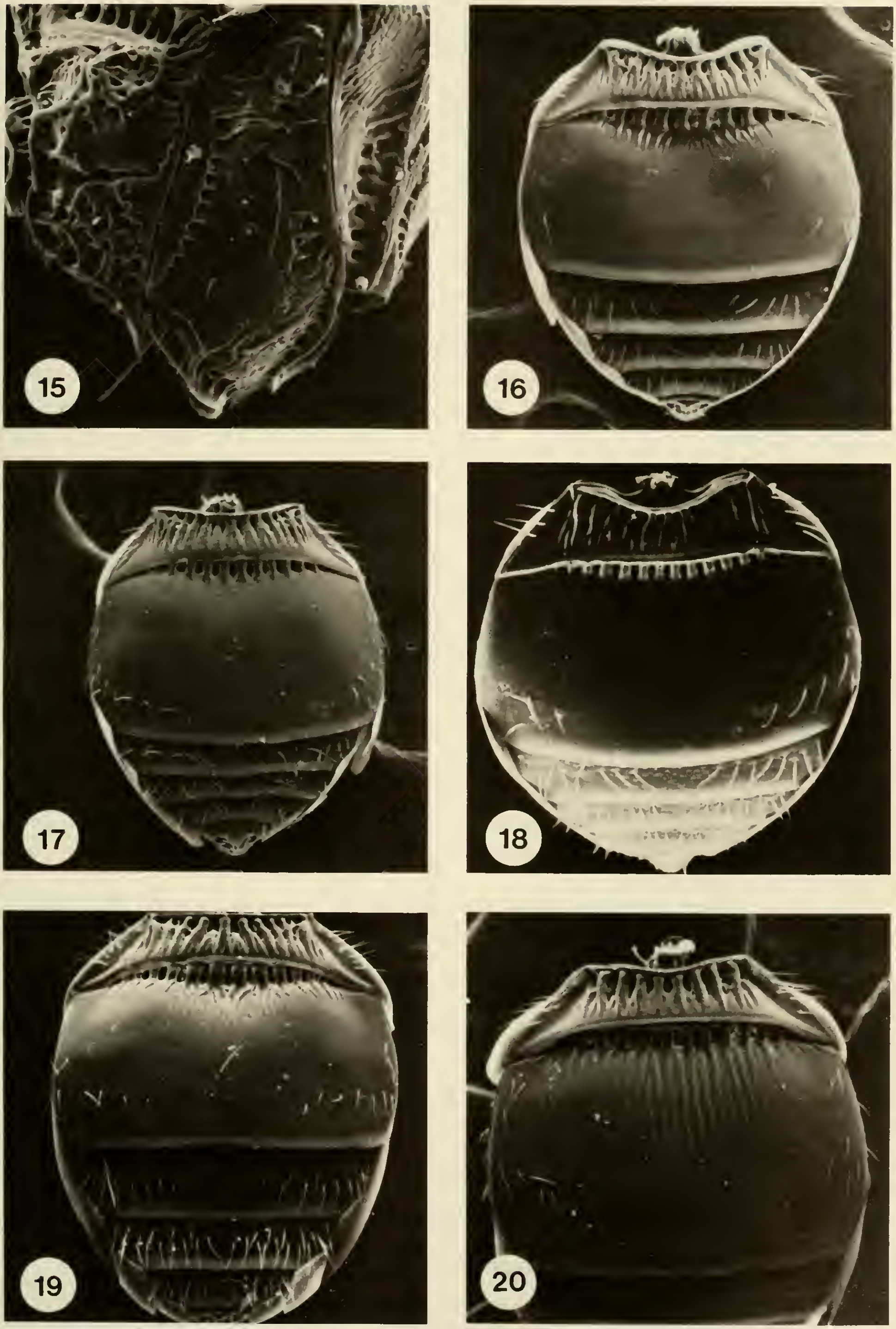


Fig. 15. *Trissolcus edessae,* mesosoma, lateral view. Figs. 16–20. Metasoma, dorsal view. 16, *T. brochymenae.* 17, *T. edessae.* 18, *T. euschisti,* small form. 19, *T. euschisti,* large form. 20, *T. strabus.*

ominae in general, but is consistent with Hidaka's (1958) observations of another pentatomid egg parasite, *Telenomus gifuensis* (see Johnson, 1984).

Trissolcus strabus, NEW SPECIES
Figs. 7, 8, 11, 12, 20

Orbital furrow strongly narrowed ventrally (Figs. 7, 8); hyperoccipital carina present (Figs. 7, 8); female antennal flagellum infuscate throughout; genae above mandibles smooth, pleurostomal puncture present; mesoscutum with coriaceous background microsculpture, rugulose throughout (Fig. 11); scutellum with same sculpture as mesoscutum, microsculpture often effaced (Fig. 12); dorsellum excavate ventrally; ventral portion of mesepisternum smooth; femora and tibiae infuscate; mesopleural carina present; metasoma (Fig. 29): no sublateral setae on T1; T2 with rugulae extending beyond costae over basal two-thirds of sclerite; T2 with short subapical band of setae, few setae along T2-laterotergite line of flexion.

Host unknown.

Material: Holotype female; *Ontario,* Hamilton, 31.vii.1981, M. Sanborne, Malaise trap (CNC). Paratypes. Two females with same locality data as holotype, one collected 31.vii.1981, one on 9–13.vii.1981 (CNC). *California*: Sta Cruz Mts., 2 females (USNM). *Florida*: Alachua Co., Gainesville, Pine Hill Estates; 27.ix.1973, H. V. Weems, Jr., Malaise trap, 1 female (FSCA). *New Jersey*: Burlington Co., Atsion, 23.vii.1980, J. E. Rawlins, 1 female (NFJ). *Tennessee*: Lexington, Natchez Trace S.P., 11–15.vi.1972, Mal. tr., G. Heinrich, 3 females (CNC). *Texas*: Brownsville, 11–16.vi.1933, Darlington, 1 female (MCZ); *Utah*: Farmington, 25.v.1936; ex eggs on peach bark; Lot No. 36-35291, 9 females, 2 males (USNM).

Remarks.—*Trissolcus strabus* is distinctive among all species of the *flavipes* group discussed here (*brochymenae, edessae, euschisti*) by the ventral constriction of the orbital furrow. In addition, among the Nearctic species it is also characterized by the relatively coarsely sculptured mesoscutum and scutellum. This species is widely distributed throughout the Nearctic region, but appears to be relatively uncommon.

The name *strabus,* from the Latin for squinting, refers to the constricted orbital furrow.

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I thank D. Blocker (Manhattan, KS), R. Brown (Mississippi State, MS), J. Hall (Riverside, CA), P. Marsh (Washington, DC), L. Masner (Ottawa, ONT), A. Newton, Jr. (Cambridge, MA), L. Stange (Gainesville, FL), M. Wasbauer (Sacramento, CA), R. Wharton (College Station, TX) and Q. Wheeler (Ithaca, NY) for the kind loans of specimens; and D. C. Darling (Ithaca, NY) for specimens and comments on the manuscript. This material is based upon work supported by the National Science Foundation under Grant No. DEB-8201082.

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FIVE NEW SPECIES OF ORCHESELLINI FROM CENTRAL MEXICO (COLLEMBOLA: ENTOMOBRYIDAE: ORCHESELLINAE)

José A. Mari Mutt

Department of Biology, University of Puerto Rico, Mayaguez, Puerto Rico 00708.

Abstract.—Five new species of Orchesellini are described from specimens collected in five states of Central Mexico and in the Federal District: *Orchesella* ***quinaria****, O.* ***bullulata****, O.* ***impavid****, Pseudodicranocentrus* ***niger****,* and *Dicranorchesella* ***seminuda****. Pseudodicranocentrus circulatus* is reported for the first time from the state of Morelos and a few details are added to its description. Forty-five figures complement the descriptions.

Through the courtesy of José G. Palacios Vargas, Universidad Nacional Autónoma de México, I have been able to study a number of Orchesellini collected by him and his colleagues in five states of Central Mexico and in the Federal District. The material includes six species, five of them new, distributed among three genera. Dr. Kenneth Christiansen, Grinnell College, Iowa, also lent me a specimen that was studied for the present contribution.

Three new species belong to *Orchesella,* a Holarctic taxon that meets its southern limits of distribution in the Nearctic areas of Mexico. The genus was first reported from this country by Palacios Vargas (1981a, b) but no species determinations were made.

The other three species belong in *Pseudodicranocentrus* and *Dicranorchesella,* genera endemic to Neotropical regions of Mexico. In only one instance, reported by Mari Mutt (1977) have species of *Orchesella* and *Dicranorchesella* been collected together. At Derrame del Chichinautzin, Morelos, *Orchesella bullulata* lives on the northern sections above 2150 m and two species of *Pseudodicranocentrus* occur on the southern slopes below 2100 m, but species of these two genera have not yet been found sympatrically.

In the descriptions of the *Orchesella* species I have used the nomenclature system for the chaetotaxy of the third abdominal segment (Abd. 3) as proposed by Christiansen and Tucker (1977), and have adapted this system to the chaetotaxy of Abd. 2. Internal and posterior to the M group is found a macrochaeta which added to the median (M) group forms a median-posterior group (MP, Fig. 14).

All the holotypes and most of the paratypes are temporarily deposited in my collection, some paratypes of all the species are deposited in the collection of J. G. Palacios Vargas, Laboratorio de Acarología, Universidad Nacional Autónoma de México, México, D.F.

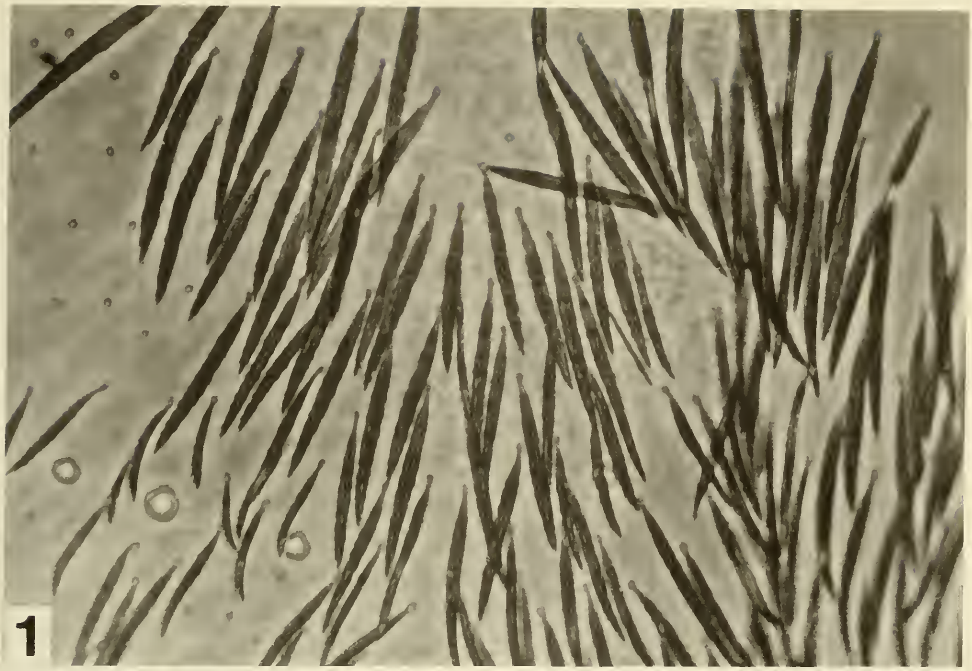
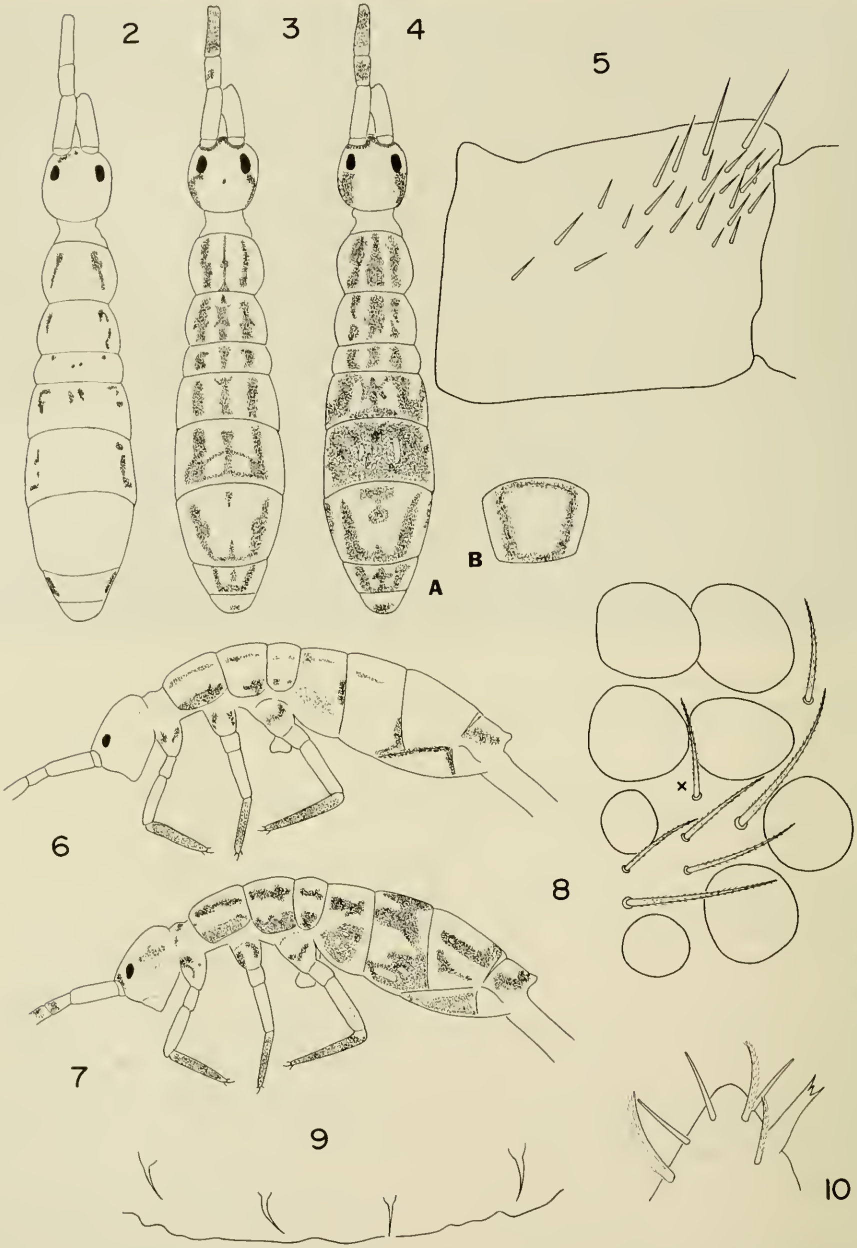


Fig. 1. *Dicranorchesella seminuda.* Scales on tergum of Abd. 2, the three sockets belong to the inner row of 3 macrochaetae present on this segment (Fig. 41).

Orchesella quinaria Mari Mutt, New Species
Figs. 2–17

Length to 4.0 mm. Body background light yellow. Typical color pattern—5 violet-black stripes (1 middorsal, 2 dorsolateral, 2 lateral) extending from the 2nd thoracic segment (Th. 2) to Abd. 4 (Figs. 3, 7). Very light individuals only with traces of these bands (Figs. 2, 6), darker specimens with much pigment between bands, rendering them less distinct (Fig. 4). Head with pigment around antennal bases and behind eyes, extending laterally to venter of head. A small spot of pigment occasionally on center of dorsum of head. Antennal segment 5 (Ant. 5) and Ant. 6 intensely pigmented, other segments with pigment decreasing in intensity towards head. Parts of coxae and tibiotarsi deeply pigmented. Collophore and furcula unpigmented. Apex of Ant. 6 (Fig. 10) with pin seta but without papillae or other projecting structures. Head macrochaetae An, A, M and S 5–7, 6–7, 4–5, and 9–10, respectively (Fig. 11), 3 macrochaetae along midline of head. Interocular chaetotaxy as in Fig. 8, an outer seta external to eyes A and D and 5 setae inside semicircular area defined by eyes C to H. Prelabral setae bifurcated (Figs. 12, 13). Labral papillae with pointed tips (Fig. 9). Differentiated seta of outer labial papilla short, placed far back on its papilla (Fig. 16). Posterior labial row internal to seta E with up to 16 setae per side ($\bar{x} = 9.8$, $n = 8$), all ciliated. Labial setae E, L_1 and L_2 ciliated (L_2 smooth on left labial base of 1 specimen). Macrochaetal formula for Abd. 2: IA = 5–8, OA = 1–2, MP = 3, L = 2 (Fig. 14). Formula for Abd. 3: IA = 3–4, OA = 0–1, M = 2, L = 3 (Fig. 15). Corpus of



Figs. 2–10. *Orchesella quinaria*. 2, Distribution of violet-black pigment on light specimen. 3, Typical specimen. 4A, Dark specimen, 4B, Abd. 4 of specimen from Otongo (Hidalgo). 5, Trochanteral organ. 6, Cf. Fig. 2. 7, Cf. Fig. 3. 8, Eyes and interocular chaetotaxy, seta with x found only on right eyepatch of 1 specimen. 9, Labral papillae. 10, Apex of Ant. 6.

tenaculum with 1 seta. Trochanteral organ (Fig. 5) with up to 100+ slender smooth setae. Inner margin of unguis with basal pair of teeth and 1 unpaired tooth; unguiculus with small tooth on proximal third of one outer lamella (Fig. 17). Dorsum of manubrium with numerous ciliated setae and no smooth setae. Mucro with 2 teeth and basal spine.

Diagnosis.—The Nearctic species closest to *O. quinaria* are *O. zebra* Guthrie, apparently widespread in the eastern half of the United States, and *O. celsa* Christiansen and Tucker, recorded from numerous localities in the same general area. The new species may be distinguished from *O. zebra* by the position of the outer unguicular tooth, number of Abd. 2 MP setae, and number of Abd. 3 IA and M setae. Also, the median longitudinal line in *O. zebra* usually extends across Abd. 4 while even in dark specimens of *O. quinaria* the line is absent from the central portion of the segment.

Some individuals of *O. celsa* could be mistaken for darker specimens of *O. quinaria* but the former has the outer unguicular tooth near the middle of its lamella and possesses fewer Abd. 2 IA setae.

Two European species are similar in coloration to *O. quinaria*: *O. irregularilineata* Stach, known only from the Caucasus mountains, and *O. orientalis* Stach, reported only from the Ukrainskaya SSR. These species possess 4-toothed ungues and the outer unguicular tooth is placed beyond the middle of its lamella. Also, the largest specimens known of these species barely reach 3.0 mm while the largest specimen of *O. quinaria* is 4.0 mm long. The largest specimens of *O. zebra* and *O. celsa* also measure 3 mm or less.

Comments.—Most specimens of *O. quinaria* possess the pigmentation of Abd. 4 shown in Figs. 3 and 4A; a broad V-shaped pattern from the two dorsolateral stripes, and some pigment on the anterior median area representing the median line. Individuals from Otongo (Hidalgo) differ from the others in that Abd. 4 has a rectangular pattern with no trace of the median line (Fig. 4B).

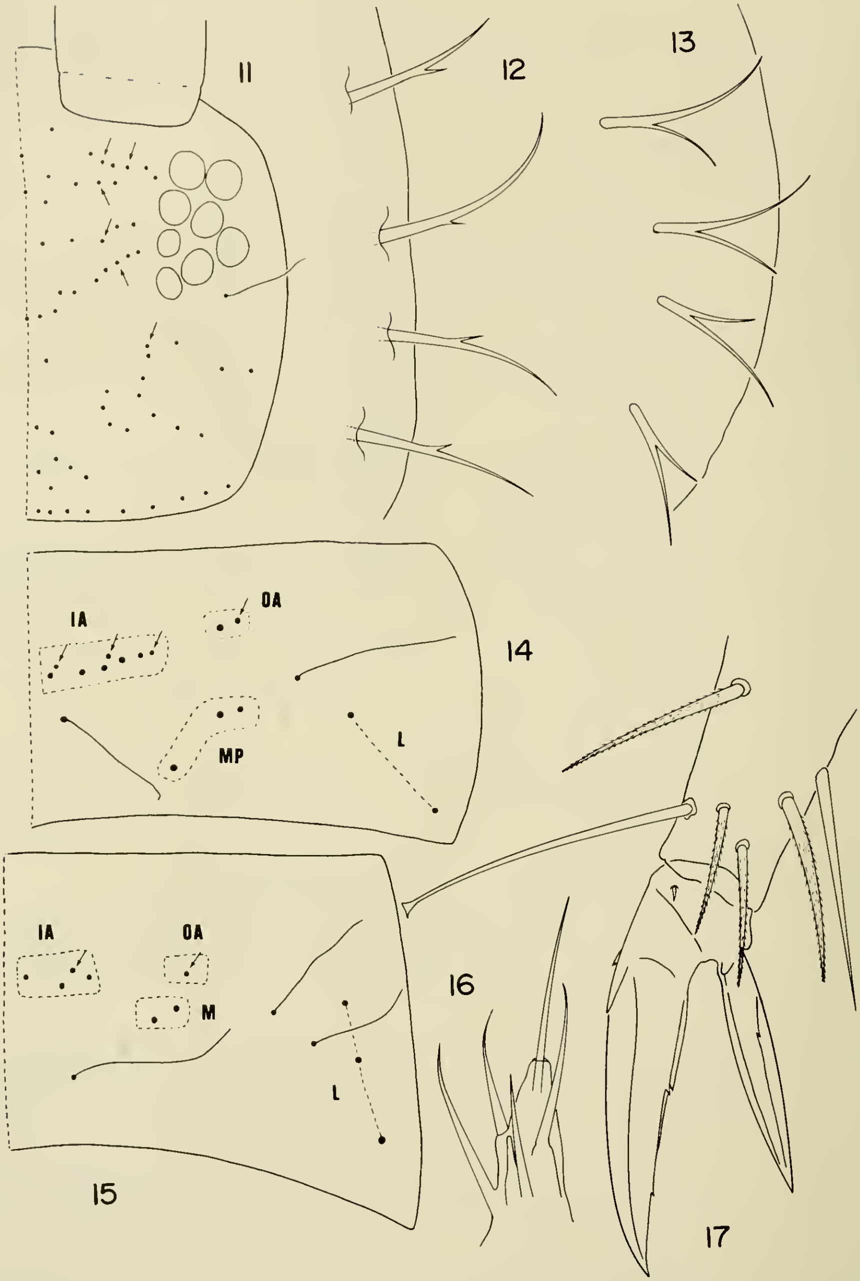
The number of setae on the trochanteral organ increases with the length of the specimen. Lengths (head + body) in mm for five specimens and the number of setae on their left and right trochanters are: 1.9 (27-27), 2.4 (37-40), 2.8 (63-54), 3.1 (75-80), 3.3 (100+-100+).

Material examined.—PUEBLA: Xecotepec de Juárez, 20.I.1980, leaf litter, J. Palacios, holotype and 18 paratypes (2 on slides). HIDALGO: Zacualtipan, road to Ferreria, 1860 m, 10–11.I.1981, bait traps placed on forest soil, A. H. Huacuja, 4 paratypes (2 on slides). As preceding but collected on 20.VI.1980, 1 paratype on slide. Hidalgo, 5 km Alumbres-Zacualtipan, 2160 m, leaf litter in mixed forest, G. Ibarra, 1 paratype on slide. Otongo, 1160 m, 3.IV.1961, necrotrap placed on secondary vegetation, M. A. Morón, 8 paratypes. Otongo, 1120 m, 3.V.–3.VI.1981, 2 paratypes (1 on slide).

Orchesella bullulata Mari Mutt, New Species

Figs. 18–24

Length to 3.9 mm. Body background light brown. Typical color pattern—wide dark-violet median band extending from Th. 2 to Abd. 3 or Abd. 4 and 2 wider broken lateral bands (Figs. 21, 23). Light specimens with more sharply defined bands (Figs. 20, 22). Head with pigment around antennal bases and behind eyes,



Figs. 11–17. *O. quinaria*. 11, Head macrochaetotaxy, setae with arrows absent from some specimens or present only on one side of the head. 12–13, Prelabral setae. 14–15, Macrochaetotaxy of Abd. 2 and Abd. 3, IA = inner anterior, OA = outer anterior, M = median, MP = median posterior, L = lateral; setae with arrows are absent from some specimens or present only on one side of the segment. 16, Outer labial papilla. 17, Metathoracic claws.

extending laterally to venter of head. Ant. 5 and Ant. 6 intensely pigmented, other segments not as intensely colored. Areas of coxae and all of tibiotarsi intensely pigmented, trochanters and femora lightly colored. Collophore with some pigment basally and distally, manubrium pigmented dorsally. Apex of Ant. 6 with a conspicuous protuberance (Fig. 24). Head macrochaetae An, A, M and S 6, 8, 5 and 13–14, respectively (Fig. 19), 3 macrochaetae along midline of head. Interocular chaetotaxy, labral papillae, differentiated seta of outer labial papilla, number of setae on tenaculum, and mucro as in *O. quinaria.* Prelabral setae not bifurcated. Posterior labial row internal to seta E with up to 15 setae per side ($\bar{x} = 9.1$, $n = 6$), all setae ciliated. Labial setae E, L_1 and L_2 ciliated. Macrochaetal formula for Abd. 2: IA = 5–8, OA = 2, MP = 3, L = 2. Formula for Abd. 3: IA = 4–5, OA = 0–1, M = 2, L = 3. Trochanteral organ with up to 54 slender smooth setae. Inner margin of ungues with basal pair of teeth and 2 unpaired teeth, unguiculus with a small tooth on middle of one outer lamella (Fig. 18).

Diagnosis.—The three longitudinal bands on the body should distinguish this species from other Nearctic forms except perhaps some individuals of *O. celsa* Christiansen and Tucker, a widespread species in the eastern half of the United States. Both species differ in the number of inner ungual teeth, number of Abd. 2 and Abd. 3 IA setae, and in the presence of the apical protuberance on Ant. 6 of *O. bullulata.* In addition, the largest individuals of *O. celsa* reach 2.7 mm while the largest specimens of *O. bullulata* are 3.9 mm long.

Orchesella balcanica Stach, known from Bulgaria and Romania, has a somewhat similar color pattern but the median longitudinal line is thinner, Abd. 4 is more intensely pigmented, Ant. 6 apparently lacks the apical protuberance, and the largest individuals reach 4.5 mm.

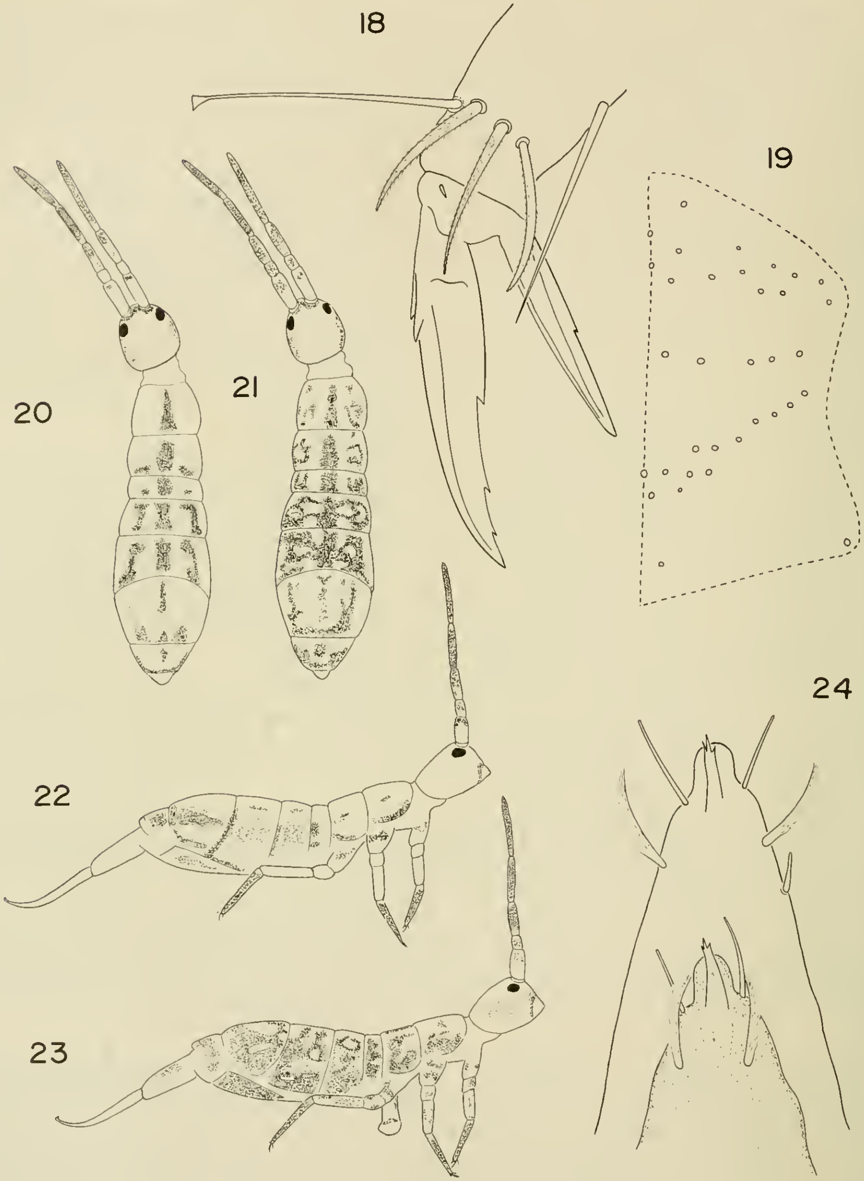
Comments.—There is some variation in the size of the protuberance on Ant. 6. Usually, the dilation is well developed but in a few specimens it is small. One specimen has it reduced on the left antenna and its right antenna lacks this structure. Absence of a cuticular depression suggests that this protuberance is not an eversible papilla. It is not an artifact caused by preservation or mounting procedure because it is present in specimens from various localities, collected on different dates, and also on the antennae of individuals preparing to molt (Fig. 24).

Material examined.—(collected by J. Palacios except as noted). MORELOS: southern slopes of Derrame del Chichinautzin, 22.I.1978, leaf litter, holotype and 20 paratypes (3 on slides). Derrame del Chichinautzin, 2260 m, 5.XII.1976, leaf litter, 2 paratypes (2 on slides). As preceding but 2450 m, *Quercus* leaf litter, 2 paratypes (1 on slide). As for preceding but 2150 m, 25.IV.1976, 1 paratype. MICHOACAN: El Tren, km 38 Rd. Hidalgo-Charo, pine leaf litter, 1 paratype on slide. DISTRITO FEDERAL: Contreras, Primer Dínamo, 9.X.1975, leaf litter, 1 paratype on slide. Barrio Capoltitla, 3000 m, 28.XI.1976, leaf litter, 1 paratype on slide. Road Xochimilco-Oaxtepec, Km 52, 15.I.1982, G. Morales, 7 paratypes (2 on slides). MEXICO: Valle de Bravo, 20.X.1979, pine litter, C. Cramer, 3 paratypes (1 on slide).

Orchesella impavida **Mari Mutt, New Species**

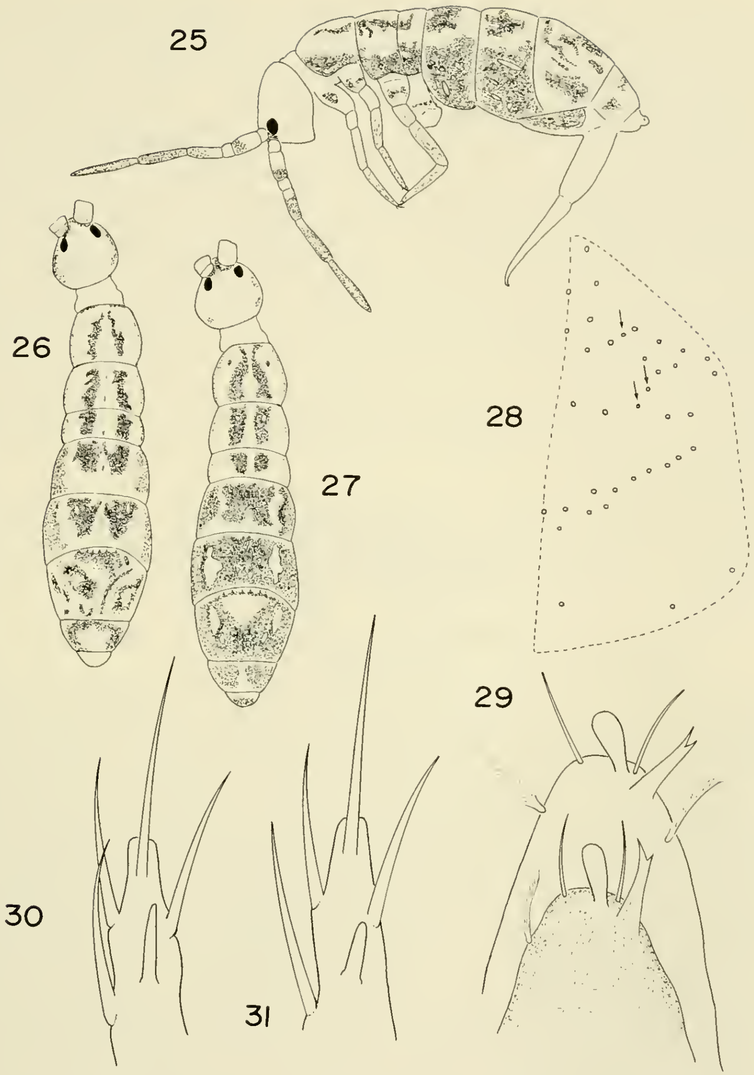
Figs. 25–29

Length to 3.0 mm. Body background light yellow. Typical color pattern—4 violet-black bands extending from Th. 2 to Abd. 3. Paramedial bands clearly



Figs. 18–24. *Orchesella bullulata.* 18, Metathoracic claws. 19, Head macrochaetotaxy. 20, Distribution of dark violet pigment on light specimen. 21, Typical specimen, 22, Cf. Fig. 20. 23, Cf. Fig. 21. 24, Apex of Ant. 6, molting specimen.

separated from each other at least through Abd. 1, most specimens have these bands separated through Abd. 3 (Fig. 26) but in darker specimens the median bands of Abd. 2 and Abd. 3 are fused (Fig. 27). Lateral bands wide, running complete length of specimens (Fig. 25). Head with pigment around antennal bases and behind eyes, extending laterally to venter of head. Ant. 5 and Ant. 6 intensely pigmented, other segments less intensely colored and with pigment restricted



Figs. 25–29. *Orchesella impavida.* 25–26, Distribution of violet-black pigment on typical specimen. 27, Dark specimen. 28, Head macrochaetotaxy, setae with arrows are absent from some specimens or present only on one side of the head. 29, Apex of Ant. 6. Figs. 30–31. *Pseudodicranocentrus circulatus,* outer labial papilla, note presence of one seta near base of differentiated seta and compare the length of the differentiated seta in both figures.

mostly to apical areas. Part of coxae intensely pigmented, other leg segments uniformly but lightly colored. Collophore with some pigment distally. Dark specimens with pigment on dorsum of manubrium. Apex of Ant. 6 with a simple papilla (Fig. 29). Head macrochaetae An, A, M and S 7, 8–9, 4–6, and 12, respectively (Fig. 28), 3 macrochaetae along midline of head. Interocular chaetotaxy seen in 2 specimens, one with 4 inner setae, other with 5 setae. One specimen with a median prelabral seta bifurcated, other prelabral setae of this specimen and of all other specimens not bifurcated. Differentiated seta of outer labial papilla, number of setae on tenaculum, setae on manubrium, and mucro as in *O. quinaria.* Claw structure as in *O. bullulata.* Posterior labial row internal to seta E with up to 6 setae per side ($\bar{x} = 4.7$, $n = 6$), all setae ciliated. Labial setae E, L_1 and L_2 ciliated. Macrochaetal formula for Abd. 2: IA = 8–11, OA = 2–3, MP = 3, L = 1. Formula for Abd. 3: IA = 3, OA = 0–1, M = 2, L = 3. Trochanteral organ with up to 36 slender smooth setae. Male genital plate circinate, with 16 smooth setae in 1 row around periphery of plate, 2 pairs of well developed smooth setae on median portion of plate and 1 pair of very small smooth setae near genital opening.

Diagnosis.—Color pattern is similar to that of *O. ainsliei* Folsom, a widespread species in the eastern half of the United States, and to that of *O. longifasciata* Stach, known from the eastern Alps. From the first, *O. impavida* may be distinguished by the presence of an apical papilla on Ant. 6, only 1 tenacular seta, number of Abd. 2 IA setae, and maximum length of the specimens (2.0 mm in *O. ainsliei,* 3.0 mm in *O. impavida*). Individuals of *O. longifasciata* have less conspicuous lateral pigment bands and the unguicular tooth is inserted before the middle of its lamella.

Material examined.—MEXICO: Volcán Popocatepetl, *Cuppressus* forest, 3000 m, 5.IV.1982, in mosses growing on trees, J. Palacios, holotype and 8 paratypes (2 on slides).

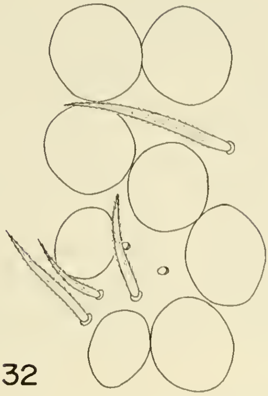
Pseudodicranocentrus niger **Mari Mutt, New Species**

Figs. 32–36

Length to 2.6 mm. Distribution of violet-black pigment as in Fig. 35; parts of antennae, dorsum of head, some leg segments, and dentes light yellow, otherwise animal is almost uniformly black. Apex of Ant. 6 with pin seta and no papilla. Eyes 8 + 8, G and H smaller but well developed. Interocular chaetotaxy as in Fig. 32. Head macrochaetae An, A, M and S 10, 7–8, 4 and 7, respectively (Fig. 33), 3 macrochaetae along midline of head. Some prelabral setae bifurcated. Labral papillae as in *Orchesella quinaria.* Differentiated seta of outer labial papilla short, placed far back on its papilla, with 2 setae flanking its base (Fig. 37). Posterior labial row to seta E with up to 9 setae, all ciliated; setae E, L_1 and L_2 ciliated. Body macrochaetotaxy as in Fig. 34. Trochanteral organ with up to 51 slender smooth setae. Inner margin of tibiotarsi without smooth setae. Tenent hair clavate. Inner margin of ungues with basal pair of teeth and 2 unpaired teeth, unguiculus with a small outer tooth. Dorsum of manubrium with many ciliated setae and no smooth setae or scales, dentes without smooth setae. Dental lobe without compound spines, no spines along inner or outer margins of dentes. Mucro with 2 teeth and basal spine.

Diagnosis.—This species is close to *P. circulatus* (Mari Mutt) which may occur sympatrically with *P. niger* and has been reported from the states of Oaxaca, Puebla and Guerrero, and from Guatemala. Both species can be distinguished by the color pattern (Figs. 35, 36), absence of compound spines on the dental lobe of *P. niger,* details of the macrochaetotaxy of Th. 3 and Abd. 1 (Fig. 34), and by the presence in *P. niger* of two setae flanking the differentiated seta of the outer labial papilla (Fig. 37, cf. Figs. 30, 31).

Material examined.—MORELOS: southern slope of Derrame del Chichinautzin, 2100 m, 4.VII.1976, leaf litter in *Bursera cuneata* forest, J. Palacios, coll. no. Z(54), holotype and 1 paratype (both on slides).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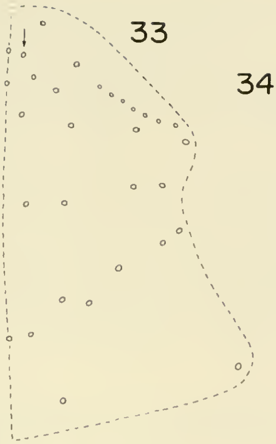
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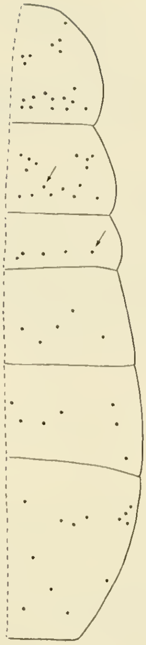
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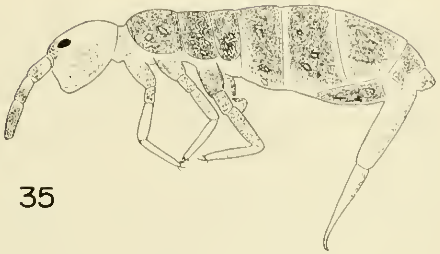
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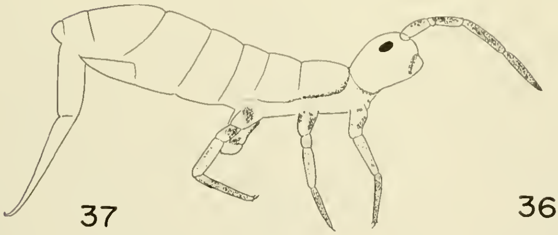
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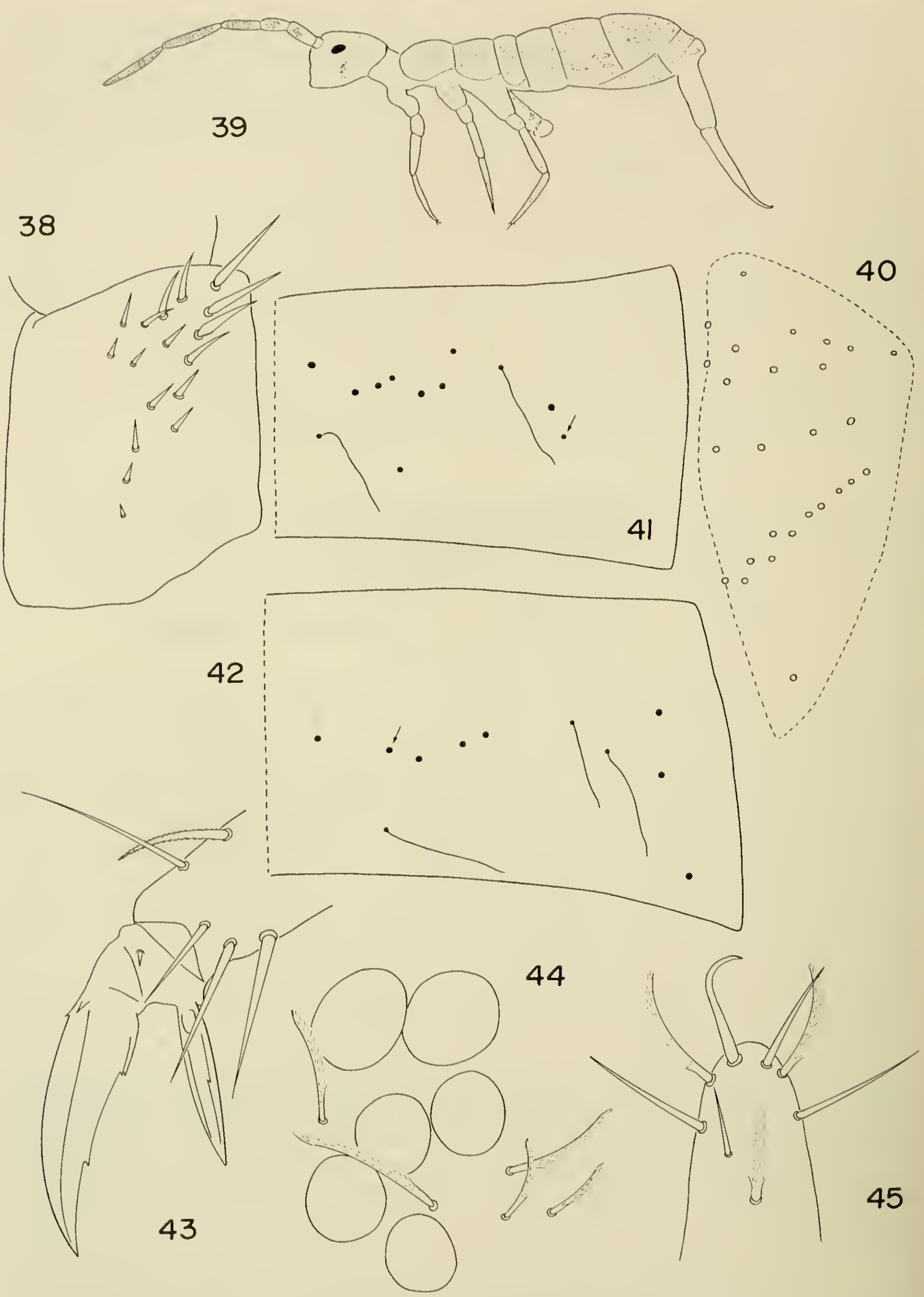
Figs. 32–36. *Pseudodicranocentrus niger.* 32, Eyes and interocular chaetotaxy. 33, Head macrochaetotaxy, this pattern is identical to that of *P. circulatus* except that seta with arrow is absent in the holotype of that species but is present in individuals from Morelos. 34, Body macrochaetotaxy, setae with arrows are absent in *P. circulatus.* 35, Distribution of violet-black pigment. 36, Outer labial papilla, note presence of two setae near base of differentiated seta. 37, *P. circulatus,* distribution of violet pigment.

Pseudodicranocentrus circulatus (Mari Mutt)

Figs. 30–31, 37

This species was described in 1979 and additional notes were added by me in 1981. Individuals sympatric with *P. niger* can be readily distinguished by the characteristic light coloration of this species (Fig. 37). Fig. 33 presents the anterior head macrochaetotaxy of *P. niger,* which is identical to that of *P. circulatus.* This



Figs. 38–44. *Dicranorchesella seminuda.* 38, Trochanteral organ. 39, Distribution of light blue pigment. 40, Head macrochaetotaxy. 41, Macrochaetotaxy of Abd. 2, seta with arrow only on the right side of one specimen. 43, Metathoracic claws. 44, Eyes and interocular chaetotaxy. 45, Apex of Ant. 6.

figure, which I have checked with the holotype, corrects the number of setae in the A and M groups given in my 1979 paper (p. 42).

A minute detail heretofore unnoticed represents a useful character worthy of investigation in other groups. The outer labial papilla of *P. circulatus* lacks a small seta near the base of the differentiated seta (Figs. 30, 31) which is present on both specimens of *P. niger* (Fig. 37).

Material examined.—MORELOS: southern slope of Derrame del Chichinautzin, 2100 m, 4.VII.1976, leaf litter in *Bursera cuneata* forest, J. Palacios, coll. no. Z(54), 3 specimens on slides. OAXACA: forest trail 25–30 km E of Huautla de Jiménez, on way to Cerro Rabón, 23.III.1981, A. Grubbs, 1 specimen on slide. GUERRERO: Zacatecolotla, outside of Aguacachil cavern, 29.XI.1980, J. Palacios, 1 specimen on slide.

Dicranorchesella seminuda **Mari Mutt, NEW SPECIES**

Figs. 1, 38–44

Length to 2.5 mm. Head, body and appendages uniformly light blue (Fig. 39), antennae darker, dentes unpigmented. Dorsum of body segments with ciliated microchaetae and few slender scales (Fig. 1), scales longer and more abundant on venter of furcula. Head, legs, collophore, dorsum of manubrium, and dentes unscaled. Venter of head with ciliated setae and smooth setae. Ant. 5 and Ant. 6 distinctly annulated; Ant. 3 well developed, about 0.75× length of Ant. 4. Apex of Ant. 6 with a long apically curved smooth seta and without pin seta or papillae (Fig. 45). Eyes apparently 6 + 6, G and H not visible in cleared specimens. Interocular chaetotaxy as in Fig. 44, 1 outer seta, 1 inner seta and 3 setae external to eyes C and F. Head macrochaetae An, A, M and S 5, 6, 4 and 11, respectively (Fig. 40), 3 macrochaetae along midline of head. Prelabral setae not bifurcated. Labral papillae and differentiated seta of outer labial papilla as in *Orchesella quinaria.* Posterior labial row internal to seta E with up to 7 setae, 2 always smooth and longer than the ciliated setae. Labial seta E smooth or ciliated, setae 1_1 and 1_2 smooth. Macrochaetotaxy of Abd. 2 and Abd. 3 as in Figs. 41, 42. Trochanteral organ with up to 20 thick spinelike setae (Fig. 38). Inner margin of tibiotarsi with irregular rows of erect smooth setae; 1–4 of these setae may be present on distal outer margin of segment. Tenent hair lanceolate. Inner margin of ungues with 3 teeth, outer margin of unguiculus with a small tooth placed near the middle of its lamella (Fig. 43). Dorsum of manubrium with many ciliated setae and 12–46 smooth erect setae, 1–4 similar smooth setae on dorsal proximal portion of each dens. Dentes with 7–9 spines which towards the mucro gradually transform into curved ciliated setae. Dental lobe with 2–3 short spines. Mucro with 2 teeth and basal spine.

Diagnosis.—This species is closest to *D. boneti* Mari Mutt, reported from the states of Hidalgo, Veracruz and San Luis Potosi. Both may be distinguished by scale morphology (compare Fig. 1 with Mari Mutt, 1978: 133, Fig. 11) and by the absence of scales from the head of *O. seminuda.*

Material examined.—PUEBLA: Xecotepec de Juárez, 20.I.1980, leaf litter, J. Palacios, holotype and 4 paratypes (2 on slides). As preceding but collected 7.IX.1980, 1 paratype on slide.

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PROC. ENTOMOL. SOC. WASH.
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SPECIES COMPOSITION IN A GUILD OF OVERWINTERING *RHYACIONIA* SPP. (LEPIDOPTERA: TORTRICIDAE, OLETHREUTINAE) POPULATIONS IN MARYLAND

Charles L. Staines, Jr., Stephen C. Malan,
Gaye L. Williams and Thomas L. Shea, Jr.

Maryland Department of Agriculture, Plant Protection Section, 50 Harry S. Truman Parkway, Annapolis, Maryland 21401.

Abstract.—A survey was conducted to determine the species composition of *Rhyacionia* populations in Maryland. Three species were detected: *R. frustrana, R. buoliana,* and *R. rigidana.* A total of 75 hymenopterous parasitoids from the families Bethylidae, Braconidae, Chalcididae, Eurytomidae, Ichneumonidae, Perilampidae, and Pteromalidae emerged from the 2368 *Rhyacionia* pupae collected. *Haltichella rhyacioniae* Gahan was the most abundant parasitoid, followed by *Eurytoma pini* Bugbee and *Campoplex frustranae* Cushman.

Larvae of *Rhyacionia* (Lepidoptera: Tortricidae, Olethreutinae) annually cause moderate to heavy damage to pines (*Pinus* spp.) in Maryland nurseries, Christmas tree plantations, and reforestation projects (Lashomb and Steinhauer, 1974). Control of these insects is difficult and results are not always satisfactory.

Powell and Miller (1978) report six species of *Rhyacionia* from Maryland: *R. adana* Heinrich, *R. aktita* Miller, *R. buoliana* (Denis and Schifflermüller), *R. busckana* Heinrich, *R. frustrana* (Comstock), and *R. rigidana* (Fernald). Many Maryland growers assume all pine tip moths in a stand are *R. frustrana.* This study was undertaken to determine the distribution and abundance of the *Rhyacionia* spp. in Maryland.

Materials and Methods

Sites with naturally occurring and planted pines were selected in 22 Maryland counties. Samples were taken between 13 December 1979 and 28 March 1980. Table 1 summarizes host plants reported in the literature of the six *Rhyacionia* spp.

Infested pine tips were placed in plastic bags, and labelled as to host species, date, and collection site. Infested tips were collected from the lower 2 m of the tree from all sides of the host when possible. All trees surveyed were *Pinus* (*Pinus*) spp.

Tips were held at 5°C until processed. *Rhyacionia* pupae and larvae were removed from tips. Larval identifications were made using MacKay (1959). No attempt was made to rear *R. buoliana* larvae. Pupal identifications were made using Yates (1967b) and Dickerson and Kearby (1972). Pupae were placed in

Table 1. Pines occurring in Maryland which have been recorded as host plants of *Rhyacionia* spp.

	R. adana	*R. aktita*	*R. buoliana*	*R. busckana*	*R. frustrana*	*R. rigidana*
Pinus echinata					x	x
P. mugo			x			
P. nigra			x		x	x
P. pungens					x	
P. resinosa	x		x	x	x	x
P. rigida		x	x		x	x
P. strobus			x			
P. sylvestris	x		x	x	x	x
P. taeda		x	x		x	x
P. thunbergii			x		x	
P. virginiana			x		x	x

individual gelatin capsules and grouped in petri dishes according to species and collection site. The dishes were held until 1 July 1980 at 20°C for adult or parasitoid emergence. Adults were identified using Powell and Miller (1978). Parasitoids were identified using Yates (1967a).

RESULTS

Samples were collected from 22 counties (Table 2). Surveys were conducted in all counties except Allegany. No infestations were located in Garrett Co.

Virginia pine (*Pinus virginiana* Mill) and loblolly pine (*P. taeda* L.) were the most commonly infested host species. *Rhyacionia* spp. were also collected from Japanese black pine (*P. thunbergii* Parl.), Scots pine (*P. sylvestris* L.), red pine (*P. resinosa* Ait), Austrian pine (*P. nigra* Arnold) and *Pinus taeda* × *P. rigida.*

Three *Rhyacionia* spp. were found in the survey: *R. buoliana, R. frustrana,* and *R. rigidana.* No specimens of *R. adana, R. aktita* or *R. busckana* were found.

The most abundant species collected was *R. frustrana,* comprising 92% of all tip moths collected. This species was found in all counties collected and specimens were taken from all *Pinus* spp. surveyed. The percentage of *R. frustrana* detected ranged from 76% in Worcester county to 100% in Calvert, Charles, and Washington counties.

The second most abundant species was *R. buoliana,* comprising 4% of all tip moths collected. This species was found in all counties except Calvert, Charles, Garrett, and Washington. The percentage of *R. buoliana* detected ranged from 0% in 4 counties to 11% in Wicomico county. Specimens were collected from *P. virginiana, P. thunbergii,* and *P. taeda.*

The third species found was *R. rigidana,* comprising 4% of all tip moths collected. This species was found in all counties except Calvert, Carroll, Charles, Frederick, Garrett, Howard, Montgomery, and Washington. The percentage of *R. rigidana* detected ranged from 0% in 8 counties to 21% in Worcester County. Specimens were collected from *P. virginiana, P. thunbergii, P. taeda,* and *P. nigra.*

Of the 114 samples, 57 contained only *R. frustrana,* 5 only *R. buoliana,* and 2 only *R. rigidana.* Mixed populations were found in 47 samples. Of the mixed samples, 18 contained *R. frustrana* and *R. buoliana,* 15 contained *R. frustrana* and *R. rigidana,* 2 contained *R. buoliana* and *R. rigidana,* 12 contained all three

Table 2. Distribution and Composition of *Rhyacionia* spp. in Maryland.

County	# Samples	No. *R. frustrana*	% Pop.	No. *R. rigidana*	% Pop.	No. *R. buoliana*	% Pop.	Total
Anne Arundel	7	95	81	15	13	7	6	117
Baltimore	7	145	97	1	1	3	2	149
Calvert	3	51	100	—	—	—	—	51
Caroline	4	85	93	1	1	5	5	91
Carroll	3	41	98	—	—	1	2	42
Cecil	7	133	98	1	1	1	1	135
Charles	6	95	100	—	—	—	—	95
Dorchester	6	130	88	15	10	3	2	148
Frederick	4	113	95	—	—	6	5	119
Garrett	0	—	—	—	—	—	—	0
Harford	7	110	95	1	1	5	4	116
Howard	6	67	91	—	—	7	9	74
Kent	4	116	97	1	1	2	2	119
Montgomery	4	72	96	—	—	3	4	75
Prince Georges	12	140	99	1	1	1	1	142
Queen Annes	5	164	94	2	1	9	5	175
St. Marys	4	94	98	1	1	1	1	96
Somerset	4	66	90	1	1	6	8	73
Talbot	6	233	90	6	2	18	7	247
Washington	2	50	100	—	—	—	—	50
Wicomico	5	175	83	13	6	23	11	211
Worcester	8	112	76	31	21	4	3	147
Total	114	2277	92	91	4	105	4	2473

species, and 3 contained no *Rhyacionia. R. frustrana* was the predominate species when present with the exception of one sample in which *R. frustrana* and *R. buoliana* were present in equal numbers.

A total of 75 hymenopterous parasitoids emerged from the *Rhyacionia* pupae. The parasitoids were: Bethylidae—1 *Gonizus columbainus* Ashmead; Braconidae—1 *Bracon gemmaecola* (Cushman); Chalcididae—16 *Haltichella rhyacioniae* Gahan; Eurytomidae—15 *Eurytoma pini* Bugbee; Ichneumonidae—1 *Atrometus clavipes* (Davis), 14 *Campoplex frustranae* Cushman, 3 *Glypta varipes* Cushman, 1 *Itoplecus quadricingulata* Privancher, and 11 unidentified; Perilampidae—2 *Perilampus hyalinus* Say; Pteromalidae—1 *Dibrachys* sp. and 9 *Habrocytus* sp. All parasitoids emerged from *R. frustrana* except 1 *E. pini* which emerged from *R. rigidana.*

Discussion

From the results of this survey *R. frustrana* is the most abundant and widespread pine tip moth in Maryland. The 46 samples (40%) with mixed populations are slightly lower but similar to the results of Miller and Yates (1964) (45% mixed) and Baer and Berisford (1975) (50% mixed). Information on species composition of tip moth population directly affects the timing of their control. Berisford (1974) and Canalos and Berisford (1981) found that the overwintering populations of *R. frustrana* and *R. rigidana* emerged simultaneously. The second generation of *R.*

rigidana emerged about 20 days later than that of *R. frustrana* (Berisford (1974), Canalos and Berisford (1981)). *R. buoliana* emerges in June in Maryland (Powell and Miller (1978)) while the other species emerge in the spring and again in the summer (Berisford (1974)).

The distribution of *R. buoliana* found by the survey was not expected. Powell and Miller (1978) record *R. buoliana* only from the northern part of Maryland. The results of this survey show the highest populations on the lower eastern shore extending the range of *R. buoliana* about 80 km south to the Virginia border.

The failure of this survey to find *R. adana, R. aktita,* and *R. busckana* was unexpected also. Of the recorded host species endemic to Maryland the only one not sampled was *P. rigida.* This indicates the above species are not common in Maryland.

The low number of parasitoids recovered was surprising. Lewis et al. (1970) found parasitism to be 12% in the overwintering pupae and Harmon (1972) found 4% parasitism for both generations. Our data showed 3% parasitism of the overwintering population. Fox and King (1963) found that parasitoids are more active in the terminal whorl of branches. On larger trees this could be a source of error in percent parasitism. The mean height of surveyed trees was 2.3 ± 1.9 m. Since the terminal whorl of branches was able to be sampled the likelihood of this sampling error was reduced.

The most numerous parasitoid in this study was *Haltichella rhyacioniae.* Lewis et al. (1970) found *Campoplex frustranae* the most abundant parasitoid. Lashomb et al. (1980) found *Lixophaga mediocris* Aldrich (Diptera: Tachinidae) to be the most numerous parasitoid during the growing season. *L. mediocris* was not detected in this survey since it overwinters as an adult (Lashomb and Steinhauer, 1982).

In our study *Eurytoma pini* was the second most abundant parasitoid. Lashomb et al. (1980) found this species to be third in abundance and Harman (1972) found this species to be second in abundance. The results are similar for *Campoplex frustranae.* Lashomb et al. (1980) found this species to be second in abundance and Harman (1972) found it to be third in abundance.

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A REVIEW OF THE GENUS *THOREYELLA* SPINOLA (HEMIPTERA: PENTATOMIDAE)

L. H. Rolston

Department of Entomology, Louisiana State University Agricultural Center, Louisiana Agricultural Experiment Station, Baton Rouge, Louisiana 70803.

Abstract.—The genus *Thoreyella,* which seems restricted to southeastern South America, is redefined. *Thoreyella cornuta, T. taurus* and *T. trinotata* are redescribed and the genitalia of these species and of *T. brasiliensis* are figured, excepting the male of *T. taurus,* which is unknown. Lectotypes and paralectotypes are designated for *Thoreyella cornuta* and *T. trinotata.* A key to the four species is provided. *Thoreyella pentamaculata* is rejected as a member of the genus.

Thoreyella is one of seven American pentatomine genera distinguished by an abdominal spine that projects beneath the metasternum and by bucculae that extend as lobes nearly to or past the distal end of the first rostral segment. Of these genera (*Aleixus, Brepholoxa, Dendrocoris, Odmalea, Rio, Thoreyella* and *Zorcadium*) only *Aleixus, Odmalea* and *Rio* contain species sympatric with *Thoreyella* species, which seem restricted to southeastern South America.

A convenient means of separating *Rio* and *Thoreyella* is the prolongation of the superior femoral surface into an acute apical spine in the latter genus. *Aleixus* is easily recognized by a large dorsal tubercle on each humerus.

Several characters serve to separate *Thoreyella* and *Odmalea.* In *Thoreyella* the juga are contiguous distally, the ostiolar rugae slightly curved, the costal angle of the coria reaches little or not at all beyond the scutellum and the frena extend little past the basal third of the scutellum. On the contrary, in *Odmalea* the juga converge distally but are not normally contiguous, the ostiolar rugae are straight, the costal angle of each corium far surpasses the scutellum and the frena extend beyond the middle of the scutellum.

Four species of *Thoreyella* are recognized here: *T. brasiliensis* Spinola, *T. cornuta* Berg, *T. taurus* Jensen-Haarup and *T. trinotata* Berg. Pirán (1957) described a fifth species, *T. pentamaculata,* which belongs among the Asopinae (Grazia, 1983).

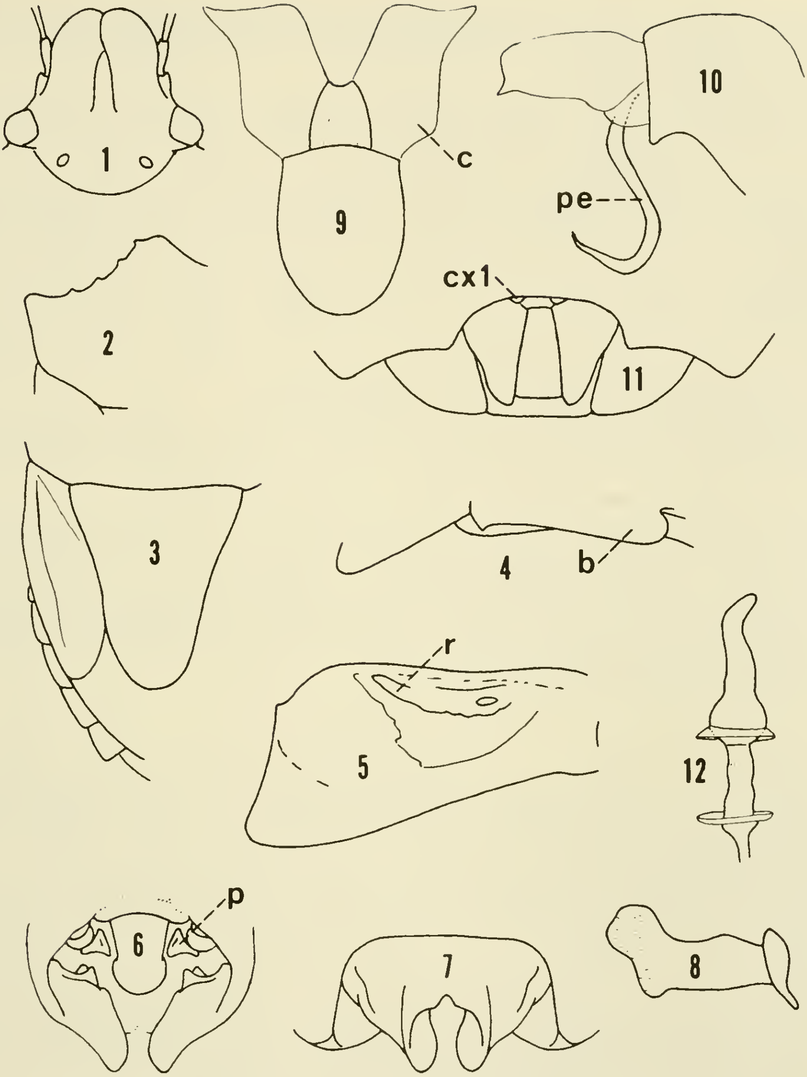
Thoreyella Spinola, 1850

Thoreyella Spinola, 1850, p. 79–80—Spinola, 1852, p. 119–120—Stål, 1872, p. 45 (synonymy)—Jensen-Haarup, 1931, p. 319–320 (key to spp.)—Pirán, 1957, p. 67–68 (key to spp.).

Uditta Stål, 1860, p. 23—Stål, 1867, p. 531 (synonymized by Stål, 1872).

Type species: Thoreyella brasiliensis Spinola, by monotypy.

Head across eyes as wide as or a little wider than long, lateral margins sigmoid,



Figs. 1–12. *Thoreyella brasiliensis*. Fig. 1, Head. Fig. 2, Pronotum. Fig. 3, Scutellum and hemelytron. Fig. 4, Buccula (b). Fig. 5, Metapleuron; ostiolar ruga (r). Fig. 6, Genital cup; parameres (p). Fig. 7, Pygophore, ventral view. Fig. 8, Right paramere. Fig. 9, Theca and related structures; conjunctiva (c); Fig. 10, Same, lateral view; penisfilum (pe). Fig. 11, Genital plates; first gonocoxae (cx 1). Fig. 12, Spermatheca.

tapering to or subparallel before apex, juga contiguous before tylus (Figs. 1, 13, 25, 30).

First antennal segment not surpassing apex of head; second, third, and fourth segments subequal in length (except in *T. brasiliensis*), longer than first, shorter than fifth. Bucculae obtusely to acutely toothed near anterior limit, prolonged as lobe at base of head, extending to or past distal end of first rostral segment (Fig. 4); rostrum reaching metacoxae.

Humeral angles produced, angulate to spinose. Anterolateral margin obtusely rounded, sparcely denticulate or entire, bearing small tubercle at anterolateral angle (Figs. 2, 14, 26, 31).

Scutellum as long as or longer than wide at base; frena reaching little beyond basal third of scutellum. Costal angle of each corium extending beyond scutellum at most by one eight length of scutellum (Fig. 3, 15, 27, 32).

Mesosternum broadly sulcate along meson; prosternum and metasternum flat. Ostiolar ruga curving from each ostiole toward anterior metathoracic margin, extending more than half the distance from inner margin of ostiole to lateral metathoracic margin (Figs. 5, 16, 28, 33). Superior surface of femora prolonged apically as spine (Figs. 17, 34); tibiae flattened or weakly sulcate on superior surface (only anterior pair flattened in *T. brasiliensis*). Abdominal spine projecting between metacoxae, sometimes attaining mesocoxae.

Pygophoral opening narrowing posteriorly on dorsal surface, continuing onto ventral surface (Figs. 6–7, 18–19, 35–36). Theca without lobes; penisfilum lying entirely on vertical median plane (Figs. 9–10, 21–22, 38–39).

First gonocoxae almost or entirely concealed (Figs. 11, 23, 29, 40). Spermathecal bulb elongate, without diverticula, enlarged only at distal flange (Figs. 12, 24, 41).

Comment.—Present incomplete evidence indicates that the lack of thecal lobes and unmodified spermathecal bulb, i.e., the absence of an enlargement other than at the distal flange and lack of diverticula, are generic features of *Thoreyella* contrasting with those of *Odmalea*.

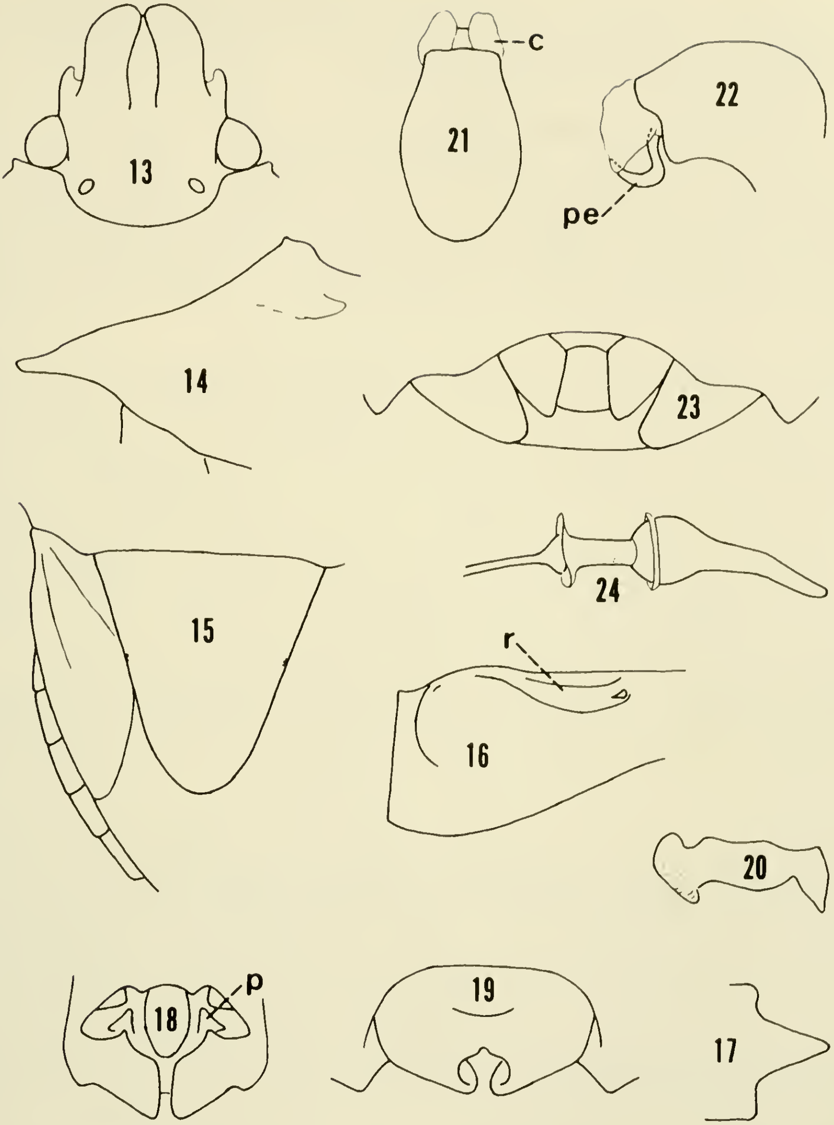
KEY TO SPECIES

1. Each spiracle slightly elevated on conspicuous callus; anterolateral margins of pronotum usually sparsely denticulate (Fig. 2) .... *T. brasiliensis* Spinola
– Spiracles neither elevated nor on callus; anterolateral margins of pronotum without clearly defined denticles 2
2. Width and length of scutellum subequal; lateral margins of juga subparallel before apex of head (Figs. 13, 25); head markedly darker than pronotal disk 3
– Scutellum about one-tenth longer than wide at base (Fig. 32); lateral margins of juga tapering toward apex of head, nowhere subparallel (Fig. 30); head nearly concolorous with pronotal disk .... *T. trinotata* Berg
3. Humeri spinose, turned little or not at all cephalad (Fig. 14) .... *T. cornuta* Berg
– Humeri angulate, directed obliquely cephalad (Fig. 31) .... *T. taurus* Jensen-Haarup

***Thoreyella brasiliensis* Spinola, 1850**

Thoreyella brasiliensis Spinola, 1850, p. 80–81—Spinola, 1852, p. 120–121—Stål, 1872, p.45—Buckup, 1961, p. 13 (record)—Rolston, 1978, p. 22 (synonymy).
Rhaphigaster acutus Herrich-Schäffer, 1851, p. 318. (synonymized by Stål, 1872).
Uditta impicta Stål, 1860, p. 24 (synonymized by Stål, 1872).
Odmalea olivacea Ruckes, 1959, p. 55 (synonymized by Rolston, 1978).

Ruckes (1959) described this species in detail and to his description only illustrations are added here.



Figs. 13–24. *Thoreyella cornuta.* Fig. 13, Head. Fig. 14, Pronotum. Fig. 15, Scutellum and hemelytron. Fig. 16, Metapleuron; ostiolar ruga (r). Fig. 17, Apex of femur, superior surface. Fig. 18, Genital cup; parameres (p). Fig. 19, Pygophore, ventral view. Fig. 20, Right paramere. Fig. 21, Theca and related structures; conjunctiva (c). Fig. 22, Same, lateral view; penisfilum (pe). Fig. 23, Genital plates. Fig. 24, Spermatheca.

The salient features distinguishing *T. brasiliensis* from congeners are the broadly contiguous and often overlapping juga (Fig. 1), the usually denticulate anterolateral margins of the pronotum (Fig. 2), and the ivory callus surrounding and elevating each spiracle.

Distribution.—Brazil: Minas Gerais, Parana, Rio de Janeiro, Santa Catarina, São Paulo, Rio Grande do Sul; Argentina: Misiones, Santa Fe, Buenos Aires. Presumably *T. brasiliensis* occurs in Uruguay since specimens have been taken to the north, west, and south of this country.

Thoreyella cornuta **Berg, 1883**

Thoreyella cornuta Berg, 1883, p. 215—Berg, 1884, p. 31—Pirán, 1956, p. 31.

Unevenly yellowish brown, head much darker dorsally due to rather dense and evenly spaced black punctation and sometimes to darker ground color as well; elsewhere on dorsum punctation mostly castaneous; beneath concolorous excepting some dark punctures on humeri. Length without membranes 6.3 to 7.8 mm.

Juga just contiguous before tylus, their lateral margins subparallel before roundly truncate apex of head (Fig. 13). Vertex and usually base of tylus somewhat elevated. Bucculae acutely toothed at anterior limit but anterior margin of tooth appressed to head. Width of head through eyes 1.5–1.8 mm, length 1.4–1.6 mm. Antennal segments 0.3–0.4; 0.5–0.6; 0.5–0.6; 0.5–0.6; 0.7–0.8 mm in length.

Humeri stoutly produced, spinose, inclined slightly upward, connected by sinuous callus traversing disk (Fig. 14). Anterior pronotal disk usually lighter in color than posterior disk, strongly declivent, sometimes bearing transverse callus passing just caudad of cicatrices. Anterolateral pronotal margins entire, somewhat rough. Width across humeri 5.8–7.5 mm, length at meson 1.8–2.3 mm.

Width and length of scutellum subequal, 2.8–3.4 mm across base. Connexiva moderately exposed, sutures usually outlined in part or whole by darker color.

Ventrally, pronotum marked on each side by dark spot near anterolateral angle and another near distal end of supracoxal cleft. Apical spine of femora prominent, especially long and acute on posterior femora (Fig. 17). Stout abdominal spine reaching mesocoxae, apex bent toward sternum; spiracles thinly black ringed, not elevated; apical angles of abdominal sternites plainly black spotted.

Margin of dorsal opening into genital cup produced as strong tooth directly caudad of parameres (Fig. 18). Apex of parameres bilaterally expanded (Fig. 20), with concave surface facing tumescence on anterolateral walls of genital cup.

Tenth sternite of female slightly longer than wide at distal margin (Fig. 23).

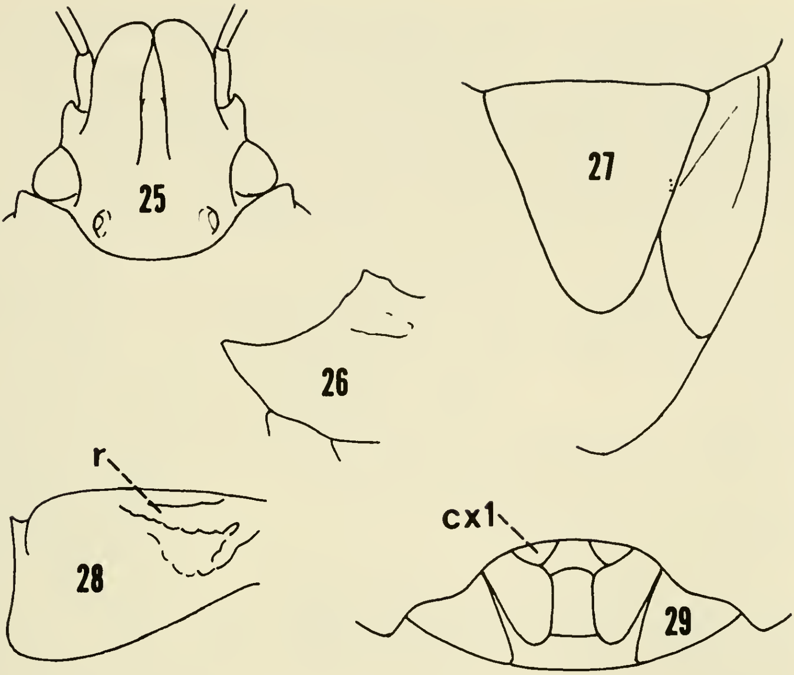
Types.—The following specimen is designated LECTOTYPE: male, labeled (a) Typus (b) Banda Oriental (c) 1409 (d) Museo La Plata. This specimen mounted above female. PARALECTOTYPES, all with same data as lectotype: ♀ mounted beneath lectotype; ♂, ♀ mounted on same pin; ♀ mounted alone.

Distribution.—Uruguay (type locality); Brazil: Mato Grosso; Argentina: Buenos Aires, Entre Ríos. Probably in Paraguay since one specimen examined came from the border town of Bela Vista, Mato Grosso, Brazil.

Thoreyella taurus **Jensen-Haarup, 1931**

Thoreyella taurus Jensen-Haarup, 1931, p. 321.

Mostly light yellowish brown above and beneath, including appendages (olive green when originally described); head darker, humeri suffused faintly with red; body shiny. Punctation dark on head, in spot on scutellum near distal end of each frenum, in part on antenniferous tubercles and humeri, otherwise nearly concolorous. Two black marks located submarginally on each side of pronotum: a small



Figs. 25–29. *Thoreyella taurus.* Fig. 25, Head. Fig. 26, Pronotum. Fig. 27, Scutellum and hemelytron. Fig. 28, Metapleuron; ostiolar ruga (r). Fig. 29, Genital plates; first gonocoxae (cx 1).

mark beneath anterolateral denticle, a larger mark about midway between anterior and humeral angles. Length of body without membranes about 6.9 mm.

Lateral margins of juga parallel for middle third of distance from eyes to apex; juga individually rounded at apex of head (Fig. 25). Ocelli each on low tubercle about twice diameter of ocellus. Antennal segments 0.4; 0.5; 0.5; 0.6; 0.8 mm in length. Head 1.6 mm wide at eyes, equally long.

Pronotum 5.6 mm wide across humeri, 2.0 mm long at meson. Anterolateral margins concave, rough. Humeri stout, turned forward, elevated, acute (Fig. 26). Disk somewhat rugosely punctate, with a low median elevation passing between cicatrices.

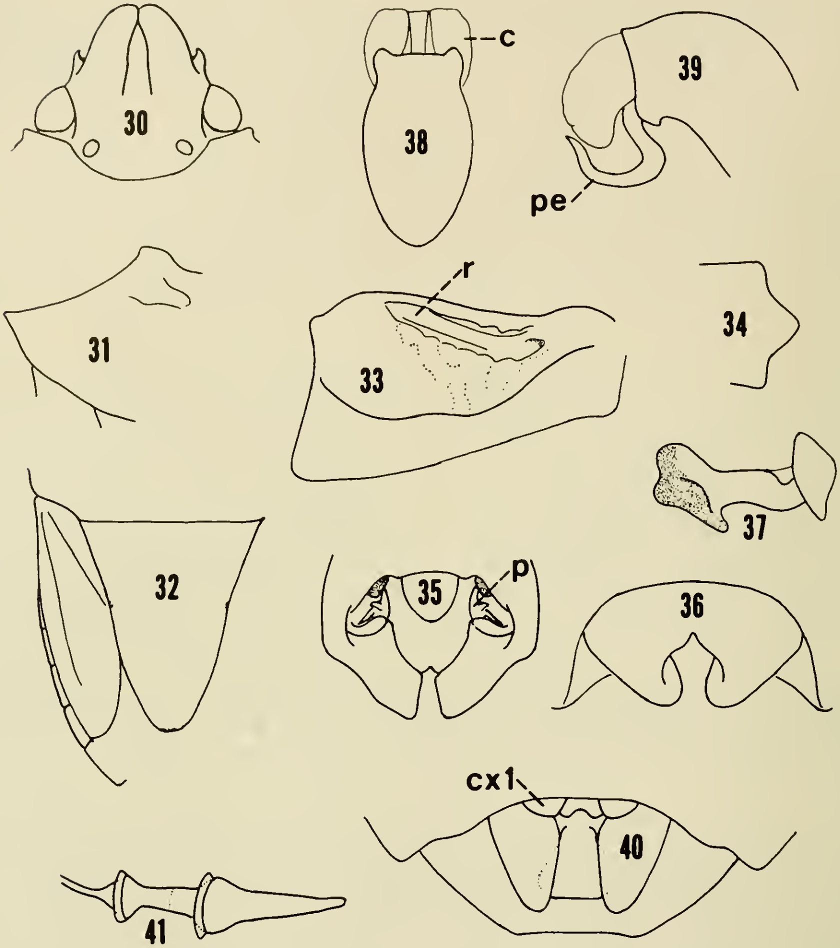
Scutellum 3.2 mm wide at base, nearly as long; apex broadly rounded. Hemelytra covering connexiva (Fig. 27).

Spiracles faintly black ringed, not tuberculate. Abdominal spine damaged in holotype. Apical angles of abdominal sternites black.

Tenth sternite slightly longer than wide distally (Fig. 29).

Distribution.—Known only form female holotype collected at "Lagoa Santa," Brazil. Lagoa Santos, in São Paulo, may have been intended.

Comment.—This species resembles *T. trinotata* but differs especially in that the width and length of the scutellum is subequal, while in *T. trinotata* the scutellum is appreciably longer than wide. The tuberculate ocelli may not be diagnostic since these occasionally appear in *T. brasiliensis.*



Figs. 30–41. *Thoreyella trinotata*. Fig. 30, Head. Fig. 31, Pronotum. Fig. 32, Scutellum and hemelytron. Fig. 33, Metapleuron; ostiolar ruga (r). Fig. 34, Apex of femur, superior surface. Fig. 35, Genital cup; paramere (p). Fig. 36, Pygophore, ventral view. Fig. 37, Right paramere. Fig. 38, Theca and related structures, dorsal view; conjunctiva (c). Fig. 39, Same, lateral view; penisfilum (pe). Fig. 40, Genital plates; first gonocoxae (cx 1). Fig. 41, Spermatheca.

***Thoreyella trinotata* Berg, 1878**

Thoreyella trinotata Berg, 1878, p. 27—Berg, 1879, p. 58—Berg, 1883, p. 214—Berg, 1884, p. 30.

Light brownish yellow above and beneath, antennae and most dorsal punctures somewhat darker, much of dorsum heavily suffused with rufous in a few specimens; conspicuously marked ventrally with submarginal black line on basal half of head and apical third of pronotum, this line interrupted by eye; lateral margins of head, posterolateral margin of each humerus at apex, and apical margin of scutellum all usually thinly edged in fuscous or black; small dark dot present on each side of scutellum near distal end of frena. Length of body without membranes 6.4–7.7 mm.

Punctation on head concolorous, uniform, denser than elsewhere on dorsum. Disk only slightly convex. Lateral margins of juga barely concave before eyes, tapering toward apex (Fig. 30). Antennal segments 0.3; 0.4–0.5; 0.4–0.5; 0.5–0.6; 0.6–0.7 mm in length. Head 1.4–1.6 mm wide across eyes, 1.2–1.4 mm long.

Pronotum 4.5–5.2 mm wide at humeri, 1.7–2.0 mm long at meson. Anterolateral margins obtuse, entire. Humeral angles moderately produce, angular to subacute (Fig. 31). Cicatrices poorly differentiated.

Scutellum 2.5–3.0 mm wide, 3.0–3.6 mm long, rather sparsely punctate, moderately rounded at apex (Fig. 32). Coria surpassing scutellum by less than one-eight length of scutellum; membrane vitreous with inconspicuous venation. Connexiva immaculate, narrowly exposed.

Venter immaculate excepting submarginal black streak at base of head and apex of pronotum. Abdominal spine subcylindrical, rather stout, reaching between metacoxae. Apical spine on superior femoral surface obtuse (Fig. 34).

Margin of dorsal opening into genital cup prominently sulcate directly caudad of parameres (Fig. 35).

Medial edge of ninth paratergites triangularly depressed (Fig. 40).

Types.—The following specimen is designated LECTOTYPE: male, labeled (a) Typus (b) Buenos Aires (c) 1411 (d) Museo La Plata (missing right hemelytron; left hemelytron broken). PARALECTOTYPES: ♀, (a) Typus (b) Buenos Aires (c) *Thoreyella 3-notata* Berg (d) 45 (e) 1411 (f) Museo La Plata (left hemelytron missing); ♀, (a) Typus (b) Baradero, F. Lynch (c) 1411 (d) Museo La Plata; ♀, same data as lectotype.

Distribution.—Paraguay: Ascuncion; Uruguay; Argentina: Entre Ríos, Buenos Aires (type locality).

Comment.—When Berg described this species he noted that at least one of the six examples was rich green ("Laete virides") and this is probably the usual ground color in life.

ACKNOWLEDGMENTS

I am grateful to N. Møller Andersen of the Universitetets Zoologiske Museum, Luis De Santis of the Universidad Nacional de La Plata, and P. Wygodzinsky of the American Museum of Natural History for the loan of types and other specimens in their care, and to R. C. Froeschner of the U.S. National Museum, W. R. Dolling of the British Museum (Natural History) and P. H. van Doesburg of the Rijksmuseum van Natuurlijke Historie for the loan of specimens pertinent to this review. Dra. J. Grazia kindly provided information concerning *Thoreyella pentamaculata* Pirán.

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86(4), 1984, pp. 835–839

CLASTOPTERA ARBORINA: SEASONAL HISTORY AND HABITS ON ORNAMENTAL JUNIPER IN PENNSYLVANIA (HOMOPTERA: CERCOPIDAE)

A. G. WHEELER, JR.

Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania 17110.

Abstract.—The seasonal history and habits of the spittlebug *Clastoptera arborina* Ball, often misidentified in the eastern United States as *C. juniperina* Ball, were observed in southeastern Pennsylvania on *Juniperus chinensis* cv 'Hetzii' during 1981–82. Overwintered eggs of this univoltine cercopid hatched in mid-May, and adults began to appear during mid-July. Notes on host plants and records of *C. arborina* from New York, North Carolina, and Tennessee are given.

Clastoptera arborina Ball, described from Iowa, has been misidentified in much of the subsequent literature as *C. juniperina* Ball. Hamilton (1978) showed that *C. newporta,* which Doering (1929) described as new from Connecticut, New Jersey, New York, and Rhode Island, is a junior synonym of *arborina.* For *C. arborina* sensu Doering, an undescribed species, Hamilton described *C. doeringae,* a cercopid found on *Juniperus* spp. from British Columbia to Arizona and New Mexico. *C. arborina* now is known from southern Ontario south to North Carolina and west to Iowa (Hamilton, 1982).

The scant biological information on *C. arborina* in eastern United States has been published under the name *C. juniperina,* a primarily Rocky Mountain species correctly interpreted by Doering (1929) (see Hamilton, 1978) [her eastern records of *juniperina* (District of Columbia, Massachusetts, West Virginia) were taken from Ball (1927) and probably are based on misidentifications]. Thus, Hanna and Moore (1966) and Hanna (1970) recorded *arborina* (as *juniperina*) from ornamental juniper in Michigan, noting that nymphs are present during June and July; adults, from July to September. Other brief references to the habits of "*juniperina*" that should be referred to *C. arborina* are those of Wilson (1977) in his guide to conifer insects of the Lake States and Wheeler et al. (1981) in a manual of juniper-associated arthropods of Pennsylvania.

In this paper the seasonal history and habits are presented for a population studied on ornamental juniper in southeastern Pennsylvania. Notes on host plants and additional distribution records are given, and development of *C. arborina* in Pennsylvania is compared with that in more northern (New York) and southern populations (North Carolina).

METHODS

The seasonality of a large population of *C. arborina* was followed by sampling a hedge of Hetz juniper, *Juniperus chinensis* cv 'Hetzii,' in a nursery at Gwynedd

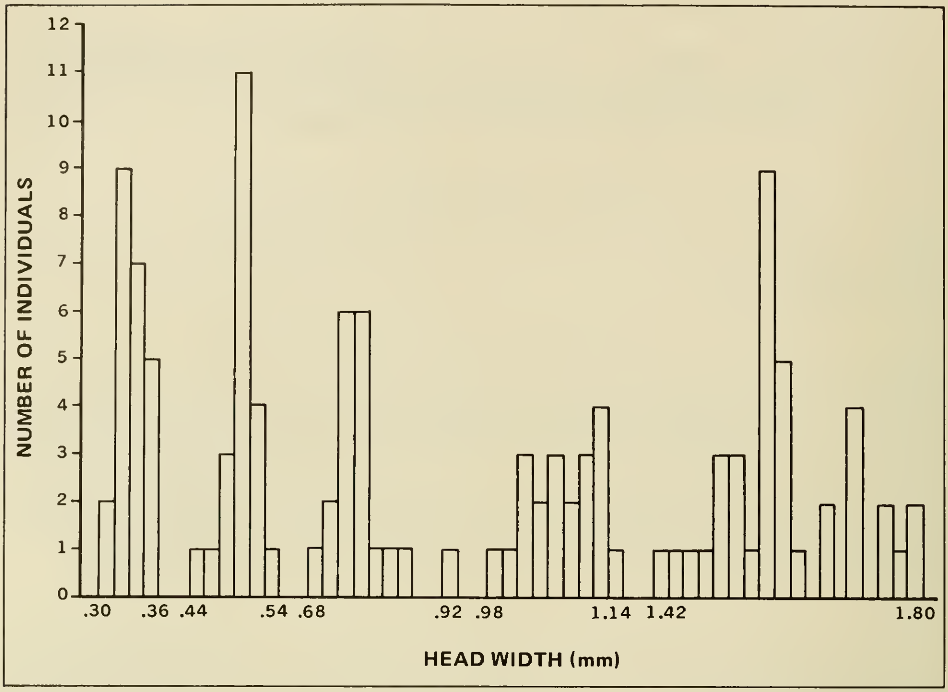

Fig. 1. Measurements of head capsules (greatest width across eyes, in mm) of nymphs of *Clastoptera arborina.*

Valley (Bucks Co.), Pennsylvania. Sampling began on 3 June 1981 when small spittle masses became apparent; the overwintered eggs, however, had hatched somewhat earlier because the population consisted mainly of second-instar nymphs. Each week from 3 June to 2 July, 10 twigs containing spittle masses were chosen at random, pruned from the hedge, and placed in 70% ethanol for later sorting. In the laboratory, head capsules of the first 10 nymphs examined (some spittle masses contained 2 nymphs) were measured (greatest width across eyes) to determine the stages present. Fig. 1, based on the measurements of 121 nymphs, illustrates the presence of 5 instars in *C. arborina.*

In 1982 the same sampling scheme was followed, and more careful early-season observations were made to determine the time of egg hatch. Nymphs were not found on 11 May, but first instars were present by 20 May. When fifth instars appeared (24 June), the hedge was sampled by beating branches over a small tray to determine the appearance of adults. Once adults were found, the relative proportion of late instars to adults was estimated. Late-season collections were made near the sample site and at other localities in Pennsylvania to determine how long adults are present. A sample of 10 nymphs also was taken on ornamental juniper at Ithaca, New York and at Charlotte, North Carolina.

Seasonal History and Host Plants

Eggs overwinter in the terminal shoots of juniper. They are laid singly (occasionally 2 are placed closed together) and inserted obliquely just beneath the

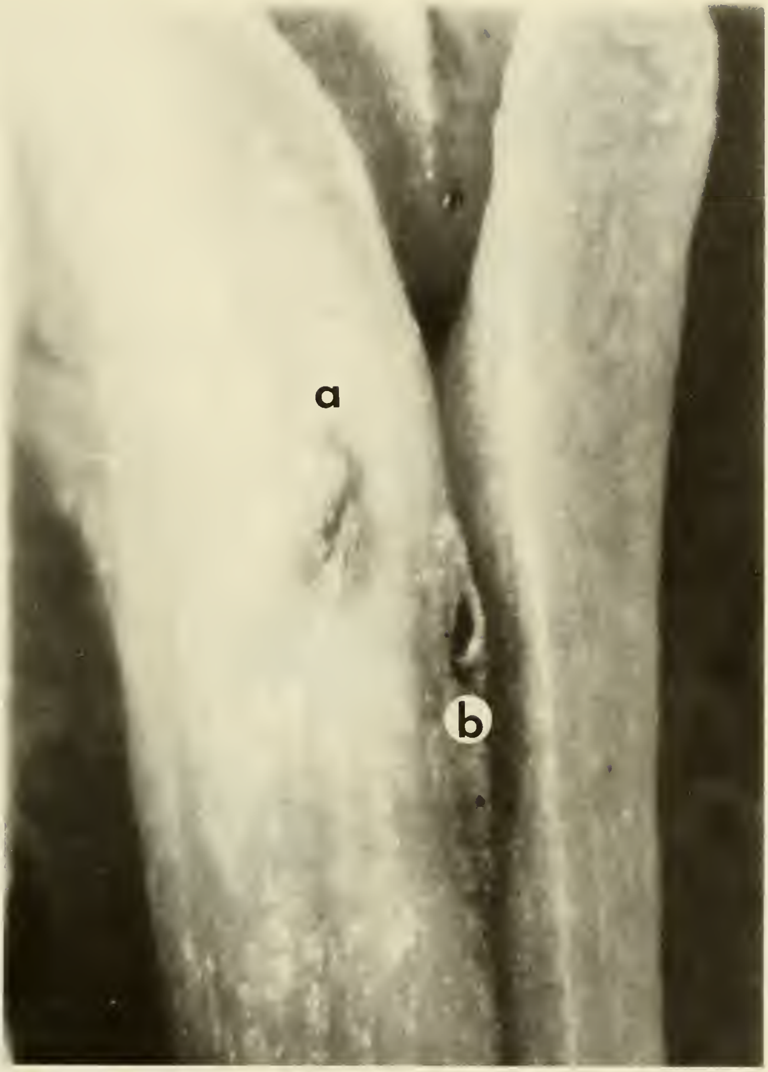

Fig. 2. Basal portion of juniper leaf and subjacent region on stem showing egg of *Clastoptera arborina* (a) and an oviposition site with egg removed (b).

epidermis of the current season's growth. The operculum is flush with the surface but visible externally; a brown necrotic area sometimes surrounds the oviposition site (Fig. 2). The egg, roughly ovoid, is about 0.40 mm wide and 0.80 mm long. Eggs excavated from juniper leaders collected in late March contained embryos lying within a hardened shell. A dark, scalelike egg burster, perhaps characteristic of *Clastoptera* spp. (see Hanna, 1969) or even cercopids in general (Hamilton, 1982), lies beneath the operculum.

Overwintered eggs begin to hatch in mid-May in southeastern Pennsylvania (Fig. 3). The first-instar nymphs settle on small twigs (2–3 mm diameter) of the terminal branches, with spittle masses often observed in twig axils within 1–2 cm

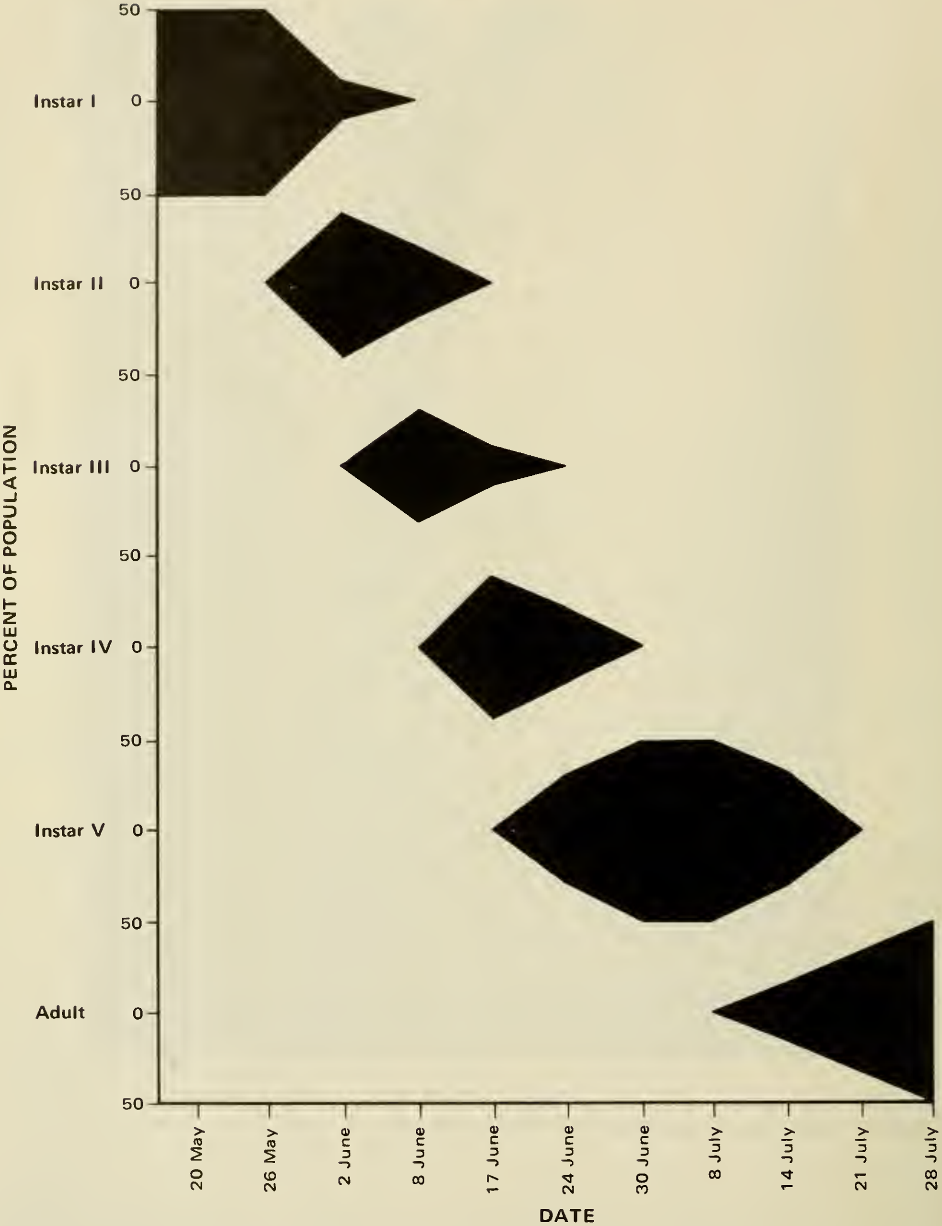

Fig. 3. Development of *Clastoptera arborina* on *Juniperus chinensis* cv 'Hetzii' in 1982 in southeastern Pennsylvania from time of first egg hatch to the appearance of adults. Overwintering eggs are not indicated.

of the tip. In the weekly samples second-instar nymphs were present by the first week of June (Fig. 3) and fourth instars, by 17 June. A few fifth-instar nymphs were found one week later, and the samples of 30 June and 8 July contained only nymphs of this stage. The first adults were taken on 14 July. An old spittle mass may persist on shoots as a whitish powder several weeks after the adult has emerged. Seasonality was similar in 1981 except that populations developed slightly earlier. Fifth instars (3 of 15 nymphs collected) were observed on 18 June, and adults appeared by 2 July. Adults were common during mid-to late July and, although sampling was discontinued after July, collections at nearby localities indicate that adults of this univoltine species are present in small numbers through August.

A sample of 10 nymphs taken on 26 June at Ithaca, New York, contained mostly third instars with a few second and fourth instars present. Adults in this more northern population were collected as late as early September. At Charlotte, North Carolina, instars II–IV were found on 21 May with third instars predominating at this more southern locality.

C. arborina seems to develop the largest populations on ornamental junipers rather than on native eastern red-cedar, *Juniperus virginiana* L. In New York (Monroe and Tompkins Co.), North Carolina (Mecklenburg and Rockingham Co.), and Pennsylvania (Bucks, Dauphin, and Northampton Co.) it has been observed on *J. chinensis,* especially the cultivars 'Hetzii' and 'Pfitzeriana,' and on cultivars of *J. virginiana.* The large numbers of spittle masses sometimes seen on ornamental juniper may attract the attention of horticulturists, but the feeding of *C. arborina* does not cause obvious injury and does not appear to affect plant vigor. In Tennessee (Knox Co.) I have taken this cercopid on native red-cedar. In Michigan, this species has been collected on ornamental junipers and occasionally on arborvitae (*Thuja*), but it is not known to occur on native red-cedar (Hanna and Moore, 1966; Hanna, 1970).

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I am grateful to Frank G. Stearns (Pennsylvania Department of Agriculture, Region VII, Lansdale, PA) for his faithful sampling of *C. arborina,* K. G. A. Hamilton (Biosystematics Research Institute, Agriculture Canada, Ottawa, Ontario) for identifying the cercopid, Priscilla S. MacLean for measuring head capsule widths, and J. F. Stimmel for the photograph used in Fig. 2 and for helping prepare Figs. 1, 3. E. R. Hoebeke (Department of Entomology, Cornell University, Ithaca, NY) and K. Valley (Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg) offered useful comments on the manuscript.

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A NEW SPECIES OF *TOXOMERUS* (DIPTERA, SYRPHIDAE) FROM BRAZIL, WITH NOTES ON THREE RELATED SPECIES

RALPH E. HARBACH

3139 Castleleigh Road, Silver Spring, Maryland 20904.

Abstract.—A new species, *Toxomerus* ***sedmani*** Harbach (Diptera, Syrphidae), from Belém, Pará, Brazil is separated and described from the paratype series of *Toxomerus apegiensis* (Harbach). Additionally, the genitalia of the male holotypes of three other *Toxomerus* species are illustrated.

While studying a small group of *Toxomerus* species from Belém, Pará, Brazil (Harbach, 1972), I discovered a new species, *Toxomerus apegiensis* (Harbach), that appeared to be related to *Toxomerus croesus* (Hull). Although it was desirable to compare the new species with the type of *croesus,* the latter was then in the collection of F. M. Hull and not available for examination. For comparative purposes, I borrowed specimens identified as *croesus* from the Canadian National Collection. When I described *apegiensis* (Harbach, 1974), I included an illustration of the male genitalia of the specimens identified as *croesus.* Unfortunately, as I later learned, these specimens had been misidentified. I also found that one of the male paratypes of *apegiensis* was not conspecific with the type. Upon reexamination of all the pertinent material, I determined that the misidentified species was *Toxomerus sylvaticus* (Hull) and found the *apegiensis* paratype to be an undescribed species related to *Toxomerus purus* (Curran). Therewith, the purpose of this work is to describe the new species and provide a brief discussion and detailed illustrations of the male genitalia of *croesus, purus* and *sylvaticus.*

Toxomerus sedmani **Harbach, NEW SPECIES**

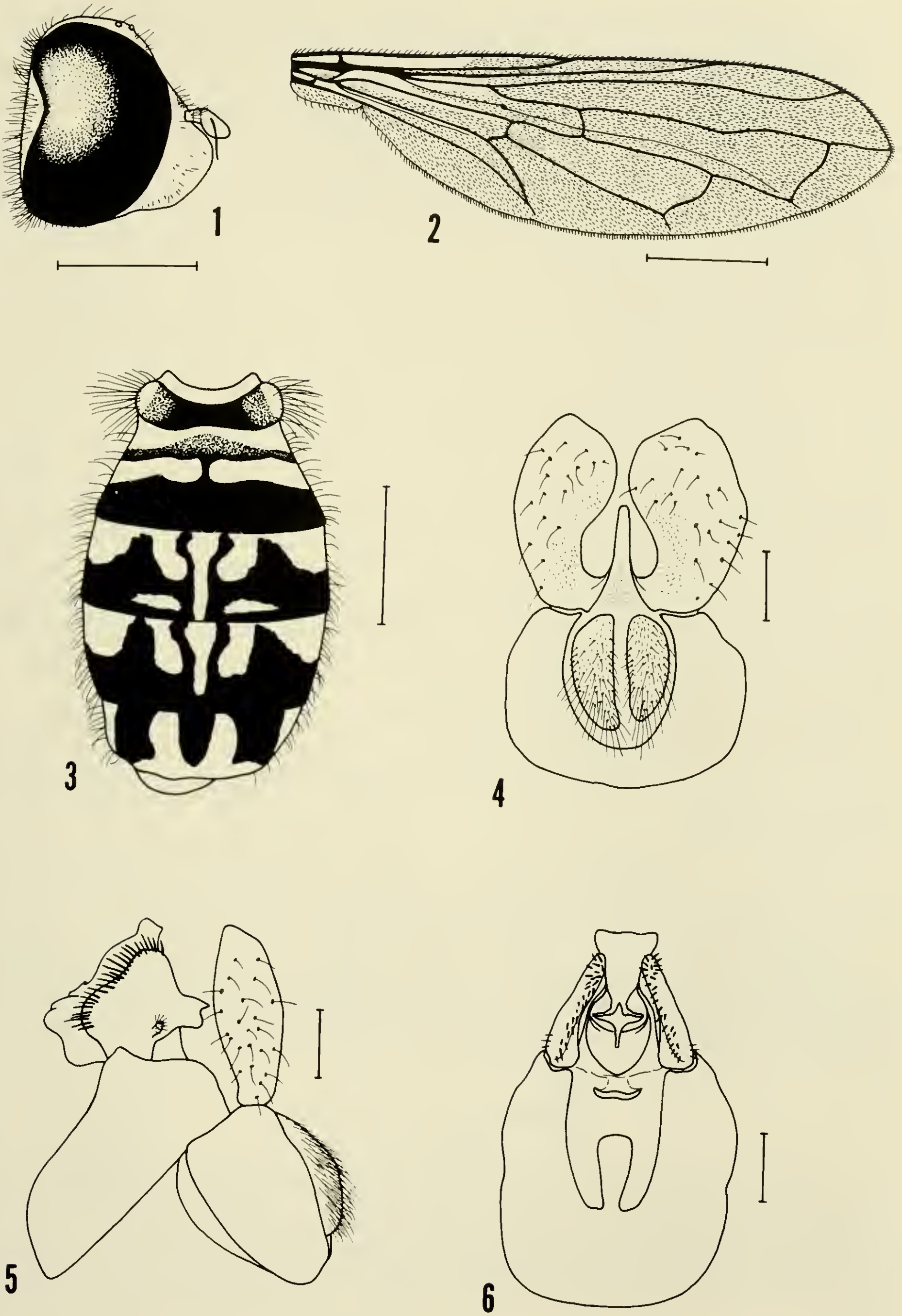
Figs. 1–6

Mesograpta apegiensis Harbach 1974: 31 (in part, one male paratype only).

Male.—Length about 6 mm; body shiny.

Head (Fig. 1): Face yellow, sparsely yellow setose, white pollinose laterally; gena yellow, narrowly brown dorsally; frons yellow, lunule brownish; vertex anterior to ocelli yellow pollinose, ocellar triangle and posterior ½ of vertex black with blue and violet reflections and bluish-green pruinescence; occiput black, golden pollinose dorsally with black setae, densely yellowish-white pollinose laterally with pale yellow scalelike setae; postgena brown, sparsely pale yellow pollinose, yellow setose; antenna yellow, slightly brownish distally, arista brown.

Thorax: Postpronotum yellow; scutum dark brown, yellow setose, with median anterior pale blue pollinose stripe not reaching transverse suture and broad median area black pruinose, the lateral margin yellow and confluent with notopleuron of same color; scutellum brown with margin broadly yellow, brown setose; medio-



Figs. 1–6. *Toxomerus sedmani,* holotype male. 1, Head (right side, drawn before right antenna was discovered missing). 2, Right wing. 3, Abdomen (dorsal). 4, Genitalia (dorsal). 5, Genitalia (lateral, left side). 6, Genitalia (ventral). Scale lines equal 1.0 mm (Figs. 1–3) and 0.125 mm (Figs. 4–6).

tergite, laterotergite, propleuron and mesopleuron mainly brown; propleuron and anatergite golden pollinose; mesopleuron sparsely yellow setose, yellow on posterior ½ of mesanepisternum, yellow spot on dorsal part of mesokatepisternum, brown areas with bluish-white luster; katatergite pale yellow pubescent; metapleuron and halter yellow. *Legs*: Mainly yellow and yellow setose; proximal ½ of forecoxa and basal ⅓ of midcoxa brown and golden pollinose; midfemur with dorsal preapical brown spot; hindfemur with preapical brown band; hindtibia brown except base and apex; hindtarsus brown setose with fourth and fifth tarsomeres brown; claw black on distal ½. *Wing* (Fig. 2): Yellowish brown, pterostigma slightly darker; distribution of microtrichiae as figured.

Abdomen (Fig. 3): Oval, yellow setose; sterna yellow; tergum 1 dark brown with bluish pruinescence medially, reddish brown sublaterally, yellow laterally; tergum 2 with four fasciae, narrow anterior reddish-yellow fascia widened laterally, 2nd fascia reddish brown and widened medially, irregular 3rd fascia reddish yellow and divided by a narrow median vitta that connects the 2nd and posterior fasciae, the broad posterior fascia dark brown with bluish pruinescence; tergum 3 reddish yellow with pattern of dark brown bearing bluish pruinescence, the reddish yellow areas include a narrow median vitta, 2 submedial lunulate spots, the basolateral angles and a pair of submedial transverse spots near the posterior margin; tergum 4 same as 3 except median vitta not reaching posterior margin and submedial transverse spots absent; tergum 5 reddish yellow with 3 dark brown vittae, the median vitta narrowed and rounded posteriorly, the sublateral vittae somewhat rectangular. *Genitalia* (Figs. 4–6): As figured.

Holotype.—Male with the following collection data: BRAZIL, Pará, Belém, 30 May 1967, Coll. Y. Sedman; and bearing a yellow paratype label and the determination label of *Mesograpta apegiensis* Harbach. Deposited in the Canadian National Collection.

Discussion.—The paratype series of *Toxomerus apegiensis* includes one male of *sedmani* that is obviously not conspecific with the type of *apegiensis*. The specimen apparently did not contribute to the description of *apegiensis*.

Toxomerus sedmani bears a striking resemblance to *purus* (Curran), differing by the character of the scutum (that of *purus* has three grayish stripes) and the structure of the male genitalia (see below). The species is named in honor of Yale S. Sedman who guided my M.S. thesis research and collected the holotype specimen.

***Toxomerus croesus* (Hull)**

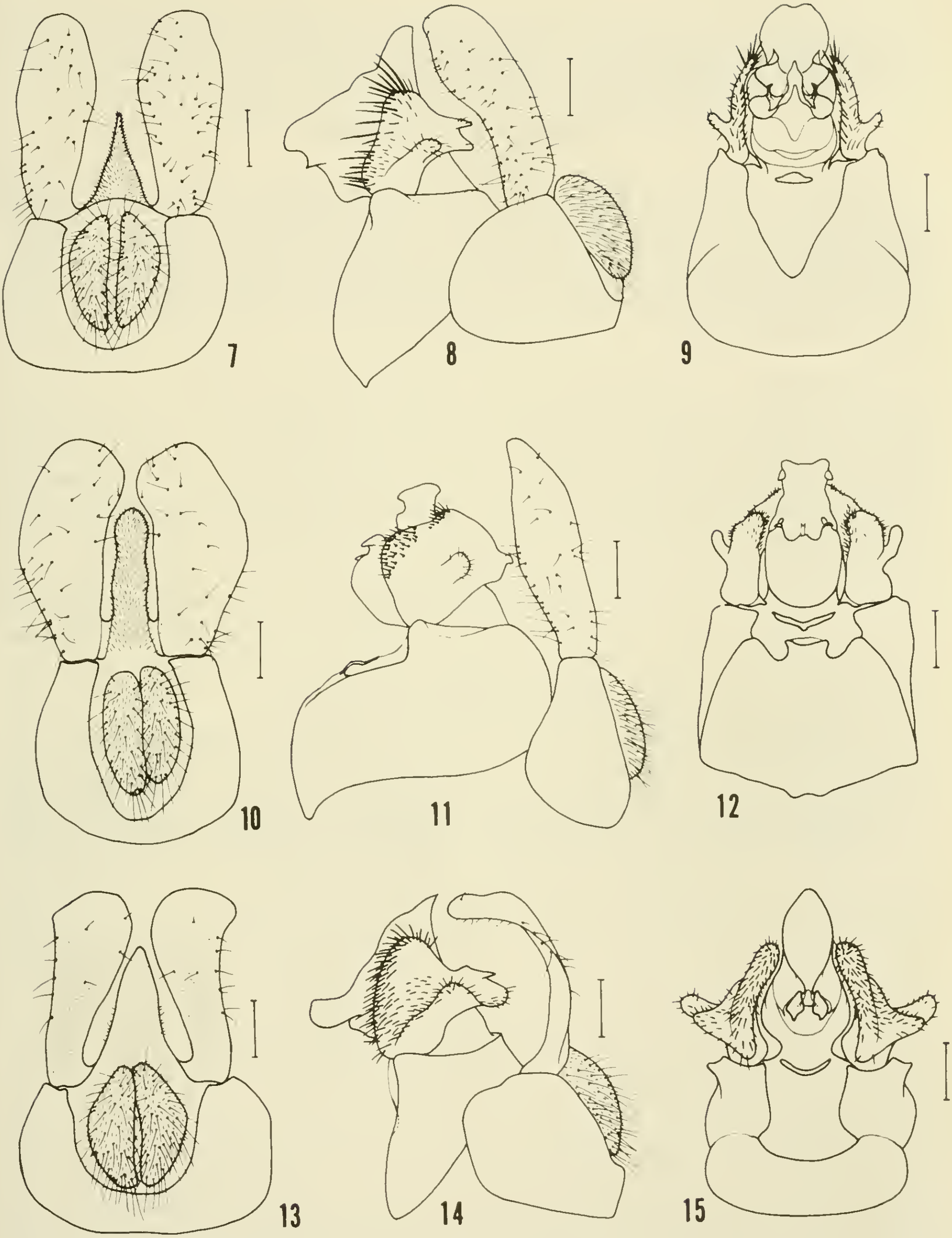
Figs. 7–9

Discussion.—The male genitalia of the holotype of *croesus* show that this species is more closely related to *sedmani* and *Toxomerus pictus* (Macquart) than to *apegiensis*. It is easily distinguished from these by the character of the median caudal lobe (= hypoproct of McAlpine, 1981) borne between the bases of the surstyli.

***Toxomerus purus* (Curran)**

Figs. 10–12

Discussion.—The genitalia of the male holotype of *purus* differs markedly from that of *sedmani* despite otherwise remarkable similarity between the two species.



Figs. 7–15. Male genitalia. 7–9, *Toxomerus croesus* (Hull), holotype. 10–12, *Toxomerus purus* (Curran), holotype. 13–15, *Toxomerus sylvaticus* (Hull), holotype. 7, 10, 13—Dorsal. 8, 11, 14—Lateral (left side). 9, 12, 15—Ventral. Scale lines equal 0.125 mm.

The male genitalia of *purus* bears pronounced resemblance to that of *Toxomerus flaviplurus* (Hall), as figured by Harbach (1972) and Gerdes (1974), although the two species differ significantly in external color pattern.

***Toxomerus sylvaticus* (Hull)**

Figs. 13–15

Discussion.—The male genitalia of the holotype of *sylvaticus* is quite distinct and bears little resemblance to that of other species which have been illustrated. This species is readily separated from both *croesus* and *apegiensis* by the characteristically-curved surstylus and the large lateral lobe of the paramere.

ACKNOWLEDGMENTS

I am grateful to J. R. Vockeroth, Biosystematics Research Institute, Agriculture Canada, Ottawa, Ontario for drawing my attention to the misdetermined paratype of *apegiensis* and the specimens that were misidentified as *croesus*. Thanks are due Pedro Wygodzinsky, American Museum of Natural History as well as Dr. Vockeroth for the loan of specimens. F. Christian Thompson, Systematic Entomology Laboratory, USDA, commented on the manuscript.

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AN ANNOTATED LIST OF THE MIRIDAE (HETEROPTERA) FOUND IN THE YAZOO-MISSISSIPPI DELTA AND ASSOCIATED AREAS IN ARKANSAS AND LOUISIANA

G. L. Snodgrass, T. J. Henry, and W. P. Scott

(GLS) Department of Entomology, Mississippi State University, Mississippi State, Mississippi 39762; (TJH) Systematic Entomology Laboratory, IIBIII, USDA-ARS, % U.S. National Museum, Washington, DC 20560; (WPS) Southern Field Crop Insect Management Laboratory, USDA-ARS, Stoneville, Mississippi 38776.

Abstract.—A list of the Miridae found in the Yazoo-Mississippi Delta and in associated areas in Arkansas and Louisiana is compiled from sweepnet, beating net, and black light trap samples taken from September 1981 through October 1982, and during May 1983. A total of 107 species representing 47 genera are reported. Thirty-nine species are considered new state records for Mississippi, 10 for Louisiana, and 5 for Arkansas. Months of collection, hosts, and methods of collection are given for each species studied.

The plant bug family Miridae is the largest and most diverse family found in the Hemiptera-Heteroptera. Most species are phytophagous, although an increasingly large number of species are known to be predatory. The best sources for information on the distribution and life cycles of species occurring in the eastern United States are the works of Blatchley (1926) and Knight (1923, 1941). In the Southeast, species of Miridae have been listed from Florida (Frost, 1964, 1966, 1969, and 1975), Georgia (Henry and Smith, 1979), Louisiana and Mississippi (Khalaf, 1971), North Carolina (Brimley, 1938; Wray, 1950 and 1967), and West Virginia (Wheeler et al., 1983).

The mirid species composition of the Yazoo-Mississippi Delta (Fig. 1) is largely unrecorded, with the exception of several crop species. The Delta, one of ten physiographic regions in Mississippi, is drained by several streams that empty into the Yazoo River that in turn empties into the Mississippi River near Vicksburg, MS. It is one of the most fertile bodies of land in the world (Bennett, 1921), and most of the land has been cleared of its native vegetation for crop production. The forests that remain are mostly restricted to state and national parks and the area found between the Mississippi River and its flood levees. Areas found along drainage ditches and between the ditches and cultivated land contain many of the species of woody and herbaceous vascular plants found in the Delta. The vascular flora of the Delta differed from that of surrounding areas by lacking at least 28 native species of trees, although many now have been introduced (Gunn et al., 1980; Little, 1971 and 1977). In addition to habitat reduction, the mirid fauna of the Delta has also been pressured by the use of insecticides for agricultural pests. In the past, insecticides were commonly applied to crops (especially cotton) on a scheduled basis regardless of need, and the use of more than 10 applications in a single season was not uncommon. These insecticides may have reduced the number of mirid species in the Delta because of the proximity of many of the suitable mirid habitats to sprayed fields. Because of the importance of the Delta as an agricultural area, this study was initiated to investigate and understand more fully plant bug-host relationships and plant bug distribution in the Delta. This study also helps document the species composition of Miridae found in the Delta so that changes in the mirid fauna potentially can be detected.

Miridae listed here were collected from September 1981 through October 1982, and during May 1983, at the sample locations shown in Fig. 1. Miridae were taken by sweepnet from the main crops and by sweepnet and beating net from wild plants growing in or near the crops. Samples were taken at each location at least on a monthly basis, except for samples at Vicksburg and Port Gibson, Mississippi that were taken during May 1983. Additional specimens also were collected in black light traps located at Greenville, MS; Mound, LA; and West Memphis, AR. A few species of Miridae were collected in pitfall traps placed in a small wooded area near Stoneville, MS. Seven-hundred and eleven host-plant specimens were collected and are deposited at The Institute for Botanical Exploration, Botany Department, Mississippi State University, Mississippi State, MS.

One hundred and seven species of Miridae representing 7 subfamilies, 13 tribes, and 47 genera were collected in the study. All were identified by the second author; specimens are deposited at the Mississippi Entomological Museum, Entomology Department, Mississippi State University, and the U.S. National Museum of Natural History. The classification system used in the list follows that used by Wheeler et al. (1983). All apparent new state records are marked with an asterisk. Although five possibly new species were discovered, they are not included in the present work. They will be treated in future papers by the second author.

State, county, and plant host(s) (when available) are given for each species. Those species collected in a black light trap (BLT) are indicated. During some months only adults or only nymphs were collected on the host plant(s) listed. These months are preceded by (A) for adults only, or (N) for nymphs only. Authors and common names for the host plants are given in Table 1.

SUBFAMILY ISOMETOPINAE

Tribe Diphlebini

Diphleps unica Bergroth. *MISSISSIPPI—Washington Co.: (A) July, on *Taxodium distichum.*

Tribe Isometopini

Corticoris signatus (Heidemann). *MISSISSIPPI—Washington Co.: (A) June, on *Taxodium distichum.*

SUBFAMILY PHYLINAE

Tribe Phylini

Keltonia sulphurea (Reuter). ARKANSAS—Phillips Co.: Aug.–Sept., on *Ambrosia artemisiifolia*; Sept., on *Eupatorium serotinum.* Chicot Co.: Sept., on *Iva annua* and *A. artemisiifolia.* Desha Co.: (A) Sept., on *Xanthium strumarium.* LOUI-

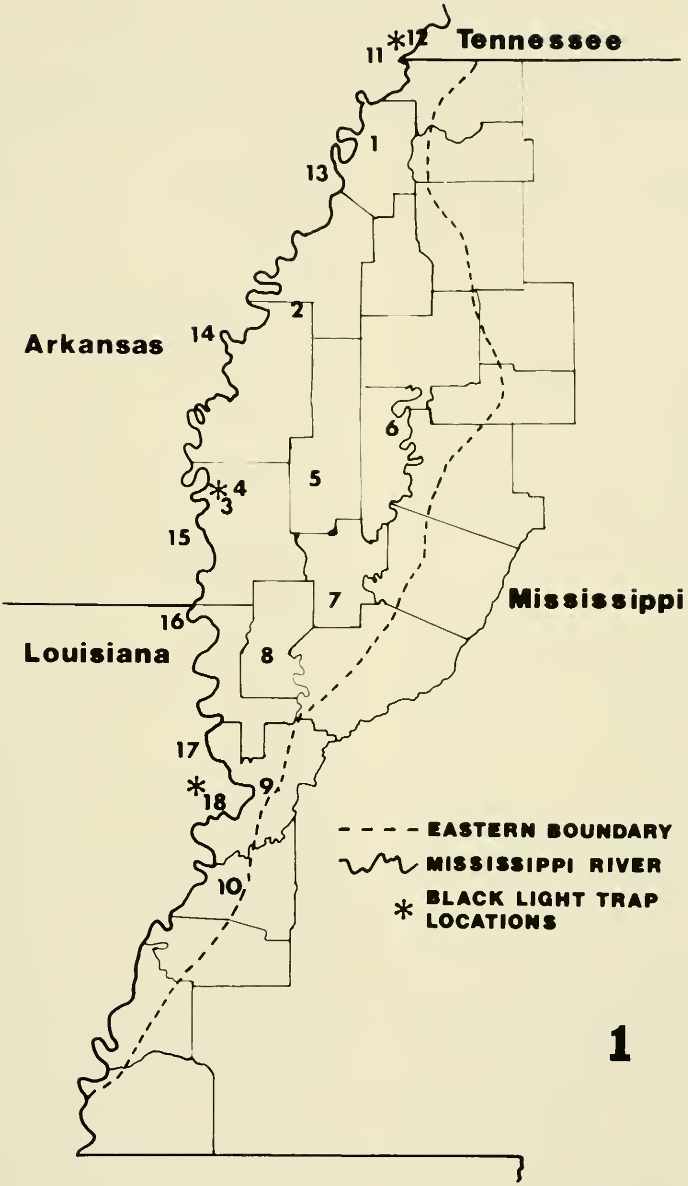

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Fig. 1. Sample locations used in the Yazoo-Mississippi Delta and associated areas in Arkansas and Louisiana (redrawn after Gunn et al., 1980). The sample locations were: (1) Tunica, MS, Tunica Co.; (2) Alligator, MS, Bolivar Co.; (3) Greenville, MS, Washington Co.; (4) Stoneville, MS, Washington Co.; (5) Indianola, MS, Sunflower Co.; (6) Money, MS, Leflore Co.; (7) Louise, MS, Humphreys Co.; (8) Onward, MS, Sharkey Co.; (9) Vicksburg, MS, Warren Co.; (10) Port Gibson, MS, Claiborne Co.; (11) Shearerville, AR, Crittenden Co.; (12) West Memphis, AR, Phillips Co.; (13) Marvel, AR, Phillips Co.; (14) Watson, AR, Desha Co.; (15) Lake Village, AR, Chicot Co.; (16) Millikin, LA, East Carroll Par.; (17) Talla Bena, LA, Madison Par.; (18) Mound, LA, Madison Par.

Table 1. Host plants of Miridae in the Yazoo-Mississippi Delta and associated areas in Arkansas and Louisiana.

Scientific Name	Common Name
Acer negundo L.	boxelder
Allium vineale L.	wild garlic
Amaranthus hybridus L.	smooth pigweed
A. palmeri Wats.	Palmer amaranth
A. retroflexus L.	redroot pigweed
A. spinosus L.	spiny amaranth
A. viridis L.	slender amaranth
Ambrosia artemisiifolia L.	common ragweed, small ragweed
A. trifida L.	giant ragweed
Amorpha fruticosa L.	false-indigo
Ampelopsis arborea (L.) Koehne	peppervine
Anoda cristata (L.) Schlecht.	spurred anoda
Anthemis cotula L.	mayweed
Aster pilosus Willd.	white heath aster, frost aster
A. subulatus Michx. var. *ligulatus* Shinners	aster
Baccharis halimifolia L.	groundsel-tree, eastern baccharis
Berchemia scandens (Hill) K. Koch	Alabama supplejack
Bidens frondosa L.	devils beggarticks
Bromus japonicus	Japanese brome
Brunnichia ovata (Wah.) Shinners	ladies' eardrops
Carya aquatica (Michx. f.) Nutt.	water hickory
C. illinoensis (Wang) K. Koch	pecan
Cassia facsiculata Michx.	partridge-pea
Celtis laevigata Willd.	sugarberry
Cephalanthus occidentalis L.	buttonbush
Chenopodium album L.	common lambsquarters
C. ambrosioides L.	Mexican-tea
Commelina virginica L.	dayflower
Coreopsis tinctoria Nutt.	plains coreopsis, tickseed
Cornus drummondii C. A. Mey	roughleaf dogwood
C. stricta Lam.	swamp dogwood
Crataegus viridis L.	green hawthorn
Croton capitatis Michx.	woolly croton
Cynodon dactylon (L.) Pers.	bermudagrass
Cyperus rotundus L.	purple nutsedge, cocograss
Digitaria ciliaris (Retz.) Koel.	southern crabgrass
Diospyros virginiana L.	persimmon
Dracopis amplexicaulis (Vahl) Cass.	coneflower
Eclipta alba (L.) Hassk.	eclipta, yerba de tajo
Eleusine indica (L.) Gaertn	goosegrass
Erigeron annuus (L.) Pers.	annual fleabane
E. bonariensis L.	erigeron
E. canadensis L.	horseweed
E. philadephicus L.	daisy fleabane, Philadelphia fleabane
E. strigosus Muhl. ex. Willd.	rough fleabane
Eupatorium capillifolium (Lam.) Small	dog-fennel
E. incarnatum Walt.	eupatorium
E. serotinum Michx.	late eupatorium
Euphorbia humistrata A. Gray	silver-leafed spurge
E. maculata L.	prostrate spurge, spotted spurge
E. nutans Lag.	eyebane

Table 1. Continued.

Scientific Name	Common Name
Forestiera acuminata (Michx.) Poir.	swamp privet
Fraxinus pennsylvanica Marsh.	green ash
Galium aparine L.	catchweed bedstraw
Geranium carolinianum L.	Carolina geranium
G. dissectum L.	cutleaf geranium
Gossypium hirsutum L.	cotton
Gleditsia triacanthos L.	honey-locust
Glycine max (L.) Merr.	soybean
Hackelia virginiana (L.) Johnst.	beggar's lice
Haplopappus divaricatus (Nutt.) Gray	haplopappus
Helenium amarum (Raf.) H. Rock	bitter sneezeweed, bitterweed
Helianthus grosse-serratus Martens	sawtooth sunflower
Heterotheca latifolia Buckl.	heterotheca
Hordeum pusillum Nutt.	little barley
Ilex decidua Walt.	deciduous yaupon, possum-haw
Ipomoea hederacea (L.) Jacquin	ivyleaf morning glory
Iva annua L.	marsh elder
Juniperus virginiana L.	eastern red-cedar
Lamium amplexicaule L.	henbit
Laportea canadensis (L.) Gaud.	wood nettle
Lathyrus hirsutus L.	caley-pea
Lepidium virginicum L.	Virginia pepperweed, peppergrass
Leptochloa panicoides (Presl.) Hitchc.	sprangletop
Ligustrum japonicum Thunb.	Japanese privet
Liquidambar styraciflua L.	sweetgum
Lythrum lanceolatum Ell.	winged loosestrife
Ludwegia alternifolia L.	seedbox
L. decurrens Walt.	primrose-willow
L. glandulosa Walt.	marsh-purslane
Matricaria matricarioides (Less.) Porter	pineappleweed
Medicago arabica (L.) Huds.	spotted burclover
M. sativa L.	alfalfa
Mikania scandens (L.) Willds.	climbing hempweed
Morus rubra L.	red mulberry
Oenothera biennis Nutt.	common eveningprimrose
O. laciniata Hill.	cutleaf eveningprimrose
O. speciosa Nutt.	white eveningprimrose
Parthenium hysterophorus L.	ragweed parthenium
Phytolacca americana L.	common pokeweed
Pluchea camphorata (L.) DC.	stinkweed
Polygonum aviculare L.	prostrate knotweed
P. coccineum Muhl. ex. Willd.	swamp smartweed, shoestring smartweed
P. hydropiperoides Michx.	mild smartweed, wild waterpepper
P. lapathifolium L.	pale smartweed, dock-leaved smartweed
P. pensylvanicum L.	Pennsylvanica smartweed, pinkweed
P. punctatum Ell.	dotted smartweed, water smartweed
Populus deltoides Marsh.	eastern cottonwood
Portulaca oleracea L.	common purslane
Pyrrhopappus carolinianus (Watl.) DC.	Carolina false-dandelion
Quercus nigra L.	water oak
Ranunculus sardous Crantz	hairy buttercup
Rhus glabra L.	smooth sumac

Table 1. Continued.

Scientific Name	Common Name
R. toxicodendron L.	poison oak
Robinia pseudoacacia L.	black locust
Rumex crispus L.	curly dock, sour dock
Salix nigra Marsh.	black willow
Sambucus canadensis L.	American elderberry
Saururus cernus L.	lizardtail
Senecio glabellus Poir.	cressleaf groundsel, butterweed
Sesbania exaltata (Raf.) ex. A. W. Hill	hemp sesbania, coffeeweed
Setaria geniculata (Lam.) Beauv.	knotroot foxtail, prairie foxtail
Sherardia arvensis L.	field madder
Solanum carolinense L.	horsenettle
S. elaeagnifolium Cav.	silverleaf nightshade, white horsenettle
Solidago altissima L.	goldenrod
Sonchus asper (L.) Hill	spiny sowthistle
Sorghum halepense (L.) Pers.	johnsongrass
Spilanthes americana (Walt.) A. H.Moore	spilanthes
Stellaria media L. Cyrillo	chickweed
Taxodium distichum (L.) Rich.	bald cypress
Torilis arvenis (Huds.) Link	hedge parsley
Trepocarpus aethusae Nutt.	trepocarpus
Trifolium incarnatum L.	crimson clover
T. repens L.	white clover
T. resupinatum L.	Persian clover
Triticum aestivum L.	wheat
Ulmus americana L.	American elm
Verbena bonariensis L.	tall vervain
V. brasiliensis Vell.	vervain
Vicia sp.	vetch
V. angustifolia L.	narrow-leaved vetch
Vitis cinerea Millardet	pigeon grape
Xanthium strumarium L.	heartleaf cocklebur

SIANA—Madison Par.: May, BLT. East Carroll Par.: (A) July, on *Heterotheca latifolia.* MISSISSIPPI—Washington Co.: June, Sept., BLT; (A) June, on *Ambrosia trifida*; (A) Aug., on *Erigeron canadensis* and *Helenium amarum*; Sept., on *I. annua*; (A) Sept., on *Aster pilosus, E. serotinum,* and *Haplopappus divaricatus.* Tunica Co.: (A) July, on *Oenothera laciniata*; Oct., on *A. artemisiifolia.* Leflore Co.: (A) Oct., on *A. pilosus.*

Lepidopsallus miniatus Knight. *ARKANSAS—Crittenden Co.: (A) Apr., on *Vicia angustifolia.*

L. rubidus (Uhler). *LOUISIANA—Madison Par.: (A) June, on *Salix nigra.* MISSISSIPPI—Washington Co.: June, BLT.

Plagiognathus caryae Knight. MISSISSIPPI—Washington Co.: June, BLT; May, on *Carya illinoensis*; (A) June, on *C. illinoensis.* Claiborne Co.: (N) May, on *C. illinoensis.*

P. cornicola Knight. *MISSISSIPPI—Washington Co.: May, on *Cornus drummondii*; (A) June, on *C. drummondii.*

P. dispar Knight. *LOUISIANA—Madison Par.: May, BLT.

P. fuscosus (Provancher). *MISSISSIPPI—Washington Co.: June, BLT; (A) May-June, on *Cornus stricta.*

P. geminus Knight. MISSISSIPPI—Washington Co.: May, on *Ilex decidua.*

P. gleditsiae Knight. *MISSISSIPPI—Washington Co.: May, on *Gleditsia triacanthos.*

P. politus Uhler. MISSISSIPPI—Claiborne Co.: May, on *Solidago altissima.*

Pseudatomoscelis seriatus (Reuter). ARKANSAS—Chicot Co.: (A) May, on *Vicia angustifolia, Oenothera laciniata,* and *Lepidium virginicum*; May–June, on *O. laciniata* and *Oenothera speciosa*; June, on *Torilis arvensis*; (A) July, on *Gossypium hirsutum*; August, on *Oenothera biennis*; Sept.–Oct., on *Croton capitatis*; Sept., on *Cassia fasciculata*; (A) Sept., on *Polygonum coccineum*; (A) Oct., on *Erigeron canadensis.* Crittenden Co.: (A) Aug., on *Polygonium lapathifolium.* Phillips Co.: (A) July, on *Helenium amarum.* Desha Co.: (A) May, on *O. speciosa*; (A) June, on *Erigeron annuus*; June, on *O. laciniata*; (A) July, on *Lythrum lanceolatum*; Sept., on *C. capitatis.* LOUISIANA—East Carroll Par.: (A) May, on *O. laciniata* and *O. speciosa*; June, on *O. laciniata*; (A) June, on *T. arvensis.* Madison Par.: May, Sept.–Oct., BLT; May, on *O. speciosa*; (A) May, on *O. laciniata*; June, on *O. laciniata*; (A) June, on *O. speciosa, T. arvensis, G. hirsutum,* and *Glycine max*; (A) July, on *Polygonium pensylvanicum* and *Ambrosia artemisiifolia*; (A) Aug., on *Medicago sativa*; (A) Oct., on *Eupatorium incarnatum* and *C. capitatis.* MISSISSIPPI—Washington Co.: May–July, Sept., BLT; (A) May, on *Trifolium incarnatum, O. laciniata,* and *Erigeron philadelphicus*; May-June, on *O. speciosa*; (A) June on *Solanum elaeagnifolium*; June–July, on *O. laciniata*; June, on *Anthemis cotula*; (N) July, on *Coreopsis tinctoria*; (A) July, on *O. speciosa,* and *E. annuus*; July, on *Parthenium hysterophorus*; July–Oct., on *C. capitatis*; (A) Aug.–Sept., on *P. pensylvanicum*; (A) Sept., on *Helenium amarum* and *P. hysterophorus.* Sunflower Co.: May, on *Vicia angustifolia, A. cotula,* and *O. speciosa*; May–June, on *O. laciniata*; June–Sept., on *C. capitatis*; (A) June–Aug., on *G. hirsutum*; July, on *E. annuus*; (N) July, on *Pyrrhopappus carolinianus*; (A) Aug., on *Aster pilosus, Amaranthus viridis, P. pensylvanicum,* and *Polygonium hydropiperoides.* Leflore Co.: (A) May–June, on *E. annuus*; (A) May, on *O. speciosa* and *O. laciniata*; June, on *O. laciniata*; June–Sept., on *C. capitatis*; July, on *H. amarum.* Sharkey Co.: (A) May, on *Stellaria media, O. laciniata, Polygonium aviculare,* and *Geranium dissectum*; June–July, on *O. laciniata*; July, on *Erigeron bonariensis*; (A) Aug., on *P. aviculare.* Humphreys Co.: (A) May, on *O. speciosa*; June, on *O. laciniata*; (A) July, on *O. laciniata*; Sept.–Oct., on *C. capitatis*; (A) Sept., on *Verbena brasiliensis.* Bolivar Co.: (A) May, on *O. laciniata* and *A. cotula*; (A) June, on *E. annuus*; June, on *O. laciniata.* Tunica Co.: (A) May, on *O. laciniata*; (A) June, on *O. speciosa*; July, on *O. laciniata.*

Reuteroscopus ornatus (Reuter). LOUISIANA—Madison Par.: May, BLT; (A) Aug., on *Chenopodium album* and *Ambrosia artemisiifolia.* MISSISSIPPI—Washington Co.: June, BLT.

Rhinacloa forticornis Reuter. MISSISSIPPI—Washington Co.: (A) Oct., on *Ulmus americana.*

Spanagonicus albofasciatus (Reuter). ARKANSAS—Phillips Co.: (A) Aug., on *Euphorbia maculata*; (A) Sept., on *Xanthium strumarium*; Sept., on *Polygonum aviculare.* Crittenden Co.: Oct., on *P. aviculare*; (N) Oct., on *E. maculata*; (A)

Jan., on *Lamium amplexicaule*; Aug., on *E. maculata* and *Helenium amarum.* LOUISIANA—East Carroll Par.: (N) Aug., on *E. maculata*; Sept., on *P. aviculare* and *Portulaca oleracea.* Madison Par.: July, on *Medicago sativa* and *Amaranthus spinosus*; (A) Aug., on *M. sativa*; Sept., on *P. aviculare*; (A) Oct., on *A. spinosus.* MISSISSIPPI—Washington Co.: June, Aug.–Oct., BLT; (A) Jan., on *L. amplexicaule*; July, on *Parthenium hysterophorus*; (A) July, on *P. oleracea*; (A) Sept., on *H. amarum*; (A) Oct., on *P. oleracea.* Leflore Co.: Aug., on *E. maculata*; (A) Aug., on *Erigeron canadensis*; (N) Aug., on *P. aviculare* and *Euphorbia humistrata*; (A) July, on *H. amarum*; (A) Sept., on *E. maculata*; (A) Oct., on *P. aviculare*; (N) Oct., on *E. maculata*; (A) Dec., on *Trifolium incarnatum.* Humphreys Co.: (A) Sept., on *Iva annua*; (A) Oct., on *P. oleracea.* Sharkey Co.: (A) Apr., on *Trifolium repens*; (A) May, *Oenothera laciniata*; (A) July, on *Amaranthus viridis*; (A) Aug., *P. aviculare*; (A) Sept.–Oct., on *P. oleracea.* Bolivar Co.: (A) July, on *P. oleracea.* Sunflower Co.: Aug., on *A. viridis.* Tunica Co.: (A) Aug., on *Solanum carolinense*; (N) Aug., on *E. maculata*; Sept., on *P. aviculare* and *P. oleracea*; (A) Sept., on *X. strumarium*; (N) Sept., on *E. maculata.*

Sthenarus mcateei Knight. MISSISSIPPI—Washington Co.: June, on *C. drummondii*; (A) June, on *Ampelopsis arborea*; (A) July, on *Vitis cinerea,* and *Ampelopsis arborea.*

SUBFAMILY ORTHOTYLINAE

Tribe Ceratocapsini

Ceratocapsus blatchleyi Henry. *MISSISSIPPI—Washington Co.: July–Aug., Oct., BLT.

C. fuscinus Knight. LOUISIANA—Madison Par.: June–July, Sept., BLT. MISSISSIPPI—Washington Co.: May–July, BLT; June, on *Ampelopsis arborea* and *Brunnichia ovata.*

C. insperatus Blatchley. *MISSISSIPPI—Washington Co.: May, BLT.

C. modestus (Uhler). *MISSISSIPPI—Washington Co.: May–June, BLT.

C. pumilus (Uhler). MISSISSIPPI—Washington Co.: June, BLT; (A) June, on *Ulmus americana, Ligustrum japonicum, Carya illinoensis, Vitis* spp., *Liquidambar styraciflua,* and *Cephalanthus occidentalis.* Bolivar Co.: (A) June, on *Robinia pseudoacacia.*

C. punctatus (Reuter). ARKANSAS—Chicot Co.: (A) June, on *Taxodium distichum.* LOUISIANA—Madison Par.: May–Oct., BLT; June, on *T. distichum*; (A) July, on *Medicago sativa.* MISSISSIPPI—Washington Co.: July, BLT; June, on *T. distichum*; (A) July, on *T. distichum* and *Cephalanthus occidentalis.*

C. quadrispiculus Knight. LOUISIANA—Madison Par.: June, BLT. *MISSISSIPPI—Washington Co.: June, BLT; (A) May, on *Salix nigra*; (A) June, on *Cephalanthus occidentalis.* Sunflower Co.: (A) June, on *C. occidentalis.*

C. seticornis Knight. *LOUISIANA—Madison Par.: July, BLT. *MISSISSIPPI—Washington Co.: June–Oct., BLT.

C. setosus Reuter. MISSISSIPPI—Washington Co.: July, BLT.

C. spinosus Henry. *MISSISSIPPI—Washington Co.: June, BLT.

C. taxodii Knight. LOUISIANA—Madison Par.: June, on *Taxodium distichum.* MISSISSIPPI—Washington Co.: June, Aug., BLT; May–July, on *T. distichum.*

C. uniformis Knight. MISSISSIPPI—Washington Co.: (A) Aug., on *Vitis cinerea.*

C. wheeleri Henry. *LOUISIANA—Madison Par.: Aug., BLT.

Tribe Orthotylini

Diaphnocoris chlorionis (Say). MISSISSIPPI—Washington Co.: May, on *Gleditsia triacanthos.* Warren Co.: (A) May, on *G. triacanthos.*

Halticus bractatus (Say). LOUISIANA—Madison Par.: (A) July, on *Amaranthus spinosus*; (A) Aug., on *Medicago sativa.* MISSISSIPPI—Washington Co.: (A) Aug., on *Phytolacca americana*; (N) Aug., on *Portulaca oleracea.*

Heterocordylus malinus Slingerland. MISSISSIPPI—Washington Co.: Apr., on *Crataegus viridis*; (A) May, on *C. viridis.*

Ilnacora stalii Reuter. ARKANSAS—Crittenden Co.: Sept., BLT. LOUISIANA—Madison Par.: June, Aug., BLT. MISSISSIPPI—Washington Co.: June, BLT. Claiborne Co.: May, on *Ambrosia trifida.*

Labopidicola allii (Knight). *MISSISSIPPI—Sunflower Co.: Apr., on *Allium vineale.* Washington Co.: (A) May, on *A. vineale.*

L. geminatus (Johnston). *ARKANSAS—Phillips Co.: (A) Apr., on *Allium vineale*; (A) Oct., on *A. vineale.*

Lopidea heidemanni Knight. ARKANSAS—Phillips Co.: Apr., on *Sherardia arvensis*; (A) May, on *Oenothera laciniata.* MISSISSIPPI—Washington Co.: (A) May, on *Ilex decidua*; (A) June, on *Anthemis cotula.*

L. robiniae (Uhler). LOUISIANA—Madison Par.: (A) June, on *Robinia pseudoacacia.* MISSISSIPPI—Warren Co.: (N) May, on *R. pseudoacacia.*

Orthotylus basicornis Knight. LOUISIANA—Madison Par.: May, BLT. *MISSISSIPPI—Washington Co.: May–June, BLT.

O. celtidis Henry. *MISSISSIPPI—Washington Co.: (A) May, on *Celtis laevigata.*

O. juglandis Henry. *LOUISIANA—Madison Par.: May, BLT.

O. modestus Van Duzee. *MISSISSIPPI—Washington Co.: May, BLT.

O. ornatus Van Duzee. *LOUISIANA—Madison Par.: (A) Apr., on *Senecio glabellus.* *MISSISSIPPI—Washington Co.: Apr., BLT; Apr., on *Salix nigra, Trifolium resupinatum* and *Vicia angustifolia.* Sunflower Co.: Apr., on *Geranium carolinianum* and *Geranium dissectum*; (A) Apr., on *Rumex crispus* and *Lepidium virginicum.* Leflore Co.: (A) Apr., on *Galium aparine.* [Although nymphs of *O. ornatus* were collected on *T. resupinatum, V. angustifolia, G. carolinianum* and *G. dissectum,* small stands of *Salix* spp. (their normal breeding host) were present near the collection sites].

O. ramus Knight. MISSISSIPPI—Washington Co.: June, on *Carya illinoensis.*

O. taxodii Knight. *MISSISSIPPI—Sharkey Co.: (N) May, *Taxodium distichum.* Washington Co.: (A) June, on *T. distichum.*

Paraproba capitata (Van Duzee). *MISSISSIPPI—Washington Co.: July, collected in a pitfall trap by log in deciduous woods.

Parthenicus juniperi (Heidemann). MISSISSIPPI—Washington Co.: Aug., Oct., BLT; (N) May, on *Juniperus virginiana*; (A) June, on *J. virginiana.*

P. taxodii Knight. *MISSISSIPPI—Washington Co.: May–July, BLT; (A) June, on *Taxodium distichum*; (A) July, on *Gossypium hirsutum.* [The breeding host of *P. taxodii* is *T. distichum*].

Saileria irrorata Henry. *MISSISSIPPI—Washington Co.: Oct., BLT; June, on *Vitis cinerea*; (A) July, on *V. cinerea*; (A) Aug., on *Carya illinoensis.*

Semium hirtum Reuter. ARKANSAS—Phillips Co.: Aug., (A) Oct.–Nov., on *Euphorbia maculata*; Sept., on *Euphorbia humistrata*. Crittenden Co.: July–Oct., on *E. maculata*; (A) Sept., on *E. humistrata*. Desha Co.: July–Oct., on *E. maculata*; Sept., on *E. humistrata*. Chicot Co.: Aug., Oct., on *E. maculata*. *LOUISIANA—East Carroll Par.: Aug.–Oct., on *E. maculata*. Madison Par.: Sept., on *E. maculata*; (A) Oct., on *Euphorbia nutans*. MISSISSIPPI—Washington Co.: July–Oct., on *E. maculata*; Aug., on *E. humistrata*. Sunflower Co.: Aug.–Sept., on *E. maculata*; (A) Oct., on *E. nutans*. Leflore Co.: July–Sept., on *E. maculata*; (N) Aug., on *E. humistrata*. Humphreys Co.: July–Oct., on *E. maculata*. Sharkey Co.: July–Oct., on *E. maculata*. Bolivar Co.: Aug.–Oct., on *E. maculata*. Tunica Co.: July–Oct., (A) Nov., on *E. maculata*.

Slaterocoris breviatus (Knight). *MISSISSIPPI—Washington Co.: May, on *Ambrosia trifida*.

S. stygicus (Say). MISSISSIPPI—Claiborne Co.: May, on *Ambrosia trifida*. Washington Co.: May, on *A. trifida*.

Tribe Pilophorini

Alepidia gracilis Uhler. MISSISSIPPI—Washington Co.: July, BLT.

Pilophorus taxodii Knight. *MISSISSIPPI—Washington Co.: June, on *Taxodium distichum*.

SUBFAMILY CYLAPINAE

Tribe Fulviini

Fulvius imbecilis (Say). MISSISSIPPI—Washington Co.: July, collected in a pitfall trap by log in deciduous woods.

SUBFAMILY DERAEOCORINAE

Tribe Deraeocorini

Deraeocoris histrio (Reuter). *ARKANSAS—Crittenden Co.: Aug., BLT.

D. nebulosus (Uhler). ARKANSAS—Chicot Co.: (A) Oct., on *Baccharis halimifolia*. Phillips Co.: (A) Sept., on *Xanthium strumarium*. MISSISSIPPI—Washington Co.: Mar.–Oct., BLT; (A) May–July, on *Gossypium hirsutum*; (A) May, on *Quercus nigra* and *Salix nigra*; Aug.–Sept., (A) May–June, on *Diospyros virginiana*; Aug., (A) Sept., on *Ulmus americana*; (A) May, on *Ligustrum japonicum, Fraxinus pennsylvanica, Crataegus viridis, Celtis laevigata,* and *S. nigra*; May–Oct., on *Carya illinoensis*; (A) July and Oct., on *Taxodium distichum*; (N) Oct., on *Solidago altissima*; (A) Sept.–Oct., on *Parthenium hysterophorus*; (A) Apr., on *Vicia angustifolia* and *Trifolium incarnatum*; Sept., on *X. strumarium* and *Sesbania exaltata*. Sunflower Co.: (A) Oct., on *S. altissima, Aster pilosus,* and *Polygonum pensylvanicum*. Sharkey Co.: (A) Apr., on *V. angustifolia* and *Lathyrus hirsutus*; (N) Sept., on *S. altissima*. Humphreys Co.: (A) Oct., on *Erigeron canadensis*.

D. poecilus (McAtee). *MISSISSIPPI—Washington Co.: May, BLT.

D. pinicola Knight. *MISSISSIPPI—Sharkey Co.: (A) May, on *Taxodium distichum*. Washington Co.: (A) May, on *T. distichum*.

Eurychilopterella luridula Reuter. *MISSISSIPPI—Washington Co.: (A) May, July, on *Taxodium distichum*.

Eustictus venatorius Van Duzee. *MISSISSIPPI—Washington Co.: June, BLT.
E. salicicola Knight. MISSISSIPPI—Washington Co.: May, BLT.
E. mundus (Uhler). MISSISSIPPI—Washington Co.: Oct., BLT.

Tribe Hyaliodini

Hyaliodes vitripennis (Say). MISSISSIPPI—Washington Co.: May, on *Solidago altissima* and *Carya illinoensis*; (A) May, on *Acer negundo, Morus rubra, Liquidambar styraciflua, Ambrosia trifida, Celtis laevigata, Fraxinus pennsylvanica,* and *Diospyros virginiana*; June, on *Vitis cinerea, Diospyros virginiana,* and *C. illinoensis*; (A) June, on *Crataegus viridis, Ampelopsis arborea, Ulmus americana, Cornus stricta, Salix nigra, Fraxinus pennsylvanica, S. altissima, Taxodium distichum* and *Ambrosia artemisiifolia*; (A) July, on *Populus deltoides* and *Gossypium hirsutum*; Aug., on *C. illinoensis, S. altissima,* and *Ulmus americana*; (A) Aug., on *Ampelopsis arborea, Phytolacca americana, T. distichum*; Sept., on *U. americana* and *C. illinoensis*; (A) Oct., on *U. americana.* Humphreys Co.: (A) Aug., on *A. trifida.*

SUBFAMILY MIRINAE

Tribe Mirini

Agnocoris pulverulentus (Uhler). LOUISIANA—Madison Par.: May–Aug., BLT; (A) June, on *Taxodium distichum.* MISSISSIPPI—Claiborne Co.: (N) May, on *Salix nigra.* Washington Co.: May–Sept., BLT; June–July, on *Salix nigra*; (A) Aug., on *Carya illinoensis.* [The breeding host of *A. pulverulentus* is *Salix* spp.].

Dagbertus fasciatus (Reuter). LOUISIANA—Madison Par.: June, BLT. MISSISSIPPI—Washington Co.: June–July, BLT; (N) Aug., on *Portulaca oleraceae.*

Dichrooscytus elegans Heidemann. MISSISSIPPI—Washington Co.: (A) June, on *Juniperus virginiana.* Warren Co.: (A) May, on *Juniperus virginiana.*

Lygocoris caryae (Knight). *ARKANSAS—Chicot Co.: (A) May, on *Vicia angustifolia.* MISSISSIPPI—Washington Co.: June, BLT; May, on *Carya illinoensis*; (A) June, on *C. illinoensis.* Claiborne Co.: (N) May, on *C. illinoensis.*

L. semivittatus (Knight). ARKANSAS—Crittenden Co.: (N) Mar., on *Vicia angustifolia.* MISSISSIPPI—Sunflower Co.: (A) May, on *Carya illinoensis.* Washington Co.: (A) Apr., on *Geranium dissectum*; (A) May, on *Senecio glabellus, Cornus drummondii, Liquidambar styraciflua, Morus rubra,* and *Acer negundo.* Leflore Co.: (A) Apr., on *Galium aparine, Geranium carolinianum,* and *Rumex crispus.*

L. tinctus (Knight). *MISSISSIPPI—Washington Co.: May, on *Gleditsia triacanthos.*

Lygus plagiatus Uhler. LOUISIANA—Madison Par.: (A) Oct., on *Ambrosia trifida.* MISSISSIPPI—Claiborne Co.: May, on *A. trifida.*

L. lineolaris (Palisot de Beauvois). ARKANSAS—Crittenden Co.: June–Oct., BLT. LOUISIANA—Madison Par.: May–Oct., BLT. MISSISSIPPI—Washington Co.: Mar., May–Oct., BLT. [*L. lineolaris* was collected on 169 plant species representing 36 plant families. These species are listed in Snodgrass et al., 1984].

Neurocolpus jessiae Knight. *ARKANSAS—Chicot Co.: (A) June, on *Sambucus canadensis.* LOUISIANA—Madison Par.: (A) June, on *S. canadensis.* MISSISSIPPI—Washington Co.: June–July, on *S. canadensis.*

N. nubilus (Say). ARKANSAS—Crittenden Co.: Aug., BLT; (A) Apr., on *Senecio glabellus.* Chicot Co.: July, on *Cephalanthus occidentalis.* Desha Co.: (A) May, on *Torilis arvensis*; (A) July, on *C. occidentalis.* Phillips Co.: June, on *Rhus glabra*; (A) July, on *Ludwegia alternifolia*; (A) Aug., on *Eupatorium serotinum*; (A) Sept., on *Xanthium strumarium.* LOUISIANA—Madison Par.: May, Aug., BLT. MISSISSIPPI—Washington Co.: May, July, BLT; May, on *Cornus stricta,* and *C. occidentalis*; (N) May, on *Ilex decidua*; (A) May, on *C. drummondii* and *O. speciosa*; June, on *C. occidentalis* and *C. stricta*; (A) July, on *C. occidentalis* and *R. glabra*; (A) Aug., on *C. occidentalis* and *Gossypium hirsutum.* Sunflower Co.: (A) June, on *G. hirsutum*; June, on *C. occidentalis*; (N) July, on *C. occidentalis.*

Phytocoris breviusculus Reuter. *MISSISSIPPI—Washington Co.: (A) May, on *Ilex decidua.*

P. canadensis Van Duzee. *MISSISSIPPI—Washington Co.: July, BLT.

P. confluens Reuter. MISSISSIPPI—Washington Co.: May–July, BLT; (A) June, on *Gossypium hirsutum.*

P. conspurcatus Knight. MISSISSIPPI—Washington Co.: Aug., BLT.

P. erectus Van Duzee. LOUISIANA—Madison Par.: May, BLT. MISSISSIPPI—Washington Co.: May–Aug., Oct., BLT; (A) June, on *Ampelopsis arborea, Forestiera acuminata* and *Carya illinoensis*; (A) July–Aug., on *Taxodium distichum*; (A) Oct., on *Polygonum pensylvanicum.*

P. eximius Reuter. LOUISIANA—Madison Par.: Oct., BLT. MISSISSIPPI—Washington Co.: May–June, BLT. Sharkey Co.: (A) May, on *Taxodium distichum.*

P. husseyi Knight. *MISSISSIPPI—Sharkey Co.: (N) May, on *Taxodium distichum.*

P. luteolus Knight. *LOUISIANA—Madison Par.: June, BLT.

P. minutulus Reuter. *MISSISSIPPI—Washington Co.: July, BLT.

P. neglectus Knight. MISSISSIPPI—Washington Co.: (N) Apr., on *Rhus toxicodendron.*

P. nigricollis Knight. *LOUISIANA—Madison Par.: Oct., BLT.

P. salicis Knight. MISSISSIPPI—Claiborne Co.: (N) May, on *Salix nigra.* Washington Co.: (N) May, on *Cornus stricta.*

P. tibialis Reuter. *LOUISIANA—Madison Par.: June, Sept., BLT; (A) June, on *Robinia pseudoacacia.* MISSISSIPPI—Washington Co.: May–June, BLT; (A) June, on *Saururus cernus, Laportea canadensis, Eupatorium serotinum, Ampelopsis arborea, Amorpha fruticosa, Vitis cinerea, Commelina virginica* and *Solidago altissima*; (A) Oct., on *Polygonum pensylvanicum* and *S. altissima*; July, on *Aster subulatus* var. *ligulatus.*

P. venustus Knight. *MISSISSIPPI—Washington Co.: May–June, BLT.

Polymerus basalis (Reuter). ARKANSAS—Crittenden Co.: July–Sept., BLT; (A) June, on *Coreopsis tinctoria* and *Oenothera laciniata*; Sept., on *Helenium amarum*; (A) Sept., on *Polygonum pensylvanicum.* Chicot Co.: July, on *C. tinctoria* and *Erigeron annuus*; (N) July, on *Erigeron canadensis*; (A) Aug., on *H. amarum*; Sept., on *H. amarum.* Desha Co.: (A) Apr. and June, on *C. tinctoria*; (A) Apr., on *Galium aparine*; July, on *C. tinctoria*; (A) Aug., on *E. canadensis*; Oct., on *Helianthus grosse-serratus* and *Aster subulatus* var. *ligulatus.* Phillips Co.: (A) Apr., on *G. aparine*; June, on *C. tinctoria*; (A) July, on *H. amarum*;

(A) Oct., on *Xanthium strumarium*; (A) Nov., on *Aster pilosus*. LOUISIANA—Madison Par.: May–Sept., BLT; (A) May, on *Verbena brasiliensis, Ambrosia trifida,* and *Anthemis cotula*; (A) June, on *Dracopis amplexicaulis*; (A) Oct., on *A. subulatus* var. *ligulatus, Parthenium hysterophorus* and *A. pilosus.* East Carroll Par.: (A) Apr., on *O. laciniata* and *Trifolium incarnatum*; (N) Sept., on *P. pensylvanicum*; (A) Oct., on *D. amplexicaulis* and *A. subulatus* var. *ligulatus.* MISSISSIPPI—Washington Co.: May–Sept., BLT; (A) Apr., on *Erigeron philadelphicus*; (N) May, on *O. laciniata*; (A) May, on *A. cotula* and *Matricaria matricarioides*; June, on *A. cotula*; July–Aug., on *C. tinctoria*; July, on *P. hysterophorus*; (A) July, on *E. annuus*; Aug.–Oct., on *Haplopappus divaricatus*; Aug.–Sept., on *H. amarum*; Aug., on *E. canadensis*; (A) Aug., on *O. biennis*; Sept., on *P. hysterophorus*; (A) Sept., on *A. subulatus* var. *ligulatus*; (A) Oct.–Nov., on *P. hysterophorus*; (A) Oct., on *Iva annua*; (A) Nov., on *A. subulatus* var. *ligulatus, Ranuculus sardous, Lamium amplexicaule,* and *H. divaricatus.* Sharkey Co.: (A) May–June, on *O. laciniata*; (A) June, on *P. hysterophorus*; June, on *D. amplexicaulis*; (A) July, on *Erigeron bonariensis* and *D. amplexicaulis*; Oct., on *P. hysterophorus*; (A) Oct., on *A. subulatus* var. *ligulatus.* Humphreys Co.: (A) May, on *O. speciosa* and *Lepidium virginicum*; June, on *V. brasiliensis*; (A) June, on *E. annuus* and *H. amarum*; (A) Aug., Oct., on *E. canadensis*; Sept.–Oct., on *H. amarum* and *V. brasiliensis*; Sept., on *I. annua*; (A) Sept., on *A. trifida*; Oct., on *Ambrosia artemisiifolia*; (A) Oct., on *Solidago altissima* and *A. pilosus.* Sunflower Co.: Apr., on *T. repens*; (A) May, on *A. cotula*; June–July, Sept., on *H. amarum*; June–July, on *C. tinctoria*; (A) June on *E. annuus*; (N) July, on *E. annuus*; (N) Sept., on *E. canadensis*; (A) Oct., on *A. pilosus* and *V. brasiliensis.* Leflore Co.: (N) June, on *E. annuus* and *O. laciniata*; July–Oct., on *H. amarum*; July, on *Eclipta alba* and *C. tinctoria*; (A) Sept., on *V. brasiliensis*; (A) Oct., on *A. pilosus.* Bolivar Co.: (A) Apr.–May, on *M. matricarioides*; (A) Apr., on *Rumex crispus*; (A) May, on *A. cotula*; (A) June, on *D. amplexicaulis*; (N) June, on *O. laciniata*; July, on *C. tinctoria*; (A) July, on *E. annuus*; (A) Aug., on *Amaranthus palmeri*; (A) Sept., on *X. strumarium*; (A) Nov., on *Polygonum aviculare* and *O. laciniata.* Tunica Co.: (A) June, on *E. annuus* and *C. tinctoria*; (N) July, on *E. annuus*; July, on *C. tinctoria*; Aug., on *H. amarum*; (A) Nov., on *H. amarum.*

Taedia celtidis (Knight). *MISSISSIPPI—Washington Co.: (A) May, on *Celtis laevigata.*

T. johnstoni (Knight). *MISSISSIPPI—Washington Co.: (N) May, on *Berchemia scandens.*

Taylorilygus pallidulus (Blanchard). ARKANSAS—Chicot Co.: (N) July, on *Erigeron canadensis*; Sept.–Oct., on *E. canadensis*; Sept.–Dec., on *Solidago altissima*; (A) Sept., on *Xanthium strumarium* and *Ambrosia trifida*; Oct.–Nov., on *Eupatorium capillifolium*; (A) Sept.–Oct., on *Baccharis halimifolia*; (A) Oct., on *Erigeron strigosus, Croton capitatis, Oenothera biennis,* and *Aster subulatus* var. *ligulatus*; (A) Oct.–Dec., on *Aster pilosus*; (A) Nov., on *Iva annua, Verbena bonariensis,* and *Erigeron annuus*; (A) Dec., on *Ranunculus sardous,* and *Lamium amplexicaule.* Desha Co.: (A) Aug., on *E. canadensis*; Sept.–Oct., on *E. canadensis*; (A) Sept., on *Helenium amarum, A. pilosus, A. trifida,* and *S. altissima*; Oct., on *A. pilosus, A. subulatus* var. *ligulatus, S. altissima,* and *Helianthus grosse-serratus*; (A) Oct., on *Polygonum punctatum, Eupatorium ser-*

otinum, Solanum carolinense, O. biennis, Eupatorium nutans, and *Cassia fasciculata*; (A) Nov., on *A. pilosus* and *X. strumarium.* Phillips Co.: July–Oct., on *E. canadensis*; Sept.–Oct., on *S. altissima*; (A) Sept.–Oct., on *A. trifida*; (A) Sept., on *Ambrosia artemisiifolia, C. capitatis, E. serotinum*; (A) Oct., on *X. strumarium*; (A) Nov., on *A. pilosus* and *E. canadensis*; (A) Dec., on *Chenopodium album.* Crittenden Co.: (A) June, on *E. annuus*; Sept.–Oct., on *E. canadensis*; (A) Sept., on *A. pilosus* and *A. trifida*; Oct., on *S. altissima* and *Polygonum pensylvanicum*; (A) Oct., on *A. pilosus* and *Anoda cristata*; Nov., on *A. pilosus*; (A) Nov., on *S. altissima* and *H. amarum.* LOUISIANA—Madison Par.: May, BLT; (A) July, on *E. canadensis* and *Lythrum lanceolatum*; (A) Aug., on *Meticago sativa*; Sept.–Nov., on *S. altissima*; (A) Sept., on *A. subulatus* var. *ligulatus*; Oct.–Nov., on *A. subulatus* var. *ligulatus*; Oct., on *A. pilosus* and *Chenopodium ambrosioides*; (A) Oct., on *A. trifida, E. canadensis, Verbena brasiliensis, Spilanthes americana, Ipomoea hederacea, Amaranthus spinosus,* and *Parthenium hysterophorus*; Nov., on *E. canadensis*; (A) Nov., on *A. pilosus.* East Carroll Par.: Sept.–Nov., on *E. canadensis*; (A) Sept., on *A. pilosus*; Oct., on *S. altissima* and *A. pilosus*; (A) Oct., on *Oenothera speciosa, V. brasiliensis,* and *A. subulatus* var. *ligulatus*; Nov., on *P. pennsylvanicum*; (A) Nov., on *C. ambrosioides, Sonchus asper, Amaranthus retroflexus, Geranium carolinianum, Portulaca oleracea, Dracopis amplexicaule,* and *S. altissima.* MISSISSIPPI—Washington Co.: Aug.–Oct., BLT; (A) Jan., on *L. amplexicaule*; (A) May, on *Anthemis cotula, Erigeron philadelphicus,* and *Matricaria matricarioides*; (A) June, on *E. annuus*; (A) July, on *Coreopsis tinctoria*; July–Oct., on *E. canadensis*; Sept.–Nov., on *P. hysterophorus*; (A) Sept.–Oct., on *A. trifida* and *A. subulatus* var. *ligulatus*; (A) Sept., on *O. biennis, S. altissima,* and *Pluchea camphorata*; (N) Sept., on *Bidens frondosa*; (A) Oct.–Nov., on *Eclipta alba*; Oct.–Dec., on *A. pilosus*; Oct.–Nov., on *S. altissima, A. subulatus* var *ligulatus,* and *E. capillifolium*; (A) Oct., on *Euphorbia maculata, A. hybridus,* and *B. frondosa*; (N) Oct., on *E. serotinum*; (A) Nov.–Dec., on *L. amplexicaule, S. altissima,* and *Vicia* spp.; (A) Nov., on *O. laciniata, X. strumarium, E. nutans, Rumex crispus, A. spinosus, R. sardous, Senecio glabellus,* and *Haplopappus divaricatus*; (A) Dec., on *Lepidium virginicum, H. amarum, A. subulatus* var. *ligulatus,* and *E. capillifolium.* Sharkey Co.: (N) July, on *E. bonariensis*; (A) Aug., on *E. canadensis*; Sept.–Oct., on *S. altissima*; Sept., on *E. canadensis*; (A) Sept.–Oct., on *A. pilosus*; (A) Sept., on *A. artemisiifolia*; Oct., on *P. hysterophorus*; (A) Oct., on *Mikania scandens, E. canadensis, A. trifida, A. subulatus* var. *ligulatus, E. serotinum, Ludwigia decurrens,* and *B. halimifolia*; Dec., on *A. pilosus*; (A) Dec., on *L. amplexicaule.* Humphreys Co.: (A) Aug., on *E. canadensis*; Sept.–Oct., on *S. altissima* and *E. canadensis*; Sept., on *A. trifida*; (A) Oct., Dec., on *C. ambrosioides*; (A) Oct., on *A. pilosus, O. laciniata, V. brasiliensis,* and *Pyrrhopappus carolinianus*; Dec., on *A. pilosus*; (A) Dec., on *Vicia* spp. Sunflower Co.: (N) July, on *E. annuus*; Sept.–Oct., on *E. canadensis*; (A) Sept., Dec., on *S. altissima*; (A) Sept., on *C. ambrosioides*; Oct., on *S. altissima* and *A. pilosus*; (A) Oct., on *E. nutans, O. biennis,* and *A. subulatus* var. *ligulatus*; (A) Dec., on *E. canadensis, A. pilosus, L. amplexicaule,* and *Medicago arabica.* Leflore Co.: (A) May, on *E. annuus*; Sept.–Oct., on *S. altissima*; Sept., on *E. canadensis* and *E. annuus*; (A) Sept., on *A. pilosus*; Oct., on *A. pilosus*; (A) Oct., on *E. annuus,* and *A. artemisiifolia*; (A) Dec., on *Vicia* spp. and *A. subulatus* var. *ligulatus.* Bolivar Co.: (A) June, on *E. annuus*; Aug.–Sept., on *E. canadensis*; (A) Sept., on *A. trifida* and *S. altissima*; Oct.–Nov., on *S. altissima*; Oct., on *A. trifida* and *A. subulatus* var. *ligulatus*; (A) Oct.–Nov., on *E. canadensis* and *A. pilosus*; (A) Nov.–Dec., on *O. laciniata*; (A) Dec., on *M. matricarioides* and *S. altissima.* Tunica Co.: (A) Aug., on *E. annuus* and *Erigeron strigosus*; Sept.–Oct., on *E. canadensis* and *S. altissima*; (A) Sept., on *E. annuus*; Oct., on *A. pilosus* and *A. artemisiifolia*; (N) on *A. trifida*; (A) Oct., on *A. cristata*; (A) Nov., on *S. altissima, A. pilosus, P. pensylvanicum,* and *E. canadensis.*

Tropidosteptes canadensis Van Duzee. *MISSISSIPPI—Washington Co.: June, BLT; (A) May, on *Acer negundo* and *Trepocarpus aethusae.*

T. cardinalis Uhler. MISSISSIPPI—Washington Co.: (A) May, on *Ilex decidua* and *Fraxinus pennsylvanica.*

T. neglectus (Knight). *MISSISSIPPI—Washington Co.: (A) May, on *Carya aquatica* and *Fraxinus pennsylvanica.*

T. tricolor Van Duzee. MISSISSIPPI—Washington Co.: May, on *Fraxinus pennsylvanica*; (N) May, on *Cornus stricta*; (A) June, on *F. pennsylvanica.*

Tribe Resthenini

Prepops fraterculus (Knight). *MISSISSIPPI—Washington Co.: (A) July, on *Vitis cinerea.*

P. fraternus (Knight). *MISSISSIPPI—Washington Co.: June, BLT.

P. rubrovittatus (Stal). LOUISIANA—Madison Par.: July, Sept., BLT. MISSISSIPPI—Washington Co.: Aug.–Sept., BLT; (A) July, on *Ludwegia glandulosa* and *Cephalanthus occidentalis.*

Opistheuria clandestina Van Duzee. LOUISIANA—Madison Par.: Oct., BLT.

Tribe Stenodemini

Trigonotylus coelestialium (Kirkaldy). ARKANSAS—Crittenden Co.: June, BLT. LOUISIANA—Madison Par.: June, BLT. MISSISSIPPI—Washington Co.: June–July, BLT. Sharkey Co.: Sept., on *Cynodon dactylon.*

T. doddi (Distant). ARKANSAS—Crittenden Co.: June–Oct., BLT; July–Oct., (A) June and Nov., on *Cynodon dactylon*; (A) Mar., on *Bromus japonicus*; (A) Sept., on *Sorghum halepense* and *Leptochloa panicoides.* Chicot Co.: May–Nov., (A) Dec., on *C. dactylon*; (A) Oct., on *Digitaria ciliaris.* Desha Co.: (A) Apr.–May, June–Nov., on *C. dactylon.* Phillips Co.: July–Oct., (A) June and Nov., on *C. dactylon.* LOUISIANA—Madison Par.: May–Nov., BLT; May–Nov., on *C. dactylon*; Oct., on *Eleusine indica.* East Carroll Par.: (A) Apr.–May, June–Nov., on *C. dactylon*; Oct., on *S. halepense.* MISSISSIPPI—Washington Co.: June–Oct., BLT; May–Nov., on *C. dactylon*; (N) July, on *E. indica.* Sunflower Co.: July–Oct., (A) June and Dec., on *C. dactylon*; (A) Oct., on *D. ciliaris* and *Setaria geniculata.* Leflore Co.: (A) May–June, July–Oct., on *C. dactylon*; Apr., on *Hordeum pusillum*; Sept., on *L. panicoides.* Sharkey Co.: Apr.–Oct., (A) Nov.–Dec., on *C. dactylon*; (N) Apr., on *H. pusillum*; Oct., on *L. panicoides*; (A) July on *Cyperus rotundus.* Humphreys Co.: May–Oct., on *C. dactylon*; (A) July, on *S. halepense.* Bolivar Co.: July–Nov., on *C. dactylon*; (A) Aug., on *S. halepense.* Tunica Co.: June–Oct., on *C. dactylon.*

SUBFAMILY BRYOCORINAE

Tribe Eccritotarsini

Pycnoderes drakei Knight. MISSISSIPPI—Washington Co.: (A) June, on *Saururus cernus* and *Laportea canadensis.* Bolivar Co.: (A) June, on *Carya illinoensis, Cornus stricta, Commelina virginica,* and *Hackelia virginiana.*

P. medius Knight. *MISSISSIPPI—Warren Co.: May, on *Commelina virginica.*

P. quadrimaculatus Guerin. MISSISSIPPI—Washington Co.: (A) Aug., on *Carya illinoensis.*

Sixeonotus albicornis Blatchley. LOUISIANA—Madison Par.: May, BLT. MISSISSIPPI—Washington Co.: (A) May, on *Ambrosia trifida.*

S. insignis Reuter. LOUISIANA—Madison Par.: Aug., BLT. MISSISSIPPI—Washington Co.: Sept.–Oct., BLT.

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We are grateful to Dr. Sidney McDaniel, Department of Biological Sciences, Mississippi State University, for his identification of the plant species collected in the study. This research was funded, in part, through Cooperative Agreement No. 58-7B30-1-300 between the Department of Entomology, Mississippi State University, and the Southern Field Crop Insect Management Laboratory, USDA-ARS.

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86(4), 1984, pp. 861–863

A NEW SPECIES OF BRACONIDAE (HYMENOPTERA) FROM MEXICO INTRODUCED INTO TEXAS TO CONTROL A SUGAR CANE BORER, *EOREUMA LOFTINI* (LEPIDOPTERA: PYRALIDAE)

Paul M. Marsh

Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland 20705.

Abstract.—A new species of Braconidae, ***Allorhogas pyralophagus*** Marsh, is described from Mexico. This parasitoid attacks larvae of a pyralid moth, *Eoreuma loftini,* on sugarcane, and is being introduced against this pest in Texas.

Specimens of a braconid parasitizing *Eoreuma loftini* (Dyar) (Lepidoptera: Pyralidae) were collected from Johnson grass stems, *Sorghum halepense* (L.), in Monterrey, N.L., Mexico in 1981 by F. D. Bennett, Commonwealth Institute of Biological Control (CIBC), Trinidad. A laboratory colony of the parasite was established in Trinidad on *Diatraea saccharalis* (F.) (Lepidoptera: Pyralidae). Subsequent expeditions to Monterrey, N.L. (1982), Culiacan and Los Mochis, Sinaloa (1983) by Texas A & M University and the CIBC secured more specimens that were colonized in College Station, Texas.

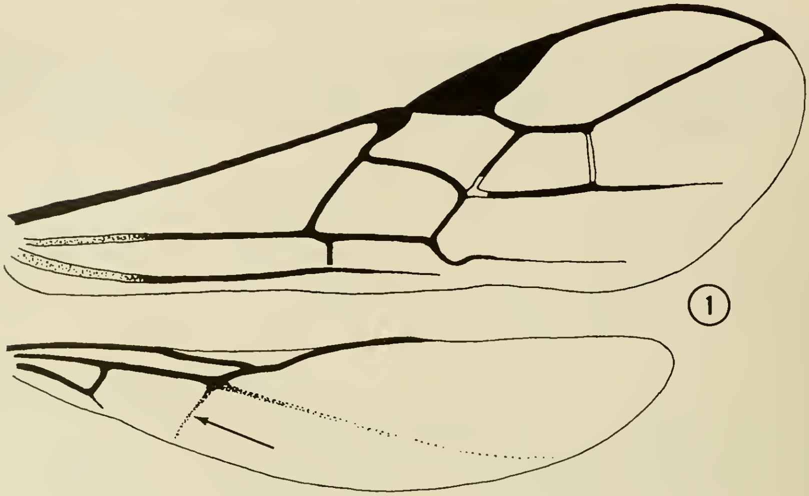
Currently this parasite is being released in the lower Rio Grande Valley of Texas for suppression of *E. loftini* on sugarcane, corn and grain sorghum. Field recoveries have been made for the past two years. Biological and ecological studies on this parasite are being conducted by J. W. Smith, Jr., and H. W. Browning of Texas A & M University. In addition to Texas, the parasite has been sent by CIBC to South America, Pakistan, and Africa for release against several species of pyralid stalk borers.

Specimens submitted to the Systematic Entomology Laboratory, USDA, by CIBC and Texas A&M were identified by me as *Allorhogas* sp. Because the species now appears to have potential for control of sugar cane stem borers, a name is provided here.

The inclusion of this new species in *Allorhogas* broadens the generic definition somewhat. The distinguishing character of the genus is the postnervellus of the hindwing; it is either perpendicular to the mediellen as in this new species (Fig. 1) or more often curves distinctly toward the wing tip as in the type-species, *A. gallicola* Gahan (Fig. 2). There are many undescribed species from the Western Hemisphere, and a thorough study of all included species is necessary before exact generic limits can be established.

Allorhogas pyralophagus Marsh, New Species
Figs. 1, 3–8

Female.—Length of body, 3.5–4.5 mm; ovipositor, 1.0–1.5 mm. Color: body entirely honey yellow; legs often yellowish-white; ovipositor and apical flagello-



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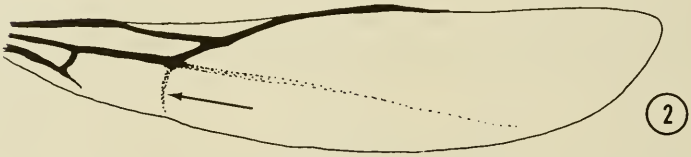

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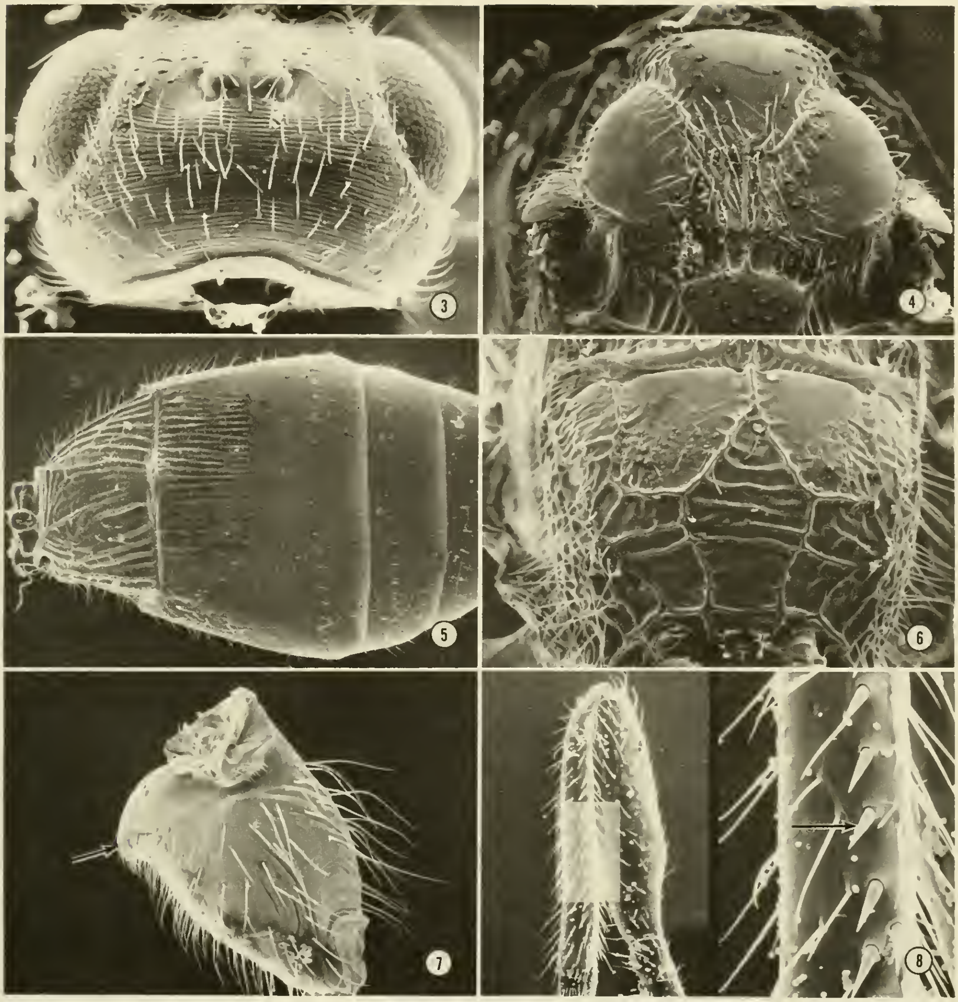
Figs. 1–2. Wings of *Allorhogas* spp. 1, Fore and hindwing of *A. pyralophagus* Marsh, n. sp. 2, Hindwing of *A. gallicola* Gahan.

meres brown; mesopleuron occasionally marked with brown along sternaulus; first and second abdominal terga often brown medially; wing veins brown, stigma honey yellow.

Head: vertex strigate (Fig. 3); face medially, frons and temples smooth; ocelli small, ocellocular distance at least three times length of lateral ocellus; 24–26 flagellomeres. *Thorax:* mesonotal lobes smooth; notauli scrobiculate anteriorly, meeting posteriorly in wide strigate area (Fig. 4); scutellar disc smooth, scutellar furrow wide, with 5–7 cross carinae; mesopleural disc smooth, sternaulus smooth or rarely finely scrobiculate, anterior corner of mesopleuron rugose; propodeum rugose laterally, strigate-rugose dorsally with strong carinae forming distinct central triangular areola, areola with transverse rugae, basal triangular areas smooth (Fig. 6). *Abdomen* (Fig. 5): first tergum with width at apex greater than length, costate, smooth basally between lateral costae; second tergum costate; remainder of terga smooth; ovipositor ½ as long as abdomen. *Legs:* hind coxae ventrally with broad tooth at base (Fig. 7); fore-tibia with row of 8–10 stout spines along anterior edge (Fig. 8). *Wings* (Fig. 1): first segment of radius of forewing ⅔ length of second segment, second segment slightly shorter than first intercubitus; postnervellus of hindwing perpendicular to mediellan, and parallel to nervellus; first segment of mediellan about as long as second segment.

Male.—Essentially as in female except for sexual characters; body length 3.0–4.0 mm; 22–24 flagellomeres.



Figs. 3–8. *Allorhogas pyralophagus* Marsh, n.sp. 3, Vertex. 4, Mesonotum. 5, Abdomen. 6, Propodeum. 7, Hind coxa. 8, Fore tibia.

Holotype ♀.—Mexico, Monterrey, ex *Acigona loftini,* Coll. V-1981, F. D. Bennett; in culture on *Diatraea,* CIBC, Trinidad, IV-1982, M. J. W. Cook. Deposited in U.S. National Museum of Natural History, Washington, D.C. (USNM).

Paratypes.—18 ♀♀, 5 ♂♂, same data as holotype; 8 ♀♀, 2 ♂♂, Pakistan, Rawalpindi, lab. culture V-27-82, reared on *Chilo partellus* in Sorghum (this culture originated from the laboratory culture in Trinidad established from the original collection in Mexico); 2 ♀♀, 2 ♂♂, Texas, College Station, lab. culture Aug. 83, originally from Mexico, Sinaloa (various localities), V-1983; 5 ♀♀, 2 ♂♂, Texas, College Station, lab. colony April 82, originally from Monterrey, Mexico. Paratypes deposited in: USNM; Texas A&M University, College Station, Texas; CIBC, London, England, and Rawalpindi, Pakistan.

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THE DISTRIBUTION AND HOST RANGE OF *ENTOMOPHAGA GRYLLI* (FRESENIUS), A FUNGAL PARASITE OF GRASSHOPPERS IN SOUTH DAKOTA

B. McDaniel and Roger A. Bohls

Plant Science (Entomology), South Dakota State University, Brookings, South Dakota 57007.

Abstract.—The effect of *Entomophaga grylli* on grasshopper populations within South Dakota was investigated during a 2-year period. Field observations established that the state's 3 most important species of grasshoppers are susceptible to pathotype 2 infections. Outbreaks are believed to be initiated annually from the soil of undisturbed areas which act as the reservoir for *Entomophaga grylli* resting spores. The occurrence of the fungus in regions of the state receiving 355 mm of rain during the growing season indicate pathotype 2 infection is maintained in dry environments.

Entomophaga grylli (Fresenius) was first described by Fresenius (1856) attacking a species of *Gryllus* near Frankfurt, Germany. *E. grylli* is best known as a pathogen of grasshoppers and locusts. The fungus is commonly found attacking insects throughout the world (MacLeod, 1956). *E. grylli* has frequently been observed attacking susceptible species of grasshoppers across the United States (Hutchison, 1963).

In South Dakota, Severin and Gilbertson (1917) stated that at least two species of grasshoppers were found to be killed by a fungus. Although these species were not identified in their report, Riker mounts made by Severin include cadavers of *Melanoplus bivattatus* (Say) containing resting spores of *E. grylli.*

E. grylli plays a significant role in the natural control of grasshoppers and is the most important fungal pathogen of grasshoppers (Dempster, 1963). Both cropland and rangeland species of grasshoppers are susceptible to infection by *E. grylli* (Hayes and DeCoursey, 1938; Hewitt, 1979; MacLeod and Muller-Kogler, 1973; Pickford and Riegert, 1964; Rockwood, 1950).

Grasshoppers succumbing to infection by *E. grylli* behave in a characteristic manner. Disease symptoms normally do not appear until the fungus is in its advanced stages. Prior to death there may be a general restlessness, cessation of feeding, and loss of coordination (Madelin, 1963). Infected individuals tend to climb upwards on vegetation and die with their legs wrapped around the plant (Fig. 1).

Following death there may be a distention of the abdomen in which the membrane separating the abdominal sclerites breaks and the fluid containing the fungus flows down the plant, collecting on the stem and leaves. The whole abdomen may tear loose from the thorax and drop to the ground during this soft stage of the grasshopper cadavers. In specimens where distention does not occur, the abdomen

Fig. 1. Fungus-killed grasshoppers clinging to vegetation.

often curls upward and forwards, in some cases touches the pronotum (Schaefer, 1936). In material observed in South Dakota, this curling was most often found to be associated with nymphal stages. In most specimens killed by the fungus the body becomes very hard and is filled with resting spores.

In South Dakota the average grasshopper hatch will begin by mid-May in the

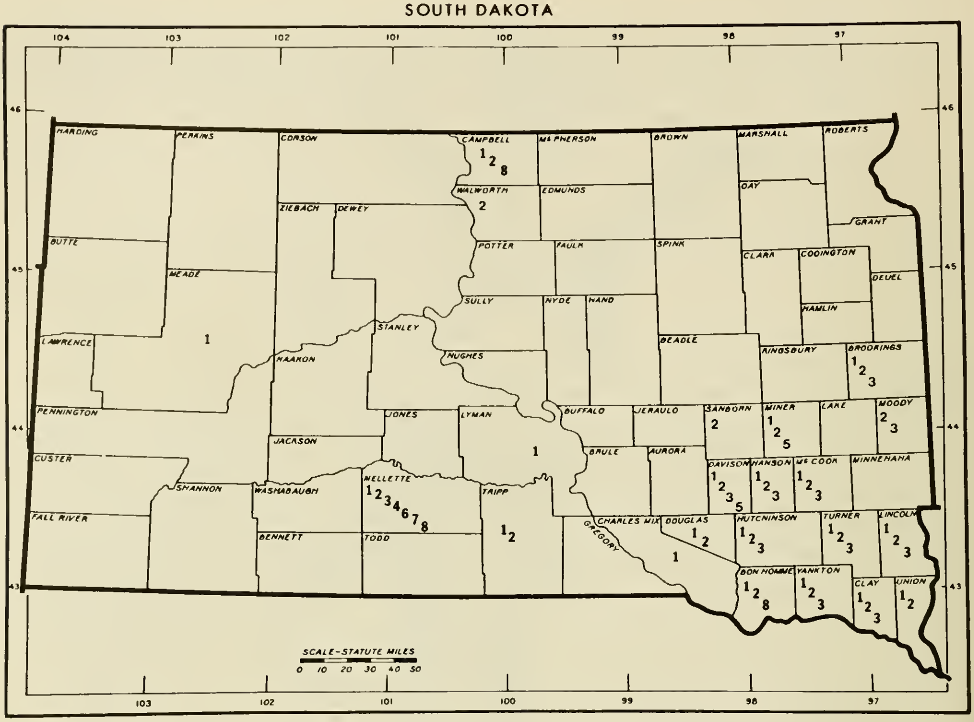

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Fig. 2. Observed occurrence of *E. grylli* in grasshoppers, 1980–81. 1, *M. bivittatus.* 2, *M. differentialis.* 3, *M. femurrubrum.* 4, *M. sanguinipes.* 5, *M. packardii.* 6. *M. confusus.* 7, *M. lakinus.* 8, *P. nebrascensis.*

western and southern regions. There may be a variance in the hatching date of approximately one month between different regions of the state. Among the state's three most important species, *Melanoplus bivittatus* (Say), *Melanoplus differentialis* (Thomas), *Melanoplus femurrubrum* (DeGeer), there may be a three week difference in hatching dates. Of these, *M. bivattatus* is the early hatching species and may appear 2–3 weeks prior to the first emergence of either *M. differentialis* or *M. femurrubum.*

In 1980–81 surveys were conducted to determine the natural distribution and host specificity of *E. grylli* in grasshopper populations within South Dakota. The map in Figure 2 shows the counties in which natural outbreaks of *E. grylli* occurred. A total of eight species of grasshoppers were found to be infected (see map for locations): *M. bivittatus* (Say), two-striped grasshopper; *M. differentialis* (Thomas), differential grasshopper; *M. femurrubrum* (DeGeer), red-legged grasshopper; *M. sanquinipes* (Fabricius), migratory grasshopper; *M. packardii* Scudder, Packard grasshopper; *M. confusus* (Scudder), little pasture spur-throated grasshopper; *M. lakinus* (Scudder), lakinus grasshopper; *Phoetaliotes nebrascensis* (Thomas), large-headed locust.

The first outbreak was observed in Mellette County July 3, 1980 at White River, S.D. The largest outbreak in the southeastern section of South Dakota in 1981 was in Davison County at Mitchell, S.D. This outbreak was first discovered in August 25, 1981. A survey of the southeastern section of the state during the month of August, 1981 indicated that small outbreaks were widespread. The majority of grasshoppers dying from the fungus were found in areas not subject to cultivation (field borders, roadside ditches, alfalfa fields). However, diseased grasshoppers were collected from the edges of cornfields (Brookings County) and soybean fields (Davison County). The outbreak in the northcentral portion of the state was in Campbell County and occurred on the South Dakota–North Dakota state line in wheat fields in late August.

Different strains of *E. grylli* have been found to be lethal to different grasshopper species according to Pickford and Riegert (1964). Soper et al. (In preparation) reported the existence of different pathotypes for *E. grylli.* Pathotype 1, which is characterized by producing both the conidial and resting spore states in contrast to pathotype 2, which lacks the conidial cycle.

Field observations suggest that only pathotype 2 infections occur within the state. Grasshopper species within South Dakota that are known to be susceptible to pathotype 1 infections, were not found to be cross infected by the pathotype 2 form of *E. grylli.* This supports the findings of others (Pickford and Riegert, 1964; Milner, 1978; Soper et al. (In preparation)) that different strains of the fungus are lethal to different species of grasshoppers. Nevertheless, from this investigation it is evident that in South Dakota all species of grasshoppers that are of immediate importance and those that have the potential to be destructive in the future are susceptible to either pathotype 1 or pathotype 2 infections of *E. grylli.*

ACKNOWLEDGMENTS

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Henry Townes, *American Entomological Institute, 5950 Warren Road, Ann Arbor, Michigan 48105.*

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STENOTHREMMA, A NEW EUPHORINE GENUS FROM AUSTRALIA (HYMENOPTERA: BRACONIDAE)

SCOTT R. SHAW

Maryland Center for Systematic Entomology, Department of Entomology, University of Maryland, College Park, Maryland 20742.

Abstract.—***Stenothremma*** Shaw, a new euphorine braconid genus from the Australian region, is described and illustrated. Three new species are included in the genus: ***S. brevicorne***, ***S. townesi***, and ***S. novicaledoniense***. A key to species is presented.

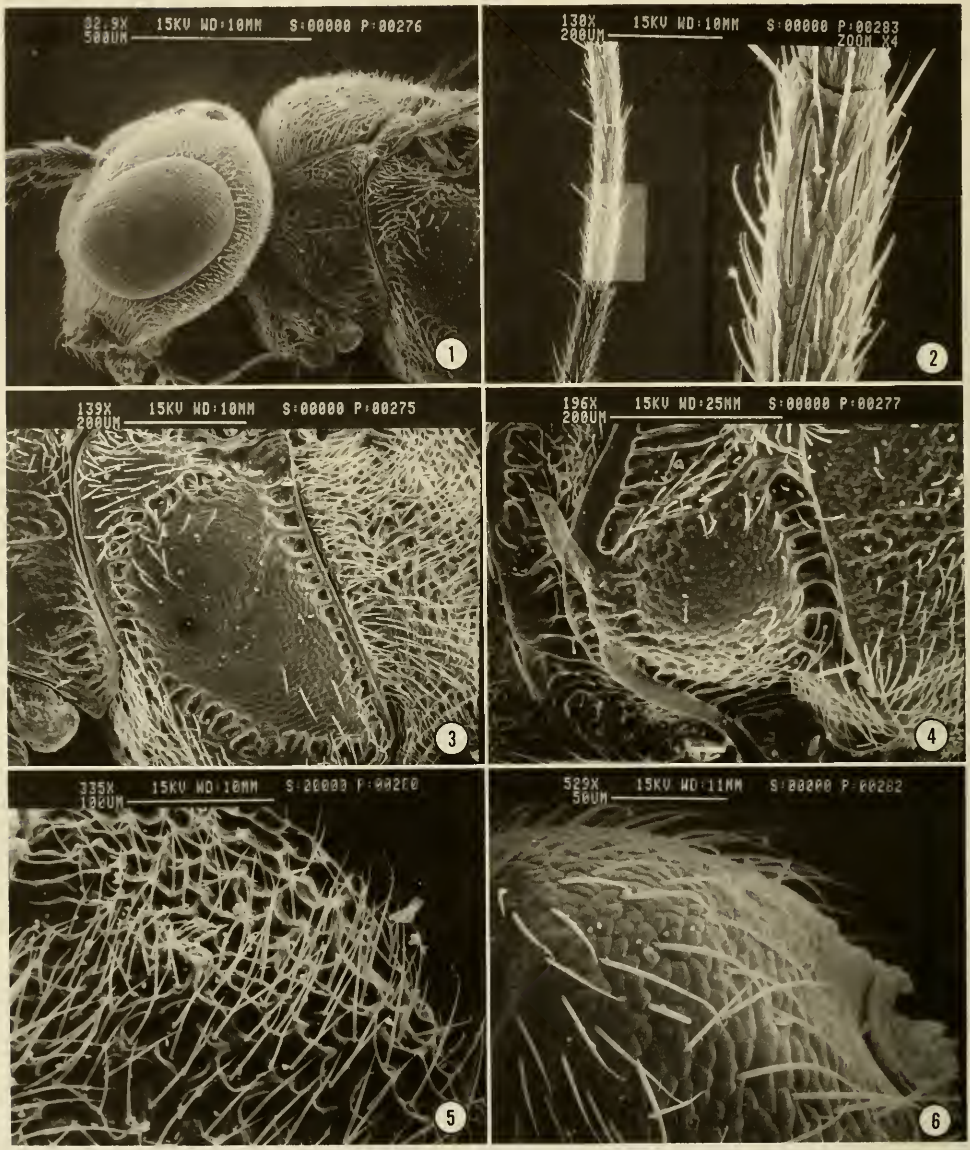
The existence of this new genus was recently called to my attention by Dr. Henry Townes, who kindly allowed me to examine the specimens from his collection. Two species of the new genus were represented in the Townes collection [AEI], and specimens of a third species were later found in the Canadian National Collection [CNC] at Ottawa. The unusual form of the metasoma is rather striking (Figs. 10–11), and allows the genus to be easily distinguished from other braconid genera. Another striking feature is the imbricate microsculpture (Figs. 3, 4, and 6), which is seldom seen in other euphorine genera. This study is in support of a larger project, currently in progress, investigating the phylogenetic relationships among the genera of Euphorinae.

Genus *Stenothremma* Shaw, NEW GENUS

Type species: Stenothremma brevicorne, new species.

Head transverse, slightly wider than mesosoma, setose, finely granular; eyes oval, glabrous, distinctly convergent ventrally, with a silvery sheen; eye large, in lateral profile occupying most of head; malar space short, about ⅕ eye height; malar suture absent; clypeus slightly convex, lower margin rounded; mandibles bidentate, apical tooth twice as long as basal tooth, mandibles overlapping nearly completely when closed; palpi very short; maxillary palpus 5-segmented, slightly shorter than mandible length; labial palpus 3-segmented, about ½ as long as maxillary palpi; antenna inserted at middle of head; inter-antennal distance about one socket width; scape length about 2× scape width; flagellum slender, 13–24 flagellomeres; each flagellomere with an apical corona of 5–6 long setae, each seta nearly as long as flagellum width; all flagellomeres longer than wide, gradually shorter distally; apical flagellomere tapering to a point; median frontal carina present, strong; ocellar triangle slightly isosceles; occipital carina complete; occiput nitid.

Mesosoma setose, mostly with fine granular sculpture; notauli indistinct; sternaulus indicated by a broad coarse depression; scutellar furrow narrow, foveate; scutellar disc slightly convex, finely granular; propodeum finely areolate-rugose,



Figs. 1–6. *Stenothremma novicaledoniense.* 1, Lateral view of head and mesosoma. 2, Flagellomeres 1–4 and detail of F2. 3, Lateral view of mesopleuron. 4, Dorsal view of scutellum. 5, Lateral view of propodeum. 6, Lateral view of hind coxa.

strongly declivous in lateral profile; postero-medial propodeal impression strong; petiolar notch deep, extending to anterior margin of hind coxa; hind coxa granular, small, about ¼ petiole length; metatibial spurs short, about ¼ metabasitarsus length; tarsal claws simple; wings hyaline; basal vein nearly straight; second intercubitus present or absent, if present lightly sclerotized; radius arcuate apically; brachius absent apically; metacarpus extending distinctly beyond apex of radial cell; medius distinctly sclerotized; hind wing venation weakly sclerotized, except apex of costella; radiella and cubitella absent.

Petiole long, from ¾ to 1 × mesosoma length, slender, apical ½ swollen relative to basal ½, entirely fused ventrally, slightly arched in lateral view; glymma and dorsope absent (see van Achterberg, 1974); petiolar spiracles posterior of middle; gaster strongly compressed, tergites overlapping slightly ventrally; tergites 2 + 3 slightly longer than petiole, with sharp lateral folds basally; tergites 4–6 exposed, combined about as long as tergites 2 + 3; hypopygium prominent, setose, folded ventrally; exserted ovipositor as long as, or longer than, petiole; ovipositor distinctly arched downwards, sharply pointed apically; sheaths slightly shorter than ovipositor, sparsely but evenly setose.

Remarks.—The genus is most closely related to the *Aridelus-Wesmaelia-Chrysopopthorus* lineage of Euphorinae. Synapomorphies of these genera include: long sickle-like mandibles; median frontal carina; areolate-rugose propodeum; strong postero-medial propodeal impression; deep petiolar notch; long slender petiole, entirely fused ventrally; glymma and dorsope absent. *Stenothremma* may be easily distinguished from these genera by its strongly compressed metasoma. *Stenothremma* is the only euphorine genus with both a long slender petiole and a laterally compressed gaster. The only other euphorine genera with a laterally compressed metasoma are *Myiocephalus* and *Bracteodes*. These genera are part of an entirely different lineage with strikingly different wing venation. The first cubital abscissa is absent in these genera, thus a large disco-cubital cell is present. The first cubital abscissa is always present in *Stenothremma*.

An interesting feature is the variability of the second intercubitus (ICu2), which makes it difficult to place the genus in existing keys. In Tobias' (1966) key to world euphorine genera those species with the ICu2 present would key to *Chrysopopthorus*, while those with the ICu2 absent would run (with difficulty) to *Perilitus*. The same is true of Marsh's (1971) key to Nearctic genera. The genus would key to *Perilitus* in Loan's (1983) key to Nearctic euphorine genera, although *Stenothremma brevicorne* could be keyed to the same couplet as *Cryptoxilos* because of its short flagellum.

Hosts.—Unknown. Related genera are mostly parasites of Hemiptera.

Etymology.—The name is neuter, from Greek, meaning narrow creature. It refers to the compressed metasoma that characterizes the genus.

KEY TO THE SPECIES OF *Stenothremma*

1. Tergite 2 at base only about as wide as petiole; tergites 3–6 folded medially; ovipositor equal to or shorter than petiole 2
– Tergite 2 broadening abruptly from base, basally distinctly wider than petiole; tergites 3–6 not folded medially; ovipositor distinctly longer than petiole .... *Stenothremma townesi*, new species
2. Flagellum short, 13-segmented; antenna less than 1.5 times head width; radial cell, along wing margin, distinctly shorter than stigma length; second intercubitus present; ovipositor about as long as petiole .... *Stenothremma brevicorne*, new species
– Flagellum longer, 19-segmented; antenna about 2.5 times as long as head

width; radial cell, along wing margin, about as long as stigma; second intercubitus absent; ovipositor about ⅔ petiole length .... *Stenothremma novicaledoniense,* new species

Stenothremma brevicorne Shaw, New Species

Figs. 8, 10, 11

Holotype.—Female, Australia: Northern Territory, Areyonga, 600m, September 28, 19 ? [AEI]

Description of holotype female.—Body length 3.5 mm; fore wing length 2.5 mm.

Color: Head mostly yellowish brown; ocellar triangle, frons medially, and occiput black; facial setae silver; scape, pedicel, and base of F1 yellow, remainder of flagellum black; mouthparts yellow, except apical mandibular tooth dark brown; mesosoma black; setae silver; tegula yellow; wings hyaline; costa, stigma, parastigma, metacarpus, radius, basal vein, cubitus, intercubiti, discoideus, nervulus, brachius basally, and costella apically brown; other veins pale yellow; legs mostly yellow; middle and hind coxae and trochanters, and apical tarsomeres dark brown to black; fore coxa and trochanter, hind tibia, and middle and hind tarsi suffused with brown; petiole dark brown to black, except dorsal apex yellowish brown; gaster yellowish brown dorsally and laterally, venter black except hypopygium yellow; ovipositor yellowish brown, sheaths dark brown to black.

Head: Face, gena, and clypeus densely setose, setae mostly obscuring granular surface sculpture; frons, vertex, and temple less densely setose, granular sculpture clearly visible through setae; antenna short, less than 1 and ½× as long as head width; 13 flagellomeres; flagellum evenly thick throughout, except for F13 which tapers to a blunt point.

Mesosoma: Pronotum distinctly visible from above, not obscured by anterior part of mesonotum; mesonotum uniformly finely granular, anterior corners of notauli slightly impressed but not sculptured differently from mesonotum; scutellar furrow 8-foveate; mesopleural disc granular; anterior mesopleural margin, dorsal margin, posterior margin, and sternaulus foveolate; propodeum squarish in lateral view, posterior face nearly perpendicular to longitudinal axis of mesosoma; second radial abscissa distinctly shorter than first radial abscissa; radial cell along wing margin distinctly shorter than length of stigma; metacoxae finely and evenly imbricate; metatarsal ratio 14:6:4:3:3.

Metasoma: Petiole about as long as length of mesosoma; postero-dorsal surface of petiole finely imbricate; tergite 2 at base only about as wide as petiole; tergites 3–6 folded medially, finely granular laterally; ovipositor about as long as petiole.

Paratype females.—Essentially same as holotype female, except body length 3.5–5.1 mm; fore wing length 2.5–2.6 mm.

Male.—Unknown.

Paratype data.—2 females, same data as holotype, except collected October 30. [AEI]

Remarks.—*Stenothremma brevicorne* is readily distinguished from other species in the genus by its short flagellum, which is 13-segmented. Other species of the genus have 19–24 flagellomeres. Also, the propodeum is squarish in lateral view, with the posterior face nearly perpendicular to the longitudinal axis of the meso-

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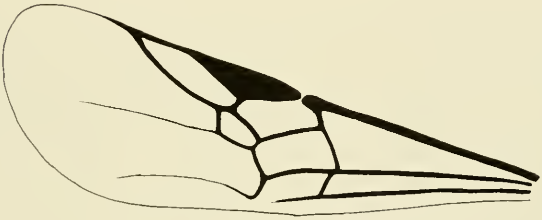

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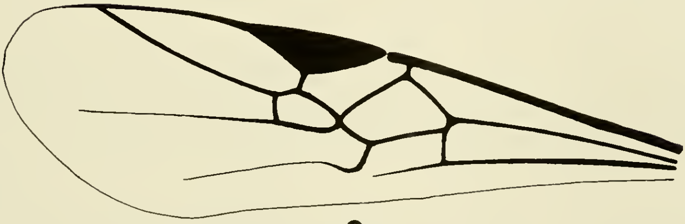

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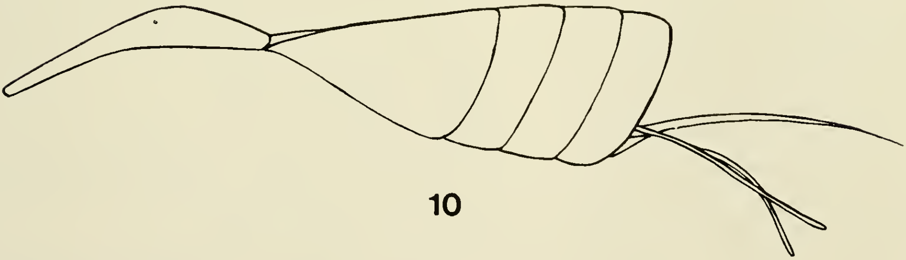

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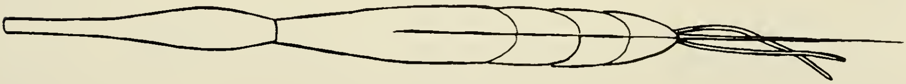

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Figs. 7–11. *Stenothremma* spp. 7, *S. novicaledoniense,* fore wing venation. 8, *S. brevicorne,* fore wing venation. 9, *S. townesi,* fore wing venation. 10, *S. brevicorne,* lateral view of metasoma. 11, *S. brevicornis,* dorsal view of metasoma.

soma. In other species the posterior face of the propodeum slopes at about 80 degrees relative to the longitudinal axis of the mesosoma.

Etymology.—The name refers to the short antennae which are distinctive of the species.

Stenothremma townesi Shaw, New Species
Fig. 9

Holotype.—Female, Australia: Northern Territory, Wave Hill, August 19 ? [AEI]

Description of holotype female.—Body length 4.8 mm; fore wing length 2.7 mm.

Color: Head mostly yellowish brown; ocellar triangle, apex of mandible, apical ½ of flagellomeres 2–3, and entire flagellum beyond F3 black; setae white; palpi brown; mesosoma mostly reddish brown, darker along edges of sclerites; tegula yellow; wings hyaline; costa, stigma, parastigma, metacarpus, radius, second cubital abscissa, intercubiti, recurrent vein, discoideus, and nervulus brown; other veins of fore wing pale yellowish brown; hind wing venation pale white; legs mostly yellowish brown, except tarsi brown to black apically; petiole yellowish brown; most of gaster yellowish brown except apex of tergite 6, venter of hypopygium, and ovipositor sheaths black; ovipositor brown.

Head: Sparsely setose, setae not obscuring surface sculpture; face, gena, temple, frons, and vertex granular; clypeus smooth and shining, more sparsely setose than face; antenna about 3 × as long as head width; 24 flagellomeres; flagellum gradually more slender apically; apical flagellomere tapering to a sharp point.

Mesosoma: Pronotum not visible when viewed from above, obscured by anterior bulge of mesonotum; mesonotum mostly granular, except anterior corners of notauli slightly more coarsely sculptured; scutellar furrow 6-foveate; mesopleural disc mostly granular; posterior mesopleural margin foveolate; sternaulus and dorsal mesopleural margin rugose; posterior face of propodeum sloping in lateral view at an angle of about 80 degrees relative to the longitudinal axis of the mesosoma; second radial abscissa as long as first radial abscissa; radial cell along wing margin fully as long as stigma; metacoxa mostly smooth, although sparsely imbricate on outer face; metatarsal ratio 15:5:4:3:3.

Metasoma: Petiole distinctly shorter than mesosoma, about ¾ greatest length of mesosoma; petiole surface smooth and polished; tergite 2 broadening abruptly from base, basally distinctly wider than petiole; tergites 3–6 not folded medially, smooth and polished; ovipositor distinctly longer than petiole.

Paratype female.—Essentially as in holotype, except body length 3.8 mm; fore wing length 3.0 mm; tergites 3–6 and venter of gaster more extensively suffused with black.

Male.—Unknown.

Paratype data.—1 female, Australia: South Australia, 10 Km. N. Kingoonya, at blacklight, 2 April 1980, (G. F. Hevel and J. A. Fortin). [USNM]

Remarks.—*Stenothremma townesi* is readily distinguished from other species of the genus by the second tergite, which is broader than the petiole; and the ovipositor which is longer than the petiole. In other species the second tergite is only about as wide as the petiole and the ovipositor is at most as long as the petiole, sometimes shorter.

Etymology.—The species is named for Dr. Henry Townes, in gratitude for his generous loan of specimens from his personal collection and for calling to my attention the existence of this new genus of Euphorinae.

Stenothremma novicaledoniense Shaw, New Species

Figs. 1–7

Holotype.—Female, New Caledonia: Ouen Toro, Noumea, 7-I-1972, (P. Cochereau). [CNC]

Description of holotype female.—Body length 3.5 mm; fore wing length 2.4 mm.

Color: Head mostly yellow; ocellar triangle, frons medially, and occiput black; facial setae silver; scape and pedicel yellow; flagellum yellowish brown basally, becoming dark brown distally; mouthparts yellow, except mandibular teeth reddish brown; mesosoma mostly black, except mesonotum, scutellar disc, dorsolateral corner of pronotum, and mesopleuron dorsally yellow; tegula yellowish white; wings hyaline; costa, stigma and parastigma dark brown, other veins of fore wing yellowish brown; hind wing venation pale yellow; legs mostly yellow, except hind tibia and tarsus brown; basal ½ of petiole yellowish brown, distal ½ dark brown; tergites 2 + 3 dark brown dorsally, remaining tergites yellowish brown suffused with dark brown; hypopygium yellowish white; ovipositor sheaths black; ovipositor yellow.

Head: Face, gena, and clypeus densely setose, setae mostly obscuring granular surface sculpture; frons, vertex, and temple less densely setose, granular sculpture clearly visible through setae; antennae about 2.5× as long as head width; 19 flagellomeres; flagellum width even throughout, except for F19 which tapers to a blunt point.

Mesosoma: Pronotum distinctly visible from above, not obscured by anterior part of mesonotum; mesonotum uniformly finely granular; notauli indistinct; scutellar furrow 8-foveate; mesopleural disc granular, sternaulus rugose, anterior, dorsal, and posterior mesopleural borders foveolate; posterior face of propodeum sloping in lateral view at an angle of about 80 degrees relative to longitudinal axis of mesosoma; second intercubitus absent, therefore second and third radial abscissae form single arcuate segment; radial cell along wing margin about as long as stigma; metacoxa finely and evenly imbricate; metatarsal ratio 14:6:4:3:3.

Metasoma: Petiole slightly shorter than mesosoma, about 7/8 greatest length of mesosoma; dorsal surface of petiole finely imbricate; tergite 2 at base only about as wide as petiole; tergites 3–6 folded medially, finely granular laterally; ovipositor about ⅔ petiole length.

Paratype females.—Essentially same as in holotype female, except body length 2.8–4.5 mm; fore wing length 2.4–2.6 mm; 18–20 flagellomeres; tergites 2–6 from extensively suffused with dark brown to nearly entirely yellowish brown; fore wing venation dark brown to pale yellowish brown.

Male.—Unknown.

Paratype data.—22 females, same data as holotype; 1 female, same data as holotype except collected 1–19 VI 1972; 1 female, same data as holotype except collected V 1972. [CNC]

Remarks.—This species is easily distinguished from other species of the genus by the absence of the second intercubitus, which is present in other species. Also, *Stenothremma novicaledoniense* has the shortest ovipositor observed for the genus, only about ⅔ the petiole length. Other species have the ovipositor at least as long as the petiole, sometimes longer.

Etymology.—The species is named for the type locality, which is isolated from the mainland distributions of other species.

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A REVISION OF AMYRSIDEA, SUBGENUS *CRACIMENOPON* (MALLOPHAGA: MENOPONIDAE)

William C. Scharf and K. C. Emerson

(WCS) Department of Biology, Northwestern Michigan College, Traverse City, Michigan 49684; (KCE) 560 Boulder Drive, Sanibel, Florida 33957.

Abstract.—Fourteen species are described in the subgenus *Cracimenopon* Carriker genus *Amyrsidea* Ewing from galliform hosts of the family Cracidae. One new species, *A.* (*C.*) ***rogersi*** from *Crax fasciolata,* is described, and 13 new synonymies are given. Illustrations and a key for identification of the species are given.

The menoponid genus *Amyrsidea* Ewing, 1927, has recently been revised to recognize five subgenera (Scharf and Price, 1977, 1983; Scharf and Emerson, 1983). The genus is distributed world-wide on galliform hosts. Each of the subgenera has a discrete host group whose geographical distribution is distinctive. These subgeneric distributions are as follows: *Amyrsidea* from three genera of the Phasianidae from southeast Asia; *Desumenopon* Carriker from neotropical quail of the genus *Odontophorus*: Phasianidae; *Argimenopon* Eichler from four families of Phasianidae from Africa, India, southeast Asia, and the Holarctic Region; *Numidimenopon* Scharf from the family Numididae from Africa; and *Cracimenopon* Carriker from the neotropical family Cracidae.

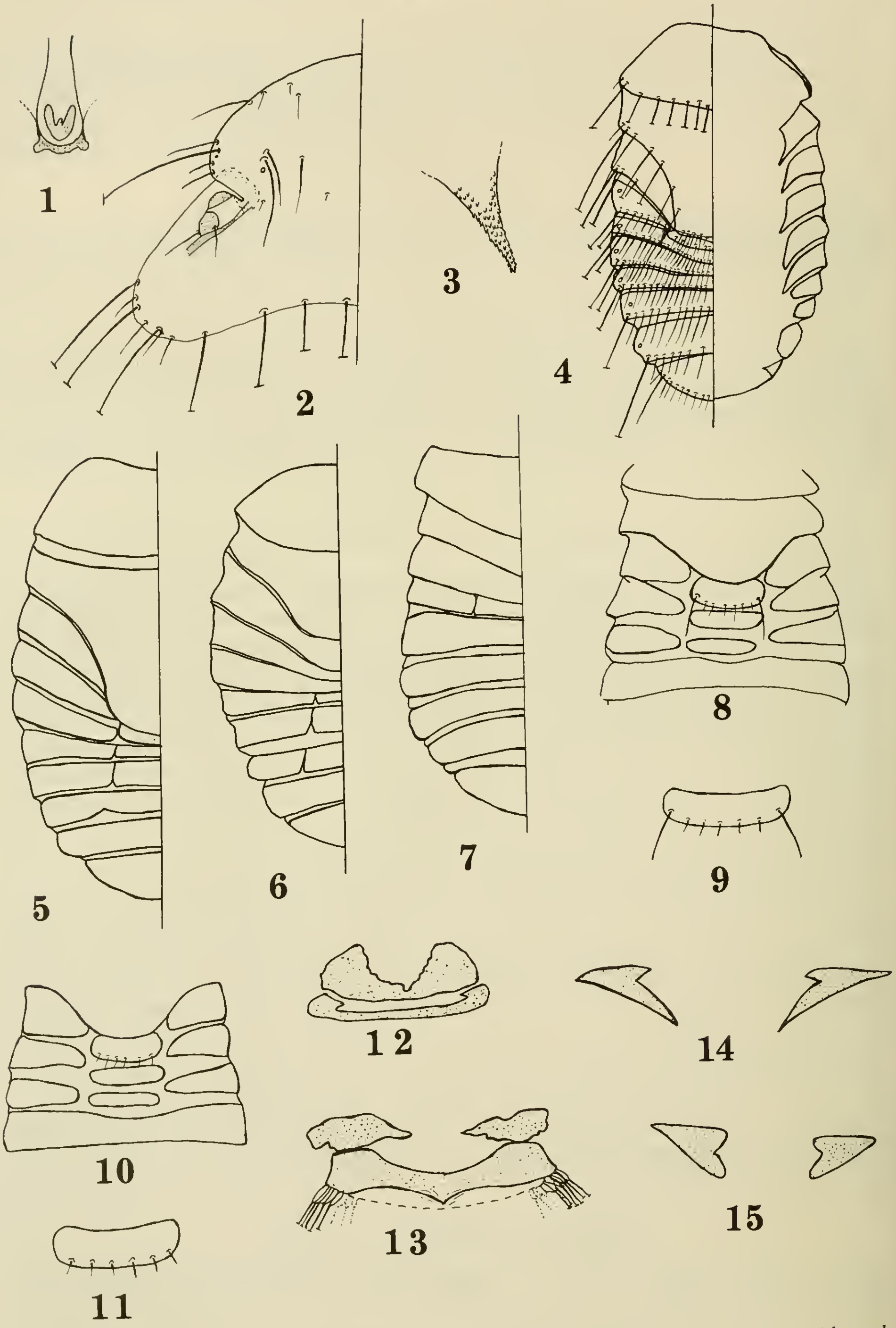
Cracimenopon species are distinctive not only in being restricted to one family of hosts, but also because of their large prominent eyes, preocular slit usually deeper than 0.025 mm, lack of setae on sternite I, sexually dimorphic ventral pleural extensions and frequent enlargement of anterior terga in females. This paper presents descriptions, illustrations, and a key to the 14 species of the subgenus *Cracimenopon.*

In the following descriptions, numbers of certain head setae are those given by Clay (1969). Measurements are in millimeters. Unless noted, all illustrations are of specimens from the type-host. The nomenclature of the hosts follows Peters (1934), but some pertinent recent changes are given based on Delacour and Amadon (1973) and Vaurie (1968).

Subgenus *Cracimenopon* Carriker

Cracimenopon Carriker, 1954: 21. Type-species: *Cracimenopon mituensis* Carriker.

The members of this subgenus form a group of closely related lice which are known only from the Cracidae. They may be separated from other subgenera by the following combination of characteristics:



Figs. 1–15. 1, Strongly developed hypopharyngeal sclerite, from *Crax rubra.* 2, *Amyrsidea rubra* head. 3, *Amyrsidea* sp. pleural extension, from *Crax rubra.* 4–11, Female tergal features, subgenus *Cracimenopon.* 4, *A. pauxis,* from *Pauxi pauxis.* 5, *A. rubra.* 6, *A. rogersi.* 7, *A. mituensis* (thorax not shown). 8, *A. caquetae.* 9, *A. caquetae,* setal arrangement on mid-tergite II. 10, *A. jacquacu.* 11, *A. jacquacu,* setal arrangement on mid-tergite II. 12–15, Pre-anal plates. 12, *Amyrsidea garruli,* from *Ortalis g. garrula.* 13, *A. aburris,* from *Penelope jacquacu granti.* 14, *A. aburris.* 15, *A. semicracis.*

1. Head with wide temples; difference between temple and preocular width 0.14–0.27.
2. All species with strongly developed hypopharyngeal sclerite (Fig. 1).
3. Preocular slit deep (0.04–0.05).
4. Preocular seta 11 shorter than 0.10 and of similar thickness to seta 10 (Fig. 2).
5. No dorsal head sensilla between sensilla *c*.
6. Terminal antennal segment short and wide, ratio of width to length more than 0.5.
7. Large prominent eyes.
8. No setae on sternite I.
9. Outer medioanterior metanotal setae shifted far anterior, near meso-metanotal suture.
10. Frequent sexual dimorphism, with females having enlarged tergite I and some with tripartite tergites among II, III, or IV. Males without enlarged tergites.
11. Females with ventral extension on pleura I–IV or II–VI (Fig. 3). This is rarely seen in males.
12. Female segment IX with anal fringes and sternal setae similar to Fig. 36; no spiniform setae.

***Amyrsidea* (*Cracimenopon*) *mituensis* (Carriker)**

Figs. 7, 30

Cracimenopon mituensis, Carriker, 1954: 22.

Type-host: *Mitu mitu* (Linnaeus).

Male.—Preocular slit 0.04 deep. Inner middorsal head seta 17 clearly anterior to outer 18. With 12 long and 4 short marginal pronotal setae. Mesothorax and metathorax not visible. Brush on femur III with 30–31 short setae. Tergite I normal length, with same proportions as other tergites; marginal tergal setae: I, 16; II, 14; III, 16; IV, 24; V, 25; VI, 24; VII, 22; VIII, 14. No anterior tergal setae on III–VIII. Sternal setae obliterated on I–VI; VII, 38; VIII, 21. Sternal brushes apparently small but obliterated on III; with short setae on each side of IV, 28; V, 30; VI, 25–26. Last tergite each side with 2 very long marginal setae, 3–4 medium setae lateroanterior to these, 10 total medium inner posterior setae, and no anterior setae. Subgenital plate with 16 marginal and anterior setae. Genitalia as in Fig. 30.

Female.—As for ♂, except as follows. Brush on femur III with 39 short setae. Tergite I enlarged, II slightly enlarged, III nearly normal with proportions as in V–VIII, IV tripartite (in Fig. 7, note thorax omitted), marginal tergal setae on I obliterated; II, 24; III, obliterated; IV, 41 (including all 3 parts); V, 49; VI, 44; VII, 31; VIII, 16. Last tergite with 4 very long marginal setae, 2 short setae lateroanterior to these, and 15 inner posterior setae. Subgenital plate with 31 marginal and 19 anterior setae. Anal fringe with 50 dorsal and 46 ventral setae.

Dimensions.—Preocular width, ♂ 0.39, ♀ 0.44; temple width, ♂ 0.58, ♀ 0.65; prothorax width, ♂ 0.41, ♀ 0.48; metathorax width, ♂ obliterated, ♀ 0.68; total length, ♂ 1.44, ♀ 1.97; ♂ genitalia width 0.15, length indistinguishable.

Remarks.—It is unfortunate that Carriker (1954) chose this species, represented by only two poor specimens, as the type-species for the genus *Cracimenopon*. It is best recognized by the ♂ genitalia and combination of enlarged tergite I, slightly enlarged II, normal III, and tripartite IV in ♀.

Material examined.—Holotype ♂, allotype ♀ of *C. mituensis,* USNM slide 68613, *Mitu mitu,* Bolivia.

Amyrsidea* (*Cracimenopon*) *pauxis **Carriker**
Figs. 4, 31–33

Amyrsidea simplex pauxis Carriker, 1950: 496. Type-host: *Pauxi pauxi gilliardi* Wetmore and Phelps.

Amyrsidea parvispina Carriker, 1950: 496. Type-host: *Pauxi pauxi unicornis* Bond and de Schauensee (= *Pauxi unicornis* Bond and de Schauensee). NEW SYNONYMY.

Amyrsidea spinigaster spinigaster Carriker, 1950: 497. Type-host: *Crax nigra* L. NEW SYNONYMY.

Amyrsidea semicracis guttatus Carriker, 1950: 505. Type-host: *Chamaepetes unicolor* Salvin. NEW SYNONYMY.

Male.—Features as for *A. mituensis,* except for the following. Middorsal head setae 17 and 18 in straight line across head. Mesosternal plate with 10–14 setae, metasternal plate with 9–12 setae, and metanotum with 14 long marginal setae. Brush on femur III with 40–42 short setae. All abdominal tergites normal length without enlargement. Marginal tergal setae: I, 15–17; II, 16–18; III, 17–22; IV, 24–27; V, 25–30; VI, 24–30; VII, 20–38; VIII, 12–16. No anterior tergal setae. Sternal setae: II, 18–20; III, 32–35; IV, 25–26; V, 25–30, VI, 16–26; VII, 14–39; VIII, 18–30. Sternal brushes: II, 12–23; III, 17–22; IV, 22–34; V, 20–35; VI, 20–28; VII, 12–15. Last tergite with 2 very long marginal setae on each side, 6–8 medium setae lateroanterior to these, and 10–12 medium inner posterior setae. Subgenital plate with 20–28 marginal and anterior setae. Genitalia somewhat variable for few specimens examined (Figs. 31–33), but all with some semblance of V-shaped sclerite.

Female.—As for ♂ except as follows. Abdominal tergite I greatly enlarged, covering half of abdomen; tergite II tripartite, with middle portion extremely short; tergites III and IV also tripartite (Fig. 4). Marginal tergal setae: I, 16–17; II, 12–15; III, 14; IV, 35–37; V, 39–45; VI, 37–42; VII, 30–33; VIII, 14. Sternal setae: II, 17–18; III, 43–44; IV, 30–32; V, 33–35; VI, 27–28; VII, 21–22. Last tergite with 2 very long marginal setae each side, 6 medium setae lateroanterior to these, and 14–15 medium inner posterior setae. Anal fringe with 48–54 setae dorsally and 60–61 setae ventrally.

Dimensions.—Preocular width, ♂ 0.38–0.52, ♀ 0.41–0.43; temple width, ♂ 0.58–0.67, ♀ 0.61–0.66; prothorax width, male 0.41–0.44, ♀ 0.42–0.50; metathorax width, ♂ 0.48–0.54, ♀ 0.67–0.68; total length, ♂ 1.66–1.78, ♀ 1.84–1.85; male genitalia width 0.14–0.16, length 0.31–0.43.

Remarks.—The combination of enlarged female tergum I with II–IV tripartite

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Figs. 16–26. 16–18, Pre-anal plates. 16, *A. aburris,* from *Chamaepetes goudoti.* 17, *A. aburris,* from *Chamaepetes rufiventris.* 18, *A. spicula.* 19–26, Male genitalia. 19, *A. garruli.* 20, *A. spicula.* 21, *A. aburris.* 22, *Amyrsidea aburris* from *Chamaepetes goudoti rufiventris.* 23, *A. aburris,* from *Penelope jacquacu granti.* 24, *A. simplex.* 25, *A. semicracis,* from *Penelope argyrotis albicauda.* 26, *A. rubra.*

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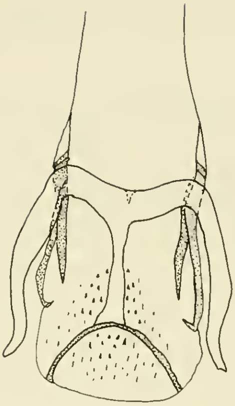

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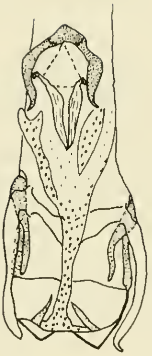

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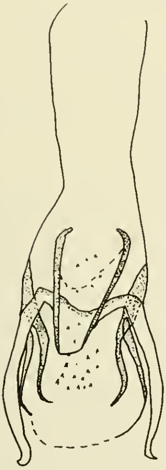

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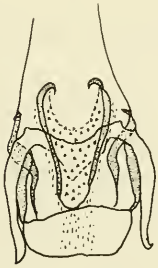

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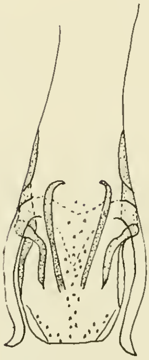

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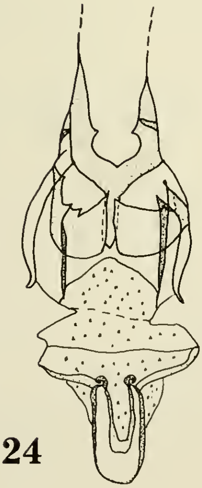

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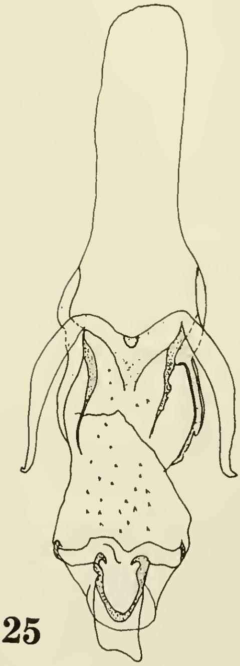

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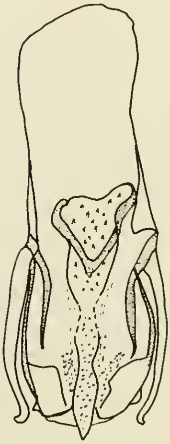

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and the V-shaped male genital sclerite are the best distinguishing features of this species.

Material examined.—3 ♂, 1 ♀ (holotype ♂, allotype ♀) on USNM slide 68591, and 2 ♂ paratypes of *A. parvispina, Pauxi pauxi unicornis,* Bolivia; 2 ♂, 3 ♀ (including holotype ♀ and allotype ♂ of *A. simplex pauxis*), *P. p. gilliardi,* Colombia; 6 ♂, 6 ♀ (including 5 ♂ paratypes of *Cracimenopon simplex pauxi* (sic), *Pauxi pauxi,* Colombia; paratype ♂ and female of *A. s. spinigaster,* (Oklahoma State University slides 967 and 968), *Crax nigra* L., Venezuela; 5 ♂, 2 ♀, *Crax alector* L. (= *Crax nigra*), Surinam; 1 ♂, 4 ♀, *Pipile cumanensis* Jaquin (= *Aburria pipile* (Jaquin), Surinam; ♂ holotype of *A. semicrasis guttatus, Chamaepetes unicolor,* Costa Rica; 3 ♀, *Ortalis guttatus columbianus* = *O. guttata,* Colombia.

***Amyrsidea* (*Cracimenopon*) *simplex* Carriker**
Fig. 24

Amyrsidea simplex simplex Carriker, 1950: 494. Type-host: *Crax annulata* Todd (= *Crax alberti* Fraser).

Amyrsidea spinigaster alberti Carriker, 1950: 498. Type-host: *Crax alberti alberti* Fraser. NEW SYNONYMY.

Amyrsidea spinigaster daubentoni Carriker, 1950: 498. Type-host: *Crax alberti daubentoni* G. R. Gray (= *Crax daubentoni* G. R. Gray). NEW SYNONYMY.

Male.—As in *A. pauxi,* but with genitalia (Fig. 24) with extensible area of sclerotization in sac and U-shaped sclerite.

Female.—As in *A. pauxi* except as follows. Tergite I greatly elongated covering nearly half of abdomen, with middle portion of II either absent or fused to I. Tergite IV–VI tripartite; anterior setae of middle portion IV indicates fusion with middle part of tergite III (similar to Fig. 5). Marginal tergal setae: I, 14–16; II, 14 on lateral portions only; III, 20–22 on lateral portions only; IV, 27–36; V, 40–46; VI, 34–45; VII, 30–35; VIII, 13–18. No anterior tergal setae except for 4–6 minute ones in middle of IV thought to represent fusion of III and IV. Anal fringes with 44–65 dorsal and 48–72 ventral setae.

Dimensions.—Preocular width, ♂ 0.33–0.42, ♀ 0.35–0.44; temple width, ♂ 0.48–0.60, ♀ 0.53–0.68; prothorax width, ♂ 0.33–0.44, ♀ 0.38–0.50; metathorax width, ♂ 0.43–0.54, ♀ 0.56–0.72; total length, ♂ 1.45–1.90, ♀ 1.40–2.10; ♂ genitalia width 0.13–0.16; length 0.39–0.41.

Remarks.—The male genitalia with U-shaped sclerites, and female tergal features with mid-portion of II either absent or fused are the best distinguishing characters of this species.

Material examined.—6 ♂, 11 ♀ (including holotype male, allotype female on USNM slide 68569, and 5 ♂, 6 ♀ paratypes of *A. simplex*) *Crax annulata,* Colombia; 3 ♂ (including holotype ♂ of *A. spinigaster alberti* on USNM slide 68572); 2 ♀, *C. a. alberti,* Colombia; 2 ♀ (including holotype ♀ of *A. spinigaster daubentoni* on USNM slide 68573), *Crax alberti daubentoni,* Venezuela.

***Amyrsidea* (*Cracimenopon*) *rubra* Carriker**
Figs. 1, 2, 3, 5, 26, 36

Amyrsidea simplex rubra Carriker, 1950; 495. Type-host: *Crax r. rubra* (Linnaeus).

Male.—As for *A. pauxi,* but without extensive sclerotization in region of genital sac and genital sclerite with less distinct U-shape (Fig. 26).

Female.—As for *A. pauxi,* but with slightly more marginal tergal setae: I, 18; II, 14 on lateral portions only; III, 18; IV, 40–42; V, 47–49; VI, 49–50; VII, 37–39; VIII, 15.

Dimensions.—Preocular width, ♂ 0.40–0.41, ♀ 0.45–0.47; temple width, ♂ 0.59–0.60, ♀ 0.68–0.70; prothorax width, ♂ 0.45–0.56, ♀ 0.50–0.52; metathorax width, ♂ 0.57–0.60, ♀ 0.79–0.80; total length, ♂ 1.88–1.90, ♀ 2.16–2.20; ♂ genitalia width, 0.13–0.14, length 0.39–0.41.

Remarks.—The lack of genital sac sclerotization and more marginal tergal setae in ♀ are the best distinguishing characters of this species.

Material examined.—2 ♂, 4 ♀, *Crax rubra,* Columbia, Republic of Panama.

Amyrsidea* (*Cracimenopon*) *rogersi **Scharf and Emerson, NEW SPECIES**

Fig. 6, 34

Type-host: *Crax fasciolata fasciolata* Spix.

Male.—As for *A. pauxi* except as follows. Longer middorsal head setae with outer seta 18 farther lateral toward preocular slit. Only 9–13 setae on subgenital plate. Genitalia (Fig. 34) with enlarged epimeres, longer parameres, and bell-shaped sclerotization with sac.

Female.—As for *A. pauxi* except as follows. Tergite I enlarged, but covering less than half of abdomen; tergites II–IV entire, conforming to contour of tergite I and progressively less enlarged; and tergites V–VII, tripartite (Fig. 6). Marginal tergal setae: I, 10; II, 18–19; III, 18–20; IV, 32–33; V, 44–46; VI, 36–38; VII, 28–29; VIII, 14. Last tergite each side with 1 very long marginal seta, 3–4 short setae lateroanterior to this, and 10 total inner posterior setae. Sternal setae as for *A. pauxi,* except 46–48 total marginal and anterior subgenital plate setae.

Dimensions.—Preocular width, ♂ 0.35–0.37, ♀ 0.39–0.41; temple width, ♂ 0.53–0.55, ♀ 0.59–0.61; prothorax width, ♂ 0.37–0.39, ♀ 0.39–0.42; metathorax width, ♂ 0.43–0.45, ♀ 0.59–0.60; total length, ♂ 1.63–1.70, ♀ 1.81–1.94; ♂ genitalia width 0.14, length 0.42–0.46.

Remarks.—The ♂ genitalia with enlarged epimeres, longer parameres, bell-shaped sclerotization, and configuration of the female abdominal tergites serve to distinguish this species. This species is named for Joseph H. Rogers, who as friend and colleague of the first author, encouraged this work.

Material examined.—Holotype ♂, *C. f. fasciolata,* Matto Grosso, Brazil, no date, T-821, in collection of U.S. National Museum. Paratypes: 2 ♂, 3 ♀, same data as holotype.

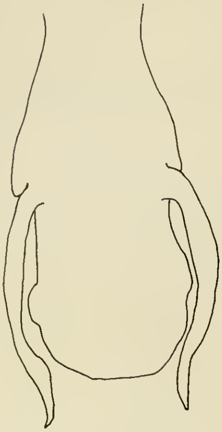
Amyrsidea* (*Cracimenopon*) *caquetae **Carriker**

Figs. 8, 9, 35

Cracimenopon caquetae Carriker, 1967: 41. Type-host: *Ortalis guttata caquetae* Chapman (= *O. guttata* Spix).

Cracimenopon huilensis Carriker, 1967: 44. Type-host: *Ortalis guttata columbianus* Hellmayr. NEW SYNONYMY.

Male.—As for *A. pauxi* except as follows. Brush on femur III with only 16 small setae. Subgenital plate with 16 marginal and 22 anterior setae; otherwise, specimen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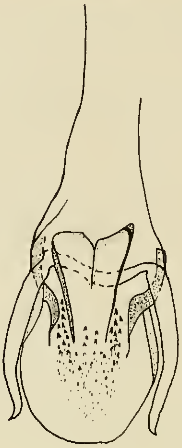
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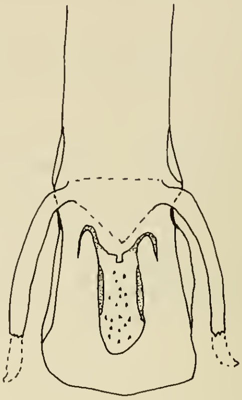
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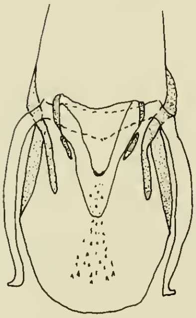
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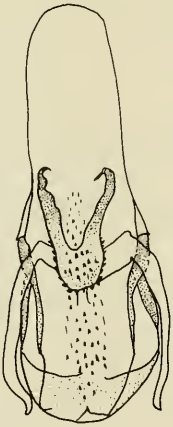
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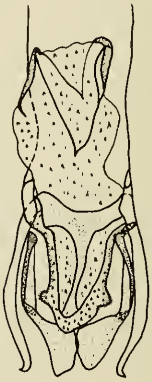
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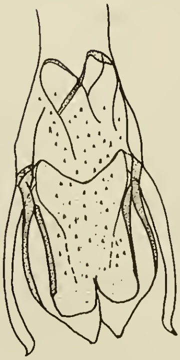
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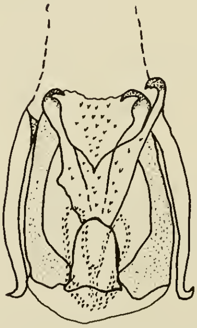
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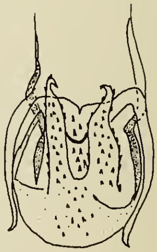
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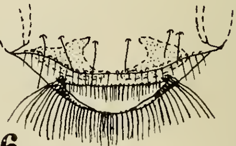
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rolled and obliterated ventrally. Genitalia (Fig. 35) with narrow epimeres, lacking prominent sclerotization in genital sac area, and with characteristic shape of sac.

Female.—As for *A. pauxi* except as follows. Abdominal tergite I enlarged; tergites II–IV tripartite, other tergites undivided (Fig. 8). Mid-portion of II with 1 long seta at each corner and 5–7 marginal minute setae between them (Fig. 9). Marginal tergal setae: I, 18; II, 21; III, 16; IV, 26; V, 30; VI, 28; VII, 30; VIII, 24. Tergites IV–VI with 40–58 marginal setae on specimen from *O. arcuan squamata* Lesson. Specimen rolled and obliterated ventrally.

Dimensions.—Preocular width, ♂ 0.48, ♀ 0.58–0.71; prothorax width, ♂ 0.37–0.46, ♀ 0.31–0.42; metathorax width, ♂ 0.48–0.68, ♀ 0.43–0.58; total length, ♂ 1.55, ♀ 1.81–2.15; ♂ genitalia width 0.14, length indistinguishable.

Remarks.—The narrow epimeres lacking prominent sclerotization in ♂ and the setal pattern on the mid-portion of tergite II of ♀ are the distinguishing characters.

Material examined.—1 ♂, 1 ♀ (including hototype ♀ of *C. caquetae* on USNM slide 68887), *Ortalis guttata caquetae,* Colombia; 1 ♀, *O. arcuan squamata* (= *O. guttata squamata* Lesson), Brazil; 2 ♂, 5 ♀ (including holotype ♀ and allotype ♂ *C. huilensis* on USNM slide 68888), *Ortalis guttatus columbianus,* Colombia.

***Amyrsidea* (*Cracimenopon*) *jacquacu* Carriker**

Figs. 10, 11

Amyrsidea semicracis jacguacu Carriker, 1950: 502. Type-host: *Penelope obscura jacquacu* Spix (= *P. j. jacquacu* Spix).

Male.—As for *A. pauxi,* except as follows. Ventral femur III with 27 short setae. Sternal setae: II, 35; III, 48; IV, 30; V, 31; VI, 33; VII, 41; VIII, 32. Sternal brushes each side: III, 20–21; IV, 24–25; V, 18–22; VI without brushes. Genitalia as for *A. aburris* (Fig. 23) with small lateral sclerotized strips along genital sac.

Female.—As for *A. caquetae* except as follows. Lacking long corner seta on mid-portion of tripartite tergite II (Figs. 10 and 11). Marginal tergal setae: I, 10; II, 20–22; III, 21–22; IV, 32–36; V, 43–44; VI, 41–42; VII, 31–35; VIII, 18–19. Sternal setae: II, 30; III, 48–50; IV, 24–25; V, 26–27; VI, 42–43; VII, 20–21. Sternal brushes: III, 17–20; IV, 20–24; V, 17–20. Terminal segment with 4 very long marginal and 18–19 anterior setae. Anal fringing setae with 86–88 dorsally and 78–80 ventrally.

Dimensions.—Preocular width, ♂ 0.36, ♀ 0.39–0.40; temple width, ♂ 0.50, ♀ 0.58; prothorax width, ♂ 0.40, ♀ 0.44–0.45; metathorax width, ♂ 0.59, ♀ 0.62; total length, ♂ 1.68, ♀ 1.86–1.88; ♂ genitalia width 0.14, length indistinguishable.

Remarks.—The combination of ♀ tergal features and male genitalic features serve to distinguish this species. There are minor differences in tergal setae and arrangement of long and very long marginal setae on the last tergite as those on *A. aburris.* However, we have also examined a specimen from the same host and

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Figs. 27–36. 27–35, Male genitalia. 27, *A. sixiola.* 28, *A. purpurascens.* 29, *Amyrsidea wagleri.* 30, *A. mituensis.* 31, *A. pauxis.* 32, *A. pauxis,* from *Pauxi unicornis.* 33, *A. pauxis,* from *Pauxi p. pauxis.* 34, *A. rogersi.* 35, *A. caquetae.* 36, Female terminal segments showing typical anal fringe and sternal setae, from *Crax rubra.*

locality dated 3 days later which is close to *A. aburris* Carriker, which does not have enlarged tergite I; and we should point out that a series of 6 ♂ and 6 ♀ specimens for *Penelope granti* Berlepsch (= *Penelope jacquacu granti* Vaurie) is also included in *A. aburris.*

Material examined.—1 ♂, 3 ♀ (including holotype ♀ and allotype ♂ of *A. semicracis jacquacu* on USNM slide 68578, and paratype ♀), *Penelope obscura jacquacu,* Peru.

Amyrsidea* (*Cracimenopon*) *garruli **Carriker**

Figs. 12, 19

Amyrsidea spicula garruli Carriker, 1950: 506. Type-host: *Ortalis garrula garrula* (Humbolt).

Amyrsidea spicula microspina Carriker, 1950: 507. Type-host: *Ortalis r. ruficrissa* Sclater and Salvin (= *O. ruficauda ruficrissa* Sclater and Salvin). New Synonymy.

Cracimenopon mirae Carriker, 1967: 41. Type-host: *Ortalis garrula mira* Griscom. New Synonymy.

Cracimenopon ruficaudatus Carriker, 1967: 44. Type-host: *Ortalis ruficauda* (Jardine). New Synonymy.

Male.—As for *A. pauxi,* except as follows. Inner middorsal head seta 17 nearly twice as long as minute outer 18. With 22–24 small setae on ventral femur III. Marginal abdominal tergal setae: I, 18–19; II, 20; III, 29–31; IV, 34–35; V, 38–40; VI, 42–43; VII, 31–32; VIII, 20–21. Sternal setae: II, 32–34; III, 58–62; IV, 28–30; V, 29–32; VI, 29–31; VII, 56–58; VIII, 41–45. Sternal brushes: IV, 20–22; V, 24–25; VI, 19–20. Last tergite each side with 1 very long marginal seta, 2–3 medium; lateroanterior to this, and 15–16 total inner posterior setae. With 23 total marginal and anterior setae on subgenital plate. Male genitalia (Fig. 19) with narrow U-shaped sclerotization at base of genital sac.

Female.—As for ♂, except as follows. Ventral terminal segment having 27–28 marginal, 20–22 anterior setae on subgenital plate and 59–60 dorsal and 56–59 ventral anal fringe setae. With pre-anal plate circular on anterior with notch as in Fig. 12.

Dimensions.—Preocular width, ♂ 0.42–0.43, ♀ 0.45–0.47; temple width, ♂ 0.63–0.64, ♀ 0.65–0.67; prothorax width, ♂ 0.45–0.48, ♀ 0.46–0.48; metathorax width, ♂ 0.55–0.57, ♀ 0.60–0.62; total length, ♂ 1.96–2.02, ♀ 2.09–2.14; ♂ genitalia width 0.15, length indistinguishable.

Remarks.—This is the first species described without sexually dimorphic tergal features. Males are best identified by the genital sclerite, and females have a characteristic pre-anal plate.

Material examined.—4 ♂, 8 ♀, (including ♀ holotype of *A. spicula garrula* on USNM slide 68583, and 2 ♀ paratypes), *O. g. garrula,* Colombia; holotype ♀ of *Cracimenopon mirae* (on USNM slide 68886, and 2 ♀ paratypes), *O. g. mira,* Colombia; 1 ♀ paratype of *A. spicula microspina, O. ruficrissa,* Colombia; 2 ♂, 4 ♀, *O. ruficauda* (Jardine), Venezuela.

Amyrsidea* (*Cracimenopon*) *aburris **Carriker**

Figs. 13, 14, 16, 17, 21, 22, 23

Amyrsidea semicracis aburris Carriker, 1950: 502. Type-host: *Aburria aburri* (Lesson).

Amyrsidea semicracis chamaepeta Carriker, 1950: 504. Type-host: *Chamaepetes goudoti rufiventris* (Tschudi). New Synonymy.

Amyrsidea semicracis sanctaemartae Carriker, 1950: 504. Type-host: *Chamaepetes goudoti sanctaemartae* Chapman. New Synonymy.

Male.—As for *A. pauxi*, except as follows. With 26–41 small setae in brush of femur III. Marginal tergal setae: I, 15–16; II, 18–20; III, 18–23; IV, 18–23; V, 20–29; VI, 18–28; VII, 16–22; VIII, 12–16. Last tergite each side with 1–2 very long marginal setae, 2–3 short setae lateroanterior to these, and 10–18 total inner posterior setae. Sternal setae: II, 19–44; III, 22–41; IV–VI, 19–33; VII, 42–45; VIII, 22–38. Sternal brushes: III, 15–22; IV–VI, 19–43. Total marginal and anterior setae on subgenital plate 15–21. Genitalia (Figs. 21, 22 and 23) with U-shaped genital sclerite elongated on lateral margins of genital sac.

Female.—As for ♂, except as follows. Marginal tergal setae as for male, except specimens from *P. obscura obscura* with greater number of marginal tergal setae than from other hosts on IV–VI, 34–37. Sternite III with 41–46, and VII with 54–62 setae. Subgenital plate with 22–31 marginal and 21–33 anterior setae. Anal fringe of 56–64 setae dorsally and 54–63 ventrally. Pre-anal plates various but always separate (Figs. 13, 14, 16, and 17).

Dimensions.—Preocular width, ♂ 0.37–0.40, ♀ 0.41–0.45; temple width, ♂ 0.53–0.59, ♀ 0.61–0.67; prothorax width, ♂ 0.37–0.43, ♀ 0.44–0.49; metathorax width, ♂ 0.49–0.54, ♀ 0.55–0.64; total length, ♂ 1.62–1.81, ♀ 1.98–2.28; ♂ genitalia width, 0.13–0.16, length indistinguishable.

Remarks.—The ♂ genitalia are the best identifying feature of this species and, although they show some variation among the 5 hosts, they are distinctive enough to consider this as a single species. The smaller number of marginal tergal setae is also indicative of the integrity of the species, but the higher count in specimens from *P. obscura obscura* overlaps with counts for *Amyrsidea garruli.*

Material examined.—2 ♂, 2 ♀ (including holotype ♀ and allotype ♂ of *A. semicracis aburris* on USNM slide 68579), *Aburria aburri,* Colombia: 6 ♂, 2 ♀ (including holotype ♀, allotype ♂ of *A. s. chamaepeta* (on USNM slide 68587, and 5 ♂ and 1 ♀ paratypes), *Chamaepetes goudoti rufiventris,* Peru; 13 ♂, 11 ♀, *Chamaepetes a. goudoti,* Colombia; 1 ♀ (holotype of *A. s. sanctaemartae* on USNM slide 68580), *Chamaepetes goudoti sanctaemartae,* Colombia; 6 ♂, 6 ♀, *Penelope granti* Berlepsch (= *P. jacquacu granti* Vaurie), Guyana; 4 ♂ 6 ♀, *P. o. obscura* Temminck, Paraguay.

***Amyrsidea* (*Cracimenopon*) *semicracis* Carriker**

Figs. 15, 25

Amyrsidea semicracis semicracis Carriker, 1950: 500. Type-host: *Penelope argyrotis colombiana* Todd.

Amyrsidea semicracis perijana Carriker, 1950: 500. Type-host: *Penelope argyrotis albicauda* Phelps and Gilliard. New Synonymy.

Male.—As for *A. pauxis,* except as follows. Fewer marginal tergal setae on V–VII, 18–27; fewer setae in brush on venter of femur III, 31–34; and more sternal setae on VII, 44–54, and VIII, 31–34. Genitalia with retrorse terminal barbs on genital sclerite and obvious connection between parameres (Fig. 25).

Female.—As for *A. pauxis,* except with 22 marginal and 32 anterior setae on subgenital plate, and pre-anal plates usually as in Fig. 15.

Dimensions.—Preocular width, ♂ 0.41–0.42, ♀ 0.42–0.44; temple width, ♂ 0.56–0.57, ♀ 0.60–0.62; prothorax width, ♂ 0.42, ♀ 0.42–0.44; metathorax width, ♂ 0.52–0.60, ♀ 0.57–0.63; total length, ♂ 1.58–1.78, ♀ 1.76–1.83; ♂ genitalia width 0.14–0.15, length indistinguishable.

Remarks.—The ♂ genitalia appear to be the singular identifying feature of this species.

Material examined.—4 ♂, 2 ♀ (including ♀ holotype and ♂ allotype of *A. s. semicracis* on USNM slide 68574), *Penelope argyrotis colombiana,* Colombia; ♂ holotype of *A. s. perijana* (on USNM slide 68575, and 1 ♀ paratype), *P. a. albicauda,* Colombia.

***Amyrsidea* (*Cracimenopon*) *purpurascens* Carriker**

Fig. 28

Amyrsidea semicracis purpurascens Carriker, 1950: 501. Type-host: *Penelope purpurascens purpurascens* Wagler.

Amyrsidea semicracis brunnescens Carriker, 1950: 502. Type-host: *Penelope purpurascens brunnescens* Hellmayr and Conover. NEW SYNONYMY.

Male.—As for *A. pauxis,* except as follows. Slightly more marginal tergal setae on IV–VI, 27–28. Subgenital plate with 4 very long and 3–4 short setae. Genitalia with spiculate sac and paired sclerites above base of parameres meeting at cleft on sac (Fig. 28).

Female.—Also as for *A. parvispina,* except for 30–34 marginal tergal setae IV–VI, 28–34 marginal and 12–16 anterior setae on subgenital plate. Pre-anal plate reduced or absent in specimens studied.

Dimensions.—Preocular width, ♂ 0.34–0.35, ♀ 0.40–0.42; temple width, ♂ 0.57–0.59, ♀ 0.62; prothorax width, ♂ 0.37–0.38, ♀ 0.42–0.46; metathorax width, ♂ 0.50–0.51, ♀ 0.57–0.60; total length, ♂ 1.72–1.76, ♀ 1.72–1.93, ♂ genitalia width 0.15–0.16, length 0.42.

Remarks.—The ♂ genitalia with parallel genital sclerites connected anteriorly are the best distinguishing feature of this species.

Material examined.—1 ♂, 1 ♀ (holotype ♂ and paratype ♀ of *Amyrsidea semicracis purpurascens* on USNM slide 68577) *Penelope purpurascens,* Mexico; 1 ♀, 1 ♂ (holotype ♀ and allotype ♂ of *Amyrsidea semicracis brunnescens* on USNM slide 68576) *Penelope purpurascens brunnescens,* Colombia.

***Amyrsidea* (*Cracimenopon*) *spicula* Carriker**

Figs. 18, 20

Amyrsidea spicula spicula Carriker, 1950, Rev. Acad. Colomb. Cienc., 7: 506. Type-host: *Ortalis vetula vetula* (Wagler).

Male.—Head and thorax as for male of *A. parvispina,* except only 18–20 short setae on ventral femur III. Slightly more marginal tergal setae on tergites III–V, 26–38. Marginal tergal setae on VI–VIII substantially more; VI, 32–36; VII, 29–33; VIII, 16–20. Ventrally with sternal setae much as for *A. parvispina,* but 45 setae on sternite VII, and sternal brushes with fewer setae; IV, 19–22; V, 19–24; VI, 15–18. Subgenital plate with 10 marginal and 21 anterior setae. Genitalia with characteristic inverted U-shaped sclerite with knob-shaped enlargement anteriorly; with a spiculate genital sac and obvious cross connection of parameres (Fig. 20).

Female.—As for ♂, but with slightly more marginal tergal setae on II–VIII, 34–45, and slightly larger in all dimensions. Pre-anal plate as in Fig. 18.

Dimensions.—Preocular width, ♂ 0.37–0.38, ♀ 0.38–0.40, temple width, ♂ 0.53–0.56, ♀ 0.55–0.57; prothorax width, ♂ 0.40–0.41, ♀ 0.42–0.44; metathorax width, ♂ 0.49–0.52, ♀ 0.60–0.62; total length, ♂ 1.78–1.81, ♀ 1.84–1.87; ♂ genitalia width 0.15, length 0.55.

Remarks.—The unusual genital sclerite of the ♂ is the most salient feature of this species.

Material examined.—4 ♂, 2 ♀ (including holotype ♀ of *Cracimenopon spicula* on USNM slide 68582, allotype and 2 paratype ♂), *Ortalis v. vetula,* Mexico.

***Amyrsidea* (*Cracimenopon*) *sixiola* Carriker**
Fig. 27

Cracimenopon sixiola Carriker, 1967: 41. Type-host: *Ortalis garrula frantzi* (Cabanis).

Male.—Head and thoracic setae as for *A. pauxis.* Marginal tergal setae: I, 18; II, 20; III–VII, 30; VIII, 18. Last tergite each side with 1 very long marginal seta, 4 medium setae lateroanterior to these, and 10 total inner posterior setae. Ventral abdomen badly rolled, setae obliterated. Genitalia (Fig. 27) very large, with long parameres, but unfortunately specimen overcleared, with no internal features visible.

Female.—Unknown.

Dimensions of ♂.—Preocular width, 0.40; temple width, 0.67; prothorax width, 0.41; metathorax width, 0.48; total length, 2.03; genitalia width 0.22, length indistinguishable.

Remarks.—This species is described from a single specimen which represents by far the largest in all dimensions of the known species of this subgenus.

Material examined.—Holotype ♂ of *Cracimenopon sixiola* (on USNM slide 68885), *Ortalis garrula frantzi,* Costa Rica. Other ♂ mentioned by Carriker (1967) was not found.

***Amyrsidea* (*Cracimenopon*) *wagleri* Carriker**
Fig. 29

Cracimenopon wagleri Carriker, 1967: 44. Type-host: *Ortalis wagleri* (G. R. Gray) (= *Ortalis poliocephala* Wagler).

Male.—Like *A. spicula* except as follows. Genitalia as in Fig. 29, with membranous connection of anterior portions of sac sclerite, anterior portion of sclerite well below base of parameres, and small retrorse sclerotizations.

Female.—As for *A. spicula.*

Dimensions.—Preocular width, ♂ 0.38, ♀ 0.41; temple width, ♂ 0.52, ♀ 0.60; prothorax width, ♂ 0.40, ♀ 0.48; metathorax width, ♂ 0.50, ♀ 0.65; total length, ♂ 1.81, ♀ 2.09; male genitalia width 0.15, length indistinguishable.

Remarks.—The ♂ genitalia are the most discernable feature distinguishing this from *A. spicula.*

Material examined.—Allotype ♂ and holotype ♀ of *Cracimenopon wagleri* (on USNM slide 68241), *Ortalis wagleri* (G. R. Gray), Mexico.

NOMINA DUBIA

Menopon cracis Giebel, 1866: 391.

Type-host: (*Crax rubirostris.* Misdetermined; see Thompson, 1948) = *Crax globulosa* Spix. Synonym indicated is from Hopkins and Clay (1952). No specimens from this host were available for this study. Specimens reportedly in collection of British Museum (Natural History) could not be located (personal communication, Mr. Christopher Moreby).

Menopon macropus Giebel, 1874: 294.

Type-host: *Crax rubirostris.* Misdetermined; see Thompson, 1948: 740. = *Crax globulosa* Spix. The type cannot be located; believed to be lost.

KEY TO SPECIES IN THE SUBGENUS *Cracimenopon*

MALES

1. Genital sac with U-shaped sclerite (inverted or upright) 2
– Genital sac with separated sclerites, no sclerite, or partially sclerotized anterior portion of sac 7
2. U-shaped genital sac sclerite inverted 3
– U-shaped genital sac sclerite in upright position 4
3. Genital sclerite on posterior portion of spinous sac (Fig. 19) . . . . *garruli*
– Genital sclerite on anterior portion of spinous sac (Fig. 20) . . . . *spicula*
4. U-shaped genital sclerite elongated on margins of spinous sac (Figs. 21–22) . . . . *aburris* (in part)
– U-shaped genital sclerite shorter 5
5. Genitalia with extensive area of sclerotization under spinous sac and sclerite (Fig. 24) . . . . *simplex*
– Genitalia without sclerotization under spinous sac 6
6. Genital sclerite with retrorse terminal barbs; connection between parameres obvious (Fig. 25) . . . . *semicracis*
– Genital sclerite without retrorse barbs, no obvious connection between parameres; small pair of projections on distal portion of the phallus (Fig. 26) . . . . *rubra*
7. Genitalia with sclerotization limited to anterior portion of spinous sac, or without sclerotization 8
– Genitalia with sclerite along lateral margins of spinous sac 11
8. Genitalia with long parameres as in Fig. 27 . . . . *sixiola*
– Genitalia with shorter parameres 9
9. Genitalia with no connection of anterior portions of sclerites (Fig. 23) . . . . *aburris* (in part) and *jacquacu*
– Genitalia with membranous connection of anterior portions of sclerites 10
10. Anterior portion of genital sclerite at or well above base of paramere (Fig. 28) . . . . *purpurascens*
– Anterior portion of genital sclerite well below base of parameres (Fig. 28) . . . . *wagleri*
11. Genital sac with 2 small strips of sclerotization on each side (Fig. 30) . . . . *mituensis*
– Genital sac with 1 strip of sclerotization on each side 11

12. Genital sac not deeply cleft below base of parameres (Figs. 31–33) .... *pauxis*
– Genital sac deeply cleft below base of parameres 12
13. Epimeres enlarged and sclerotized with bell-shaped sac connecting them distally (Fig. 34) .... *rogersi*
– Epimeres narrow and not connected (Fig. 35) .... *caquetae*

FEMALES

(excluding *sixiola*)

1. Tergite 1 enlarged posteriorly (Figs. 4–8; note thorax omitted in Fig. 7) 2
– Tergite I not enlarged posteriorly 7
2. Tergite I extending to middle of abdomen (Figs. 4 and 5) 3
– Tergite I shorter, covering less than half of abdomen 4
3. Tergites II–IV tripartite (Fig. 4) .... *pauxis*
– Tergites IV–VI tripartite; anterior setae of middle section indicate fusion of tergites III and IV (Fig. 5) .... *simplex* and *rubra*
4. Tergites V–VII tripartite; tergites III and IV neither divided nor fused (Fig. 6) .... *rogersi*
– One to all of tergites II–IV tripartite (Fig. 7) 5
5. Only tergite IV tripartite (Fig. 7) .... *mituensis*
– Tergites II–IV tripartite 6
6. Median plate of tergite II with long seta at each posterior corner (Fig. 8) .... *caquetae*
– All setae on median plate of tergite II minute (Fig. 10) .... *jacquacu*
7. Pre-anal plate entire with roughly circular anterior margin and small rounded notch (Fig. 12) .... *garruli*
– Pre-anal plate divided or apparently absent 8
8. Pre-anal plates arranged in relation to anal sclerite as in Fig. 13 .... *aburris* (in part)
– Pre-anal plates arranged variously (Figs. 14–18) .... *aburris* (in part) *semicracis, purpurascens, spicula,* and *wagleri.*

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A NEW SPECIES OF *DICTYA* FROM MEXICO (DIPTERA: SCIOMYZIDAE)

R. E. Orth

Department of Entomology, Division of Biological Control, University of California, Riverside, California 92521.

Abstract.—Dictya sinaloae, n. sp., is described from Sinaloa, Mexico. The new species is a member of the *abnormis* group of which there are now six recognized species. Within the *abnormis* group it most closely resembles *D. bergi* Valley. A photograph, illustrations and a key are provided.

The genus *Dictya* in the Americas south of the United States is poorly known. The external morphology of the species of *Dictya* is very similar and terminalia dissection is generally required for positive determination. Prior to the publication by Curran (1932) only one species, *Dictya umbrarum* Linnaeus, now known to be strictly Palaearctic, was recognized in North America. *Dictya pictipes* Loew (1859), described from three females from Washington, D.C., was synonymized by Cresson (1920). Curran (1932) recognized seven species, including *D. pictipes,* and separated each by genitalic characters. His work provided the basis for the taxonomic studies that followed. Today 33 species are recognized, including the new species described herein. All but one, *D. umbrarum,* are New World species.

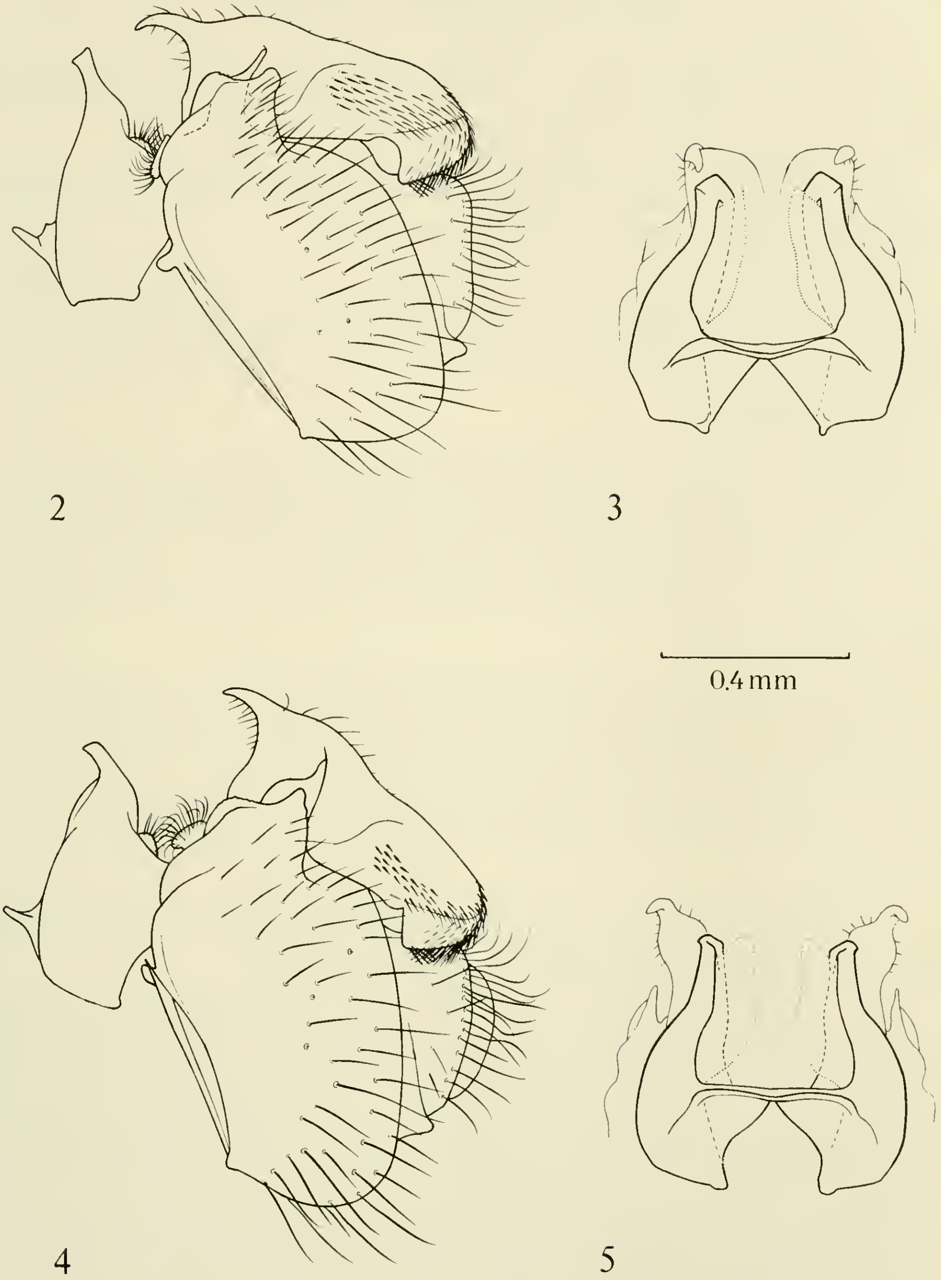
Steyskal (1954) assigned the 22 *Dictya* species then known to three groups. The number of species now recognized in each group are: *abnormis* (6), *ptyarion* (1), and typical (26). *Dictya sinaloae,* new species, is a member of the *abnormis* group. According to Steyskal (1954) the distinguishing characteristics of this group are: second antennal segment shining on outer upper half or more, longer than high; deep black parafrontal spots present. The group is now comprised of the following six species: *D. abnormis* Steyskal, *D. bergi* Valley, *D. guatemalana* Steyskal, *D. insularis* Steyskal, *D. matthewsi* Steyskal, and *D. sinaloae,* new species. All are Neotropical and the known distribution of two, *D. abnormis* and *D. matthewsi,* extends northward into the Mexican Nearctic, with *D. matthewsi* extending into Arizona.

KEY TO THE *DICTYA ABNORMIS* GROUP BASED ON MALE TERMINALIA

1. Surstylus with apical dorsal tip strongly projecting 2
– Surstylus with apical dorsal tip not strongly projecting 5
2. Ventral process of epandrium with a slender digitiform posterior lobe, anterior lobe not present; ventral process of hypandrium rather slender, gently curved forward; surstylus with apical dorsal tip rounded .... *D. abnormis* Steyskal
– Ventral process of epandrium without slender digitiform posterior lobe 3

Fig. 1. *Dictya sinaloae,* holotype male. Abdominal segments excised and retained in genitalia vial on pin beneath specimen. Photo by M. E. Badgley, University of California, Riverside.

3. Surstylus with a deep emargination in the apical dorsal tip forming a ligulate lobe fringed with small bristles; ventral process of hypandrium short, stout, strongly tapering and curved forward; ventral process of epandrium lacking posterior and anterior lobes, but with a small mammiform projection on inner side at middle near margin . . . *D. guatemalana* Steyskal
– Surstylus with no emargination in the apical dorsal tip; no ligulate lobe 4
4. Surstylus with apical dorsal tip angulate; ventral process of hypandrium stout, thickened in cross section, apex angulate, directed anteriad; ventral process of epandrium with posterior lobe moderately large, bluntly pointed; anterior lobe less pronounced . . . . *D. bergi* Valley
– Surstylus with apical dorsal tip sharply angulate; ventral process of hypandrium flattened in cross section, apex truncate; ventral process of epandrium with posterior lobe moderately large, rounded, anterior lobe smaller, less pronounced . . . . *D. sinaloae* new species
5. Surstylus with apical extension directed posteriad, apical dorsal tip directed dorsally; ventral process of hypandrium nearly truncate with a very small anteriorly directed tip; ventral process of epandrium with posterior lobe moderately large, rounded, the anterior lobe much smaller . . . . *D. matthewsi* Steyskal
– Surstylus with apical extension sinuate and turned mesad beyond middle, apical tip directed posteriad; ventral process of hypandrium thick at base then abruptly constricted anteriorly and curved forward; ventral process of epandrium with a large somewhat pointed posterior lobe followed by another less pronounced lobe, anterior lobe not present . . . . *D. insularis* Steyskal



Figs. 2–5. 2–3, *Dictya sinaloae,* holotype male. 2, Postabdomen, lateral view, inverted. 3, Hypandrium, anterior view, inverted. 4–5, *Dictya bergi,* paratype male, Costa Rica, Cartago Prov., Coris, Finca Hernan Molina, 13 July 1969, Karl R. Valley. 4, Postabdomen, lateral view, inverted. 5, Hypandrium, anterior view, inverted.

Dictya sinaloae Orth, New Species

Figs. 1–3

Holotype male.—Head: Face white with black central spot; parafrontal spot distinct, ovoid, blackish; orbito-antennal spot brown. Second antennal segment subshining, longer than high; arista with long, sparse black hairs.

Thorax: Mesopleuron and pteropleuron each with a strong bristle; a cluster of bristles, one heavier, are present on a ridge just ventrad and posteriad to the vallar ridge; prosternum without hairs. Wing length 4.3 mm.

Genitalia: Terminalia very similar to members of the typical group; surstylus with apical dorsal tip sharply angulate; ventral process of hypandrium flattened in cross section, apex truncate; ventral process of epandrium with posterior lobe moderately large, rounded; anterior lobe smaller, less pronounced; ventral margin with minute serrations.

Female.—Not known.

Paratype.—(1 ♂) Same data as holotype. Wing length 4.1 mm.

Diagnosis.—Within the *abnormis* group the male terminalia of *Dictya bergi* and *D. matthewsi* show similarities to *D. sinaloae.* The terminalia of the above three species closely resemble those of the typical group. In the remaining species of the *abnormis* group as presently understood, i.e., *D. abnormis, D. guatemalana* and *D. insularis,* the surstylus and ventral process of the epandrium are unmistakably distinct in form.

When separating specimens of the *abnormis* group it is advisable to consult the illustrations of Steyskal (1954, 1960), Valley and Berg (1977), and Fisher and Orth (1983). The terminalia of *D. bergi,* the most recently described species in the abnormis group, are shown in Figs. 4 and 5 for comparison with *D. sinaloae.*

Holotype male.—Mexico, Sinaloa, Cortinez, Hwy. 15, 3 October 1967, T. W. Fisher, AS-661. Deposited in the National Museum of Natural History, Washington, D.C.

Etymology.—This species is named after the state of Sinaloa in Mexico. I know of no derivation of the word, or English translation. It may have had its origin from one of the early Indian tribes that inhabited the area.

Notes.—Sinaloa lies almost exclusively between 23° and 27° north latitude. It is a long, narrow state bordered to the west on one of its long sides by the Gulf of California. The following brief account is given of the type locality under Accession #661 notes of T. W. Fisher: "October 3, 1967; Cortinez, Sinaloa, Hwy. 15; 6 p.m.; 300 ft. elevation; D-vac collection, photo. Roadside pond, shallow water, water hyacinth, sedge (all low); frogs, some *Physa* present. Also made three passes along the grassy border of a nearby canal bank. Site on NE corner of Hwy. 15 and the canal." Los Mochis is the closest large town to the type locality and is approximately 100 miles (160 km) south of the northern limit of the Neotropical region. According to Francisco Pacheco Mendivil, Instituto Nacional de Investigaciones Agricolas del Noroeste, Cuidad Obregon, Sonora, Mexico, in litt. Cortinez "is a little village located approximately 24 km south of Los Mochis, Sin. As a matter of fact the exact name is Ruiz Cortinez, which are the father's and mother's last name of a Mexican president."

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PERCH SITES AND FOOD OF ADULT CHINESE MANTIDS (DICTYOPTERA: MANTIDAE)

EDWARD M. BARROWS

Department of Biology, Georgetown University, Washington, D.C. 20057.

Abstract.—In old fields, most adult Chinese mantids, *Tenodera aridifolia sinensis,* used *Cirsium vulgare* or *Solidago* spp. as perch sites, usually being in the upper branches of these plants. In these fields and in a suburban garden, their prey included *Apis mellifera, Bombus* sp., *Chauliognathus pennsylvanicus, Danaus plexippus, Gryllus* sp., *Melanoplus* sp., *Papilio glaucus, Polistes fuscatus,* and *Xylocopa virginica.* In the laboratory, most female mantids that ate possibly toxic *D. plexippus,* in addition to crickets, produced viable young.

The Chinese mantid, *Tenodera aridifolia sinensis* Saussure, was introduced into the United States in the vicinity of Philadelphia, Pennsylvania, about 70 yr ago (Borror et al., 1981). Hadden (1927) published a list of 21 insect species eaten by this mantid, but he did not state whether his observations were made in the field or laboratory. Johnson (1976) reported the capture and consumption of a *Trionyx* soft-shelled turtle by this insect in the laboratory. Hurd et al. (1978) studied the relationships between density, maturation, and mortality, and Nickle and Harper (1982) studied the predation of a *Peromyscus* mouse by a Chinese mantid.

My investigation concerns perch locations of adult Chinese mantids and some of the foods that they consumed in old fields and in a suburban flower and vegetable garden. There appear to be no published field reports of these subjects for this mantid species, and published information on them in the hundreds of other species of mantids is fragmentary (Barrows, 1982).

MATERIALS AND METHODS

Mantids were studied in old fields in Reston, Virginia, and in a suburban vegetable and flower garden in Glen Echo, Maryland, in September and October, 1980–1983. Mantids were located in the fields by examining plants, especially those in flower. The kinds of foods that mantids were seen consuming, the plants on which they perched, and their approximate heights on plants (estimated to the nearest ⅓ m) were recorded. Also, I searched the ground beneath each mantid for any insect parts that they might have dropped. In mid-September, 1982, to increase mantid density and my chances of seeing them feed, 17 field-collected adult mantids (5 males and 12 females) were released in my flower and vegetable garden in Glen Echo.

In addition, 10 field-collected female mantids were maintained in separate 4.2-liter jars in the laboratory. Each was fed two adult monarch butterflies, *Danaus plexippus* L., and as many house crickets, *Acheta domestica* L., as she would eat.

Table 1. Perch sites of 38 mantids in Reston, Virginia (1980–1982). All plants were in full bloom, except Poaceae and *L. tulipifera.*

Plants	Perch heights in meters (mean ± 1 SE, range, N)	
	Males	Females
Ambrosia trifida L., giant ragweed	2.0 ± 0, 0, 1	—
Bidens aristosa (Michx.) Britt., tickseed-sunflower	—	1.7 ± 0, 0, 2
Cirsium vulgare (Savi) Tenore, bull thistle	0.8 ± 0.08, 0.7–1, 3[a]	1.1 ± 0.07, 0.3–1.7, 19[a]
Liriodendron tulipifera L., tulip tree	0.7 ± 0, 0, 1	0.7 ± 0, 0, 2
Poaceae, grass	0.3 ± 0, 0, 2	0 ± 0, 0, 1
Senecio vulgaris L., common groundsel	—	1.7 ± 0, 0, 1
Solidago spp., goldenrod	0.9 ± 0.09, 0.7–1.3, 4[b]	0.9 ± 0.06, 0.7–1.3, 12[b]

[a] One of these mantids was in copula.
[b] Two of these mantids were in copula.

Egg cases produced by these females were stored in individual plastic bags with air holes, and I noted whether nymphs hatched from the cases. The Statistical Analysis System computer package (Ray, 1982) was used to analyze data with the Fisher exact probability test (FEPT) and the *t*-test corrected for heteroscedasticity (TT).

RESULTS AND DISCUSSION

Perch locations.—In September in Reston, 50 mantids perched on or near the fully-blooming flowers of plants representative of five genera and on the leafy shoots of plants in two other genera (Table 1). Eighty percent of the mantids were on *Cirsium vulgare* (Savi) Tenore and *Solidago* spp., suggesting that these plants were the best ambush sites for prey that were probably attracted to the flowers. For unknown reasons, mantids were not found on other common plants in bloom at the time such as *Eupatorium purpureum* L., *E. coelestinum* L., *Gnaphalium obtusifolium* L., *Impatiens capensis* Meerb., and *Vernonia noveboracensis* (L.) Michx. Heights of *E. purpureum, I. capensis,* and *V. noveboracensis* were within the height ranges of *C. vulgare* and *Solidago* spp. Females on *Liriodendron* saplings were likely to have been feeding, searching for oviposition sites, or both. Oothecae were found on these saplings. Heights of mantid perches are also given in Table 1. Perches were usually on the highest branches, but not the highest points of herbaceous plants.

Since males fly in the field and they approach females, rather than vice versa, prior to mating under laboratory conditions (pers. obs.), I hypothesized that males choose higher perches than females. Higher sites might be better lookout and takeoff places for these large, heavy male insects. However, 13 males perched 0.9 ± 0.12 SE (0.3–2.0) m above the ground which was not significantly different from 37 females' perch heights of 1.0 ± 0.06 (0–1.7) m above the ground ($P = 0.1585$, TT), not supporting my supposition.

Prey.—During field observations, I found two female mantids eating red-legged grasshoppers, *Melanoplus* sp.; two females eating bumble bees, *Bombus* sp.; one female eating a soldier beetle, *Chauliognathus pennsylvanicus* (DeGeer); and one female eating a male monarch, *Danaus plexippus* L. Insect parts found on plants or on the ground directly below mantids indicated that 12 other mantids ate 2.3 ± 0.64 (1–8) monarchs, and one other mantid ate one bumble bee. Most instances of mantids eating monarchs were seen in 1980. Seventy-six percent of 37 monarchs consumed were males based on my observations of mantids eating monarchs and counts of wings found beneath mantids and on the ground below mantid perches. In addition to monarch wings, I found part of a monarch abdomen below eight of 20 mantid perches. Wings of one male and three female tiger swallowtails, *Papilio glaucus* L., were also found among one group of monarch wings. In Glen Echo, I observed mantids eating one paper wasp, *Polistes fuscatus* (F.); one honey bee, *Apis mellifera* L.; one cricket, *Gryllus* sp.; one carpenter bee, *Xylocopa virginica* L.; and one conspecific female mantid.

Because part of a monarch abdomen was found below some mantids and monarchs are distasteful and toxic to birds (Brower and Glazier, 1975), I tested the hypotheses that mantids also find monarch abdomens distasteful and, further, eating them decreases their egg viability. In three of 10 mantids that I observed feeding on living monarchs in the laboratory, a mantid that started eating a monarch abdomen quickly moved her forelegs downward from her mouth and dropped the abdomen, as if it were distasteful. However, in the remaining seven cases, mantids ate entire monarch abdomens.

Nine of these 10 female mantids that ate crickets and parts of or whole bodies of two monarchs in the laboratory produced eggs which hatched into apparently normal, mobile nymphs. The eggs of the tenth mantid did not hatch. This frequency of viable offspring is significantly different from a hypothetical case in which none of 10 females produce viable offspring ($P = 0.001$, FEPT), indicating that their consumption of monarchs did not stop them from producing viable young. Thus, if the monarchs were toxic, they were not poisonous enough to hinder viable egg production.

To my knowledge, only Gelperin (1968) previously conducted a laboratory study of Chinese mantid feeding on aposematically colored, possibly distasteful and toxic prey. Inexperienced mantids struck at, captured, tasted, and discarded milkweed bugs, *Oncopeltus fasciatus* (Dallas), which are orange and black like the monarch. But after experience in tasting these bugs, only sufficiently starved mantids ate them and his mantids, like mine, did not show symptoms of poisoning.

The mantid cannibalism mentioned above occurred when one female mantid ate most of another female several days after I introduced 17 adult mantids into my garden, placing them all on a 3-m tall *Thuja* tree. This cannibalism may have occurred because the mantids were unusually concentrated on this one plant, food was limited, or both. Cannibalism in the Chinese mantid has been noted previously (Didlake, 1926; Hadden, 1927; Hurd et al., 1978). Nymphs in the laboratory practiced cannibalism infrequently except when they were deprived of an alternative food source (Hurd et al., 1978). In the old fields, I did not see adult mantids of the same sex closer than 1 m to each other. The dispersion may have resulted from behaviors such as cannibalism earlier in the season and intrasexual repulsion among mantids.

ACKNOWLEDGMENTS

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THE STATUS OF CERTAIN BRACONIDAE (HYMENOPTERA) CULTURED FOR BIOLOGICAL CONTROL PROGRAMS, AND DESCRIPTION OF A NEW SPECIES OF *MACROCENTRUS*

Robert A. Wharton

Department of Entomology, Texas A&M University, College Station, Texas 77843.

Abstract.—Descriptions and illustrations of diagnostic features of certain Braconidae (Hymenoptera) are provided for several biological control programs. *Macrocentrus* ***prolificus***, new species, is described from specimens reared from *Diatraea considerata* Heinrich (Pyralidae) infesting sugar cane in Sinaloa, Mexico and subsequent cultures established on *Diatraea saccharalis* (F.). The status of *Opius dissitus* Muesebeck, *O. bruneipes* Gahan, *O. dimidiatus* (Ashmead), and *Oenonogastra microrhopalae* (Ashmead) is clarified. These names have been misapplied during recent studies of the natural enemies of leaf-miners (*Liriomyza*, spp. (Diptera: Agromyzidae)).

A previously undescribed braconid species has recently been discovered during an expedition to Sinaloa, Mexico for natural enemies of pyralid stem borers of sugar cane in Texas. It is described here to make the name available for this program. The holotype is deposited in the U.S. National Museum of Natural History (USNM), and paratypes in the Texas A&M University Collection, the Rijksmuseum van Natuurlijke Historie, Leiden, and the Haeselbarth collection, Munich.

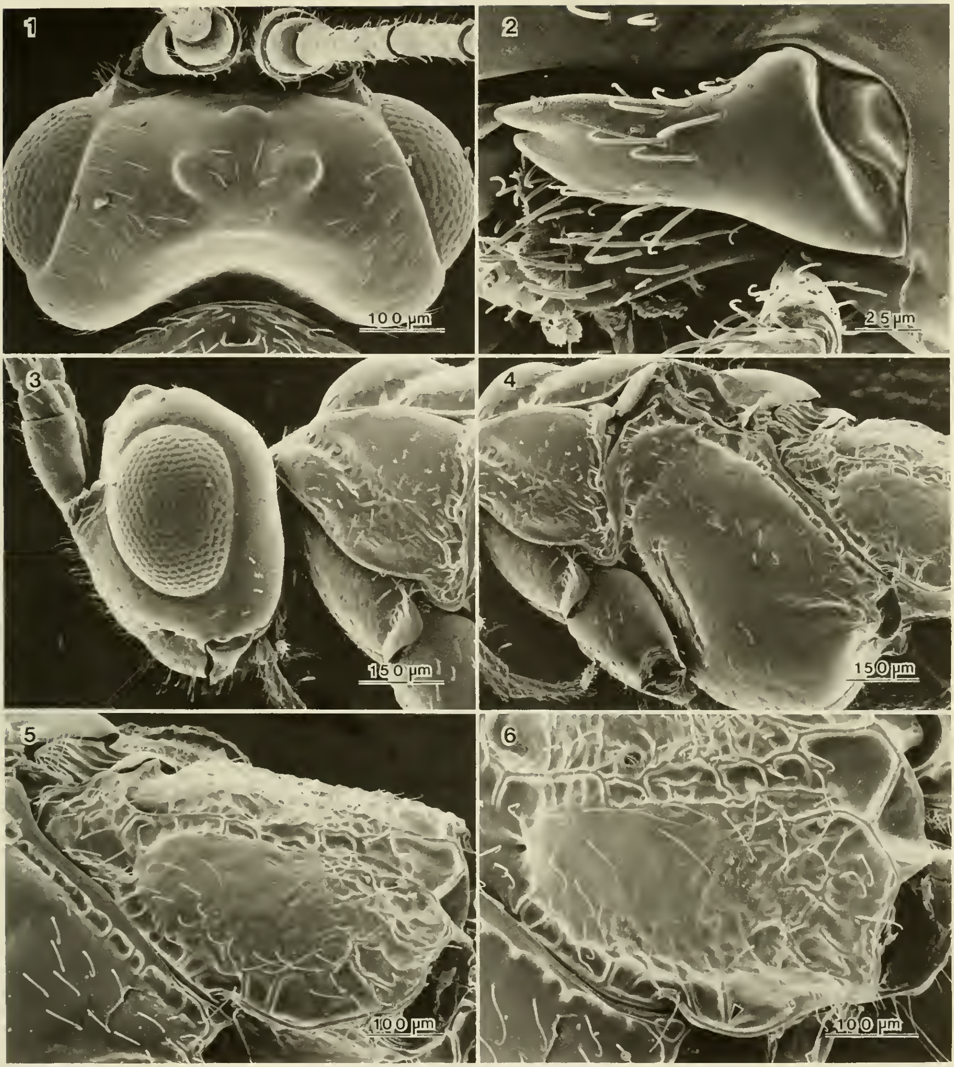
Several previously described opiine and alysiine braconids are also being used against leaf-miners of the genus *Liriomyza* in biological control programs in California, Georgia, Florida, and the British Commonwealth. Descriptive information and illustrations of diagnostic features are provided for these poorly known species to assist in their identification.

Descriptive terminology is principally after Wharton (1977) except as follows: terms used by van Achterberg (1979) are given in parentheses for *Macrocentrus prolificus*, n. sp., to facilitate comparisons with recent revisionary work on this group (e. g., van Achterberg, 1982). Mesosoma and metasoma are used respectively for thorax plus propodeum and petiole plus gaster. Variation in quantitative characters is indicated by a mean and standard deviation based on 10 individuals. Measurements and analyses of sculpture patterns were made at 50 × magnification.

Macrocentrus ***prolificus*** Wharton, New Species

Figs. 1–13, 21

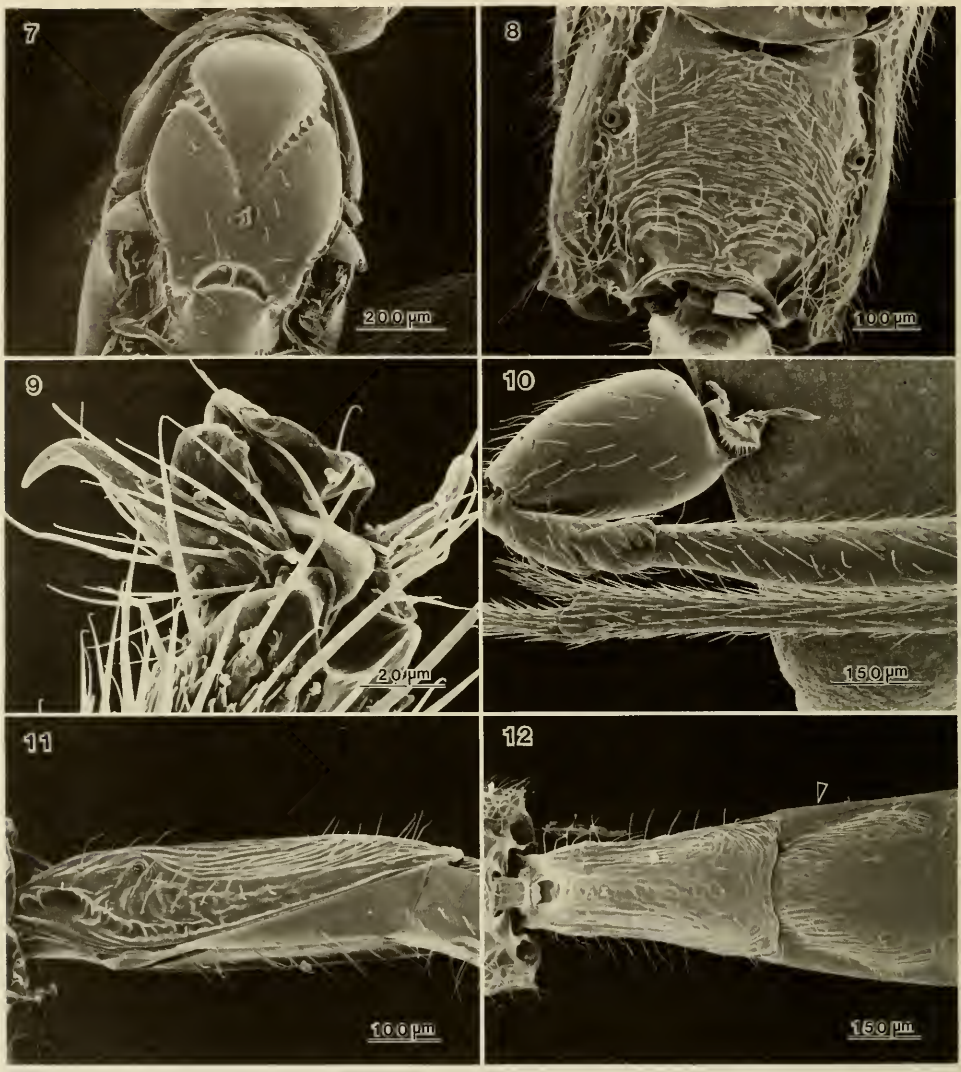
♀ Head.—36–38 antennal segments, 3rd segment 1.43 ± 0.08 × longer than 4th, 3rd and 4th segments, respectively, 7.19 ± 0.88 and 5.34 ± 0.69 × longer than



Figs. 1–6. *Macrocentrus prolificus,* new species. 1, Dorsal view of head, showing size of ocellar triangle. 2, Left mandible. 3, Lateral view of head and pronotum. 4, Lateral view of mesonotum. 5, Lateral view of metapleuron and propodeum. 6, Dorsolateral view of metapleuron, showing flange (arrow).

wide, apical segment with "spine." Maxillary palp nearly equal in length to head height. Eye length in dorsal view 3.23 ± 0.38 times temple; temple weakly receding. Ocelli as in Fig. 1; frons nearly flat, unsculptured. Face weakly convex, sparsely punctate; clypeus weakly convex, apically truncate. Malar space equal in length to basal width of mandible; apical half of mandible twisted; dorsal tooth a little longer and much narrower than ventral tooth (Fig. 2).

Mesosoma.—Length 1.64 ± 0.5 times height. Pronotum with shallow pronope; pronotum laterally with weakly crenulate to nearly smooth median groove (Fig. 3), posterior margin more distinctly crenulate. Prepectal carina complete ventrally,



Figs. 7–12. *Macrocentrus prolificus,* new species. 7, Dorsal view of pronotum and mesonotum. 8, Dorsal view of propodeum. 9, Hind tarsal claw. 10, Anterior face of middle leg, showing teeth on trochanter and femur. 11, Lateral view of petiole, showing sculpture. 12, Dorsal view of metasoma, showing sculpture and scabrous spot (arrow).

continuing dorsally nearly to margin of mesopleuron; subalar depression (= epicnemial area) smooth, moderately hairy; sternaulus (= precoxal sulcus) shallow, distinct only over posterior half of mesopleuron, weakly crenulate to smooth or nearly so (Fig. 4); pleural sulcus crenulate. Metapleural flange long, narrow, somewhat crenulate dorsally (Figs. 5–6); metapleuron largely smooth medially. Notauli crenulate, the sculpture rarely extending to posterior margin of mesonotum; mesonotum sparsely hairy (Fig. 7); prescutellar pit (= scutellar sulcus) with midridge and usually 1 or 2 weaker lateral ridges or carinae; scutellum moderately convex, sparsely hairy. Propodeum densely transversely strigose (Fig. 8), median longitudinal carina absent.

Figs. 13–16. 13, Apical portion of ovipositor of *Macrocentrus prolificus*, new species. 14–16, *Opius lissitus* Muesebeck, head. 14, dorsal view. 15, Anterior view. 16, Base of left mandible.

Wings (Fig. 21).—Discal cell subsessile anteriorly; subbasal cell setose throughout; 1st and 2nd radial segments (= r and 3-SR) long, r2 (= 3-SR) 1.91 ± 0.17× longer than r1 (= r); r3 (= SR1) 2.80 ± 0.16× longer than r2; 1-SR + M very weakly sinuate; nervulus (= cu-a) curved, inclivous; cuqul (= 2-SR) 0.92 ± 0.10× length of r2; anal cross vein (= 2A) usually present as a small, sclerotized knob.

Legs.—Hindcoxa smooth; tarsal claws slender, without lobes (Fig. 9). Hindfemur 6.38 ± 0.24 times longer than wide, hindtibia 12.29 ± 0.86× longer than wide, hindbasitarsus 9.04 ± 0.73× longer than wide; hindtibial spurs about ⅓ length of basitarsus; second segment of hind- and midtrochanter usually with 4 or 5 teeth on anterior face (Fig. 10), foretrochanter with 4–6 teeth, anterior face of hind- and midfemora with 4 to 11 teeth (highly variable), forefemur usually with 3 or 4 teeth, curved.

Metasoma.—Petiole 1.72 ± 0.10× longer than apical width, rugulose along midline (Fig. 12), striate or weakly striate on either side of midline, striate to rugose laterally (Fig. 11); 2nd tergum variously striate, the sculpture weaker than on petiole, usually smooth median-apically; scabrous spot distinctly anterior to middle of tergum; 3rd tergum occasionally with weak striae at extreme base; metasoma otherwise smooth. Ovipositor with a weak subapical notch (Fig. 13); ovipositor a little longer than length of body, sheath 1.52 ± 0.05× longer than forewing.

Color.—Yellow-orange; ovipositor sheath brown; flagellum gradually darkening from yellow at base to brown at apex; head dark brown above, face, clypeus, and gena usually pale, brown in some specimens. Stigma dark medially, with parastigma, basal ⅕ to ⅙, and extreme apex yellow; wings hyaline.

Length.—3–4 mm.

♂.—Essentially as in ♀, but with distal flagellomeres more narrowly elongate, and the prepectal carina often weaker dorsally, sometimes interrupted; metasoma beyond 3rd tergum brown; body length up to 4.5 mm.

Material examined.—Holotype ♀: MEXICO: Sinaloa, El Dorado Sugar Mill near Culiacan, V-26-1983, F. Bennett, J. W. Smith, Jr., H. Browning, ex *Diatraea considerata* Heinrich. Paratypes: 50 ♀ 50 ♂, Sinaloa, El Dorado Sugar Mill near Culiacan, V-26-1983, and La Primavera Sugar Mill near Navalota, V-27,28-1983, F. Bennett, J. W. Smith, Jr., H. Browning, all reared from *D. considerata* and *D. grandiosella* (Dyar). USA: Texas A&M University, laboratory cultures established from Sinaloa collections, and reared on *D. saccharalis* (F.). The species is apparently polyembryonic, with about 50 individuals of the same sex emerging from a single host. The specific epithet is derived from this biological feature.

Diagnosis.—This species is most similar to *M. crambi* (Ashmead) and *M. crambivorus* Viereck, and keys to couplet 4 in Muesebeck (1932). All three species have short palpi, long legs, and slender tarsal claws (without lobes). In addition, there are relatively few antennal segments, the ovipositor is only a little longer than the body, and the 2nd tergum is similarly striate in all three species. *Macrocentrus prolificus* differs from the other two species in the shape of the 2nd cubital cell, which is narrower and longer. The mandibular teeth are also more nearly equal in length (dorsal tooth much longer in *M. crambi* and *M. crambivorus*), and the meso- and metasoma are pale throughout in the female.

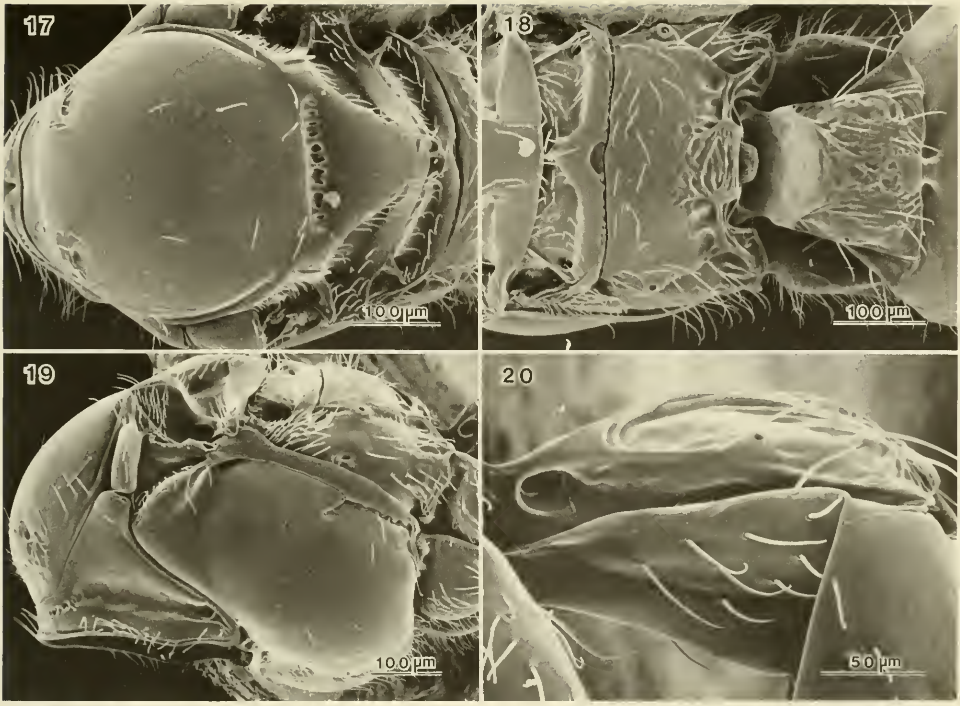
Discussion.—Variation in sculpture and morphometrics is evident in the large amount of material available for study. The sculpture of the metasomal terga, sternauli, notauli, and mesonotal midline seems to incease slightly with specimen size. The propodeal sculpture is also variable, and not always obviously transversely strigose, especially in males. The number and pattern of teeth on the trochanter, and especially on the femur, was surprisingly variable. However, these teeth were always better developed in *M. prolificus* than in either *M. crambi* or *M. crambivorus.*

Opius dissitus Muesebeck

Figs. 14–20, 22

Opius dissitus Muesebeck, 1963: 289–290.
Opius dissitus Muesebeck: Fischer, 1977: 596–598 (redescription).

Head.—1.43 ± 0.05× broader than mesonotum, temples receding in dorsal view; eye in lateral view 1.87 ± 0.36× longer than temple. Frons glabrous, vertex nearly so, ocelli as in Fig. 14. Face (Fig. 15) very weakly hair-punctured, nearly smooth, not densely hairy, with midridge very weak to absent. Clypeus about twice wider than high, semicircular, with 2 rows of long hairs (hairs at least 2× length of those on face); no opening between clypeus and mandibles when mandibles closed. Mandible (Fig. 16) broad basally, abruptly narrowing along ventral border, with apical ½–⅔ very narrow; dorsal tooth longer and broader than ventral tooth. Malar space distinctly less than basal width of mandible. Antennae 20–22 segmented, widely separated, distance between sockets greater than distance be-

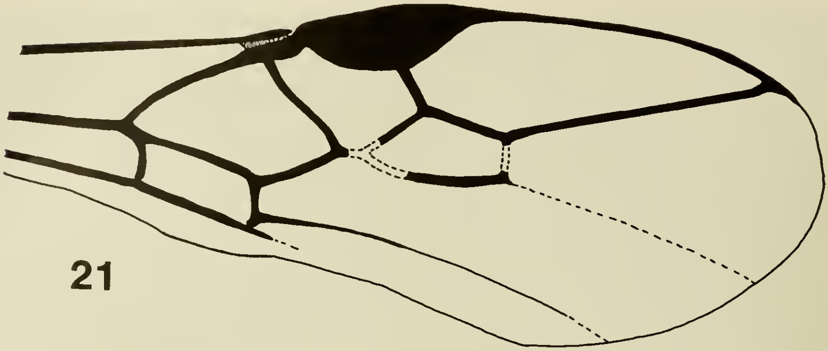


Figs. 17–20. *Opius dissitus* Muesebeck. 17, Dorsal view of pro- and mesonotum. 18, Dorsal view of propodeum and petiole. 19, Lateral view of mesosoma. 20, Lateral view of petiole.

tween socket and eye; antenna nearly 1.5× longer than body. Maxillary palpi shorter than head height.

Mesosoma.—1.21 ± 0.03 times longer than high, 1.46 ± 0.06 times higher than wide. Pronope small and deep. Mesonotum nearly bare, with a line of hairs along lateral margin from notaulus to tegula, and 1–3 hairs per side between end of notaulus and posterior border (Fig. 17). Notaulus represented by a short crease confined to declivous portion of mesonotum. Midpit absent. Scutellum with only a few hairs laterally. Prescutellar groove short and wide, with numerous ridges (Fig. 17). Propodeum largely smooth and bare (Fig. 18), long erect hairs confined primarily to basal lateral area, median apical region weakly rugulose. Pro- and mesopleura smooth and bare or nearly so (Fig. 19), sternaulus absent or represented only by a very broad, weak crease, posterior border of mesopleuron unsculptured dorsally. Metapleuron smooth medially, with a few scattered hairs, weakly rugulose just above coxa and below wing base. Hindfemur 4.08 ± 0.40 times longer than wide.

Wing (Fig. 22).—Stigma wedge-shaped, broader than r1, r1 arising from about basal third; r2 about 6.5–8.5× longer than r1, 1.40 ± 0.17× longer than cuqu1, r2 and r1 forming a straight line (without a distinct angle between them), r3 sinuate, nearly reaching wing tip, 2.32 ± 0.44× longer than r2; n. rec. strongly postfurcal; second cutibal cell distinctly narrowing distally; d3 nearly always absent, brachius weak distally, leaving brachial cell open at lower distal corner.



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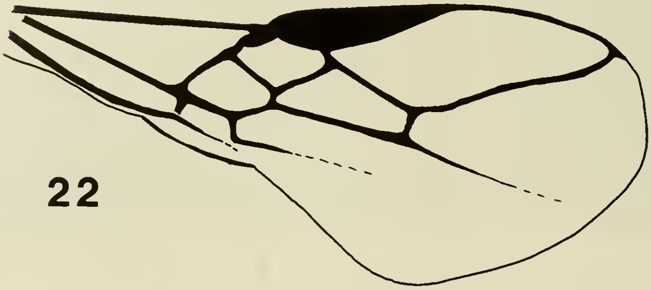

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Figs. 21–22. Fore wings. 21, *Macrocentrus prolificus,* new species; 22, *Opius dissitus* Muesebeck.

Hindwing with postnervellus and radiellan present, but only as very weakly pigmented creases.

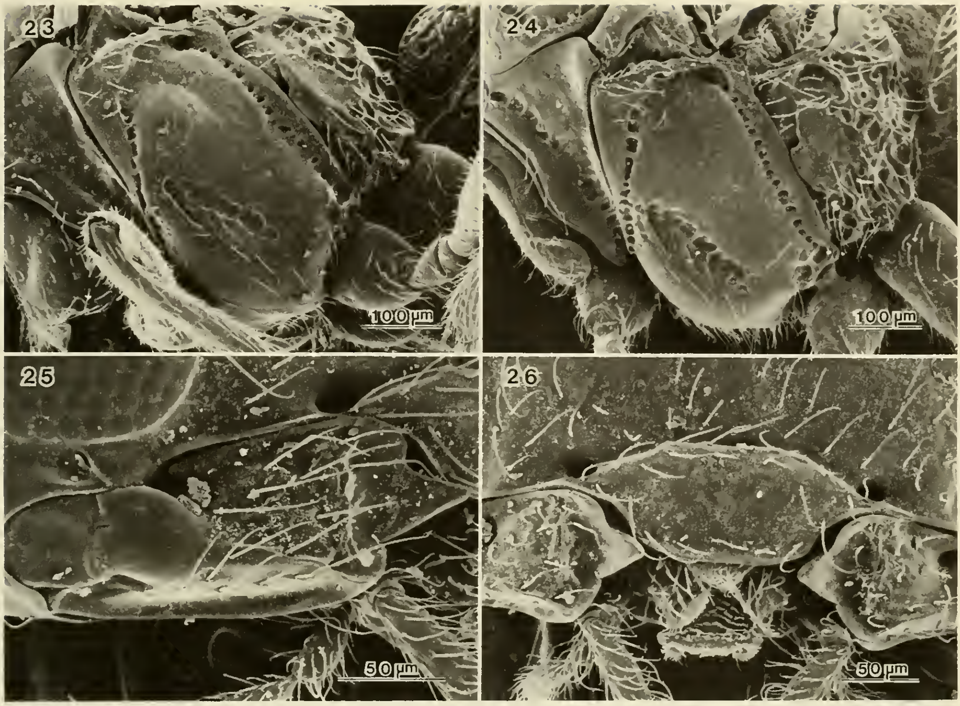
Metasoma.—Petiole about as long as apical width, apex 1.72 ± 0.16× wider than base; carinae strong over apical half, weakly converging but still widely separated posteriorly, not reaching posterior margin; petiole (Figs. 18, 20) rugulose over posterior half. Rest of metasoma unsculptured. Ovipositor short, barely extending beyond tip of abdomen; sheath as long as petiole, but full length rarely visible without dissection.

Color.—Black; flagellum dark brown; tergum 2, and usually at least base of tergum 3, palps, scape (at least ventrally), annellus, coxae, trochanters, and femora yellow; petiole variable, usually dark yellow with brown patch medially; mandibles (except teeth) and clypeus dark to pale yellow; hindtarsi and most of hindtibia weakly infumate dorsally, fore- and midtibia and tarsi usually not distinctly infumate, except 5th tarsomeres brown.

♂.—Essentially as in female, but with measurements a little more variable; mesosoma 1.20–1.25× longer than high; lower mesopleuron between fore- and midcoxae frequently brown to yellow rather than black.

Length.—1.0–2.0 mm.

Material examined.—USA: Florida, Lake Buena Vista, III-16 to IV-5-1983, D. J. Vondal, B. M. Scott, reared from *Liriomyza sativae* Blanchard on *Sorghum,*



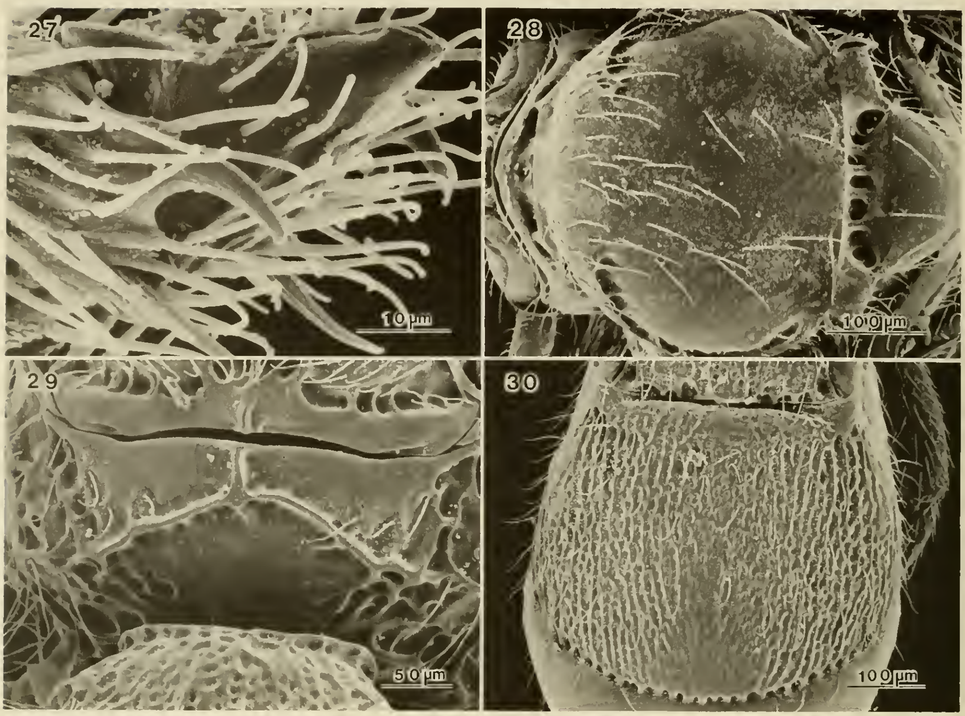
Figs. 23–26. *Oenonogastra microrhopalae* (Ashmead). 23, Lateral view of mesosoma, male. 24, Lateral view of mesosoma, female. 25, Mandible. 26, Clypeus.

Lycopersicon esculentum, and *Phaseolus* (4 ♀, 9 ♂); Homestead, 1983, reared from *Liriomyza* sp. on beans (2 ♀, 3 ♂). Hawaii, Oahu, Waimanalo, VII-1962, D. H. Habeck, M. Tamashiro, reared from *Liriomyza minutiseta* (Paratype series, 12 ♀, 5 ♂).

Diagnosis.—This species is nearly identical to *O. pallipes* Wesmael, but the petiole is distinctly lighter in color (completely dark in *O. pallipes*). Both *O. dissitus* and *O. pallipes* have been confused with some of the other opiines attacking *Liriomyza* in North America. They may be readily identified, however, by the combination of sternaulus and mesonotal midpit absent, mandible abruptly widened at base, and clypeus large, semicircular (without opening between clypeus and mandibles).

Discussion.—*Opius dissitus* was originally described from Hawaii, and was previously known only from this state. It is possible that this may represent an accidental introduction of *O. dissitus* from Hawaii to Florida. However, it may be more likely that the Hawaiian population originated from North America, since *O. dissitus* belongs to a species group which is largely Holarctic.

The clypeus was somewhat darker in the material from Florida, and the body dark brown rather than black in the material from Hawaii. However, the color pattern was affected slightly by state of preservation and especially whether or not specimens had first been stored in alcohol before pinning. In 80% of the material examined, the third discoideal segment was completely absent. In the



Figs. 27–30. *Oenonogastra microrhopalae* (Ashmead). 27, Tarsal claw. 28, Dorsal view, pro- and mesonotum. 29, Dorsal view, propodeum and petiole. 30, Dorsal view, metasomal sculpture.

other 20%, it was represented either by a very weakly sclerotized segment or a more strongly sclerotized, but incomplete stub. This segment was represented in 41.1% of the males, but only 5.6% of the females.

Opius bruneipes Gahan and *Opius dimidiatus* (Ashmead)

These two species have frequently been reared from *Liriomyza* in North America, and are sometimes confused, either with each other or with *O. dissitus*. Unlike *O. dissitus*, both *O. bruneipes* and *O. dimidiatus* have a narrow clypeus with concave lower border. There is thus a distinct opening present between the clypeus and mandibles when the mandibles are closed. The brachial cell is broadly open at its posterior distal corner in *O. bruneipes*, but closed or nearly so in *O. dimidiatus*. The sternaulus is absent or nearly so in *O. bruneipes* (never sculptured), but represented by a short, usually weakly crenulate crease in *O. dimidiatus*. The propodeum is unsculptured in *O. bruneipes*, and sculptured in *O. dimidiatus*. The two are placed in different subgenera by Fischer (1977), and the holotypes in the USNM, which I have examined, conform to his diagnoses.

Oenonogastra microrhopalae (Ashmead)
Figs. 23–30

Mesocrina (?) *microrhopalae* Ashmead, 1896: 217.
Oenonogastra microrhopalae (Ashmead): Ashmead 1900: 105.

Ashmead (1896) described this species from several specimens collected from Rosslyn, Va. The lectotype with Ashmead's hand-written labels "Mesocrina microrhopalae Ash" and "Type" is in the USNM. Although both the label and the original description indicate a male, the specimen is actually a female. This fact has been overlooked in previous treatments of this species (e. g., Fischer, 1967; Shenefelt, 1974; Marsh, 1979; Wharton, 1980) because the lectotype either had not been examined or had not been examined in detail. The ovipositor is very short, not visible in dorsal view, and was apparently missed when Ashmead prepared his description of this species. It is also possible that Ashmead's description was based on one of the other members of the Rosslyn series. Since the female mentioned above bears both type and ♂ labels, however, it seems preferable to regard it as the lectotype. To avoid further confusion, I hereby designate it as such. In addition to the 2 labels in Ashmead's handwriting, and a "Rosslyn Va" label, there are the following: "Note No. 1402^{03}" and "Type No. 50158 U.S.N.M.," the latter in red.

Fischer (1967) redescribed *O. microrhopalae,* and figured the forewing. Wharton (1980) presented a generic diagnosis, and figured the forewing of an undescribed species. *O. microrhopalae* is widely distributed in eastern United States (Marsh 1979), but sculptural variation in the material at hand is as great within various reared series as it is between them (e.g., Figs. 23–24). Intraspecific variation is most evident in the relative strength or development of the sculptural features; and in coloration of the metasoma. Interspecific variation in *Oenongastra* is most evident in the pattern of abdominal sculpture; and in mesosomal coloration.

Sculpture and shape of mandibles, clypeus, tarsal claws, mesosoma, and metasoma are illustrated in Figs. 23–30 for *O. microrhopalae.* The shape of mandibles and clypeus are distinctive for the genus. The latter is distinctly impressed ventrally, and truncate. The claws (Fig. 27) are very short and hairy. A small pronope is present, with deeper depressions to either side. Tergum 2 + 3 is distinctly punctate with longitudinal ridges more distinct laterally. This pattern is typical of *O. microrhopalae.* The legs of *O. microrhopalae* are yellow, with most of hindtibia and hindtarsi dorsally weakly infumate. The head and mesosoma vary from light to dark brown, and the metasoma varies from yellow to dark brown (rarely uniform in coloration).

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A SYNOPSIS OF THE GENUS *TETRAONYX* IN ARGENTINA (COLEOPTERA: MELOIDAE)

RICHARD B. SELANDER AND ANTONIO MARTÍNEZ

(RBS) Professor, Departments of Genetics and Development and of Entomology, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801; (AM) Investigador de Carrera, Consejo Nacional de Investigaciones Científicas y Técnicas, Rosario de Lerma, Salta, Argentina.

Abstract.—Seventeen species of *Tetraonyx* Latreille are recorded from Argentina, including two new species: *T.* ***lycoides*** from Misiones and *T.* ***sericeus*** from Salta. A key to species on the basis of adults is provided. Previous locality and food plant records are cited and new ones summarized. The genus in Argentina is limited largely to northern and northwestern regions; no species is known from the Pampa and only two reach Patagonia. It is considered unlikely that any of the Argentine species is endemic. A distinction is drawn between species on the basis of the presence or absence of modifications of the foretarsus and antennal sensory setae of the adult male. The triungulin larva of *T.* ***sericeus*** is described and compared with that of the North American *T. fulvus* LeConte.

Tetraonyx Latreille is a New World genus of Meloidae containing 98 nominal species, most of which are tropical (Selander, 1983). Its systematic position has been much disputed: Kaszab (1969) and others place the genus in the Meloinae; MacSwain (1956) assigns it to a separate subfamily; and Selander (1964, 1983) treats it as a nemognathine. Bionomic information is scanty, but so far as known, adults of the genus are flower feeders and larvae are specialized predators in the nests of wild bees.

Our recent discovery, in the course of field work in Salta, Argentina, of a new species of *Tetraonyx* has prompted us to prepare a key to the Argentine species and to summarize available data on their geographic distribution and food plants. In the process we have identified an additional new species as well as 15 previously described ones, bringing the total for Argentina to 17.

The fact that *Tetraonyx* is primarily a tropical genus is clearly reflected in the composition and distribution of the Argentine fauna. In Argentina it is limited largely to the tropical and subtropical northern region from Misiones to Salta and the arid basin and range country of the northwest. None of the species is recorded from the Pampa and only two from Patagonia (in Río Negro). Eleven are known to range into neighboring Brazil or, in the case of *T. brevis,* Brazil and Paraguay. Five have not yet been recorded outside Argentina, but one of these (*T. lycoides*), described herein from the frontier province of Misiones, will undoubtedly be found also in both Brazil and Paraguay, and the other four (*T. kirschi, T. propinquus, T. lampyroides,* and *T. sericeus*) all occur as far north as Salta and very

Fig. 1. *Tetraonyx brunnescens,* adults.

likely extend into Bolivia and/or Paraguay; *T. propinquus* has, in fact, been taken in Jujuy at the Bolivian border. The only Argentine species not represented in the northern part of the country is *T. septemguttatus,* which ranges extensively along the western Andean slopes of central Chile and enters Argentina from the west, in northern Patagonia.

In at least six of the species recorded from Argentina (*Tetraonyx albomarginatus, T. brevis, T. brunnescens, T. lampyroides, T. sericeus,* and *T. sexguttatus*) the male foretarsus is not modified, and in both sexes the length of the sensory setae of the antenna (pale erect setae scattered among dark, recumbent clothing setae) is only a small fraction of the width of a segment. Four species (*T. clythroides, T. distincticollis, T. telephoroides,* and *T. innotaticeps*) are unknown to us from either sex and one (*T. lycoides*) is known only from the female. The remaining species agree in having the male foretarsus strongly expanded and more heavily padded ventrally than in the female and the sensory setae on the ventral surface of male antennal segments III-XI greatly elongated and forming a conspicuous, sparse fringe. On the middle antennal segments the length of the setae is at least ¾ the width of a segment. In the female of these species the same setae are longer than usual; on the middle segments their length varies from ⅕ to nearly ½ the width of a segment. The foretarsal and antennal modifications of the male are associated with a distinctive pattern of courtship behavior (Selander, in preparation) and, as such, should be of considerable value in future systematic studies of the genus *Tetraonyx.*

Since it has been necessary to place four of the Argentine species in our key solely on the basis of their original descriptions, we have had to rely more heavily on color than we would have liked and to sacrifice precision in certain contrasts. Still, this course of action seemed preferable to the alternative of omitting these species from the key.

KEY TO ARGENTINE SPECIES OF *TETRAONYX* BASED ON ADULTS

1. Pronotum with sides concave at middle; body length usually more than 12 mm ... 2
– Pronotum with sides straight or convex at middle ... 3
2. Largely yellow; pronotal disk usually with pair of large, angled black marks; elytron with or without black vittae ... *brunnescens*
– Black except for transverse series of yellow or orange elytral spots; venter and legs with blue sheen ... *sexguttatus*
3. Elytral cuticle yellow, either immaculate or with black spots ... 4
– Not as above ... 12
4. Head, pronotum, and elytron immaculate yellow ... 5
– Not as above ... 6
5. Elytron densely setate, pubescent; pronotum less than 1½× as wide as long, not deeply impressed on disk laterally; femora entirely yellow, tibiae largely so ... *sericeus*
– Elytron sparsely setate, setae separated by distance nearly equal to their length; pronotum 2× as wide as long, with deep impression in basolateral area of disk; femora black at apex, tibiae entirely black ... *brevis* (part) and *innotaticeps*
6. Pronotum and legs entirely black; head black ... *clythroides*
– Pronotum and legs at least partly yellow; head black or not ... 7
7. Elytron with black or brown spot covering basal ¼ to ⅓ except for margins and another covering entire apical ⅓ to ⅖ ... 8
– Elytron with pair of black spots at base (rarely absent or partially fused) and another pair just behind middle (may be fused), not reaching apex ... 9
8. Head entirely black; pronotum immaculate yellow, sides subparallel; elytral form normal; body length 10–12 mm ... *bimaculatus*
– Head with tempora and underside yellow; pronotum yellow with median brown spot, sides strongly convergent from base; elytron flared laterally in distal ½; body length 18 mm ... *lycoides*
9. Postmedian pair of elytral spots arranged diagonally, with outer spot clearly more distal in position than mesal spot and, unless both spots are reduced to round dots, longer than it; elytron usually distinctly paler than head and pronotum; tibiae largely or entirely yellow ... 10
– Postmedian pair of elytral spots arranged transversely or nearly so, with outer spot rarely longer than mesal spot (and then only if spots are almost fully fused); elytron not paler than head and pronotum; tibiae largely yellow or entirely black ... 11
10. Elytral spots reduced to round dots; basal spots set distad of level of

apex of scutellum (rarely absent); postmedian pair of spots same size as basal pair, separated from each other by more than diameter of one spot; venter of body yellow .... *kirschi*

– Elytral spots larger, oval; inner basal spot extending to basal margin, outer spot usually to humerus; postmedian pair of spots larger than basal pair, separated by no more than width of one spot; venter of body largely black .... *maudhuyi*

11\. Elytral setae nearly erect; inner hindtibial spur subequal in width to midtibial spurs; clothing setae of body black or piceous; tibiae and abdomen entirely black; head and pronotum yellow, each with median black spot .... *septemguttatus*

– Elytral setae decumbent; inner hindtibial spur clearly wider than midtibial spurs; clothing setae of body colorless; tibiae largely yellow and apex of abdomen yellow or, if as above, head entirely black and pronotum largely so .... *propinquus*

12\. Elytral cuticle and setae entirely black 13

– Cuticle of lateral margin of elytron yellow or clothed with pale (yellow or white) setae or both 15

13\. Pronotum with sides distinctly rounded, gradually convergent from base to apex; legs long, slender; black with yellow pronotum ..... *distincticollis*

– Pronotum with sides subparallel from base to near apex, then convergent; legs shorter, thicker; color as above or not 14

14\. Legs and venter of body black; pronotum abruptly constricted apically .... *telephoroides*

– At least coxae and base of femora yellow; pronotum more gradually constricted apically .... *nigriceps*

15\. Elytron black, lacking discal vitta; legs entirely black or with femora yellow basally .... *albomarginatus*

– Elytron black or brown, with discal vitta marked by pale setae and, often, yellow cuticle; if elytron black, legs entirely black 16

16\. Elytral setation sparser, with 10 or less setae in transect between sutural margin and discal vitta; elytron black, with pale margining and vitta narrow; male abdominal sternum VIII (last visible) with lateral lobes well defined, acute; apex of aedeagus not hooked .... *lampyroides*

– Elytral setation denser, with more than 10 setae in transect between sutural margin and discal vitta; elytron as above or brown, with pale margining and vitta wide; male abdominal sternum VIII with lateral lobes broadly rounded; aedeagus with apical hook .... *brevis* (part)

NOTES, RECORDS, AND DESCRIPTIONS

Collections other than our own are generally identified in this section by acronyms defined in the Acknowledgments, our collections by our initials. Values accompanying sample means, in parentheses, are estimated standard errors.

***Tetraonyx brunnescens* Haag-Rutenberg**

Fig. 1

Recorded from Corrientes by Burmeister (1881) and from Tapia, Tucumán, by Pic (1915a) (as *T. baeri* Pic).

New records.—*Corrientes:* Santo Tomé, I-27 (AM) 2. *Formosa:* Formosa, XI-52, Peña (RBS) 1; Gran Guardia, Foerster (RBS) 1. *Jujuy:* (MLP) 1; El Naranjo, Rosario de la Frontera, I-44, Duret and Martínez (AM) 1. *Salta:* Sumaloa, 18-I-83, eating flowers of Sapindaceae, Martínez (AM, RBS) 22. *Santa Fé:* Barranquillas, 2-XI-54 (AM) 1.

The elytral vittae are reduced to indistinct basal spots in the specimens from Formosa and entirely lacking in those from Corrientes. In the latter specimens, which are assignable to Haag-Rutenberg's (1879) variety *minor,* described from "Irisanga," Brazil, the dark markings of the head and pronotum are nearly obsolete.

Tetraonyx sexguttatus (Klug)

A widely distributed species in tropical America, not previously known from Argentina.

New record.—*Misiones:* Puerto Iguazú, XII-57, Martínez (AM) 1.

Tetraonyx clythroides Haag-Rutenberg

Both Bruch (1914) and Denier (1935b) indicated that this species occurs in Argentina.

Tetraonyx bimaculatus (Klug)

Reported from Misiones by Bruch (1914).

Tetraonyx lycoides Selander and Martínez, NEW SPECIES

Adult female.—Basic color of head, pronotum, and elytron yellow. Head with middle of vertex and entire front except for small median area between antennae brown; antennae and last segment of maxillary and labial palpi brown. Pronotum with ill-defined discal brown spot, ⅓ as wide as pronotum, extending from near apical margin to basal ⅓. Scutellum yellow. Elytron with large basal and apical fasciae; basal fascia deeply notched on posterior margin, well separated from sutural and lateral margins of elytron, extending to basal ¼ of elytron; apical fascia with anterior margin jagged but not deeply notched, completely covering distal ⅖ of elytron. Hindwing yellow. Venter brown except prosternum, mesepimeron, and lateral and median areas of abdominal sternum VI yellow. Legs brown with trochanters and basal ½ of femora yellow; some yellow mottling apically on coxae; midtibia lightened to near yellow on posterior surface except at base and apex. Head, pronotum, and scutellum conspicuously clothed with long, nearly erect setae; setae forming conspicuous fringe on occiput and margins of pronotum; elytral cuticle nearly obscured by dense clothing of decumbent setae; venter with setae fine, decumbent, rather inconspicuous, most of those on abdomen very short. Setae throughout tending to match color of underlying cuticle (colorless on yellow areas, brown on brown areas), except that brown setae often encroach on yellow areas; on head, pronotum, and elytra in particular this softens edges of brown marks; setae on dorsum about ⅖ as long as antennal segment II. Length: 18 mm.

Head with sides divergent above eyes, rounding smoothly into tempora; occiput evenly convex; length (to base of labrum) equal to width at tempora, which is in turn equal to width across eyes; interocular distance (ID) .56 width of head across eyes; coronal suture limited to occiput; frontal area flat with fine, smooth, weakly elevated ridge; cuticle moderately shiny, finely, densely, evenly punctate. Antenna reaching 2 segments beyond base of pronotum, not clavate; segments well differentiated, expanded from base to apex, with result that antenna is almost serrate; length of segment I .64 ID, $1\frac{1}{10}\times$ width; II $\frac{3}{10}$ as long as I, as wide as long; III about $\frac{3}{5}$ as long as I, $\frac{3}{5}$ as wide as long; III–X becoming progressively slightly longer; X $1\frac{3}{10}\times$ as long as III; III–VII becoming progressively slightly wider, VII–XI progressively narrower; VII nearly $1\frac{2}{5}\times$ as wide as III; XI subequal in length to I, $2\frac{3}{4}\times$ as long as wide, as wide as III, abruptly narrow in distal $\frac{1}{3}$, which appears superficially to be a separate segment. Eye prominent; width .76 length, .61 ID; inner margin facing antennal insertion deeply, broadly excised. Clypeus and labrum more sparsely punctate than front and with longer setae; labrum deeply emarginate medianly. Last segment of maxillary palpus widest at middle; length $\frac{1}{3}$ ID, $2\times$ width; apex subtruncate; sensory area represented by inconspicuous, oblique impression. Last segment of labial palpus small, bud-shaped, compressed, slightly longer than wide, truncate at apex.

Pronotum strongly transverse, .54 as long as wide, $1.55\times$ as wide as head at tempora, roughly trapezoidal in form; sides evenly and rather strongly convergent from base to near apex, then abruptly convergent and nearly transverse; hind angles well defined, prominent; median $\frac{1}{3}$ of pronotum except at base strongly elevated, evenly convex; lateral $\frac{1}{3}$ on each side deeply, evenly impressed, so that pronotum is "winged" laterally; base flat medianly, with margin evenly rounded in median $\frac{2}{3}$; cuticle as on vertex. Scutellum large, triangular, broadly rounded at apex, densely punctate and setate, with deep, glabrous median sulcus.

Elytron weakly flared laterad in distal $\frac{1}{2}$, obliquely truncate at apex, with well defined corner at sutural margin; width about $\frac{1}{4}$ length at level of apex of scutellum, $\frac{1}{3}$ length at distal $\frac{1}{3}$; surface finely, densely rugose-punctate; costulae narrow, very weakly elevated, visible only in median yellow area. Venter shiny, smooth, very finely punctate, rather densely so on metasternum, sparsely so on abdominal sterna except III. Abdomen with pygidium shallowly excised medianly; sternum VII shallowly, evenly emarginate; VIII flattened distally, shallowly, roundly emarginate; apical margins of pygidium and sternum VIII fringed with long setae.

Legs slender, relatively short. Mid- and hindtibia distinctly bowed. Fore- and midtibial spurs long, slender, spiniform; hindtibial spurs similar to each other in size and form, thicker than others, parallel-sided, very obliquely truncate to base, rounded at apices. Tarsi with segments II–IV on fore- and midleg and II–III on hindleg bilobed; pads (ventral pale setae) well developed, dense on all segments except segment I of mid- and hindtarsus, which is setate but lacks differentiated pad. Foretarsus (measured on dorsal midline) with segment I $\frac{1}{10}$ as long as foretibia, little more than $\frac{1}{2}$ as wide as long; II and III about $\frac{1}{2}$, IV $\frac{2}{5}$, and V $1\frac{2}{5}\times$ as long as I.

Male.—Unknown.

Type material.—Holotype female from Campo Grande, Misiones, Argentina, XII-57, Walz, in Martínez collection.

Remarks.—This species, like *Tetraonyx superbus* Pic (1915a), described from "Mineiro," Brazil, is presumably a lycid mimic. On the basis of Pic's description, the two species have essentially the same color pattern. In Pic's species, however, the pronotal spot is "narrow," the scutellum black, and the middle of the tibiae yellow, whereas in *T. lycoides* the dark pronotal spot is broad, the scutellum yellow, and the tibiae brown except for the middle area of the posterior surface of the midtibia. Pic referred to the dark color of his species as black. In the type specimen of *T. lycoides* it varies from medium to light brown. This specimen, collected 27 years ago, is perhaps faded, but it seems unlikely that the brown areas were ever dark enough to be characterized as black.

Typically, Pic mentioned few structural characters in describing *T. superbus.* The pronotum was characterized as subtransverse, with the sides almost straight, and the elytron as rather elongate and costate. In *T. lycoides* the pronotum is strongly transverse and the elytral costulae are hardly elevated.

Tetraonyx kirschi **Haag-Rutenberg**

Fig. 2

Recorded previously from Catamarca, Córdoba (El Sauce), Mendoza, San Luis (Carolina), and Tucumán (Haag-Rutenberg, 1879; Burmeister, 1881; Bruch, 1914; Viana and Williner, 1972, 1973).

New records.—*Mendoza:* Mendoza, 29-I-70, Peña (RBS) 5; Uspallata, 24-I-49, Aczel (IML) 1. *Neuquén:* Zapala, 17-XII-30, Kohler (MLP) 4. *Río Negro:* Río Colorado, (MLP) 1, XII-30, Reed (CAS) 1. *Salta:* Cafayate, 5-I-56, Peña (RBS) 17. *San Luis:* 45 km NNE Beazley, 4-III-83, eating flowerheads of *Baccharis,* Selander and Peña (RBS) 10.

The pale yellow color of the adult closely matches the color of *Baccharis* flowerheads on which the sample from San Luis was taken. The basal elytral spots are absent in the specimen in the MLP (Denier collection) from Río Negro.

Tetraonyx maudhuyi **Pic**

Bosq (1943) recorded this species (as *T. lineolus* var. *maudhuyi*) from flowers of a wild Liliaceae at Pindapoy, Misiones. At least part of his material, collected October 1935, is in the Denier collection, MLP, where it is determined both as *T. maudhuyi* (five specimens) and as *T. pallidus* Haag-Rutenberg (eight specimens). As Denier's indecision suggests, *T. maudhuyi* is similar to *T. pallidus* Haag-Rutenberg and may prove to be a junior synonym.

New records.—*Buenos Aires:* Tandil, XI-51, Andrae (AM) 3. *Córdoba:* Arguello, 300 m, XI-58, Walz (RBS) 23. *Formosa*: Formosa, 1-X-52, Peña (RBS) 6; Gran Guardia, XI-57, Walz (RBS) 34.

Tetraonyx septemguttatus **Curtis**

This species has not been recorded previously from Argentina.

New records.—*Río Negro:* El Bolsón, XI-55, Walz (RBS) 20; III-56, 18/25-XI-56, and II-57, Kovacs (LACM) 10. *Province unknown:* NW Patagonia, XII-19, Box (BM) 1.

The Argentine specimens are small but otherwise agree well with material from Chile.

Tetraonyx propinquus **Burmeister**

Fig. 3

A common and widely distributed species, recorded in the literature from Catamarca (Valle de Santa María), Córdoba (Alta Gracia, El Sauce), Mendoza, San Luis (Carolina), Santiago del Estero, and Tucumán (Burmeister, 1881; Pic,

Figs. 2–3. Adults. 2, *Tetraonyx kirschi.* 3, *T. propinquus,* heavily marked individual.

1915b (as *T. argentinus* Pic), 1916 (as *T. argentinus* var. *disjunctus* Pic); Bosq, 1943; Viana and Williner, 1973). Found destroying flowers of German *Iris* by Bosq; collected on flowers of Cactaceae by Viana and Williner.

New records.—*Catamarca:* El Rodeo, Santa Rosa, II-42, Schaeler (AM) 1; Punta de Balasto, 2200 m, 17-I-83, Selander and Peña (RBS) 4; 4 km N Santa María, 1900 m, 19-I-83, Selander and Peña (RBS) 36; Sorohuasi, I-25, Weiser (IML) 1. *Córdoba:* Dpto. Punilla, I-81, Yarh'nez (AM) 1; Villa Nueva, 6-I-38 (IML) 1. *Jujuy:* La Quiaca, 3442 m, 17-II-51, Ross and Michelbacher (CAS) 2. *Mendoza:* between Beazley (San Luis) and San Rafael, 4-III-83, Selander and Peña (RBS) 3. *Salta:* Cerro San Bernardo, Capital, II-46, Martínez (AM) 2. *Santa Fé:* Villa Ana, I-46, Hayward and Willink (IML) 4. *Santiago del Estero:* 33 km S Santiago del Estero, 20-XII-71, flowers of *Solanum elaeagnifolium,* Selander and Mathieu (RBS) 3. *Tucumán:* Amaicha del Valle, 2000 m, 18-XII-64 to 9-I-65, flowers of *Opuntia, Solanum elaeagnifolium,* and Convolvulaceae, Selander and Storch (RBS) 75; Siambón, III-45, Olea (IML) 2; Tafi del Valle, XII-45, Hayward (IML) 3.

In the specimens from Jujuy and Salta the legs are entirely black and the head and pronotum largely so. These specimens resemble the Bolivian *T. chevrolati* Haag-Rutenberg (1879), of which *T. propinquus* is perhaps a geographic race.

Tetraonyx distincticollis Pic

Recorded by Denier (1935a, 1935b) from Argentina, without mention of a specific locality. Otherwise known only from the state of Santa Catarina, Brazil. We have placed the species in our key on the basis of Pic (1916) and Kaszab's (1959) descriptions.

Tetraonyx telephoroides Haag-Rutenberg

Listed for Argentina by Denier (1935b).

Tetraonyx nigriceps Haag-Rutenberg

Reported eating flowers of *Ipomoea* at Eldorado, Misiones, by Bosq (1943). Twelve of Bosq's specimens, collected May 1936, are in the Denier collection, MLP. A single specimen, presumably also from Bosq's series, is in the CAS.

Tetraonyx albomarginatus Haag-Rutenberg

We have tentatively identified three specimens from Misiones and one from Formosa as representing this species, described originally (Haag-Rutenberg, 1879) from "Salto Grande," Brazil.

New records.—*Formosa:* Parque Nacional Laguna Blanca, 25 km W Clorinda, I-50, Martínez (AM) 1. *Misiones:* Loreto, II-56 (AM) 3.

This is a largely black species with an immaculate yellow prothorax. The lateral margin of the elytron is finely yellow from the base to at least the distal ⅖. The scutellum is yellow basally in one specimen. The femora are bright yellow in the basal ½ to ⅔ in three of the specimens and an obscure yellow at the very base in one. None of the specimens exhibits the metallic elytral luster noted by Haag-Rutenberg in some of his material. The pronotum, described by Haag-Rutenberg as more than 2 × as wide as long, ranges from 1.61 to 1.85 × as wide as long. The elytra, described as not much wider than the pronotum, are (at the level of the apex of the scutellum) 1.30 × (.004) ($N = 4$) as wide as the pronotum. Otherwise, our material agrees with the structural characteristics given by Haag-Rutenberg.

Tetraonyx lampyroides Burmeister

Described originally from Tucumán (Burmeister, 1881) and reported subsequently from Iliar, La Rioja (Viana and Williner, 1974).

New records.—*Catamarca:* 5 km N Santa María, 1900 m, Catamarca, 9-II-83, *Sphaeralcea,* Selander and Peña (RBS) 1. *La Rioja:* Patquía, I-33, Hayward (IML, MLP) 2. *Salta:* Cafayate, II-62, Hayward, and II-50 (IML) 6. *Santiago del Estero:* Campo Gallo, III-43, Prosen (AM) 1; Ocaño (MLP) 1; Río Salado (BR, MLP) 6. *Tucumán:* Dpto. Burruyacu, III-46, Araoz (AM) 4; Río Mixta, 45 km SSE Tucumán, 6/8-XII-64, *Sphaeralcea bonariensis,* Selander and Storch (RBS) 15; Tucumán, IV-49, Monros and Goldbach (IML) 1.

This species is similar to *T. brevis* (Klug) (=*T. vittatus* Haag-Rutenberg). In the series from Río Mixta, Tucumán, the head varies from entirely black to entirely yellow. The elytron is consistently black with a fine light area beneath the discal vitta; the venter and legs are black. The elytral setae are sparser than in *T. brevis.* The eye is usually not so prominent as in that species, but the difference is subtle and not particularly useful for identification. In the males there are consistent interspecific differences in the form of abdominal sternum VIII and the aedeagus (Figs. 6–9).

Tetraonyx brevis (Klug)

Recorded from Argentina without a specific locality by Denier (1940). In addition to one specimen from Formosa, Argentina, we have examined good series of specimens from Bolivia, Brazil, and Paraguay.

New record.—*Formosa:* Parque Nacional Laguna Blanca, 25 km W Clorinda, I-50, Martínez (AM) 1.

The color pattern is highly variable. The head varies from black to largely yellow. The pronotum is commonly immaculate yellow but may have a median black spot. The elytron varies from black to (rarely) immaculate yellow. The venter of the body may be entirely black, yellow mottled with black or brown, or (rarely) entirely yellow. The basal ¾ of the femora is usually yellow, but occasional specimens have entirely black legs. The Argentine specimen is a lightly marked one. See *T. lampyroides,* above.

***Tetraonyx innotaticeps* Pic**

Listed for Argentina by Denier (1940). Pic's (1915a) superficial description of the type specimen (from Brazil) provides no basis for distinguishing adults of this species from lightly marked individuals of *T. brevis.*

***Tetraonyx sericeus* Selander and Martínez, NEW SPECIES**

Figs. 4–5, 10–13

Adult.—Orange yellow; elytra paler than rest, nearly straw yellow; venter often suffused with light brown, especially on thorax; antennal segments II-XI, very base of tibiae, and all tarsal segments dark brown; last two segments of maxillary palpus and last segment of labial palpus light brown. Head, pronotum, and venter moderately densely, conspicuously clothed with colorless, sericeous setae; elytron pubescent, setae twice as dense as elsewhere, producing a distinct satiny sheen; setae on dorsum of body slightly shorter, on the average, than those on venter, about ⅔ as long as antennal segment II. Length: 5–9 mm.

Head quadrate above eyes, with well developed tempora; length (to base of labrum) .96 (.011) (N = 10 for this and means that follow) greatest width above eyes, which is .94 (.007) width across eyes; interocular distance (ID) .65 (.008) width of head across eyes; coronal suture distinct, finely impressed, brown, extending to level of dorsal margin of eye; cuticle shiny, densely, rather evenly punctate, punctures large, separated by much less than diameter of single puncture; clothing setae mostly directed anteriad, longer on sides and anterior part of front than on vertex. Antenna reaching base of pronotum, not clavate; segments bead-like, well differentiated; sensory setae not elongated; length of segment I .40 (.009) ID, 2× width; II about ⅖ as long as I, $\frac{6}{7}$ as wide as long; III-VII equal in length, $1\frac{3}{10}$× as long as II, becoming progressively slightly wider; III ⅔ as wide as long; VII more than ⅘ as wide as long; VIII-X slightly shorter and narrower than VII; XI about ⅘ as long as I, twice as long as wide, as wide as X. Eye prominent; width .82 (.009) length, .49 (.072) ID; inner margin facing antennal insertion straight, not excised. Clypeus and labrum with punctures and setae as on front. Labrum shallowly emarginate medianly. Last segment of maxillary palpus slightly widened distally; length .29 (.005) ID, 2× width; apex rounded; large, oblique sensory area dorsolaterally. Last segment of labial palpus small, bud-shaped, $\frac{6}{7}$ as wide as long.

Pronotum subquadrate, .69 (.009) as long as wide, 1.07 (.011)× as wide as head above eyes; sides subparallel and weakly rounded for basal ⅘, then abruptly convergent to apex; disk rather evenly convex, with fine median sulcus just indicated at center and deep impression in basal ⅖, extending laterad ½ distance

Figs. 4–5. *Tetraonyx sericeus*, adults. 4, Alert posture. 5, "Sleeping" posture.

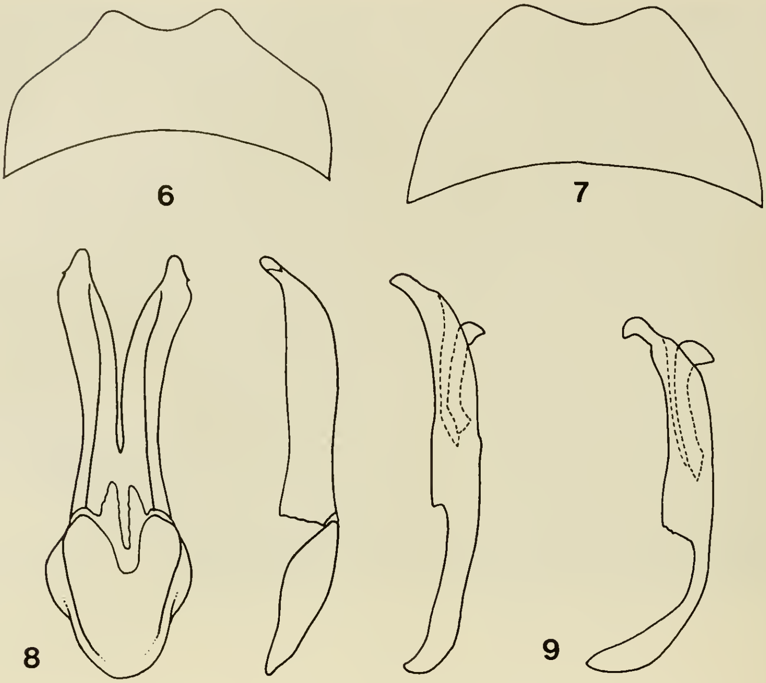
to lateral margin of disk; basal margin strongly recurved behind impression; cuticle of disk as on vertex; lateral ridge separating disk from deflexed portion well developed in basal ⅔, the deflexed portion in that region deeply concave, impunctate, glabrous. Scutellum large, triangular, rounded at apex, densely setate.

Elytron parallel-sided, not expanded distally; width at level of apex of scutellum about ⅕ length; cuticle dull, densely scabropunctate. Venter microgranulose, finely punctate. Abdomen with pygidium truncate.

Legs relatively short. Midtibia moderately bowed. Fore- and midtibial spurs long, moderately heavy, foretibial pair widely separated from each other by deep ventral emargination of tibial apex; hindtibial spurs similar to each other in size and form, much thicker than others, sticklike, very obliquely truncate; apices not acute. Tarsi with segments cylindrical; penultimate segment not bilobed; pads (ventral pale setae) absent on last segment, present but not dense on other segments. Foretarsus (measured on dorsal midline) with segment I ⅕ as long as foretibia, ⅖ as wide as long; II about 7/10, III ⅔, IV ½, and V 1⅔× as long as I.

Male.—Abdominal sternum VII broadly emarginate to depth of ¼ its length; sternum VIII semicircularly emarginate to depth of ¼ its length, median area and lateral lobes with scattered hooked setae that are much heavier than rest; tergum IX consisting of pair of large, elongate sclerites in lateral position; sternum IX as in Fig. 13. Genitalia with gonostylus deeply notched at apical ⅕, apical portion thus defined modified ventrally to form elongate, concave pad; aedeagus strongly curved and cupped basally, with single, heavy, barely recurved ventral hook at apex; dorsal hook heavy, triangular.

Female.—Abdominal sterna VII and VIII entire. Gonostylus elongate, rodlike, more than 7× as long as wide.

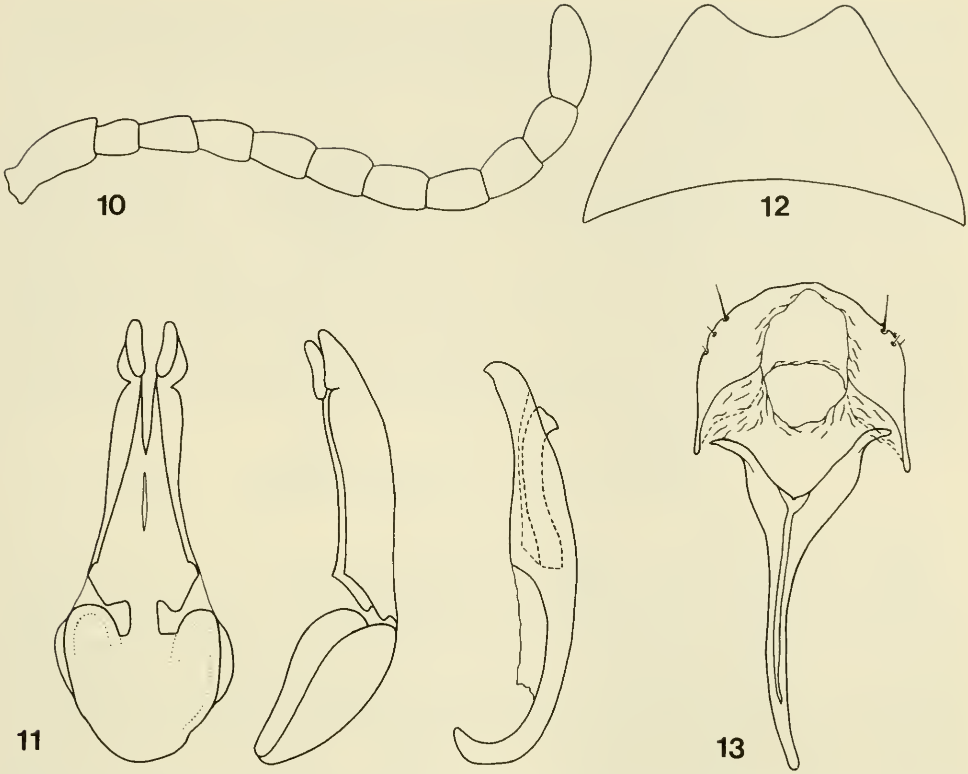


Figs. 6–9. Male sexual characters. 6, *Tetraonyx lampyroides,* abdominal sternum VIII. 7, *T. brevis* (Brazil), same. 8, *T. lampyroides,* genitalia (ventral and lateral views of gonoforceps, lateral view of aedeagus). 9, *T. brevis* (Brazil), aedeagus (lateral view).

Type material.—Holotype male and 23 paratypes (7 males, 16 females) from Cabra Corral, 20 km E Colonel Moldes, Salta, Argentina, 27 January 1983 (2 paratypes 28 January 1983), *Abutilon* sp., A. Martínez and R. B. Selander. Three additional paratypes (1 male, 2 females), same data as above but collected by M. J. Viana. Holotype in R. B. Selander collection. Paratypes in the Field Museum of Natural History, Chicago; Museo Argentino de Ciencia Natural "Bernardino Rivadavia," Buenos Aires; Museo de La Plata, La Plata; and the Martínez, Selander, and Viana collections.

Remarks.—The thoracic venter is entirely orange yellow in 7 specimens, suffused with light brown on the mes- and metepisternum in 10, and entirely light brown in 6. The abdominal venter is light brown in 3 of the specimens of the second type and in all 6 of the third type. There is no indication that the variation is related to sex. Sexual dimorphism in structural characters seems to be limited to the form of the last two visible sterna of the abdomen and the genitalia themselves.

In Haag-Rutenberg's (1879) key this species runs to division C ("Thorace lateraliter numquam exciso . . . parapleuris plerumque distincte separatis") and thence, on the basis of color, to *Tetraonyx nigricornis* (Klug, 1825) (= *T. nigricornis* Haag-Rutenberg, 1879), recorded from Brazil and Colombia by Haag-Rutenberg and (as var. *atripes* Pic) from Peru by Pic (1916). The two species are immediately distinguished from all other members of the genus assignable to



Figs. 10–13. *Tetraonyx sericeus,* male. 10, Antenna. 11, Genitalia (ventral and lateral views of gonoforceps, lateral view of aedeagus). 12, Abdominal sternum VIII. 13, Abdominal segment IX, ventral view.

division C by the absence of black or brown markings on both the pronotum and elytron. Yet on the basis of Haag-Rutenberg's (1879) description and a female specimen in the Denier collection, MLP, *T. nigricornis* is quite distinct from *T. sericea* and, in our opinion, probably not a close relative. In *T. nigricornis* the color is more nearly orange; there is a small dark spot on the front of the head; the femora and tibiae are tipped with brown; the pronotal disk has an impression on each side and sharply defined posterior angles; the elytron is smooth, shiny, finely punctate, and clothed with relatively short, decumbent setae; and the outer hindtibial spur is wider than the inner one. (We have not seen the male of the species.) Among the Argentine species, *T. sericeus* is anatomically most similar to *T. lampyroides* and *T. brevis.*

Bionomics.—The type locality is in a region of arid scrub vegetation bordering the Cabra Corral reservoir in the center of the province of Salta. Here all our adult material was taken on an apparently undescribed species of *Abutilon* (Malvaceae) characterized by cordate, finely dentate leaves and small flowers of almost precisely the same orange yellow color as the beetles. A similar species of *Abutilon,* distinguishable by its more coarsely dentate leaves, occurs commonly with the food plant but is evidently not utilized by the beetles. Most of the beetles were feeding singly on flowers and flower buds; a few were resting on bracts under buds. Those that were active often took to flight rapidly when approached. This behavior, together with the small size and cryptic coloration of the beetles, made it difficult to collect them.

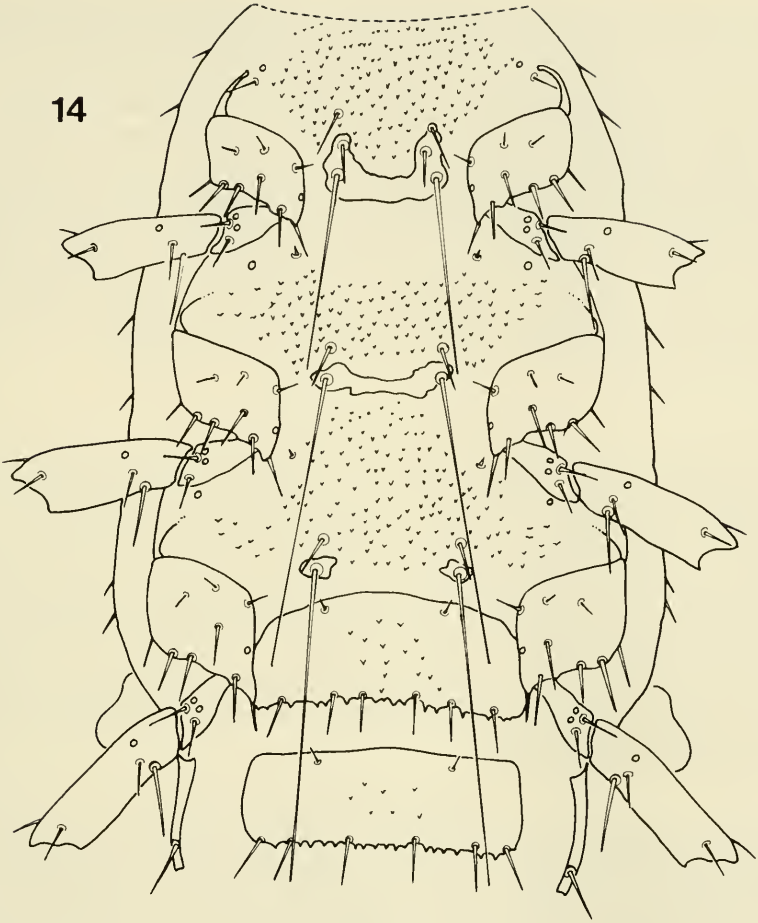
In captivity the beetles ate all parts of the flowers of the food plant, including pollen. At night and on cool, overcast days they adopted a characteristic "sleeping" posture, with the head lowered and the antennae directed to the sides (Fig. 5). Females plastered their eggs, which are quite sticky, in compact, flat masses on the underside of leaves of the food plant (two cases) or on gray paper used as a floor covering in their cages (nine cases). The eggs stand upright on the substrate. The adhesive is not water soluble. The number of eggs per mass in 11 masses ranged from 61 to 433, with a mean of 274.5. (For nine masses obtained separately, the mean was 266.0 (41.26).) Incubation time at ambient temperature, determined for six egg masses, averaged 11.7 (.41) days.

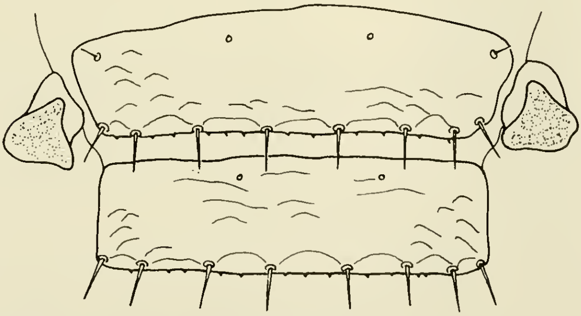
Triungulin Larva of ***Tetraonyx sericeus***
Figs. 14–15

Differs from the larva of *T. fulvus* LeConte as follows:

Color much darker brown. Head with median phragma more strongly protuberant posteriorly. Maxillary palpus with segment III slightly more than 4 × length of II (5 × in *T. fulvus*). Thoracic venter with cuticular reticulations more strongly developed, drawn into conspicuous spines over most of median area of all three segments (few such spines also on abdominal sternites I–III) (spines lacking in *T. fulvus*); minute cuticular papillae confined largely to posterior and lateral areas (densely distributed over median area in *T. fulvus*); anteriormost pair of median setae on prothorax more posteriad in position, arising at level of anterior margin of coxa (at level of anterior end of pleurite in *T. fulvus*); major median setae on pro- and mesothorax arising from a common, transverse sclerite (small, separate sclerites in *T. fulvus*); major median setae on metathorax as long as those on mesothorax, each arising from separate, small sclerite (setae much shorter and sclerites absent in *T. fulvus*). Legs with coxae transverse, 1⅓ × wider than long (⁹⁄₁₀ as wide as long in *T. fulvus*); femur with subbasal posterior seta larger than others, ⅓ length of femur (⅕ in *T. fulvus*). Abdominal tergite I with 8 posterior marginal setae, II–V with 12 (I with 6, II–IV with 14, V with 12 in *T. fulvus*); bases of adjacent setae on tergites I–VII connected by arcuate line, producing a scalloped effect (less conspicuous in *T. fulvus*); sternites I–V each with 6 posterior marginal setae (I with only 4 setae in *T. fulvus*); posterior margin of sternites I–VIII strongly, coarsely dentate (as finely spinose as tergites in *T. fulvus*). Median pair of caudal seta 3 × as long as tergite V (2½ × in *T. fulvus*). Length .8 mm.

Remarks.—MacSwain (1956) characterized the genus *Tetraonyx* in the triungulin (first) larval instar almost entirely on the basis of the North American *T. fulvus*. In our comparison of *T. sericeus* and *T. fulvus* we have utilized larval material of the latter species from Chihuahua and Coahuila in Mexico and New Mexico in the United States. Several of the character states specified above for *T. fulvus* were not mentioned by MacSwain. In five characters we noted significant discrepancies between our material and MacSwain's description: (1) If one measures the sclerotized portions of antennal segments I and II, II is only slightly longer than I, not almost 2 × as long, as described by MacSwain. (2) Again mea-





Figs. 14–15. *Tetraonyx sericeus*, triungulin larva. 14, Ventral aspect of thorax and abdominal segments I–II. 15, Dorsal aspect of abdominal segments I–II.

suring sclerotized parts, we find that maxillary palpal segment III is 2½× as long as I and II combined, not "almost twice as long." (3) In none of several species of *Tetraonyx* that we have studied in the larval stage have we seen the "vestigial, wartlike" labial palpi reported by MacSwain and earlier figured for the larva of

T. quadrimaculatus (Fabricius) by Böving and Craighead (1931). (4) The tarsungulus is fully ½ as long as the tibia. (5) In MacSwain's drawing of the larva of *T. fulvus* the median pair of caudal setae are much too short.

Tetraonyx sericeus possesses a unique combination of states in the two characters used by MacSwain (1956) in his key to *T. quadrimaculatus* and *T. fulvus* and therefore will not run to either species. With respect to the length of the pair of major median setae on the metathorax, *T. sericeus* agrees with *T. quadrimaculatus,* but the latter species differs from both *T. sericeus* and *T. fulvus* in having the subbasal posterior seta of the femora greatly elongated (longer than the corresponding femur, according to MacSwain). Unfortunately, further comparison of these species is not possible at this time, since the condition of MacSwain's specimen of *T. quadrimaculatus* precluded detailed description.

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SEASONAL OCCURRENCE AND MATING AT FLOWERS BY *ANCISTROCERUS ANTILOPE* (HYMENOPTERA: EUMENIDAE)

D. P. Cowan and G. P. Waldbauer

(DPC) Department of Biology, Western Michigan University, Kalamazoo Michigan 49007, and The University of Michigan Biological Station; (GPW) Department of Entomology, 320 Morrill Hall, University of Illinois, Urbana, Illinois 61801.

Abstract.—The eumenid *Ancistrocerus antilope* (Panzer) is scarce at flowers in early summer, but abundant by late summer. Samples systematically collected at flowers are strongly male biased while comparable samples reared from trap nests are female biased. This indicates that males spend a greater proportion of their time at flowers than do females. Females visit flowers for nectar, but the males also search flowers for mates. Mating is initiated at flowers, but may be completed elsewhere.

Eumenid wasps, like many other insects, seek mates at blossoms, nest sites and other resources (Parker, 1978). The site or sites chosen and the details of the search strategy differ among species. Males of the colonial soil-nester *Euodynerus crypticus* (Say) wait on vegetation overlooking the colony and pounce on passing females (Vest, 1936) or visit nest entrances, paying particular attention to those that contain advanced females (Isley, 1913). The non-colonial *Paraleptomenes miniatus* (Saussure) builds two-celled mud nests in sheltered areas, one cell containing a male and the other a female. The male emerges first, remaining on the nest to mate with his sister who emerges a little later (Jayakar and Spurway, 1966). *Euodynerus foraminatus* (Saussure) and *Ancistrocerus adiabatus* (Saussure) nest in vacant insect tunnels in dead wood and exhibit comparable sibling mating. Females not inseminated as they emerge from their natal nest mate later on flowers or foliage (Cowan, 1979, 1981). *Epsilon* sp. has a similar mating system (Smith and Alcock, 1980).

In contrast to the species that copulate at nest sites, males of other eumenids seek mates where females gather water or mud for nest construction. Smith and Alcock (1980) reported mating at pools on an ephemeral stream by *Abispa ephippium* (Fabricius), and at small farm ponds by two species of *Paralastor*. Iwata (1953) observed copulation by several species of *Eumenes* along the edge of a brook.

Although many species of Eumenidae are common and important components of the insect community at flowers, their activities at these sites have not been the subject of careful study. We here present data indicating that for at least one eumenid, *Ancistrocerus antilope* (Panzer), flowers are apparently the primary site for encounters between the sexes.

Females of *A. antilope* nest in tubular cavities in wood. The female deposits an egg in the cavity and then brings in enough paralyzed caterpillars for the complete growth of one offspring. She then seals the cell with a mud partition. Oviposition, provisioning, and partitioning are then repeated until the cavity is filled with a linear series of cells. Females are opportunistic and readily accept artificial nest sites (trap-nests) consisting of wooden blocks with drilled holes (Cooper, 1953; Krombein, 1967).

MATERIALS AND METHODS

This study is based on observations of the sex ratios and mating behavior of *A. antilope* adults reared from trap nests or collected at blossoms. Unless otherwise indicated, the observations were made on or near the University of Michigan Biological Station (UMBS) in Emmet and Cheboyan cos., Michigan in 1982. The sex ratio at blossoms was estimated from samples taken with an aerial net for three hours in late morning about once a week from June 8 to September 4 along a transect that followed Reed Rd. in Emmet Co. (Waldbauer, 1983). The sex ratio of the whole population was estimated from a sample reared from trap nests. Seventy-five bundles of five trap nests each were placed on UMBS property; all were within three to five miles of the Reed Rd. transect. Each trap nest was a 19 mm × 19 mm × 150 mm block of pine with a drilled hole about 135 mm deep. Each bundle of five had one nest each with hole diameters of 4.8, 5.6, 6.4, 7.1 and 7.9 mm. Occupied nests were taken into the laboratory, opened and the larvae reared to adulthood in individual chambers made from depressions in wooden blocks covered with microscope slides. Behavior was observed at flowers in Emmet Co. in 1982 and 1983 and at trap nests from which adults were emerging in the field from 1976 to 1980 (Cowan 1979, 1981) in Washtenaw and Kalamazoo Cos., Michigan.

The data were analyzed by means of a chi square test of independence using a 2 × 2 contingency table. Yates' correction for continuity was applied.

RESULTS

Ancistrocerus antilope was scarce at blossoms in June and early July, but was abundant from late July through August (Table 1). The individuals caught in June, and perhaps those taken in early July, presumably represent the diapausing population that overwintered as prepupae from the previous summer. The individuals caught from July 28 onward presumably represent the summer generation, whose offspring will enter diapause and lie dormant until the following June. The blossoms visited and the number of *A. antilope* taken at each are as follows: *Anemone canadensis* L. (Ranunculaceae), 1; *Cornus stolonifera* Mich. (Cornaceae), 2; *Pastinaca sativa* L. (Umbelliferae), 85; *Solidago* spp. (*S. rugosa* Mill., *S. canadensis* L. and *S. gigantea* Ait.) (Compositae), 108; *Viburnum trilobum* Marsh. (Caprifoliaceae), 1; other blossoms, 4. The great majority was, of course, taken at *P. sativa* and *Solidago* spp., plants that blossom from mid- to late summer. The preference for *Solidago* spp. is marked, and may have been even more striking before *Pastinaca sativa* was introduced from Europe.

The observations made at nests from which young adults were emerging indicate that males of *A. antilope* do not frequent nesting areas in search of mates. The wasps simply emerge and disperse. Males were never seen lingering or returning

Table 1. The seasonal occurrence of *Ancistrocerus antilope* adults at blossoms in 1982 along the Reed Rd. transect in Emmet Co., Michigan.

	June				July				August				September	
	8	14	23	30	6	13	20	28	6	12	18	25	4	Total
No. males	0	0	0	1	0	0	2	22	48	57	14	26	8	178
No. females	2	1	0	0	0	1	0	0	3	0	0	2	0	9

to the nest area, as is the case with other eumenid species (Cowan, 1979, 1981; Smith and Alcock, 1980).

The behavior of male and female *A. antilope* visiting blossoms differed markedly. Females flew comparatively slowly and directly from one inflorescence to another. When they landed, they spent a few tens of seconds feeding before departing. Males, although they also fed at flowers, were much more often seen flying quickly from flower to flower, where they hovered or circled briefly before moving on. If a eumenid was on the flower, males of *A. antilope* dropped down to touch it lightly, but quickly moved on if it was not a female *A. antilope.* Males patrolling flowers sometimes encountered one another and briefly hovered or circled before going their separate ways.

The sample of *A. antilope* that emerged from trap nests during mid- to late summer of 1982 indicates that the non-diapausing generation was strongly female biased (22 males and 35 females). However, the following diapausing generation (progeny of the 1982 summer generation) was found to be male biased, as indicated by the emergence of a total of 16 males and 4 females from overwintered trap nests in spring of 1983. These sex ratios are significantly different ($x^2 = 9.98$, 1 df, $P < 0.005$). More extensive unpublished data from Kalamazoo Co., MI, also indicate a male bias in the diapausing generation. Similar male biases have been observed by other workers (Fye, 1965; Longair, 1981) and are to be expected on theoretical grounds (Seger 1983). The sample of *A. antilope* collected at blossoms was extremely male biased (178 males and 9 females) and differs significantly from the sample of non-diapausing wasps (22 males and 35 females) reared from trap nests ($\chi^2 = 90.6$, $P < 0.0005$).

On three occasions in early August of 1982 or 1983 we collected coupled male and female *A. antilope* at blossoms. Two pairs were associated with either *Solidago* sp. or *Pastinaca sativa,* but no host plant record was kept. The third pair was caught on an inflorescence of *Solidago* sp. In a fourth instance we observed the initiation of pairing. A female feeding on a *Solidago* inflorescence was discovered by a male. He immediately landed on her and began courtship. Within a few seconds, a second male discovered the pair and landed on top of the first male. A struggle ensued; the trio fell to the ground and the second male was dislodged. Then the coupled pair flew up into nearby trees.

Discussion

Despite diligent observation, we have not seen interactions between the sexes at *A. antilope* nests, either while the females were provisioning them or later when newly molted adults were emerging. If mating does occur at the nests, it is rare. Mating, therefore, can be expected to occur at some resource for the females such as nectar flowers or mud and water for building nest partitions. We have not made observations at the sources of building material, nor can we eliminate the possibility that mating occurs at a mating area (lek) that is not associated with a resource. Our observations do indicate that flowers are an important, if not the sole, mating site for *A. antilope.*

Our contention is supported by: 1) the discovery of several mating pairs on nectar blossoms, 2) the observation that males, unlike females, patrol inflorescences in an apparent search for mates, and 3) the extreme difference in sex ratio between samples taken at flowers and samples that emerged from trap nests. This difference in sex ratios apparently results from the different activities of the sexes. Females devote most of their time to nesting activities which keep them scattered in wooded areas where nest sites and prey occur. Only occasionally do they visit flowers to obtain nectar. (In forested areas patches of suitable flowers may be localized.) The males, on the other hand, presumably devote their time almost exclusively to searching for mates. Thus, they predominate in samples from flowers because, in addition to feeding, they remain at the flowers in search of females.

Although male and female *A. antilope* often meet on inflorescences, they apparently finish mating elsewhere. In the laboratory a pair may stay together for over 80 minutes and may copulate several times before separating (Cowan, unpublished; Cooper, 1955). Thus, the relative paucity of mating pairs at blossoms suggests that pairs leave the blossoms to finish mating. They may fly some distance away, as did the one pair that we watched; perhaps some hide below the foliage of the nectar plants. At any rate, it seems that they seek out a hiding place where they will not be conspicuous to predators or interloping males.

The eumenids *A. adiabatus* and *E. foraminatus* are found in the same habitats and have nesting behavior similar to *A. antilope,* but the first two species mate at emergence sites. This difference may be at least partly explained by the fact that female *A. adiabatus* and *E. foraminatus* mate with only one male (Cowan, 1981), while female *A. antilope* mate with more than one male (Cowan, unpublished). If, as is typical with other insects (Parker, 1970), the last male to mate with a female before oviposition fertilizes the majority of her eggs, then there would be little reward to a male *A. antilope* for being the first to locate a female. The eumenid with a known mating system most similar to that of *A. antilope* is *Abispa ephippium* (Smith and Alcock, 1980). In this species, males patrol stream banks rather than flowers; the paired wasps fly together into foliage where they copulate repeatedly before separating. The females are also receptive to more than one male.

Alcock et al. (1978) identified two key factors determining male reproductive behavior of wasps and bees: 1) whether females mate only once or multiply, 2) the distribution of receptive females. Although we have some information for a few species of Eumenidae, the ultimate reasons for single or multiple mating by females and the ecological determinants of individual distribution in nature remain obscure.

ACKNOWLEDGMENTS

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A NEW GENUS AND TWO NEW SPECIES OF ARMORED SCALES FROM MEXICO (HOMOPTERA: DIASPIDIDAE)

SUEO NAKAHARA

Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, Beltsville, Maryland 20705.

Abstract.—A new genus ***Selenaspidopsis***, and two new species, *S.* ***browni*** and *S.* ***mexicana***, are described from Mexico. The genus is differentiated from the other genera in the Aspidiotini with pronounced marginal constrictions of the thorax.

A new genus, *Selenaspidopsis*, and two new species, *S. browni* and *S. mexicana*, are described from material intercepted at agricultural quarantine on *Chamaedorea* sp. (Arecaceae) leaves from the states of Chiapas and Veracruz, Mexico. The two species were originally reported in the "Lists of Intercepted Plant Pests" (Plant Protection and Quarantine 1979: 342, 490; 1980: 70; 1981: 66; 1982: 87) as members of the genus *Pseudoselenaspidus* Fonseca (1962: 26), which is currently known only from the type species, *P. inermis* Fonseca, from foliage of an unknown plant collected near São Paulo, Brazil. The new genus is differentiated from other genera in the Aspidiotini with pronounced marginal constrictions of the thorax.

The holotypes are illustrated exactly as observed on the slides. Because the holotypes are not mounted precisely dorso-ventrally, some marginal morphological characters are illustrated dorsally or ventrally on the head and thorax. The correct positions of these characters are given in the descriptions. On the venter, the submedial row of minute setae extends posteriorly aligned with the posterior spiracle; the sublateral row lies between the submedial row and the submargin of abdomen. Unless specifically stated, quantitative descriptions are for one-half of the body. Numerical values are given first for the holotype followed in parentheses by values based on 10 paratypes. Numerical values for both sides of the holotypes are given when their values differ.

Abbreviations for the depositories of types: BM (British Museum [Natural History], London); CDA (California Department of Food and Agriculture, Sacramento); FSCA (Florida State Collection of Arthropods, Gainesville); HUS (Faculty of Agriculture, Hokkaido University, Sapporo); MNC (Museo de Historia Natural de la Ciudad de Mexico, Mexico City); MNH (Museum National d'Histoire du Naturelle, Paris); UCD (University of California, Davis); USNM (U.S. National Museum of Natural History, Washington, D.C.); and VPI (Virginia Polytechnic Institute and State University, Blacksburg).

Selenaspidopsis **Nakahara, NEW GENUS**

Type species: Selenaspidopsis browni Nakahara, NEW SPECIES.

Etymology.—Gender feminine; derived from combining the generic name, *Se-*

lenaspidus, with Greek suffix, *-opsis,* which means: having the appearance of *Selenaspidus.*

Generic diagnosis.—Diaspididae belonging to the Aspidiotini. Adult female body becoming strongly sclerotized with advancing age, body anterior of abdominal segment 2 more strongly sclerotized than rest of abdomen; intersegmental lines strongly indicated, abdominal segment 1 with intrasegmental line. Body longer than wide; pronounced marginal constriction between prothorax and mesothorax differentiates body into semilunar prosoma and somewhat turbinate postsoma, constriction less pronounced in young adults; anterior margin of head broadly rounded, straight or slightly concave. Antenna small tubercle with 1 long seta. Thoracic spiracles without paraspiracular pores. Venter with minute setae in submedial row, 1 each on abdominal segment 1–5 and mesad of perivulvar pores; in sublateral row, 1 each on segments 1 and 2, 1 pair each on segments 3–5 and mesad of perivulvar pores, occasionally 1 seta of pair missing on 1 or 2 segments.

Pygidium with 3 pairs of well-developed unilobular lobes, usually slightly constricted at base, lateral margin with 1 notch or entire, rounded apically; median lobes largest, often with small notch on mesal margin. Short paraphyses at mesal angle of lobes 2 and 3. Plates fringed apically, well-developed, slightly longer than lobes, 2 between median lobes, 2 between median lobe and lobe 2, 3 between lobes 2 and 3, anterior to lobe 3 in series of 5–9 broad plates becoming shorter anteriorly, terminating in series of short, spinelike processes; plates with long microducts. Dorsal macroducts mainly in 3–4 longitudinal rows, few on margin and submargin. Dorso-central reticulations absent. Perivulvar pores in 1–3 lateral groups, occasionally few present anterior to lateral pores.

Discussion.—Pronounced thoracic constrictions occur in some genera in the *Selenaspidus* complex. Mamet (1958: 362), in his review of the complex, treated the different positions of the thoracic constrictions as generic characters. The new genus is closely related to *Pseudoselenaspidus* and differs only by the position of the thoracic constriction. *Selenaspidopsis* is constricted between the mesothorax and prothorax and *Pseudoselenaspidus* is constricted between the mesothorax and metathorax. Both genera have intrasegmental line on abdominal segment 1, which is also present in some members of the *Selenaspidus* complex.

In this complex, *Entaspidiotus* and *Selenaspidus* are constricted between the mesothorax and metathorax, and *Schizentaspidus* is constricted between the mesothorax-metathorax and metathorax-abdominal segment 1. *Paraselenaspidus* is constricted between the prothorax and mesothorax but differs from *Selenaspidopsis* by having spur-like lobe 3 and lacking perivulvar pores; conversely, *Selenaspidopsis* has apically rounded lobe 3 and perivulvar pores.

Duplaspidiotus, Pseudaonidia and *Pseudotargionia* in the Pseudaonidina also have pronounced thoracic constriction between the prothorax and mesothorax. They have dorso-central reticulation on the pygidium which is lacking from *Selenaspidopsis.*

Selenaspidopsis browni **Nakahara, New Species**

Fig. 1

Slide-mounted adult female body longer than wide, 1335(745-1395) μ long; prosoma 953(558-1067) μ wide, anterior margin straight or slightly concave,

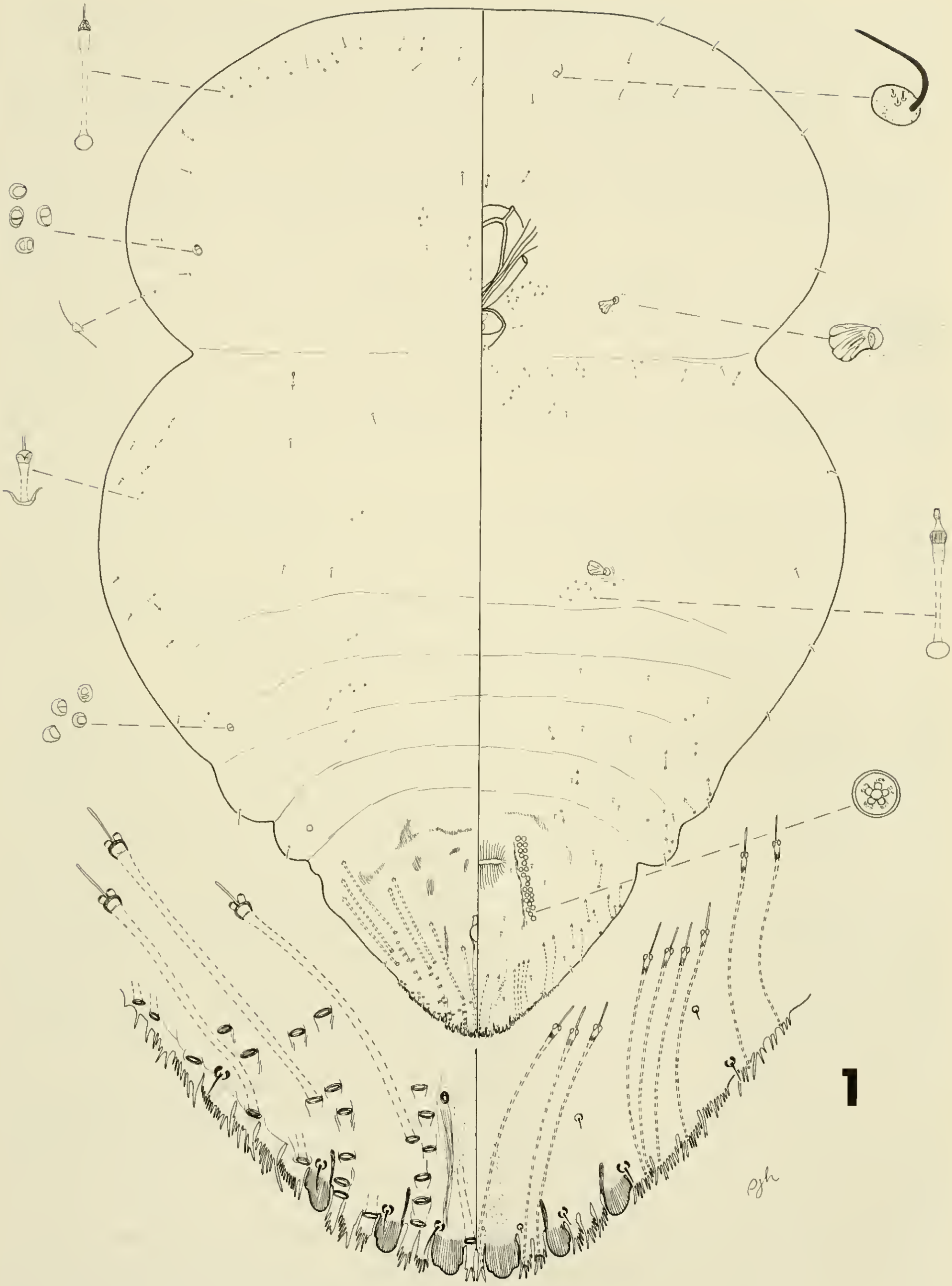

Fig. 1. *Selenaspidopsis browni,* dorsal and ventral aspects.

occasionally broadly rounded, lateral margin broadly rounded or partially straight; postsoma longer than prosoma, 972(568-999) μ wide, broadly rounded laterally. Prothorax with 1 small marginal tubercle. Submarginal, dorsal cicatrices, simple or divided, 1 each on prothorax and abdominal segment 1 often larger than 1 on segment 3. Microducts in marginal row on head with orifices not protruding or slightly protruding from derm as short, conical tubercles. Dorsal microducts few, medially over mouthparts, submedially on thorax and abdominal segments 1–3, shorter microducts submarginally on thorax and abdominal segment 1; ducts absent from abdominal segment 4, occasionally from segment 3. Ventral microducts in loose cluster laterad and anterior to mouthparts; along anterior margin of mesothorax, often more numerous in medial area; in cluster posterior of metathoracic spiracle; medially and submarginally on prepygidial abdominal segments.

Pygidium wider than long, broadly pointed apically. Median lobe wider than long or slightly longer than wide, separated by space less than its width, 1 notch on mesal and lateral margins; lobe 2 longer than wide, lateral margin with 1 notch or entire; lobe 3 longer than wide, lateral margin with 1 notch, axis of lobe slightly converging. Median lobe with basal sclerosis, longer than lobe; lobes 2 and 3 each with short paraphysis at mesal angle. Two plates between median lobes often bifurcate, occasionally simple; other plates fringed apically, 2 plates between median and lobe 2, 3 plates between lobes 2–3, 5–6 broad plates and few short, spinelike processes anterior to lobe 3. Dorsal and marginal macroducts 34–39(19–50) on each side: Dorsal macroducts mainly in 3–4 longitudinal rows, anterior ducts not distinctly longer than ducts nearer margin; between median lobe and lobe 2, 6(4–7) ducts in short, single or double row; between lobes 2 and 3, 10–13(4–13) ducts in irregular, diverging row; anterior to lobe 3, 8(4–13) ducts in irregular diverging row usually extending anteriorly to level of anal orifice or slightly more anteriorly, laterad a shorter row of 3–5(3–7) ducts or with 1–3 submarginal ducts; occasionally 1 submarginal duct on segment 4. Marginal macroducts 1 between median lobes; 1 duct between median lobe and lobe 2; 2 ducts between lobes 2 and 3; 4 ducts, occasionally 3 or 5, anterior to lobe 3; rarely 1 duct on segment 4. Microducts absent from dorsum, few submarginally on venter, long microducts arising from plates not seen between lobes 2 and 3 on holotype, present on paratypes. Anal orifice oval or elongate oval, positioned between center and apical one-third of pygidium. Vulva positioned in about basal one-third of pygidium; dermal striations posterior of vulva aligned longitudinally. Perivulvar pores 25–26(16–28) in 1–3 elongate lateral groups, 1–3 pores wide; rarely few pores anterior to lateral pores or supernumerary pores posterior to lateral pores. Dorsal scleroses short; 3 near base of pygidium, medial and submarginal scleroses transverse, submedial widened longitudinally; 3 short submedial scleroses posterior to basal scleroses; 1 transverse and 1 longitudinal scleroses aligned medially. Venter with 2 short, basal transverse scleroses; 1 elongate sclerosis extending anteriorly from submargin near base of lobe 2 to another slender sclerosis bordering lateral perivulvar pores.

Type material examined.—Adult female holotype (USNM type number 100417): MEXICO, Papantla, Veracruz, *Chamaedorea* leaf, 26-III-74, in quarantine at Laredo, D. A. Gutierrez, (Laredo 7211). Adult female paratypes 25(24 slides) intercepted at quarantine on *Chamaedorea* leaves at Laredo and San Antonio, Texas and Miami, Florida; MEXICO: 6-V-72, L. Beikman (San Antonio 3677); 2-VIII-72, J. A. Palmer (Laredo 4133); 6-IX-72, C. Parker (San Antonio 4343); 9-X-72, D. J. Provencher (Laredo 4510); 1-XI-72, A. V. Garrett (Laredo 4610); 5-III-73, C. Parker (San Antonio 5037); 6-III-73, C. Parker (San Antonio 5050); 11-IV-73, D. Johnston (San Antonio 5506); 3-VII-73, D. Johnston (San Antonio 5677); 5-VII-73, D. Johnston (San Antonio 6156); 2-IV-74, D. Johnston (San

Antonio 6793); 8-X-74, D. Johnston (San Antonio 7905); 17-X-74, R. Gaspari (San Antonio 7599); 12-I-75, D. Johnston (San Antonio 7993); 19-III-75, D. Johnston (San Antonio 8313); 27-V-75, D. Johnston (San Antonio 8669); 17-VI-75, D. Johnston (San Antonio 8791); 13-V-76, R. L. Haymond (Miami 13361); Arriaga, Chiapas, 19-XI-74, T. E. Johnson (Laredo 8546); Arriaga, Chiapas, 3-III-75, A. B. Garcia (Laredo 8545); Papantla, Veracruz, 26-XII-73, A. V. Garrett (Laredo 6581); Santiago Tuxtla, Veracruz, 21-V-73, T. E. Johnson (Laredo 5639). Depositories of paratypes: BM 2, CDA 1, HUS 1, FSCA 1, MNC 2, MNH 1, UCD 1, USNM 15, VPI 1.

Discussion.—The species differs from *S. mexicana* by having 19–50 macroducts on each side mostly in single, irregular, dorsal rows, row anterior to lobe 3 extending anteriorly to about level of anal orifice, and submarginal macroducts absent from segment 4 or rarely 1 present; whereas, *S. mexicana* has 77-116 macroducts on each side, row anterior to lobe 3 extends anteriorly to basal, submarginal sclerosis and terminates in a cluster, and submarginal macroducts present on segment 4.

Etymology.—This species is named in honor of my dear friend, William J. N. Brown of Bellevue, Washington, in recognition of his contributions to the protection of U.S. agriculture from foreign plant pests as a former plant pathologist with the Plant Quarantine Division in Seattle.

Selenaspidopsis mexicana **Nakahara, NEW SPECIES**

Fig. 2

Slide-mounted adult female body longer than wide, 976(1158–1725) μ long; prosoma 703(840–1249) μ wide, semilunar, anterior margin broadly rounded, occasionally partially straight, lateral margin rounded; postsoma longer than prosoma, 745(863–1271) μ wide, usually slightly wider than prosoma, broadly rounded laterally. Small dermal tubercle marginally on prothorax. Submarginal cicatrices one each on prothorax and abdominal segment 1 larger than 1 on segment 3. Dorsal microducts few submedially on thorax and abdominal segments 1–3 or 4; shorter microducts submarginally on metathorax and abdominal segment 1. Marginal microducts with orifices protruding from derm as short, conical tubercles on head, thorax and abdominal segments 1–4. Ventral microducts few; laterad and anterior of mouthparts, submarginally along anterior margin of mesothorax, just posterior of posterior thoracic spiracle, submedially and submarginally on prepygidial abdominal segments.

Pygidium wider than long, rounded apically. Median lobes as wide as long, or slightly longer than wide, separated by space less than its width, 1 notch on lateral margin, mesal margin with 1 smaller notch or entire; lobe 2 longer than wide, lateral margin with 1 notch or entire; lobe 3 longer than wide or about as long as wide, lateral margin with 1 notch, axis of lobe slightly converging. Median lobe with basal sclerosis longer than lobe; lobes 2 and 3 each with short paraphysis at mesal angle. Two plates between median lobes usually bifurcate; other plates apically fringed, slightly longer than lobes; 2 plates between median lobe and lobe 2, 3 plates between lobes 2–3, 7–9 broad plates and few short, spinelike processes anterior to lobe 3. Dorsal and marginal macroducts 85–89(77–116) on each side: Dorsal macroducts mainly in 4 longitudinal rows, anterior ducts shorter than those toward margin; between median lobe and lobe 2, 8(7–10) ducts in short, irregular double rows; between lobes 2–3, 15–19(18–25) ducts in single or double

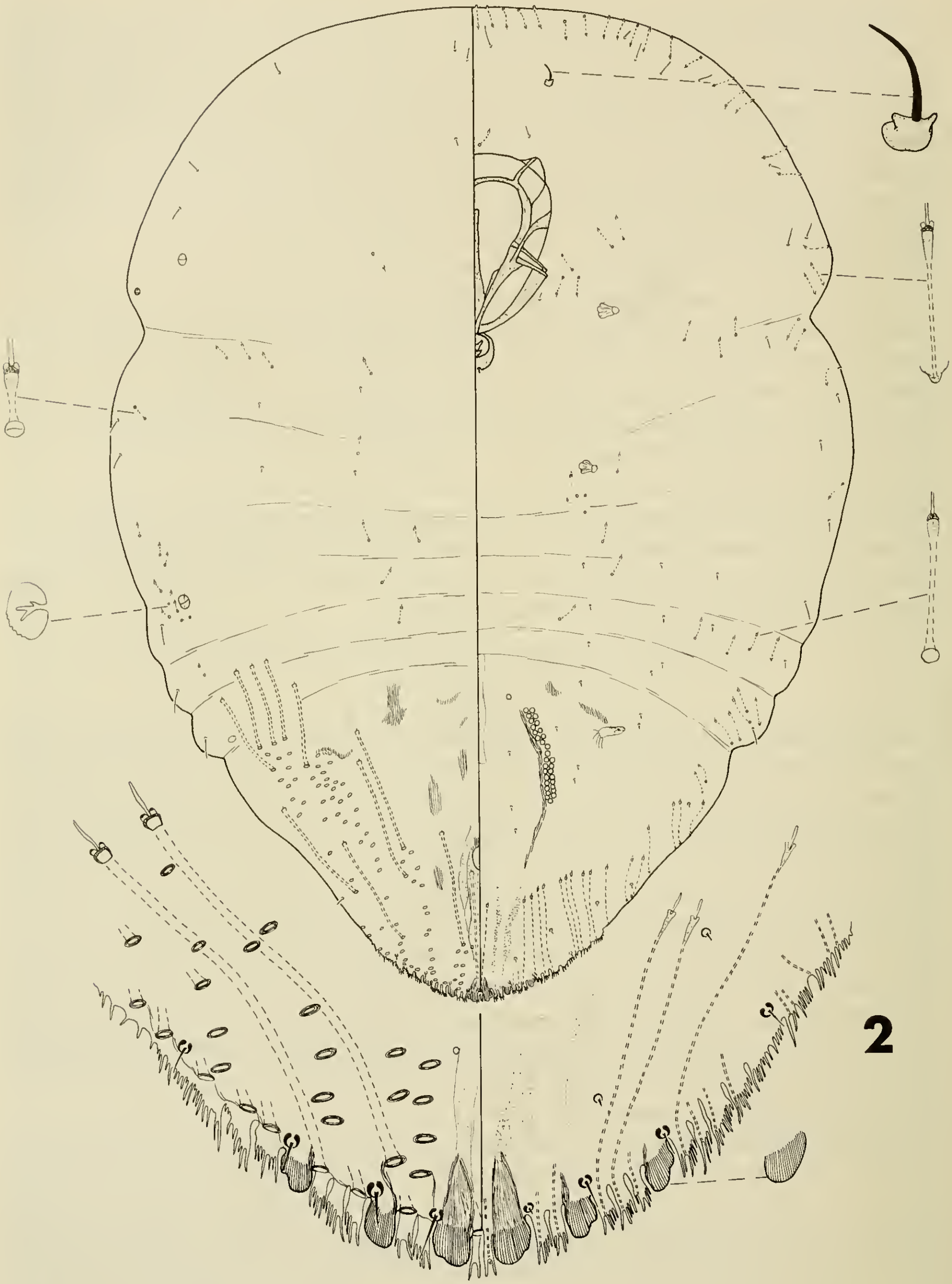

Fig. 2. *Selenaspidopsis mexicana*, dorsal and ventral aspects.

irregular row, usually in double row anteriorly; on fifth segment, 33(30–40) ducts in single or double irregular row extending anteriorly to basal, submarginal sclerosis, terminating in cluster; laterad, 20(14–30) ducts in single irregular row extending anteriorly to submargin of segment 4, terminating in submarginal cluster; occasionally 1 submarginal duct on segment 3. Marginal macroducts 1 between median lobes, 1 between median lobe and lobe 2, 2 between lobes 2–3, 6(5–7) anterior to lobe 3. Microducts absent from dorsum; 3–4 short ventral ducts submarginally on fifth segment, long microducts arising from plates. Anal orifice oval, positioned between center and apical one-third of pygidium. Vulva positioned about basal one-third of pygidium between lateral perivulvar pore groups. Perivulvar pores 22–23(16–28) usually in elongate lateral group, 1–3 pores wide, occasionally in 2 groups separated by diameter of a pore; 1 or 2 pores occasionally anterior to lateral groups. Dorsal scleroses short; basal scleroses 3, medial transverse, submedial longitudinal, submarginal sigmoid; 2–3 submedial scleroses aligned posterior to basal scleroses; 1 transverse and 1 longitudinal scleroses aligned medially. Venter with 2 short, basal transverse scleroses; 1 elongate slender sclerosis extending anteriorly from submargin near base of lobe 2 to another slender sclerosis bordering lateral perivulvar pores.

Type material.—Adult female holotype (USNM type number 100418); MEXICO, Santiago Tuxtla, Veracruz, *Chamaedorea* leaf, 25-I-73, in quarantine at Laredo, A. V. Garrett (Laredo 5020). Paratypes 11 adult females on 11 slides, intercepted in quarantine on *Chamaedorea* leaves at Laredo and San Antonio, Texas. MEXICO: 20-IV-71, L. Beikman (San Antonio 1952); 5-I-72, C. Parker (San Antonio 3087); 16-V-72, D. W. Duewall (Laredo 3761); 18-II-74, D. J. Provencher (Laredo 6948); 2-IV-74, D. Johnston (Laredo 6793); Papantla, Veracruz, 5-I-74, A. V. Garrett (Laredo 6238); 14-I-74, D. J. Provencher (Laredo 6852); 18-II-74, D. J. Provencher (Laredo 6948, 6960); Santiago Tuxtla, Veracruz, 6-III-63, A. V. Garrett (Laredo 5238); 25-I-73, A. V. Garrett (Laredo 5019); Veracruz 27-III-74, C. R. Guettler (Laredo 7287). Depositories of paratypes: BM 1, CDA 1, FSCA 1, MNC 1, USMN 7.

Discussion.—The differences between *S. mexicana* and *S. browni* are discussed under *S. browni.*

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NEW *NOTIPHILA* (DIPTERA: EPHYDRIDAE) FROM THE OKEFENOKEE SWAMP, GEORGIA[1]

Alexander D. Huryn

Department of Entomology, University of Georgia, Athens, Georgia 30602.

Abstract.—Two previously unknown species of *Notiphila* (*Notiphila*) Fallén, *Notiphila* ***mathisi*** n. sp. and *Notiphila* ***theonae*** n. sp., are described from the Okefenokee Swamp, Georgia.

Recent collecting in the Okefenokee Swamp (Charlton County, Georgia) has resulted in the discovery of two undescribed species of *Notiphila* (*Notiphila*) Fallén, *Notiphila mathis* n. sp. and *Notiphila theonae* n. sp. Both species are members of the *adjusta* group as defined by Mathis (1979: 19). The site of collection was an emergent-macrophyte prairie located about 6 km west of Billy's Island. Specimens were captured as they rested upon the foliage of *Nuphar luteum macrophyllum* (Small) Beal.

In the descriptions below, numerical characters follow Mathis (1979: 6–10) and are based upon male specimens. Unless otherwise noted, other character states utilized in the species diagnoses are based upon examinations of both male and female specimens.

Notiphila (*Notiphila*) *mathisi*, New Species

Figs. 1–2, 5

Moderately small shore flies, length 2.93–3.12 mm (N = 4); ground color blue-gray, lightly dusted with brown dorsally; extreme dorsolateral margins of mesonotum bordered by a pair of distinct dark brown stripes.

Head: Eye ratio of 1:0.63–1:0.70; eye-to-cheek ratio 1:0.21–1:0.27; postfrons ratio 1:1.14–1:11.42; prefrons ratio 1:0.68–1:0.87. Median triangular area and lateral margins of frons gray, generally concolorous; median area of frons with greenish pollinosity. Paravertical bristles medium in size, noticeably more robust than the postocellar setae. One pair of fine proclinate, fronto-orbital setae present. First and second antennal segments brown, third segment orange proximally becoming brown distally; arista with 10–12 dorsal branches. Face lightly pruniose, yellow near antennae bases becoming silver toward oral margin; facial setae fine, 3–4; genae gray; genal bristle stronger than paravertical bristle; maxillary palps orange.

Thorax: Mesonotum light brown, lateral margins with distinct dark brown stripes extending posteriad from an area anterior of the presutural bristle, across

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[1] This research was supported by NSF grant BSR 8114823. Okefenokee ecosystem publication #44.

the extreme dorsal region of the notopleuron, terminating near the base of the supra-alar bristle. Pleural regions generally blue-gray; anapisternum with a transverse, irregularly ovoid, dark brown region situated dorso-centrally on pleurite. Lateral margins of scutellum nearly black with pigmentation extending anteriad onto the mesonotum to form short stripes which terminate near the bases of the intra-alar bristles. Femora light gray, yellow apically; tibia and tarsi yellow; setal fascicle of hind basitarsus yellow; mesothoracic tibia with 3 dorsal extensor bristles; mesothoracic femora and tibia of males with comblike row of setae along postero-ventral margins.

Abdomen: Abdominal ratio 1:0.64–1:0.78; tergum V/IV ratio 1:1.11–1:1.57; tergum V ratio 1:0.37–1:0.45. Ground color blue-gray with dark brown, geminate, triangulate fascia on segments III–V (Fig. 2). Male genitalia: Ventral epandrial processes narrow, forming lateral boundaries of an extensive, truncate emargination (Fig. 5); basiphallus heavily sclerotized, recurved, narrowing apically (Fig. 1, AED); hypandrial process considerably longer than wide with apical ½ covered with short, fine, spinules (Fig. 1, HYP PR); hypandrial receptacle reduced to 2 elongate, sclerotized strips (Fig. 1, HYP REC).

Type material.—Holotype ♂: Georgia, Charlton County, Okefenokee Swamp, 6 km W of Billy's Island, 26 September 1982, ADH, deposited in the United States National Museum; Paratypes, 3 ♂, 10 ♀, same data as Holotype, deposited in USNM (2 ♂, 9 ♀) and University of Georgia (1 ♂, 1 ♀).

Etymology.—The genitive *mathisi* is given in honor of Wayne N. Mathis in recognition of his outstanding (1979) revision of the North American *Notiphila.*

Remarks.—In the key to the North American species of *Notiphila* (*Notiphila*) given in Mathis (1979: 17–19), *N. mathisi* will key to couplet 6 which includes *N. taenia* Mathis and *N. bella* Loew. Although closely resembling these species externally, *N. mathisi* can be easily distinguished by its distinctive basiphallus and epandrium.

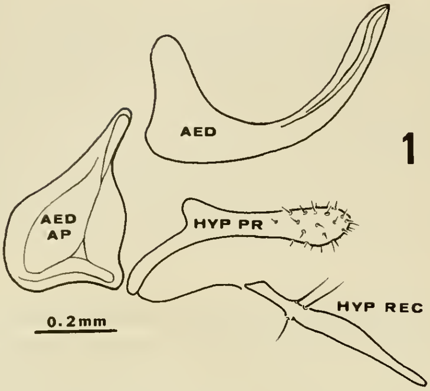
***Notiphila* (*Notiphila*) *theonae*, New Species**

Figs. 3–4, 6

Medium-sized shore flies, length 3.12–3.25 mm (N = 2); ground color blue-gray lightly dusted with brown dorsally; thorax immaculate.

Head: Eye ratio 1:0.71–1:0.75; eye-to-cheek ratio 1:0.20–1:0.24; postfrons ratio 1:1.15; prefrons ratio 1:0.50–1:0.52. Median triangular area light gray, contrasting with the dark brown lateral margins of frons; median area of frons concolorous with the preceding. Paravertical bristles fine, equal to the postocellar setae. One pair of fine proclinate, fronto-orbital setae present. First and second antennal segments brown, third segment orange proximally, becoming light brown distally; arista with 5–8 dorsal branches. Face lightly pruniose, silver; facial setae fine, 4; genae gray, genal bristle moderate in size, about 2× the length of the paravertical bristle; maxillary palps pale yellow.

Thorax: Mesonotum, immaculate with light brown pollinosity. Pleural sclerites, immaculate, blue-gray. Scutellum with lateral margins appearing dark brown when viewed from a postero-oblique angle. Femora light gray, yellow apically; tibia and tarsi yellow; setal fascicle of hind basitarsus yellow; mesothoracic tibia with 3 dorsal extensor bristles; mesothoracic femora and tibia of males with comblike row of setae along postero-ventral margins.



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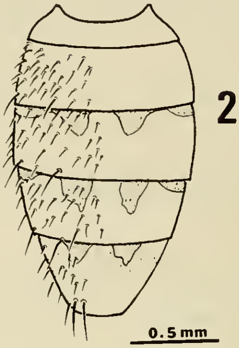

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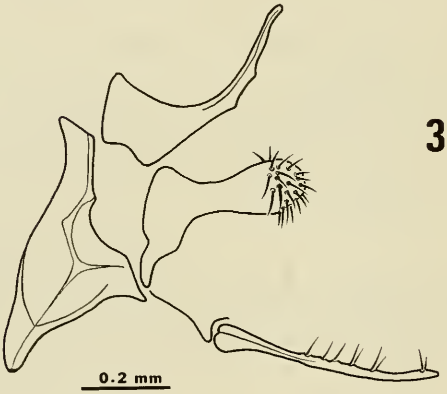

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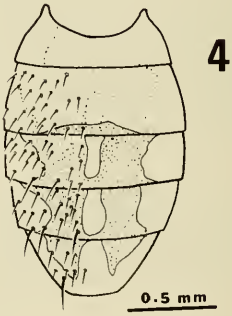

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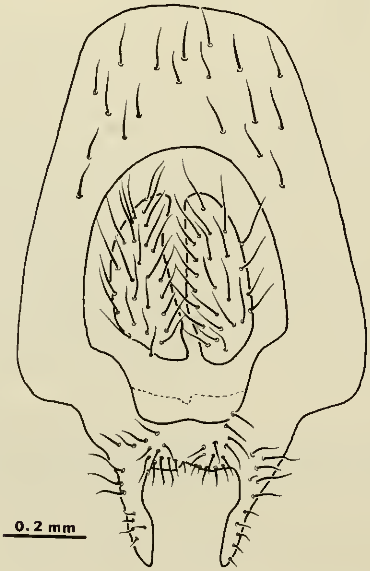

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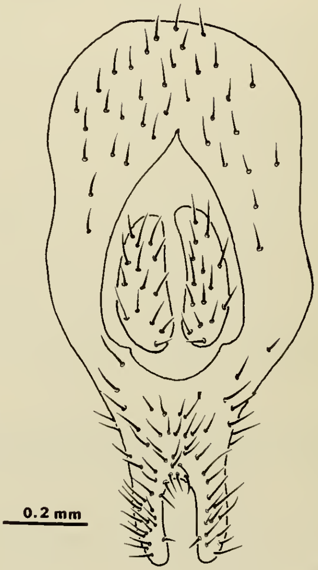

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Abdomen: Abdominal ratio 1:0.63–1:0.66; tergum V/IV ratio 1:1.10; tergum V ratio 1:0.48–1:0.50. Ground color blue-gray with brown, parallel, continuous fascia extending from the posterior margin of segment II to segment V (Fig. 4). Male genitalia: Ventral epandrial processes forming lateral boundaries of a narrow U-shaped emargination (Fig. 6); basiphallus heavily sclerotized, strongly recurved, becoming markedly narrow apically (Fig. 3); hypandrium triangular in lateral view, bearing 2 stout setae at apex; hypandrial process longer than wide with apical ⅓ covered with relatively long, stout, spines (Fig. 3); hypandrial receptacle reduced to 2 elongate, sclerotized strips (Fig. 3).

Type material.—Holotype ♂: Georgia, Charlton County, Okefenokee Swamp, 6 km W of Billy's Island, ADH, deposited in the United States National Museum; Paratypes, 1 male, 6 females, same data as Holotype, deposited in USNM (5 females) and University of Georgia (1 ♂, 1 ♀).

Etymology.—The genitive *theonae* is given in memory of Theona S. C. Huryn; one who enthusiastically supported my early interests in entomology.

Remarks.—The setation of the hypandrial process and the structure of the basiphallus renders *N. theonae* distinct from all other members of the subgenus *Notiphila.* In the key to the North American species of *Notiphila* (*Notiphila*) provided by Mathis (1979: 17–19), *N. mathisi* will key to couplet 6 where it can be readily distinguished from *N. taenia* and *N. bella* by the lack of thoracic stripes.

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Figs. 1–6. 1, *Notiphila mathisi* n. sp., internal male genitalia, lateral (AED = aedeagus, AED AP = aedeagal apodeme, HYP PR = hypandrial process, HYP REC = hypandrial receptacle). 2, *N. mathisi,* male abdomen, dorsal. 3, *N. theonae* n. sp., internal male genitalia, lateral. 4, *N. theonae,* male abdomen, dorsal. 5, *N. mathisi,* epandrium, cerci and epandrial processes. 6, *N. theonae,* epandrium, cerci and epandrial processes.

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86(4), 1984, pp. 946–950

TAXONOMIC AND NOMENCLATORIAL NOTES ON CARIBBEAN *TROPICUS* PACHECO (COLEOPTERA: HETEROCERIDAE)

Michael A. Ivie and James B. Stribling

Department of Entomology, The Ohio State University, Columbus, Ohio 43210.

Abstract.—The West Indian species, *Heterocerus lituratus* Kiesenwetter, *H. pumilio* Kiesenwetter, and *H. bilineatus* Chevrolat are transferred from "validez incierta" to the genus *Tropicus* Pacheco. *H. bilineatus* and *H. lituratus* are considered valid species, with *H. pumilio* and *Tropicus cithara* Pacheco placed as junior synonyms of *T. lituratus. Tropicus* ***ladonnae*** new species is described from Trinidad. These species are diagnosed, integrated with Pacheco's keys, and a discussion of distribution and taxonomic history given. Male genitalia and mandibles of *T. bilineatus* and *T. ladonnae* are illustrated.

The genus *Tropicus* was erected for 13 species from temperate and tropical America by Pacheco in his revision of the Heteroceridae of the Americas (1964). In that same paper, 15 species of American *Heterocerus* were placed "validez incierta" due to inadequate descriptions and unavailable types. Types of 2 West Indian Kiesenwetter species so placed have been examined through the courtesy of Dr. M. Uhlig of the Humboldt Museum, and found to belong to *Tropicus*. Material provided by Dr. P. Spangler of the U.S. National Museum has allowed us to place one of Chevrolat's Cuban species in this genus. We also take this opportunity to describe a new species of *Tropicus* from Trinidad.

Material from this study is deposited in the following collections: American Museum of Natural History, New York (AMNH); British Museum (Natural History), London (BMNH); Centro de Investigaciones Agricolas del Noroeste, Ciudad Obregón (CIAN); California Academy of Sciences, San Francisco (CASC); Canadian National Collection of Insects, Ottawa (CNCI); College of the Virgin Islands, Cooperative Extension Service, St. Croix (CVIX); Field Museum of Natural History, Chicago (FMNH); Institute Royal des Sciences Naturelles de Belgique, Bruxelles (ISNB); Instituto de Zoología, Academia de Ciencas de Cuba, La Habana (IZAC); J. B. Stribling, Columbus (JBSC); M. A. Ivie, Columbus (MAIC); Museum of Comparative Zoology, Cambridge (MCZC); Muséum National d'Histoire Naturelle, Paris (MNHP); National Museum of Natural History, Washington (NMNH); Department of Entomology, Ohio State University, Columbus (OSUC); Richard S. Miller, Columbus (RSMC); Stovall Museum, University of Oklahoma, Norman (SMSH); Department of Entomology, University of California, Davis (UCDC); University of the West Indies, St. Augustine, Trinidad (UWIT); Zoological Institute, Academy of Sciences, Leningrad (ZILC); Zoologisches Museum, Humboldt-Universität, Berlin (ZMHB); Zoologisck Museum, Universitets, København (ZMUK); Museu de Zoologia, Universidade de São Paulo, São Paulo (ZUSP).

The following species are placed in *Tropicus,* as defined by Pacheco (1964). They share with *Tropicus* characters of the male mandible and aedeagus, as well as the maculation of the elytra and the 9-segmented antennae.

Tropicus lituratus **(Kiesenwetter) NEW COMBINATION**

Heterocerus lituratus Kiesenwetter 1843: 221, t. 3, f. 17; Zaitzev 1910: 59; Leng and Mutchler 1914: 424; Blackwelder 1944: 270.

Heterocerus pumilio Kiesenwetter 1851: 296; Zaitzev 1910: 61; Leng and Mutchler 1914: 424; Blackwelder 1944: 270. NEW SYNONYMY.

Tropicus cithara Pacheco 1964: 109, figs. 376–385, 500. NEW SYNONYMY.

Type localities.—Of *H. lituratus,* St. Thomas (holotype in ZMHB).

Of *H. pumilio,* St. Thomas, here corrected to St. John (see below) (syntypes in ZMHB).

Of *T. cithara,* St. Croix (holotype in NMNH).

Distribution.—Puerto Rico, St. Thomas, St. John, St. Croix, Dominica, Venezuela? [The source of Zaitzev's (1910: 59) citation of this species from Venezuela is unknown to us, and needs substantiation.]

Remarks.—The holotype of *H. lituratus* in the ZMHB is labeled as follows: "male symbol; TYPE [on pink paper]; Hist. coll. Nr./ 9642; lituratus Kiesen./ det. Mamitza; Zool. Mus./ Berlin." The genitalia and abdomen are in a glycerin vial on the pin. It stands fourth in a series behind a lead label "lituratus/ Mor. Kies.*/ St. Jean/ St. Thom. Mor." Although the "TYPE" label was certainly added by a later worker, perhaps Mamitza, Kiesenwetter cited "eine Exemplar" (an example) in his description. The earlier worker may have had an indication, not now obvious, that the labeled specimen was indeed the holotype, and we recognize this specimen as such.

In his description of *H. pumilio,* Kiesenwetter cited two specimens labeled "nanus" by Moritz in the Berlin Museum. A series of 2 females was received from the Humboldt Museum bearing the label "(nanus)/ Moritz/ nomen mutablum/ St. Jean Moritz." No other specimens were found. It seems that the St. Thomas in Kiesenwetter's description was a mistake for St. John, since the names look similar at a glance in the formal script in which the labels were written. Thus the type locality of *H. pumilio* is corrected to St. John. Though the syntypes are females, the synonymy of *pumilio* with *lituratus* is reasonably certain since the species of West Indian *Tropicus* can be distinguished by color pattern. The *H. pumilio* types are typical of *lituratus* in color pattern. Although we consider these specimens the true syntypes, we will not designate a lectotype at this time, leaving this for a revisor in case Thomian specimens are eventually found.

Pacheco's *T. cithara* was described from a single specimen from St. Croix in the NMNH. The genitalia and prostheca of the holotype and a topotypic specimen (MAIC) were compared by Dr. J. M. Kingsolver and found to be conspecific. This specimen was then compared to the holotype of *H. lituratus,* and their synonymy confirmed.

To Pacheco's description (based on a unique male) we would like to add the following notes on variation: the development of the dorsal projection of the mandible is variable in size and to a lesser degree, shape. It is always acute at the tip, but can be quite small. The females agree with the male in size and color pattern, differing mainly in the smaller mandible that lacks the dorsal projection.

Material examined (in addition to the type series from St. Thomas, St. John, and St. Croix).—Puerto Rico: 1 ♂—Moritz (ZMHB). St. Croix: 1 ♂—H. A. Beatty (MCZC). 43 (17 ♀, 26 ♂—Golden Grove, various dates from 21 Jan 1980 to 21 May 1981, at U.V. light, D. F. Keaveny colr., 1 ♂ Upper Love, 20 Jan 1980, at U.V. light, D. F. Keaveny (CVIX, 2 ♂, 1 ♀; JBSC, 2 ♂, 2 ♀; MAIC, 12 ♂, 9 ♀; MZHB, 1 ♂, 1 ♀; NMNH, 2 ♂, 1 ♀; OSUC, 2 ♂, 1 ♀; RSMC, 2 ♂, 1 ♀; UCDC, 2 ♂, 1 ♀). Dominica: 2 ♂—W. Cabrit, 3 Mar 1964, D. F. Bray, at light (NMNH).

Tropicus bilineatus **(Chevrolat) NEW COMBINATION**

Figs. 1–3

Heterocerus bilineatus Chevrolat 1864:407. Zaitzev 1910:55. Leng and Mutchler 1914: 424. Blackwelder 1944: 270.

Diagnosis.—Body, antennae, and legs yellowish, pronotum with a brown longitudinal median stripe, broadened apically and basally; scutellum brown; elytra with suture narrowly brown and usually with a cuniform brown macula on disk, extending from base for ⅔ length. Aedeagus as in Figs. 1 and 2. Male mandible and prostheca as in Fig. 3. The female mandible lacks a dorsal projection. Length 2.5–3.0 mm, width 0.9–1.0 mm.

Type locality.—Cuba, type in Gundlach collection, Habana.

Distribution.—Cuba.

Remarks.—Although we have not seen Chevrolat's type, the topotypic specimens at hand fit his description, and the color pattern is quite distinctive.

The width of the pronotal stripe is variable, ranging from indistinct to ⅕ width of the pronotum. The size of the dorsal process of the male mandible is also variable. In some specimens the elytral macula is virtually absent. These light-colored specimens may be slightly teneral.

T. bilineatus will key to *T. insidiosus* in Pacheco's key (1964: 104). It may be distinguished from *T. insidiosus* by the color pattern and the shape of the aedeagus.

Material examined.—Cuba: 8 ♂, 8 ♀—Pinar de Rio, Soroa, 28 April 1983, P. J. Spangler, blacklight; 1 ♂—ibid, 27–29 April 1983, P. J. Spangler and I. Fernandez-G. (6 Habana, 6 NMNH, 3 MAIC, 2 JBSC).

Tropicus ladonnae **Ivie and Stribling, NEW SPECIES**

Figs. 4–6

Male.—Length 2.0–2.5 mm, width at humeral angles 0.8–1.0 mm. Mandible varying from short to long, with a dorsal projection of variable size, major male as in Fig. 6; prostheca as in Fig. 6. Head and pronotum dark reddish-brown; pronotum finely granulate. Elytron yellowish to clear brown, suture very narrowly dark; a broad dark macula starting at suture behind scutellum and surrounding disk rejoining suture behind, often extending along suture to apex; covered with regularly-spaced setae. Ninth abdominal sternite evenly sclerotized throughout, posterior arms widened and scoop-shaped, anterior arm curved and without sclerotized apodeme. Aedeagus as in Figs. 4 and 5.

Female.—Differs from male in having smaller mandibles which lack a dorsal projection.

Types.—HOLOTYPE ♂ (in USNM). Trinidad, West Indies; Espagnole River

Figs. 1–6. 1–3, *Tropicus bilineatus* Chevrolat. 4–6, *Tropicus ladonnae* Ivie and Stribling. 1, 4, Aedeagus (dorsal). 2, 5, Aedeagus (lateral). 3, 6, Male mandible and prostheca.

and Princess Margaret Highway; 07 January 1979; M. A. & L. L. Ivie, colrs. 900 PARATYPES (same data as holotype) in AMNH, BMNH, CIAN, CASC, CNCI, FMNH, ISNB, JBSC, MAIC, MCZC, MNHP, NMNH, OSUC, RSMC, SMNH, UCDC, UWIT, ZILC, ZMHB, ZMUK, ZUSP.

Derivation of specific name.—After LaDonna Lynn Clark-Ivie for her efforts in collecting the type-series as well as her many other contributions to the senior author's entomological activities.

Remarks.—*T. ladonnae* will key to *T. insidiosus* in Pacheco's key (1964: 104). The new species can be distinguished from *T. insidiosus* by the trilobed apex of the aedeagus (Fig. 4) as well as the strong dorsal projection of the aedeagus (as seen from lateral view) (Fig. 5).

ACKNOWLEDGMENTS

We would like to thank Mr. Daniel Keaveny of the California Department of Food and Agriculture, for the donation of some of the material used in this study;

Drs. Alfred F. Newton (MCZC), Paul J. Spangler (NMNH), and Manfred Uhlig (ZMHB) for the loan of material from their respective museums; and Dr. John Kingsolver, Systematic Entomology Laboratory, USDA, Washington, who compared specimens with Pacheco's holotype of *T. cithara.* We also thank Charles A. Triplehorn and Francisco Pacheco for reviewing this manuscript and for rendering several helpful comments for the final draft. Adam Rubinstein executed the illustrations.

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86(4), 1984, pp. 951–960

A REVISION OF THE GENUS *ALEPTINA* (LEPIDOPTERA: NOCTUIDAE)

E. L. Todd, A. Blanchard, and R. W. Poole

(ELT, RWP) Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % United States National Museum, NHB 168, Washington, D.C. 20560 (E. L. Todd, retired); (AB) 3023 Underwood, Houston, Texas, 77025.

Abstract.—The North American noctuid genus *Aleptina* is revised and a key to species provided. The adults, male, and female genitalia are illustrated. One new species, *Aleptina* ***junctimacula***, is described. The five species occur in southwestern United States and in northern and central Mexico.

The genus *Aleptina* is a small group of five species from the desert regions of southwestern United States and northern and central Mexico. The genus is currently placed in the Acontiinae in the tribe Eustrotiini. This placement is not correct because in *Aleptina* the hood of the tympanic region is well developed. In the Eustrotiini the hood is typically greatly reduced or entirely absent. It cannot be placed in the tribe Acontiini either. In addition to the presence of the hood (absent in the Acontiini), the alula is not large and sclerotized, veins M_3 and Cu_1 of the hindwing are not stalked, and the hair pencil of the last abdominal sternite is brush-shaped, not as two eversible hair pencils as found in the Acontiini. For the moment its exact placement must remain uncertain. Some diagnostic characters are: 1) the front is strongly produced into a shelf-like process or swollen, 2) the base of the uncus is modified into a large, balloon-shaped structure, 3) the hindwing venation is unambiguously quadrifid, 4) an accessory cell is present in the forewing, 5) the eyes are neither hairy nor lashed, 6) the tibiae are unspined and without claws, 7) the juxta is usually (but not always) produced into a long, thin spine, 8) the valves of the male genitalia are membranous with a long, sharp, pointed clasper, and 9) the outward side of the uncus is armed with spines.

Aleptina **Dyar**

Aleptina Dyar, 1902, Can. Entomol. 34: 105. Type-species: *Aleptina inca* Dyar, 1902, Can. Entomol. 34: 105, by monotypy.

Paracretonia Dyar, 1912, Proc. Entomol. Soc. Wash. 14: 167. Type-species: *Paracretonia xithon* Dyar, 1912, Proc. Entomol. Soc. Wash. 14: 167, by monotypy.

Adult.—*Head:* Front produced into a large shelf in type species, but merely swollen in others, front covered with scales, descending as a flattened tuft from apex of head between antennal bases; antennae simple, minutely hairy, covered with scales dorsally; eyes naked, not lashed; palpi with first segment with large white scales on outer side, third segment not at an angle with second; proboscis not reduced. *Thorax:* Covered with scales; no noticeable tufts except for weak tuft at posterior end of thorax. Wing venation: Forewing venation typical of trifid noctuids, accessory cell present; hindwing with Cu_1 and M_3 not stalked, M_2 present. *Legs:* No significant tufts or hair pencils; prothoracic tibia without claw; tarsal spines of first four tarsal segments arranged in three rows; spines of fifth segment irregular in no set pattern; tarsal claw toothed; mesothoracic tibia with one pair of spurs, metathoracic tibia with two. *External tympanic area:* Alula neither reduced nor enlarged, not greatly sclerotized; anterior edge of first abdominal tergite membranous, lobed; hood moderate to large, separated by a depression from a small bulla in intersegmental membrane toward rear margin of the first abdominal tergite; tympanal groove not extended into second abdominal tergite. *Internal tympanic structure:* Not examined. *Abdomen:* First abdominal tergite with a small tuft; abdomen covered with scales; last tergite of male with U-shaped sclerotization with lateral projections present; hair pencil of tergite a brush and non-eversible; sclerotization of last sternite weak, generally consisting of two distal round flat areas and a proximal diamond-shaped area projecting proximally into a rounded knob. *Male genitalia:* Uncus with spines on outer edge of apex; bases of uncus swollen into two slightly membranous balloons; juxta either produced into a long spine or not; valve various but always with a long, point clasper; aedeagus with apex usually produced into a point; vesica with two groups of spines, one at the base and a second on a rounded lobe distal to that; vesica continued as a slightly spinose tail. *Female genitalia:* Ovipositor lobes unmodified; ostium produced into a variety of spine-like processes depending on the species; ducutus bursae long, not strongly sclerotized; corpus bursae single lobed, slightly spiculate, ductus seminalis arising from top of bursa.

Key to Species of *Aleptina*

1. Front produced into a large shelf-like prominence .... *inca* Dyar
– Front swollen but not produced into a shelf-like prominence 2
2. Forewing dirty white with a dull black median area ...... *semiatra* (Smith)
– Forewing not as above 3
3. Forewing with most of basal area light red-brown, contrasting with remainder of wing .... *clinopetes* (Dyar)
– Forewing with basal area not light red-brown, not contrasting with rest of wing 4
4. Forewing with orbicular laterally elongate, fusing with reniform; claviform elongate, superficially appearing to run to base of wing; Texas ....*junctimacula* A. Blanchard, new species
– Forewing with orbicular round, not laterally elongate or fusing with reniform; claviform not elongate, not appearing to run to base of wing; Mohave Desert region of California and Arizona .... *aleptivoides* (Barnes and McDunnough)

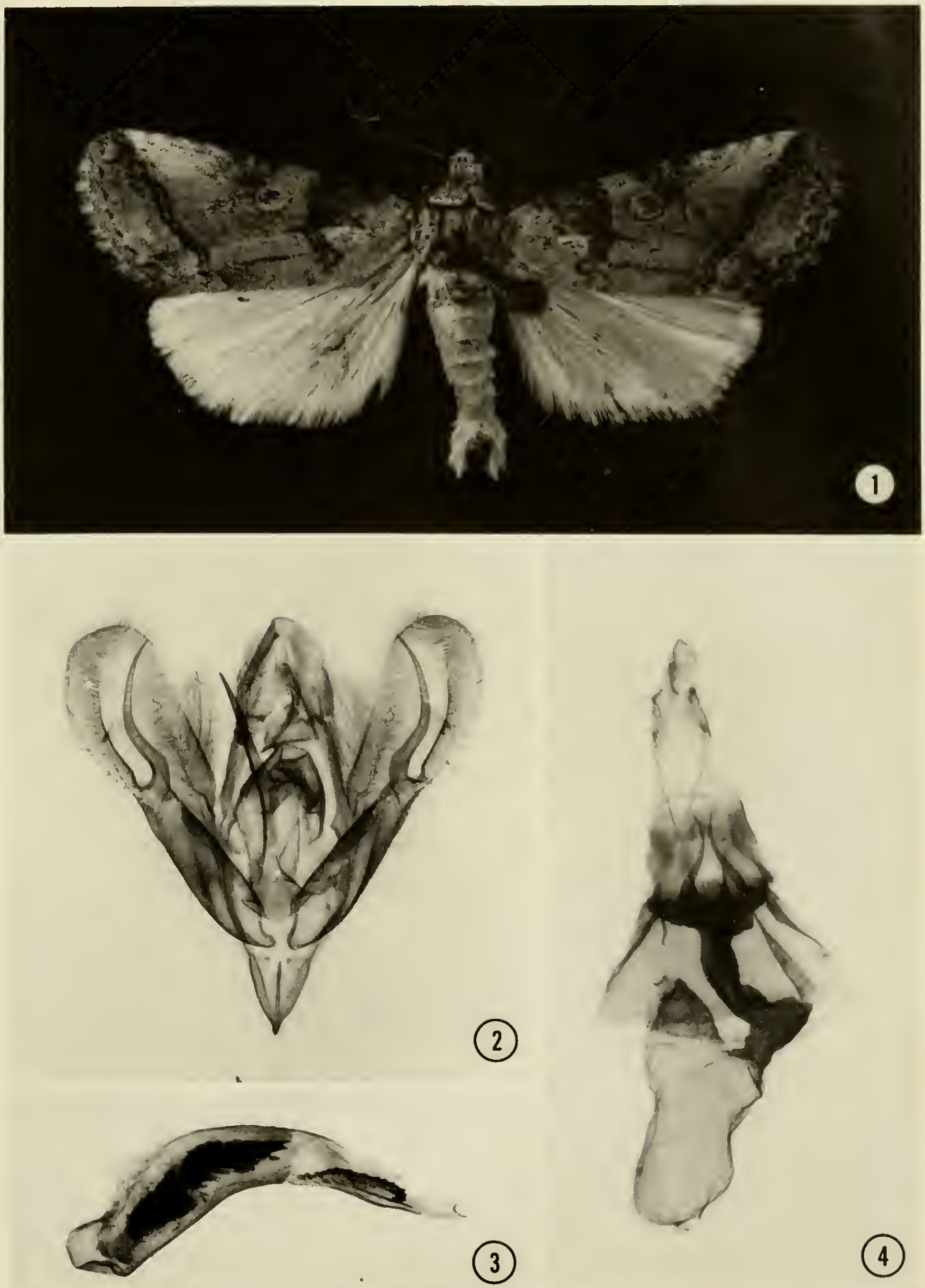
***Aleptina inca* Dyar**

Figs. 1–4

Aleptina inca Dyar, 1902, Can. Entomol. 34: 105.

Type-locality: "So. Arizona" [United States National Museum].

Types.—Dyar described this species from two ♂ from Arizona and two ♀ from Texas. One of the ♀ specimens is a cotype of *Aleptina inca texana.* The two ♂ are



Figs. 1–4. 1, *Aleptina inca* Dyar adult. 2, Male genitalia. 3, Aedeagus. 4, Female genitalia.

marked "type" and "male type." The specimen marked "type" is in poor condition. The ♂ bearing the label "male type" is in good condition but is missing the right forewing. We hereby designate and have labeled as LECTOTYPE the specimen labeled "So. Arizona, Poling," "Barnes Collection," "Leptina inca Dyar male type," "Photo Noc. 481."

Aleptina inca texana Barnes and McDunnough, 1913, Contributions to the Natural History of the Lepidoptera of North America, 2(3): 115.

Type-locality: Brownsville, Texas [United States National Museum].

Aleptina inca is the only species of this genus with a large shelf-like prominence of the front. All of the other species have the front either merely swollen or with only a hint of a ridge. The male genitalia are also distinctive (Figs. 2, 3). The valve is, to a degree, membranous and the elongate clasper rests in a pocket in the valve. Within this pocket there is a small, pointed sclerotization. The outer margin of the valve lacks the sclerotized process found in *clinopetes* (Dyar). The species is superficially like *clinopetes,* but the prominence of the front or its absence will immediately separate the two species.

This species occurs thoughout southern Texas, New Mexico, Arizona, Nevada, and southern California. In Mexico the species has been collected in the states of San Luis Potosi and Coahuila. It is apparently a desert species. The biology, larva, and foodplants are unknown. The species is variable. The basal area of the forewing is usually suffused to some extent with light salmon brown. In a few specimens the salmon brown spills all across the inner margin. The forewing varies in color from a dark black grey with a white suffusion near the apex to a uniform medium grey. The Texas specimens contain the highest proportion of the grey form and if a subspecific concept is used, the name *texana* is available.

***Aleptina clinopetes* (Dyar), New Combination**

Figs. 5–8

Bryocodia clinopetes Dyar, 1920, Insec. Inscit. Menstr. 8: 192.

Type-locality: Venadio, Sinaloa, Mexico [United States National Museum].

Aleptina clinopetes (Dyar) has not been recorded from the United States before, probably because specimens have been consistently misidentified as *inca.* However, the absence of a shelf-like prominence of the front of the head will immediately separate it from *inca.* In addition, the costa of the valve of the male genitalia has a sclerotized process that is absent in *inca.* The forewing of *clinopetes* is a bluish-grey and the basal area is strongly suffused with salmon brown. Therefore any *Aleptina* which looks like *inca* but lacks the frontal prominence will probably be this species.

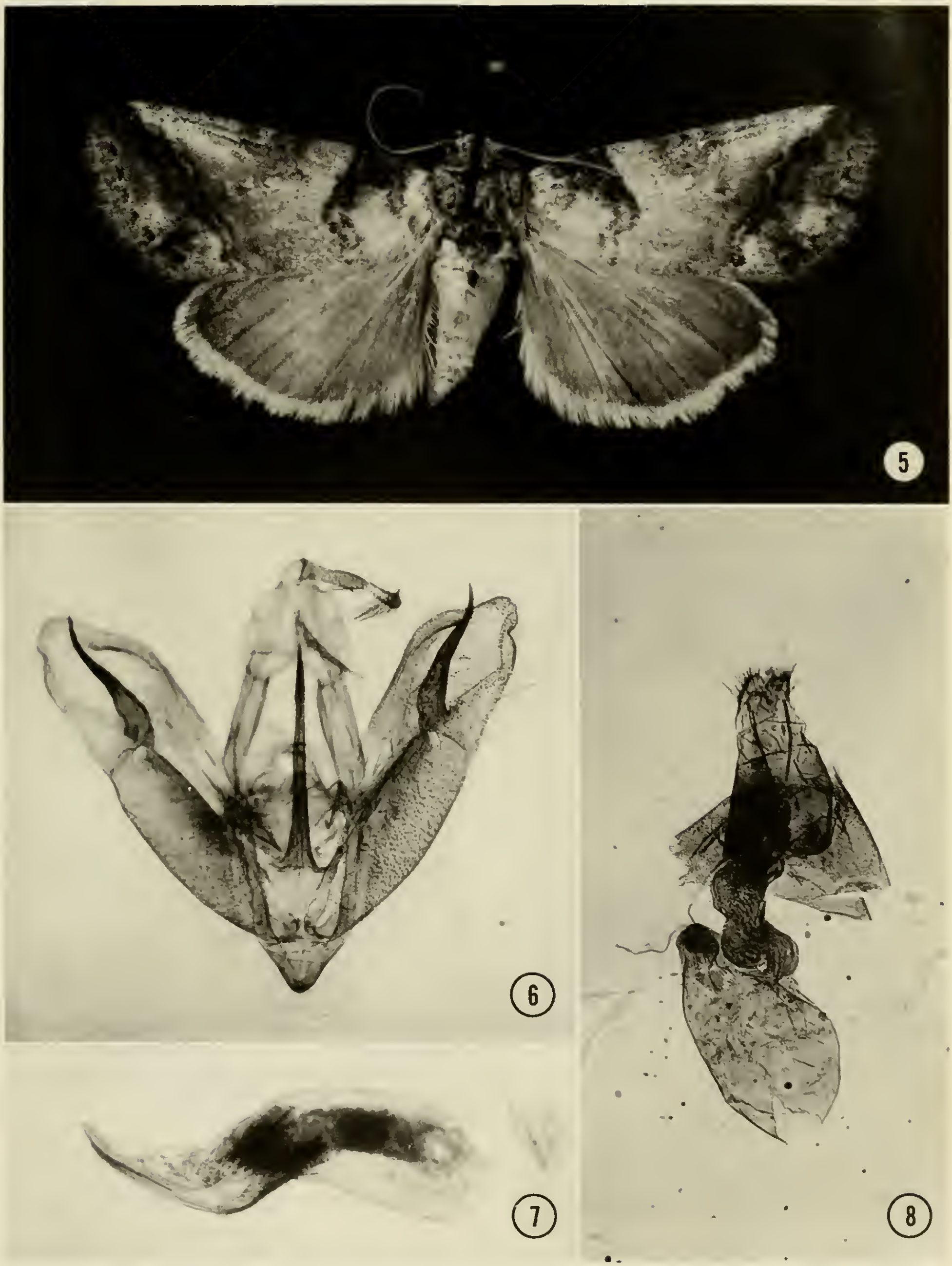
Aleptina clinopetes appears to be primarily a Mexican species that reaches into the mountains of southern Arizona. In Mexico it has been collected in the states of Sinaloa, Oaxaca, and Morelos. In Arizona it has been taken in the Santa Rita and Baboquivari Mountains. The foodplants and larva are unknown.

***Aleptina junctimacula* A. Blanchard, New Species**

Figs. 9–12

Aleptina junctimacula A. Blanchard, new species.

Type-locality: Dugout Wells, Big Bend National Park, Texas [United States National Museum].



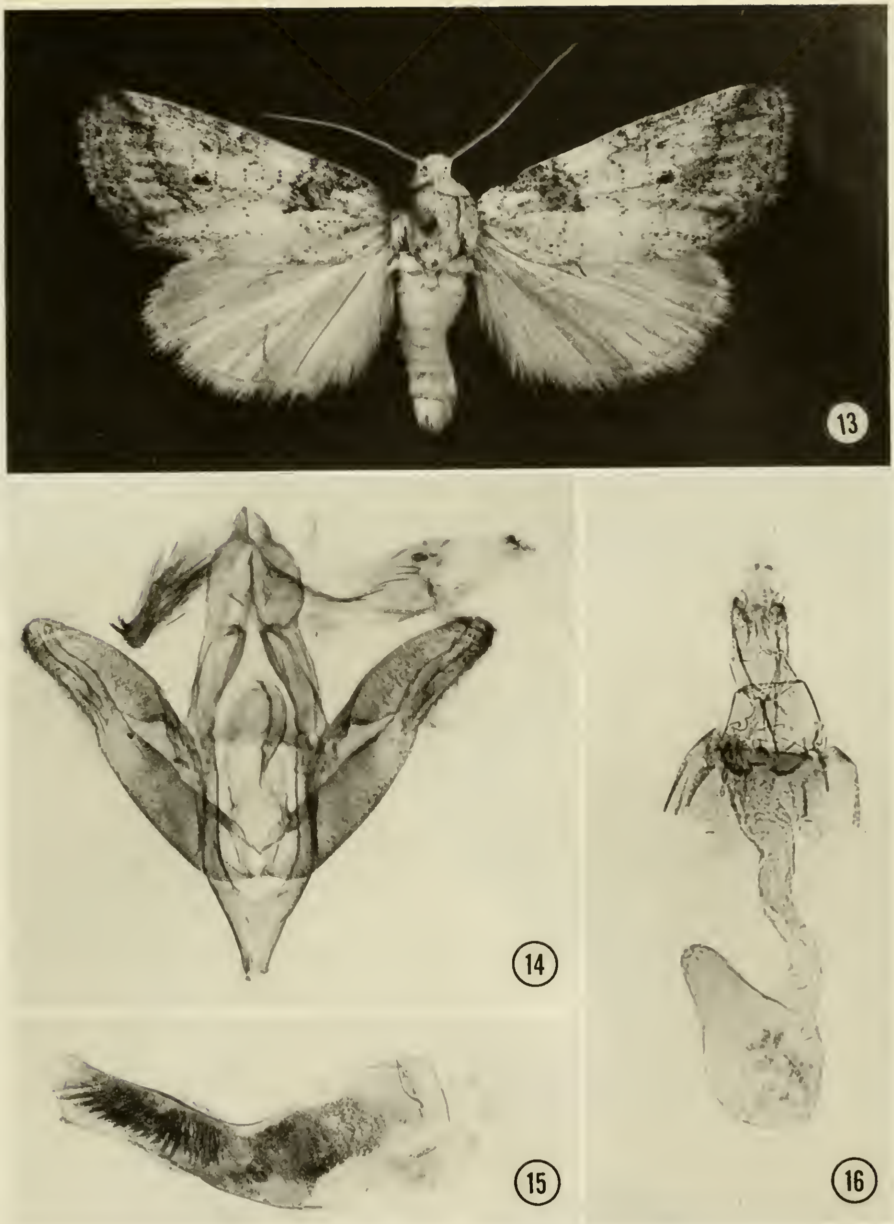
Figs. 5–8. 5, *Aleptina clinopetes* (Dyar) adult. 6, Male genitalia. 7, Aedeagus. 8, Female genitalia.

This new species is to be credited to Blanchard only. *Aleptina junctimacula* is characterized by the elongate orbicular and claviform of the forewing. The orbicular is laterally elongate, running into and fusing with the reniform. The claviform appears to run all the way into the base of the wing. The hindwing is tinged with brown. This species is the only species in the genus in which the juxta is not

Figs. 9–12. 9, *Aleptina junctimacula* A. Blanchard, adult. 10, Male genitalia. 11, Aedeagus. 12, Female genitalia.

produced into a spine or elongate process. *Aleptina junctimacula* is known only from the Big Bend area of western Texas.

Description.—Head with mixed white and grey scales. Wings with maculation as in Fig. 9; orbicular and claviform laterally elongated, orbicular running into and fusing with reniform, not round as in *aleptivoides*; claviform appearing to run all the way to base of wing; overall coloration of forewing grey with a very slight violet tint; claviform, orbicular, and reniform white, orbicular with a dark grey central spot; antemedial line absent or obscure; postmedial line a thin black line running as in Fig. 9; lower two-thirds of subterminal area with a dull black,



Figs. 13–16. 13, *Aleptina aleptivoides* (Barnes and McDunnough), adult. 14, Male genitalia. 15, Aedeagus. 16, Female genitalia.

but obscure, patch; terminal line a series of distinct black dashes. Hindwing light brown. Prothoracic and mesothoracic tibiae and femora covered with mixed white and grey scales; tarsal segments vaguely banded with white and grey; metathoracic femur and tibia all white. Abdomen with tuft of grey scales on first abdominal segment. Male genitalia as in Figs. 10, 11; juxta not produced into a spine as in

Figs. 17–20. 17, *Aleptina semiatra* (Smith), adult. 18, Male genitalia. 19, Aedeagus. 20, Female genitalia.

other four species; claspers of valves extending beyond margins of valve, not shortened as in *aleptivoides.* Female genitalia as in Fig. 12.

Types.—Holotype: ♂, Big Bend National Park, Dugout Wells, Texas, 29-VIII-1965, A & M. E. Blanchard, male genitalia on slide AB 1100, in the United States National Museum. Paratypes: 1 ♂ and 6 ♀ from the type locality and collectors, 4-VI-73, 13-IX-71, 9-VIII-64, 27-VIII-65, in the collection of A. Blanchard; 1 ♂, Shafter, Presidio County, Texas, 9-IX-69, A & M. E. Blanchard, in the United States National Museum; 1 ♂, Chihuahuan Desert, near Nugent Mountain, Big Bend National Park, Texas, A & M. E. Blanchard, 17-IX-71, in the collection of A. Blanchard; 1 ♂, Nugent Mountain, Chisos Mountains, Brewster Co., Texas, D.C. Ferguson, 6-VI-73, in the United States National Museum.

This species is known only from the Big Bend Region of Texas. The larva and its foodplants are unknown. The species has an uncanny resemblance to the species of the genus *Oxycnemis.*

Aleptina aleptivoides **(Barnes and McDunnough) New Combination**

Figs. 13–16

Phyllophila aleptivoides Barnes and McDunnough, 1912, Can. Entomol. 44: 217.

Type-locality: La Puerta Valley, San Diego County, California [United States National Museum].

Types.—This species was described from one ♂ and one ♀. The ♂ is in the San Diego Museum and the ♀ is in the United States National Museum. The ♀ type bearing the labels "Geo. H. Field, La Puerto Valley, Cal., July 11," "Photograph pl. 5, fig. 14," "Phyllophila aleptivoides B & McD, type female" is designated and has been labeled as LECTOTYPE.

Paracretonia xithon Dyar, 1912, Proc. Entomol. Soc. Wash. 14: 167.

Type-locality: La Puerta Valley, California [San Diego County], [United States National Museum].

Types.—Described from three specimens. The ♀ specimen bearing the labels "Geo. H. Field, La Puerta Valley, Cal., July 11," "56," "Type no. 15112 U.S.N.M.," "Paracretonia xithon, type Dyar" is designated and has been labeled as LECTOTYPE.

Aleptina aleptivoides looks most like *junctimacula,* but even that comparison is strained. The general color of the forewing is a grizzled grey. The orbicular and claviform of the forewing are not laterally elongate. The male genitalia are distinctive because the clasper of the valve is shorter than in any of the other four species and does not extend past the margin of the valve.

This species has been collected in southern California, western Arizona, and southern Arizona. The larva and its foodplants are unknown.

Aleptina semiatra **(Smith) New Combination**

Figs. 17–20

Acontia semiatra Smith, 1902, J. N. Y. Entomol. Soc. 10: 52.

Type-locality. Quartzite, Yuma Co., Arizona [American Museum of Natural History].

Types.—This species was described from one ♂ and three ♀. The lectotype was designated by Todd, 1982, U.S.D.A. Tech. Bull. 1645, p. 193.

This species is unmistakable and superficially is totally unlike the rest of the genus. The forewing is dirty white with a dull grey median area. The subterminal area is also generally suffused with dull grey.

The species is fairly common in the Mohave Desert region of southern California and western Arizona. The larva and its foodplants are unknown.

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86(4), 1984, p. 960

NOTE

Editha magnifica (Perty) in Venezuela (Hymenoptera: Sphecidae: Nyssoninae)

Editha magnifica (Perty) is probably the largest (length 40 mm or more) member of the tribe Bembecini and, although described 150 years ago, is still poorly known. This handsome wasp was previously recorded only from Brazil (Bohart & Menke, 1976, Sphecid Wasps of the World), and all collections were made south of the Amazon River. Therefore, the discovery of *magnifica* in Venezuela, some 1500 airmiles to the north, is significant. I have examined two females belonging to two different Venezuelan institutions. The records are as follows: *Anzoategui:* Aragua dist., El Chaparro, XII-20-74 (Universidad del Zulia, Maracaibo); *Yaracuy:* Chivacoa, Centrale Matilde, IX-12-72 (Universidad Centro Occidental Lisandro Alvarado, Barquisimeto). Both specimens are identical in yellow abdominal markings with Brazilian females. I would like to thank Edmundo Rubio, Maracaibo, and Enrique Yustiz, Barquisimeto, for permitting me to examine wasps in their institutions.

A. S. Menke, *Systematic Entomology Laboratory, IIBIII, ARS, USDA, c/o National Museum of Natural History, NHB 168, Washington, DC 20560.*

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THREE NEW SPECIES OF *MACRUROHELEA* FROM ARGENTINA WITH A KEY TO THE NEOTROPICAL SPECIES (DIPTERA: CERATOPOGONIDAE)

Gustavo R. Spinelli and William L. Grogan, Jr.

(GRS) Instituto de Limnologia (ILPLA), Republica Argentina, Becario Externo, Consejo Nacional de Investigaciones Científicas y Técnicas de la República Argentina; (WLG) Department of Biological Sciences, Salisbury State College, Salisbury, Maryland 21801.

Abstract.—The following three new species of the predaceous midge genus *Macrurohelea* from Argentina are described and illustrated: ***gentilii, monotheca*** and ***wirthi***. Two of these new species, *M.* ***gentilii*** and *M.* ***monotheca***, differ from all other species of *Macrurohelea* in possessing a single spermatheca instead of the usual two. A key to the 9 Neotropical species is presented.

The genus *Macrurohelea* is presently known from seven species, six of which are southern Neotropical in distribution. These are *M. caudata* Ingram and Macfie (1931) and *M. thoracica* I. & M. from southern Argentina, *M. kuscheli* Wirth (1965) and *M. setosa* Wirth from southern and northern Chile respectively, and *M. irwini* Grogan and Wirth (1980) and *M. paracaudata* G. & W. from central Chile.

Lee (1962) described *M. commoni* from Australia, the only species presently known from that continent. However, Grogan and Wirth (in prep.) are in the process of describing two new Australian species and it is not unreasonable to expect many more species from that part of the southern hemisphere. *Macrurohelea* is very similar to the northern Holarctic genus *Ceratopogon* and is apparently a southern hemisphere analogue of that genus (Grogan and Wirth, 1980).

In this paper we are describing three new species of *Macrurohelea* recently collected by Mario Gentili from San Martin de los Andes, Argentina. This locality is located 120 km. N of San Carlos de Bariloche (ca. 40°S), the type-locality of *M. thoracica*, and represents a typical Patagonian Andes forest habitat. Specimens of *Macrurohelea* have been taken just north of the Tropic of Capricorn at Vega de San Andres in northern Chile (23°S) to as far south as Lake Gutierrez in southern Argentina (41.5°S). It is of interest to note that none of the six previously described species of *Macrurohelea* from South America have subsequently been collected. This may be an indication that they are quite rare, that they inhabit very unique or specialized habitats, or that standard light trapping methods are not very efficient. The senior author has never encountered them during the course of several collecting trips to suitable habitats. It is also noteworthy that two of our new species, *M. gentilii* and *M. monotheca*, differ from all other species of *Macrurohelea* in possessing a single spermatheca instead of the usual two.

For an explanation of general ceratopogonid terminology see Downes and Wirth (1981); terms dealing with antennal sensilla are those of Wirth and Navai (1978).

The holotypes and allotypes of our new species are deposited in the collection of the Museo de La Plata, La Plata, Argentina. Paratypes of *M. gentilii* will be deposited in the collection of the Instituto de Limnologia (ILPLA), La Plata, Argentina, and in the National Museum of Natural History, Washington, D.C., U.S.A.

The senior author (G.R.S.) gratefully acknowledges support from the Consejo Nacional de Investigaciones Científicas y Técnicas de la República Argentina.

Key to the Neotropical Species of *Macrurohelea*

1\. Females 2
– Males 9
2\. One spermatheca 3
– Two spermathecae 4
3\. Wing with intercalary fork in cell R$_5$; wing membrane infuscated, veins dark brown .... *monotheca* new species
– Wing without intercalary fork in cell R$_5$; wing membrane whitish hyaline, veins pale .... *gentilii* new species
4\. Wing with intercalary fork in cell R$_5$ 5
– Wing without intercalary fork in cell R$_5$ 6
5\. Second radial cell of wing 2.5 times longer than 1st, veins brown; antennal ratio 1.61 .... *wirthi* new species
– Second radial cell of wing 3 times longer than 1st, veins pale; antennal ratio 1.00 .... *caudata* Ingram and Macfie
6\. Second radial cell of wing twice as long as 1st 7
– Second radial cell of wing at least 3 times as long as 1st 8
7\. Flagellum very short, flagellomeres 9–12 each broader than long, antennal ratio 0.59; very small species, wing length 0.94 mm ... *kuscheli* Wirth
– Flagellum longer, flagellomeres 9–12 each twice as long as broad, antennal ratio 1.06–1.16; small species, wing length 1.27–1.42 mm .... *irwini* Grogan and Wirth
8\. Flagellomeres 5–8 with apical sensilla coeloconica; legs with inconspicuous setae; wing including veins pale .... *thoracica* Ingram and Macfie
– Flagellomeres 5–8 lacking apical sensilla coeloconica; legs with numerous long bristly setae; wing including veins infuscated dark brown .... *setosa* Wirth
9\. Large species, wing length 2.1 mm or greater 10
– Smaller species, wing length 1.5 or less 11
10\. Legs with numerous long bristly setae; wing including veins infuscated dark brown .... *setosa* Wirth
– Legs with inconspicuous setae; wing including veins pale .... *thoracica* Ingram and Macfie
11\. Very small species, wing length 0.90 mm .. *paracaudata* Grogan and Wirth
– Small species, wing length 1.3 mm or greater 12
12\. Wing with intercalary fork in cell R$_5$; second radial cell of wing subequal to 1st; aedeagus more or less crescent shaped . *caudata* Ingram and Macfie

– Wing without intercalary fork in cell R_5; second radial cell of wing 1.7–2.0 times longer than 1st; aedeagus triangular 13

13. Gonostylus bent abruptly subapically at 90°; sternum 9 with deep caudomedial excavation .... *gentilii* new species

– Gonostylus curved subapically, not bent at 90°; sternum 9 with shallow caudomedial excavation .... *irwini* Grogan and Wirth

Macrurohelea gentilii **Spinelli and Grogan, New Species**

Fig. 1

Diagnosis.—A medium sized species of *Macrurohelea,* the females distinguished from all other species in the genus except *M. monotheca* n. sp. by its single large spermatheca. Females of *M. gentilii* differ from those of *M. monotheca* by their wing with pale membrane and veins that lack an intercalary fork in cell R_5 (wing including veins of *M. monotheca* infuscated brown and cell R_5 possesses an intercalary fork). Males of *M. gentilii* differ from all other males in the genus by their gonostyles that are abruptly bent subapically at 90°.

Female.—Wing length 1.68 (1.58–1.74, n = 3) mm; breadth 0.77 (0.74–0.79, n = 3) mm.

Head: Brown. Eyes pubescent, separated for a distance equal to the diameter of 2.5 ommatidial facets. Antenna with dark brown pedicel; flagellum (Fig. 1a) brown; first flagellomere with 2–3 apical sensilla coeloconica; flagellomeres with lengths in proportion of 25-15-14-14-15-15-15-15-30-32-34-40-50; antennal ratio 1.45 (1.40–1.50, n = 3). Palpus (Fig. 1c) brown; lengths of segments in proportion of 10-15-20-12-16; third segment with well defined pit; palpal ratio 1.90 (1.65–2.05, n = 3). Mandible with 9 teeth.

Thorax: Brown; scutum with a few scattered setae and extremely fine pubescence. Legs uniformly brown incuding tarsi; hind tibial comb with 5 spines; hind tarsal ratio 2.16 (2.10–2.28, n = 3); palisade setae well developed on first tarsomere of fore and hind leg; fifth tarsomere of fore leg about 2.5× longer than broad, 3.5× longer than broad on mid and hind legs; fourth tarsomeres deeply cordate; claws small equal sized without basal inner teeth, but with slender basal hair like barbs. Wing (Fig. 1d) with membrane whitish hyaline, veins pale; two radial cells present, the second about 3× as long as first; costa extends 0.74 (0.73–0.76, n = 3) of wing length; venation as figured. Halter light brown.

Abdomen: Brown, slightly paler than thorax. Tenth segment elongated and bent forward ventrally as is typical for members of the genus. One single large spermatheca (Fig. 1e) with moderately long neck; partially collapsed, measuring 0.09 mm by 0.07 mm.

Male.—Wing length 1.44 (1.40–1.52, n = 5) mm; breadth 0.51 (0.50–0.52, n = 5) mm. Similar to female with the following sexual differences: Flagellum (Fig. 1b) with dense brown plume; flagellomeres with lengths in proportion of 28-17-17-17-17-17-17-17-18-20-30-54-65. Palpus with segments in proportion of 10-13-22-13-24; palpal ratio 2.30 (2.20–2.40, n = 2). Wing with costa extending to 0.63 (0.62–0.65, n = 5) of wing length, second radial cell 1.7× longer than first. Genitalia (Fig. 1f–g): Sternite 9 short with a very deep caudomedian excavation, caudal membrane spiculate; tergite 9 gradually tapering distally to a somewhat rounded apex bearing two moderately long apicolateral processes, cerci well de-

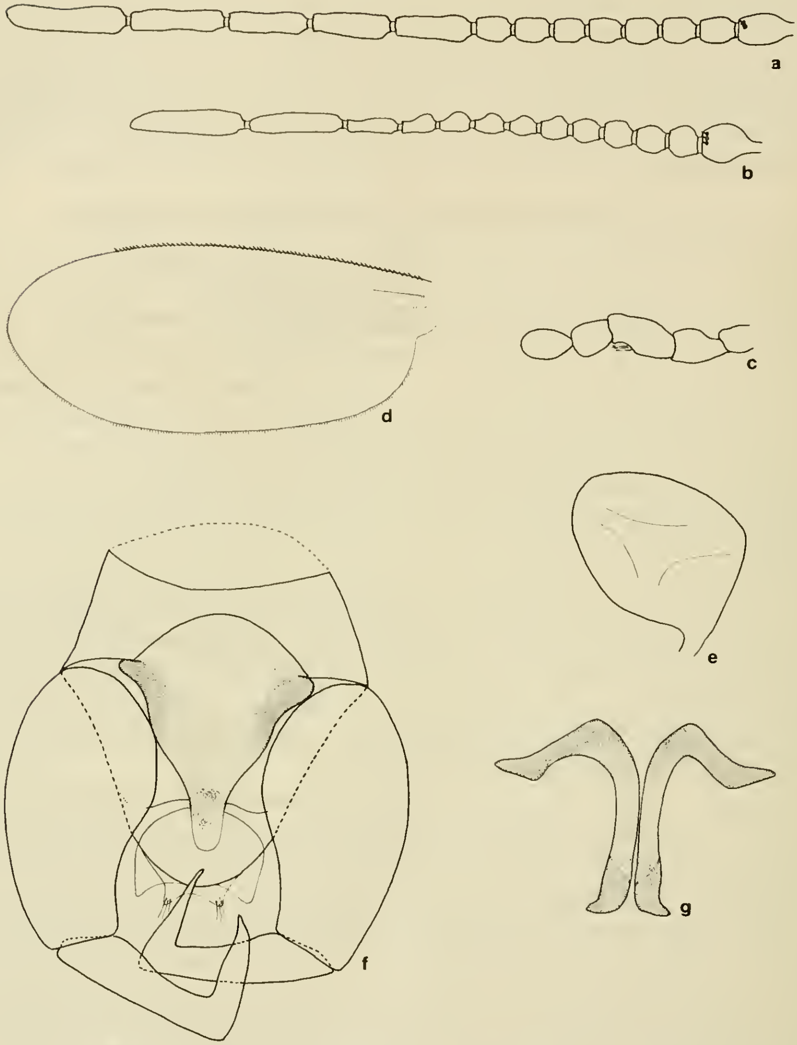

Fig. 1a–g. *Macrurohelea gentilii.* a, Female flagellum. b, Male flagellum. c, Female palpus. d, Female wing. e, Spermatheca. f, Male genitalia, parameres removed. g, Parameres.

veloped. Gonocoxite elongate, slightly curved, about twice as long as broad; gonostylus slender, abruptly bent subapically forming an angle of 90°, tapering distally to narrow pointed tip. Aedeagus triangular, about as long as broad; basal arch 0.3 of total length; basal arm heavily sclerotized, tapering distally to a narrow rounded tip. Parameres (Fig. 1g) separated; basal arm heavily sclerotized, recurved doubly, distal portion lightly sclerotized except tip, which is bent outward on extreme apex.

Types.—Holotype ♀, allotype ♂, Argentina, Provincia de Neuquen, San Martin de los Andes (1400 m) 15-IV-1982, M. Gentili, at light; paratypes, same data as types, 2 ♀, 4 ♂.

Discussion.—This species is named in honor of Mario Gentili, who collected all of the specimens described in this paper, in recognition of his important contributions to the collection and study of Argentine insects.

Macrurohelea monotheca Spinelli and Grogan, New Species
Figs. 2a, c, e, g, h

Diagnosis.—A large species of *Macrurohelea* distinguished from all other species in the genus except *M. gentilii* n. sp. by its single large spermatheca, and differing from *M. gentilii* by its wing with an intercalary fork in cell R_5 and the wing membrane and veins infuscated dark brown (wing of *M. gentilii* lacking intercalary fork and wing membrane and veins pale).

Holotype female.—Wing length 2.05 mm; breadth 0.87 mm.

Head: Brown. Eyes pubescent, separated for a distance equal to the diameter of 2 ommatidial facets. Antennal pedicel dark brown; flagellum (Fig. 2a) brown; first flagellomere with 2 apical sensilla coeloconica; flagellomeres with lengths in proportion of 38-20-20-20-20-20-20-20-55-52-55-60-80; antennal ratio 1.70. Palpus (Fig. 2c) brown with lengths of segments in proportion of 18-25-30-20-37; third segment with well defined pit; palpal ratio 2.00. Mandible with 12 teeth.

Thorax: Brown; scutum with a few scattered setae and extremely fine pubescence; scutellum bearing 3 similar setae, 1 central and 2 marginal. Legs brown including tarsi; hind tibial comb with 5 spines; hind tarsal ratio 2.40; palisade setae well developed on first tarsomere of fore and hind legs; fourth tarsomeres deeply cordate; fifth tarsomere of fore leg about 2.5 × longer than broad, 3.5 × on mid leg, lost on hind leg; claws small, equal sized, without basal inner teeth, but with slender basal hair like barbs. Wing (Fig. 2e) with membrane infuscated, veins dark brown, coarse and well defined; cell R_5 with weak intercalary fork; two radial cells present, the second about 3.5 × longer than first; costa extends 0.74 of wing length; M_2 becomes nearly obsolete at base. Halter light brown.

Abdomen: (Fig. 2g) Brown, slightly paler than thorax. Tenth segment long, as typical for the genus. One single large spermatheca (Fig. 2h) partially collapsed, apparently pyriform with short broad neck, measuring 0.1 mm long by 0.07 mm broad.

Male.—Unknown.

Type.—Holotype ♀, Argentina, Provincia de Neuquen, San Martin de los Andes, 23-IV-1982, M. Gentili, light trap.

Discussion.—The specific epithet is from the Greek, *mono* (one), and *theca* (sac), in reference to the single large spermatheca that this species possesses.

Macrurohelea wirthi Spinelli and Grogan, New Species
Figs. 2b, d, f, i

Diagnosis.—A small species of *Macrurohelea* females of which are distinguished from all other members of the genus by the following combination of characters: small size (wing length 1.33 mm); cell R_5 of wing with intercalary fork; 2nd radial cell of wing 2.5 × longer than the 1st; wing veins infuscated; two spermathecae; antennal ratio 1.61.

Holotype female.—Wing length 1.33 mm; breadth 0.62 mm.

Head: Brown. Eyes pubescent, separated for a distance equal to a diameter of two ommatidial facets. Antenna with dark brown pedicel; flagellum (Fig. 2b) brown, flagellomeres 9–12 about 3 times as long as broad; first flagellomere with

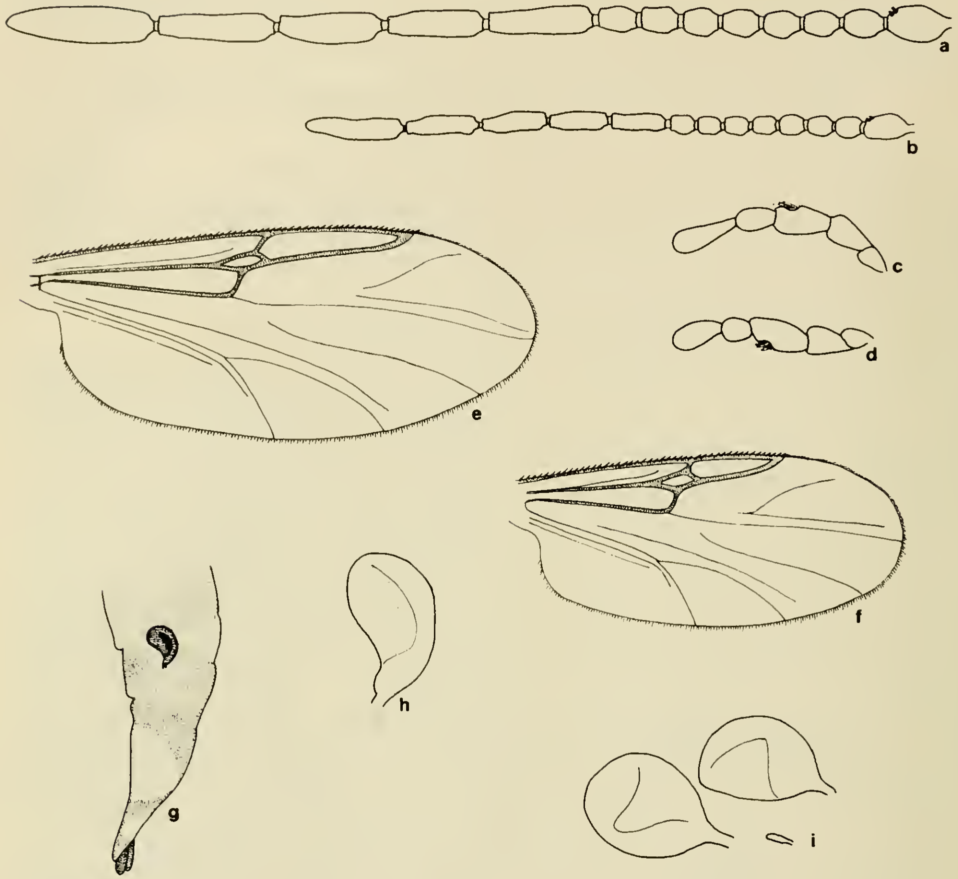

Fig. 2. *Macrurohelea monotheca* (a, c, e, g–h) and *M. wirthi* (b, d, f, i). Females: a–b, flagella, c–d, palpi; e–f, wings; g, abdomen; h–i, spermathecae.

2–3 apical sensilla coeloconica; flagellomeres with lengths in proportion of 18-11-11-11-11-11-11-12-24-26-29-32-44; antennal ratio 1.61. Palpus (Fig. 2d) brown; lengths of segments in proportion of 10-14-18-9-16; third segment with well defined pit; palpal ratio 1.8. Mandible with 8 teeth.

Thorax: Brown; scutum with a few scattered setae and extremely fine pubescence. Legs uniformly brown including tarsi; palisade setae well developed on first tarsomere of fore and hind legs; hind tibial comb with 5 spines; hind tarsal ratio 2.55; fourth tarsomeres deeply cordate; fifth tarsomere of fore leg about 3.5 × longer than broad with small simple equal claws, fifth tarsomeres and claws lost on mid and hind legs. Wing (Fig. 2f) about 2.15 × longer than broad; membrane slightly infuscated, veins dark brown, coarse and well defined; intercalary fork present in cell R_5; two radial cells present, the second 2.5 × as long as first; costa extends 0.7 of wing length. Halter light brown.

Abdomen: Brown, tapering distally. Tenth segment elongated as is typical for the genus. Spermathecae (Fig. 2i) slightly unequal, ovoid to spheroid with slender necks, measuring 0.062 mm by 0.050 mm with a 0.012 mm neck, and 0.054 mm by 0.046 mm, with a 0.012 mm neck, plus a small vestigial spermatheca.

Male.—Unknown.

Type.—Holotype female, Argentina, Provincia de Neuguen, San Martin de los Andes (1400 m.), 15-IV-1982, M. Gentili, at light.

Discussion.—We are pleased to name this species in honor of our good friend and colleague Willis W. Wirth in recognition of his outstanding contributions to the study of Ceratopogonidae during the past 35 years.

This species is similar to *M. caudata* Ingram and Macfie by virtue of its similar sized wing with an intercalary fork in cell R_5 and two spermathecae. Females of *M. caudata* differ from those of *M. wirthi* by having the 2nd radial cell 3× longer than the 1st, the wing veins pale and having an antennal ratio of 1.00.

The female of *M. irwini* Grogan and Wirth also resemble that of *M. wirthi* in having a similar sized wing and two spermathecae. The female of *M. irwini* differs from that of *M. wirthi,* however, in lacking an intercalary fork in cell R_5, having the 2nd radial cell twice as long as the 1st, wing veins grayish and an antennal ratio of 1.06–1.16.

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NOTE

On the Question of the Selector of the Lectotypes of the Species of Ichneumonidae Described by Ezra Townsend Cresson

In the *Catalog of Hymenoptera in America North of Mexico* (Smithsonian Institution Press, 1979), p. 317, paragraph four, reference is made to "The Cresson Types of Hymenoptera" (1916. Mem. Am. Entomol. Soc. 1: 1–134). It is there stated that Cresson in this paper "indicated which single specimen was to be regarded as the type for each; thus he selected lectotypes for those cases in which he had described a species from more than one specimen." My reading of the Cresson paper suggests that Cresson indeed considered a single specimen to be the type, since he describes the condition of each one, but I am unable to see how it can be claimed that he *indicated* a single specimen, since there are no limiting details to accomplish this. In effect, the "Cresson Types" merely indicates the location of the specimen the author considered the type.

Furthermore, I have good reason to believe that holotypes and lectotypes were not segregated by Cresson. In brief, from about 1934 to 1939, I spent two afternoons a week at the Academy of Natural Sciences of Philadelphia studying Ichneumonidae in the collections of the American Entomological Society there, and on one occasion I for one reason or another examined one of the reputed Cresson types, at that time stored in a separate case containing only types. To my surprise, I found that the "type" was not of the correct sex. I called this to the attention of E. T. Cresson, Jr., Assistant Curator of Entomology, who informed me that he (a dipterist) and V.S.L. Pate (a worker on aculeates) had picked them (the holotypes or lectotypes) out and were not good on sex in Ichneumonidae, and that I should select the lectotype (a term not then known to me and not mentioned) on the basis of the original description and my (then) knowledge of his father's handwriting, from the series of specimens then kept in cases of the kind described in the introduction to "The Cresson Types," which in this instance and others rather clearly consisted of syntypes (often topotypes).

Evidently the segregated types as I (as well as Townes and other subsequent students) found them had been selected from these series by E. T. Cresson, Jr. and Pate, who would therefore seem to have been the effective lectotype selectors (except for the one I did, which may have been *Ichneumon regnatrix*—I have no record). I find nothing in the Townes catalog of 1944, 1945 (Mem. Am. Entomol. Soc. 11(1, 2)) to support the suggestion in the last sentence of the paragraph in the 1979 catalog referred to above that Townes might technically be the lectotype selector.

It is unfortunate that nothing was published establishing the actual selection.

H. Pearson Hopper, *3713 35th Street, NW, Washington, DC 20016.*

PROC. ENTOMOL. SOC. WASH.
86(4), 1984, pp. 969–970

BOOK REVIEW

A Guide to Observing Insect Lives, by Donald W. Stokes. Little, Brown and Company, Boston, Massachusetts. 371 pp. 1983. Cost: $8.95 paperback.

This book is one of four Stokes Nature Guides that are "designed to take the active and inquisitive nature-watcher beyond field identification into the most exciting aspects of the inner lives of plants and animals," as stated on its back cover. With great enthusiasm, I recommend that people should learn more about nature, and especially about some of my favorite organisms: insects.

Thus, the idea of this Guide is excellent and the intentions of the author are commendable. The Guide discusses many highly interesting insects and has scores of pleasant ink sketches of the animals and their habitats. It has eight main parts: Watching Insects, The Basic Facts about Insects, Spring Insects, Summer Insects, Fall Insects, Winter Insects, Glossary, and Bibliography.

Unfortunately, I found that the Guide has three main detracting defects. First, it does little to synthesize its information about insect life histories and behavior using an evolutionary perspective. Many biologists have found that an evolutionary approach is highly rewarding; it is the best way that we presently have to understand these subjects (Mayr, E., 1982, *The Growth of Biological Thought. Diversity, Evolution, and Inheritance,* Harvard University Press, Cambridge, Massachusetts, 974 pp.).

Second, this Guide simplifies an appreciable amount of its subject matter so much that it seems to give many erroneous impressions. For example, its 7-page chapter to solitary bees is hardly enough space to outline the life history of one well studied solitary bee species, let alone do justice to the whole group of thousands of species. Stokes also covers June beetles, ants, ichneumon wasps, bumble bees, cicadas, aphids, and many other large groups in similarly short chapters. In these chapters, it would be preferable to concentrate on one species per chapter and then, perhaps, make a few careful generalities about the species' groups. Stokes' better chapters are the ones that are devoted to only one species, e.g., the chokecherry tentmaker, woolly alder aphid, monarch butterfly, and goldenrod gall fly.

Third, this Guide makes many untrue statements about insects with which I am familiar and this makes me uneasy about any of its subjects that are not already familiar to me. For example, on page 77, Stokes states, "The ovipositor [of *Megarhyssa macrurus*] is obvious when the insect is in flight and looks like several strands of thread trailing behind." The living adult *Megarhyssa* that I have seen hold their ovipositor parts together; however, these parts may spread apart in a dead *Megarhyssa.* The illustration on page 79 accurately shows a *Megarhyssa* ovipositor as one long rod, but in an unusual U-shaped configuration. On page 84, flying ants are compared with flying termites, indicating that one can descriminate the termites from the ants because the former are white and the latter are not. Nonetheless, our local *Reticulitermes* and other termites have dark-colored reproductives. Wing venation and presence or absence of a propodeum are better discriminating characters than color for these two groups. Getting back to the chapter on solitary bees, Stokes says, "Before it [the domesticated honey bee] arrived, the only bees around were solitary bees and bumblebees." What about the primitively eusocial halictines and metasocial carpenter bees? On page 99 still discussing solitary bees, he says, "In some species, one female always waits at the entrance of the burrow, possibly as a guard against predators or parasites." The author seems to be confusing solitary with social bee species here, and even in the social species, there is not *always* a guard in the entrance of an active nest. This kind of hyperbole does not belong in a scientific book where it can mislead readers.

Further, this book contains an inconsistency about monarch butterflies. On page 129, Stokes says that they are "red and black," but on page 235, he says that they are orange and black (their actual coloration). On page 127, the orange-and-black large milkweed bug, *Oncopeltus fasciatus,* is also wrongly described as red and black.

This Guide should have been written more carefully to be more worthy of its subject matter. I suggest that a reprint be published soon that would correct its problems.

Edward M. Barrows, *Department of Biology, Georgetown University, Washington, D.C. 20057.*

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86(4), 1984, pp. 971–973

THE CENTENNIAL OF THE ENTOMOLOGICAL SOCIETY OF WASHINGTON MARCH 12, 1984

MANYA B. STOETZEL

Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, Beltsville, Maryland 20705.

The Entomological Society of Washington was officially formed when its constitution was adopted on March 12, 1884. From the group of 16 "founders," membership in ESW has increased to more than 600 with members from every state in the United States except Alaska and from 25 foreign countries.

The day of March 12, 1984, was filled with Society activities. The Society's cofounder and first president, Charles Valentine Riley, was honored by the establishment of the Charles Valentine Riley Memorials Program. The formal announcement of the Riley Memorials Program by the U.S. Department of Agriculture was made on March 12, 1984 in order to coincide with the Centennial of the ESW. Secretary of Agriculture John R. Block officially accepted the gift of $150,000 from Emilie Wenban-Smith, a granddaughter of Dr. Riley. The gift was part of a bequest made by Catherine Vedalia Riley, who, until her death in 1978, was a physician on Long Island, New York, and who was the last surviving child of Dr. Riley, in honor of her father. C. V. Riley was the Chief Entomologist for the USDA from 1881 to 1894, and he is generally regarded as having established what is now the National Collection of Insects in the Smithsonian Institution. Assistant Secretary of Agriculture Orville G. Bentley addressed the USDA Interagency Work Group that will participate in the administration of the Riley Memorials Program and other representatives of the USDA, the Smithsonian, and the scientific community of the Washington area. The ESW was represented by its President, Neal O. Morgan, by its immediate Past President and Centennial Committee Chairman, Manya B. Stoetzel, and by its 1972 President and Centennial Banquet Speaker, Curtis W. Sabrosky.

Following the formal presentation, the participants attended a luncheon hosted by Victor John Yannacone, jr., an influential environmental leader, a long-time friend and neighbor of Catherine Vedalia Riley, and a trustee of her estate. Mr. Yannacone discussed his hopes and aspirations for the future of the Riley Memorials Program. The USDA was selected as the recipient of the gift primarily because of Catherine Riley's concern that the memorial to her father bring together the diverse and disparate groups that are concerned with American agriculture and forestry. The gift will be used to convene colloquia on scientific topics, followed by the awarding of a substantial cash award to an outstanding scientist. Commensurate with C. V. Riley's professional career, pest management has been selected as the first special topic.

The evening's activities began at 6:30 p.m. with a cash bar and entertainment by The Metropolitan String Quartet provided through the courtesy of Arly Allen of Allen Press, Inc., CIBA-GEIGY Corporation, Monsanto Company, and the Pest Science Society of Washington. A total of 190 members, spouses, associates, and invited guests attended. Each member's name tag bore the year that he/she joined the Society. All present and past officers had ribbons on which were printed the year or years for all offices held. Dinner was served at 7:30 p.m., and the main program began at 8:45 p.m. The Centennial Banquet Chairman was Donald M. Anderson, the Society's President Elect. The Master of Ceremonies was Manya B. Stoetzel.

The Society's Honorary President Carl F. W. Muesebeck (member since 1920) was unable to attend the banquet, but a letter conveying his good wishes was read to the audience, and it was announced that a check for $5,000 had been received from Mr. Muesebeck and had been deposited in the ESW Special Publication Fund. The Society's three Honorary Members, Fred W. Poos, Ashley B. Gurney, and Theodore L. Bissell, were present as were various members of their families. Of the 33 living Past Presidents, the following 24 attended: 1945 Fred W. Poos, 1951 Alan Stone, 1953 William H. Anderson, 1954 Ashley B. Gurney, 1955 Theodore L. Bissell, 1959 Robert H. Nelson, 1961 J. F. Gates Clarke, 1962 Harold H. Shepard, 1963 William E. Bickley, 1965 Paul A. Woke, 1966 Louise M. Russell, 1968 Richard H. Foote, 1969 Helen Sollers-Riedel, 1970 Karl V. Krombein, 1972 Curtis W. Sabrosky, 1973 Victor A. Adler, 1975 H Ivan Rainwater, 1976 George C. Steyskal, 1977 Maynard J. Ramsay, 1978 Douglass W. S. Sutherland, 1980 Theodore J. Spilman, 1981 Jack E. Lipes, 1982 Margaret S. Collins, and 1983 Manya B. Stoetzel. Floyd F. Smith, a member since 1921, and George S. Langford, a member since 1924, were introduced.

In the United States only the American Entomological Society (1859), the Cambridge Entomological Club (1874), and the Brooklyn Entomological Society (1872) which is now absorbed in the New York Entomological Society (1892) are older than the ESW. The American Entomological Society was represented at the banquet by its 1984 President, Charles E. Mason. The Cambridge Entomological Club was represented by one of its members, Norman E. Woodley who joined the ESW in 1983. The Biological Society of Washington (1880) was represented by Paul J. Spangler, a life member of the ESW, who joined the Society in 1958. In 1898 the Entomological Society of Washington and the Biological Society of Washington joined with six other societies to form the Washington Academy of Sciences, and the Academy was represented by its current treasurer, Ronald W. Manderschied. The Entomological Society of America was represented by its immediate Past President W. Donald Duckworth, a member of the ESW since 1961. Congratulatory letters were read from Ray F. Morris, President of the Entomological Society of Canada (1950), from Hugh D. Sissler, Chairman of the Pest Science Society of Washington (1934—as the Insecticide Society of Washington until 1981), and from President Ronald Reagan, The White House, Washington.

The special guest for the evening was Emilie Wenban-Smith of Hampshire, England, the last surviving grandchild of the late, eminent entomologist Charles Valentine Riley, the President of ESW during 1884, 1885, 1892, and 1893. Ms. Wenban-Smith was presented a copy of the Vol. 1, No. 1, 1890, issue of the *Proceedings* which contains the organizational information on the Society and which documents the prominent part her grandfather, C. V. Riley, played in the formation of the Society and a copy of the Vol. 86, No. 1, January 1984, issue which contains T. J. Spilman's "Vignettes of 100 years of the Entomological Society of Washington" and M. B. Stoetzel's "ESW Past-Presidents for the years 1884 through 1983, Photographs and Support Officers." In 1873 the French government presented C. V. Riley with a gold medal, struck in appreciation of his services in the study of the grape phylloxera. Ms. Wenban-Smith took the occasion of the banquet to present the medal to the U.S. Department of Agriculture; it was accepted for the USDA by Orville G. Bentley, Assistant Secretary for Science and Education. The medal has been placed with Dr. Riley's desk in the National Agricultural Library, Beltsville, Maryland. Dr. Bentley referred to the establishment of the Charles Valentine Riley Memorials Program and presented some of the background information on and the intent of the Riley Memorials Program. Victor John Yannacone, jr. provided each person with a brochure of interesting facts about the life and scientific accomplishments of Dr. Riley.

The main speaker for the evening was Curtis W. Sabrosky, Cooperating Scientist, Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, a member of the ESW since 1946. Dr. Sabrosky's talk, titled "In Days of Yore," focused on the formation of the Society, its activities through the 100 years of its existence, recollections of some of the Society's early members, and photographic slides of some of the Society's more illustrious members. Dr. Sabrosky's talk appears elsewhere (p. 733–737) in the October 1984 issue of the *Proceedings.*

The evening's festivities ended at 10:45 p.m. The day was filled with reminiscences of the past 100 years and expectations for the future not only of the Entomological Society of Washington but also of the science of entomology.

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SOCIETY MEETINGS

901st Regular Meeting—January 5, 1984

The 901st Regular Meeting of the Entomological Society of Washington was called to order by President Neal O. Morgan in the Naturalist Center, National Museum of Natural History at 8 p.m. on January 5, 1984. Thirty-two members and five guests were present. The minutes of the previous meeting were read and approved. Membership Chairman Geoffrey White read the names of the following applicants for membership: James M. Carpenter, NHB 168, Smithsonian Institution, Washington, DC 20560; Paul Hendricks, Department of Zoology, University of Montana, Missoula, MT 59812.

D. M. Anderson presented details of the centennial banquet to be held on March 12, 1984, on the College Park campus of the University of Maryland. He also mentioned that the Entomological Society of America has a 1984 calendar available which uses many drawings done by illustrators at the Smithsonian Institution.

It was moved by M. B. Stoetzel and seconded by M. Ramsey that the Society enact changes in the bylaws to establish an additional officer of the Society. This new officer will be called the Associate Editor, shall assist the Editor in the production of the publications of the Society, and shall be elected at least 1 year prior to the termination of service by the Editor. The Associate Editor, when there is one, shall be a member of the Publications Committee. The motion was approved by majority vote.

Hiram Larew reported that he would present his ideas on the subject of a scholarship fund to the Executive Committee at its next meeting.

The speaker for the evening was Manya B. Stoetzel, Research Entomologist, Systematic Entomology Laboratory, Agricultural Research Service, Beltsville, Maryland, whose talk was entitled, "Phylloxeridae: Perplexing, Pretty and Pergande." Dr. Stoetzel discussed various species in the family Phylloxeridae with particular emphasis on those species that are pests of pecans. *Phylloxera texana* Stoetzel was discussed in detail and the interesting search to discover its life cycle and alternate host was presented.

The meeting was adjourned at 9:15 p.m. after which refreshments were served.

Thomas E. Wallenmaier, *Recording Secretary*

902nd Regular Meeting—February 2, 1984

The 902nd Regular Meeting of the Entomological Society of Washington was called to order by President Neal O. Morgan in the Naturalist Center, National Museum of Natural History at 8:00 p.m. on February 2, 1984. Thirty-eight members and thirty guests were present. The minutes of the previous meeting were read and approved. Membership Chairman Geoffrey White read the names of the following applicants for membership: David P. Cowan, Department of Biology, Western Michigan University, Kalamazoo, MI 49088; James E. Keirans, Department of Entomology, Museum Support Center, Smithsonian Institution, Washington, DC 20560; Janet J. Knodel-Montz, Entomology Department, Price Hall, VPI&SU, Blacksburg, VA 24061; Beth B. Norden, 1 Austin Ct., College Park, MD 20740; Donald R. Riley, 6500 Dockberry #15, Brownsville, TX 78521; and Rupert L. Wenzel, Field Museum of Natural History, Roosevelt Road at Lake Shore Drive, Chicago, IL 60605.

D. M. Anderson presented more details concerning the Society Centennial banquet. M. B. Stoetzel announced that the United States Department of Agriculture is establishing a C. V. Riley Memorial. To mark this occasion, a member of his family will be present at our Centennial banquet in March. Hiram Larew provided a report on the work of his committee to establish a scholarship fund.

Victor Adler announced that Ralph Sherman passed away. Mr. Adler also stated that a collection of insects is needed for a handicapped group in Howard County, Maryland. He also suggested consideration be given to having a reduced student rate at the Society banquet.

C. W. Sabrosky stated that he is looking for slides of past members and officers of the Society to incorporate into his talk at the Centennial banquet. Manya Stoetzel noted that Arnold Mallis passed away.

The speaker for the evening was Murray S. Blum, Research Professor of Entomology, University of Georgia, Athens, Georgia, whose talk was entitled, "Orchids, bees, and misguided sex." Dr. Blum related the amazing evolutionary development of members of the orchid family with the parallel development of species of Euglossine bees. The importance of the behavior of each species of bee toward pollination of a species of orchid was considered and attempts at measuring the attractants involved was discussed.

The meeting was adjourned at 9:20 p.m. after which refreshments were served.

Thomas E. Wallenmaier, *Recording Secretary*

CENTENNIAL BANQUET—March 12, 1984

The Centennial Banquet was held on the College Park Campus of the University of Maryland. The festivities began with a social hour at 6:30 p.m. A string quartet entertained the guests from 6:30 p.m. to 7:30 p.m. This was made possible by contributions from Arly Allen Jr. of Allen Press, Inc., CIBA-GEIGY Corporation, the Pest Science Society of Washington, and Monsanto Company. At 7:30 p.m. the formal dinner was served. At 8:30 p.m. the program began. The Master of Ceremonies was Manya B. Stoetzel. There were 190 people in attendance. A congratulatory letter from Honorary Member C. F. W. Muesebeck was read in his absence. Dr. Muesebeck also provided a donation of $5,000 to the Society with his letter. Three other honorary members, F. W. Poos, A. B. Gurney, and T. L. Bissell, were introduced along with the current officers of the Society. Of the 33 living past presidents, 24 were present and were introduced. Two additional members recognized for length of their membership in the Society were Floyd F. Smith and George S. Langford. A large number of important entomological societies were present at the banquet and they were recognized as follows:

American Entomological Society, Charles E. Mason, President
Cambridge Entomological Club, Norman E. Woodley, Member
Entomological Society of America, W. Donald Duckworth, Past-President

Entomological Society of Canada, Letter from Ray F. Morris, President
Biological Society of Washington, Paul J. Spangler, Member
Washington Academy of Sciences, Ronald W. Manderscheid, Treasurer
Pest Science Society of Washington, Letter from Hugh D. Sissler, Chairman

A letter of congratulations from Ronald Reagan, President of the United States of America, was read.

The special guest for the evening was Ms. Emilie Wenban-Smith of Hampshire, England, the granddaughter of the late, eminent entomologist Charles Valentine Riley, one of the founders of the ESW and its President during its first, second, ninth, and tenth years. Ms. Wenban-Smith was presented with a copy of the first issue and one of the last issue of the *Proceedings.* In 1873 the French presented Dr. Riley with a grand gold medal, struck in appreciation of his services in the study of the grape phylloxera; and Ms. Wenban-Smith took the occasion of the banquet to present the medal to the U.S. Department of Agriculture. The medal was accepted for the USDA by Dr. Orville G. Bentley, Assistant Secretary for Science and Education, USDA, who then announced the establishment of the C. V. Riley Memorials Program [which will be supported by a gift of $150,000 from the estate of the late Catheryn Vedalia Riley, formerly a physician on Long Island, the last surviving child of Dr. Riley, and an aunt of Ms. Wenban-Smith]. Dr. Bentley presented some of the background information on and the intent of the Riley Memorials Program.

The main speaker for the evening was Curtis W. Sabrosky, Cooperating Scientist, Systematic Entomology Laboratory, USDA, and was entitled, "In Days of Yore." Through slides, anecdotes, and interesting historical details, Dr. Sabrosky presented a panorama of the history of the Society.

Thomas E. Wallenmaier, *Recording Secretary*

904th Regular Meeting—April 5, 1984

The 904th Regular Meeting of the Entomological Society of Washington was called to order by President Neal O. Morgan in the Naturalist Center, National Museum of Natural History at 8 p.m. on April 5, 1984. Twenty-six members and nine guests were present. The minutes of the February meeting and the Centennial Banquet were read and approved with minor changes. Membership Chairman Geoffrey White read the names of the following applicants for membership: Joseph J. Anderson, Department of Entomology, MCSE, University of Maryland, College Park, MD 20740; George W. Byers, Department of Entomology, University of Kansas, Lawrence, KS 66045; Charles F. Cornell, 7418 Allan Avenue, Falls Church, VA 22046; Maurice H. Farrier, Department of Entomology, North Carolina State University, Box 5215, Raleigh, NC 27650; Richard L. Hall, 4400 Mobile Drive, Apt. 217, Columbus, OH 43220; John F. McDonald, Department of Entomology, Purdue University, West Lafayette, IN 47907; Peter Mason, Research Station, Agriculture Canada, 107 Science Crescent, Saskatoon, Saskatchewan S7N0X2; Weste L. A. Osbrink, 10313 Pradera Avenue, #D, Montclair, CA 91763; Emily Rock, Biology Department, University of Akron, Akron, OH 44304; George Roemhild, Department of Biology, Montana State University, Bozeman, MT 59717; Peter A. Rush, USDA Forest Service, 1992 Folwell Avenue, St. Paul, MN

55108; Michael K. Rust, Department of Entomology, University of California, Riverside, CA 9 521; Joseph C. Schaffner, Department of Entomology, Texas A&M University, College Station, TX 77843; G. G. E. Scudder, Department of Zoology, University of British Columbia, 6270 University Boulevard, Vancouver, BC VGT2A9; Hector Delgado Zambrano, Calle 35 No. 18-21 of .607, Bucaramanga, Columbia; and Gaye L. Williams, Maryland Department of Agriculture, Annapolis, MD.

President Morgan announced that photographs from the centennial banquet were on display at the meeting. John Kingsolver exhibited specimens of *Novelsis aequalis* Sharp (Coleoptera—Dermestidae), larval specimens of which he received from a Washington, DC, neighborhood around 1959. He was not able to rear out adults, however, until he obtained more specimens about three years ago and now has a reproducing colony. This beetle has the potential for becoming a museum pest.

A meeting of the Executive Committee was announced for April 12, 1984, in Beltsville.

It was noted that Rupert Wenzel had suffered a heart attack and is recovering.

The speaker for the evening was LTC Bruce Harrison, Manager, Walter Reed Biosystematics Unit, National Museum of Natural History, Washington, D.C., whose talk was entitled, "Mosquito Taxonomists' Collecting Experiences in Egypt." Colonel Harrison is engaged in biosystematic studies on mosquito vectors of human diseases. He spent 58 days in Egypt collecting at various localities with most of the work being done adjacent to the Nile River. The purpose was to gather adult specimens with associated larval and pupal skins. Colonel Harrison described the various habitats in which he sampled, the people he worked with, and many of the temples and monuments in Egypt. A number of changes in the taxonomy of mosquitoes resulted from the trip. Many excellent slides were shown.

The meeting was adjourned at 9:20 p.m. after which refreshments were served.

Thomas E. Wallenmaier, *Recording Secretary*

905th Regular Meeting—May 3, 1984

The 905th Regular Meeting of the Entomological Society of Washington was called to order by President-elect Donald Anderson in the Naturalist Center, National Museum of Natural History at 8:00 p.m. on May 3, 1984. Twenty-five members and seven guests were present. The minutes of the April meeting were read and approved. Membership Chairman Geoffrey White read the names of the following applicants for membership: Edward W. Evans, Division of Biology, Kansas State University, Manhattan, KS 66506; Analia Constancia Paggi, Institute de Limnologia, C.C. 55, 1923 Berisso, Argentina; Jonathan Coddington, Smithsonian Institution, Washington, DC 20560; and Sean Kane, 3520 W. Place, NW., Washington, DC 20007.

Dr. Anderson brought before the members the concept of the Society sponsoring a Scholarship Fund. After a few minutes of discussion, it was moved by R. Gagné and seconded that the discussion be tabled. The motion was carried.

William Bickley exhibited a book by Samuel Breeland entitled, "Bugs, Folks and Fun." John Fales discussed the recently published folder on the State of

Maryland symbols which now includes the Baltimore Checkerspot Butterfly. George Steyskal exhibited a book on butterflies by Paul Opler and George Krizek. It was noted that Floyd Smith passed away on April 26, 1984.

The speaker for the evening was Dr. Luther Brown, Biology Department, George Mason University, whose talk was entitled, "Why some beetles have horns and why they come in different sizes." The function of horns in various beetle species was related to sexual selection activities. Dr. Brown next discussed his recent research with *Bolitotherus cornutus* Sharp (Coleoptera: Tenebrionidae). The life history of the species was discussed; examination of the relationship of horn length, body length and courtship behavior showed a positive correlation of horn length/body length ratio to courtship behavior. Tests on the heritability of horn length gave negative results and indicated that environmental factors were influential in determining horn length.

The meeting was adjourned at 9:45 p.m. after which refreshments were served.

Thomas E. Wallenmaier, *Recording Secretary*

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