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Meetings of the Society are held on the third Tuesday of each month (except June through September) at 8 p.m. in the American Museum of Natural History, Central Park West at 79th Street, New York, New York.

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ANNOUNCEMENT

BEQUEST AND PUBLICATION FUND

Late in 1983 the Society was informed that it would be the recipient of generous bequests from the estates of the late Dr. Charles Alexander and Mrs. Patricia Vaurie.

Dr. Alexander was a world renowned expert on crane flies, which interest he pursued during his career as a professor of entomology at the University of Massachusetts in Amherst. Mrs. Vaurie took up entomology as an avocational interest, but soon established a strong working relationship with the Department of Entomology of the American Museum of Natural History in New York City, where as a Research Associate she pursued her interests in beetle classification, particularly of the families Curculionidae, Languriidae, and Scarabaeidae. Both Dr. Alexander and Mrs. Vaurie stipulated that their gifts be used for the benefit of the Society's publications.

The interests of C. P. Alexander and Patricia Vaurie were strongly oriented towards monographic work on the groups of insects which they studied. The same interests have long been associated with the publications of the New York Entomological Society and the Brooklyn Entomological Society, which were incorporated in 1968.

The Society has therefore established a "Journal Publication Endowment Fund," the proceeds of which will be devoted to the costs of publication of the *Journal of the New York Enntomological Society.* The Society officers intend the endowment to: 1) encourage the publication of monograph-length papers; 2) increase the number of pages published annually in the *Journal*; 3) reduce the per-page cost to authors; and 4) maintain the costs of membership and subscription at reasonable and competitive rates.

NEW YORK ENTOMOLOGICAL SOCIETY
92(1), 1984, pp. 2–18

DIRECTORY OF SYSTEMATIC ENTOMOLOGISTS AND ACAROLOGISTS IN THE PEOPLE'S REPUBLIC OF CHINA

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Insect Identification and Beneficial Insect Introduction Institute,
U.S. Department of Agriculture, Beltsville, Maryland 20705

Abstract.—Listings of 188 systematic entomologists in the People's Republic of China are given by institution, speciality and name.

This directory is a revised and expanded version of a list that originally appeared in the volume *Biological Control of Pests in China* (p. 249 ff.), which was published in 1982 by the Office of International Cooperation and Development (OICD), United States Department of Agriculture (USDA). The directory lists 188 persons who are conducting or who have recently conducted taxonomic studies of insects and mites at 63 institutions in the People's Republic of China (PRC). The directory is derived from articles published in *Entomotaxonomia, Contributions of the Shanghai Institute of Entomology,* and *Acta Entomologica Sinica*; from lists prepared by J. R. Coulson and D. R. Davis during their visits to the PRC in 1979; from information obtained by P. M. Marsh and E. E. Grissell during their visit in 1980; and from information obtained by L. Knutson and R. D. Gordon during their visit in 1981. Many subsequent additions and corrections have been made by L. Knutson.

Names that appear in parentheses below the name of an institution indicate personal visits to the pertinent institution by the named individual (J. R. Coulson, E. E. Grissell, R. D. Gordon, P. M. Marsh, and L. Knutson IIBIII, USDA; D. R. Davis, Department of Entomology, Smithsonian Institution). These persons may be able to provide additional information about these institutions to requestors.

This directory is arranged according to the historical arrangement of directories in the PRC—by province, generally from the northeast to the southwest, then the center, then the central and coastal southeast, then lastly the tropical southern provinces. Within each province the institutions are arranged according to the following sequence: 1) institutions affiliated with Academia Sinica; 2) other research institutions (universities, health stations, etc.); and 3) museums. Old names of provinces are included in brackets at first mention. Names of persons are arranged alphabetically within each institution, except for the large Institutes in Beijing and Shanghai.

Since 1949, formal titles and a hierarchical ranking system have generally not been used in universities, colleges, and scientific units in the PRC. Exceptions to this apply to persons who have received a doctoral degree in an overseas university and, in some cases, persons who received a doctoral degree in China prior to 1949. Most units apparently have someone who serves as "Chairman" or "Director" in the Western sense of the term, although they may not be officially titled as such. Western titles such as "Dr.", "Mr.", "Miss", and "Mrs." are appropriate in addressing persons verbally. Note that married women retain their family name but may be addressed verbally as "Madame ____." In addressing someone in writing in China, titles are usually not used, but a female character is placed after the name of a female. Westerners addressing persons in China in writing should use a title or not as seems appropriate. Where known, we have included Western-style titles in this directory.

In this directory, the modern (pinyin) transliteration of the names of persons is given first, followed by the old spelling (Wade-Giles), where both are known. In a few instances, the spelling used here is that used by the scientist, particularly for persons who have published under the old transliteration. In the Chinese system, the family name is written first and the given name second. In the past few years, the hyphen in the given name often has been dropped, so that now the given name consists of one word. However, the use of the hyphen, and in fact the spelling of the given name, may be inconsistent; different spellings have been used for two different articles in even one issue of a journal. The pinyin system is used exclusively for place names herein. Names or parts of names have been underlined where the spelling is uncertain. Names preceded by a question mark and in brackets are neither pinyin nor Wade-Giles and cannot be corrected without the appropriate Chinese characters.

We would like to thank A. C. F. Hung, Beneficial Insect Introduction Laboratory (BIIL), IIBIII, for reviewing the directory and correcting the spelling of many names. We also thank William L. Davis, formerly Agricultural Counselor, Beijing, for his helpful comments on the formation of Chinese names; Prof. Yang Pinglan, Director, Institute of Entomology, Academia Sinica, Shanghai, for his useful comments; and Huo Shaotang, Academy of Agricultural Sciences, Yangling, Shaanxi Province, for offering many important corrections and additions and for assisting in the organization of the information.

No words of appreciation would be complete without recognition of the support received from the USDA's Office of International Cooperation and Development, which has coordinated the U.S.–China agricultural exchanges, sponsored visits to the PRC by Agricultural Research Service entomologists, and encouraged publication of results—an outgrowth of which is the present effort. We are most appreciative of the various kinds of expert assistance and advice provided by the OICD staff and especially by Thomas F. Kelly.

This directory, as well as several other directories of insect systematists and biological control workers, is being maintained and updated in the Insect Identification and Beneficial Insect Introduction Institute as part of the Institute's computerized Biosystematic and Biocontrol Information System. Thus, it would be greatly appreciated if any corrections or additions to this directory would be sent to Lloyd Knutson, Chairman, Insect Identification and Beneficial Insect Introduction Institute, Room 1, Bldg. 003, Beltsville Agricultural Research Center—West, Beltsville, MD 20705, to be incorporated into future revisions.

INSTITUTIONAL INDEX

1. *Institute of Zoology, Department of Insect Taxonomy and Faunology, Academia Sinica,* BEIJING [PEKING] (Coulson—79, Davis—79, Grissell and Marsh—80, Knutson and Gordon—81)

Mr. Meng Xianling (Meng Hsiang-Ling) [Director for Research, Administrative Section, Institute of Zoology].

Mr. Zhao Jianming (Chao Chien-ming) [Vice Director, Associate Research Scientist]—Diptera: Tachinidae, Sarcophagidae.

Prof. Dr. Zhu Hongfu (Chu Hung-fu) [Deputy Director]—Lepidoptera: Geometridae, Sphingidae, Saturniidae, Bombycidae, Drepanidae, Hepialidae, Brahmaeidae, Uraniidae, Pterothysanidae, Callidulidae, Endromidae, Episopeiidae. Homoptera: Aphidoidea.

Coleoptera

Mr. Chang Youwei [Assistant Research Scientist]—Scarabaeoidea.

Prof. Dr. Chen Shixiang (Chen Secien or Chen Shih-Hsiang) [Director]—Chrysomelidae.

Ms. Chen Yuanquing [Research Assistant]—Curculionoidea.

Mr. Huang Fusheng [Associate Research Scientist]—Scolytidae. Protura. Zoraptera.

Mr. Li Hongxing (Lee Hung-shing) [Assistant Research Scientist]—Bruchidae, Curculionidae.

Ms. Pu Fuji (Pu F. J.) [Assistant Research Scientist]—Cerambycidae.

Ms. Tan Zhuanjie (T'an Chuanchieh) [Associate Research Scientist]—Meloidae, Cicindelidae, Eumolpidae, fossil insects.

Ms. Yin Hui-fen (Hweifeng) [Associate Research Scientist]—Scolytidae, Platypodidae.

Ms. Yu Peiyu [Associate Research Scientist]—Carabidae, Criocerinae.

Lepidoptera

Mr. Cai Rongquan [Assistant Research Scientist]—Notodontidae, Limacodidae.

Ms. Chao Chungling [Assistant Research Scientist]—Lymantriidae, Psychidae, Thyatridae.

Mr. Chen Yixin [Assistant Research Scientist]—Noctuidae, Agaristidae, Cossidae.

Ms. Fang Chenglai [Assistant Research Scientist]—Arctiidae, Amatidae, Hypsidae, larvae and pupae of Noctuidae.

Mr. Hou Taogion [Assistant Research Scientist]—Lasiocampidae, Thaumetopoeidae. Coleoptera: Buprestidae.

Prof. Li Zhuanlong (Li Chuanlung)—Rhopalocera, Papilionidae.

Mr. Liu Yujiao (Liu Yu Chiao) [Associate Research Scientist]—Tortricidae, Cochylidae, Ethmiidae.

Mr. Wang Pingyuan [Associate Research Scientist]—Pyralidae, Zygaenidae.

Hymenoptera

Mr. Chen Tailu—*Trichogramma.*

Mr. Liao Dingxi (Liao Tingshi) [Associate Research Scientist]—Chalcidoidea.

Ms. Wang Jinyan [Research Assistant]—Braconidae.

Ms. Wang Sufang [Assistant Research Scientist]—*Bombus,* Ichneumonidae.

Ms. Wu Yanru (Wu Yenju) [Assistant Research Scientist]—Apoidea, Proctotrupoidea.

Diptera

Mr. Li Tiesheng [Assistant Research Scientist]—Ceratopogonidae. Hymenoptera: Vespoidea.

Ms. Ma Sufang [Assistant Research Scientist]—Culicidae.

Ms. Shi Yongshan [Assistant Research Scientist]—Tachinidae, Syrphidae. (Works with Mr. Zhao.)

Ms. Sun Caihong [Assistant Research Scientist]—Syrphidae, Anthomyiidae, Calliphoridae, Muscidae.
Ms. Wang Zunming (Mrs. Li Tiesheng) [Research Assistant]—Tabanidae. (Visited at Oregon State University, 1982.)

Homoptera

Mr. Wang Ziqing (Wang Tzeching) [Assistant Research Scientist]—Coccoidea.
Mr. Zhang Guangxue (Chang Guangshyue) [Assistant Research Scientist]—Aphidoidea. Thysanoptera.
Mr. Zhong Tiesen—Aphidoidea (*Entomotaxonomia*).

Orthoptera

Liu Jupeng—Acrididae.

Acari

Mr. Teng Kuofan [Associate Research Scientist]—Ixodoidea, Gamasoidea. Anoplura.
Ms. Wang Xiangfu [Assistant Research Scientist]—Tetranychidae.

2. *Department of Plant Protection, Beijing Agricultural University,* BEIJING (Coulson—79)
Prof. Yang Ji-kun (Yang Chi-Kun)—Neuroptera: Chrysopidae. Other beneficial insects. Diptera: Rhagionidae. Coleoptera: Stylopidae.

3. *Forest Research Institute, Chinese Academy of Forestry,* BEIJING (Knutson and Gordon—81)
Ms. Huang Xiaoyun—Hymenoptera: Tenthredinoidea.
Mr. Li Guan-wu—Hymenoptera: Tenthredinoidea.
Prof. Xiao Gangrou (Hsiao Kang-Jou) [Vice Director]—Hymenoptera: Tenthredinoidea.
Dr. Zhou Shushi—Hymenoptera: Tenthredinoidea.

4. *Institute of Microbiology and Epidemiology, Chinese Academy of Military Medical Sciences,* P.O. Box 130, BEIJING
Dou Guilan—Siphonaptera.
Ji Shuli—Siphonaptera.
Li Peisi—Diptera: Ceratopogonidae, Culicidae.
Liu Chi-ying—Siphonaptera: Ceratophyllidae.
Liu Quan—Siphonaptera: Ceratophyllidae.
Prof. Lu Baolin (Luh Paoling)—Diptera: Ceratopogonidae, Culicidae.
Ren Shiming—Siphonaptera.
Wang Tai-hua—Diptera: Ceratopogonidae.
Wu Houyong—Siphonaptera: Hystrichopsyllidae.
Mr. Yu Yixin—Diptera: Ceratopogonidae.

5. *Museum of Natural History,* BEIJING (Davis—79)
Mr. Liu Sinan (Liu Szenang)—General entomology.
Ms. Wang Xicheng (Wang Shechan)—General entomology.
(Both are involved mainly in exhibit work at present; no publications.)

6. *Laboratory of Taxonomy and Ecology, Shanghai Institute of Entomology, Aca-*

demia Sinica, Chungkin Road (S.), 225 SHANGHAI (Coulson—79, Davis—79, Grissell and Marsh—80, Knutson and Gordon—81)

Prof. Xia Kai-ling (Hsia Kai-ling) [Laboratory Head]—Orthoptera: Acridoidea. Isoptera: Rhinotermitidae, Termitidae. Diptera: Asilidae.

Protura

Prof. Ms. Yin Wen-ying (Yin Wen-Ying) [Vice Director]—Eosentomidae.
Mr. Zhang Zhi-yuan (Zhang Zhi-yang)—Eosentomidae.

Isoptera

Mr. Fan Shu-de (Fan Shu-teh)—Rhinotermitidae.
Ms. Han Meizhen.
He Xiu-song—Termitidae.

Orthoptera

Ms. Bi Dao-ying—Acridoidea.
Ms. Jin Xing-bao—Acridoidea.

Homoptera

Mr. Hu Jing-lin (Hu Jin-lin)—Coccoidea: Diaspididae.
Prof. Yang Pinglan (Bain-ley Young) [Director of the Institute]—Coccoidea: Diaspididae. Aleyrodidae.

Diptera

Mr. Chen Zhi-zi (Chen Tzi-Tze) [Assistant Engineer]—Anthomyiidae, Calliphoridae, Muscidae, Sarcophagidae.
Prof. Fan Zi-de (Fan Tze-teh)—Anthomyiidae, Muscidae, Calliphoridae (especially synanthropic calyptrate Diptera), Hypodermatidae, Syrphidae, Sarcophagidae (not including Tachinidae).
Prof. Liu Wei-de (Liu Wi-teh) [Vice Director]—Tabanidae, Culicidae.
Yao Yun-mei—Tabanidae.

Lepidoptera

Mr. Li Chengzhang (Li Cheng-chang)—Pyralidae.

Hymenoptera

Mr. Shi Dasan [Deputy Head of the Laboratory]—*Trichogramma,* Aphidiidae. Diptera: Syrphidae.

Acari

Mr. Wang Xiaozu (Wang Shiao-tsu)—Acaridae, Cheyletidae, Glycyphagidae.

Hemiptera

Ms. Jin Quinying.

7. *Department of Biology, Fudan University,* SHANGHAI (Knutson and Gordon—81)

Acari

Ms. Ding Tingzhong—Tarsonemidae (cyclamen mites), Eriophyidae.
Ms. Dong Huiqing—Eriophyidae.
Mrs. Ke Lisheng—Phytoseiidae.

Mr. Liang Lairong—Phytoseiidae.
Prof. Xin Jieliu (Shin Kai-lou)—Especially Trombidiidae.

8. *Shanghai College of Agriculture,* SHANGHAI
Mr. Ma En-Pei—Acari: Tetranychidae.

9. *Shanghai First Medical College,* SHANGHAI
Prof. Hsu Yinchi—Acari: chiggers, *Demodex.*
Prof. Wen Tinghuan—Acari: Acariformes, Trombiculidae.

10. *Second Military Medical College, Department of Parasitology,* SHANGHAI (Davis—79)
Prof. Xu Feng-yi (Chu Fengi)—Diptera: Culicidae, Ceratopogonidae.

11. *Museum of Natural History,* SHANGHAI (Davis—79)
Ms. Yuan Yilan—Acari: Tetranychidae.

12. *Department of Biology, Nankai University,* TIANJIN (TIENTSIN)
Mr. Zheng Leyi (Zheng Le-yi)—Hemiptera: Lygaeidae.

13. *Tianjin Animal and Plant Quarantine Service, Pu-Cow Road,* TIANJIN
Mr. Guan Lianghua—Taxonomy of stored-product pests, especially Coleoptera, and quarantine.

14. *Tianjin (Tientsin) Museum of Natural History,* TIANJIN
Mr. Liu Shengli—Hemiptera: Acanthosomatidae.

15. *First Control and Research Institute of Endemic Disease,* JILIN [KIRIN] PROVINCE
Ma Liming—Acari: Parasitiformes: Rhodacaridae.

16. *Northeastern Normal University, Changchun,* JILIN PROVINCE
Zhang Fengling—Orthoptera: Acrididae.

17. *Health and Anti-epidemic Station of Benxi City,* LIAONING PROVINCE
Xue Wanqi—Diptera: Muscidae.

18. *Sanitary and Epidemiological Station of Liaoning Province,* LIAONING PROVINCE
Ma Zhong-yu—Diptera: Anthomyiidae.

19. *Shenyang Agricultural College,* SHENYANG, LIAONING PROVINCE (Coulson—79)
Ma Ning—Homoptera: Cicadellidae.
Wang Jinling—Hymenoptera: Trichogrammatidae.
Mr. Zhang Jing—Hymenoptera: Trichogrammatidae.

20. *Nei-Monggol (Inner-Mongolian) College of Agriculture and Animal Husbandry,* HUHHOT, INNER MONGOLIA
Li Hong-Zhang (Lee Hung-Chang)—Coleoptera: Curculionidae.

21. *North West Plateau Institute of Biology, Academia Sinica,* YANGLING, SHAANXI [SHENSI] PROVINCE
Yin Xiangchu—Orthoptera: Acrididae.

22. *Academy of Agricultural Sciences,* YANGLING, SHAANXI PROVINCE
Huo Shaotang—Hymenoptera: biotypes of *Trichogramma.*

23. *Shaanxi Medical College,* SHAANXI PROVINCE
Lu Yin-lian—Diptera: Muscidae, Calliphoridae, Sarcophagidae.
Wang Chang-jing—Diptera: Muscidae, Calliphoridae, Sarcophagidae.

24. *Forest Research Institute,* YANGLING, SHAANXI PROVINCE
Mr. Dang Xinde—Parasitic Hymenoptera.
Mr. Jin Buxian—Parasitic Hymenoptera.

25. *Department of Biology, Shaanxi Normal University,* XIAN, SHAANXI PROVINCE
Prof. Zheng Zhemin—Orthoptera: Acrididae, Tetrigidae.

26. *Xian Medical College,* XIAN, SHAANXI PROVINCE
Xiao Aixiang—Siphonaptera: Ischnopsyllidae.

27. *Health and Anti-epidemic Station of Yanbei Region,* SHAANXI PROVINCE
Wang Mingfu—Diptera: Muscidae.

28. *Department of Plant Protection, Northwestern College of Agriculture,* YANGLING, SHAANXI PROVINCE (Knutson and Gordon—81)
Mr. Chen Tong [Assistant]—Apterygota.
Prof. Dr. Chou Io (Zhou Yao)—Homoptera: Membracidae, Fulgoridae, Cercopidae. Coccoidea: Diaspididae. Hymenoptera: Aphidiidae. Lepidoptera: Plusiinae, Noctuidae. Apterygota. Mecoptera.
Mr. Liu Shaoyou [Lecturer]—Syrphidae (*Syrphus* and *Sphaerophoria*).
Prof. Lu Jinsheng—Hemiptera: Nabidae.
Ms. Lu Zheng (Lu Tseng) (Mrs. Chou Io)—Homoptera: Cercopidae. Acari. Lepidoptera: Noctuidae.
Ms. Ran Ruibi [Lecturer]—Neuroptera: Chrysopidae.
Mr. Wei Jianhua [Lecturer]—Coleoptera: Coccinellidae.
Mr. Xiang Longcheng—Hymenoptera: Aphidiidae.
Mr. Yuan Feng [Lecturer]—Homoptera: Membracidae.

29. *Lanzhou University,* LANZHOU, GANSU [KANSU] PROVINCE
Wang Xin-e—Siphonaptera: Hystrichopsyllidae.

30. *201st Institute of Gansu Province,* GANSU PROVINCE
Zhang Rongguang—Siphonaptera: Hystrichopsyllidae.

31. *Institute of Forestry, Qinghai Academy of Agriculture & Forestry,* QINGHAI [CHINGHAI] PROVINCE
Xu Chenkuo (Hsu Chenkuo)—Lepidoptera: Lasiocampidae.

32. *Qinghai Province (West) Institute of Biology,* XINING, QINGHAI PROVINCE
Beng Guiying—Acari.
Chen Xiudao—Acari.
Su Tizhi—Acari.

33. *Institute of Plant Protection, Sichuan Academy of Agriculture,* CHENGDU, SICHUAN [SZECHUAN] PROVINCE (Davis—79)
Prof. Chen Fang-jie [Institute Director]—Homoptera: Coccidae.
Mr. Jiang Guang-Zao (K. T. Chiang)—Homoptera: Coccidae.

34. *Southwestern Agricultural College,* CHONGQING (=CHUNGKING), SICHUAN PROVINCE (Coulson—79)
Prof. Jiang Shunan (Chiang Shunan) [President of the College]—Coleoptera: Cerambycidae.
Prof. Li Longshu—Acari.

35. *Citrus Research Institute,* CHONGQING, SICHUAN PROVINCE
Yu Zhiren—Acari: Phytoseiidae. (Studied at University of California, Riverside, 1981–1982.)

36. *Department of Parasitology, Chongqing Medical College,* CHONGQING, SICHUAN PROVINCE
Jeu Minghaw—Diptera: Ceratopogonidae.
Rong Yunlong—Diptera: Ceratopogonidae.

37. *Division of Medical Zoology and Entomology, Health & Anti-epidemic Station of Sichuan,* SICHUAN PROVINCE
Chen Ningyu—Siphonaptera.
Wei Shufeng—Siphonaptera.

38. *Department of Biology, Nanchung Teachers College,* NANCHUNG, SICHUAN PROVINCE
Mr. Zheng Fa-ke—Coleoptera: Staphylinidae.

39. *Chengdu Institute of Termite Control,* SICHUAN PROVINCE
Gong Anhu—Isoptera: Kalotermitidae.

40. *Academy of Agricultural Sciences,* SHANDONG [SHANTUNG] PROVINCE
Feng Jianguo—Hymenoptera: biotypes of *Trichogramma.*

41. *Nanjing Agricultural College,* JIANGSU [KIANGSU] PROVINCE
Ding Jin-Hua—Homoptera: Delphacidae.
Mr. Tian Li-Xin—Homoptera: Delphacidae.

42. *Military Medical Research Institute,* NANJING, JIANGSU PROVINCE
Wu Chenglin—Acari: Acariformes: Trombiculidae.
Wu Guanghua—Acari: Acariformes: Trombiculidae.
Yang Zhesheng—Acari: Acariformes: Trombiculidae.

43. *Nanjing Institute of Termite Control,* JIANGSU PROVINCE
Gao Daorong—Isoptera: Kalotermitidae.
Zhu Benzhong—Isoptera: Kalotermitidae.

44. *Institute of Agriculture,* NANTUNG, JIANGSU PROVINCE
You Qi-Ti—Hymenoptera: Ichneumonidae.
You Shi-Jin—Hymenoptera: Ichneumonidae.

45. *Anhui Agricultural College,* ANHUI [ANHWEI] PROVINCE
Prof. Ge Zhong-Lin (Ge Chung-Lin)—Homoptera: Delphacidae.
Meng Xuwu—Lepidoptera: Sphingidae.

46. *Sanitarian and Anti-epidemic Station,* HUBEI [HUPEH] PROVINCE
Zhang Di—Siphonaptera: Ceratophyllidae.

47. *Hupei Medical College, Wuhan,* HUBEI PROVINCE
Zhang Mengyu—Diptera: Sarcophagidae.

48. *Kunming Institute of Zoology, Academia Sinica,* KUNMING, YUNNAN PROVINCE (Davis—79)
Mr. Chao Wanyuan—Homoptera: Aphididae.
Mr. Gan Yunxing [Head of Division of Taxonomy]—Diptera: Calliphoridae. Lepidoptera: Noctuidae.
Mr. Kiong Tiang—Hemiptera: Coreidae.

49. *Division of Forest Protection, Yunnan Forestry Institute, Hot Springs,* KUNMING, YUNNAN PROVINCE
Wu Yi—Hymenoptera: Diprionidae.

50. *Health and Epidemic Station of Jianchuan,* YUNNAN PROVINCE
Yang Xue-Shi—Siphonaptera.

51. *Control and Research Institute of Epidemic Diseases of Yunnan,* YUNNAN PROVINCE
Hu Gui—Siphonaptera.
Gong Zhengda—Siphonaptera: Hystrichopsyllidae, Ceratophyllidae.
Xie Pao-Ji (or Baoqi) (Hsieh, Pao-Chi)—Siphonaptera: Hystrichopsyllidae, Ceratophyllidae.
Yang Guang-Rong—Acari. Siphonaptera: Hystrichopsyllidae.
Yu Shi-Jin—Acari.

52. *Guiyang (Kweiyang) Medical College,* GUIZHOU [KWEICHOW] PROVINCE
Chen Hanbin—Diptera: Culicidae.
Prof. Jin Daxiong (Chin Ta-hsiung)—Anoplura: Enderleinellidae.
Prof. Li Guizhen (Li Kuei-chen)—Siphonaptera: Ceratophyllidae.

53. *Guangdong Institute of Entomology, Insect Taxonomy Division, Academia Sinica,* GUANGZHOU [CANTON], GUANGDONG [KWANGTUNG] PROVINCE (Coulson—79, Davis—79)
Mr. Chu Jie-lin—Isoptera.
Mr. Dai Zi-Rong—Isoptera.
Mr. Li Guixiang (Li Guei-shan)—Isoptera.
Ms. Li Liying (Mrs. Pang Xiongfei) [Director]—Hymenoptera: Trichogrammatidae.
Mr. Li Yan Chuyan [Curator of Collection]—General classification.
Mr. Lin Ping [Vice Director]—Coleoptera: Scarabaeidae: Rutellinae.
Lin Shanxiang—Collembola.
Mr. Ping Zhengming—Isoptera.

Mr. Ren Huai [Research Assistant—Student]—Hymenoptera: Chalcidoidea, especially Chalcididae.

Mr. Wu Weinan—Acari: Phytoseiidae: *Amblyseius.*

54. *Zhongshan University (=Chung San University or Sun Yat Sen University), Department of Biology, Entomology Research Institute,* GUANGZHOU, GUANGDONG PROVINCE (Coulson—79, Davis—79)

Chen Chunyao—Hemiptera: Scutelleridae, Pentatomidae.

Prof. Gjoan Yuwein (Djou Yu-Wen)—Hymenoptera: parasites of scale insects.

Hua Lizhong—Coleoptera: Cerambycidae.

Prof. Pu Zhelong (Pu Chih-Lung) [Department Chief]—Coleoptera: Hydrophilidae and other aquatic Coleoptera.

55. *Department of Plant Protection, South China Agricultural College,* GUANGZHOU, GUANGDONG PROVINCE (Coulson—79, Knutson and Gordon—81)

Mr. Chen Shoujian—Coleoptera: Carabidae (biological control of citrus insects).

Ms. Liu Chuanlu—Lepidoptera: Phyllocnistidae: *Phyllocnista.* Diptera: Muscidae.

Prof. Pang Xiongfei (Pang Hsui-fei) [Deputy Director]—Hymenoptera: Trichogrammatidae. Coleoptera: Coccinellidae. (Worked in Beltsville, Maryland in 1982 with A. C. F. Hung and R. D. Gordon, Insect Identification and Beneficial Insect Introduction Institute, USDA.)

Mr. Zhang Weiqiu (Chang Wai-chiu)—Thysanoptera: Phlaeothripidae.

56. *Jiangxi (=Kiangsi) Communist Labour University,* JIANGXI [KIANGSI] PROVINCE

Jin I-Shou—Hemiptera: Pentatomidae.

Prof. Zhang Shimei—Hemiptera: Pentatomidae.

57. *Jiangxi University, Department of Biology,* NANCHANG, JIANGXI (KIANGSI) PROVINCE

Dr. Chu Chimin—Acari: Phytoseiidae.

Dr. Jiang (Chiang) [President of the University]—Coleoptera: Cerambycidae.

Lin Yujian—Hemiptera: Pentatomidae.

58. *Fujian Agricultural College,* SHAXIAN, FUJIAN [FUKIEN] PROVINCE

Mr. Chen Jiahua—Hymenoptera: Aphidiidae (biological control of vegetable insects).

Prof. Huang Bangkan—Coleoptera: Coccinellidae (biological control of fruit insects).

Dr. Zhao Xiufu (Chao Hsiu-fu)—Hymenoptera: Ichneumonoidea (biological control of rice insects).

59. *Zhejiang Agricultural University, Department of Plant Protection,* HANGZHOU, ZHEJIANG [CHEKIANG] PROVINCE (Coulson—79, Knutson and Gordon—81)

Mr. He Junhua (He Chuen-hua)—Hymenoptera: Ichneumonoidea: Braconidae (biological control of rice insects).

Prof. Li Xueliu (Lee H. L.)—Hymenoptera: Chalcidoidea: Encyrtidae, Aphelinidae (biological control of citrus insects).

Prof. Tang Jiao—Hymenoptera: Formicidae.

60. *Zhejiang Provincial Museum,* HANGZHOU, ZHEJIANG PROVINCE
Mr. Cai Chanmo.
Mr. Zhou Wenbao—Odonata. Coleoptera: Cerambycidae.

Complete addresses for the following individuals have not been located. The information provided here, however, may be of use to some researchers.

61. *Sanitary and Epidemiological Station of Henan Province,* ZHENGZHOU, HENAN [HONAN] PROVINCE
Ge Feng-Xiang—Diptera: Anthomyiidae.

62. *Team of Epidemic Prevention, Logistics Department of Xizang Military Region, PLA,* LASA, XIZANG AUTONOMOUS REGION
Wu Fu-lin—Diptera: Calyptrata.
Zhong Yin-Hong—Diptera: Calyptrata.

63. *Institute of Tropical Forestry, Chinese Academy of Forest Science* (city and province unknown)
Chen Zhi-qing—Orthoptera: Acrididae.

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Numbers in parentheses following researchers' names correspond to numbers assigned in previous section to institutions. Hyphens have been omitted from the second (given) name.

Acari
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Cheyletidae: Wang Xiaozu (6)
Eriophyidae: Ding Tingzhong (7); Dong Huiqing (7)
Gamasoidea: Teng Kuofan (1)
Glycyphagidae: Wang Xiaozu (6)
Ixodoidea: Teng Kuofan (1)
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Rhodacaridae: Ma Liming (15)
Tarsonemidae: Ding Tingzhong (7)
Tetranychidae: Ma Enpei (8); Wang Xiangfu (1); Yuan Yilan (11)
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Protura
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Protura, General: Huang Fusheng (1)
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  Acridoidea: Bi Daoying (6); Jin Xingbao (6); Xia Kailing (6)
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  Lygaeidae: Zheng Leyi (12)
  Nabidae: Lu Jinsheng (28)
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  Diaspididae: Chou Io (28); Hu Jinglin (6); Yang Pinglan (6)
  Fulgoridae: Chou Io (28)
  Membracidae: Chou Io (28); Yuan Feng (28)
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  Chrysopidae: Ran Ruibi (28); Yang Jikun (2) (and other beneficial insects)
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  Bruchidae: Li Hongxing (1)

- Buprestidae: Hou Taogion (1)
- Carabidae: Chen Shoujian (55) (biological control of citrus pests); Yu Peiyu (1)
- Cerambycidae: Hua Lizhong (53); Jiang (57); Jiang Shunan (34); Pu Fuji (1); Zhou Wenbao (60)
- Chrysomelidae: Chen Shixiang (1); Yu Peiyu (1) (Criocerinae)
- Cicindelidae: Tan Zhuanjie (1)
- Coccinellidae: Huang Bangkan (58) (biological control of fruit insects); Pang Xiongfei (55); Wei Jianhua (28)
- Curculionoidea: Chen Yuanquing (1); Li Hongxing (1); Li Hongzhang (20)
- Eumolpidae: Tan Zhuanjie (1)
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- Platypodidae: Yin Huifen (1)
- Scarabaeidae: Lin Ping (53)
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- Scolytidae: Huang Fusheng (1); Yin Huifen (1)
- Staphylinidae: Zheng Fake (38)
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- Mecoptera, General: Chou Io (28)

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- Agaristidae: Chen Yixin (4)
- Amatidae: Fang Chenglai (1)
- Arctiidae: Fang Chenglai (1)
- Bombycidae: Zhu Hongfu (1)
- Brahmaeidae: Zhu Hongfu (1)
- Callidulidae: Zhu Hongfu (1)
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- Drepanidae: Zhu Hongfu (1)
- Endromidae: Zhu Hongfu (1)
- Episopeiidae: Zhu Hongfu (1)
- Ethmiidae: Liu Yujiao (1)
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- Hepialidae: Zhu Hongfu (1)
- Hypsidae: Fang Chenglai (1)
- Lasiocampidae: Hou Taogion (1); Xu Chenkuo (31)
- Limacodidae: Cai Rongquan (1)
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- Noctuidae: Chen Yixin (4); Chou Io (28); Fang Chenglai (1) (larvae and pupae); Gan Yunxing (48); Lu Zheng (28)
- Notodontidae: Cai Rongquan (1)
- Papilionidae: Li Chuanlung (1)
- Phyllocnistidae: Liu Chuanlu (55) (*Phyllocnista*)
- Plusiinae: Chou Io (28)
- Psychidae: Chao Chungling (1)
- Pterothysanidae: Zhu Hongfu (1)

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Rhopalocera: Li Chuanlung (1)
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Thaumetopoeidae: Hou Taogion (1)
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Tortricidae: Liu Yujiao (1)
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Diptera

Anthomyiidae: Chen Zhizi (6); Ge Fengxiang (61); Ma Zhongyu (18); Sun Caihong (1)
Asilidae: Xia Kailing (6)
Calliphoridae: Chen Zhizi (6); Fan Zide (6) (especially synanthropic calyptrate Diptera); Gan Yunxing (48); Lu Yinlian (23); Sun Caihong (1); Wang Changjing (23)
Calyptrata: Wu Fulin (62); Zhong Yinhong (61)
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Culicidae: Chen Hanbin (52); Li Peisi (4); Liu Weide (6); Lu Baolin (4); Ma Sufang (1); Xu Fengyi (10)
Muscidae: Chen Zhizi (6); Fan Zide (6); Liu Chuanlu (55); Lu Yinlian (23); Wang Mingfu (27); Xue Wanqi (17); Sun Caihong (1); Wang Changjing (23)
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Sarcophagidae: Chen Zhizi (6); Fan Zide (6) (not including Tachinidae); Lu Yinlian (23); Wang Changjing (23); Zhang Mengyu (47); Zhao Jianming (1)
Syrphidae: Fan Zide (6); Liu Shaoyou (28) (*Syrphus* and *Sphaerophoria*); Shi Dasan (6); Shi Yongshan (1); Sun Caihong (1)
Tabanidae: Liu Weide (6); Wang Zunming (1); Yao Yunmei (6)
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Ceratophyllidae: Gong Zhengda (51); Li Guizhen (52); Liu Chiying (4); Liu Quang (4); Xie Paoji (51); Zhang Di (46)
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Apoidea: Wang Sufang (1) (*Bombus*); Wu Yanru (1)
Braconidae: He Junhua (59) (biological control of rice insects); Wang Jinyan (1)
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Classification, General: Li Yan Chuyan (53)
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VEGETATIONAL COMPLEXITY AND PARASITISM OF GREEN PEACH APHIDS (*MYZUS PERSICAE* (SULZER) (HOMOPTERA: APHIDAE)) ON COLLARDS

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Abstract.—In 1978–1979, parasitized green peach aphids (GPA) were recovered from collards in adjacent weedy and weedless habitats. During each season, 22 percent of GPA were parasitized, primarily in weedless plots wherein *Diaeretiella rapae* comprised 94 percent of primary parasitism. Parasitism by *Aphidius* spp. was concentrated on GPA from collards in weedy plots. Secondary parasitism occurred much more frequently in weedless plots, wherein 59 percent of primary parasitoids were parasitized. Secondary parasitoids were: *Asaphes lucens* (53 percent of all parasitoids recovered), *Aphidencyrtus aphidivorus* (34 percent), *Alloxysta* nr. *megourae* and nr. *discreta* (7 percent), *Phaenoglyphis ambrosiae* and n. sp. (3 percent), *Dendrocerus niger* (3 percent) and *D. incompletus* (<1 percent); *A. lucens* was more abundant in 1978 than 1979 while the reverse was noted in *Alloxysta* spp. Secondary parasitoids were evidently attracted to higher densities of primary hosts on collards located in weedless plots.

Influence of vegetational complexity on interactions between parasitic Hymenoptera and their hosts is a subject of ongoing interest. A widely-held tenet is that added environmental complexity may impart stability to otherwise disequilibrial systems. Such increased complexity may be spatial heterogeneity (Huffaker, 1958), addition of predators (Paine, 1966), vegetational diversity (Pimentel, 1961) or some combination of these. In agricultural production there is increasing interest in development of minimum-tillage systems that increase complexity by encouraging the growth of ground cover. Little information exists on the effects of reduced tillage on insect host–parasitoid interactions. The present study reports initial results on the effects of weed cultivation on parasitism of green peach aphids (hereinafter GPA) by Aphidiidae (Hymenoptera) on collards (*Brassica oleracea* var.) in central Ohio. Weeds were expected to provide greater availability of alternate hosts and nectar sources for adult parasitoids. Van Emden (1963) found densities of Ichneumonidae to be higher in weedy than in tilled plots, and Copland (1979) noted reduction in secondary parasitism of hop aphids when weeds were eliminated. I (Horn, 1981) found that densities of aphidophagous Coccinellidae, Chrysopidae, and Syrphidae were higher on collards surrounded by unmanaged weeds despite lower densities of GPA there. When weeds were regularly trimmed to 10 cm maximum height, predators moved to more dense populations of GPA on adjoining weedless collards. In the present study I therefore expected that primary and secondary parasitism on GPA might increase when weeds were uncontrolled.

METHODS

Fieldwork was conducted on the Horticultural Farm, Ohio State University. Collards (var. "Georgia", Ferry-Morse Seed Co.) were started in a greenhouse, and during early May were transplanted into a 9 m × 28 m area outdoors. Transplants were 50 cm apart (later thinned to 1 m) in 1 m rows. The experimental area was subdivided into 8 4 m × 7 m plots. Plots were tilled weekly by machine and hand. The other 4 plots were untilled; the ground cover 1 July was *Amaranthus retroflexus* L. (65 percent) and *Chenopodium album* L. (20 percent) with scattered *Xanthium strumarium* L., *Portulaca oleracea, Polygonum* spp., and grasses.

Four randomly-selected collard plants per plot were sampled weekly from 15 May through 20 July 1978. I counted all GPA and collected all parasitized mummies into gelatin capsules (#000) which were held at 25°C and 15 hr photophase for emergence of parasitoids. Mummies from which had emerged Chalcidoidea or Cynipoidea were dissected to verify evidence of secondary parasitism. Voucher specimens of each species were deposited in the Ohio State University Collection of Insects.

Overhead sprinklers irrigated the area when necessary. Surrounding areas were planted to onions, squash, melons and tomatoes, which were treated heavily and repeatedly with carbaryl and malathion. This may have limited immigration of GPA and parasitoids from adjacent crops.

In 1979 I followed similar procedures except as follows: Weeds were trimmed weekly to a maximum height of 10 cm, and weedless plots were kept free of weeds by black plastic placed over the soil surface between rows. Plots were 4 m × 8 m, and sampling continued through August. Major weeds in 1979 were grasses (60 percent), *Chenopodium album, Cirsium* spp., *Ambrosia artemisiifolia* L., and *Polygonum* spp. The experiment was located in a community garden with local and intermittent insecticide application, probably allowing immigration of GPA and parasitoids from nearer sources than in 1978.

RESULTS

Figure 1 indicates abundance of living aphids on collards in weedy and weedless plots. All aphids were GPA except late in 1978 when there was a small influx of cabbage aphids (*Brevicoryne brassicae* L.). Cultivated collards, contrasting with either bare soil or black plastic, were more readily colonized by alate GPA (Horn, 1981) and their higher intensities on weedless collards reflect this. Subsequent production of apterous GPA resulted in significantly higher total intensity of functioning aphids on weedless collards especially in 1979.

Eleven species of parasitic Hymenoptera were recovered from mummified GPA during this study. *Diaeretiella rapae* McIntosh accounted for 94 percent of all primary parasitism. It is a solitary, cosmopolitan endoparasitoid of many species of crucifer-infesting aphids (Read et al., 1970). Figure 2 shows seasonal trends in primary parasitism on GPA within weedy and weedless subplots. In 1978, there appeared no significant difference in percent parasitism between habitats, though total parasitism was higher on weedless collards, where more hosts were present (Fig. 1). *Aphidius* spp. were recovered almost exclusively from weedy collards. In 1979, these trends were more pronounced; parasitism was very low on GPA from weedy collards.

Figure 3 depicts secondary parasitism on *D. rapae*. Table 1 lists the complex of

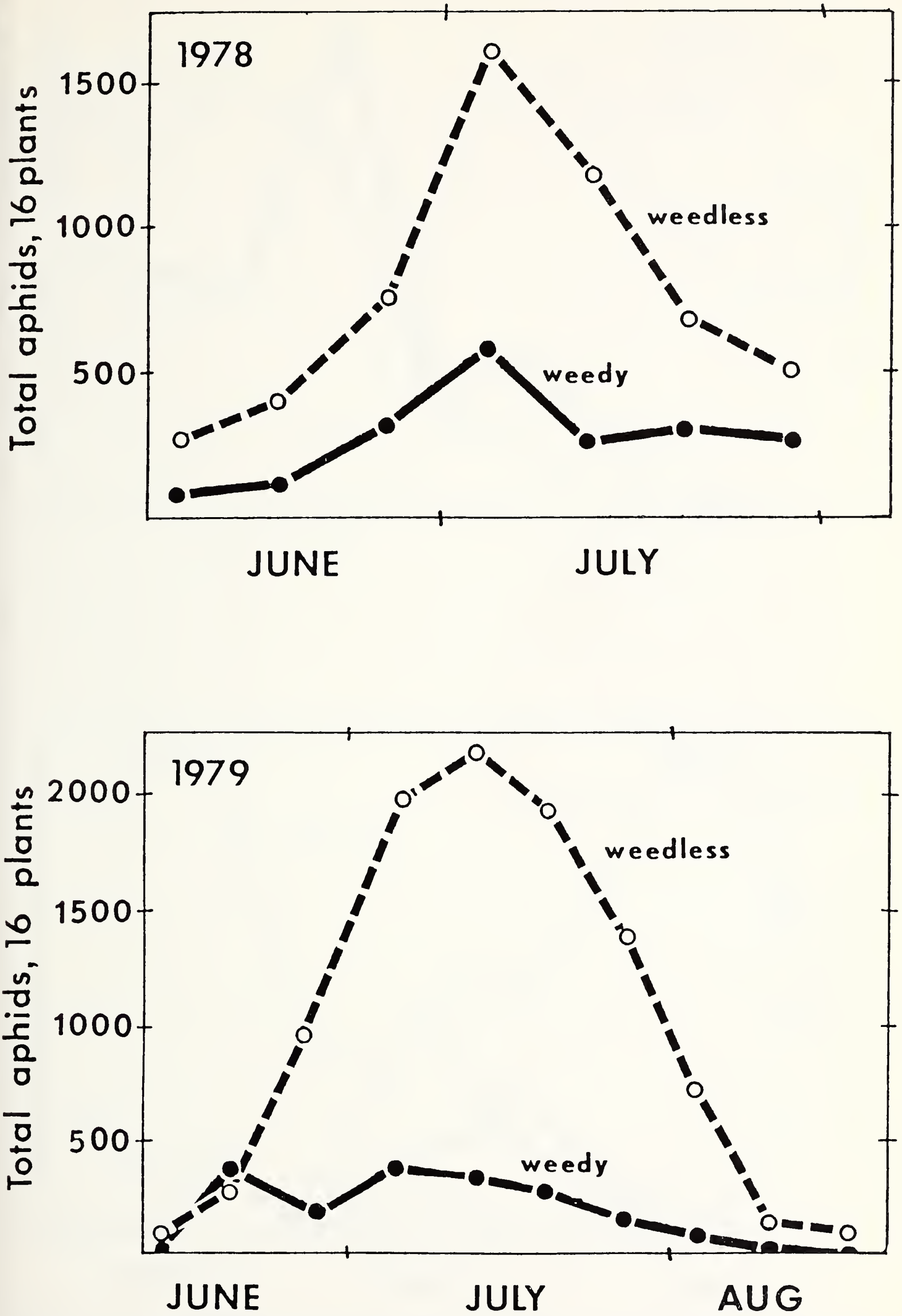

Fig. 1. Total living *Myzus persicae* on weedy and weedless collards, Columbus, Ohio. 1978: weeds not trimmed. 1979: weeds trimmed to 10 cm tall.

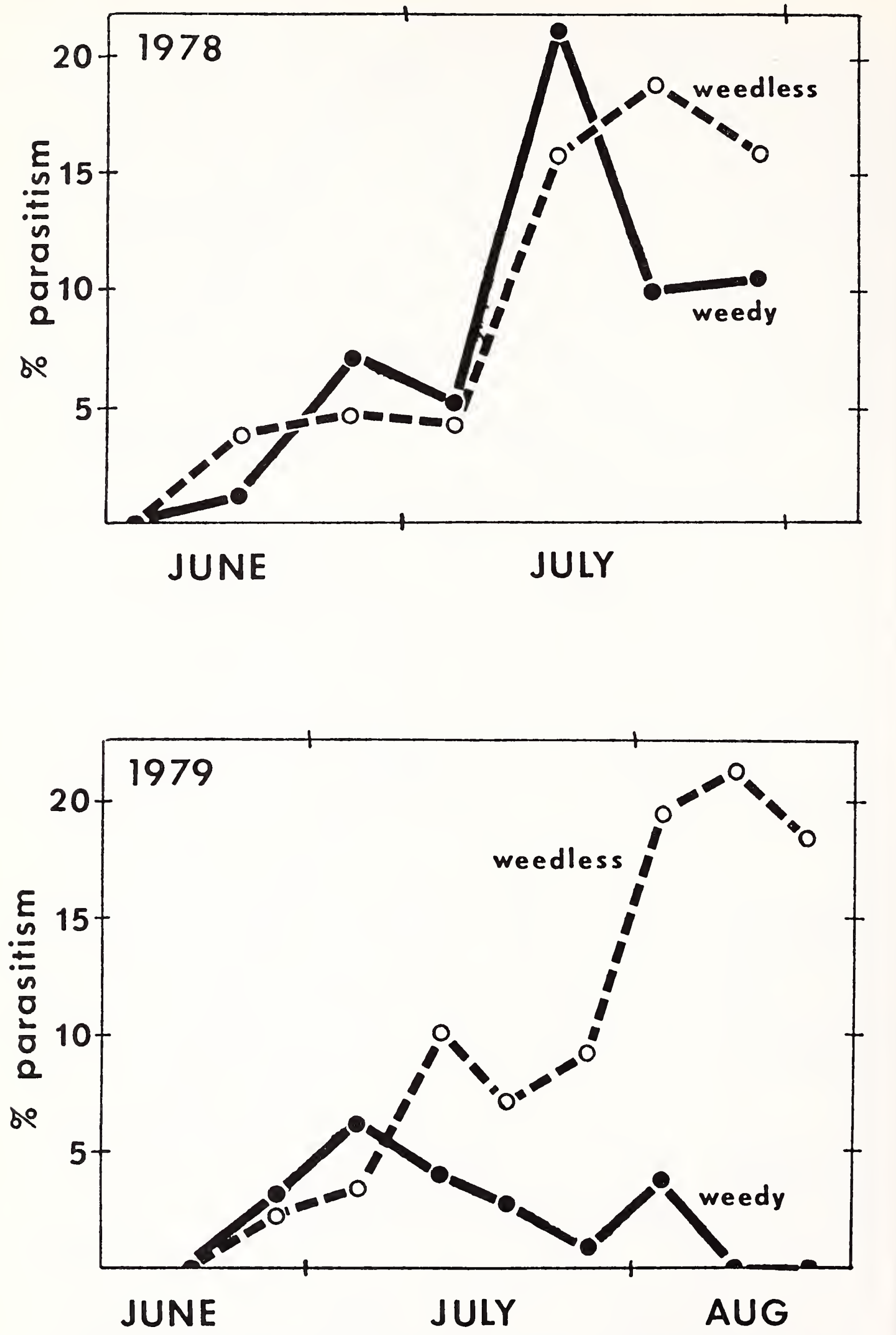

Fig. 2. Percent parasitism by Aphidiidae on *Myzus persicae*. Proportion of parasitism due to *Diaeretiella rapae* in weedy, 84 percent in 1978, 98 percent in 1979; in weedless, 100 percent each year.

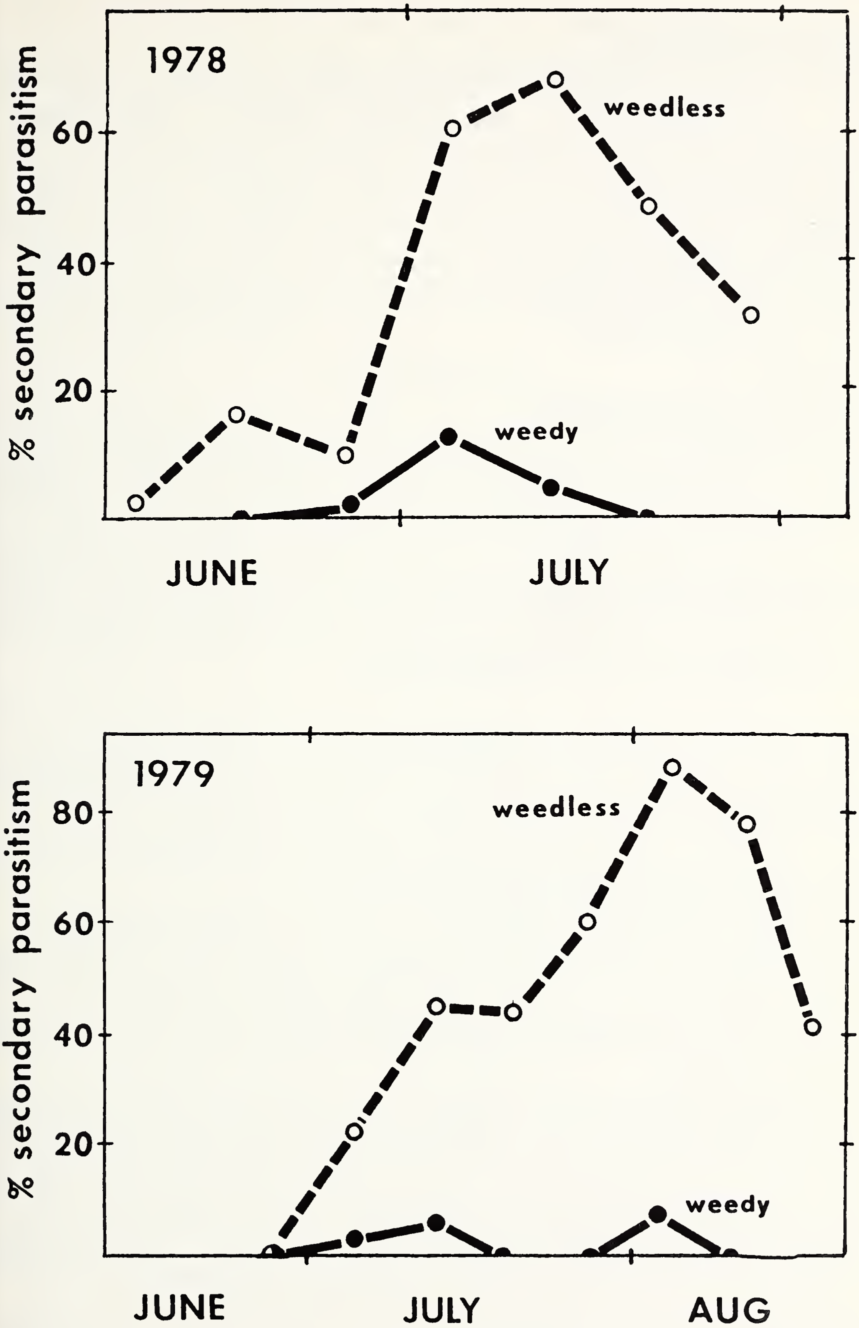

Fig. 3. Percentage of Aphidiidae secondarily parasitized on weedy and weedless collards.

Table 1. Secondary parasitoids recovered from parasitized mummies of green peach aphid, Columbus, Ohio, 1978–1979.

Parasitoid	1978		1979	
	Weedy	Weedless	Weedy	Weedless
Pteromalidae				
Asaphes lucens Provancher	17	209	12	209
Encyrtidae				
Aphidencyrtus aphidivorus Mayr	2	58	0	226
Alloxystidae				
Alloxysta nr. *megourae* (Ashmead) *Alloxysta* nr. *discreta* (Foerster)	0	16	0	39
Phaenoglyphis spp.	0	2	0	20
Megaspilidae				
Dendrocerus incompletus Muesebeck	0	0	0	4
D. niger (Howard)	1	6	0	23
Totals	20	291	12	521

secondary parasitoids. The secondary parasitoids occurred primarily in weedless habitats. There was little seasonal succession in the complex, except that *A. aphidivorus* was earliest to arrive (mid-June) and Alloxystidae and *Dendrocerus* spp. were limited to when GPA was most abundant (July).

DISCUSSION

The greater intensity of GPA on weedless collards apparently reflects the ease with which the plants are located. Their contrast with backgrounds of bare soil or black plastic enhances their attractiveness to colonizing GPA. The weedy plots harbor a variety of aphidophagous predators whose activity serves to further depress GPA populations on collards in weedy plots (Horn, 1981).

The complex of parasitoids reported here is similar to that found elsewhere on *Brassica* (Chua, 1977; Takada, 1976a, b) and other crops regardless of vegetational complexity (Copland, 1979; Jones, 1979; Sullivan and van den Bosch, 1971; van den Bosch et al., 1979). Usually there are a few species of Aphidiidae, one or two dominant secondary parasitoids (often *Asaphes* or *Alloxysta*), and several minor secondary parasitoids.

In my experiments parasitism of GPA by *D. rapae* was concentrated on weedless collards, especially when weeds in adjacent plots were trimmed (1979). Proximity of weedy and weedless plots may have permitted these widely-ranging parasitoids to quickly locate, and concentrate oviposition on, GPA populations of higher intensity on weedless collards. Parasitism by *Aphidius* spp., by contrast, occurred mostly in weedy plots, where alternate hosts were available, especially on *Chenopodium*. Despite a greater diversity of primary parasitoids, a lower percentage parasitism resulted, at least in 1979, on GPA in the vegetationally more diverse habitat.

Secondary parasitoids occasionally parasitize one another (Bennett and Sullivan, 1978; Griswold, 1923), so that estimates based on rearing may not accurately reflect the relative abundance of searching parasitoids in the field. However, excepting *A. lucens,* there was very little secondary parasitism of Aphidiidae on collards in weedy plots (Table 1). Higher GPA densities on collards in weedless plots led to increased primary parasitism which in turn supported higher secondary parasitism and a more diverse array of parasitoids. The proximity of plots may have contributed, as relatively mobile insects could cross the 1m gap rather easily. Higher densities of parasitized GPA concentrated an attractive resource for secondary parasitoids. Root (1973) found diversity of all Hymenoptera to be higher in collard monoculture than on collards planted within an old-field habitat. Vegetational complexity, therefore, might dilute the apparency of primary parasitoids such as *D. rapae* rather as it hides collards from colonizing GPA.

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LITERATURE CITED

Bennett, A. W. and D. J. Sullivan, S.J. 1978. Defensive behavior against tertiary parasitism by the larvae of *Dendrocerus carpinteri,* an aphid hyperparasitoid. J. New York Ent. Soc. 86:153–160.

Chua, T. H. 1977. Population studies of *Brevicoryne brassicae* (L.), its parasites and hyperparasites in England. Res. Pop. Ecol. 19:125–140.

Clausen, C. P. 1940. Entomophagous Insects. McGraw-Hill Book Co., New York.

Copland, M. J. W. 1979. Hymenoptera in hop gardens, with particular reference to parasitoids associated with the damson-hop aphid, *Phorodon humuli.* Entomologia Experimentalis et Applicata 25:146–152.

Emden, H. F. van. 1963. Observations on the effects of flowers on the activity of parasitic Hymenoptera. Ent. Mon. Mag. 98:265–270.

Force, D. C. 1974. Ecology of insect host-parasitoid communities. Science 184:624–632.

Griswold, G. H. 1929. On the bionomics of a primary parasite and of two hyperparasites of the geranium aphid. Ann. Ent. Soc. Amer. 22:438–457.

Gutierrez, A. P. and R. van den Bosch. 1970. Studies on the host selection and host specificity of the aphid hyperparasite *Charips victrix* (Hymenoptera: Cynipidae) 1. Review of hyperparasitism and the field ecology of *Charips victrix.* Ann. Ent. Soc. Amer. 63:1345–1354.

Horn, D. J. 1981. Effect of weedy backgrounds on colonization of collards by green peach aphid, *Myzus persicae,* and its major predators. Environ. Ent. 10:285–289.

Huffaker, C. B. 1958. Experimental studies on predation: dispersion factors and predator-prey oscillations. Hilgardia 27:343–383.

Jones, M. G. 1979. Abundance of aphids on cereals from before 1973 to 1977. J. Appl. Ecol. 16:1–22.

Paine, R. T. 1966. Food web complexity and species diversity. Amer. Nat. 100:65–75.

Pimentel, D. 1961. Natural control of aphid populations on cole crops. Ann. Ent. Soc. Amer. 54:885–888.

Read, D. R., P. P. Feeny and R. B. Root. 1970. Habitat selection by the aphid parasite *Diaeretiella rapae* (Hymenoptera:Braconidae) and hyperparasite *Charips brassicae* (Hymenoptera:Cynipidae). Can. Ent. 102:1567–1578.

Root, R. B. 1973. Organization of a plant-arthropod association in simple and diverse habitats: the fauna of collards. Ecol. Monogr. 43:95–124.

Sedlag, U. 1958. Untersuchungen über Bionomie und Massenweschel von *Diaeretiella rapae* (Curtis) (Hymenoptera: Aphidiidae). Transactions of the First Conference on Insect Pathology and Biological Control, Prague, pp. 367–373.

Sekhar, P. 1958. Studies on *Asaphes fletcheri* (Crawford), a hyperparasite of *Aphidius testaceipes* (Cresson) and *Praon aguti* (Smith), primary parasites of aphids. Ann. Ent. Soc. Amer. 51:1–7.

Sullivan, D. J. and R. van den Bosch. 1971. Field ecology of the primary parasites and hyperparasites of the potato aphid, *Macrosiphon euphorbiae,* in the east San Francisco Bay area. Ann. Ent. Soc. Amer. 64:389–394.

Takada, H. 1976a. Studies of aphids and their parasites on cruciferous crops and potatoes. I. Parasite complex of aphids. Kontyu 44:234–253.

Takada, H. 1976b. Studies of aphids and their parasites on cruciferous crops and potatoes. II. Life cycle. Kontyu 44:366–384.

van den Bosch, R. et al. 1979. Biological control of the walnut aphid in California: impact of the parasite, *Trioxys pallidus.* Hilgardia 47:1–13.

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THE MEMBRACIDAE AND OTHER HOMOPTERA DESCRIBED BY ASA FITCH, 1851, AND EBENEZER EMMONS, 1855: HISTORICAL PERSPECTIVE AND ANALYSIS[1]

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Abstract.—The historical background to Fitch's and Emmons' publications on Homoptera is discussed. Correct publication dates and authorships of new taxa described in Fitch's Homoptera catalogue and Emmons' report on injurious insects are established using information derived from recently discovered Fitch manuscript notes and correspondence and from obscure government documents. Collecting data and specimen numbers are provided for types of new species of Membracidae described in Emmons' report. Types of Homoptera described in Fitch's catalogue are discussed briefly.

Since the death of Dr. Asa Fitch in 1879, several papers dealing with his type specimens of Membracidae and other Homoptera have appeared (Sanborn and Lintner, 1879; Goding, 1893; Lintner, 1893; Osborn, 1905; Felt, 1910; Sanders, 1910; Funkhouser, 1915; Woodruff, 1924; McCabe and Johnson, 1980). Inaccuracies in this literature have raised questions about the true dates of publication of the species names, the correct authorship of new species described in Emmons' *Insects of New York,* and the identity of type specimens of Fitch's and Emmons' species. Archival research has helped to resolve this confused situation.

HISTORICAL BACKGROUND

On April 15, 1836, the New York State Legislature directed the Governor to employ competent persons to make a geological survey of the State, and to "furnish a full and scientific description of its rocks, soils and minerals, and of its botanical and zoological productions" (Laws of New York, Chapter 142). The reports of this early survey were published in the voluminous series entitled "Natural History of New York." James E. DeKay was placed in charge of the zoological department of the survey, but he chose not to report on the insects (Assembly Document 137, 1855), despite Asa Fitch's desire for that assignment.[2] Ebenezer Emmons was given charge of the agricultural portion of the survey, and with the assistance of Dr. Fitch he reported on the insects of interest to farmers. Dr. Fitch also responded to a request from the Regents of the University of the State of New York that he build a collection of insects for the State Cabinet of Natural History. He authored two catalogues based on specimens in that collection (Fitch, 1849, 1851).

Many interesting details concerning the history of Emmons' report and Fitch's

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[1] Published as New York State Museum Journal Series Number 416.

[2] Fitch to William S. Robertson, letter dated March 26, 1840; in Fitch's Diary 8, Yale University Library.

work on Homoptera can be gleaned from Fitch's letters to Thaddeus William Harris.[3] Dr. Harris was librarian of Harvard University and an eminent entomologist. Mallis (1971) stated that Fitch and Harris apparently had no dealings with each other, but this series of correspondence attests differently.

"At present I am engaged in preparing some account of our noxious insects for Dr. Emmons' forthcoming volume on the Agricultural Geology of the state, which is to form one of the 'by authority' quartos of the State Natural History. The season for making personal observations was nearly past when Dr. E. first intimated a desire for a paper of this kind; consequently I am obliged to borrow much from books, and particularly from your invaluable 'Report.' I trust, however, that no one on this or any other occasion, will have grounds for accusing me of *borrowing* without giving *due credit.* In this paper I intend describing several new species, mostly of the sub-order Homoptera: —the time allowed for completing the article will scarcely enable me to work out much more than this that is new." [Letter of December 30, 1846.]

". . . I will, as I now think revise the Homoptera, and devote next year assiduously to further collecting, studying and describing our species, and have scarcely a doubt, that, with the facilities which you tender me, I can by the close of the year be prepared to present this sub-order in a very accurate and perfect shape." [Letter of June 22, 1848.]

"The Homopterous Hemiptera, which have already been adverted to in our correspondence are again before me. I have been collecting further, and am now preparing a descriptive catalogue of all the species I have been able to find, their synonyms, the plants on which they occur, etc.—which catalogue will be published in the course of the coming winter. Dr. Emmons is also having a number of them very nicely figured for his final volume (*Deo gratias*!) of the State Nat. Hist. series . . . . I am quite anxious to work these Homopterous insects out, in the best manner I am capable of doing." [Letter of November 13, 1850.]

"Last evening's mail brought me also the proof-sheets of what I had prepared upon our Homoptera. Those species that I had been able to make out to my satisfaction had been ticketed and placed in the State Cabinet at Albany a few weeks ago—and the paper containing my descriptions of them (28 pages octavo) the printers are now waiting to strike off. In this emergency I have concluded to go down to Albany tomorrow morning, to see if I can get them to delay a day or two, to enable me to compare your specimens with mine and change my names for yours, in those instances where we both have had the same species." [Letter of February 20, 1851.]

"I reached home from Albany last evening, and hasten to inform you of the result of my visit. The printers reluctantly consented to defer their work for one day, to enable me to re-examine the specimens in the State Cabinet and make alterations in my copy . . . . Herewith are forwarded copies of my article upon these insects. My final revisal of the proof I perceive was scarcely looked at by the printers; hence there are some typographical errors, but I see none of moment." [Letter of March 1–4, 1851.]

"I have not yet obtained Emmons' 'big book.' Indeed, I dread looking into it, knowing what a hotch-potch thing it must be, and not knowing what use has been

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[3] Fitch to Harris, 15 letters dated December 30, 1846, to February 26, 1855; file bMu 998.10.2, Museum of Comparative Zoology, Harvard University.

made of my name in it. Last September, as I was packing up to start next day on a journey, the Dr. unexpectedly dropped in on me, with a bundle of the engravings, for me to *name the figures* therein. The specimens from which the drawings were made he did not think it was necessary to bring, as the figures were 'perfectly accurate' *showing everything* which the specimens showed! On hastily glancing over the plates (for I had not time to examine deliberately) some of the figures I recognized, others I could only guess at, & others still I could form no conception what they were. He also looked over my cabinet and took down some names from thence, although informed they were of no value, some of the families having been ticketed many years ago, when I had scarcely any authorities at hand to aid me in the work. As mineralogy is the Doctor's spécialité, and I have some minerals which I should like to have named, I think it will be but fair for me to ask the Dr. to reciprocate the favor he asked of me, and send him 'accurate drawings' of these minerals, that he may name them for me. Like his volume on Fruits, this on Insects, I think, must fall still born from the press." [Letter of February 26, 1855.]

FITCH'S HOMOPTERA CATALOGUE

The full title of Fitch's Homoptera catalogue is "Catalogue with References and Descriptions of the Insects Collected and Arranged for the State Cabinet of Natural History," and it appeared in the *Fourth Annual Report of the Regents of the University, on the Condition of the State Cabinet of Natural History, and the Historical and Antiquarian Collections Annexed Thereto, Made to the Senate, January 14, 1851.* That report is also known as Senate Document 30. Fitch dated his introduction to the catalogue February 22, 1851. In his letter of March 1–4, 1851, he informed Harris that he was forwarding copies of his "article upon these insects," and he mentioned the typographical errors that it contained. That article was unmistakably his Homoptera catalogue. Evidently, it was printed and ready for distribution sometime between February 22 and March 1, so February 28, 1851, is the earliest date of publication demonstrated by evidence, in the meaning of the International Code of Zoological Nomenclature, Article 21. J. A. Lintner had the catalogue reprinted, with corrections and notes by E. P. Van Duzee and C. V. Riley, in 1893 in his *Ninth Report on the Injurious and Other Insects of the State of New York for the Year 1892* [*From the Forty-sixth Report of the New York State Museum*].

EMMONS' REPORT

The correct title of Emmons' report is *Insects of New York,* although this title appears only on the first page of text, above the title of the first chapter. The first "title page" reads "Natural History of New York, By Authority," and it is followed by a page that reads "Agriculture of New York: Comprising an account of the Classification, Composition and Distribution of the Soils and Rocks, and of the Climate and Agricultural Productions of the State; Together with Descriptions of the More Common and Injurious Species of Insects, Volume V." The latter page also bears the date 1854, and the Preface is dated July 25, 1854. In New York State Assembly Document 53, dated January 30, 1855, E. W. Leavenworth and T. Romeyn Beck, commissioners appointed to superintend the completion of the publication of the

"Natural History of New York," reported that ". . . another volume has been completed, viz: the treatise of Dr. Emmons on Insects Injurious to Agriculture. It will probably be ready for general distribution during the month of January." In his letter of February 26, 1855, Fitch told Harris that he had not yet seen Emmons' report, but he seemed to imply that it was available. The publication date, in the meaning of the code, therefore, seems to be January 31, 1855.

EMMONS' MEMBRACIDAE

Thirty-five species of Membracidae are described in Emmons' report, two of them simply as named figures. Emmons credited Fitch for providing specimens and names of the genera and species. In his letter of November 13, 1850, Fitch told Harris that he was preparing a descriptive catalogue of all the species of Homoptera he was able to find, and that Emmons was having some of them figured for the "Natural History of New York." It is evident that Fitch presented Emmons with specimens, some of which he had identified and others of which he had recognized as belonging to new species that he named. According to Article 50 of the Code, the author of a species name is the person who first publishes it in a way that satisfies the criteria of availability, "unless it is clear from the contents of the publication that . . . some other person is alone responsible both for the name and the conditions that make it available." Because Emmons credited Fitch with the species names, but not the descriptions or illustrations, Emmons must be considered the author of any new species named in his report. Goding's (1893) conclusion that "there is no valid reason for crediting such species to Emmons because the descriptions "were written by Dr. Fitch, as is stated by Emmons" is misleading and supported by false evidence.

Emmons attributed eight of the species described in his report to previous authors. By comparing Fitch's manuscript species notes—most of which were recently found in the New York State Museum—with Emmons' report, it becomes apparent that eleven or twelve more species should have been attributed to previous authors. These include *Thelia lutipes,* which is apparently a misspelling of *latipes* Say. The corresponding figure in Emmons' report is labelled *Enchophyllum latipes,* and in Fitch's notes it is given as *Enchenopa latipes* Say, with the generic names *Enchophyllum* and *Membracis* crossed out. The status of *Gargara inermis* is discussed below. The remaining fifteen or sixteen membracid species names in Emmons' report must be attributed to Emmons. Some of them appear in Fitch's notes, but others do not.

FITCH'S SPECIMEN REGISTERS

The types of Emmons' species came from Fitch's personal collection. Fitch never designated a type for any of his species, but he did list individual specimen code numbers in his notes under each species name. The listed specimens that were collected before the publication date of each of his species names must be considered the specimens of his type series. With each code number he gave the collecting locality, date, and frequently other valuable information. The code numbers also correspond with four registers that list the numbers and give the collecting conditions of nearly all of the specimens in his personal collection. In one of the registers, now in the New York State Museum, Fitch wrote:

"All (nearly) of the specimens in my collection have a number upon the pin. Numbers written on white paper with black ink, are all from the State of New York; and are registered in this book; or, those with one or more red-ink lines across the number, are registered in another book similar to this. Specimens from other parts of the U. States, & from Canada are numbered with red ink on white paper, & recorded in a separate book. Specimens numbered with black ink upon colored paper, are from other parts of the world, & are registered in a fourth book."

In another register, Fitch wrote:

"List of Insects with numbers attached crossed with *a* single red line up to No. 10,000—two red lines, 10,000 to 20,000 . . . . These are all taken in the state of New York."

In a third register, also in the possession of the New York State Museum, he wrote:

"List of Insects numbered with red ink. These are all North American, but collected *out of the state of New York,* but in the other United States or Canada or north of there."

In the fourth register, now in the library of the Museum of Science, Boston, Fitch recorded his specimens from places other than the United States or north of there.

It is evident that most of Fitch's specimens, if recognized as such, can be matched with the proper date and locality given in his manuscript notes or registers. It is also evident, as Funkhouser (1915) found, that Fitch's specimens that carry a number in red ink and those that are marked with a red line across the label are not necessarily the true types. The only possible types are those specimens that are listed in Fitch's manuscript notes and registers and that were collected before the species name was published.[4]

TYPES OF EMMONS' MEMBRACIDAE

Emmons' membracid species, together with excerpts from the existing notes on type series in Fitch's manuscripts, are listed below. Any number preceded by an asterisk is a specimen number that Fitch crossed with a single red line.

1. *Telamona acclivata* Emmons, 1855:155 [=*Heliria cristata* (Fairmaire)]. 11,782, Stillwater, NY, 16.vii.1846, on oaks.

2. *Cyrtosia arcuata* Emmons, 1855:154 [=*Cyrtolobus arcuatus* (Emmons)].

3. *Gargara cinereum* Emmons, 1855:156 [=*Cyrtolobus cinereus* (Emmons)]. *4536, Salem, NY, 26.vi.1846, on oaks. 11,760, Stillwater, NY, 16.vi.1846, on oaks. 11,766–777, Stillwater, NY, on plants.

Goding (1893) stated that a specimen numbered 4536 was in the U.S.N.M., but I have been unable to locate it.

4. *Gargara discoidalis* Emmons, 1855:157 [=*Cyrtolobus discoidalis* (Emmons)]. 3038, Salem, NY, 24.vi.1846, on white oak trees, beat from leaves. 4837, Salem, NY, 5.vii.1847, on white oak tree.

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[4] Fitch's notes on Psyllidae and Coccidae are in the Smithsonian Institution Archives, those on Aphididae are with the United States National Museum aphid collection in Beltsville, those on Collembola are in the library of the Museum of Science in Boston, and those on all other arthropod groups, constituting the bulk of his manuscript species notes, are in the New York State Museum in Albany.

Goding (1893) stated that specimens numbered 3038 and 4837 were in the U.S.N.M., but I have been unable to locate them.

5. *Cyrtosia fuliginosa* Emmons, 1855:154 [=*Cyrtolobus fuliginosus* (Emmons)]. 11,756, 11,764, Stillwater, NY, 16.vii.1846, on oak in big swamp.

Goding (1893) found specimen number 11,764 in the U.S.N.M., but I have been unable to locate it.

6. *Gargara inermis* Emmons, 1855:157 [=*Cyrtolobus inermis* (Emmons)]. *2550–*2555, Salem, NY, 20.v.1846, beat from trees (chiefly chestnut and oak). 1787, 1788, 3047, Tullehassie, AR [presumably Tullahassee, Wagoner Co., OK], July 1851, from Wm. S. Robertson.

Although Fitch's notes indirectly suggest that this name should have been attributed to Fabricius, the species Emmons described and illustrated was apparently new. The name is usually attributed to Emmons (Funkhouser, 1927; Metcalf and Wade, 1966; Kopp and Yonke, 1973).

7. *Cyrtosia intermedia* Emmons, 1855: plate 13, figure 16 [=*Xantholobus intermedius* (Emmons)]. *4635, Salem, NY, 28.vi.1847, on oaks.

8. *Gargara maculifrontis* Emmons, 1855:156 [=*Cyrtolobus maculifrontis* (Emmons)]. *3039, Salem, NY, 24.vi.1846, beat from white oaks. 11,762, Stillwater, NY, 16.vii.1846, on oaks in big swamp.

9. *Gargara majus* Emmons, 1855:156 [=*Carynota mera* (Say)].

10. *Gargara nigricephala* Emmons, 1855:157 [=*Atymna castaneae* (Fitch)]. *3598, Salem, NY, 24.vii.1846, on chestnut. *5181, Stillwater, NY, 15.vii.1847, beat from chestnut bushes.

11. *Telamona ornata* Emmons, 1855:155 [=*Telamona concava* (Fitch)]. 5419, Stillwater, NY, 1834, a female.

12. *Gargara pallidifrontis* Emmons, 1855: plate 13, figure 7 [=*Cyrtolobus pallidifrontis* (Emmons)]. *3034, Salem, NY, 24.vi,1846, beat from white oak trees. 11,763, Stillwater, NY, 16.vii.1846, on oaks in the big swamp. *4897, Salem, NY, 5.vii.1847, on black oak, bank of the kill. *5107, Stillwater, NY, 15.vii.1847, on oak bushes.

Goding (1893) found specimen number 11,763 in the U.S.N.M., and Dr. James P. Kramer has confirmed its existence (pers. comm.). It is labelled "11,763/*pallidifrontis*/Lectotype, *Cyrtolobus pallidifrontis* (Emmons), L. B. Woodruff."

13. *Gargara pectoralis* Emmons, 1855:157 [=*Stictocephala lutea* (Walker)].

14. *Gargara pubescens* Emmons, 1855:157 [=*Ophiderma pubescens* (Emmons)].

15. *Telamona turriculata* Emmons, 1855:155 [=*Glossonotus turriculatus* (Emmons)].

16. *Smilia viridis* Emmons, 1855:154 [=*Cyrtolobus viridis* (Emmons)]. 11,767, Stillwater, NY, 16.vii.1846, on plants. *5178–79, Stillwater, NY, 15.vii.1847, on walnut bushes. *5364, Salem, NY, 23.vii.1847, on white oak.

FITCH'S HOMOPTERA

The Homoptera collection that Fitch described in his 1851 catalogue is in the New York State Museum, successor to the State Cabinet of Natural History. The specimens in it were taken from his personal collection and renumbered. Fitch enumerated consecutively all specimens in his two catalogues and in the State Cabinet. Specimens referred to in his 1849 catalogue were numbered 1–608, and those in his 1851 catalogue were numbered 609–874. These numbers bear no relation to Fitch's species notes or specimen registers.

In the Homoptera catalogue, Fitch described 6 new genera, 85 new species, and 5 new subspecies, including 3 genera, 15 species, and 2 subspecies of Membracidae. The State Museum's collection still contains original specimens of 60 of the species and subspecies. The specimens of Psyllidae, many of the Aphididae, and a few specimens from other families were destroyed by museum pests (Lintner, 1893). The remaining specimens, as well as specimens from Fitch's personal collection that were collected prior to February 28, 1851, must be considered types. Fitch's notes indicate that for most species he had more than one specimen prior to the publication of his catalogue. In these cases, a lectotype should be designated if that has not already been done. Funkhouser (1915) designated specimens from the State Museum collection as lectotypes for Fitch's species and subspecies of Membracidae that were described in his catalogue. Specimens of Homoptera from Fitch's personal collection are in the U.S.N.M. and in the T. W. Harris Collection, Museum of Comparative Zoology, Harvard University.

A catalogue to the taxa and known existing specimens described by Fitch, a bibliography of his entomological papers, and a biography of Fitch are in preparation.

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LITERATURE CITED

Emmons, E. [1855]. Insects of New York. Agriculture of New York, volume 5. Natural history of New York. Albany, 272 pp.

Fitch, A. 1849. Catalogue of the insects in the State Cabinet of Natural History, December 1, 1848. Pages 27–39 *in:* Second annual report of the Regents of the University, on the condition of the State Cabinet of Natural History, with catalogues of the same. Made to the Senate January 12, 1849. Albany, 103 pp.

Fitch, A. 1851. Catalogue with references and descriptions of the insects collected and arranged for the State Cabinet of Natural History. Pages 43–69 *in:* Fourth annual report of the Regents of the University, on the condition of the State Cabinet of Natural History, and the historical and antiquarian collection, annexed thereto. Made to the Senate, January 14, 1851. Albany, 146 pp.

Felt, E. P. 1910. Insect types in the New York State Museum. New York State Museum Bulletin 141:119–122.

Funkhouser, W. D. 1915. Types of Fitch's species of Membracidae. Bull. Brooklyn Ent. Soc. 10:45–50.

Funkhouser, W. D. 1927. General catalogue of the Hemiptera, Fascicle I. Membracidae. Smith College, Northampton, Massachusetts, 581 pp.

Goding, F. W. 1893. Fitch's types of N. A. Membracidae. Can. Ent. 25:171–196.

Kopp, D. D. and T. R. Yonke. 1973. The treehoppers of Missouri: Part 3. Subfamily Smiliinae; tribe Smiliini. J. Kansas Ent. Soc. 46:375–421.

Lintner, J. A. 1893. Catalog of the known Homoptera of the State of New York in 1851. Annual Report of the New York State Museum 46(1892):381–413.

Mallis, A. 1971. American entomologists. Rutgers University Press, New Brunswick, New Jersey, 549 pp.

McCabe, T. L. and L. M. Johnson. 1980. Catalogue of the types in the New York State Museum insect collection. New York State Museum Bulletin 434:1–38.

Metcalf, Z. P. and V. Wade. 1965. General catalogue of the Homoptera. A supplement to Fascicle I—Membracidae, of the general catalogue of the Hemiptera. Membracoidea. North Carolina State University, Raleigh, 1552 pp.

Osborn, H. 1905. Jassidae of New York State. New York State Museum Bulletin 97:498–545.

Sanborn, F. G. and J. A. Lintner. 1879. An account of the collections which illustrate the labors of Dr. Asa Fitch. Psyche 2:273–276.

Sanders, J. G. 1910. A review of the Coccidae described by Dr. Asa Fitch. Proc. Ent. Soc. Washington 12:56–61.

Woodruff, L. B. 1924. Critical observations in the membracid genus *Cyrtolobus* Goding. (Hemip.-Homop.). J. New York Ent. Soc. 32:1–62.

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ASSOCIATION OF *PARATRECHINA ARENIVAGA* (HYMENOPTERA: FORMICIDAE), WITH NYMPHS OF *OECLEUS BOREALIS* (HOMOPTERA: CIXIIDAE)[1,2]

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Abstract.—The previously unknown nymphs of the planthopper *Oecleus borealis* Van Duzee were found in the subterranean nests of the ant *Paratrechina arenivaga* (Wheeler). The nymphs appear to associate only with this ant species. Food plants of the *O. borealis* nymphs are suspected to be the roots of sand pine *Pinus clausa* (Engelm.) Sarg., saw palmetto *Serenoa repens* (Bartr.) Small, or turkey oak *Quercus laevis* Walter, although radioisotope experiments to establish this were inconclusive.

The family Cixiidae is a member of the superfamily Fulgoroidea, or planthoppers. This family, to which *Oecleus* belongs, has an extensive distribution in the temperate regions of the world (Van Duzee, 1908). J. P. Kramer (1977) listed 40 species of *Oecleus* in the U.S. The distribution of the genus is mostly western, with only 3 species occurring east of the Mississippi River. *O. borealis* occurs from the Gulf states north to New York and west and north to Texas and Kansas (Kramer, 1977). Literature on cixiid biology is extremely sparse and is contained for the most part, in small notes following taxonomic descriptions. Dozier (1926) took both adult sexes of *O. borealis* by sweeping grasses in pinewoods. He speculated that one of these plants was probably the food plant. Ball and Klingenberg (1935) collected adults "throughout the season" and suspected this was the hibernating stage. They found adults on many trees and shrubs and believed the species was a general feeder, or that the nymphal hosts were low, widespreading plants and adults flew to higher vegetation.

Although one species was reported to oviposit in *Yucca* (Townsend, 1892), Myers (1929) was the first to report the habitat of cixiid nymphs: *Mnemosyne cubana* Stål and *Bothriocera signoreti* Stål from Cuba. Instars of the *Mnemosyne* were found in a rotted stump in March. They had filamentous wax tails and were feeding on roots covered with this wax. Myers found the nymphs in apparent association with the ponerine ant, *Odontomachus haematoda insularis* var. *pallens* Wheeler. He stated that the ant was tending the nymphs, although he did not actually observe this activity. In addition, the ponerines are primitive ants; none are known to attend homopterans (Nixon, 1951). Late instar nymphs of *Bothriocera* were found under stones feeding on rootlets in March. The nymphs were covered with a white flocculent wax. In neither case, apparently, did Myers determine the identity of the food plants.

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The nymphs of the cixiid *Oliarus vicarius* (Walker) have been found feeding on roots beneath rotted stumps and logs in the same ecosystem as *O. borealis* (Thompson et al., 1979). Two species of ants seemed to be associated with these nymphs. The ant-Homoptera relationship reported in this paper is distinct, and appears to be obligatory for the *Oecleus* nymphs.

MATERIALS AND METHODS

The nest of *P. arenivaga* is marked by a distinctive crater. This ant is the predominant ant species in the sand pine habitats in which it is found. Excavations were undertaken in sand pine woods, *Pinus clausa* (Engelm.) Sarg. ca. 27 km east of Silver Springs, Florida (Marion County) in Ocala National Forest, on the south side of Highway 40. The vegetation in this area was composed of saw palmetto, *Serenoa repens* (Bartr.) Small, and turkey oak, *Quercus laevis* Walter.

After experimentation with various collecting methods, I found two effective in excavating maximum numbers of nymphs. One method was to shovel 4 vertical 20 cm thrusts to form a square around the crater of a *Paratrechina* nest. The entire clump was lifted and transported to a flat surface. It was broken apart with the hands while having an aspirator ready. The clump often broke, particularly when wet, along the tunnels of the ants. A second method, utilizing the element of surprise, was to thrust a shovel downward 3 to 4 cm from a crater and then carefully flip the shovel upwards. The nymphs were usually found among the greatest concentrations of ants. In this quick-attack method, the nymphs could be collected before they had time to escape. They were placed in separate vials from the ants.

Difficulties were encountered during warm weather in keeping the nymphs, ant queens and even ant workers alive until they were brought to the laboratory. It was found that moisture must be available at all times. To maintain collected live specimens in good condition, shell vials containing the insects were buried in a shaded place. Upon departure, tubs were filled with cool, moist sand, into which the vials were reburied. This method allowed successful transportation of live specimens during hot weather.

Captured *Oecleus* nymphs were brought to the laboratory and placed in Wilson cells (Wilson, 1962) with moist cotton floors. To approximate the *Oecleus* natural habitat, roots and sand from their original chambers were placed with the nymphs. The nymphs were kept under observation and disturbed as little as possible.

Radioisotype tracer studies and field observation were used to study food plant preferences of *Oecleus* nymphs. Prior to the isotope experiment, roots of three different plants were repeatedly found in the *Paratrechina* nests. Two of these root types were identified as pine and saw palmetto. Subsequently, young pine and saw palmetto plants were dug up and brought to the laboratory. Their roots were sandwiched between small pieces of non-absorbent cotton (to stop possible isotope leaks in the external root surfaces), then between small, back-to-back petri dish lids. The root space was taped shut around the sides of the petri dishes with water-proof tape, then packed tightly full of sand. The protruding roots were placed in water containing 100 μCi P^{32} per plant. After 24 hr, the nymphs were placed in cells through which passed roots in direct contact with the tracer solution. After contact with the plants for 36 hr, the nymphs were tested for radioactivity by both Geiger-Mueller and liquid-scintillation counters.

In a preliminary experiment, nymphs exposed to radioactive pine roots died after becoming trapped in water film which had collected on the inside chamber wall. To reduce film formation, the facing plastic of each chamber, sealed with clay against the petri dish, was perforated with a hot needle.

RESULTS AND DISCUSSION

Nymphs of *O. borealis* were discovered while excavating nests of the ant *P. arenivaga* in Ocala National Forest, Marion County, Florida. *Oecleus borealis* nymphs were also found in *P. arenivaga* nests in Putnam County, ca. 48 km north of the first discovery site, and later, in Broward and Orange Counties. These areas had similar habitats and were characterized by areas of white sand.

Many hundreds of nests were dug up during the course of this study. *Oecleus* nymphs were found in the *Paratrechina* nests from December through August (Table 1). Subsequent collections have been made in September and November (Wilson et al., 1983). The largest number of nymphs found in a single nest was five, but the actual numbers present could not be determined because of the methods used to excavate the nests. The ratios of nests with, to those without, *Oecleus* varied, but there was a pattern. During most months the ratio was 1:5, 6 or 7. In December–February the ratio was often 1:20 or more. At the other extreme, during July the ratio was reduced to 1:2.

Paratrechina nests were not found in heavily shaded areas. The preferred habitats of the ants were clearings, pathways within the woods, or disturbed areas including roadways. Nests were found only where the sand was clear of thick debris. A cover of sand pine needles was sufficient to exclude the ants from an area. Even when the nests were in the middle of a wide road, the roots of sand pine, saw palmetto, and what was probably turkey oak were found thickly matted beneath the soil surface. In some cases, measurement showed the nearest plant to be 3–4 m away.

Areas with similar vegetation, but without *Paratrechina* nests, were also excavated in attempts to locate *Oecleus* nymphs. These efforts were not successful. *Oecleus* nymphs were not found except in the company of the ants.

The nymphs collected varied in length from 0.8 mm to 3.7 mm. The smallest nymphs were faint yellow, darkening in later instars to bright yellow with orange bands on the abdominal segments. This coloration made the nymphs highly visible against the sand of the ant nests. Late instars had wing pads and dark reddish orange markings on the abdomen. The posterior white wax filaments were rarely found on the nymphs in the field, but grew out on nymphs in the laboratory within 12 hr. Full descriptions and a key to the nymphs are in Wilson et al., 1983.

Oecleus nymphs were repeatedly observed directly in the chambers of the ants. In at least 6 cases (2 in the laboratory, 4 in the field) ants were observed carrying first or second instar nymphs in their mandibles. This appeared to be a reaction to colony disturbance. When nests were dug between 9 or 10 A.M. and 4 P.M., few if any, nymphs were found. Temperatures are highest during this time and the sand becomes dry and hot in the upper layers. The nymphs and ants may avoid the heat by retreating down into the sand. During this time I was unable to find the ants or nymphs by digging downward ca. 30 cm. One nest was excavated to a depth of 80 cm and searched laterally, layer by layer, but no queens, brood or nymphs were found. The nymphs were also less frequently found if no rain had recently fallen. This was

Table 1. Collections of *Oecleus borealis* nymphs in *Paratrechina arenivaga* nests.

Date	Numbers of nymphs	Location	Notes
1/11/75	5	Ocala	—
1/25/75	4	Ocala	—
3/22/75	3	Ocala	2-L nymphs
4/5/75	4	Ocala	—
4/13/75	5	Putnam	1-S, 2-M, 2-L nymphs
4/21/75	1	Putnam	1-S nymph in worker's mandibles
6/18/75	9	Ocala	8-S, 2-M, 2-L nymphs
6/19/75	13	Ocala	—
6/29/75	2	Ocala	—
7/16/75	18	Ocala	—
7/25/75	1	Ocala	—
8/2/75	10	Ocala	—
8/4/75	3	Gainesville	1-M nymph
8/12/75	0	Ocala	—
12/—/75	1	Ocala	1-M nymph
1/22/76	0	Ocala	—
2/19/76	1	Ocala	1-M nymph
3/22/76	1	Ocala	1-S nymph
3/31/76	8	Ocala	5-S, 3-M nymphs
4/1/76	2	Ocala	2-L nymphs
4/5/76	2	Ocala	3-L nymphs
4/6/76	1	Ocala	—
4/15/76	1	Ocala	1-L nymph
4/27/76	8	Ocala	2-S, 6-M nymphs
5/10/76	6	Ocala	2-L nymphs
7/2/76	3	Putnam	1-M, 2-L nymphs
7/15/76	24	Putnam	24-S nymphs

Explanation of letters: S, M, L = estimates of *Oecleus* nymph size (Small, Medium, Large).

probably due in part to the tendency of the dry sand blocks to fall apart during excavation.

During collecting trips in December and January, the gasters of *Paratrechina* workers dug up were extremely distended with a clear liquid. This coincided with the presence of relatively large *Oecleus* nymphs in the ant nests. It is known that 1 aphid can produce copious amounts of honey dew relative to its size and weight and that the honey dew of some aphids is high in amino acids, protein and other nutritional substances (Way, 1963). If the *Paratrechina* are obtaining honey dew from the *Oecleus,* a relatively small number of nymphs might be able to support an entire colony—or at least to provide a substantial amount of its food supply.

Observations of *Paratrechina* behavior support this hypothesis. *Paratrechina arenivaga* is a crepuscular and mostly nocturnal ant and excavates or repairs its nests at that time. Many nights I have observed the ants, at the moment the head lamp light hit them, doing no foraging; carrying only sand grains. The light caused them to retreat: the workers quickly dropped the sand on the crater and returned down the entrance. When offered baits of honey, sugar water, corn syrup, egg or raw hamburger, the ants were most attracted to the sweet solutions, but consumed all the baits. Aside from the bait experiment, however, *Paratrechina* workers were not observed returning to a nest with anything in their mandibles or with distended gasters. They were rarely found more than 20 cm from their nest entrances. It is possible that these ants obtain their food from an underground source, perhaps the cixiid nymphs, at least during the winter months.

Attempts to rear *Oecleus* nymphs were not successful until several large nymphs were collected in March 1975. These were placed in Wilson cells with *Paratrechina* workers. An adult emerged several days later, but was almost entirely eaten by the ants. The ants were removed and a second adult emerged. It was found in an arm of the Wilson cell. The exuvia was clinging by the tarsi to the inside cell wall. This adult was determined to be *Oecleus borealis* Van Duzee.

In the pine and saw palmetto experiment, the radiation levels of roots removed only from the nymphal chambers varied from 113 to 2,585 cpm on the Geiger-Mueller counter and from 637 to 21,450 cpm on the liquid scintillation counter. Every set of roots had a count well above background on even the less sensitive Geiger-Mueller counter. None of the 5 nymphs recovered were radioactive.

A number of factors may have caused the non-radioactivity of the nymphs. Some of these are: 1) the plants were too young, possessing roots too small, or lacking sufficient sap; 2) sap flow in the plants was affected by the methods used to handle the plants or roots; 3) the nymphs were not able to feed due to handling methods or unnatural surroundings; or 4) neither of these plants is the natural food plant of *O. borealis* nymphs.

The difficulty involved in ascertaining the food plant of the *Oecleus* nymphs in the field lies with tearing apart the soil of the nest without disturbing these sensitive insects. Many times a nest was dug to find the nymphs already disturbed and jumping about (some can jump at least 8 cm). Other subterranean Homoptera known to associate with ants, such as coccids and aphids, are relatively sessile organisms. Even when alarmed, these insects are not capable of jumping and running, while this is the usual reaction of an *Oecleus* nymph. Even if the nymphs feed on ant nest roots and the ants are obtaining honey dew, it is doubtful that the ants could tend large nymphs directly. This is because the nymphs appear to avoid the ants (see below) and can move much more quickly than the ants themselves.

A number of interesting behaviors were noted in laboratory Wilson cell groups of nymphs and ants. The nymphs would not remain with the ants. If antennated by the ants, the nymphs moved quickly away. If antennated a number of times within a short period, the nymphs jumped away from the ants. The nymphs rested on roots in the cell, but did not seem to select one kind of root over another to rest upon. One nymph on a root was observed to move around the root and, in a squirrel-like motion, kept the root between itself and a nearby ant. The nymphs were extremely sensitive to any jarring of the cell, which caused them to move around or to jump.

During a 24 hr observation period, the wax filaments of a nymph's tail slowly lengthened ca. 2 mm. At one point, the nymph jumped, and when it landed the tail filaments had been flicked off. The most unusual behavior noted for a nymph occurred at 7:52 A.M., 21 hr after observation had begun. A medium-sized nymph was observed arching its head and abdomen downward, bending itself into a C shape. These movements continued periodically until 9:37 A.M., when the abdominal intersegmental membranes began to protrude from between the original abdominal plates. By 10:11 A.M., three new abdominal bands as wide as the 4 abdominal plates were present. They were a slightly lighter yellow-orange and glistening. The nymph arched, often while clinging to a root, and the haemolymph was observed flowing up and down in the proboscis and head. A change occurred in the nymph's behavior. Although it still avoided the ants, the nymph became extremely active. It had jumped only 3 times prior to 10:30 A.M. (twice in response to ant antennation), but between 10:30 and 11:00 A.M., when observation was terminated, it jumped 15 times. The nymph also continued to arch periodically during this time.

CONCLUSIONS

The nymphs of the planthopper *O. borealis* were found in the subterranean nests of the ant, *P. arenivaga.* These nymphs, members of the homopteran family Cixiidae, were previously unknown. Adding to Wilson's (1971) catalog of associations, Cixiidae is the ninth homopteran family known to be symbiotic with ants. Nymphs were present in the ant nests throughout the year.

It is suggested that the ant–nymph relationship is obligatory for *Oecleus,* involving the need for *Oecleus* to reach its host plant roots, which it does by penetrating a *Paratrechina* nest where roots are exposed by excavations of the ants. In all known ant–homopteran relationships, the ant obtains honey dew from the homopteran. In the ant–*Oecleus* relationship, this is also presumed to occur, but was not observed in field or laboratory colonies.

Although attempts to determine the *Oecleus* food plant with P^{32} were not successful, the author believes the technique was valid with the exception of nymph handling. Better handling techniques are needed since many nymphs succumbed to or did not feed under experimental conditions.

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LITERATURE CITED

Ball, E. D. and P. Klingenberg. 1935. The genus *Oecleus* in the United States (Homoptera: Fulgoridae). Ann. Ent. Soc. Am. 28:193–213.

Dozier, H. L. 1926. The Fulgoridae or plant-hoppers of Mississippi, including those of possible occurrence. Tech. Bull. Miss. Agri. Exp. Stn. 14:1–152.

Kramer, J. P. 1977. Taxonomic study of the planthopper genus *Oecleus* in the United States (Homoptera: Fulgoroidea: Cixiidae). Trans. Am. Ent. Soc. 103:379–449.

Myers, J. G. 1929. Observations of the biology of two remarkable cixiid plant-hoppers (Homoptera) from Cuba. Psyche 36:283–292.

Nixon, G. E. J. 1951. The Association of Ants with Aphids and Coccids. Commonw. Inst. Ent., London, 36 pp.

Thompson, C. R., J. C. Nickerson and F. W. Mead. 1979. Nymphal habitat of *Oliarus vicarius* (Homoptera: Cixiidae), and possible association with *Aphaenogaster* and *Paratrechina* (Hymenoptera: Formicidae). Psyche 86:321–325.

Townsend, C. H. T. 1892. Oviposition of a homopterous insect in yucca. Psyche 6:353–354.

Van Duzee, E. P. 1908. Studies in North American Fulgoridae. Proc. Acad. Nat. Sci. Philadelphia 1907:467–498.

Way, M. J. 1963. Mutualism between ants and honey-dew producing Homoptera. Annu. Rev. Ent. 8:307–344.

Wilson, E. O. 1962. Chemical communication among workers of the fire ant, *Solenopsis saevissima* (Fr. Smith). 1. The organization of mass foraging. Anim. Behav. 10:134–137.

Wilson, E. O. 1971. The Insect Societies. Belknap Press of Harvard Univ. Press, Cambridge, Massachusetts, 548 pp.

Wilson, S. W., J. H. Tsai and C. R. Thompson. 1983. Descriptions of the nymphal instar of *Oecleus borealis* (Homoptera: Fulgoroidea: Cixiidae). J. New York Ent. Soc. 91:418–423.

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A NEW SPECIES OF *SIGARA* FROM WESTERN OREGON AND WASHINGTON (HEMIPTERA: CORIXIDAE)

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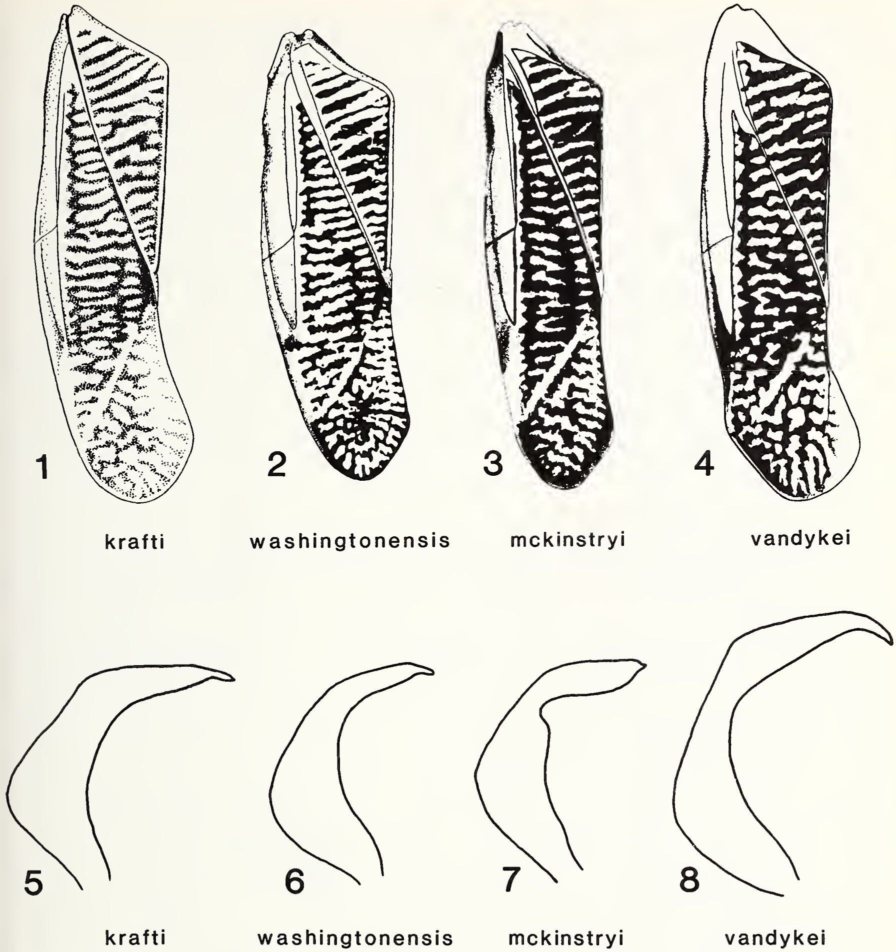
Abstract.—A new corixid, *Sigara krafti,* is described from specimens collected in western Oregon and Washington. This species seems to prefer shallow, slow-moving water in streams and small rivers, and is most abundant over silty or muddy substrates. Illustrations of the male abdominal terga, right pala and right paramere of the male, left hemelytron of the female, and the mesepimeron are provided for *Sigara krafti* and three related species (*S. mckinstryi* Hungerford, *S. vandykei* Hungerford, *S. washingtonensis* Hungerford) found in Oregon and Washington.

Hungerford (1948) reported the following five species of the genus *Sigara* from Oregon and Washington: *S. alternata* (Say), *S. omani* (Hungerford), *S. ornata* (Abbott), *S. vandykei* Hungerford, *S. washingtonensis* Hungerford. All of these species are common in the Pacific Northwest except for *S. ornata,* which appears to have been erroneously recorded from this region. Hungerford reported *S. ornata* from an unspecified locality in Oregon, basing his identification on three specimens from the Uhler collection (USNM). I have examined a male and two female specimens from the Uhler collection that I believe are the ones Hungerford said were from Oregon. The writing on the labels is barely discernible, but it appears to read "Oro, 4-21-00." Hungerford apparently thought the label read "Ore" as in Oregon. However, it is more probable that "Oro" pertains to a specific locality or its abbreviation (e.g., Orono, Maine). In any case, all other records of *S. ornata* are from the northeastern United States and Canada, and it is doubtful this species occurs outside of that region.

Besides the species reported by Hungerford (1948), four other *Sigara* species occur in Oregon and/or Washington. These are *S. decoratella* (Hungerford), *S. grossolineata* Hungerford, *S. mckinstryi* Hungerford, and a new species, *S. krafti,* described below. *Sigara krafti* is distinguished from other *Sigara* species of the Pacific Northwest by the following combination of characters: body length 5.3–6.1 mm; ostiole located about midway between lateral bend and apex of mesepimeron; mesepimeral process broadest just anterad of ostiole, then slightly narrower to lateral bend (Fig. 13); anterior one-third to one-half of metaepisternum fuscous; posteromedial projection of male seventh abdominal tergum triangular (Fig. 9); right paramere of male thickened preapically (Fig. 5); and male pala with 29–34 pegs (Fig. 17).

The following abbreviations are used for specimen depositories cited in the locality data: American Museum of Natural History (AMNH); California Academy of Sciences (CAS); John T. Polhemus, personal collection (JTP); Oregon State University (OSU); National Museum of Natural History, Smithsonian Institution (USNM).



Figs. 1–8. 1–4. Hemelytron of female. 5–8. Right paramere of male.

Sigara krafti, new species
(Figs. 1, 5, 9, 13, 17, 18)

Description. SIZE: Length: males, 5.3–5.8 mm; females, 5.4–6.1 mm. Width of head across eyes: males, 1.6–1.8 mm; females, 1.7–1.9 mm. Synthilipsis: males, 0.5–0.6 mm; females, 0.6–0.7 mm. COLOR: Pale yellow to yellowish brown ground color with brown to fuscous markings; pronotal disk and hemelytra grayish yellow with fuscous bands, sometimes lightly tinged with red. Pronotum with eight or nine transverse bands, dark bands equal in width or slightly narrower than pale intervening regions; middle one or two bands often broken, sometimes extending only across central portion of disk. Clavus with regular transverse bands, sometimes forked at

Figs. 9–17. 9–12. Abdominal terga of male. 13–16. Mesepimeron. 17. Male pala.

outer margin; bands tending to coalesce along commissure of hemelytra. Corial pattern distinctly transverse, bands coalescing to form longitudinal stripe along embolium and short longitudinal band across from apex of clavus. Membranal pattern irregular, sometimes fading along inner margin; membrane separated from corium by pale line. Embolium smoky, often fading to yellowish brown beyond nodal furrow. Head pale yellow, sometimes brownish yellow between eyes. Sternum and venter mostly darkened; sternum sometimes lighter in females. Mesepimeron pale, mesepimeral process moderately to heavily infuscated; metaepisternum pale, anterior one-third to one-half fuscous. Legs pale, coxae lightly to moderately infuscated. STRUCTURAL CHARACTERISTICS: Head half as long as pronotal disk; synthilipsis about equal to width of eye; postocular space narrow; vertex slightly produced; facial hairs sparse; fovea of male broad and shallow. Pronotum, clavus, and corium strongly rastrate. Pronotum 1.5×–1.7× as wide as long; lateral angles acute; posterior margin angulate; median carina small but distinct. Mesepimeron broadest just anterad of ostiole, slightly narrower and parallel-sided between ostiole and lateral bend; ostiole about two-fifths the distance from the tip to the lateral bend. Metaxyphus distinctly broader than long. Pala of male with 29–34 pegs arranged in single, curved row (Fig. 17). Male abdomen dorsally as in Fig. 9; abdominal strigil small, subspherical, composed of four or five combs; posteromedial projection of seventh abdominal tergum triangular. Right paramere of genital capsule as in Fig. 5.

Etymology. This species is named for Dr. Gerald F. Kraft (Biology Department, Western Washington University, Bellingham, Washington); while under his supervision I developed a strong interest in the family Corixidae, as well as other aquatic and semiaquatic Hemiptera.

Comparative notes. Sigara krafti is very similar to three other species of *Sigara* found in Oregon and Washington. In Hungerford (1948) and Lauck (1979), *S. krafti* keys to a couplet containing two of these species, *S. mckinstryi* and *S. washingtonensis. Sigara krafti* differs from these species by the more extensively darkened embolium, fuscous anterior region of the metaepisternum, weakly produced vertex, and by the shape of the right paramere of the male (compare Figs. 5–7). *Sigara krafti* is further differentiated from *S. washingtonensis* by the more regular transverse banding of the corium (compare Figs. 1 and 2), smaller abdominal strigil, and by the shape of the posteromedial projection of the seventh abdominal tergum of the male (compare Figs. 9 and 10). The pronotal disk of *S. krafti* is 1.5×–1.7× as broad as long, whereas in *S. washingtonensis* the disk is nearly twice (1.8×–1.9×) as broad as long. These two species also differ in the width of the postocular space. When measured at the inner posterior angle of the eye, the postocular space of *S. krafti* is distinctly narrower than the width of the middle tarsus. In *S. washingtonensis,* the postocular space is equal to or greater than the tarsal width. Finally, males of *S. krafti* usually have more palar pegs (29–34) than males of *S. washingtonensis* (26–30), but some overlap occurs in the range of peg numbers of these two species.

The hemelytral patterns of *S. krafti* and *S. mckinstryi* are similar, but the dark bands are usually narrower in *S. krafti* (compare Figs. 1 and 3). *Sigara krafti* also differs from *S. mckinstryi* by the shape of the mesepimeral process. In the latter species, the process is parallel-sided or weakly divergent from the ostiole to the lateral bend (Fig. 15), whereas in *S. krafti* the process is broadest just anterad of the ostiole, then slightly narrower to the lateral bend (Fig. 13).

Sigara krafti is superficially similar to a third *Sigara* species in Oregon and Washington, *S. vandykei.* The latter species is easily distinguished from *S. krafti* by the subapical position of the ostiole on the mesepimeral process (compare Figs. 13 and 16), the explanate anterolateral margin of the clavus that projects laterally over the clavoprunia, the protuberance on the posterolateral margin of the female hemelytron (compare Figs. 1 and 4), and by the right paramere of the male (compare Figs. 5 and 8).

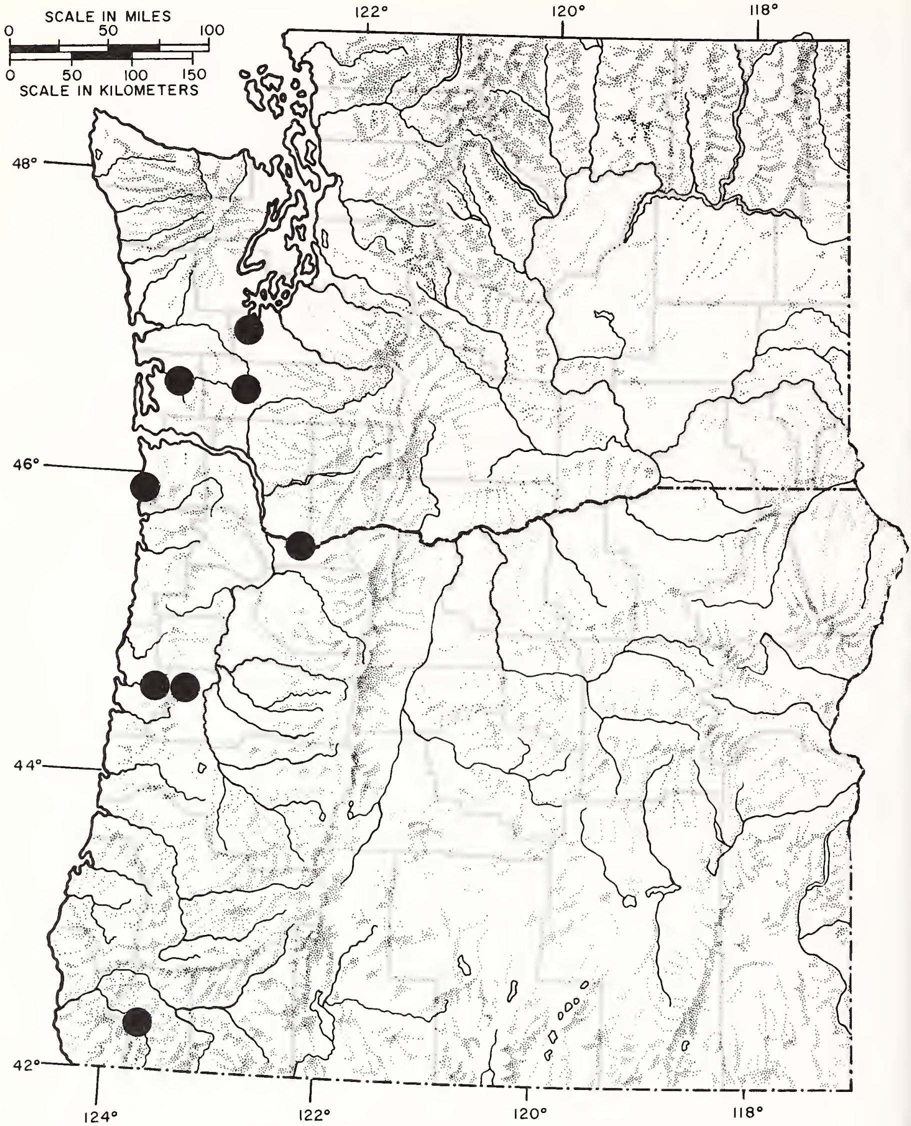


Fig. 18. Distribution of *Sigara krafti* Stonedahl, new species.

Distribution (Fig. 18). *Sigara krafti* is distributed west of the Cascade Range in Oregon and Washington. The majority of records are from streams and small rivers, but several specimens have been collected from small ponds (near rivers) in west-central Oregon. This species appears to be most abundant in shallow, static or slow-moving water over silty or muddy substrates. Three other species of *Sigara* are found in similar habitats in western Oregon and Washington, and are sometimes collected with *S. krafti.* Of these, *S. washingtonensis* is encountered most often; the other species are *S. vandykei* and *S. omani.*

Holotype. Male: Oregon, Benton Co., Mary's R., 1 mi. W jct. St. Hwy, 34 on US 20, 2 Aug. 1983, G. M. Stonedahl (CAS).

Paratypes. OREGON. Benton Co.: 19 males and 19 females, same data as holotype (AMNH, CAS, JTP, OSU, USNM); 4 males, 4 mi. S Blodgett, 26 March 1959 (OSU); 1 male, Log pond, W end Philomath, 17 April 1962, B. Courtright (OSU); 1 male, Mary's R., 3 mi. W Philomath, 26 April 1956, J. D. Lattin (OSU). Clatsop Co.: 1 male, East Humbug Crk., 23 April 1966, S. G. Jewett, Jr. (OSU). Josephine Co.: 1 male and 8 females, 10 mi. W Selma, 13 May 1972, Wu Shuang Lee (OSU). Lincoln Co.: 1 female, Kasner Pond, 2 mi. E Burnt Woods, 22 April 1962, D. Hipply (OSU). Multnomah Co.: 1 male, Rooster Rock, Columbia R. Gorge, 15 April 1972 (OSU). WASHINGTON. Lewis Co.: 8 females, Chehalis R. at Alexander Park, 11 Sept. 1977, G. M. Stonedahl (author's collection); 1 male, T13N, R3W, Sec. 18, 12 Sept. 1977, G. M. Stonedahl (author's collection). Pacific Co.: 1 male, T14N, R8W, Sec. 19, 12 Sept. 1977, G. M. Stonedahl (author's collection); 2 males and 2 females, Willapa R., 9 Sept. 1930 (OSU); 19 males and 20 females, Willapa R., T13N, R8W, Sec. 25, 12 Sept. 1977, G. M. Stonedahl (author's collection). Thurston Co.: 1 female, Tumwater, 3 Sept. 1929 (OSU).

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LITERATURE CITED

Hungerford, H. B. 1948. The Corixidae of the Western Hemisphere (Hemiptera). University of Kansas Science Bulletin 32:1–827.

Lauck, D. R. 1979. Corixidae. Pages 87–123 *in:* A. S. Menke (ed.), The semiaquatic and aquatic Hemiptera of California. Bulletin of the California Insect Survey 21:1–166.

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CARVALHOMA (HEMIPTERA: MIRIDAE): REVISED SUBFAMILY PLACEMENT

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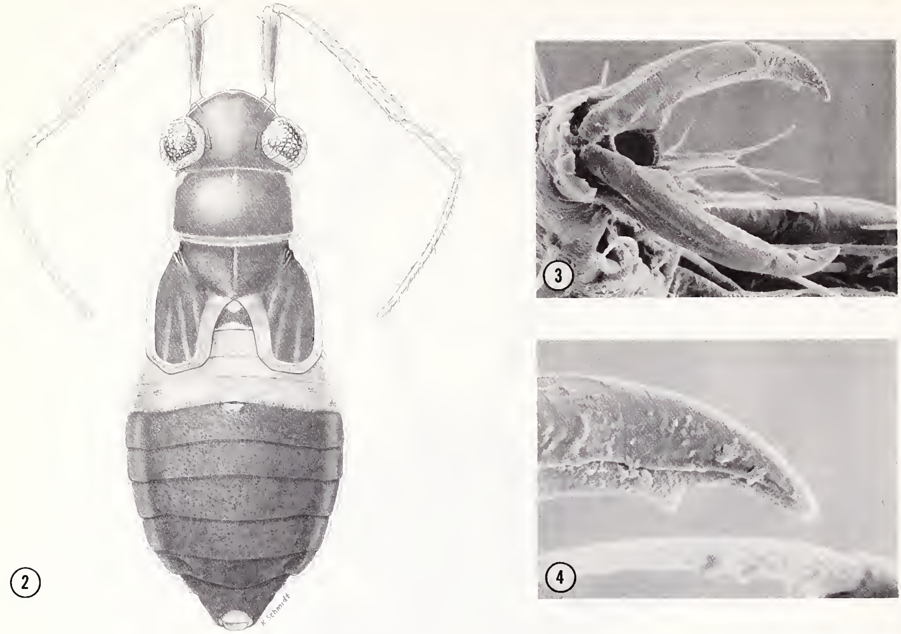
Abstract.—*Carvalhoma* Slater and Gross is transferred from the Phylinae to the Cylapinae. The nymphal and adult male habitus, male genitalia, and claws of *Carvalhoma malcolmae* Slater and Gross are figured. Characters used to determine subfamily placement are discussed, and it is suggested that the Cylapinae, Isometopinae, and *Psallops* Usinger form a monophyletic group.

Slater and Gross (1977) described from Australia two species of *Carvalhoma* on the basis of female specimens. They placed the genus in the mirid subfamily Phylinae on the basis of its hairlike (setiform) parempodia, simple sclerotized rings, and the narrow straplike interramal sclerites in the female. We question the correctness of this subfamilial assignment for the following reasons: the habitus of *Carvalhoma* is unusual in the Phylinae; setiform parempodia occur in cylapine, deraeocorine, and bryocorine mirids in addition to the Phylinae and are therefore not diagnostic of any one of these groups; and the simple structure of the female genitalia illustrated by Slater and Gross is not necessarily diagnostic for the Phylinae. We have examined a male specimen of *Carvalhoma malcolmae* collected in forest litter at Talbingo Mountain, 47.8 km S of Tumut, New South Wales, Australia, on April 3, 1976. The specimen is illustrated in Figure 1. The nymph is illustrated in Figure 2. The male of *C. malcolmae* is similar in appearance to the female as illustrated by Slater and Gross (1977) but has a slightly more elongate and swollen pronotum and somewhat differently shaped hemelytra which cover less of the abdomen. We have studied the pretarsal structures (Figs. 3, 4) and male genitalia in detail (Figs. 5–9). We believe our examination supports placement of *Carvalhoma* in the subfamily Cylapinae (we have tentatively placed it in the tribe Cylapini based on the structure of the head and the condition of the ostiolar peritreme which is without an ocelloid shining tubercle). Our reasons are as follows.

1. The claws are elongate and slender and lack pulvilli, attributes which, in conjunction with the setiform parempodia, have traditionally been used to diagnose the Cylapinae. None of these pretarsal characteristics is unique to the Cylapinae, however, and therefore do not provide suitable defining characters for the group. The one unique structural detail of the pretarsus of *Carvalhoma* and all other cylapines of which we are aware is the subapical tooth, seen in Figures 3 and 4. This feature has been illustrated by Knight (1918), Carvalho (1955), and Schuh (1976), but was not observed in *Carvalhoma* by Slater and Gross. A similar claw structure occurs in the Isometopinae as shown by McAtee and Malloch (1924) and Schuh (1976) and in *Psallops* Usinger as shown by Schuh (1976), strongly suggesting that these three groups together form a monophyletic unit in the Miridae. The strength of this argument lies

Fig. 1. *Carvalhoma malcolmae.* Adult male, dorsal view.

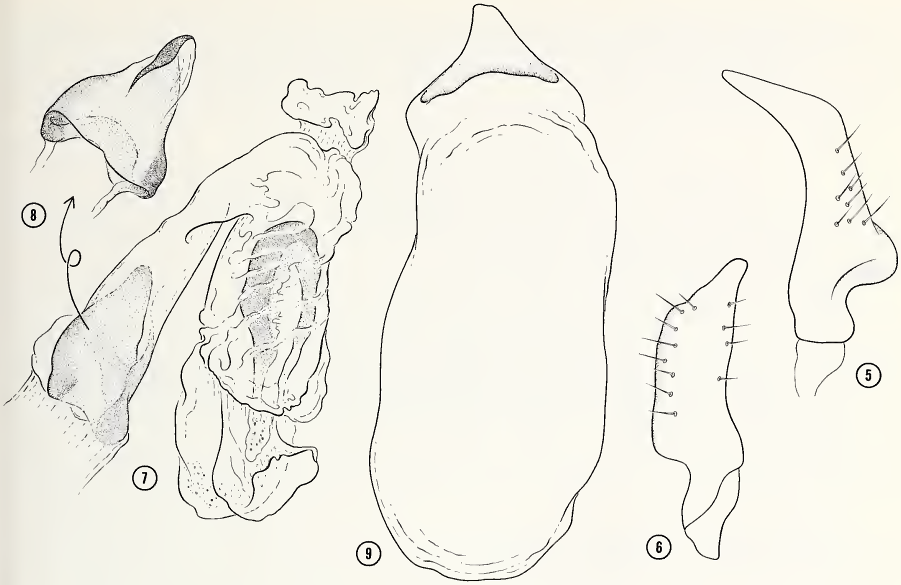


Figs. 2–4. *Carvalhoma malcolmae.* 2. Nymph, dorsal view. 3. Pretarsus. 4. Detail of claw.

in the fact that the subapical tooth occurs only in the Miridae and does not occur in those subfamilies and/or tribes of Miridae which have been recognized as monophyletic on the basis of other characters.

2. The Phylinae are recognized by the unique structure of the male genitalia, with the straplike vesica, the phallotheca attached to the posterior wall of the genital capsule (rather than the phallobase which is the condition in all other Miridae), and the characteristic shape of the left clasper, which supports the phallotheca in repose. The male genitalia of *Carvalhoma malcolmae* are clearly unlike those of any Phylinae and appear not to have been derived from a phyline type. The parameres (Figs. 5, 6) are of a form similar to that found in some Cylapinae (see Carvalho and Lorenzato, 1978, and Carvalho, 1982) and in some Isometopinae (see Slater and Schuh, 1969). In *C. malcolmae* the right and left parameres are almost identical in shape and size, whereas in some cylapines (e.g., *Fulvius* spp.) the right paramere is extremely small. The membranous vesica (Fig. 7) is of a type found in many cylapines (see Carvalho and Lorenzato, 1978) and is similar in structure to that of some other non-phyline Miridae. The small membranous vesica of *malcolmae* has a large secondary gonopore (as also occurs in species of *Cylapocerus* and *Peltidocylapus* [Carvalho and Fontes, 1968]) with an additional heavily sclerotized ringlike structure basad of it which surrounds the ductus seminis (Fig. 8). The phallotheca surrounds the vesica and is attached to the phallobase; the dorsal surface is sclerotized and tapering distally; the ventral surface is membranous (Fig. 9).

3. The structure of the head, with its protruding eyes and depressed vertex, and



Figs. 5–9. *Carvalhoma malcolmae.* 5. Left paramere, lateral view. 6. Right paramere, lateral view. 7. Vesica, dorsal view. 8. Ring-like structure of vesica, ventral view. 9. Phallotheca, ventral view.

the very long appendages, appear to be a synapomorphy for *Carvalhoma* with some mirid taxa placed in the Cylapinae by Carvalho (1957) (e.g., *Cylapus* Say and *Corcovadocola* Carvalho, the latter also known to dwell in the litter [Carvalho, 1948]).

The characters used by Slater and Gross to assign *Carvalhoma* to the Phylinae are not unique to that group of Miridae. The claws and male genitalia appear to offer a character unique to a grouping of mirid taxa which has not been formally recognized by previous authors. Further study of other characters in the Cylapinae, Isometopinae, and *Psallops,* will help to determine the validity of the theory that these three taxa form a monophyletic group.

Our justification for the subfamilial placement of *Carvalhoma* is based on an interpretation of characters which contradicts the hypothesis of relationships presented by Schuh (1976). In that paper the absence of ocelli was interpreted as a character uniting all Miridae except Isometopinae and the subapical claw tooth was considered to be plesiomorphic within the Miridae and to have been lost in the phyline-orthotyline and mirine-deraeocorine-bryocorine clades. Furthermore, Schuh gave no unequivocal defining characters for *Psallops* or the Cylapinae as groups. A more parsimonious interpretation of character distributions is to lose the ocelli twice and to define a group including Isometopinae, Cylapinae, and *Psallops* on its possession of the subapical claw tooth.

The idea that *Psallops* and Isometopinae are related is not new; it was first suggested by Carvalho (1956) and reassessed by Schuh (1974, 1976). In fact there seems to be little justification for considering the pronotal collar of Cylapinae as homologous with that found in the Mirinae-Deraeocorinae-Bryocorinae as was done by Schuh (1976); the Bothriomirini lack a pronotal collar, a point overlooked by Schuh, and in addition several orthotyline genera have well developed rounded collars.

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LITERATURE CITED

Carvalho, J. C. M. 1948. Mirideos Neotropicais. XXXV. Generos "Corcovadocola" n.g., "Guanabarea" n.g., e "Caulotops" Bergroth (Hemiptera). Rev. Brasil. Biol. 8:525–533.

Carvalho, J. C. M. 1955. Key to the genera of Miridae of the World. Bol. Paraense Emilio Goeldi 11:1–151.

Carvalho, J. C. M. 1957. Catalogue of the Miridae of the World. Part I. Arq. Mus. Nac., Rio de Janeiro 44:158 pp.

Carvalho, J. C. M. 1965. Insects of Micronesia. Heteroptera: Miridae: Miridae. Bernice P. Bishop Museum, Honolulu 7:1–100.

Carvalho, J. C. M. 1968. Mirideos Neotropicais. CI. Revisao do complexo "*Cylapus*" Say com descricoes de generos e especies novos (Hemiptera). Rev. Brasil. Biol. 28:273–282.

Carvalho, J. C. M. 1982. Mirideos Neotropicais. CCXXXIX. Descricoes de algumas especies de Cylapinae do Amazonas (Hemiptera). Acta Amazonica 12:811–815.

Carvalho, J. C. M. and L. M. Lorenzato. 1978. The Cylapinae of Papua New Guinea (Hemiptera: Miridae). Rev. Brasil. Biol. 38:121–149.

Knight, H. H. 1918. Synoptic key to the subfamilies of Miridae (Hemiptera-Heteroptera). J. New York Ent. Soc. 26:40–44.

McAtee, W. L. and J. R. Malloch. 1924. Some annectant bugs of the superfamily Cimicoidea (Heteroptera). Bull. Brooklyn Ent. Soc. 19:69–83.

Schuh, R. T. 1974. The Orthotylinae and Phylinae (Hemiptera: Miridae) of South Africa with a phylogenetic analysis of the anti-mimetic tribes of the two subfamilies for the World. Ent. Amer. 47:332 pp.

Schuh, R. T. 1976. Pretarsal structure in the Miridae (Hemiptera) with a cladistic analysis of relationships within the family. Amer. Mus. Novitates 2601:39 pp.

Slater, J. A. and G. F. Gross. 1977. A remarkable new genus of coleopteroid Miridae from southern Australia (Hemipera: Heteroptera). J. Austr. Ent. Soc. 16:135–140.

Slater, J. A. and T. Schuh. 1969. New species of Isometopinae from South Africa (Hemiptera: Miridae). J. Ent. Soc. Southern Africa 32:351–366.

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LIFE HISTORY AND LABORATORY REARING OF *EUSCHISTUS ICTERICUS* (HEMIPTERA: PENTATOMIDAE), WITH DESCRIPTIONS OF IMMATURE STAGES

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Abstract.—The life history of *Euschistus ictericus* was studied in southern Illinois, and the immature stages were described. The bug was also reared from egg to adult in the laboratory. Adults emerged from overwintering sites in early May, began feeding on *Carex comosa* Boott, and reproduced shortly thereafter. Eggs were generally laid on *C. comosa* and nymphs were found only on this plant. No individuals were found after mid-August. *E. ictericus* was reared on green beans under a 16L:8D photoperiod and constant temperature of 23.9 ± 1.1°C. The incubation period averaged 7.33 days. Durations of the 5 subsequent stadia averaged 3.99, 7.72, 7.27, 9.03, and 12.62 days, respectively. The external anatomy of the egg and each of the 5 nymphal instars is described.

Euschistus ictericus (L.) occurs from eastern Canada south to Florida, and west and southwest to Utah, Oklahoma, and Texas (McPherson, 1982). It has been collected on sedges, *Iris versicolor* L., water lilies, *Saururus cernuus* L., *Salix*, yellow thistle, cow-parsnip, *Cuscuta*, soybeans, and common mullein (McPherson, 1982).

Little has been published on the field life history of this stink bug. It overwinters as adults (Blatchley, 1895; Parshley, 1923). Torre-Bueno and Engelhardt (1910) found mating specimens on 24 July on water lilies in North Carolina. This paper presents information on the life history and laboratory rearing of *E. ictericus* and includes descriptions of the immature stages.

MATERIALS AND METHODS

Life history. On 12 June 1981, several adults, including copulating pairs, were observed on the heads, leaves, and stems of *Carex comosa* Boott growing in water near the shore of La Rue Swamp, Union County, Illinois. The presence of copulating adults suggested a life history study was possible and, therefore, a study was conducted from June 1981 to July 1982. Collection of data during 1981 ended in August after the insects left the host plants. During 1982, data were collected from April to July, before the bugs appeared on, and after they left the plants.

Data were collected weekly during the study and consisted primarily of counts of all stages present. Few animals were actually collected because the population size appeared small. The only exceptions were a few egg clusters and young nymphs that were reared to adults to confirm their identities and, with nymphs, to confirm their instars when collected. Data gathered during the 2 years of the study were combined to gain a better understanding of the annual life cycle.

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Laboratory rearing. Fifteen adults (9♂♂, 6♀♀) were collected from *C. comosa* at La Rue Swamp on 12 June 1981, taken to the laboratory, and placed in a 1-qt. (ca. 0.95-liter) Mason jar covered on the bottom with filter paper. Green snap beans (*Phaseolus vulgaris* L.) served as food and were placed on end in the bottom of the jar. A strip of paper toweling was added which, together with the filter paper, increased absorption of excrement and provided a good walking surface for the nymphs. The jar was closed with wire screen and paper toweling and secured with the band of the 2-piece Mason jar lid. A cheesecloth strip (ca. 6 × 20 cm), which served as an oviposition site, was placed inside the jar with 1 end over the lip and held in place by the band.

The cage was examined daily for eggs. Cheesecloth, with attached egg clusters, was removed and placed on moist filter paper in the bottoms of petri dishes (ca. 9 cm diam., 2 cm depth) and covered with the lids. Water was added daily to keep the filter paper moist.

The first instars (an apparently nonfeeding stage) were also kept in the petri dishes. The second through fifth instars were kept in Mason jars prepared similarly to the oviposition cage except for the absence of cheesecloth.

Food, filter paper, and strips were changed every 3–4 days. The dishes and jars were kept in an incubator maintained at 23.9 ± 1.1°C and a 16L:8D photoperiod.

Descriptions of immature stages. The description of each stage is based on 10 individuals that were collected from the laboratory culture and preserved in 95 percent ETOH. The first instar is described in detail, but only major changes from previous instars are described for subsequent instars. Comparative statements refer to previous instars (e.g., "more numerous"). Length is measured from tip of tylus to tip of abdomen; width is measured across the mesonotum. Dimensions are expressed in mm as $\bar{x}$ ± SE. Drawings were made with the aid of a camera lucida, measurements with an ocular micrometer.

RESULTS AND DISCUSSION

Life history. Fifty-nine adults, 70 eggs, and 35 nymphs were found during this study. Adults emerged from overwintering sites in early May and began feeding on the heads of *C. comosa.* Shortly thereafter, they were observed copulating on the heads, leaves, and stems of the host plant; as in many other pentatomoids (McPherson, 1982), the copulating position was end-to-end.

The 70 eggs were laid in 6 clusters, an average of 11.7 eggs/cluster (range, 6–14). These clusters and those deposited in the laboratory usually consisted of 2 to 4 rows of eggs. The first cluster was collected on 14 May and had been deposited on a head of *C. comosa.* The 5 remaining clusters were collected on 18 June; 4 had been laid on *C. comosa* (2 on heads, 2 on bracts) and 1 on *Sagittaria latifolia* Willdenow (on a leaf) that was growing in a stand adjacent to *C. comosa.*

No first or second instars were collected. Five third instars were collected between 4 June and 3 July, 12 fourths between 12 June and 30 July, and 18 fifths between 18 June and 6 August; all were collected on *C. comosa.* Adults occurred on *C. comosa* until mid-August; most (55.2 percent) were observed between 12 and 18 June.

From these limited data, it is difficult to decide whether *E. ictericus* was uni- or bivoltine at Pine Hills. Both interpretations are reasonable.

Laboratory rearing. The 230 eggs deposited (Table 1) were laid on the cheesecloth

Table 1. Duration (in days) of each immature stage of *E. ictericus*.

Stage	No. completing stadium	Days		
		Range	$\bar{x} \pm$ SE	Cumulative mean age
Egg	227[a]	6–8	7.33 ± 0.04	7.33
Nymph				
1st instar	226	3–5	3.99 ± 0.05	11.32
2nd instar	205	6–15	7.72 ± 0.09	19.04
3rd instar	184	5–14	7.27 ± 0.10	26.31
4th instar	171	6–18	9.03 ± 0.13	35.34
5th instar	165	9–21	12.62 ± 0.15	47.96

[a] 230 eggs were laid.

in 14 clusters, an average of 16.4 eggs/cluster (range, 8–31). The incubation period averaged 7.33 days. The eye spots and mouth parts were visible in 3–4 days.

The first instars were gregarious and remained atop the egg shells unless disturbed. They apparently did not feed. The duration of this stadium averaged 3.99 days.

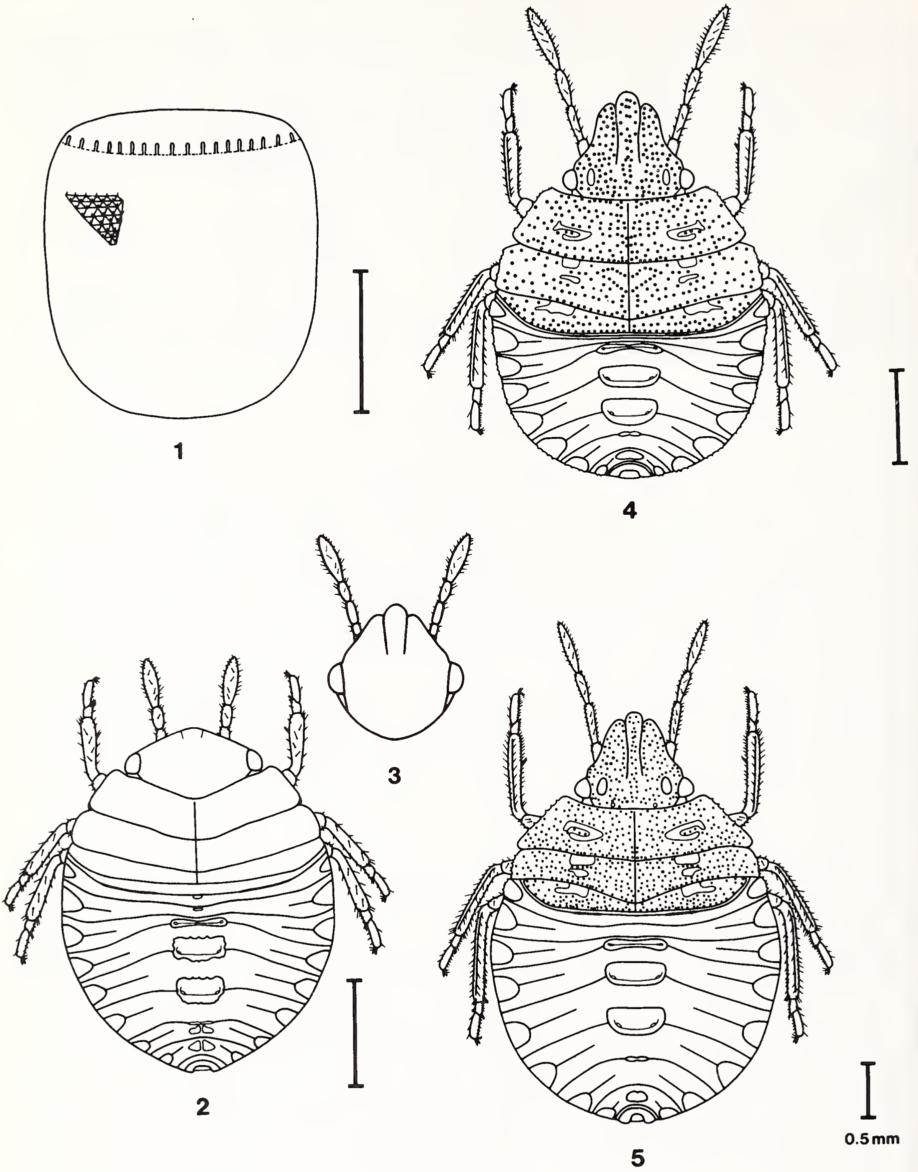
The durations of the second through fifth stadia averaged 7.72, 7.27, 9.03, and 12.62 days, respectively. Total developmental time from egg to adult averaged 47.96 days. Of the 226 individuals that began the second stadium, 73.0 percent (165 individuals) reached adults.

Descriptions of immature stages. EGG (Fig. 1). Length, 1.13 ± 0.01; width, 1.00 ± 0.01. Generally laid in clusters of 14; each egg kettle-shaped, yellowish white. Chorion with irregular triangular and quadrangular reticulations; spine at apex of each angle. Operculum present, surrounded by 34–38 micropylar processes, each process ca. 0.06 mm long and slightly dilated at tip.

FIRST INSTAR (Figs. 2, 3). Length, 1.67 ± 0.02; width, 1.23 ± 0.01. Body oval, greatest width at abdominal segments 2–3. Punctures present dorsally and ventrally, all punctures minute.

Head declivent, anterolateral margins sinuate; yellowish brown to light brown dorsally with vertex yellow medially and tylus reddish to yellowish brown, often with red U-shaped marking between eye and midline of head; tylus exceeding juga; line extending from each eye posteromedially and disappearing beneath pronotum. Eyes red. Antennae 4-segmented; segments 1–3 brownish to red; segment 4 largest, fusiform, reddish brown to brown; incisures albidus; distinct constrictions at junctures of 2–3 and 3–4; ratio of antennal segment lengths ca. 10:11:12:25. Ventral surface of head whitish to yellowish brown. Beak 4-segmented, whitish to brown, segments 3–4 darker.

Thoracic nota reddish brown to brown, yellow medially, yellow mediolongitudinal line extending from anterior margin of pronotum nearly to or reaching posterior margin of metanotum; lateral margins entire; pro- and mesonota sclerotized, posterior margins arcuate; metanotum sclerotized except posteriorly, posterior margin of metanotal plate slightly arcuate medially, bending cephalad laterally; faint calli occasionally present on all segments; intersegmental line between metanotum and first



Figs. 1–5. Immature stages of *E. ictericus.* 1. Egg. 2, 3. First instar. 4. Second instar. 5. Third instar.

abdominal tergum often sclerotized either side of midline ca. one-half way between lateral margin and midline of body. Pleura light brown; pro- and mesopleura fused to respective nota; metapleura separated from metanotal plate by membranous area. Spiracles located on posterior margins of pro- and mesopleura. Sterna concolorous with ventral surface of abdomen. Coxae whitish, each with central brown mark on lateral surface; trochanters pale brown; femora brownish with apices reddish; tibiae reddish with apices yellowish, front tibiae each with bifurcate spine on inner posterior margin of distal one-third; tarsi 2-segmented, yellowish, apex of segment 2 darker; tarsal claws and pulvilli brown to yellowish brown.

Dorsum of abdomen white, or yellow, with red markings; sparsely punctate light brown to brown medial and lateral plates present. Faint pseudointersegmental lines on all but first and last segments, each originating at inner margin of lateral plate. Eight medial plates present; plates 1–2 small, plate 2 may be weakly sclerotized; plate 3 narrowed medially; plate 4 subrectangular with markedly irregular margins, slightly narrower than, and 4 to 5 times medial length of, plate 3; plate 5 subtrapezoidal with markedly irregular margins, slightly narrower than, and 5 to 6 times medial length of, plate 3; plate 6 often consisting of anterior transverse strip and paired posterior pieces; plate 7 variable in shape, often split or partially split medially; plate 8 fused to laterals; paired ostioles of scent glands located on plates 3–5. Nine lateral plates present, subelliptical, extending dorsally and ventrally from margin of abdomen; plate 1 small; plates 2–6 largest; remainder generally decreasing in size posteriorly. Sterna generally concolorous with dorsum, occasionally redder; segments 5–9 occasionally with weakly sclerotized subrectangular medial plates, that of sternum 9 fused with laterals. Spiracles located on segments 2–8, those of segment 8 reduced, each with brown peritreme. A single trichobothrium located posteromesad to each spiracle on segments 3–7.

SECOND INSTAR (Fig. 4). Length, 2.15 ± 0.04; width, 1.77 ± 0.02. Body broadly pyriform; dorsum of head and thorax with numerous punctate brown spots, punctures large, brown; ventral punctures still minute.

Head less declivent, anterolateral margins more sinuate; white to yellow dorsally with posterior margin dark brown, oval brown spot slightly medial to each eye, red U-shaped markings of first instar absent, yellow area on vertex replaced by faint yellow V-shaped marking, tylus white to reddish. Antennal segments 1 and 4 brown; segments 2–3 reddish brown to brown, each red distally; incisures albidus to red; ratio of antennal segment lengths ca. 12:21:20:36. Ventral surface of head dark brown except for white area either side of beak and white to red strip beneath beak.

Thoracic nota white to yellow, lateral margins explanate, dentate, edged with brown (pro- and mesonota), posterior margins brown; mesonotum with medial area extended posteriorly; intersegmental line between metanotum and first abdominal tergum sclerotized either side of midline ca. one-half way between lateral margin and midline of body; pro- and metanota each with 1 pair, and mesonotum with 2 pairs, of brown calli. Pleura white, each edged with brown and with brown spots and brown longitudinal stripes. Sterna red. Coxae white, each with lateral edge and central spot brown; trochanters white; femora each with proximal one-half white, distal one-half brown, apex often red; tibiae reddish brown to brown, red basally, carinate; tarsi brown.

Dorsum of abdomen white to yellow with numerous, short, longitudinal, red markings. Medial and lateral plates with minute punctures. Medial plates 1–2 absent; plates 3–8 brown; plate 3 with transverse white stripe; plate 4 subtrapezoidal without marked irregular margins, ca. 3 times medial length of plate 3, transverse white marking present that is often anchor-shaped; plate 5 without marked irregular margins, ca. 4 times medial length of plate 3, white markings present and consisting of transverse anchor-shaped mark and short mediolongitudinal mark posterior to anchor; plate 6 small, linear, not divided into anterior strip and posterior pieces; plate 7 often undivided, white marking present medially; plate 8 with white marking present medially. Lateral plates white, margins brown, generally 1–4 brown spots in white areas. Ventrally, linear sclerite present posterior to each metacoxa. Sterna concolorous with dorsum in lateral one-half, whitish medially with sparse red markings; medial plates brown with minute punctures, now often on segments 4–9. Two trichobothria posterior to each spiracle on segments 3–7.

THIRD INSTAR (Fig. 5). Length, 4.04 ± 0.06; width, 2.40 ± 0.02. Dorsum of head and thorax with punctate brown spots limited primarily to humeri, remaining punctures more numerous and relatively smaller.

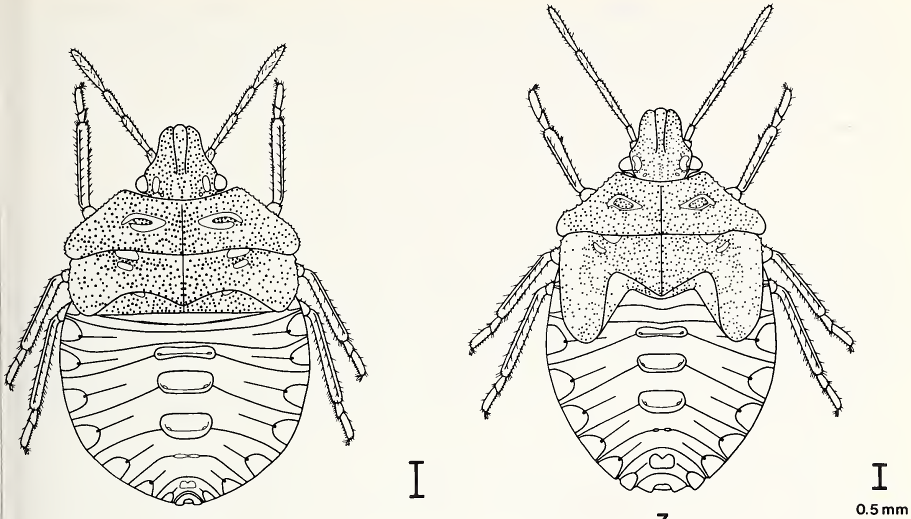
Head with anterolateral margins more sinuate; dorsally, yellow to yellow with lateral one-half of juga reddish, oval brown spot of second instar near each eye now yellow to yellowish brown; 2 red ocelli present posteromedially but often obscured by brown along posterior margin of head. Antennal segment 1 yellow to brown, with red to brown markings; segments 2–3 red; segment 4 reddish brown to brown; ratio of antennal segment lengths ca. 13:30:25:40. Ventral surface of head brown except for white areas either side of beak and around bases of antennae, yellow area which is often present between beak and eye, and white to red strip beneath beak.

Thoracic nota with paired calli yellow to brown; pronotum with medial area slightly extended posteriorly. Femora each with proximal two-thirds white, distal one-third mottled.

Dorsum of abdomen yellow with numerous short, longitudinal, yellow to red markings; terga 1–7 each with red to brown spot midway between lateral margin and midline of abdomen, spot may be obscure. Medial plate 3 yellow with brown anterior and posterior margins; plates 4–5 with markings similar to third instar but yellow instead of white, plates 3–5 often with brown spots on yellow areas; plates 7–8 yellow with brown spots. Lateral plates with brown spots small and more numerous. Sterna with medial plates on segment 4–9 varying from almost transparent with brown spots to brown; intersegmental lines between segments 2–3, 3–4, and 4–5 often sclerotized either side of midline.

FOURTH INSTAR (Fig. 6). Length, 6.20 ± 0.09; width, 3.62 ± 0.04. Dorsum of head and thorax with punctures more numerous in some areas and generally relatively smaller.

Head yellow dorsally with lateral one-third of juga reddish; ocelli now always visible. Antennal segment 1 yellow, apex brown, with red to brown spots; segment 2 yellow to reddish yellow; segment 3 yellow to red; segment 4 red to yellow proximally, brown distally; ratio of antennal segment lengths ca. 5:13:10:14. Ventral surface of head yellow except for lateral dark brown stripe extending from each eye at least to base of antennal segment 1, dark brown mark behind eye that may be continuous with dark brown mark on either side of midline along posterior margin



6

7

Figs. 6, 7. Immature stages of *E. ictericus.* 6. Fourth instar. 7. Fifth instar.

of head, and occasional pink spot beneath beak. Beak with segment 1 yellow to yellow with apex brown; segment 2 yellow to brown; segments 3–4 yellowish brown to brown.

Thoracic nota with brown borders along posterior margins reduced or absent; humeri with brown spots more numerous; calli yellow, those of meso- and metanota often with brown central spot. Meso- and metanotal wing pads ca. the same length, extending onto first abdominal segment. Pleura with brown spots and brown longitudinal stripes limited primarily to lateral one-half except for 1 brown spot at base of each coxa. Sterna yellow. Coxae white to yellowish white, each with light brown band on lateral edge absent and central brown spot occasionally absent; trochanters whitish yellow; femora yellow to reddish yellow proximally, yellow with reddish to brown spots distally; tibiae yellow to reddish brown, with red to brown markings; tarsal segment 1 yellow, apex often darker, segment 2 yellow basally, brown distally.

Dorsum of abdomen yellow with red spots medially. Medial plates 3–5 with brown spots more numerous; plates 4–5 yellow to brown and, if yellow, anchor-shaped markings of third instar obscured; plates 7–8 with brown spots more numerous. Lateral plates transparent, each with brown margins broken and sometimes reduced to large brown spot at base of pseudointersegmental line on plates 2–7; small brown spots often more numerous but may be absent. Ventrally, linear sclerite posterior to each metacoxa reduced to 1–4 brown spots. Sterna yellow; medial plates reduced or transparent, to transparent with a few small brown spots; sclerotized stripes on intersegmental lines between segments 2–3, 3–4, and 4–5 not evident.

FIFTH INSTAR (Fig. 7). Length, 9.30 ± 0.09; width, 5.38 ± 0.12. Dorsum of head and thorax with punctures more numerous in some areas and generally relatively smaller.

Head with posterior margin yellow to yellowish brown, yellow to yellowish brown oval spot near eye of third and fourth instars now broadly crescent-shaped. Antennal segment 1 yellow to reddish, with brown spots; segment 2 yellow to red, with brown spots; segments 3–4 red to yellowish red, apex of segment 4 darker; ratio of antennal segment lengths ca. 7:22:15:19. Ventral surface of head without pink spot beneath beak, brown mark either side of midline along posterior margin of head often reduced or absent.

Humeri with brown spots more numerous and extended anteriorly in band along each lateral margin. Meso- and metanotal wing pads ca. same length, extending onto third abdominal segment. Pleura yellow, brown spot at base of each coxa, propleura each with brown mark present laterally, other brown spots and brown stripes of fourth instar absent. Coxae white, without central brown spot on lateral surface; femora and tibiae yellowish, with red to brown spots.

Medial plates 3–5 with brown spots more numerous; plate 6 reduced or absent. Lateral plates with brown margins much reduced, large brown spot at base of pseudointersegmental lines still present but limited to 3–7, other small brown spots of fourth instar absent or much reduced. Ventrally, linear sclerite posterior to each metacoxa not evident; medial plates generally obscure or absent, brown spots absent.

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LITERATURE CITED

Blatchley, W. S. 1895. Notes on the winter insect fauna of Vigo County, Indiana—II. Psyche 7:267–270.

McPherson, J. E. 1982. The Pentatomoidea (Hemiptera) of Northeastern North America with Emphasis on the Fauna of Illinois. Southern Illinois University Press, Carbondale and Edwardsville, 240 pp.

Parshley, H. M. 1923. Families Pentatomidae, Cydnidae, Scutelleridae. *In* W. E. Britton, Guide to the insects of Connecticut. Part IV. The Hemiptera or sucking insects of Connecticut. Conn. State Geol. Natur. Hist. Surv. Bull. 34:1–807.

Torre-Bueno, J. R. de la and G. P. Engelhardt. 1910. Some Heteroptera from Virginia and North Carolina. Can. Entomol. 42:147–151.

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LABORATORY REARING OF *AMAUROCHROUS CINCTIPES* (HEMIPTERA: PENTATOMIDAE: PODOPINAE) WITH DESCRIPTIONS OF IMMATURE STAGES

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Abstract.—Amaurochrous cinctipes (Say) was reared in the laboratory under a 16L:8D photoperiod and constant temperature. Egg and first instar development averaged 6.13 and 4.98 days, respectively. The second through fifth stadia for nymphs reared on *Sagittaria latifolia* Willdenow averaged 15.91, 16.80, 15.33, and 20.00 days, respectively; and on green beans averaged 14.20, 18.67, 15.67, and 17.00 days, respectively. The external anatomy of the egg and each of the 5 nymphal instars is described.

Amaurochrous cinctipes (Say) occurs from Quebec and New England south to the Carolinas, and west and southwest to Minnesota, Nebraska, Kansas, Missouri, Louisiana, and Texas (Barber and Sailer, 1953). It generally seems to occur on vegetation in low marshy places or near bodies of water (McPherson, 1982) and to overwinter beneath cover near water (Blatchley, 1926). It has been collected on *Typha, Scirpus, Carex, Juncus gerardi* Loiseleur-Deslongchamps, and at *Spartina* consocies (McPherson, 1982); nymphs have been found in high numbers on *Typha* (Davis, 1925) and *J. gerardi* (Parshley, 1923). The egg, first, third(?), and fifth instars have been briefly described (Parshley, 1923). This paper presents information on the laboratory rearing of *A. cinctipes* and descriptions of the immature stages.

MATERIALS AND METHODS

Laboratory rearing. Between 12 June and 3 July 1981, 23 adults, including copulating pairs, were observed on the leaves and petioles of duck-potato (*Sagittaria latifolia* Willdenow) growing in water near the shore of La Rue Swamp, Union County, Illinois. Ten specimens (3♂♂, 7♀♀) were collected, taken to the laboratory, and placed in an oviposition cage.

The oviposition cage consisted of a round, glass battery jar (ca. 16 cm diam., 20 cm depth) with filter paper covering the bottom. A freshly cut petiole of duck-potato, and attached leaf, served as food and was placed in a water-filled vial stoppered with cotton. A fresh cutting was provided every 3–4 days, and the vial was refilled as needed. The jar was closed with 2 layers of cheesecloth held in place with an elastic band.

The cage was examined daily for eggs. Plant sections, with attached eggs, were removed, placed on moist filter paper in the bottoms of petri dishes (ca. 9 cm diam., 2 cm depth), and covered with the lids. Water was added daily to keep the filter paper moist.

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The first instars (an apparently nonfeeding stage) were also kept in the petri dishes. The second instars were transferred to one of two types of containers and reared to adults. The first type consisted of a lantern globe (ca. 16.8 cm high) set on a clay flower pot (ca. 10.5 cm ID at top) filled with white silica sand and placed in a fingerbowl; water was added as needed to the sand to compact it and provide the insects with better footing. A freshly cut petiole of duck-potato, with attached leaf, served as food and was placed in a water-filled vial stoppered with cotton; the vial was pushed into the sand up to the lip to provide the nymphs easy access to the plant. A fresh cutting was provided every 3–4 days and the vial was refilled as needed. The globe was closed with 2 layers of cheesecloth held in place with an elastic band.

The second type of rearing container consisted of a 1-qt. (ca. 0.95-liter) Mason jar covered on the bottom with filter paper. Green snap beans (*Phaseolus vulgaris* L.) served as food and were placed on end in the bottom of the jar. A strip of paper toweling was added and, together with the filter paper, increased absorption of excrement and provided a good walking surface for the nymphs. The jar was closed with wire screen and paper toweling and secured with the band of the 2-piece mason jar lid. Food, filter paper, and paper toweling were changed every 3–4 days.

The oviposition cage and rearing containers were kept in an incubator maintained at 23.9 ± 1.1°C and a 16L:8D photoperiod.

Descriptions of immature stages. The description of each stage is based on 10 individuals, unless stated otherwise, that were collected from the laboratory culture and preserved in 95 percent ETOH. The first instar is described in detail, but only major changes from previous instars are described for subsequent instars. Comparative statements refer to previous instars (e.g., "more numerous"). Length is measured from tip of tylus to tip of abdomen; width is measured across the mesonotum. Dimensions are expressed in mm as $\bar{x}$ ± SE. Drawings were made with the aid of a camera lucida, measurements with an ocular micrometer.

RESULTS AND DISCUSSION

Laboratory rearing. Eggs were deposited in clusters on the petioles and leaves of duck-potato. Each cluster consisted of an alternating double row of 9 or 10 eggs ($N = 7$, $\bar{x} = 9.71$). Each egg was yellowish brown with a brown operculum. A triangular egg burster was readily visible after hatching. The incubation period averaged 6.13 days (Table 1).

The first instars were gregarious and remained atop the egg shells unless disturbed. They apparently did not feed. The duration of this stadium averaged 4.98 days.

The duration of the second through fifth stadia of nymphs reared on duck-potato averaged 15.91, 16.80, 15.33, and 20.00 days, respectively; and on green beans averaged 14.20, 18.67, 15.67, and 17.00 days, respectively. Total developmental time from egg to adult on the 2 plants averaged 79.53 and 76.13 days, respectively.

Heaviest mortality on both duck-potato and green beans (an unnatural host) occurred during the second stadium, the earliest stadium in which nymphs apparently feed. This and the fact that no eggs or nymphs were ever found on duck-potato at La Rue Swamp, and no adults after early July, suggest that this plant is not a natural host.

Descriptions of immature stages. EGG (Fig. 1). Length, 0.93 ± 0.01; width, 0.63 ± 0.01. Generally laid in clusters of 10; each egg cylindrically shaped, yellowish brown

Table 1. Duration (in days) of each immature stage of *A. cinctipes.*

Stage		No. completing stadium	Food source	Days		
				Range	$\bar{x} \pm$ SE	Cumulative mean age
Egg		37[a]	—	6–7	6.24 ± 0.07	6.24
		27[b]	—	5–7	5.96 ± 0.16	5.96
	Total	64		5–7	6.13 ± 0.08	—
Nymph						
1st instar[c]		36	—	5–6	5.25 ± 0.07	11.49
		27	—	4–5	4.63 ± 0.09	10.59
	Total	63		4–6	4.98 ± 0.07	—
2nd instar		11	duck-potato	12–19	15.91 ± 0.58	27.40
		5	green beans	13–16	14.20 ± 0.58	24.79
3rd instar		5	duck-potato	14–23	16.80 ± 1.59	44.20
		3	green beans	16–22	18.67 ± 1.76	43.46
4th instar		3	duck-potato	15–16	15.33 ± 0.33	59.53
		3	green beans	13–18	15.67 ± 1.45	59.13
5th instar		1	duck-potato	—	20.00	79.53
		3	green beans	16–19	17.00 ± 1.00	76.13

[a] 38 eggs were laid (nymphs subsequently reared on duck-potato).

[b] 30 eggs were laid (nymphs subsequently reared on green beans).

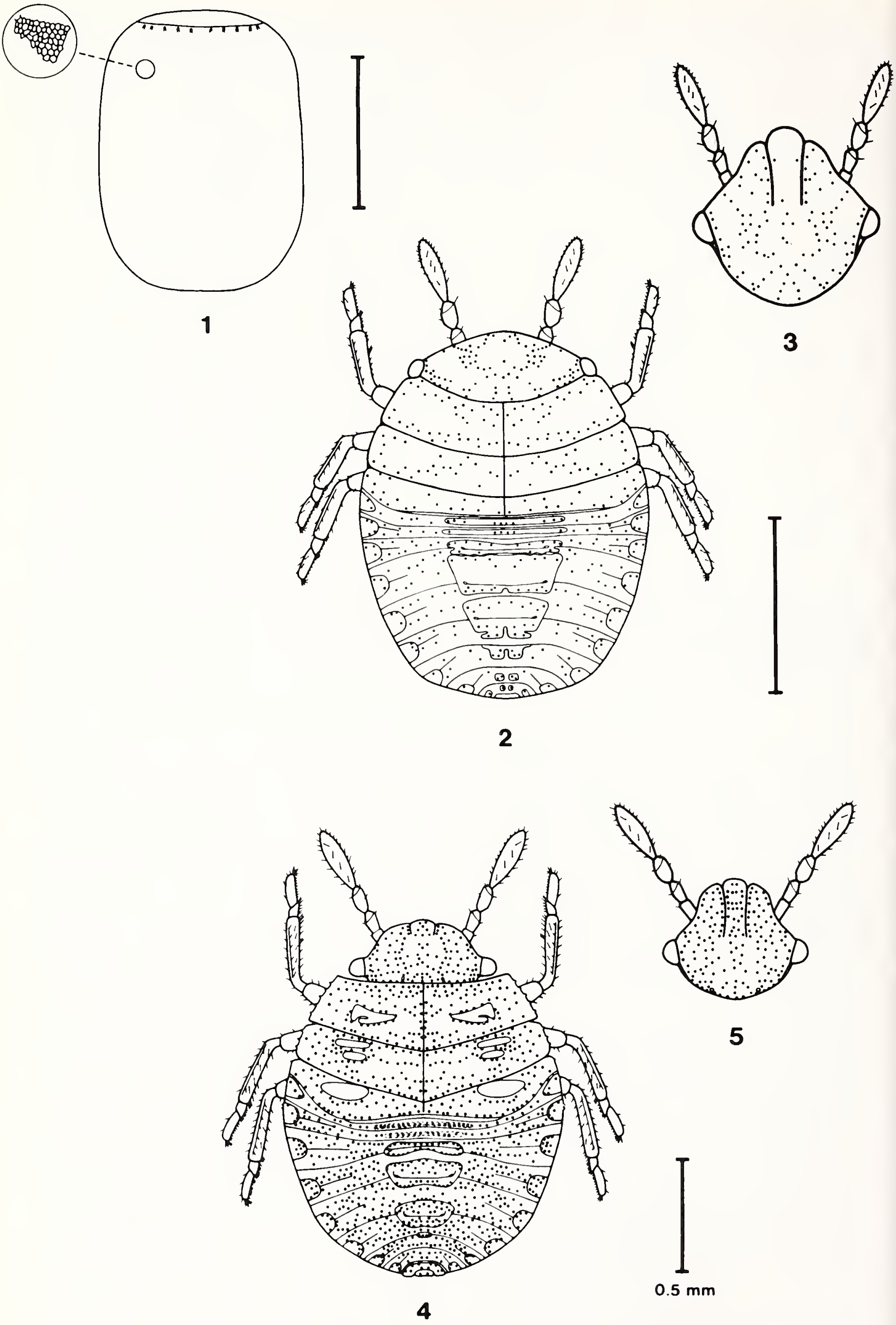
[c] Nonfeeding stage.

with brown operculum at oviposition but fading to yellow after preservation. Chorion with small, irregular pentagonal and hexagonal reticulations. Operculum surrounded by 18–23 micropylar processes, each process ca. 0.03 mm long.

FIRST INSTAR (Figs. 2, 3). Length, 1.05 ± 0.02; width, 0.82 ± 0.01. Body elliptical-ovoid, greatest width at abdominal segments 1–2. Large brown punctures present dorsally but not ventrally.

Head declivent, anterolateral margins sinuate; brown dorsally; tylus exceeding juga. Eyes red. Antennae 4-segmented; segments 1–3 brown to light brown; segment 4 largest, fusiform, yellowish brown to brown, apex darker; incisures albidus; distinct constrictions at junctures of 2–3 and 3–4; ratio of antennal segment lengths ca. 21:22:20:57. Ventral surface of head light brown. Beak 4-segmented, whitish to brown.

Thoracic nota brown, mediolongitudinal line extending from anterior margin of pronotum nearly to or reaching posterior margin of metanotum; pro- and mesonota sclerotized, posterior margins moderately arcuate; metanotum sclerotized except posteriorly, posterior margin of plate straight medially, bending cephalad laterally. Pleura concolorous with and reaching nota. Spiracles located on posterior margins of pro- and mesopleura. Sterna concolorous with ventral surface of head and abdomen. Coxae light brown to brown, each with central brown spot on lateral surface; trochanters light brown to brown; femora and tibiae reddish brown to brown, tibiae slightly carinate, dilated distally, front tibiae each with bifurcate spine or inner posterior margin of distal one-third; tarsi 2-segmented, yellowish, apex of segment 2 darker; tarsal claws and pulvilli yellow, translucent.



Figs. 1–5. Immature stages of *A. cinctipes*. 1. Egg. 2, 3. First instar. 4, 5. Second instar.

Dorsum of abdomen whitish to reddish with punctate brown medial and lateral plates. Faint pseudointersegmental lines on all but first and last segments, each originating at inner margin of lateral plate. Eight medial plates present; plates 1–2 linear; plate 3 subrectangular, slightly constricted medially, partially fused to plate 4; plate 4 subtrapezoidal with posteromedial notch, subequal in width and ca. 3–4 times medial length of plate 3; plate 5 subtrapezoidal with posteromedial notch, ca. three-fourths width and ca. 4–5 times medial length of plate 3; plate 6 often with posteromedial notch that almost bisects the plate; plates 7–8 small, paired; paired ostioles of scent glands located on plates 3–5. Nine lateral plates present, subelliptical, extending dorsally and ventrally from margin of abdomen, plates 1–8 (occasionally 9) punctate; plate 1 small; plates 2–5 largest; remainder generally decreasing in size posteriorly. Sterna concolorous with dorsum, segments 4–9 with faint medial plates. Spiracles readily apparent only on segments 2–7. A single trichobothrium located posterior to each spiracle only on segments 4–5.

SECOND INSTAR (Figs. 4, 5). Length, 1.59 ± 0.03; width, 1.14 ± 0.02. Body elliptical, greatest width at metanotum and abdominal segments 1–2. Punctures more numerous dorsally, now present ventrally.

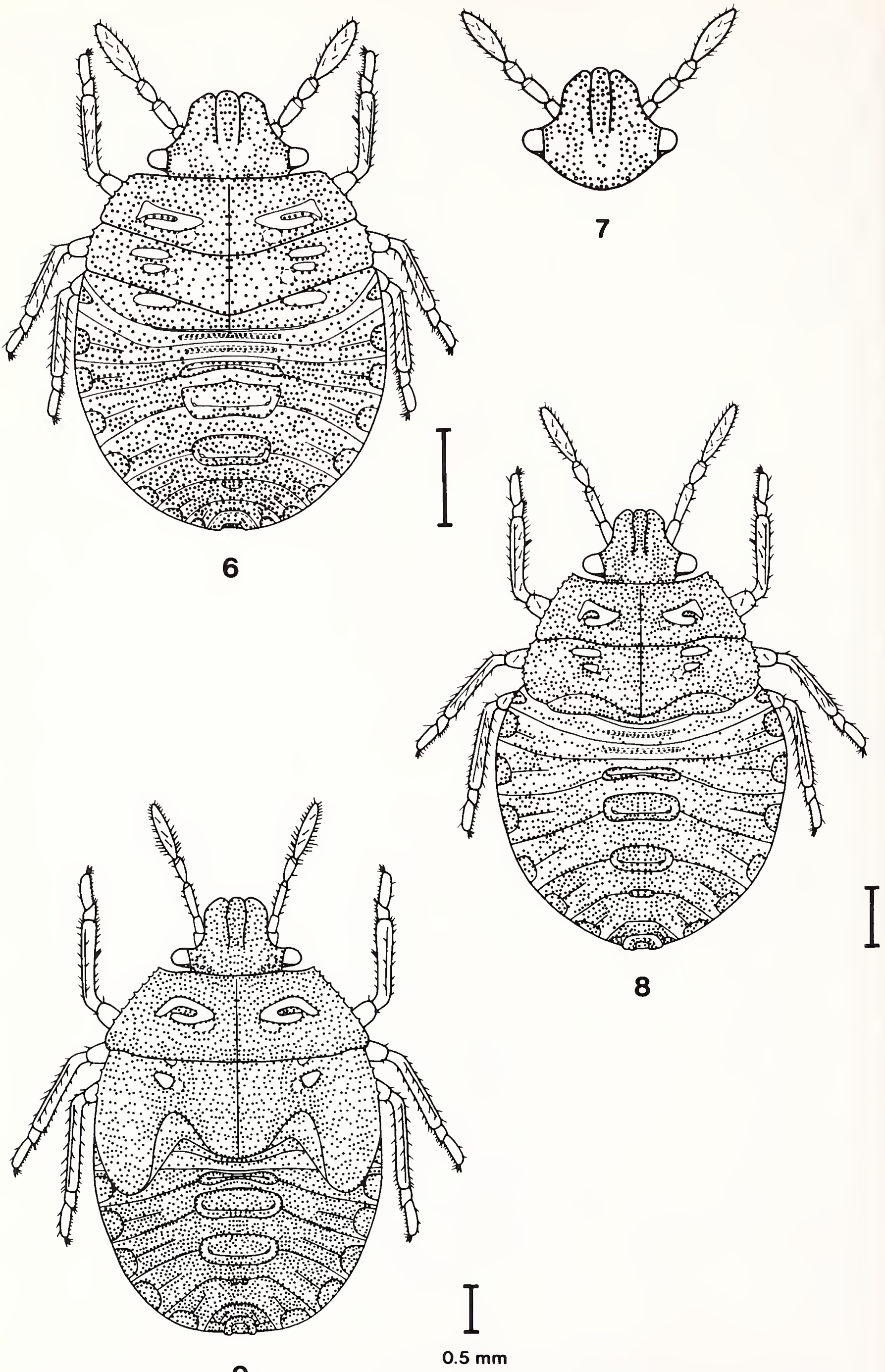
Head less declivent, anterolateral margins more sinuate; yellow to brown dorsally with 2 brown markings near base of tylus that extend and converge ca. one-half way to posterior margin of head, and brown mark adjacent to inner margin of each eye that occasionally extends back to and then medially along posterior margin of head; 2 small red ocelli present posteromedially. Eyes protruding. Antennal segments brown, incisures albidus to red; ratio of antennal segment lengths ca. 10:13:12:29. Ventral surface of head concolorous with dorsum except for white to yellow strip beneath beak and along posterior margin of head. Beak whitish to yellow with apex of last segment darker.

Thoracic nota yellow to brown, lateral margins yellowish, explanate, and dentate; pro- and metanota each with 1 pair, mesonotum with 2 pairs, of brown calli; pro- and mesonota with medial area extended posteriorly. Meso- and metapleura of expanded specimens separated from respective nota by membranous area. Trochanters white to brown; femora and tibiae brown, each lighter at base, tibiae more carinate.

Dorsum of abdomen with medial plates 3–5 and often 8 yellowish brown to brown; lateral plates yellowish. Medial plates 1–2 poorly defined, often appearing as a transverse row of punctures; plate 3 more constricted medially, not fused to plate 4; plates 4–5 subequal in size, slightly wider than, and ca. 4 times medial length of, plate 3, each plate with posteromedial notch greatly reduced; plate 6 small, linear, without posteromedial notch; plate 7 greatly reduced or absent; plate 8 fused to laterals, not paired. Lateral plates slightly crenate along margin of abdomen. Sterna 5–9 (and often 4) with sclerotized subrectangular medial plates, plates impunctate or nearly so; nonsclerotized portions of sterna impunctate medially. Spiracles now apparent on segments 2–8, those of 8 much reduced.

THIRD INSTAR (Figs. 6, 7). Length, 2.37 ± 0.06; width, 1.69 ± 0.02. Body with greatest width at abdominal segments 1–3. Punctures more numerous dorsally and ventrally.

Head less declivent, 2 brown markings near base of tylus converging two-thirds way to posterior margin of head, brown marking along posterior margin of second instar generally absent. Eyes dark reddish brown. Ratio of antennal segment lengths



Figs. 6–9. Immature stages of *A. cinctipes.* 6, 7. Third instar. 8. Fourth instar. 9. Fifth instar.

ca. 7:9:8:19. Ventral surface of head yellowish brown to brown except for white to yellow strip beneath beak and along posterior margin of head, and occasional yellow area on either side of beak that is continuous with yellowish brown stripe between it and base of antenna.

Thoracic nota yellow to brownish yellow; pro- and mesonota often with white to yellow markings posterior to calli. Pleura brown. Sterna white to pink. Coxae pinkish to light brown, each with central brown spot on lateral surface; trochanters white; femora whitish basally, brown distally.

Dorsum of abdomen whitish to yellow, with red markings; medial plate 7 absent; plate 8 yellow. Sterna 4–9 with sclerotized subrectangular medial plates, posterior plates with a few large punctures; nonsclerotized portions of posterior sterna punctate medially. A single trichobothrium located posterior to each spiracle on segments 3–7.

FOURTH INSTAR (Fig. 8). Length, 3.84; width, 2.24; 1 specimen examined. Body with greatest width at abdominal segment 3. Punctures more numerous dorsally and ventrally.

Head less declivent, yellowish brown, 2 brown markings near base of tylus converging near posterior margin of head; tylus and juga subequal in length. Ratio of antennal segment lengths ca. 9:13:11:24. Ventral surface of head brown, markings similar to third instar except that yellow area on either side of beak is larger and yellowish brown stripe between it and base of antenna is now red.

Thoracic nota yellowish brown; lateral margins of metanotum not explanate or dentate; pro- and mesonota with markings posterior to calli now whitish yellow. Meso- and metanotal wing pads ca. same length, extending onto first abdominal segment. Pleura reddish brown. Sterna whitish. Coxae whitish with central brown spot on lateral surface; trochanters whitish.

Dorsum of abdomen whitish yellow with red markings; medial plates 3–5 yellowish brown.

FIFTH INSTAR (Fig. 9). Length, 5.00; width, 3.22; 1 specimen examined. Body with greatest width at abdominal segments 2–3. Punctures more numerous dorsally and ventrally.

Head brownish yellow. Antennal segment 1 yellowish brown; segment 2 yellowish brown with apex red; segment 3 brown; segment 4 black; ratio of antennal segment lengths ca. 12:21:14:34. Ventral surface of head dark brown, markings similar to fourth instar except that red stripe extending from beak to base of antenna is now yellow.

Thoracic nota brownish yellow; pro- and mesonota with markings posterior to calli now white. Meso- and metanotal wing pads ca. same length, extending onto third abdominal segment. Pleura brown, yellowish at bases of coxae. Coxae whitish, central brown spot faint; femora whitish basally, whitish with brownish markings distally; tibiae yellowish brown.

Dorsum of abdomen with medial plates 3–5 yellow with brown margins.

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LITERATURE CITED

Barber, H. G. and R. I. Sailer. 1953. A revision of the turtle bugs of North America (Hemiptera: Pentatomidae). J. Wash. Acad. Sci. 43:150–162.

Blatchley, W. S. 1926. Heteroptera or True Bugs of Eastern North America with Especial Reference to the Faunas of Indiana and Florida. Nature Pub. Co., Indianapolis, 1,116 pp.

Davis, W. T. 1925. Note on *Podops cinctipes* and *Solubea pugnax*. Bull. Brooklyn Entomol. Soc. 20:147.

McPherson, J. E. 1982. The Pentatomoidea (Hemiptera) of Northeastern North America with Emphasis on the Fauna of Illinois. Southern Illinois Univ. Press, Carbondale and Edwardsville, 240 pp.

Parshley, H. M. 1923. On the ecology of *Podops cinctipes* Say and *Rhytidolomia saucia* Say, (Hemiptera, Pentatomidae). Can. Ent. 55:69–71.

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A CONSPECTUS OF PENTATOMINI OF THE WESTERN HEMISPHERE. PART 3 (HEMIPTERA: PENTATOMIDAE)

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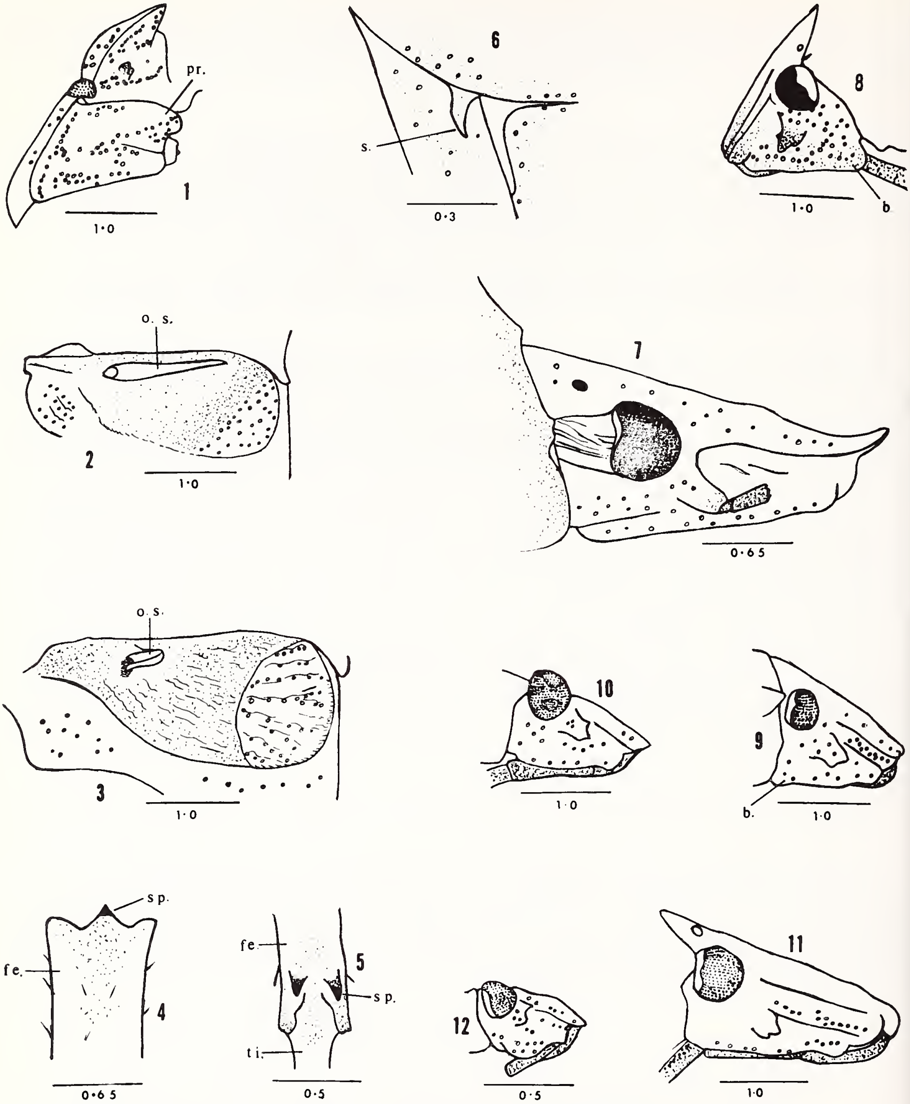
Abstract.—A key is provided for those North American, Central American and West Indian genera of Pentatomini that do not have a basal tubercle or spine on the abdominal venter. *Pentatoma antiguensis* Westwood, *Thyanta bimini* Ruckes, *T. elegans* Malloch and *T. elegantula* Jensen-Haarup are transferred to *Cyptocephala* Berg from *Thyanta* Stål. *Tepa* Rolston and McDonald, new genus, is proposed for 6 species transferred from *Thyanta: Pentatoma rugulosa* Say, type species, *Thyanta brevis* Van Duzee, *T. jugosa* Van Duzee, *T. panda* Van Duzee, *T. punctiventris* Van Duzee and *T. yerma* Rolston. *Caribo* Rolston, new genus, is proposed for *C. subgibbus* Rolston, new species from the Bahamas, and *C. fasciatus* Rolston, new species from Jamaica and St. John, Virgin Islands. *Neurohalys* Bliven, 1960, is placed in the synonymy of *Prionosoma* Uhler, 1863, and *N. bucculatus* Bliven, 1960, in the synonymy of *P. podopioides* Uhler, 1863. *Thyanta* subgenus *Parathyanta* Jensen-Haarup, 1928, is a junior synonym of *Cyptocephala* Berg, 1883. *Phacidium euchlorum* Breddin, 1912, whose type locality was erroneously reported as Costa Rica, is a junior synonym of *Thyanta aeruginosa* Berg, 1878, a species known only from Argentina and Uruguay. A lectotype is designated for *Phacidium euchlorum* Breddin.

We have previously provided keys for those genera of Pentatomini of the Western Hemisphere which possess a spine or tubercle at the base of the abdominal venter (Rolston et al., 1980; Rolston and McDonald, 1981). This paper concerns those genera of Pentatomini that do not have such a spine or tubercle, but it is geographically restricted to exclude South America.

KEY TO GENERA

1. Margins of propleura before coxae produced, anterior margin covering base of head from eyes mesad nearly to rostrum (Fig. 1) 48
– Propleura not produced 2
2(1). Sulcus and/or ruga of various lengths extending laterad from metathoracic ostiole (Figs. 2, 3) 3
– Metathoracic ostiole unattended by sulcus or ruga 46
3(2). Superior surface of femora produced distally as stout spine (Fig. 4) 49
– Superior surface of femora unarmed distally, at most obtusely produced 4
4(3). Ostiolar ruga extending less than ⅖ distance from mesial margin of ostiole to lateral margin of metapleuron, usually auriculate in form (Fig. 3) 5
– Ostiolar ruga extending ⅖ or more of distance from mesial margin of ostiole



Figs. 1–12. 1. *Neottiglossa undata.* Propleural production and reflexion. 2. *Thyanta pallidovirens.* Ostiolar sulcus. 3. *Euschistus servus.* Auriculate ostiolar ruga. 4. *Loxa flavicollis.* Apical spine on superior surface of femur. 5. *Sibaria englemani.* Subapical spines on inferior surface of femur. 6. *Moromorpha tetra.* Spine on posterior angle of pronotum. 7. *Proxys punctulatus.* Eyes in relation to anterior pronotal margin. 8. *Hymenarcys nervosa.* Lobed type of bucculae. 9. *Hymenarcys aequalis.* Truncate type of bucculae. 10. *Agroecus griseus.* Buccula and first rostral segment, lateral view. 11. *Tibraca limbativentris.* Buccula and first rostral segment, lateral view. 12. *Galedanta myops.* Evanescent type of bucculae. *Abbreviations:* buccula (b); femur (fe); ostiolar sulcus (o.s.); propleural reflexion (pr.); pronotal spine (s); spine (sp.); tibia (ti.).

to lateral margin of metapleuron, usually bordering an elongate sulcus (Fig. 2) 34

5(4). At least anterior femora armed on inferior surface with one or more stout subapical spines (Fig. 5) .... *Sibaria*

– Femora unarmed or bearing low setose tubercles 6

6(5). Posterolateral angles of pronotum armed with small flat spine extending over base of each corium (Fig. 6) .... *Moromorpha*

– Posterolateral angles of pronotum unarmed 7

7(6). Eyes separated from pronotum by about ½ their diameter, their base striated between reticulation of eye and pronotum (Fig. 7) .... *Proxys*

– Eyes usually contiguous with pronotum, their base smooth 8

8(7). Width of scutellum at distal end of frena more than ½ of basal width, usually ⅗ or more 9

– Width of scutellum at distal end of frena ½ or less of basal width 17

9(8). Bucculae lobed or truncate posteriorly (Figs. 8, 9) 12

– Bucculae evanescent or arcuate posteriorly (Figs. 10, 11) 10

10(9). First rostral segment projecting beyond bucculae (Fig. 10); 2 rows of small tubercles present on inferior surface of femora .... *Agroecus*

– First rostral segment lying entirely between bucculae (Fig. 11); inferior surface of femora lacking tubercles 11

11(10). Distance between ocelli less than ⅖ width of head across eyes . . . (in part) .... *Tibraca*

– Distance between ocelli more than ⅖ width of head across eyes . . . (in part) .... *Hymenarcys*

12(9). Superior surface of tibiae sulcate 13

– Superior surface of tibiae rounded 16

13(12). Anterior width of pronotum more than ½ width at humeri; coria scarcely or not surpassing apex of scutellum .... *Coenus*

– Anterior width of pronotum less than ½ width at humeri; coria usually extending well past apex of scutellum 14

14(13). Mesial margin of metathoracic ostiole V-shaped; head and usually pronotum with vesture of numerous long setae . . . (in part) .... *Trichopepla*

– Mesial margin of metathoracic ostiole rounded; head and pronotum glabrous or with short, scattered setae 15

15(14). Metathoracic ostiole at right angle to plane of metapleuron, invisible from view perpendicular to metapleuron; ventral border of anterolateral pronotal margins punctate . . . (in part) .... *Hymenarcys*

– Metathoracic ostiole inclined to plane of metapleuron but entirely visible from view perpendicular to metapleuron; anterolateral pronotal margins with obscurely punctate ventral border of uneven width .... *Codophila*

16(12). Body hirsute; first rostral segment lying entirely between bucculae .. *Prionosoma*

– Body glabrous; apex of first rostral segment projecting beyond bucculae .... *Cosmopepla*

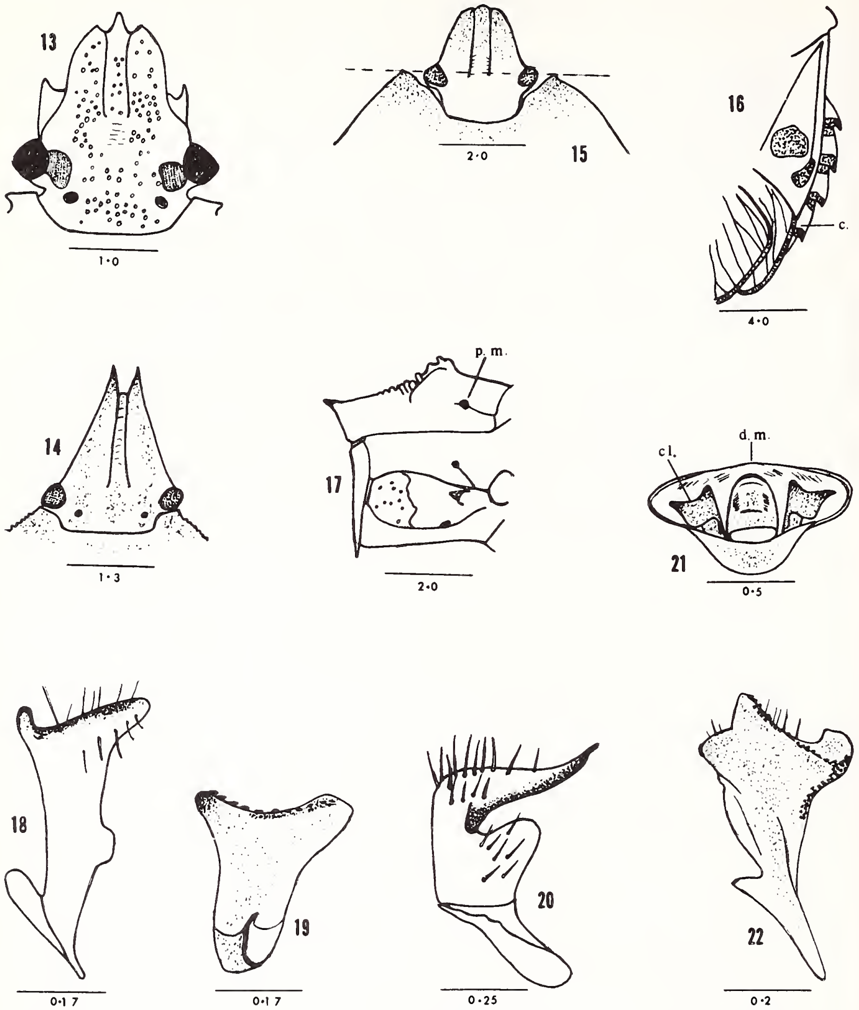
17(8). Bucculae lobed or abruptly truncated posteriorly (Figs. 8, 9) 18

– Bucculae evanescent or arcuate posteriorly (Fig. 12) 20

18(17). Juga projecting beyond tylus by at least width of tylus at apex, acute apically (Fig. 14) . . . (in part) .... *Dichelops*

– Juga projecting little if at all beyond tylus, if angulate the angle a right or obtuse angle 19

19(18). Post-frenal portion of scutellum ⅖ or more of scutellar length; green or stramineous dorsally; length 7.5 mm or less excluding hemelytral membranes . . . (in part) .... *Tepa,* new genus



Figs. 13–22. 13. *Berecynthus delirator.* Head. 14. *Dichelops* sp. Head. 15. *Menecles insertus.* Head and anterior pronotal margin. 16. *Runibia* sp. Connexivum and hemelytron. 17. *Euschistus biformis.* Macules on thoracic pleura. 18. *Tepa rugulosa.* Paramere. 19. *Cyptocephala antiguensis.* Paramere. 20. *Thyanta perditor.* Paramere. 21. *Cyptocephala bimini.* Genital cup. 22. *Cyptocephala bimini.* Paramere. *Abbreviations:* connexivum (c); paramere (cl); dorsal margin (d.m.); pleural macule (p.m.).

–	Post-frenal portion of scutellum less than ⅖ of scutellar length; black or brown dorsally; length without hemelytral membranes 8.5 mm or more	*Padaeus*
20(17).	Superior surface of tibiae sulcate for most of their length	23
–	Superior surface of tibiae rounded for most of their length	21
21(20).	Large species, about 18 mm long	23
–	Moderate sized species, about 12 mm or less in length	22
22(21).	Apex of first rostral segment projecting past bucculae	*Mormidea*

– First rostral segment lying entirely between bucculae .... *Oebalus*

23(20,21). Both juga and tylus angulate apically, a small incision separating each jugum from tylus at apex of head; tylus usually spinose and projecting well past juga (Fig. 13) .... *Berecynthus*

– Either juga or tylus or both juga and tylus obtuse apically 24

24(23). Juga separated and acute apically, projecting beyond obtuse tylus; incision in apex of head expanding toward apex 25

– Juga no longer than tylus, or longer than tylus but either contiguous apically or leaving a quadrate to rectangular incision in apex of head 26

25(24). Connexiva marked with black spot or line at transverse sutures . . . (in part) .... *Chlorocoris*

– Connexiva immaculate . . . (in part) .... *Dichelops*

26(24). Juga longer than tylus, contiguous apically or leaving quadrate to rectangular incision in apex of head 27

– Juga little or no longer than tylus 28

27(26). Black tubercle present in each basal angle of scutellum; humeral angles obtusely rounded .... *Galedanta*

– Basal angles of scutellum lacking tubercle; humeral angles acute to spinose . . . (in part) .... *Chlorocoris*

28(26). Head deeply inserted into pronotum, imaginary line drawn across anterior limits of pronotum bisecting eyes near middle (Fig. 15) .... *Menecles*

– Imaginary line drawn across anterior limits of pronotum passing near posterior margin of eyes 29

29(28). Lateral jugal margins strongly reflexed; antennae 4-segmented . . . (in part) .... *Boea*

– Lateral jugal margins not reflexed; antennae 5-segmented 30

30(29). Costal angle of coria produced; lateral connexival margins strongly serrate (Fig. 16); bicolored species, orange with black markings . . . (in part) .... *Runibia*

– Costal angle of coria acute but not produced, lateral connexival margins entire or weakly serrate; not colored as above 31

31(30). Metasternum moderately produced, sloping downward from anterior margin to hind coxae; rostrum not attaining metacoxae .... *Hypatropis*

– Metasternum nearly flat or shallowly sulcate, not produced; rostrum reaching between or beyond metacoxae 32

32(31). Thoracic pleura with small black spot at base of each subcoxa (usually with additional spot at anterolateral angle of propleuron and at distal end of supracoxal cleft on mesopleuron) and/or anterolateral margins of pronotum denticulate (Fig. 17) .... *Euschistus*

– Thoracic pleura immaculate or otherwise marked; anterolateral pronotal margins entire 33

33(32). First and second antennal segments subequal in length; fovea in basal angles of scutellum deep, black . . . (in part) .... *Tibraca*

– First antennal segment shorter than second segment; fovea in basal angles of scutellum shallow, not black . . . (in part) .... *Chlorochroa*

34(4). Post-frenal portion of scutellum comprising ½ or more of scutellar length 35

– Post-frenal portion of scutellum less than ½ of scutellar length 37

35(34). Juga neither contiguous nor markedly convergent apically . . . (in part) .... *Trichopepla*

– Juga contiguous or convergent before tylus 36

36(35). Anterolateral margins of pronotum strongly concave .... *Dendrocoris*

– Anterolateral margins of pronotum weakly concave at most . . . (in part) .... *Holcostethus*

37(34). Bucculae lobed or right-angularly truncate posteriorly; length of body 7.5 mm or less; parameres bilobed, without serrations between lobes (Fig. 18) . . . (in part) .... *Tepa,* new genus

– Bucculae evanescent or arcuate posteriorly, or if lobed length of body more than 10 mm; parameres not as above 38

38(37). Ostiolar ruga reaching ½ or less of distance from inner margin of ostiole to lateral margin of metapleuron 39

– Ostiolar ruga reaching more than ½ distance from inner margin of ostiole to lateral margin of metapleuron 41

39(38). Lateral jugal margins strongly reflexed; antennae 4-segmented; rostrum ending at metacoxae . . . (in part) .... *Boea*

– Lateral jugal margins not reflexed; antennae 5-segmented; rostrum reaching onto abdomen 40

40(39). Costal angle of coria produced; lateral connexival margins strongly serrate (Fig. 16) . . . (in part) .... *Runibia*

– Costal angle of coria not produced; lateral connexival margins entire or weakly serrate . . . (in part) .... *Chlorochroa*

41(38). Anterolateral margins of pronotum reflexed in part and/or rimmed .... *Arocera*

– Anterolateral margins of pronotum neither reflexed nor rimmed 42

42(41). Width of scutellum at distal end of frena ½ or more basal width; hemelytral membranes fumose . . . (in part) .... *Holcostethus*

– Width of scutellum at distal end of frena ⅖ or less width at base; hemelytral membranes vitreous 43

43(42). Juga contiguous or convergent before tylus, or projecting beyond tylus by distance equal to or greater than apical width of tylus . . . (in part) .. *Chloropepla*

– Juga little or no longer than tylus 44

44(43). Anterolateral margins of pronotum vertically rounded; costal angle of coria reaching last connexival segment .... *Caribo,* new genus

– Anterolateral margins of pronotum carinate at least near humeri; costal angle of coria reaching penultimate connexival segment 44

45(44). Parameres bilobed with fine denticulations between two of lobes (Fig. 19); length including membrane usually less than 8 mm, rarely as much as 9 mm .... *Cyptocephala*

– Parameres simple, acute apically (Fig. 20); more than 8.5 mm in length .... *Thyanta*

46(2). Distal end of first rostral segment surpassing bucculae by distance subequal to rostral width at posterior limit of bucculae; brightly colored species .. *Murgantia*

– First rostral segment not or scarcely projecting past bucculae; dull colored yellowish brown species 46

47(46). First segment of labium scarcely visible below bucculae from lateral view; width of scutellum at distal end of frena about 3/5 width at base; last sternite of male much shorter than preceding sternites combined .... *Capivaccius*

– Distal portion of first labial segment largely visible below bucculae from lateral view; width of scutellum at distal end of frena about ⅖ width at base; last sternite of male more than twice length at meson of preceding sternites combined .... *Pylophora*

48(1). Antennifer hidden from lateral view by anterior production of propleuron .... *Aelia*

– Antennifer not covered by anterior production of propleuron ...... *Neottiglossa*

49(3). Last rostral segment lying entirely caudad of metacoxae and abdominal segments 3–5 shallowly sulcate mesially .... *Fecelia*

– Last rostral segment lying partially between metacoxae, or if lying entirely caudad of metacoxae abdominal sulcus not extending onto sternite 5 49

50(49). Ostiolar ruga extending more than ⅗ of distance from mesial margin of ostiole to lateral margin of metapleuron . . . (in part) .... *Chloropepla*

– Ostiolar ruga extending ⅓ or less of distance from mesial margin of ostiole to lateral margin of metapleuron 51

51(50). Ostiolar ruga extending less than ⅙ of distance from mesial margin of ostiole to lateral margin of metapleuron .... *Loxa*

– Ostiolar ruga extending ¼ to ⅓ of distance from mesial margin of ostiole to lateral margin of metapleuron .... *Mayrinia*

ANNOTATED LIST OF GENERA

1. *Aelia* Fabricius, 1803. Holarctic. One species in Western Hemisphere, *A. americana* Dallas, 1851.
2. *Agroecus* Dallas, 1851. Generic revision by Buckup (1957). One species in region covered, *A. griseus* Dallas, 1851.
3. *Arocera* Spinola, 1837. Revision by McDonald (1984).
4. *Berecynthus* Stål, 1862. One species in region covered, *B. delirator* (Fabricius, 1787).
5. *Boea* Walker, 1867. Redescribed by Kormilev (1950) as *Willinerinia.* One species in region covered, *B. costaricensis* Distant, 1890.
6. *Capivaccius* Distant, 1893. Monotypic, based on *C. bufo* Distant, 1893.
7. *Caribo* Rolston and McDonald, new genus. See following pages.
8. *Chlorochroa* Stål, 1872 (as subgenus of *Lioderma* Uhler). Holarctic. Generic synonymy, subgenus *Rhytidilomia,* and Opuntiae species group of nominate subgenus treated by Thomas (1982). Species of Sayi species group treated by Buxton et al. (1984).
9. *Chlorocoris* Spinola, 1837. Needs revision.
10. *Chloropepla* Stål, 1867. One species in Panama. Grazia (1980a) gives a key to species.
11. *Codophila* Mulsant, 1866 (as subgenus of *Carpocoris* Kolenati). Holarctic. Thomas (1974) gives diagnosis for genus, treats the 2 species in Western Hemisphere.
12. *Coenus* Dallas, 1851. Two species, *C. delius* (Say, 1832) and *C. inermis* Harris and Johnson, 1936.
13. *Cosmopepla* Stål, 1867. Generic review by McDonald (1984).
14. *Cyptocephala* Berg, 1883. See following pages.
15. *Dendrocoris* Bergroth, 1891 (as new name for *Liotropis* Uhler, 1877). Generic revision by Nelson (1955). This genus actually belongs in Section 2 (Rolston and McDonald, 1981). However, males of *D. humeralis* (Uhler, 1877) and *D. variegatus* Nelson, 1955, have no spine at base of abdominal venter.
16. *Dichelops* Spinola, 1837. Generic revision by Grazia (1978). One species in region covered, *D. bicolor* Distant, 1890.
17. *Euschistus* Dallas, 1851. Revision of Middle American species by Rolston (1974). Species in northeastern North America treated by McPherson (1982).
18. *Fecelia* Stål, 1872. Generic revision by Grazia (1976), corrections and one species added by Grazia (1980b) another by Eger (1980). The 4 species of *Fecelia* occur in the Greater Antilles.

19. *Galedanta* Amyot and Serville, 1843. Generic revision by Grazia (1967) modified by Grazia (1981). One species in region covered, *G. myops* (Fabricius, 1803).
20. *Holcostethus* Fieber, 1860 (=*Peribalus* Mulsant and Rey, 1866). Holarctic. Revision of Western Hemisphere components by McDonald (1975), revised key by McDonald (1982).
21. *Hymenarcys* Amyot and Serville, 1843. Generic review by Rolston (1973c).
22. *Hypatropis* Bergroth, 1891 (as new name for *Melpia* Stål, 1867). Needs revision. One unidentified species in region covered.
23. *Loxa* Amyot and Serville, 1843. Revision by Eger (1978).
24. *Mayrinia* Horvath, 1925. Revised by Grazia-Vieira (1972). One species occurs in the region covered, *M. variegata* (Distant, 1880).
25. *Menecles* Stål, 1867. Revision by Rolston (1973b).
26. *Mormidea* Amyot and Serville, 1843. Revision by Rolston (1978).
27. *Moromorpha* Rolston, 1978. Monotypic, based on *Moromorpha tetra* (Walker, 1868).
28. *Murgantia* Stål, 1862. Needs review.
29. *Neottiglossa* Kirby, 1837. Holarctic. McPherson (1982) keys 4 of the 7 nominal American species. Needs revision.
30. *Oebalus* Stål, 1862. Revision by Sailer (1944), synonymy and checklist by Sailer (1957).
31. *Padaeus* Stål, 1862. Needs revision, of 6 nominal species apparently only 4 belong in this genus. These 4 are in region covered.
32. *Prionosoma* Uhler, 1863. Monotypic, based on *P. podopioides* Uhler, 1863. McPherson (1982) summarizes literature concerning this species. See following pages.
33. *Proxys* Spinola, 1837. Needs review.
34. *Pylophora* Van Duzee, 1923. Van Duzee (1923) described the 2 species. From Gulf of California region.
35. *Runibia* Stål, 1861. Needs review.
36. *Sibaria* Stål, 1872. Reviewed by Rolston (1976).
37. *Tepa* Rolston and McDonald, new genus. See following pages.
38. *Thyanta* Stål, 1862. Needs revision. *Thyanta antiguensis* (Westwood), *T. bimini* Ruckes, *T. elegans* Malloch, and *T. elegantula* Jensen-Haarup are transferred to *Cyptocephala* Berg, and *Thyanta rugulosa* (Say), *T. brevis* Van Duzee, *T. jugosa* Van Duzee, *T. panda* Van Duzee, *T. punctiventris* Van Duzee and *T. yerma* Rolston are transferred to *Tepa* Rolston and McDonald, new genus. See following pages.
39. *Tibraca* Stål, 1860. Needs revision.
40. *Trichopepla* Stål, 1867. Revised by McDonald (1976).

NEW GENERA, SPECIES, AND COMBINATIONS

Cyptocephala Berg, 1883

Cyptocephala Berg, 1883:209–210 (reprinted, 1884:25–26).
Crato Distant, 1893:457.
Thyanta subgenus *Parathyanta* Jensen-Haarup, 1928:186. **New Synonymy.**

Type species. Cyptocephala cogitabunda Berg, 1883.

Diagnosis. Metathoracic ostiole a fissure in metapleuron, not on notable elevation; ostiolar ruga sulcate proximally, reaching $\frac{7}{10}$–$\frac{8}{10}$ distance from mesial margin of ostiole to lateral margin of metapleuron. Post-frenal portion of scutellum comprising about $\frac{2}{5}$ of scutellar length; scutellar width at distal end of frena about $\frac{2}{5}$ of basal width. Bucculae arcuately truncate at posterior termination; basal segment of rostrum not projecting beyond bucculae. Anterolateral margins of pronotum carinate, entire, neither reflexed nor rimmed.

Parameres bilobed or trilobed apically, minutely denticulate between anterior and lateral lobes (Figs. 21, 22).

Species. Species here transferred from *Thyanta* to *Cyptocephala* are: *Pentatoma antiguensis* Westwood, 1837, *Thyanta bimini* Ruckes, 1952, *Thyanta elegans* Malloch, 1919, and *Thyanta* (*Parathyanta*) *elegantula* Jensen-Haarup, 1928.

Comments. Cyptocephala differs from *Thyanta* and *Tepa* primarily in the lobed, denticulate parameres (Figs. 19, 22). In *Thyanta* the parameres are apically spinose or acute (Fig. 20); in *Tepa* the parameres have a thumb-like lateral lobe (Fig. 18); denticles are absent from the parameres of *Thyanta* and *Tepa.* The aedeagus is quite similar in these three genera, simple, and apparently of little taxonomic use.

The spermathecae of *Cyptocephala* species are not entirely uniform. In *C. antiguensis, C. bimini* and *C. elegans* there is an enlargement at the base of the proximal flange, but this structure is absent in *C. cogitabunda* and *C. elegantula* (Figs. 36–41). This enlargement is present and variously modified in the *Thyanta* species examined (Figs. 23–35); it is absent in *Tepa* species (Figs. 42–48). The membranous sac of the spermathecal duct does not dilate the full length of the enclosed sclerotized rod in *Cyptocephala* (Figs. 36–39), as it does in *Tepa* (Figs. 42, 43) and as it usually, but not always, does in *Thyanta* (Figs. 23–26).

New records for *C. bimini* are Cuba and Jamaica.

New records for *C. elegantula* are Catamarca, Córdoba and Tucumán provinces in Argentina.

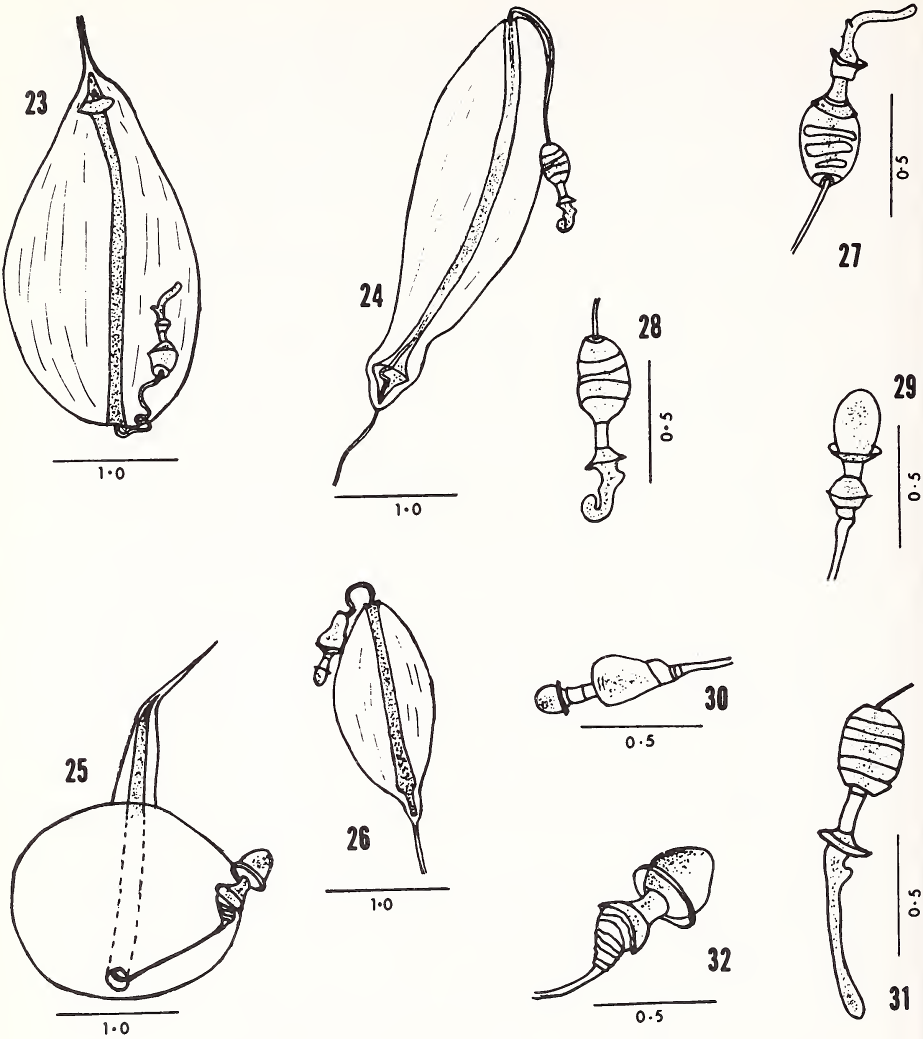
The holotypes of *Thyanta bimini* and *T. elegantula,* and a male and female homotype of *Cyptocephala cogitabunda* were examined. Type material of *Thyanta antiguensis* and *T. elegans* was not seen.

Tepa Rolston and McDonald, new genus

Type species. Pentatoma rugulosa Say, 1832.

Diagnosis. Metathoracic ostiole a fissure in metapleuron, not on notable elevation; ostiolar ruga sulcate proximally, reaching $\frac{2}{5}$–$\frac{3}{5}$ distance from mesial margin of ostiole to lateral margin of metapleuron. Post-frenal portion of scutellum $\frac{2}{5}$–$\frac{1}{2}$ of scutellar length; width of scutellum at distal end of frena $\frac{2}{5}$–$\frac{1}{2}$ of basal width. Bucculae lobed or right-angularly truncate posteriorly. Parameres bilobed; dorsal lobe narrowly rounded; lateral lobe smaller, thumb-like, variously bent dorsad; denticles absent (Fig. 18). Spermathecal bulb hemispherical, base of proximal flange unmodified (Figs. 42–48). Length less than 7.5 mm excluding hemelytral membranes.

Species. Species transferred from *Thyanta* to *Tepa* are: *Pentatoma rugulosa* Say, 1832, *Thyanta brevis* Van Duzee, 1904, *Thyanta jugosa* Van Duzee, 1923, *Thyanta*

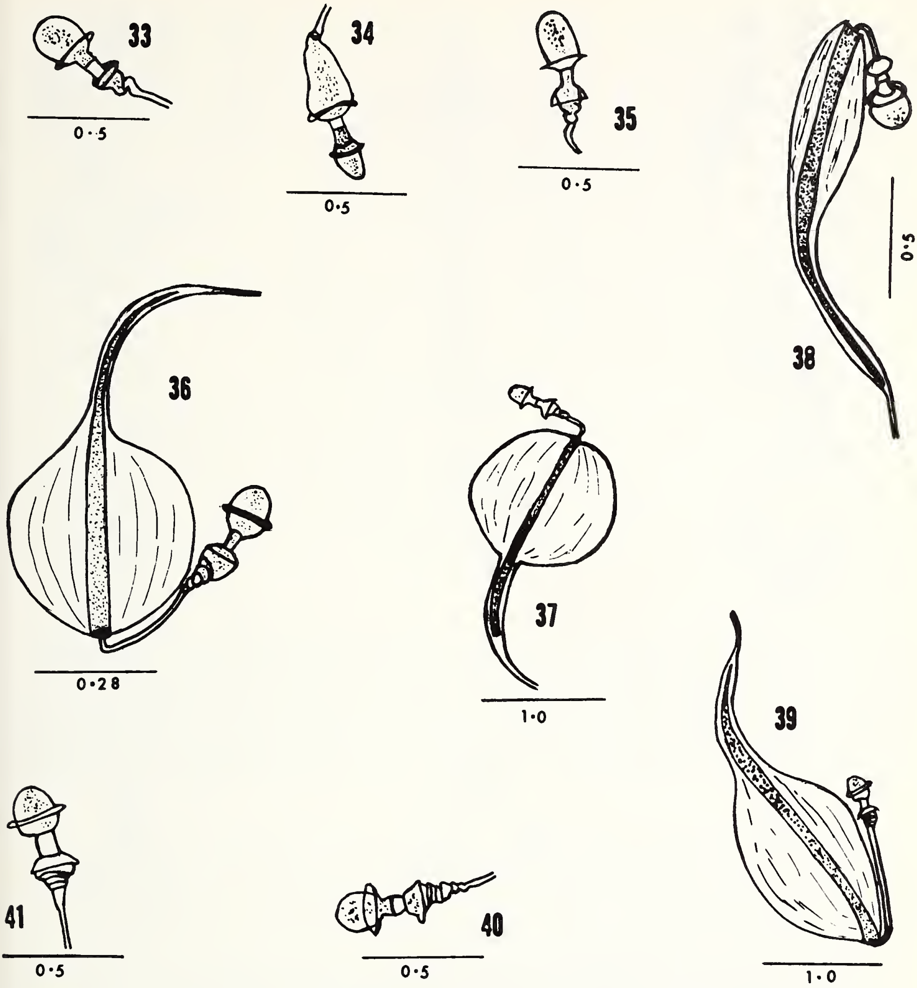


Figs. 23–32. 23–26. Spermatheca. 23. *Thyanta calceata.* 24. *T. custator.* 25. *T. patruellis.* 26. *T. pseudocasta.* 27–32. Spermathecal bulb and pump. 27. *Thyanta calceata.* 28. *T. custator.* 29. *T. maculata.* 30. *T. nitidula.* 31. *T. pallidovirens.* 32. *T. patruellis.*

panda Van Duzee, 1923, *Thyanta punctiventris* Van Duzee, 1904, and *Thyanta yerma* Rolston, 1972.

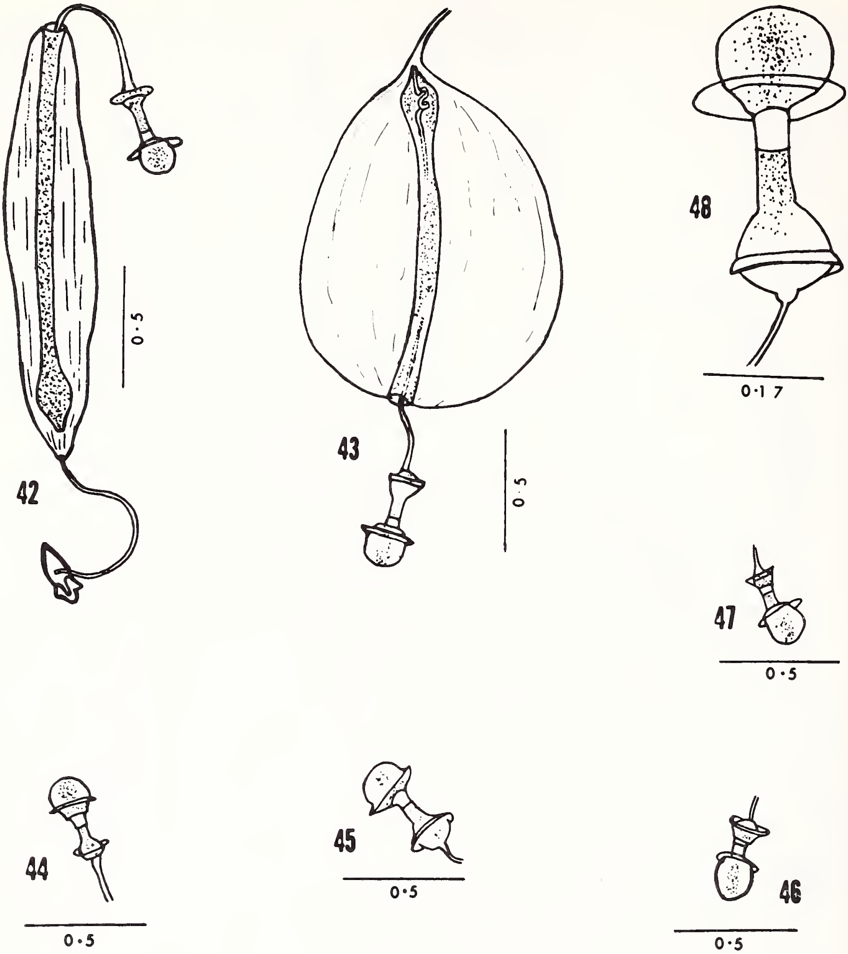
Comments. The species of *Tepa* are included in a key to the small North American species then considered to be in *Thyanta,* and the male genitalia are figured (Rolston, 1972).

Tepa differs from *Thyanta* and *Cyptocephala* primarily in the form of the para-



Figs. 33–41. 33–35. Spermathecal bulb and pump. 33. *Thyanta planifrons*. 34. *T. pseudocasta*. 35. *T. signoreti*. 36–39. Spermatheca. 36. *Cyptocephala antiguensis*. 37. *C. bimini*. 38. *C. cogitabunda*. 39. *C. elegans*. 40, 41. Spermathecal bulb and pump. 40. *Cyptocephala bimini*. 41. *C. elegans*.

meres. The parameres in *Thyanta* are acute or spinose apically (Fig. 22); in *Cyptocephala* they are bilobed with minute denticles between two of the lobes (Fig. 24). *Tepa* also differs from the *Thyanta* species known to us with the exception of *T. aeruginosa* Berg, and from *Cyptocephala* in having the posterior termination of the bucculae lobed or right-angularly truncate. The spermatheca in all *Tepa* species is simple without the enlargement that seems to be characteristic of *Thyanta* and *Cyptocephala* species other than *C. cogitabunda* and *C. elegantula*.



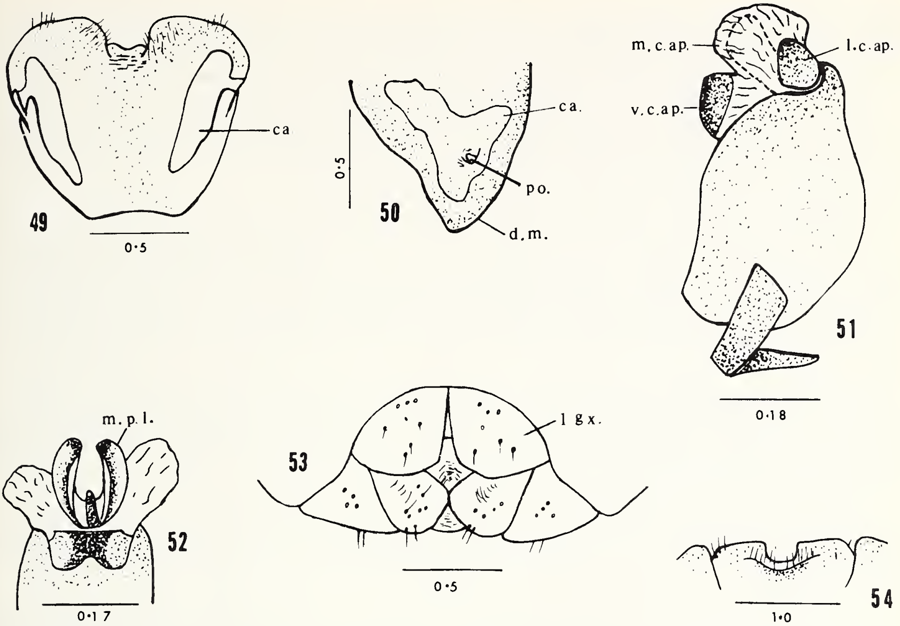
Figs. 42–48. 42, 43. Spermatheca. 42. *Tepa rugulosa.* 43. *T. yerma.* 44–48. Spermathecal bulb and pump. 44. *Tepa brevis.* 45. *T. jugosa.* 46. *T. panda.* 47. *T. punctiventris.* 48. *T. yerma.*

Tepa is confined to the western U.S.A. and northern Mexico with the exception of *T. panda* which is recorded from California, Curaçao and Florida.

Caribo Rolston, new genus

Type species. Caribo subgibbus Rolston, new species.

Diagnosis. Metathoracic ostiole inclined to plane of metapleuron; ostiolar ruga sulcate proximally, extending from mesial margin of ostiole slightly more than ½–⅗ of distance to lateral margin of metapleuron. Juga no longer than tylus, their lateral margins not reflexed. First antennal segment not reaching apex of head. Bucculae evanescent posteriorly; basal segment of rostrum projecting beyond bucculae by less



Figs. 49–54. 49–53. *Caribo subgibbus*. 49. Pygophore, ventral view. 50. Pygophore, lateral view. 51. Aedeagus, lateral view. 52. Aedeagus, ventral view. 53. Genital plates, caudoventral view. 54. *Caribo fasciatus*. Pygophore, ventral view. *Abbreviations:* cavity (ca.); dorsal margin (d.m.); basal plates (1 gx); lateral conjunctival appendage (l.c.ap.); median conjunctival appendage (m.c.ap.); median penial lobes (m.p.l.); orifice (po.); ventral conjunctival appendage (v.c.ap.).

than thickness of segment at apex; second rostral segment reaching mesocoxae. Anterolateral margins of pronotum rounded vertically, lacking distinct carinae except at humeri, entire. Post-frenal part of scutellum about ⅖ of scutellar length; scutellar width at distal end of frena nearly ½ of basal width; length and width of scutellum subequal. Costal angle of each corium extending to last connexival segment. Prosternum longitudinally sulcate; mesosternum feebly carinate mesially; metasternum weakly concave. Femora unarmed; superior surface of tibiae flattened, obscurely sulcate. Length less than 7.5 mm without hemelytral membranes.

Small orifice in lateral surface of pygophore on each side exposed only when pygophore partially extracted (Fig. 50), opening into large internal cavity (Fig. 49).

Comments. The pair of cavities opening on the lateral pygophoral surfaces have not been reported previously in pentatomids.

Caribo subgibbus Rolston, new species
Figs. 49–53

Description. Pale stramineous above and below; punctation irregular, fuscous to black. Markings on head consisting of irregular fuscous to black longitudinal bands on lateral margins of tylus basally, lateral margins of slightly elevated vertex from base of head to eye (enclosing ocellus) on each side. Cicatrices outlined in black, thickly so except anteriorly. Patches on subgibbous base of scutellum densely punctate, black, irregular in form. Punctures on ventral disk of abdomen black, sparse, variable in size, a few quite large; punctation along lateral borders small, rather uniform, many concolorous with background. Spots on legs variable in size, coalescing into irregular incomplete preapical band on femora; distal end of tibiae and tarsi infuscate.

Jugal margins briefly parallel between anteocular concavity and rounded apex of head; juga not convergent; tylus broadened at apex. Width of head across eyes 1.5 mm, length 1.3–1.5 mm. Antennal segments 0.3–0.4, 0.6–0.7, 0.5–0.6, 0.7, 0.7–0.8 mm long; distal ¾ of segment 5, distal ½ of segment 4, sometimes distal ⅓ of segment 3 dark. Rostrum reaching onto sternite 4 (3rd visible); segments 2–4 about 1.0, 0.7–0.8, 0.6–0.7 mm long.

Anterior submargin of pronotum depressed; cicatrices elevated; additional irregularities in anterior pronotal disk. Thin impunctate line divides pronotum at meson. Humeral angles somewhat produced laterad, rounded. Pronotal width across humeri 3.6–3.8 mm; mesial length 1.4–1.5 mm.

Basal ⅖ of scutellum subgibbous; fovea in basal angles triangular, shallow, black. Membranes of hemelytra projecting well beyond body, vitreous, each of 5 veins in fumose band.

Abdominal sternites 3–4 and 5 basally with shallow longitudinal sulcus mesially. Spiracles nearly concolorous with surrounding area of sternite. Posterolateral and anterolateral angles of sternites with small black macule. Length of body 5.2–5.5 mm excluding hemelytral membranes.

Posterior margin of each basal plate convexly arcuate (Fig. 53). Gonocoxae 2 diamond shaped, broader than long, carinate mesially. Surface of paratergites 9 concave, especially so adjacent to gonocoxae 2; their posterior margin broadly convex. Sternite 10 small, triangular. Sternite 7 of female bearing large fuscous macule mesially at base.

Pygophore with U-shaped mesial emargination in posterior margin, black mesial macule at anterior margin; posterior border bearing fringe of long setae (Fig. 49). Ventral conjunctival appendages sclerotized apically, forming plate (Figs. 51, 52); lateral appendages sclerotized, medial appendages membranous.

Holotype. ♂, labeled "Bahamas:Mayaguana Isl. (3 words inked out) 28-VIII-63. C. Murvosh. Blacklight trap." Deposited in the Florida State Collection of Arthropods.

Paratypes. ♀, labeled as holotype, deposited with holotype; ♂ labeled as holotype, deposited in senior author's collection.

Caribo fasciatus Rolston, new species
Fig. 54

Description. Light stramineous above and below, appearing brown dorsally from dense fuscous to black punctation. Pronotum traversed dorsally between cicatrices and humeri by stramineous fascia with sparse fuscous punctation. Cicatrices mostly black. Base of head, lateral margins of vertex and base of tylus densely black punctate. Ivory callus present on mesopleura about ⅓ distance from lateral margin; another irregularly shaped and sparsely dark punctate callus in posterolateral corner of metapleura. Punctures on ventral disk of abdomen of various sizes, some quite large; punctures along lateral borders small, more nearly uniform in size. Each abdominal sternite bearing black dot at anterolateral and posterolateral corners. Legs sparsely dotted with black; distal end of tibiae and tarsi infuscate.

Jugal margins subparallel between anteocular concavity and rounded apex of head. Width of head across eyes 1.8–2.0 mm, length 1.5–1.7 mm. Antennal segments about 0.4, 0.7, 0.7–0.8, 1.0, 1.1 mm long; distal ¾ of last antennal segment dark, remainder of antennae pale. Rostrum reaching sternite 4 (3rd visible); length of segments 2–4 about 1.2, 0.7–0.9, 0.7–0.9 mm.

Anterolateral margins of pronotum concave. Humeri moderately produced laterad, narrowly rounded. Cicatrices somewhat elevated; pronotal disk otherwise smooth excepting shallow depression anterior to cicatrices. Width across humeri 4.7–5.4 mm; mesial length 1.7–2.0 mm.

Scutellum 2.8–3.3 mm wide at base, 2.7–3.2 mm long. Fovea in basal angles shallow, small, triangular. Four ill-defined clusters of punctures evenly spaced along base, similar in size to foveae. Scutellar disk evenly convex. Hemelytral membranes vitreous with fumose mottling along 7–8 veins, projecting well past abdominal apex.

Abdominal sternite 3 and base of 4 shallowly sulcate mesially. Spiracles black.

Length of body 6.5–7.4 mm excluding membranes.

Genital plates similar to those of *C. subgibbus.* Sternite 7 bearing large black macule mesially at base.

Posterior margin of pygophore truncate with small U-shaped mesial notch; black mesial macule present at base (Fig. 54).

Holotype. ♂, labeled "Antilles:Jamaica. Falmouth. July 19, 1960. C. & P. Vaurie." Deposited in the American Museum of Natural History.

Paratype. ♀ labeled (a) "Virgin Is:St. John, Est. Carolina, NW of Coral Bay, 31 May 1982, 250 ft" (b) "at ultraviolet light, W. B. Muchmore." Deposited in senior author's collection.

ADDITIONAL NEW SYNONYMY

Prionosoma Uhler, 1863

Prionosoma Uhler, 1863:363–364.
Neurohalys Bliven, 1960:34. **New Synonymy.**

Prionosoma podopioides Uhler, 1863

Prionosoma podopioides Uhler, 1863:364–365.
Neurohalys bucculatus Bliven, 1960:34–36, Pl. 5, figs. 1, 1a. **New Synonymy.**

The type of *N. bucculatus,* type species of *Neurohalys,* in the California Academy of Sciences, was examined. It is an unremarkable example of *Prionosoma podopioides.*

Thyanta aeruginosa Berg, 1878

Thyanta aeruginosa Berg, 1878:24.
Phacidium euchlorum Breddin, 1912:92–93. **New Synonymy.**

The type series of *Phacidium euchlorum,* in the Université Louis Pasteur, Strasbourg, France, was compared with specimens determined by H. Ruckes, one of them designated a homotype, as *Thyanta aeruginosa* Berg. Without doubt *Phacidium euchlorum* and *Thyanta aeruginosa* are synonyms of this quite distinctive species from Argentina and Uruguay. The purported provenance of the type series of *P. euchlorum,* Costa Rica, is obviously erroneous.

The type series of *P. euchlorum* consists of 2 males and 1 female, all labeled "Costa-Rica, San-Jose" (in error) above a red label bearing "Type." A male, here designated lectotype, bears an additional label, presumably inscribed by Breddin with "Phacidium euchlorum Bredd. n. gen. n. sp., typus" (the "t" in typus is not crossed). Pronotal width of this specimen is 3.45 mm. The smaller male, pronotal width 3.25 mm, and female are paralectotypes.

This species appears to be somewhat aberrant among other *Thyanta* species known to us, and once *Thyanta* is revised *Phacidium* may stand as a valid generic or subgeneric name. The species synonymy is mentioned now to resolve the previously vexing question as to the identity of *P. euchlorum.*

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LITERATURE CITED

Berg, C. 1878. Hemiptera Argentina: ensayo de una monografia de los Hemipteros Heteropteros y Homopteros de la Republica Argentina. Anal. Soc. Cient. Arg. 6(1):23–36.

Berg, C. 1883. Addenda et emendanda ad Hemiptera Argentina. Anal. Soc. Cient. Arg. 15: 193–217.

Berg, C. 1884. Addenda et emendanda ad Hemiptera Argentina. Bonariae.

Berg, C. 1891. Nova Hemiptera faunarum Argentina et Uruguayensis. Anal. Soc. Cient. Arg. 32:277–287.

Bliven, B. P. 1960. Studies on insects of the Redwood Empire III: new Hemiptera with notes on others. The Occidental Entomologist 1:35–42.

Breddin, G. 1912. Zwei neue Pentatomiden-Gattungen (Hem.). Archiv Naturgeschichte 78 Abt. A 6:90–93.

Buckup, L. 1957. Pentatomideos neotropicais I—sobre o gênero *Agroecus* Dallas, 1851, com a descricão de duas especies novas (Hem.-Pentatomidae). Iheringia (Zool.) 6:1–20.

Buxton, G. M., D. B. Thomas, Jr. and R. C. Froeschner. Revision of the species of the Sayi-group of *Chlorochroa* Stål (Hemiptera: Pentatomidae). Calif. Dep. Food Agric. Occas. Pap. Ent., no. 29, 25 pp.

Distant, W. L. 1880–1893. Insecta. Rhynchota, Hemiptera-Heteroptera. *In:* F. D. Godman and O. Salvin, Biologia Centrali-Americana. London. Vol. 1, xx + 462 pp., 39 pls.

Eger, J. E. 1978. Revision of the genus *Loxa* (Hemiptera:Pentatomidae). J. New York Ent. Soc. 86(3):224–259.

Eger, J. E. 1980. *Fecelia biorbis* n. sp. (Heteroptera, Pentatomidae), a new species from Haiti. J. New York Ent. Soc. 88(1):29–32.

Grazia, J. 1967. Estudos sôbre o gênero *Galedanta* Amyot and Serville, 1843 (Hemiptera, Heteroptera, Pentatomidae). Iheringia (Zool.) 35:45–49.

Grazia-Vieira, J. 1972. O gênero *Mayrinia* Horvath, 1925 (Heteroptera, Pentatomidae, Pentatomini). Rev. Per. Ent. 15(1):117–124.

Grazia, J. 1976. Revisão do gênero *Fecelia* Stål, 1872 (Heteroptera, Pentatomidae, Pentatomini). Rev. Brasil. Biol. 36(1):229–237.

Grazia, J. 1978. Revisão do gênero *Dichelops* Spinola, 1837 (Heteroptera, Pentatomidae, Pentatomini). Iheringia (Zool.) 53:3–119.

Grazia, J. 1980a. Nova espécie de *Chloropepla* Stål, 1867 coletada em Tucurui, Pará, Brasil (Heteroptera, Pentatomidae). An. Soc. Ent. Brasil 9(1):123–131.

Grazia, J. 1980b. Uma nova espécie do gênero *Fecelia* Stål (Heteroptera, Pentatomidae, Pentatomini). Rev. Brasil. Biol. 40(2):261–266.

Grazia, J. 1981. Novas consideracões sobre *Galedanta* Amyot and Serville, 1843 com a descricão de duas novas espécies (Heteroptera, Pentatomini). An. Soc. Ent. Brasil 10(1): 9–19.

Kormilev, N. A. 1950. Notas Hemipterologicas. Acta Zool. Lilloana 9:495–503.

McDonald, F. J. D. 1975. Revision of the genus *Holcostethus* in North America (Hemiptera: Pentatomidae). J. New York Ent. Soc. 84(4):245–258 (1974).

McDonald, F. J. D. 1976. Revision of the genus *Trichopepla* (Hemiptera: Pentatomidae) in N. America. J. New York Ent. Soc. 82(1):9–22.

McDonald, F. J. D. 1982. Description of the male genitalia of *Holcostethus hirtus* (Van Duzee) with a revised key to North American species (Hemiptera:Pentatomidae). J. New York Ent. Soc. 90(1):5–7.

McPherson, J. E. 1982. The Pentatomoidea (Hemiptera) of Northeastern North America with Emphasis on the Fauna of Illinois. Southern Illinois Univ. Press.

Nelson, G. H. 1955. A revision of the genus *Dendrocoris* and its generic relationships. Proc. Ent. Soc. Wash. 57(2):49–67.

Rolston, L. H. 1973a. The small *Thyanta* species of North America (Hemiptera:Pentatomidae). J. Georgia Ent. Soc. 7(4):278–285.

Rolston, L. H. 1973b. The genus *Menecles* Stål (Hemiptera:Pentatomidae). J. New York Ent. Soc. 80(4):234–237 (1972).

Rolston, L. H. 1973c. A review of *Hymenarcys* (Hemiptera:Pentatomidae). J. New York Ent. Soc. 81(2):111–117.

Rolston, L. H. 1974. Revision of the genus *Euschistus* in Middle America (Hemiptera, Pentatomidae, Pentatomini). Ent. Amer. 48(1):1–102.

Rolston, L. H. 1976. A new species and review of *Sibaria* (Hemiptera:Pentatomidae). J. New York Ent. Soc. 83(4):218–225 (1975).

Rolston, L. H. 1978. A revision of the genus *Mormidea* (Hemiptera:Pentatomidae). J. New York Ent. Soc. 86(3):161–219.

Rolston, L. H. and F. J. D. McDonald. 1981. Conspectus of Pentatomini genera of the Western Hemisphere—part 2 (Hemiptera:Pentatomidae). J. New York Ent. Soc. 88(4):257–272 (1980).

Rolston, L. H., F. J. D. McDonald and D. B. Thomas, Jr. 1980. A conspectus of Pentatomini genera of the Western Hemisphere. Part 1. (Hemiptera:Pentatomidae). J. New York Ent. Soc. 88(2):120–132.

Ruckes, H. 1952. Two new species of *Thyanta* Stål (Pentatomidae:Heteroptera). Bull. Brooklyn Ent. Soc. 47:65–68.

Sailer, R. I. 1944. The genus *Solubea* (Heteroptera:Pentatomidae). Proc. Ent. Soc. Wash. 46(5):105–127.

Sailer, R. I. 1957. *Solubea* Bergroth, 1891, a synonym of *Oebalus* Stål, 1862, and a note concerning the distribution of *O. ornatus* (Sailer) (Hemiptera, Pentatomidae). Proc. Ent. Soc. Wash. 59(1):41–42.

Thomas, D. B., Jr. 1974. The genus *Codophila* Mulsant in North America (Hemiptera: Pentatomidae). Pan-Pacific Ent. 50(4):441–442.

Thomas, D. B., Jr. 1983. The taxonomic status of the genera *Chlorochroa* Stål, *Rhytidolomia* Stål, *Liodermion* Kirkaldy, and *Pitedia* Reuter, and their included species (Hemiptera: Pentatomidae). Ann. Ent. Soc. Amer. 76(2):215–224.

Uhler, P. R. 1863. Entomological contributions.—No. 2. Proc. Ent. Soc. Philadelphia 2:361–366.

Van Duzee, E. P. 1923. Expedition of the California Academy of Sciences to the Gulf of California in 1921. The Hemiptera (true bugs etc.). Proc. Calif. Acad. Sci. (4)12(11): 123–200.

Westwood, J. O. 1837. *In:* F. W. Hope, A Catalogue of Hemiptera in the Collection of the Rev. F. W. Hope, M. A. with Short Latin Descriptions of the New Species. Part 1. London, 46 pp.

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TEMPORAL AND SPATIAL VARIATION IN SEX RATIO AND MATING FREQUENCY IN SOLDIER BEETLES[1]

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Abstract.—Previous studies of the mating system of the soldier beetle, *Chauliognathus pennsylvanicus,* have not considered spatial or temporal variation in sex ratio or the relative frequency of mating and single adults. These two attributes of the mating system were sampled at mid-day and again in the early evening thrice weekly throughout one adult flight season at two localities in Tennessee. Sex ratios were equivalent within days but became increasingly male biased as the season progressed. The proportion of all adults found copulating is about 5 times greater in the early evening than at mid-day. Some between-site differences were found.

The soldier beetle, *Chauliognathus pennsylvanicus* (Coleoptera: Cantharidae), is one of the most common old field insects in the eastern United States during late summer and early autumn. A number of studies have examined mating behavior as it relates to the operation of sexual selection in natural populations of this beetle (Mason, 1972; McCauley and Wade, 1978; Mason, 1980; McCauley, 1981; McLain, 1981; Woodhead, 1981; McLain, 1982). Most of these studies have focused on identifying those characteristics of individuals that determine the probability of being found in copula when a random sample of single and mating adults is taken from a field population. Body size, antennal morphology, population density, presence or absence of interspecific competitors, and female reproductive status have all been shown to influence the probability that an individual will be found mating.

The published studies of the *Chauliognathus* mating system are based on short term observations. Typically, several collections are made at mid-day several days apart. Any temporal or spatial variation in attributes of the mating system such as the operational sex ratio or female receptivity that would be likely to affect the process of mate selection would go undetected when data is taken in such a fashion. It is unknown whether the mate selection process varies with time of day, between days, or from locality to locality. A more complete assessment of the *Chaulignathus* mating system would require knowledge of any such variation. The present study describes one full season of mating activity of the beetles and analyzes daily and seasonal variation in operational sex ratios and the frequency of mating in two natural populations of *C. pennsylvanicus* located in middle Tennessee.

MATERIALS AND METHODS

The two study sites (A and B) in Davidson County, Tennessee were selected such that their close proximity ensured nearly identical weather conditions on any given census day. While field A was considerably larger than field B, they were similar in the relative abundances and phenologies of the numerically dominant plants. Adult

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[1] Requests for reprints should be addressed to D. E. McCauley.

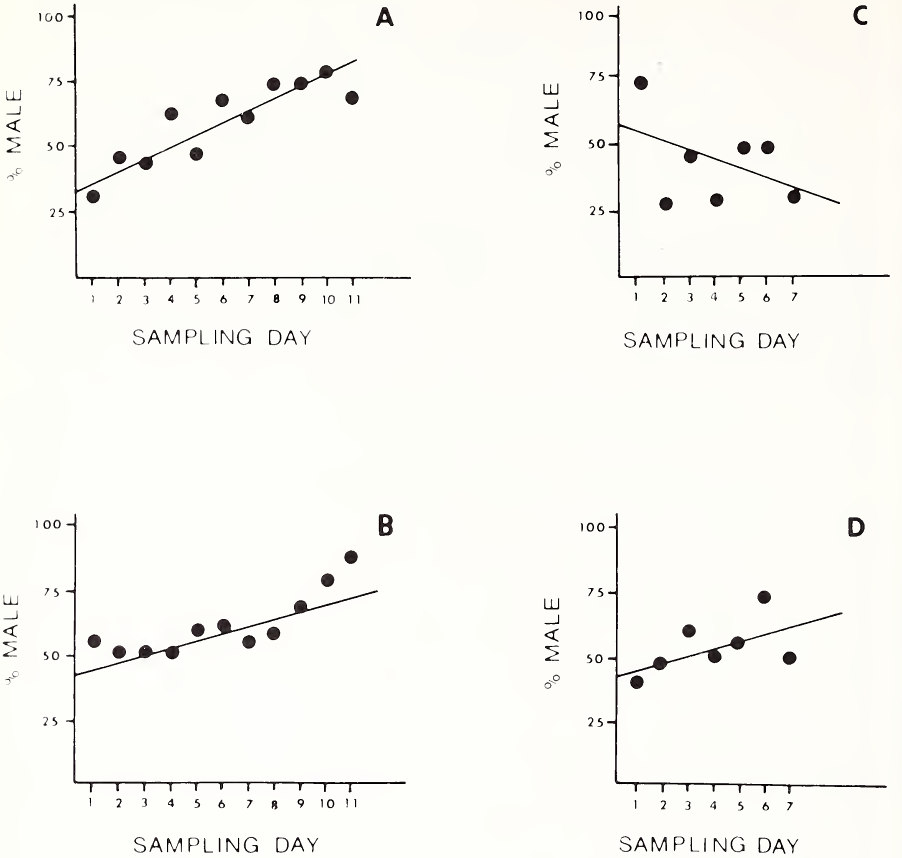

Fig. 1 (A–D). Percent males represented in samples of adult *Chauliognathus pennsylvanicus* taken: A) at study site A at mid-day, B) at site A in the evening, C) at site B at mid-day, and D) at site B in the evening. Least squares regression equations of percent males on (Y) sampling day (X) are: A) $Y = 32.5 + 4.4X$; B) $Y = 43.4 + 2.8X$; C) $Y = 55.9 - 2.8X$; D) $Y = 42.9 + 2.8X$.

soldier beetles are pollen feeders and mate at the feeding sites. Goldenrod (*Solidago* spp.) provided the primary food resource at the beginning of the study in September and was gradually replaced in October by an aster (*Helianthus* sp.). Adult sex ratio and percentage adults seen in copula were censused at each site. In Field A (the larger field) the first 200 beetles encountered in a random transect of the field were sexed and categorized as either "mating" or "solitary." The same procedure was applied to the first 100 beetles observed in Field B. Care was taken at both sites to look for beetles throughout the vegetation (not just on the flowerheads where they tend to aggregate) in order to prevent sampling bias in the sex ratios.

The populations of *Chauliognathus* were sampled during three mid-day surveys (11:00 A.M.–1:00 P.M.) and three late afternoon surveys (5:00–7:00 P.M.) each week

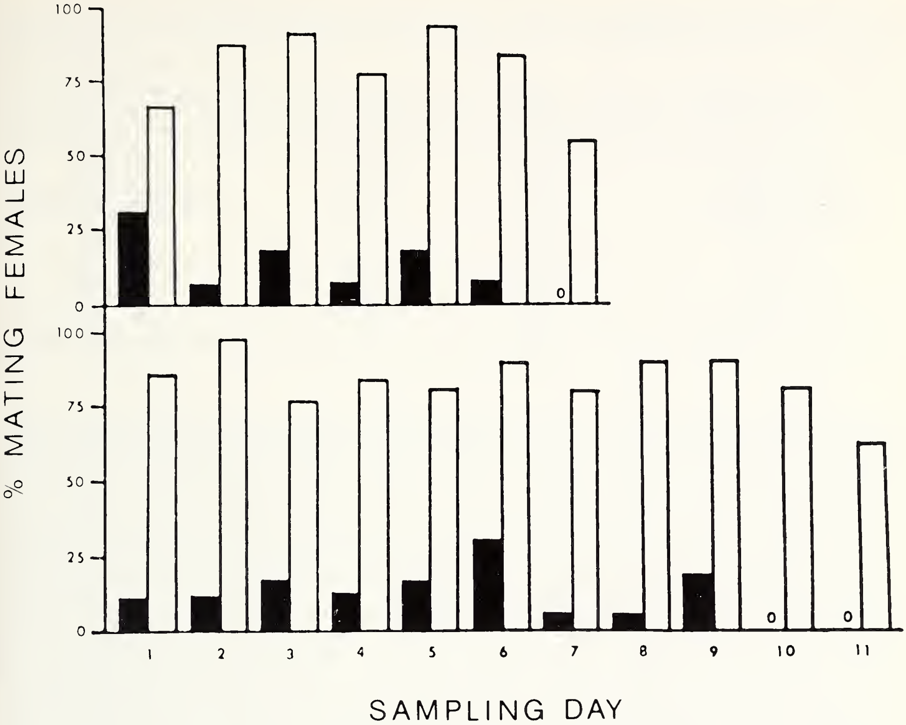

Fig. 2. Percent of sampled females found mating at study sites B (top) and A (bottom). Dark bars represent mid-day samples; open bars evening samples.

beginning September 13, 1982. Field A was sampled until October 18; Field B until October 4. Surveys were terminated at each site when adult beetles became very rare or non-existent. When mid-day and late afternoon surveys could not be taken on the same day, surveys taken on successive days were paired to facilitate temporal and spatial comparisons.

RESULTS

The operational sex ratios estimated at the 2 study sites are presented in Figure 1 (A–D). At study site A the sex ratios became increasingly male biased as the season progressed. Linear regression of percent males on time reveals this trend to be statistically significant for both the mid-day ($P < 0.01$) and evening samples ($P < 0.05$). At study site B no such trend can be documented statistically ($P > 0.10$ in both cases). The 4 regression lines were compared with respect to the equality of their slopes and found to be highly heterogeneous ($P < 0.001$). There appears to be a real difference between localities in temporal trends in the sex ratios. Testing of individual samples for a goodness of fit to a 50:50 sex ratio reveals that not only are later samples at site A significantly male biased but that the mid-day samples are actually slightly

Table 1. Three factor analysis of variance of the percent of sampled females found mating. With one replicate per treatment cell the A × B × C interaction term serves as the error mean squares.

Source of variation	df	M.S.	*F*	
Location, A	1	0.040	3.64	N.S.
Sample day, B	8	0.011	1.00	N.S.
Time of day, C	1	4.310	398.80	$P < 0.001$
A × B	8	0.011	1.00	N.S.
A × C	1	0.010	0.91	N.S.
B × C	8	0.050	4.55	N.S.
A × B × C	8	0.011		

female biased at the onset of the adult flight season. As a group, the goodness of fit *G* tests are highly heterogeneous as would be expected from the results of the regression analysis.

Given that sex ratios are male biased, at least some of the time, a study of temporal variation in mating frequency requires that the proportion of males found mating be analyzed separately from that of females. The proportions of females found to be mating at the various censuses is presented in Figure 2. It is obvious that far more females can be found mating in the early evening than at mid-day. The data were analyzed by a three-factor analysis of variance in which the 3 factors were time of day, day of season, and locality. Only time of day was found to be statistically significant (Table 1). Pooling results across census days and fields, it was shown that, on average, 13.2 percent of the adult females are mating at mid-day compared to 84.3 percent in the evening. A similar analysis of the proportion of males found mating reveals that in addition to the highly significant effect of time of day, the day of the season also has an effect (Table 2). This is not surprising given the observations made on the sex ratio.

DISCUSSION

Despite the large number of studies of mate selection in *C. pennsylvanicus,* little is known about those characteristics of its natural history and reproductive physiology relevant to a more complete description of its mating system. Male biased sex ratios have been shown previously (Wiener, 1974; Brown and Brown, 1984) but the extent of the temporal trend in variation in the sex ratio has not been previously documented. The mechanism by which populations become increasingly male biased is not clear since these studies were not designed to partition sex-specific mortality effects from emigration. Females could have a shorter life expectancy than males or they could disperse from the old fields prior to oviposition. That sex ratios are not male biased at all localities and are not male biased at the onset of the breeding season suggests that the male bias does not result from unequal sex ratios at birth nor from differential survivorship during the larval period. Whatever the mechanism, seasonal changes in the operational sex ratio would be expected to exert an influence on the mating system, probably intensifying competition among males for mates.

Table 2. Three factor analysis of variance of the percent of sampled males found to be mating. With one replicate per treatment cell the A × B × C interaction term serves as the error mean squares.

Source of variation	df	M.S.	F	
Location, A	1	0.00	0.00	N.S.
Sample day, B	8	0.04	3.64	$P < 0.05$
Time of day, C	1	2.70	245.45	$P < 0.001$
A × B	8	0.01	0.91	N.S.
A × C	1	0.01	0.91	N.S.
B × C	8	0.03	2.73	N.S.
A × B × C	8	0.01		

It is also not clear what generates the daily cycle in the proportion of the population found to be mating. Behavioral observations by McCauley and Wade (1978) suggest that males will attempt to copulate with nearly any single female that they encounter. Most females resist copulating with males, at least until the male has succeeded in subduing the female with antennal stroking. Woodhead (1981) has shown that a female's receptivity seems to be predicted by the maturity of her eggs, at least at mid-day. It would seem that female receptivity must further change with the time of day, perhaps as a function of ambient temperature or incidental light. Depending on the frequency and timing of oviposition and the manner in which sperm is transferred and utilized, the success of a male of a given body size at mating at mid-day could be a poor predictor of his overall reproductive success.

This paper is not intended to discredit those previous short term studies of *C. pennsylvanicus* but rather to add to them by pointing out that temporal variation in some rather obvious populational parameters could greatly influence our interpretation of the mating system and what determines a fit male.

LITERATURE CITED

Brown, L. and V. Brown. 1984. Dispersal and dispersion in a population of soldier beetles, *Chauliognathus pennsylvanicus* (Coleoptera: Cantheridae). Environ. Ent. (in press).

Mason, L. G. 1972. Natural insect populations and assortative mating. Amer. Midl. Natur. 88:151–157.

Mason, L. G. 1980. Sexual selection and the evolution of pair-bonding in soldier beetles. Evolution 34:174–180.

McCauley, D. E. 1981. Application of the Kence-Bryant model of mating behavior to a natural population of soldier beetles. Amer. Natur. 117:400–402.

McCauley, D. E. and M. J. Wade. 1978. Female choice and the mating structure of a natural population of the soldier beetle, *Chauliognathus pennsylvanicus.* Evolution 32:771–775.

McLain, D. K. 1981. Interspecific interference competition and mate choice in the soldier beetle, *Chauliognathus pennsylvanicus.* Behav. Ecol. and Sociobiol. 9:65–66.

McLain, D. K. 1982. Density dependent sexual selection and positive phenotypic assortative mating in natural populations of the soldier beelte, *Chauliognathus pennsylvanicus.* Evolution 36:1227–1235.

Wiener, J. G. 1974. Unbalanced sex ratios in populations of *Chauliognathus pennsylvanicus.* Environ. Ent. 3:572–573.

Woodhead, A. P. 1981. Female dry weight and female choice in *Chauliognathus pennsylvanicus.* Evolution 35:192–194.

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BOOK REVIEWS

Bark Beetles in North American Conifers.—Jeffrey B. Mitton and Kareen B. Sturgeon (eds.). University of Texas Press, Austin. 527 pp. $17.50.

It is appropriate for a discipline to step back and examine itself occasionally, as is done in this work. The volume consists of 10 chapters, each written by one or two specialists in the areas treated, with chapters 1 and 10 by the editors. It appears that camera-ready copy was prepared by the contributors in order to keep printing costs minimal, but without stringent editorial control as judged by the irregularity in the lower margin of each page and unused blank areas on several pages (e.g., p. 257). In spite of these minor lapses, the articles are clear and informative, with surprisingly little redundancy. Clerical errors vary from virtually none in one chapter to many in another.

Each chapter reviews principal contributions to existing knowledge and attempts to summarize the present status of the 10 fields treated. Several authors suggest areas where future research would be appropriate. The chapters for the most part are authoritative, but are unequal in quality, ranging from the very scholarly review of Aggregation Pheromones by Borden to two that might cause one to wonder if the authors had been exposed to literature of the past decade or two. In spite of this inconsistency, the volume should be required reading for anyone engaged in bark beetle research everywhere, not just in North America. However, the reader must be informed and alert, because all that is written is not so.

If the volume is to be criticized, first on the list should be the lack of adequate editorial and/or peer review prior to publication to remove archaic taxonomic nomenclature, outright errors in species citations, and other erroneous information. Second, with about three notable exceptions, the authors restricted their discussions to American species on conifers when a worldwide perspective was needed to make the point under consideration. No one called attention to the fact that Mexico, not the United States, is and has been the center of *Dendroctonus* evolution, or that two species, not just one member of this genus, occur in Asia. Third, a conspicuous void in this volume is the absence of a chapter on mating systems and mating behavior, recent advances of notable significance are not mentioned. Fourth, territorial behavior, including same-sex butting or dislodgement by attacking scolytids on the bark surface, and courtship ritual by non-stridulating beetles are not mentioned. Fifth, in the final chapter there are so many oversights, errors, and erroneous suppositions that its credibility is seriously undermined. For example, (a) scolytids are unknown from the Triassic (*Paleoscolytus* is an error in family placement and *Paleoipidus* is unassignable to any family), (b) scolytids are primarily polyphagous (not monophagous or oligophagous, as stated), (c) since few scolytid insect parasites prey exclusively on scolytids, evolutionary radiations tied closely to scolytids are very unlikely (parasitic mite radiations tied to scolytids are much more probable), (d) speciation models (pp. 352–357) are based primarily on ecotypes (host races often are examples) that are ephemeral populations that ordinarily do not form geographical races (subspecies) or species. However, they occasionally can become important in preadapting a population to a new environment which in turn could then lead to speciation, (e) the lack of genetic (or biochemical) diversity in Colorado ponderosa pine (as compared to great diversity in California) is attributed to interaction with scolytids. However, pondersa pine did not occur in Colorado until about 12,000 years ago or within several hundred miles of Colorado as recently as 16,000 years ago. It has occurred in California for a considerably longer period of time. Its recent migration into Colorado alone could have resulted in the lack of genetic diversity observed today. Considerably better evidence of bark beetle limitation of genetic diversity on ponderosa pine must be documented before they can be identified as significant factors in the suggested role.—*Stephen L. Wood, Department of Zoology, Brigham Young University, Provo, Utah 84602.*

Biological Diversification in the Tropics: Proceedings of the Fifth International Symposium for the Association for Tropical Biology.—G. T. Prance (ed.). 1982. Columbia University Press, New York. 714 pp. $60.00.

This large volume champions the thesis that the myriad of moist forest patches (brejos) isolated during the Quaternary in several tropical areas of the world has resulted in a good deal of allopatric divergence and, thus, diversity. The result of such "refugia" are high degrees of endemism. This work is simply one of historical biogeography, which is a province primarily of systematists. Since there are probably more tropical insect species in the world than all other animals, it remains largely for systematic entomologists to grapple with the problem as to how these faunas originated. Although only 5 of the 37 papers in this book deal exclusively with insects (and 4 of the 5 are on Lepidoptera), there is plenty of food for thought on the subject provided by disparate disciplines. Unfortunately, the state-of-the-art on the historical biogeography of the region emphasized in the book, the Neotropics, is not progressive, let alone that of the other regions just casually covered.

Included are a section each on refugia theory and its applications, geology and paleoclimatology, vegetation, insects, vertebrates, primates and anthropology, and the Paleotropics. Redundancy throughout the book makes it much longer than is necessary. The introductions of the majority of papers cite the few early works on the subject and briefly review refugia theory despite the fact that a good introduction is already provided in the first chapter by Haffer. Maps overlap considerably, too, especially of the South American vegetation and climatic zones. Ab'Saber's 1977 map of Pleistocene climates, for instance, is presented twice, each time on a full page. A detailed map section in an appendix would serve for good general reference, although many of the figures in each paper are very informative. Limiting each contribution to four or five pages of original findings would not only have shortened the volume, but would have prevented reiteration of what some five authors (at least to my knowledge) have essentially published elsewhere.

The main accomplishment of the book is detailing endemism among various Neotropical taxa. The botanists, in particular, are very lengthy in their descriptions of floral regions. Some papers, such as those of Steyermark, Andrade-Lima, and Huber on Neotropical plants, are mostly just big lists. Lamas, with the standard zeal that lepidopterists have for geographic variation in wing patterns, lists subspecies of mostly pierids, ithomiine nymphalids, and satyrids endemic to 48 Peruvian sites. Although, as Strong comments, categorizations lead refugia theory to suffer because they are without precise, falsifiable criteria, such thoroughness is nonetheless the right beginning in understanding the biogeography of a traditionally neglected area.

Some authors do more than just detail endemism and they actually consider floral and faunal relationships. However, as do Grubb (studying African forest mammals), Walker (on the origin of the southeast Asian rain forests), and Magliazza (on linguistic diversity in Amazonian languages), statements of evolutionary relationships are made that rely upon inferences such as those endemic centers of greatest diversity being the center of origin. One could very plausibly argue the opposite, that ancestral regions should be relatively depauperate due to longer exposure to extinction. The obvious shortcoming in most papers is a complete lack of phylogenetic thinking. In this respect, the term refuge—supposedly the theme of the book—is prematurely used, probably because it is such an attractive term to biogeographers. How does one actually recognize a refuge? It is a relatively old area that has provided taxa that have diversified subsequent to its isolation. Pragmatically, criteria and limits should be defined to test, say, the requisite proportion of ancestral species found in a proposed refuge. Such an approach is analogous to what many vicariance biogeographers are doing based upon cladistic reconstructions of a taxon's phylogeny (Patterson, 1981).

The vertebrate contributors are the most advanced in their approaches, which perhaps reflects the status of vertebrate systematics in general. Heyer and Maxson conclude that *Leptodactylus* frogs have diverged prior to the Quaternary in South America, whereas Duellman shows that some refugia have influenced divergence in two *Hyla* species groups. If improved, Heyer and Maxsons' approach can be very useful. However, their estimate of *Leptodactylus* divergence time is simply one of the albumins on which the immunological distance matrices were based. With direction given to their phenetic tree, and more loci incorporated, divergence time could then be more accurately compared with the geological date for area divergence. Probably the best conceived and written paper in the book is by Weitzmann and Weitzmann, who (with several other authors) recognize the danger in scenario building based on predetermined notions of occasional dispersal events. They construct a cladogram for each of two small fish genera (*Carnegiella* and *Nannostomus*), but find little congruence between these and refugia proposed on independent grounds. Dispersal to the present-day distributions is then suggested. Several authors, such as Pearson (on birds) and Gentry (on woody angiosperms in Colombia) find that endemism is sometimes a result of specific ecological conditions (due either to extinction in inhospitable areas and/or dispersal to good areas). The preliminary indication is, then, that dispersal has been important in the distribution of many taxa (hardly surprising given the geographic scale of many groups); this should not, however, deter us from adopting a vicariant test as the initial approach (Platnick and Nelson, 1978).

It is interesting that many of the proposed refugia do not overlap among taxa. Exceptional is the very impressive superimposition, shown in Figure 16.36, of the refugia based on ithomiine and heliconiine Nymphalidae subspecies distributions (worked on by K. S. Brown) and the refugia compiled by Brown based on many other data. Oren, at least, proposes that the average size of refugia varies among taxa because of differences in the minimal critical population sizes (i.e., that number needed to sustain a breeding population). This can partly explain a difference in refugia distributions, but the matter as a whole is not attacked.

Dispute between some ecologists and the remainder of the authors provides some controversy to the topic. Endler antagonizes refugia theory with well constructed arguments. However, his assertions are not well founded that many of the assumptions of refugia theory are unreasonable. For example: Many 'refugiests' do not maintain allopatry is required for divergence, nor that it necessarily results in differentiation. Generally agreed upon is that allopatric speciation is a ubiquitous, but not universal, mode, and that sympatric speciation has certainly enjoyed no resounding support in theory or fact despite the effort to prove otherwise (Futuyma and Mayer, 1980; Jaenike, 1981). Benson, working on *Heliconius* communities, supports Endlers' parapatric model. The argument is that divergence is easily explained by a cline of selection pressures, so much so that vicariance has little influence in distributions. But, Bensons' work deals with a small number of overt racial patterns with simple genetic bases, the appearance of which are demographically mediated. Can one make inferences of faunal origins based on studies of a simple and adaptive trait? This line of argument would also claim that distinct populations of *Biston betularia* have not been affected by any dispersal or vicariant event in England because the appearance of color morphs accord so well with the presence or absence of air pollution.

Erwin and Adis seem to be dealing more with habitat selection in carabids than with the beetles' biogeography. They attempt to reconcile this by stating "habitat vicariance is simply geographic vicariance at a much finer resolution." This seems to suggest that sympatric speciation is the rule rather than exception for creatures of low vagility, such as their arboreal *Agra.* The implication, of course, is that communities can be inherently very unstable assemblages—a very unorthodox view, given the persuasion of this symposiums' participants.

Will we ever be able to reconstruct the effects of Quaternary forest fragmentation on tropical diversity? Not unless better distributional and geological data is collected and put into a phylogenetic perspective. At least with our present state of knowledge on endemism, as stressed in the concluding chapters by Myers and by Lovejoy, we can determine the best areas in which to establish natural preserves. For those who feel that the biological diversity of the rapidly depleting tropics will be salvaged and the origins of which are worth studying, I recommend gleaning this book for a few salient references.—*David Grimaldi, Department of Entomology, Cornell University, Ithaca, New York 14853.*

LITERATURE CITED

Futuyma, D. J. and G. C. Mayer. 1980. Non-allopatric speciation in animals. Syst. Zool. 29: 254–271.

Jaenike, J. 1981. Criteria for ascertaining the existence of host races. Amer. Nat. 117:830–834.

Patterson, C. L. 1981. Methods of paleobiogeography. Pages 446–489 *in:* G. Nelson and D. E. Rosen (eds.), Vicariance Biogeography: A Critique. Columbia University Press, New York.

Platnick, N. I. and G. Nelson. 1978. A method of analysis for historical biogeography. Syst. Zool. 27:1–16.

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REVISION OF *AROCERA* SPINOLA (HEMIPTERA: PENTATOMIDAE)

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Abstract.—The neotropical genus *Arocera* Spinola is revised and two keys are provided to species, one based on color the other on the male genitalia. Two new species are described, *A. colombiana* from Venezuela and Colombia and *A. verdana* from Panama and Costa Rica. The following new synoymies are recognized: *A. spectabilis* (=*A. apta* Walker, =*A. jalapensis* Distant, =*A. patibula* Distant, =*A. melanopygai* Stal, =*A. crucigera* Haglund); *A. nigrorubra* (=*A. affinis* Distant, =*A. altivola* Distant, =*A. chiriquensis* Distant, =*A. contralineata* Piran, =*A. placens* Walker, =*A. protea* Distant); *A. elongata* (=*A. repleta* Van Duzee).

Arocera Spinola occurs in Central and South America, with one species extending into the Caribbean Islands. There is a great deal of synonymy in this genus due to the fact that many color variants were described as species. The genus is fairly closely related to *Runibia* Stal, the male genitalia of both genera being similar. However, in *Runibia* the osteolar sulcus is plate-like extending less than half the distance between the osteole and the margin of the pleuron, in *Arocera* the sulcus extends for two thirds this distance and is narrow and curved cephalad. The first rostral segment extends well past the bucculae in *Runibia,* whereas the first rostral segment is almost the same length as the bucculae in *Arocera.* Nothing, unfortunately has been published so far on the biology of this species. Rolston (1976) verified the generic assignment of some species of *Arocera.* Distribution records indicate countries only, in the case of larger countries, federal states are cited where possible to indicate smaller geographic regions. Froeschner (1981:68) gives a number of additional distribution records for several species of *Arocera* in Ecuador.

Arocera Spinola, 1837

Arocera Spinola, 1837:316; Stal, 1867:529; Stal, 1872:37; Lethierry and Severin, 1893:158; Kirkaldy, 1909:109.
Ooedosoma Amyot and Serville, 1843:128. (Synonymized by Kirkaldy, 1909.)
Estphoria Gistel, 1848:VIII. (Synonymized by Kirkaldy, 1909.)

Type. Arocera aroleuca (Perty, 1833). Type not located.

Diagnosis. Brightly colored bugs patterned in a combination of yellow, orange or red and black or brown, or mostly metallic green or brown. HEAD: Tylus and jugae of equal length; jugae with margins raised at least at apex, in some species entire margin raised, with diagonal striae. Antennae with segment 3 flattened, sometimes grooved, flattening not very apparent in *A. spectabilis*; some species also with either 2 flattened, or 4 flattened or both 2 and 4 flattened. Rostrum extending to hind coxae or well beyond in *A. elongata,* first rostral segment projecting slightly beyond bucculae. THORAX: Prothorax with a small spine on each anterior angle. Osteolar peritreme elongate, curved cephalad, and extending for ⅔ distance between osteole and plural margin; evaporative area extensive, extending onto mesopleuron. ABDOMEN: Connexiva covered by hemelytra.

Male genitalia. Pygophore with small rounded tubercles or large horns covered with spicules on margin. Claspers, simple L or T shaped with a small thumb-like process in *A. rufolimbata, A. verdana, A. colombiana, A. rufonotata* and *A. splendens.* Theca small, simple with well developed basal plates. Conjunctival appendages bi- or tri-lobed apically, sclerotized to varying degrees; median penial lobes rod-like or flattened disc-like structures fused basally; ejaculatory duct short, not protecting beyond conjunctival lobes.

Female genitalia. External genitalia typically pentatomoid, dorsal surface of 8th paratergites deeply concave in *A. splendens, A. rufonotata, A. colombiana,* n. sp., *A. verdana,* n. sp., and *A. rufolimbata,* in the remaining species dorsal surface flat. Spermatheca with well developed reservoir and pump; bulb of pump with an elongate appendage in *A. nigrorubra, A. spectabilis,* and *A. elongata,* in the remaining species bulb without appendages. Ring sclerites and accessory sclerites present in vulva around spermathecal entrance.

KEY TO THE SPECIES OF *Arocera* SPINOLA

1\. Dorsal surface* largely metallic green (sometimes blue), shades of metallic green or dull brown, reddish brown, or brownish green 2

– Dorsal surface colored in patterns of black or brown or yellow, orange or red 6

2(1). Dorsal surface metallic green (sometimes blue), with a narrow red band around anterior margin of pronotum; or dorsal surface duller green or brown with abdominal connexiva checked black and red 3

– Dorsal surface dull red-brown or green-brown with narrow yellow or red band around anterior margin of pronotum; abdominal connexiva unicolorous 5

3(2). Dorsal surface uniformly metallic green or greenish brown ..... *splendens* (Blanchard)

– Dorsal surface marked with red at least on scutellum 4

4(3). Scutellum with a brick red stripe centrally, outer margins of elytra with a brick-red stripe from inner angle .... *verdana* McDonald

– Pronotum with a red spot centrally; red maculae on scutellum and hemelytra .... *rufonotata* Stal

5(4). Dorsal surface cinnamomeus, margins of hemelytra and pronotum distinctly outlined to varying degrees with black .... *colombiana* McDonald

– Dorsal surface brunneus or brown-green, unicolorous .... *rufolimbata* Stal

6(1). Nota and hemelytra with 5 longitudinal stripes of alternating yellow and black; black stripes, uniting basally in membrane to form a horseshoe pattern, Fig. 9 .... *acroleuca* (Perty)

– Color pattern otherwise 7

7(6). Dorsal surface dark to pinkish red with oblong black or brownish maculae on pronotum scutellum and hemelytra; antennal segments 2 + 3 usually distinctly flattened. If background color is yellow or orange, then maculae on pronotum, scutellum and hemelytra are a faded smoky brown .... *rufifrons* (Dallas)

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* This term refers collectively to the pronotum, mesoscutellum and corium-clavus of the hemelytra.

– Species with yellow, brown or orange background, maculae on pronotum, scutellum and hemelytra distinctly black; color if red not patterned as above 8

8(7). Dorsum patterned in distinct square maculae of black on yellow or orange (Fig. 1); first antennal segment yellow; species usually larger than 11.0 mm long, 6.2 mm wide (male) and 11.3 mm long and 6.5 mm wide (female) .... *spectabilis* (Drury)

– Color pattern variable; first antennal segment black 9

9(8). Dorsal surface bright orange red or black with red spots, well over 14 mm long .. .. *elongata* Showalter

– Dorsal surface with variable diffuse color patterns in brown or black with orange, red or yellow; species usually no larger than 11.8 mm long and 6.1 mm wide (male) or 11.1 mm long and 6.4 mm wide (female) .... *nigrorubra* (Dallas)

KEY TO THE SPECIES OF *Arocera* BASED ON THE MALE GENITALIA

1. Dorsal margin without tubercles or plates. Claspers with a distinct finger-like process on stem (Fig. 47) 2

– Dorsal margin with tubercles or plates (Fig. 30). Claspers without finger-like process on stem 6

2(1). Ventral margin produced into two stout arms one on each side of the proctiger and an outer pair of plates, both structures covered in fine tubercles (Fig. 17) 3

– Ventral margin not so developed, lower plates absent 4

3(2). Claspers small triangular with a small process on stem (Fig. 20). Conjunctival appendages multi-lobed (Fig. 22) .... *splendens* (Blanchard)

– Claspers L-shaped, process longer and curved (Fig. 53). Conjunctival appendages bi-lobed (Fig. 54) .... *rufolimbata* Stal

4(2). Inferior ridge with small tubercles below the horn-like protuberances on either side of the proctiger (Figs. 45, 67) 5

– Inferior ridge without tubercles .... *colombiana,* new species

5(4). Tubercles on inferior ridge arranged in a triangular patch below horns (Fig. 45). Claspers distinctly L-shaped, apex blunt; process on stem elongate ..... *rufonotata* Stal

– Tubercles on inferior ridge arranged in a more linear fashion below horns (Fig. 67). Claspers more triangulate with an acute apex, process small and stout (Fig. 47) .. .. *verdana,* new species

6(1). Dorsal margin of pygophore with distinct plates fully visible; superior ridge not developed .... *acroleuca* (Perty)

– Dorsal margin with tubercles partly concealed beneath the margin; superior ridge or depression well developed (Fig. 2) 7

7(6). Dorsal margin of pygophore with a distinct depression above base of proctiger (Fig. 57). Claspers with a small tubercle on stem, apically blunt (Fig. 60) .... *elongata* Showalter

– Dorsal margin of pygophore with a well developed superior ridge. Claspers without tubercle, often acute apically (Fig. 40) 8

8(7). Claspers tri-lobed (Fig. 4). Ventral margin of pygophore almost straight (Fig. 3) .. .. *spectabilis* (Drury)

– Claspers otherwise. Ventral margin of pygophore either centrally concave or convex 9

9(8). Proctiger divided dorsally into two plates (Fig. 38). Apex of ejaculatory duct lying well below outer margins of median penial lobes (Fig. 42) .... *rufifrons* (Dallas)

– Proctiger not divided dorsally into two plates (Fig. 30). Apex of ejaculatory duct reaching outer margins of median penial lobes (Fig. 34) .... *nigrorubra* (Dallas)

Arocera spectabilis (Drury, 1782)

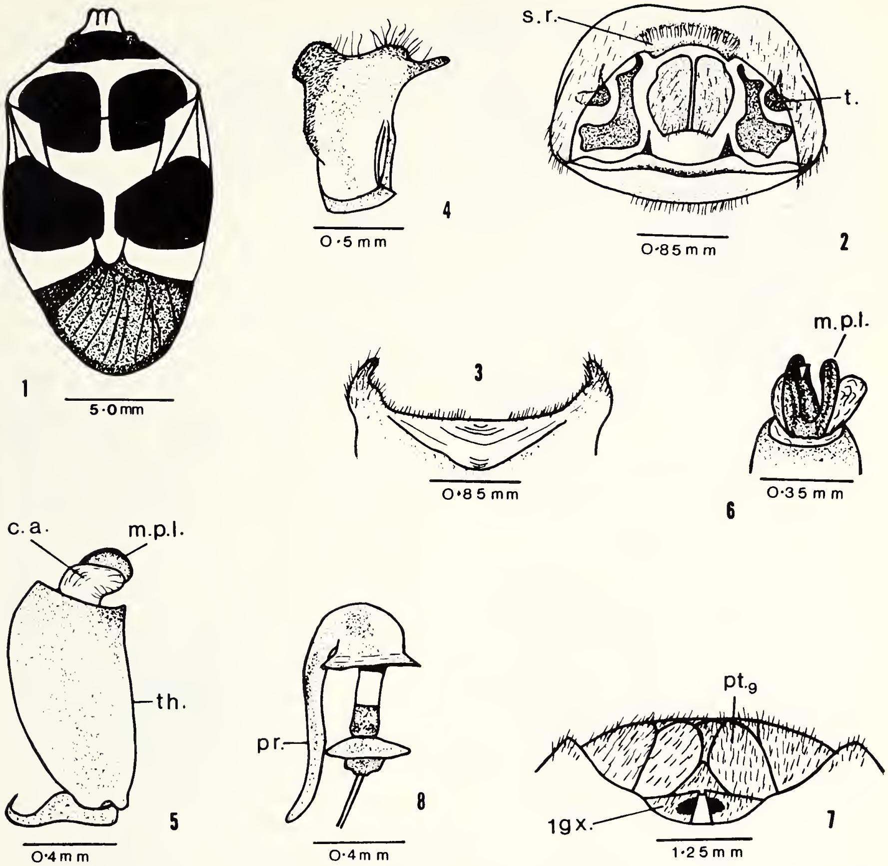
Figs. 1–8

Cimex spectabilis Drury, 1782:Index and p. 66, pl. 46.
Strachia spectabilis Dallas, 1851:266.
Strachia generosa Stal, 1854:233.
Arocera spectabilis Stal, 1872:38; Kirkaldy, 1909:110; Grazia, 1977:163.
Arocera schumanni Distant, 1890:336, pl. 31; Kirkaldy, 1909:110; Rolston, 1976:3. **New Synonymy.**
Strachia melanopyga Stal, 1858:437. **New Synonymy.**
Strachia apta Walker 1867:323. **New Synonymy.**
Arocera melanopyga Stal, 1862:107.
Arocera crucigera Haglund, 1868:157. **New Synonymy.**
Arocera apta Distant, 1880:73, pl. 7; Kirkaldy, 1909:109; Piran, 1963:107; Becker and Grazia-Vieira, 1977:55.
Arocera jalapensis Distant, 1890:337, pl. 30; Kirkaldy, 1909:109. **New Synonymy.**
Arocera patibulata Distant, 1880:74, pl. 7. **New Synonymy.**

Types. The type of *Cimex spectabilis* was not located. However, from Drury's description and figure this is clearly *A. spectabilis.* The types of *Strachia apta* Walker ♀; *Arocera jalapensis* Distant ♀; *Arocera schumanni* Distant ♂ and *Arocera patibulata* Distant ♀, all in the British Museum (Nat. Hist.) were examined. The type of *Strachia melanopyga* Stal, *A. crucigera* Haglund were examined, both types are in the Naturhistoriska Riksmuseet, Stockholm.

Diagnosis. HEAD: Dorsal surface black basally, yellow apically; ventral surface yellow. Eyes black. Antennae. First segment orange, remainder black; segments 2 and 3 slightly flattened. Rostrum surpassing mesocoxae, segments 1–3 orange, 4 black. THORAX: Pronotum yellow, with a black band between anterior angles and basally two oblong black patches separated by a mesial strip of yellow. Scutellum yellow with two oblong patches basally; confluent with those on the prothorax; two further oblong black patches about three quarters length of scutellum separated from basal patches by a band of yellow, apex yellow. Hemelytra yellow with two broad oblong black patches in middle of coria confluent with patches on the scutellum. Ventral surface orange, usually with large black spot in middle of each propleuron. Evaporative area extending from base of mesopleuron to metapleuron. Legs. Coxae, trochanters and proximal $\frac{5}{6}$, orange; femora orange; distal $\frac{1}{6}$ fuscous; tibiae and tarsi black. ABDOMEN: Connexiva orange; ventral surface orange and yellow.

Male genitalia. Pygophore with ventral margin smoothly and shallowly emarginate, a crescent shaped depression found beneath centre of margin on central surface of pygophore. Dorsal margin deeply arched with well defined superior ridge. A small pair of triangular tubercles found on lateral inner margin, one on each side. Proctiger oblong, box-like with unsclerotized mid-line. Numerous long fine setae found on margins of pygophore and on proctiger. Clasper apically expanded into 3 lobes, dorsal lobe finger-like, stem thick. A number of fine setae on outer surface of clasper. Aedeagus. Theca cylindrical and very heavily sclerotized, basal plates large oblong. Dorsal rim bearing a small membraneous bi-lobed process. One pair of conjunctival appendages; small oblong membraneous structures slightly sclerotized apically. Me-

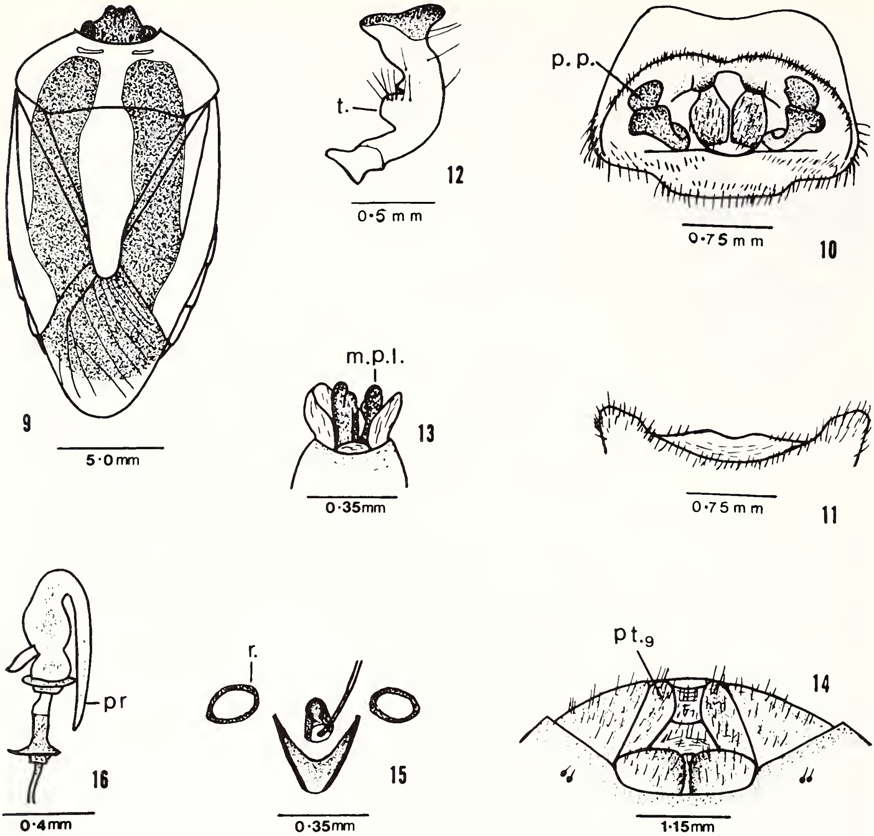


Figs. 1–8. *A. spectabilis*. 1. Dorsal view. 2. Pygophore, dorsal view. 3. Ventral border of pygophore. 4. Right clasper, ental view. 5. Aedeagus, lateral view. 6. Aedeagus, dorsal view. 7. Female genitalia. 8. Spermathecal bulb. Conjunctival appendage (c.a.), first gonocoxa (1gx.), median penial lobe (m.p.l.), process (pr.), paratergite 9 (pt.9), superior ridge (s.r.), tubercle (t.), theca (th.).

dian penial lobes flattened disc-like. Ejaculatory duct lying entirely between median penial lobes, short heavily sclerotized, slightly sinuous.

Female genitalia. Paratergites 8 triangular; paratergites 9 elongate, spatula-like. 1st gonocoxae triangular meeting centrally. 2nd gonocoxae visible as a triangular section above 1st gonocoxae. Paratergites and gonocoxae covered with long fine setae. Entrance of spermathecal duct surrounded by a number of small sclerites and ring sclerites. Spermatheca, typically pentatomoid with large spermathecal reservoir and pump with distal and proximal flanges; one long process on bulb of pump.

Variations. The color of this species varies from pale cream to burnt sienna; ventrally most specimens have large oblong black spots on the thoracic pleura on



Figs. 9–16. *A. acroleuca.* 9. Dorsal view. 10. Pygophore, dorsal view. 11. Pygophore, ventral border. 12. Left clasper, ectal view. 13. Aedeagus, dorsal view. 14. Female genitalia. 15. Entrance of spermatheca. 16. Spermathecal bulb. Median penial lobe (m.p.l.), process (pr.), paratergite 9 (pt.9), ring sclerite (r.), tubercle (t.).

each side, but these vary in size and shape and some may be missing; the femora have the dark brown color extending a ¼–½ way from distal end of segment.

Distribution. Colombia; Panama; Peru; Ecuador (Iquitos); Costa Rica; Brazil (Rio de Janeiro, Mato Grosso, Obidos, Manaus, Teffe); Venezuela; Bolivia; Guatemala; Guiana; French Guiana; Paraguay; Mexico.

Arocera acroleuca (Perty, 1833)
Figs. 9–16

Pentatoma acroleucum Perty, 1833:168, pl. 33.
Cimex acroleucus Burmeister, 1835:366.
Pentatoma aequinoxialis Westwood, 1837:33. (Synonymized by Distant, 1900b:823.)

Ooedosoma acroleucum Amyot and Serville, 1843:128.
Arocera acroleuca Stal, 1872:37; Kirkaldy, 1909:109; Piran, 1966:86.

Type. Holotype *Pentatoma acroleucum,* Zoologische Museum, Munich. Type seen.

Diagnosis. HEAD: Dorsally and ventrally black except bucculae sometimes yellow and extending from them a yellow band around base of head; bucculae distinctly raised along outer margins, with lateral striae. Eyes black. Ocelli amber. Antennae black, segments 3 and 4 flattened. Rostrum extending beyond metacoxae, yellow except for apex smoky brown. THORAX: Yellow with broad horseshoe shaped black mark, open anteriorly; black beginning on each side of pronotum basally, continuing caudad across lateral portion of scutellum at base and coria excepting costal margin into black membrane; anterolateral and anterior margins of pronotum, mesial stripe on pronotum and scutellum, costal margin of coria, all yellow. Ventral surface of thorax yellow. Legs. Coxae, trochanters yellow; basal half of femora yellow, apical half dark brown; tibiae and tarsi dark brown. ABDOMEN: Connexiva yellow; sterna yellow.

Male genitalia. Pygophore with ventral border biconcave on either side of a median rounded projection, a shallow emargination found centrally beneath border. Dorsal border broadly arched with a central collar forming a median emargination into which the apex of the proctiger sits when at rest. A small flattened oval pygophoral plate found one on each side laterally just adjacent to margin of border; apex of claspers lying on top of this plate when at rest. Proctiger oblong. Claspers C-shaped, apically broad, bi-lobed; basally with a small tubercle on inner dorsal margin; short setae on tubercle and longer ones on outer margin of clasper. Aedeagus. Theca cylindrical, moderately sclerotized; 1 pair membraneous conjunctival appendages, small lobe-like. Median penial lobes small, spatulate, basally tapering; ejaculatory duct small, straight, completely enclosed by median penial lobes.

Female genitalia. External genitalia very similar to *A. elongata.* A number of small crescent shaped sclerites around ejaculatory duct opening (Fig. 15). Ring sclerites present. Spermatheca. Bulb with a long and short process.

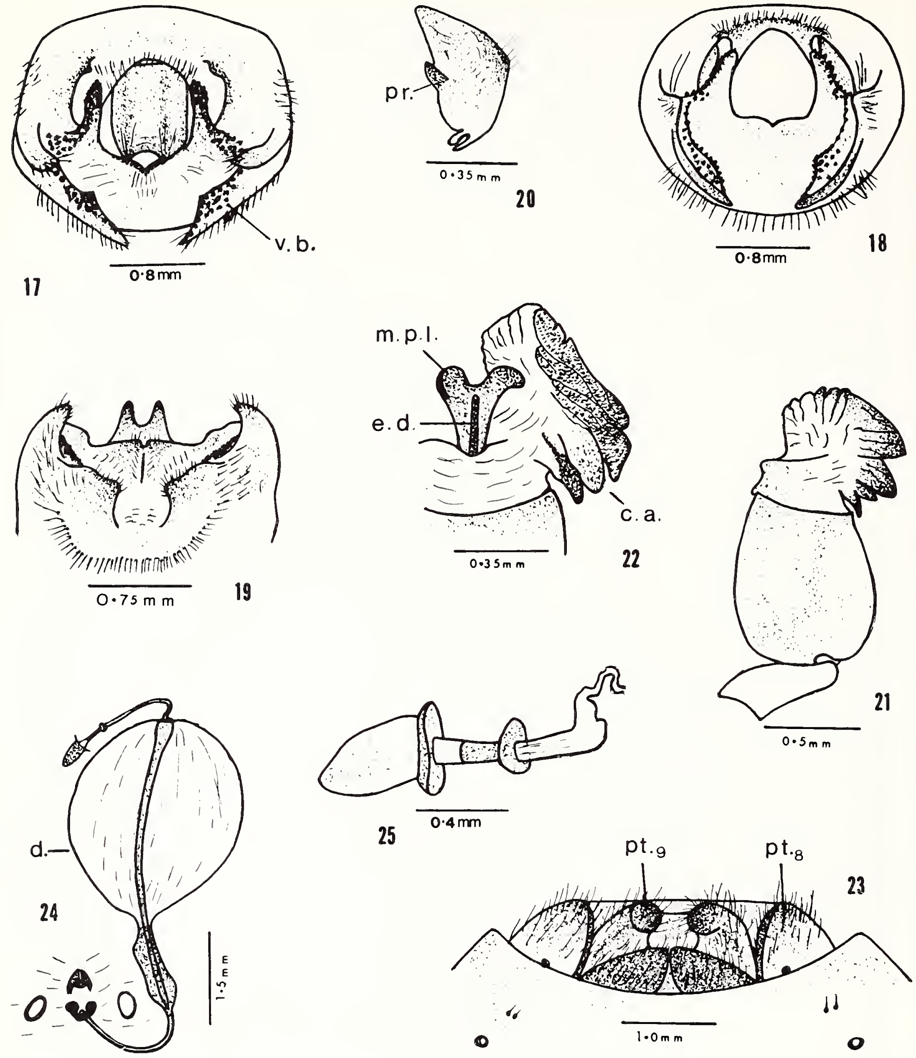
Distribution. Brazil (Goiaz, Encruzilhada; Vicosa; São Paulo; Teffe; Mato Grosso; Barroso; Diamantino); Peru; Colombia; Surinam; Bolivia; Ecuador; Guatemala; Panama; Guyana.

Arocera splendens (Blanchard, 1841)
Figs. 17–25

Pentatoma splendens Blanchard, 1841:148.
Pentatoma splendida Dallas, 1851:256.
Pentatoma principalis Stal, 1855:182; 1856:58.
Arocera principalis Stal, 1862:107; Becker and Grazia-Vieira, 1971:12.
Arocera splendens Stal, 1872:38; Distant, 1880:pl. 7, figs. 13–17; Kirkaldy, 1909: 110; Becker and Grazia-Vieira, 1971:12.

Type. Type of *Pentatoma splendens* not located.

Diagnosis. HEAD: Dark metallic green or blue dorsally, reddish brown ventrally. Eyes dark brown. Ocelli reddish brown. Antennae fuscous, segments 2 and 3 flattened. Rostrum reaching hind coxae, dark brown. THORAX: Pronotum dark metallic green



Figs. 17–25. *A. splendens.* 17. Pygophore, dorsal view. 18. Pygophore, caudal view. 19. Pygophore, ventral border. 20. Right clasper, ental view. 21. Aedeagus, lateral view. 22. Aedeagus, ventral view. 23. Female genitalia. 24. Spermatheca. 25. Spermathecal bulb. Conjunctival appendage (c.a.), dilation (d.), ejaculatory duct (e.d.), median penial lobe (m.p.l.), process (pr.), paratergite 8 (pt.8), paratergite 9 (pt.9), ventral margin (v.b.).

with anterior and anterolateral margins outlined in red; scutellum dark metallic green. Hemelytra, dark metallic green, coria with costal margin red basally. Pleura and sterna red suffused with brown. Legs. Coxae reddish pink; trochanters basally red darkening to brown apically; femora brown; tibiae and tarsi dark brown. ABDOMEN:

Connexiva alternated red and dark brown; sterna red suffused with brown, lateral margins of segments 3–7 with a bright red oblong spot.

Male genitalia. Pygophore with ventral margin divided into two sections, upper margin consisting of two stout arms, one on each side projecting across the lateral margins of the pygophoral opening; these arms covered on their apices and outer margins with a series of small tubercles. Lower margin developed into two flat plates meeting centrally in a deep U-shaped median emargination, between these plates lies the inferior ridge which is broadly U-shaped with a small median notch forming the ventral border to genital opening. Inner margins of lower plates covered with small heavily sclerotized tubercles bearing fine setae. Dorsal margin broadly arched, forming a small blunt horn-like process at its junction with ventral margin on each side. Proctiger tube-like, distal margin produced into two upturned horns. Claspers small, triangular, bearing a small thumb-like process half way along outer margin and numerous fine setae on margins. Aedeagus. Theca small, weakly sclerotized. Conjunctival appendages large, basally membraneous, apically divided into 4 finger-like lobes, apical two broader and larger than basal two, all lobes moderately sclerotized, upper 3 lobes covered in small fine teeth. Median penial lobes sclerotized and completely enclosed by conjunctival appendages, basally fused into a solid stem, apically divided into two bluntly rounded curved flattened arms. Ejaculatory duct a small sclerotized straight tube lying within median penial lobes.

Female genitalia. Externally similar to *A. elongata,* however 8th paratergites with a vertical side on inner surface forming a concavity; 9th paratergites deeply impressed centrally forming the anterior wall of concavity; 1st gonocoxae ovoid, with a posterior fringe of hairs; 2nd gonocoxae fused and lying vertically at right angles to 1st gonocoxae, facing posteriorly. Ring sclerites and small accessory sclerites present round entrance to spermathecal duct. Spermatheca. Reservoir apically spherical with a short sclerotized sausage-like base. Pump with distal and proximal flanges; bulb simple, dome-like.

Variations. Color varies from light metallic green to metallic blue or dark brown with a slight metallic green sheen dorsally. Anterior margins of pronotum ventrally outlined in yellow brown. Abdominal sterna may be dark brown or yellow brown, sometimes with 3 patches of red or yellow brown centrally on each segment; lateral spots may be yellow brown.

Distribution. El Salvador; Mexico; Guatemala; Ecuador; Colombia; Venezuela; Panama; British Honduras; Tobago; Jamaica; Peru.

Arocera nigrorubra (Dallas, 1851)
Figs. 26–36

Strachia nigrorubra Dallas, 1851:267.

Strachia quadripunctata Signoret, 1851:337, pl. 10.

Arocera nigrorubra Stal, 1872:38; Kirkaldy, 1909:109; Rolston, 1976:3.

Arocera affinis Distant, 1880:74, pl. 7; Kirkaldy, 1909:109; Rolston, 1976:3. **New Synonymy.**

Arocera altivola Distant, 1890:337, pl. 31; Kirkaldy, 1909:109; Rolston, 1976:3. **New Synonymy.**

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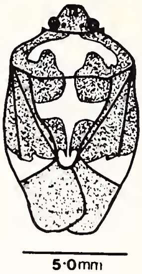

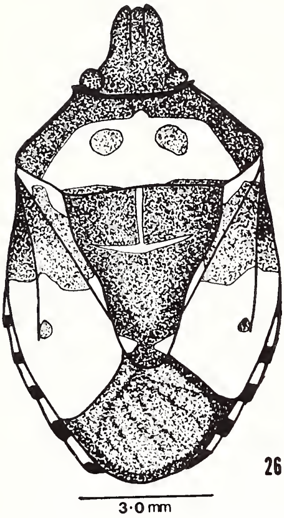

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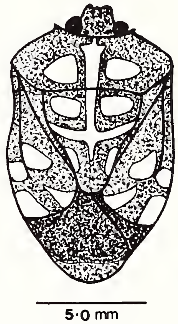

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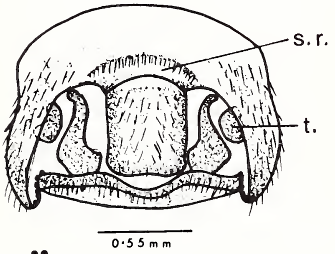

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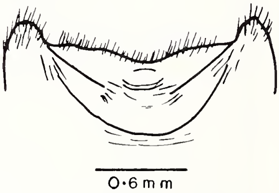

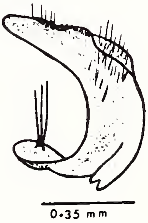

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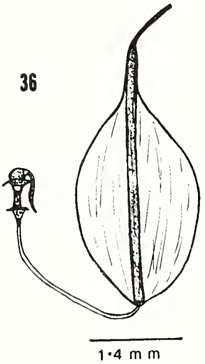

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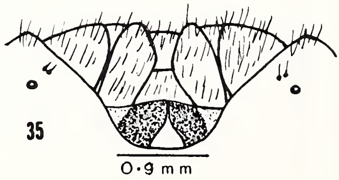

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Arocera chiriquensis Distant, 1890:337, pl. 30; Kirkaldy, 1909:109; Becker and Grazia-Vieira, 1971:11; Rolston, 1976:3. **New Synonymy.**

Arocera contralineata Piran, 1955:82; Becker and Grazia-Vieira, 1971:11. **New Synonymy.**

Strachia placens Walker, 1867:316.

Arocera placens Distant, 1900:391; Kirkaldy, 1909:110; Rolston, 1976:3. **New Synonymy.**

Arocera protea Distant, 1880:73, pl. 7; Kirkaldy, 1909:110; Rolston, 1976:3. **New Synonymy.**

Types. Holotype *Strachia nigrorubra* Dallas ♂, British Museum (Nat. Hist.). Type seen. The following types in the British Museum (Nat. Hist.) were also examined: *Arocera affinis* Distant ♀; *Arocera altivola* Distant ♂; *Arocera chiriquensis* Distant ♂; *Strachia placens* Walker ♂. The holotype of *Arocera contralineata* Piran could not be obtained, however a paratype in the collection of the University Nacional de la Plata was examined.

Comment. This proved to be an exceedingly difficult species to define. It consists of a maze of color patterns which actually integrade with *A. spectabilis.* There are, however, overall differences between these insects and their congeners in size and in the male genitalia to warrant retaining species status for these forms. I suspect many of the color patterns are local populations and a great deal of ecological work needs to be done on this species to determine the limits of each color morph.

Diagnosis. HEAD: Dorsally and ventrally black; jugae swollen apically and raised. Eyes brown. Ocelli red. Antennae black, segments 2, 3 and 4 flattened. Rostrum black, apex exceeding hind coxae. THORAX: Pronotum with a broad black margin around outer margins, central portion bright red with two black spots. Scutellum black with two red spots one on each side near apex; elytra bright red with broad black bands proximad, two small black spots in centre of distal red portion. Pleura, sterna and legs black. ABDOMEN: Connexiva alternated red and black; sterna red with a central broad black band and small black spots surrounding each spiracle; further oblong black spots found in the disto-lateral corner of each segment.

Male genitalia. Pygophore with ventral margin almost straight with a shallow median emargination, a triangular depressed area found below margin giving the appearance of a vertical wall when pygophore is in situ. Fine setae on margins and surface of pygophore. Dorsal margin with a superior ridge and a pair of small oval well sclerotized tubercles, one on each side, lying beneath the border. Claspers L-shaped, apex produced into a finger-like process, basally flattened and curved up, bearing a tuft of long setae, fine setae and serrations on outer margin. Proctiger box-like, bearing numerous fine setae. Aedeagus similar to *A. spectabilis.*

Female genitalia. Similar to *A. spectabilis,* paratergites 9 somewhat more slender; 1st gonocoxae with inner margins sinute (generally straight in *A. spectabilis*). Spermatheca similar to *A. spectabilis.*

⟵

Figs. 26–36. *A. nigrorubra.* 26–29. Dorsal view showing color patterns. 30. Pygophore, dorsal view. 31. Pygophore, ventral border. 32. Right clasper, ental view. 33. Aedeagus, lateral view. 34. Aedeagus, ventral view. 35. Female genitalia. 36. Spermatheca. Conjunctival appendage (c.a.), median penial lobe (m.p.l.), superior ridge (s.r.), tubercle (t.).

Variations. There are several color patterns, the basic type of each will be described although various integrades between each can readily be found.

1. Color pattern basically similar to that of *A. spectabilis,* color background may vary from bright yellow to deep orange; head bicolored above and below, pattern variable.
2. Prothorax with a broad orange T-shaped mark; scutellum with an orange cross; distal portion of elytra with irregular orange macula. Abdominal sterna may lack central maculae except on 7 (Fig. 28).
3. Prothorax and scutellum with a large cross outlined in brown; areas on each side of cross orange or brown margining into dark brown across top of prothorax; hemelyra with more orange or reddish orange areas. Abdominal sterna with small central maculae and no maculae around spiracles. Some specimens have only a broad brown band along the distal margin of each sternum (Fig. 27).
4. As above but intervening dark brown or black, leaving cross in yellow or red, apical portion of cross swollen. Abdominal sterna without maculae around spiracles (Fig. 29).
5. Dorsum uniformly yellow to red excepting black on part or all of head, anterior margin of pronotum and small macula on disk of costal margin of coria.

Distribution. Peru; Mexico; Ecuador; Brazil (Rio de Janeiro, Bahia, Mato Grosso, Obidos, Manaus, Teffe); Colombia; Cuba; Guatemala; Paraguay; Argentina; Panama; Haiti; Jamaica; St. Lucia; Trinidad.

Arocera rufifrons (Dallas, 1851)

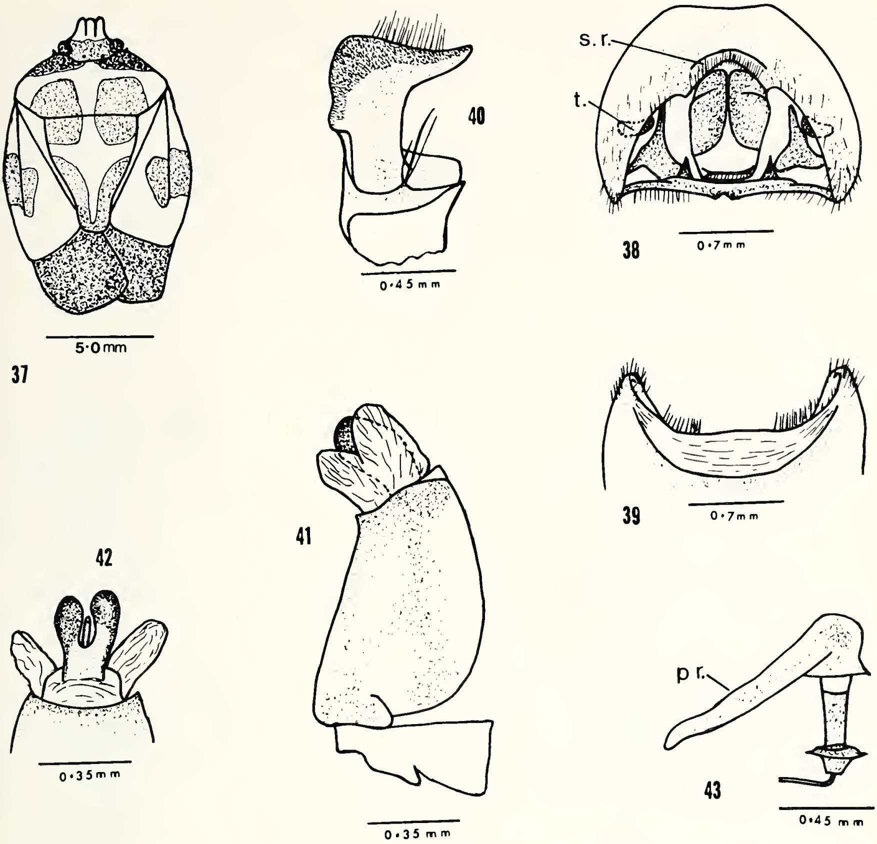
Figs. 37–43

Strachia rufifrons Dallas, 1851:267.
Arocera rufifrons Stal, 1872:38; Kirkaldy, 1909:110; Rolston, 1976:3.

Type. Two syntypes, both ♀, British Museum (Nat. Hist.). Types seen. I select the specimen with the label 85a as LECTOTYPE, the other specimen labelled 85b, is the PARALECTOTYPE.

Diagnosis. HEAD: Dorsally, apical ⅔ scarlet, basal ⅓ dark brown, ventrally scarlet. Jugae raised along outer margins with a series of diagonal striae (sometimes absent); margins of jugae continued inwards to form a short ridge in front of each eye. Eyes brown. Ocelli amber. Antennal segment 1 red, 2–5 dark brown; 2–4 flattened. Rostrum extending well beyond mid coxae, segment 1 red, 2–4 brunneus. THORAX: Pronotum scarlet with black maculae in anterior angles; and two oblong black patches in center of pronotum extending onto scutellum forming 2 large oblong maculae. Scutellum scarlet with two further black maculae extending midway to near apex—these merge with maculae on the hemelytra to form 2 bands separated centrally across the mid portion of the species. Pleura mottled reddish brown. Legs. Coxae, trochanters brunneus; remaining segments mid-brown. ABDOMEN: Connexiva and sterna scarlet, with paired black spots on each side laterally on segments 3–6.

Male genitalia. Similar to *A. spectabilis.* Pygophore with ventral margin straight, impressed below margin forming a vertical wall when pygophore in situ. Superior ridge not as well defined as in *A. spectabilis* tubercles mainly concealed below dorsal margin. Claspers, L-shaped with finger-like process apically; upper margin smoother



Figs. 37–43. *A. rufifrons.* 37. Dorsal view. 38. Pygophore, dorsal view. 39. Pygophore, ventral border. 40. Right clasper, ectal view. 41. Aedeagus, lateral view. 42. Aedeagus, dorsal view. 43. Spermathecal bulb. Process (pr.), superior ridge (s.r.), tubercle (t.).

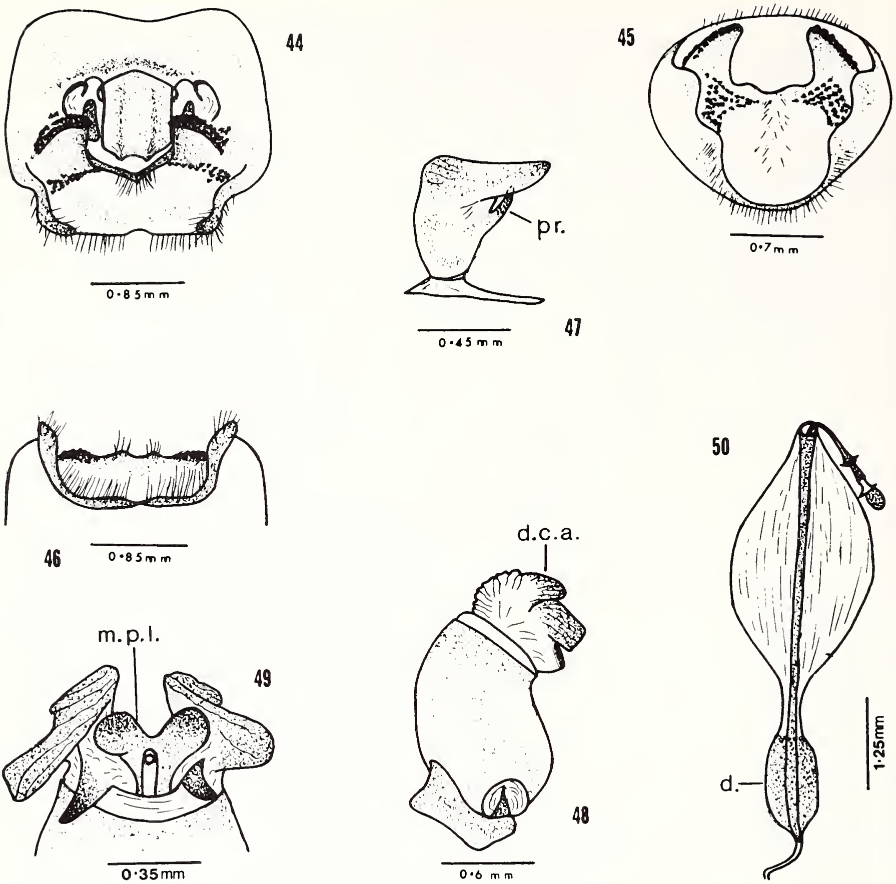
than in *A. spectabilis.* Aedeagus similar to *A. spectabilis,* median penial lobes more rounded and club-like.

Female genitalia. External genitalia similar to *A. spectabilis.* Spermathecal bulb with one process.

Variations. Background color may be orange or yellow brown. The proportion of reddish and brownish color on head is variable. Some specimens have no maculae on the abdominal sterna but spots at lateral margins; others have a large central spot as well as lateral maculae. The color of the dorsal maculae can vary from black to faded smoky-brown.

Distribution. Colombia; Peru; Belize; Mexico; Brazil.

Note. This species is very close to *A. spectabilis* and may with further biological information prove to be only a color variant of that species.



Figs. 44–50. *A. rufonotata.* 44. Pygophore, dorsal view. 45. Pygophore, caudal view. 46. Pygophore, ventral border. 47. Right clasper, ectal view. 48. Aedeagus, lateral view. 49. Aedeagus, ventral view. 50. Spermatheca. Dilation (d.), dorsal lobe of conjunctival appendage (d.c.a.), median penial lobe (m.p.l.), process (pr.).

Arocera rufonotata Stal, 1861
Figs. 44–50

Arocera rufonotata Stal, 1861:140; Distant, 1880:pl. 7; Kirkaldy, 1909:110.

Type. Holotype. Naturhistoriska Riksmuseet, Stockholm. Type seen.

Diagnosis. HEAD: Very dark metallic green dorsally, centrally dark brown with patches of red on either side of bucculae. Jugae slightly raised apically with distinct diagonal striae. Eyes brown. Ocelli amber. Antennae black, segments 2 and 3 flattened. Rostrum reaching to or slightly past metacoxae, dark brown. THORAX: Prothorax dark metallic green with red spots at anterior angles and lateral angles and one red spot centrally. Scutellum dark metallic green with an elongate red spot in lateral angles. Hemelytra dark metallic green with an elongate red spot centrally at distal margin of corium. Ventral surface of thorax black with red spots at anterior and lateral angles of prothorax; base of proepisternum and proepimeron red; mesepisternum above metacoxae, red. Metepisternum with red patch above metacoxae extending below evaporative area to posterior and lateral margins of segment. ABDOMEN: Connexiva alternated red and black, sterna black with red oblong spots at lateral margins of segments 3–7 and a further two large red spots, one on either side of the mid line on segments 3–6, widely separate on 3, less widely separated on 6.

Male genitalia. Pygophore very similar to *A. rufolimbata,* shape of inferior ridge somewhat different, deeper and without central notch. Clasper similar to *A. rufolimbata,* finger-like process longer, narrower; apex of clasper less acute than in *A. rufolimbata.* Aedeagus. Conjunctival appendages tri-lobed; dorsal lobe bluntly rounded, sclerotized; middle lobe oblong, sclerotized and with minute spines over entire surface; lower lobe acute, heavily sclerotized on upper surface; base of appendages membraneous. Median penial lobes fused basally, apically developed into two broad rounded lobes, heavily sclerotized. Ejaculatory duct short, straight, enclosed by median penial lobes.

Female genitalia. External genitalia similar to *A. splendens.* Spermatheca similar to *A. splendens,* dilation with small thickened base somewhat differently shaped from that of *A. splendens.*

Variations. Some specimens appear almost metallic dark brown and the dorsal spots may be orange-brown; ventral surface may be orange-brown with no spotting on the abdominal sterna. In other specimens the ventral surface is brown, the two central spots of the abdomen become diffuse, giving the abdomen a mottled brown and red appearance. Some specimens have 2 central red spots on abdominal sternum 7.

Distribution. Mexico.

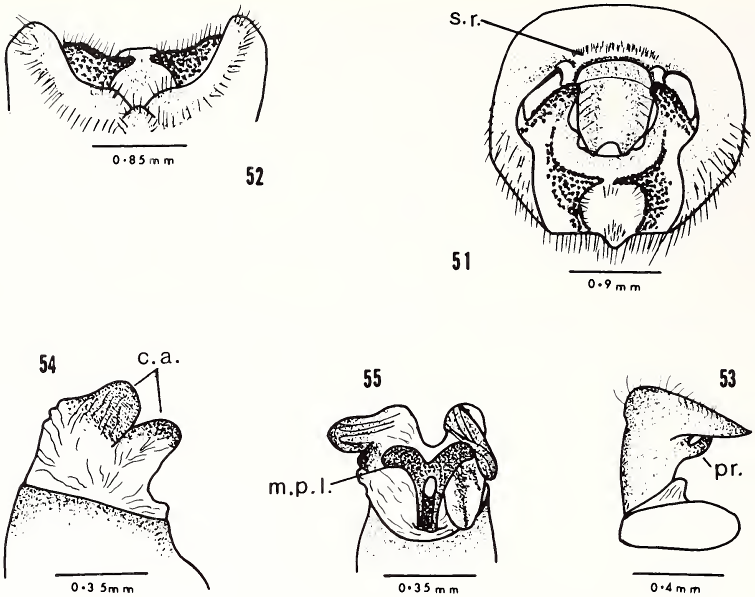
Arocera rufolimbata Stal, 1872
Figs. 51–55

Arocera rufolimbata Stal, 1872:38; Kirkaldy, 1909:110; Monte, 1945:269; Grazia, 1977:163.

Type. Holotype. Naturhistoriska Riksmuseet, Stockholm. Type seen.

Diagnosis. HEAD: Dorsally greenish black overlaid with a metallic green sheen, ventrally buff; jugal margins raised anteriorly, diagonal striae on jugae and tylus. Eyes and ocelli brown. Antennae black, segments 2–4 flattened. Rostrum slightly surpassing metacoxae; segment 1 buff, 3–4 dark brown. THORAX: Pronotum dark greenish-black with slight metallic sheen; a yellow stripe running right round outer margin of pronotum and extending down outer margins of elytra for ⅓ their length. Scutellum and elytra same color as pronotum. Pleura and sterna testaceous. Legs. Coxae, trochanters, femora testaceous; tibiae and tarsi dark brown. ABDOMEN: Connexiva testaceous; sterna yellow.

Male genitalia. Pygophore similar in some respects to *A. colombiana.* Ventral



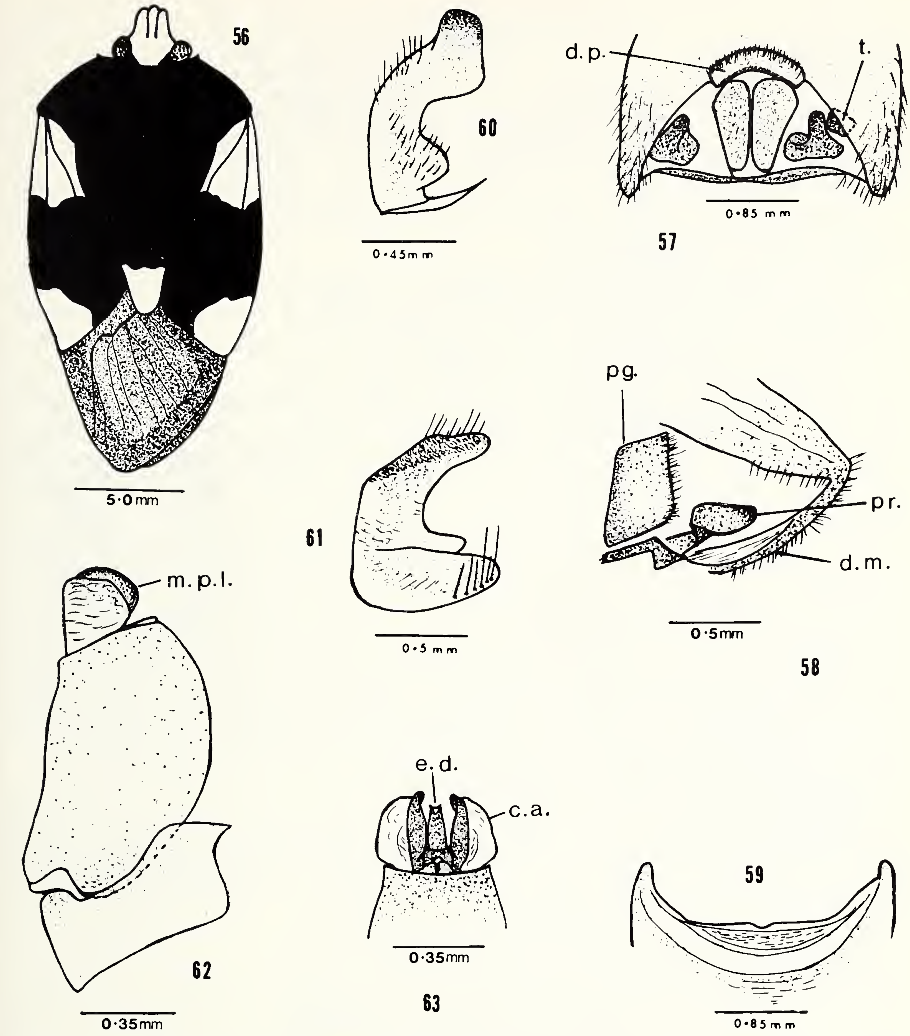
Figs. 51–55. *A. rufolimbata.* 51. Pygophore, dorsal view. 52. Pygophore, ventral border. 53. Left clasper, ectal view. 54. Aedeagus, lateral view. 55. Aedeagus, ventral view. Conjunctival appendage (c.a.), median penial lobe (m.p.l.), process (pr.), superior ridge (s.r.).

margin developed into two large horn-like processes, one on each side, laterally covered with small heavily sclerotized tubercles; centre of margin deeply emarginate and crenulated. Inferior ridge shallow forming a flattened and somewhat depressed area below ventral margin, bearing two distinct patches of tubercles one on each side produced into two acute ridges centrally and separated by a short gap. Dorsal margin with a deep oval depression one on either side of a narrow superior ridge. Numerous long stout setae found on margins of pygophore. Proctiger box-like well sclerotized, caudally expanded into two blunt projections. Claspers L-shaped, apically acute and with a distinct thumb-like process near apex of stem. Aedeagus. Theca short sausage-like. One pair of conjuntival appendages divided into two lobes, upper lobe oblong sclerotized and covered with fine spines; lower lobe bluntly rounded, sclerotized apically; basically both appendages membraneous. Median penial lobes Y-shaped, basally fused, apically curved and cylindrical. Ejaculatory duct short, tubular and sclerotized.

Female genitalia. Similar to *A. splendens.* Spermatheca also similar.

Variations. Some specimens may be dorsally distinctly reddish brown with abdominal sterna black with 3 red spots centrally on segments 3–6; and 2 centrally on 7; lateral margins of segments 2–7 with broad red maculae. The abdominal sterna of other specimens may be patterned in the same way with yellow or orange. Reductions of this pattern are also found.

Distribution. Colombia; Venezuela; Brazil.



Figs. 56–63. *A. elongata.* 56. Dorsal view. 57. Pygophore, dorsal view. 58. Pygophore, dorsal view, right clasper removed. 59. Pygophore, ventral border. 60. Right clasper, ectal view. 61. Right clasper, ventral view. 62. Aedeagus, lateral view. 63. Aedeagus, dorsal view. Conjunctival appendage (c.a.), dorsal margin (d.m.), depression (dp.), ejaculatory duct (e.d.), median penial lobe (m.p.l.), proctiger (pg.), process (pr.), tubercle (t.).

Arocera elongata Showalter, 1929
Figs. 56–66

Arocera elongata Showalter, 1929:33, pl. V, and p. 40; Van Duzee, 1937:25–27; Piran, 1962:5; Becker and Grazia-Vieira, 1971:11; Sabrosky, 1972:87–88.
Arocera repleta Van Duzee, 1931:94. **New Synonymy.**

Types. Lectotype No. 52107, U.S. National Museum (designated Sabrosky, 1972). Type seen. The holotype of *Arocera repleta* Van Duzee, California Academy of Sciences has also been examined.

Diagnosis. HEAD: Bright orange-red dorsally except for two triangular black patches running across ocelli, ventrally orange-red; jugae slightly swollen apically and recurved; diagonal striae near base. Antennae. Segment 1 orange, 2–5 black, segments 2–4 flattened. Rostrum projecting well beyond hind coxae; segment 1 orange, 2–5 black. THORAX: Pronotum black; scutellum black with orange-red tip; hemelytra with orange maculae at base and apical corners of corium; black in between; membrane black; pleura black except for an orange band at lateral margin, sterna black; legs black. ABDOMEN: Connexiva red; sterna orange with a black band at tip of abdomen, covering segment 7 and small sections of 6.

Male genitalia. Pygophore with ental margin widely excavated forming two blunt prominences one at each outer corner. Dorsal border deeply excavated bearing centrally a crescent-shaped depression. Proctiger oblong, swollen basally, divided into two plates down centre. Pygophore and proctiger bearing numerous fine setae. Inner dorsal margin of cup bearing a small rounded club-like process one on each side. Claspers L-shaped with broad base, bearing a number of setae on outer margin. Aedeagus similar to *A. spectabilis.* Median penial lobes broadly hook-shaped, flattened, sclerotized on outer dorsal margins, basally fused by a short cross bar.

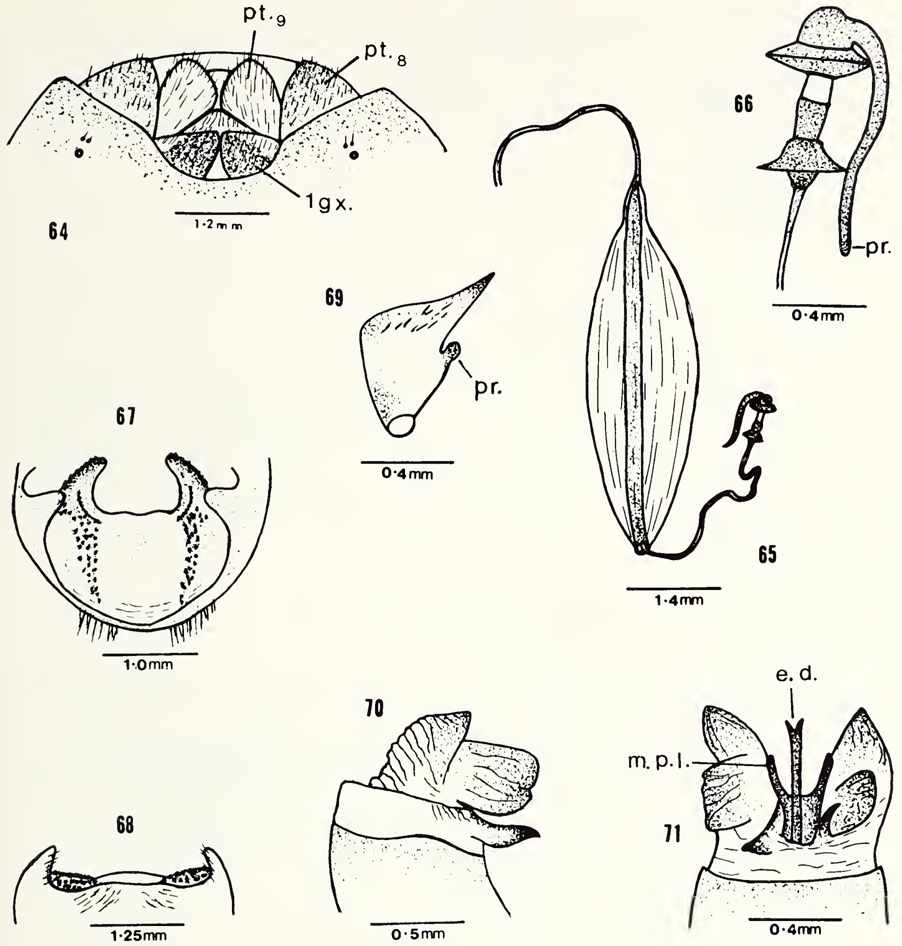
Female genitalia. Similar to *A. spectabilis.*

Variations. Small black spots may be found on lateral margins of abdominal segments 3–5. A distinct color variety exists which is dorsally bright orange-red or orange-brown; some specimens have varying degrees of black forming maculae on the prothorax/scutellum and black spots on hemelytra.

Distribution. Panama; Ecuador; Peru; Venezuela; Bolivia; Colombia. The bright orange-red variety appears to be restricted to Panama.

Acrocera verdana, new species
Figs. 67–71

Description. HEAD: Dorsally metallic green, ventrally dark brown suffused with red. Jugae only slightly raised anteriorly with numerous diagonal striae. Eyes black. Ocelli amber. Antennae black, segments 2 and 3 flattened. Rostrum extending to hind coxae, black. THORAX: Pronotum metallic blue-green with a broad brick-red band running right around outer margin from lateral angles, this band extends down along the outer margins of the hemelytra. Scutellum and remainder of hemelytra metallic blue-green with an irregular brick-red broad stripe running centrally from base of scutellum to the tip. Membrane metallic blue-green. Pleura iridescent black with a broad brick-red band running along outer margins of propleura down the lateral margins of the meso- and metapleura and along basal margin of metapleuron.



Figs. 64–71. 64–66. *A. elongata.* 64. Female genitalia. 65. Spermatheca. 66. Spermathecal bulb. 67–71. *A. verdana.* 67. Pygophore, caudal view. 68. Pygophore, ventral border. 69. Right clasper, ectal view. 70. Aedeagus, lateral view. 71. Aedeagus, dorsal view. Ejaculatory duct (e.d.), 1st gonocoxa (1gx.), process (pr.), paratergite 8 (pt.8), paratergite 9 (pt.9).

Legs dark reddish brown. ABDOMEN: Connexiva brick-red, sterna iridescent black with a broad brick-red band along lateral margins of abdomen.

Male genitalia. Pygophore similar in many respects to *A. rufonotata.* Inferior ridge not as deeply excavated and forming a shallower depression behind ventral margin. A series of small tubercles running from large peg-like structures on lateral margin inside this depression, position of these tubercles is different from those found in *A. splendens* and *A. rufonotata.* Clasper very acutely pointed with a short thumb-like process. Aedeagus. Conjunctival appendages tri-lobed as in *A. rufonotata,* ventral most appendages heavily sclerotized, more acute than in *A. rufonotata.* Median penial lobes, slender arms fused to a broad base forming a Y; ejaculatory duct long, straight, extending well beyond median penial lobes (unlike any other related species).

Female genitalia. External genitalia similar to *A. splendens,* spermatheca similar to *A. rufonotata.*

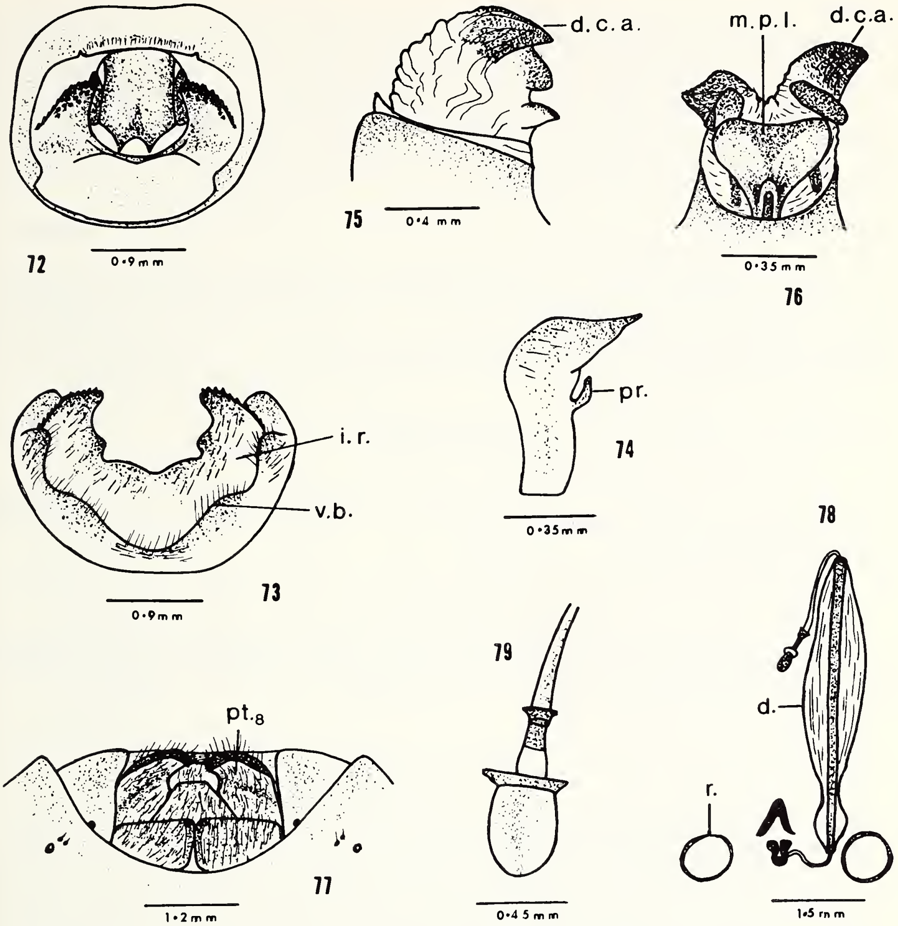
Holotype. ♂, labeled Panama: Chiriqui Pr., 3 km W. Cerro Punta, 80°51′N, 82°36′W, 8-VI-77. Deposited in U.S. National Museum. Type No. 100413.

Paratypes. PANAMA: ♀, Chiriqui Dist., Renacimiento, Sta. Clara, 17-V-77, R. Hartman; ♀, same data, except July 5, 1977; ♀, same data, except 16–20-VI-77; ♂, same data, except 4-VII-77; ♀, same data, except 17-V-77; 2♂♂, same data, except 5-VII-77; ♀, Chirique, Boquette, 1,250 m, 8°48′N, 82°26′W, 14-X-1976, H. Wolda; ♀, same data, except 26-V-1977; ♀, Chirique Dist., Renacimiento, Oeste Clara, 5500′, 16–20 Feb. '77, lights, A. & E. Thurman; 2♀♀, Chiriqui Dist., Renacimiento, 5500′, 18–22-V-77, at lights, Engleman and Matos; ♀, Chiriqui Pr., 3 km W. Cerro Punta, 8°51′N, 82°36′W, 1,700 m, 8-VI-77 [In H. Dodge Engleman collection]. COSTA RICA: ♀, Guanacaste, V.17.1932, A. Alfaro, J. C. Butz Collection, 1961; ♀, Juna Vimas, Collection Wm. Schausz [In U.S.N.M.]. PANAMA: ♂, Barriles, Chiriqui, 1-31-31, M. E. McLellan; ♀, vicinity Boqueta, VIII-39, J. R. Slevin [In California Academy of Sciences].

Arocera colombiana, new species
Figs. 72–79

Description. HEAD: Dorsally black with a slight metallic green sheen; ventrally dark brown suffused with cream centrally; jugae with lateral angles slightly turned up with horizontal striae. Eyes, ocelli brown. Antennae dark brown; segments 2, 3 and 4 flattened. Rostrum extending to hind coxae, first segment brown suffused with yellow, segments 2–4 brown. THORAX: Pronotum anterior portion with a broad yellow band extending along lateral margins, remainder black with a central brown patch. Scutellum with a central brown patch surrounded by black. Hemelytra with a yellow streak on costal margins of coria extending about ⅓ way along, remainder black surrounding a central triangular patch of brown. Propleura dark brown with anterior margins yellow; meso- and metapleura dark brown. Legs chocolate brown. ABDOMEN: Connexiva alternated yellow and brown; sterna chocolate brown with 4 large yellow spots one on each lateral margin and two on either side of mid line; widely separate on segment 3, closer together on 7.

Male genitalia. Pygophore with ventral margin deeply excavated and bearing a well developed inferior ridge forming an inner vertical wall facing caudad. Central margin of inferior ridge deeply excised, laterally on each side developed into a stout well sclerotized horn covered with tubercles and short setae. Dorsal margin broadly arched bearing medianly a narrow ill-defined superior ridge. Patches of long setae on margins of pygophore and on face of inferior ridge. Proctiger well sclerotized box-like, caudal margin produced into two short acute tails. Claspers small triagular with a finger-like process on the inner margins; claspers firmly embedded into wall of pygophore. Aedeagus. Theca small squat. Conjunctival appendages tri-lobed, lobes apically bluntly pointed, upper and middle lobes covered with small spines, lower lobes sclerotized on inner surfaces. Sclerotized median penial lobes fused into a flattened collar-like



Figs. 72–79. *A. colombiana.* 72. Pygophore, dorsal view. 73. Pygophore, ventral border. 74. Right clasper, ectal view. 75. Aedeagus, lateral view. 76. Aedeagus, ventral view. 77. Female genitalia. 78. Spermatheca. 79. Spermathecal bulb. Dilation (d.), dorsal lobe of conjunctival appendage (d.c.a.), inferior ridge (i.r.), median penial lobe (m.p.l.), process (pr.), paratergite 9 (pt.9), ring sclerite (r.), ventral margin (v.b.).

structure surrounding base of ejaculatory duct, latter a short tube moderately sclerotized.

Female genitalia. Paratergites 8 triangular. Paratergites 9 hook-shaped, deeply impressed centrally giving the paratergite a twisted appearance. Swollen apically and covered with long stout setae. 1st gonocoxae oblong heavily sclerotized, covered with stout setae. 2nd gonocoxae fused into a trapezoid plate lying vertically above 1st gonocoxae. Ring sclerites and accessory sclerites present internally. Spermatheca. Dilation swollen into a bulb basally; spermathecal pump without appendages.

Variations. Brown areas on pronotum scutellum and elytra may be extensive to the extent of eliminating most of the black areas leaving only a thin black line around scutellum and outer margins of elytra. Sterna may be completely orange-red with evaporative areas black. Spots on abdominal sterna may be red with black maculae centrally. Abdominal sterna may also be yellow with dark brown spots around spiracles and brown maculae centrally. Integrades between these types may also be found.

Holotype. ♂, labelled Venez. Deposited in the U.S. National Museum. Type No. 100414.

Paratypes. VENEZUELA: ♀, (a) Merida, (b) W. Robinson bequest 1929; ♀, H. Pittier; ♀, Rancho Grande Nr. Marcay, Ven. 8-V-1946. COLOMBIA: ♂, (a) Pres. by the Hono. Apolinar-Maria, (b) Fusagasuga, S. A. Rep. Col. 1915; ♀, same data; ♀, (a) Muzo, S. A. Colombia, (b) Pres. by Hono Apolinar-Maria. [All in U.S.N.M.].

Nomina dubia

Arocera fasciativentris Breddin, 1901

The type of this species could not be located. From Breddin's description it is probably synonymous with *A. spectabilis.*

Arocera capitata Breddin, 1901

The type of this species could not be located. From Breddin's descriptions this species is probably synonymous with *A. spectabilis.*

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LITERATURE CITED

Amyot, C. J. B. and A. Serville. 1843. Histoire Naturelle des Insectes. Hemipteres. Roret, Paris, LXVI + 675 + 6 pp., 12 pls.

Becker, M. and J. Grazia-Vieira. 1971. Contribuicao as conhecimento da superfamilia Pentatomoidea na Venezuela (Heteroptera). Iheringia (Zool.) 40:3–25.

Becker, M. and J. Grazia-Vieira. 1977. The Pentatomoidea (Heteroptera) collected in French Guiana by the expedition of the Museum National d'Histoire Naturelle. Ann. Soc. Ent. Fr. (N.S.) 13:53–67.

Blanchard, E. 1841. Histoire Naturelle des Insectes. Orthopteres, Neuropteres, Hemipteres, Hymenopteres, Lepidopteres et Dipteres. Dumenil, Paris, 3 vols., 3 + 85–212 pp.

Burmeister, H. C. C. 1835. Handbuch der Entomologie, Bd. 2. Berlin, ii + 400 + 4 pp., 2 pls.

Dallas, W. S. 1851. List of Specimens of Hemipterous Insects in the Collection of the British Museum. Brit. Mus. Pub. Pt. 1, 592 pp.

Distant, W. L. 1880–1893. Biologia Centrali-Americana. Insecta, Rhynchota, Vol. 1. London, XX + 462 pp., 39 pls.

Distant, W. L. 1900a. Rhynchotal notes—iv. Heteroptera:Pentatominae (Part). Ann. Mag. Nat. Hist. (7)5:386–397.

Distant, W. L. 1900b. Revision of the Rhynchota belonging to the family Pentatomidae in the Hope collection of Oxford. Proc. Zoo. Soc. London (1900):800–824.

Drury, D. 1782. Illustrations of Natural History, Vol. II. B. White, London.

Froeschner, R. C. 1981. Heteroptera or true bugs of Ecuador: a partial catalog. Smithsonian Contrib. Zool. 322:i–iv, 1–147.

Gistel, J. 1848. Naturgeschichte des Thierreichs fur hohere Schulen. Zweite Auflage. Scheitlin & Krais, Stuttgart, 216 pp., 32 pls.

Grazia, J. 1977. Revisao dos Pentatomineos citados no "Quarto catalogo dos insetos que vivem nas Plantas do Brasil." (Hemiptera—Pentatomidae—Pentatomini). Dusenia 10(3): 161–174.

Haglund, C. J. E. 1868. Hemiptera nova. Stett. Ent. 29:157.

Kirkaldy, G. W. 1909. Catalogue of the Hemiptera (Heteroptera) Vol. 1. Cimicidae. Felix Dames, Berlin, XL + 392 pp.

Lethierry, L. and B. Severin. 1893. Catalogue General des Hemipteres Vol. 1. Pentatomides. Brussels and Berlin, IX + 286 pp.

Monte, O. 1945. Notas sobre alguns pentatomideos. Rev. Agr. São Paulo 20:269–273.

Perty, J. A. M. 1833. Delectus animalium articulatorium quae in itinere per Brasiliam. Fasc. 3. Monachii. Pp. 125–224, pls. 25–40.

Piran, A. A. 1955. *Arocera contralineata,* especie neuva de la fauna Argentina (Hemiptera, Pentatomidae). Neotropica 1:81–84.

Piran, A. A. 1962. Hemiptera neotropica V. Notas sobre sistematica y Zoogeografia de Pentatomidae. Acta Zool. Lilloana 18:5–10.

Piran, A. A. 1963. Hemiptera neotropica VIII. Especies neuvas o poco conocidas de las jauans de Colombia, Peru, Brasil, Bolivia y Paraguay. Physis 24(67):107–112.

Piran, A. A. 1966. Hemiptera Neotropica X. Rev. Soc. Ent. Arg. 28:85–89.

Rolston, L. H. 1976. An evaluation of the generic assignment of some American Pentatomini (Hemiptera: Pentatomidae). J. New York Ent. Soc. 84(1):2–8.

Sabrosky, C. W. 1972. The case of the elusive author. Proc. Ent. Soc. Wash. 74:87–88.

Showalter, W. J. 1929. Insects: exploring the wonders of the insect world. Nat. Geog. Mag. (July):1–90.

Signoret, V. 1851. Description de nouvelles especes d'Hemipteres. Ann. Soc. Ent. Fr. (2)9: 329–348.

Spinola, M. 1837. Essai sur genres d'insectes appartenants a l'ordre des Hemipteres L., on Rhyngotes Fabr. et a la section des Heteropteres, Dujour. Chez Yves Gravier, Genes, 383 + 16 pp.

Stal, C. 1854. Nya Hemiptera. Ofversigt Svenska Vet.-Akad. Forh. 12:27–47.

Stal, C. 1855. Nya Hemiptera. Ofversigt Svenska Vet.-Akad. Forh. 12:181–192.

Stal, C. 1856. Hemipterologiska bidrag. Ofversigt Svenska Vet.-Akad. Forh. 13:51–68.

Stal, C. 1861. Miscellanea Hemipterologica. Stett. Ent. Zeit. 22:129–153.

Stal, C. 1862. Hemiptera Mexicana enumeravit speciesque novas descripsit. Stett. Ent. Zeit. 23:81–118.

Stal, C. 1867. Bidrag till Hemipteranas systematik. Ofversigt Svenska Vet.-Akad. Forh. 24: 522–532.

Stal, C. 1872. Enumeratio Hemipterorum. Svenska Vet.-Akad. Handl. 10(4):3–65.

Van Duzee, E. P. 1931. Four new neotropical Heteroptera. Pan-Pacific Ent. 8:93–95.

Van Duzee, E. P. 1937. A few new Hemiptera. Pan-Pacific Ent. 13:25–27.

Walker, F. 1867. Catalogue of the specimens of Hemiptera Heteroptera in the collection of the British Museum. Brit. Mus. Publ. Pt. 1:1–240.

Westwood, J. O. 1837. A catalogue of Hemiptera in the collection of the Rev. W. F. Hope. J. C. Bridgewater, London, 46 pp.

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PARATHROSCINUS, A NEW GENUS OF BEETLES FROM SOUTHEAST ASIA (LIMNICHIDAE: CEPHALOBYRRHINAE)

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Abstract.—The genus *Parathroscinus* is characterized. A new species, *P. orientalis,* is described from the Philippine Islands and *P. oculatus* (Motschulsky) is transferred to the genus from *Byrrhinus.*

The limnichid subfamily Cephalobyrrhinae (Champion, 1925) has heretofore contained only the genus *Cephalobyrrhus* Pic (1923) from the Old World and *Throscinus* LeConte (1874) from the New World. While attempting to determine a series of limnichids from the Philippine Islands I discovered a few beetles that obviously belonged to the subfamily but which agreed with neither genus. Recently, while examining types of limnichids described by Motschulsky from India, I discovered that the specimens he had described as *Byrrhinus oculatus* are actually not *Byrrhinus* but belong to the Cephalobyrrhinae and are closely allied to the new Philippine species. This paper describes the new taxa and transfers Motschulsky's species to the new genus.

Parathroscinus, new genus

Type-species. Parathroscinus orientalis Wooldridge, here designated.

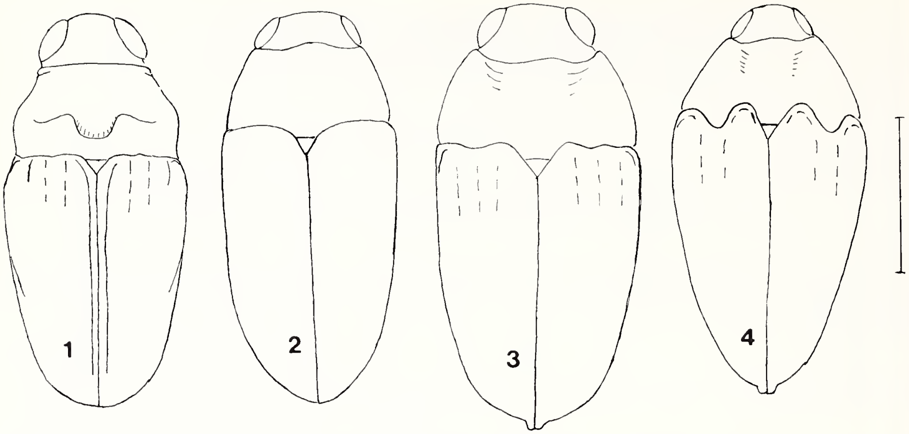
General. Color black except legs red-brown, antennae and palpi dark red-brown. Body elongate oval, shallowly convex. Overall vestiture short, dense, even, recumbent, with scattered erect longer hairs except on legs. Punctation variable from fine to impressed, sometimes forming indistinct rows on elytra.

Head. Vertical, broad; eyes large, prominent, visible from above, separated on vertex by more than their diameters; antennae inserted in shallow depressions on front between eyes, segments 6 to 11 forming a slightly flattened, gradually enlarged club.

Thorax. Pronotum narrowing from base, sinuate at base; disk evenly, strongly convex, no sinuous depression; sides margined, margins continuous in outline with elytral margins. Scutellum of moderate size. Prosternal process broad and flat. Metacoxae contiguous, transverse, flattened to about middle, grooved for reception of femora.

Elytra. Narrowing gradually from humeri, attenuate toward rear; humeri prominent; sides margined; epipleural folds continuous to apex; faint longitudinal grooves from base onto disk of each elytron; elytral apices slightly projecting.

Abdomen. Closely punctate; first visible sternum with a low, curved, longitudinal ridge on each side from the inner metacoxal margin to the posterior margin of the



Figs. 1–4. Dorsal views showing relative shapes. 1. *Cephalobyrrhus* sp. 2. *Throscinus* sp. 3. *Parathroscinus orientalis*. 4. *P. oculatus*. Line equals 1 mm.

sternum; fifth visible sternum notched at tip, with a short longitudinal depression extending forward from middle of notch.

This genus can be separated from *Cephalobyrrhus* by the form of the pronotum. *Cephalobyrrhus* (Fig. 1) has a sinuous, depressed, more or less transverse groove near the base of the pronotum; there is no sign of the groove in *Parathroscinus*. From *Throscinus, Parathroscinus* differs in having the antennae set in shallow depressions on the sides of the front (Fig. 5) rather than in deep pit-like excavations as in *Throscinus* (Fig. 6). *Throscinus* also appears parallel-sided (Fig. 2) while *Parathroscinus* narrows from about the humeral angles (Figs. 3, 4).

Parathroscinus orientalis, new species

Figs. 3, 7

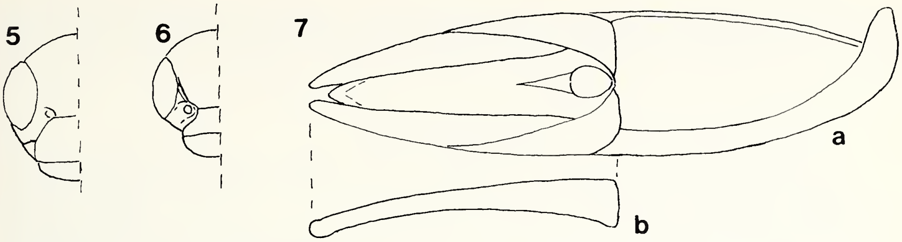
Holotype. ♂, Philippine Islands, Calian, Davao Prov., Mindanao, VII.23.30. C. F. Clagg (FMNH).

Allotype. ♀, same data as holotype.

Paratypes. 25 specimens, same data as holotype (22 FMNH, 3 in author's collection); Philippine Is., 1910–1912, 3 spec. Acc. No. 8643, 2 spec. Acc. No. 8457, Lot Bu. of Sci., P.I. (BMNH).

Diagnosis. This species has the bases of the elytra and pronotum less acutely sinuate than *oculatus* (Fig. 3).

Description of holotype. Length 2.3 mm; greatest width 1.3 mm; elongate oval, convex. Black. Overall vestiture of short variegated silver and yellow hairs and longer gray hairs. Head with small, even punctation; eyes prominent, oval; antennae with first segment small and short, 2nd and 3rd larger and longer, $2 > 3$; 4 and 5 smaller in diameter, $4 < 5$; 6 to 11 gradually enlarged, slightly flattened, $11 > 10$. Pronotum with punctation somewhat impressed at sides, not impressed on disk; base shallowly bisinuate. Elytra with regular, impressed punctation, punctures separated by 2–3×



Figs. 5–7. 5, 6. Frontal view of right side of head showing antennal insertions. 5. *Parathroscinus.* 6. *Throscinus.* 7. *Parathroscinus orientalis,* male genitalia: a, dorsal view; b, paramere, lateral view. Overall length 0.45 mm.

their diameters; humeri prominent; each elytron with a small, broad, flat tooth at apex. Ventral punctation minute, even. Prosternal process broad, hatchet-shaped, margined at sides. Epipleura with a row of punctures on inner margin.

Aedeagus with parameres evenly converging to the rounded tips; penis broad and flat, narrowing to an acute tip; basal piece about as long as parameres (Fig. 7).

Variation. Except for length (2.25–2.75 mm) there is little variation. In the female the tooth at the tip of each elytron is broader than in the male. A single specimen from Quan Nam Prov., Viet Nam, in the U.S. National Museum probably belongs to this species but it differs somewhat in its punctation and it has not been included as a paratype.

Parathroscinus oculatus (Motschulsky), **New Combination**

Fig. 4

Byrrhinus oculatus Motschulsky, 1858, p. 52. Ind. or. Lectotype here designated.

Type-material. There are three specimens of Motschulsky's type-series mounted on a single card in the Moscow Lomonosov State University Museum. These have been numbered by me and the following labels are on the pin. 1. A small yellow disk. 2. Handwritten on yellow: Byrrhinus/oculatus/Motsch./Ind. or. 3. On blue: Spec. #1 Lectotype/Byrrhinus/oculatus/Motsch. 1858/by D. Wooldridge 1983. 4. On blue: Lectoparatype/Byrrhinus/oculatus/Motsch. 1858/by D. Wooldridge/Spec. #2+3. 5. Parathroscinus/oculatus/(Motsch.)/Det. D.P. Wooldridge.

Another specimen with only a yellow disk is among the types of *Limnichus orientalis* Motsch. and has been labelled as *P. occulatus* by me.

Diagnosis. This species can be separated from *orientalis* by the acutely bisinuate bases of the pronotum and elytra (Fig. 4). Because of this sinuation *oculatus* superficially resembles a *Byrrhinus.* Motschulsky noted in his original description that it should probably be in a new genus.

Description of lectotype. Length 2.4 mm, width 1.2 mm; elongate oval, convex. Eyes large and prominent. Pronotum with fine, shallow punctation; base deeply and acutely bisinuate on either side of scutellum. Elytra with shallowly impressed punctation, punctures separated by 2–3 × their own diameters, punctures regular, forming vague longitudinal rows; bases bisinuate; strongly attenuate, tapering from humeri to apex, humeri prominent. Prosternal process broad, margined at sides. Metasternum, metacoxal plates, and abdomen finely, closely, evenly punctate.

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LITERATURE CITED

Champion, G. C. 1925. Some Indian (and Tibetan) Coleoptera (17). Ent. Mon. Mag. 61:169–181.

LeConte, J. L. 1874. Descriptions of new Coleoptera chiefly from the Pacific Slope of North America. Trans. American Ent. Soc. 5:43–72.

Motschusky, V. von. 1858. Insectes des Indes orientales. Etudes Entomologique 7:20–122.

Pic, M. 1923. Nouveautés diverses. Mélanges Exotico-entomologiques 40:1–32.

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FLEAS (SIPHONAPTERA) FROM NESTS OF WOODPECKERS IN ALASKA

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Abstract.—A total of 955 specimens came from 39 nests in 34 localities west of the Yukon Territory, 1974–1978. Two Holarctic species were *Ornithophaga anomala* Mikulin with 371 specimens from 21 nests (mostly Downy Woodpecker and Three-toed Woodpecker) in 20 localities and *Ceratophyllus zhovtyi* Emel'yanova and Goncharov with 28 specimens from three nests (two Flicker and an unknown species) in three localities. Two Nearctic species were *C. adustus* Jordan with 168 specimens from 15 nests (mostly Three-toed Woodpecker) in 13 localities and *C. rauschi* Holland with 388 specimens from eight nests (seven Flicker) in six localities.

Our survey of ectoparasites in nests of the Tree Swallow (*Trachycineta bicolor* (Vieillot)) and Violet-green Swallow (*Tachycineta thalassina* (Swainson)) yielded data on fleas of swallows (Haas et al., 1981). The swallows sometimes built nests in tree cavities made by woodpeckers. Thus, four species of little-known bird fleas were discovered in old nests of woodpeckers, namely: *Ornithophaga anomala* Mikulin, *Ceratophyllus zhovtyi* Emel'yanova and Goncharov, *C. adustus* Jordan and *C. rauschi* Holland. The first two species were originally described from southcentral USSR and the last two from northwestern Canada not far from the Alaska border. Hopkins and Rothschild (1971) thought that *O. anomala* might be represented in North America by the unique specimen of *O. nearctica* Holland and Loshbaugh from Utah. Therefore, in Alaska, only the finding of *C. zhovtyi* could be considered unexpected.

Some morphological anomalies in *O. anomala* and *C. adustus* were noted and described (Haas, 1983). Our survey of fleas on birds found dead included one record of *C. adustus* from *Picoides tridactylus* (Linnaeus) in southcentral Alaska (Haas et al., 1980). The original description of *C. adustus* from a porcupine (*Erethizon dorsatum* (Linnaeus)) in British Columbia (Jordan, 1932) had obscured its relationship with woodpeckers. The present report concerns records of 955 specimens of four species of fleas from 39 nests of *Picoides* spp. and *Colaptes auratus* (Linnaeus) in 34 localities of Alaska west of the Yukon Territory, 1974–1978.

MATERIALS AND METHODS

In forested regions of Alaska west of the Yukon Territory, especially the interior Copper River lowland and lowlands near upper Cook Inlet, dead stubs of spruce (*Picea glauca* (Moench) Voss), poplar and cottonwood (*Populus* spp.), birch (*Betula papyrifera* Marshall) and other trees were scanned from a distance for woodpecker cavities. Stubs with cavities not being used by nesting birds were cut down or pushed over to collect any nests present (Haas et al., 1981). Stubs that fell intact were cut open to remove nests with scraper, brush and forceps. The same tools were used for retrieving nests that spilled from cavities when stubs broke open on impact with the ground. Nests of woodpeckers, swallows (Haas et al., 1981), squirrels (Haas and Wilson, 1982) and voles (Haas, 1982) were bagged separately. Nests of *Colaptes auratus* were identified by the large cavity and presence of ant heads and flicker feathers. Nests of *Picoides* spp. that contained small red-tipped feathers were classified as *P. villosus* (Linnaeus) or *P. pubescens* (Linnaeus), not *P. arcticus* (Swainson) or *P. tridactylus*. Nests of *Picoides* that were not of the last two species are indicated by (NT) in the Records.

Five nests were held in plastic bags with moist towels for several weeks to rear immature fleas. All nests of woodpeckers, except old ones that had become compressed into a crust, were picked apart in a light-colored pan, and fleas were transferred with brush or forceps to labelled vials. Specimens selected for permanent mounts in Canada balsam were mostly those found in good condition, but all specimens of *C. zhovtyi* were mounted despite severe structural damage. Specimens of *C. rauschi* were deposited in the Canadian National Collection and collections of the authors; specimens of the other species were retained by Haas.

RESULTS

Specimens totaling 955 (102 reared) of four species of fleas were obtained from 39 nests of woodpeckers (*Colaptes auratus* and *Picoides* spp., mostly *P. pubescens* and *P. tridactylus*) in 34 localities in Alaska west of the Yukon Territory, 1974–1978. Neither fleas nor fragments of them could be found in very old nests, and 14 cavities without nests were negative for these species of fleas.

Ornithophaga anomala Mikulin, 1957

Specimens totaling 371 (15 reared) were obtained from 21 nests of woodpeckers in 20 localities in two regions. All nests were of unidentified *Picoides* spp.; five contained small red-tipped feathers. One nest appeared to be in an abandoned cavity of *C. auratus*. The nests were in cavities an average of 3 m above ground. All cavities were in dead stubs: 11 in birch, six in poplar and four in spruce.

Records. All from nests of *Picoides* spp. Chickaloon (mile 78 Glenn Highway): two males, nine females (eight dead, one gravid), poplar, 8.IV.1976. Eklutna Lake, 3 km SE, 320 m: two males (dead), two females (also *C. adustus*), poplar (NT), 18.X.1974. Glennallen, 53 km W (mile 4.5 Lake Louise Road): three males (dead), two females (dead) (also *C. adustus*), spruce (probable cavity of *C. auratus*), 14.VI.1976. Kasilof, 6.4 km S (Tustumena Lake Road): two females (one dead), under nest of swallow, poplar, 31.VII.1976. Kenai (city): one, sex unknown (left metepimeron only), birch, 23.IV.1976. Kenai Lake, west shore (mile 6 Snug Harbor Road): one male, three females, birch, 29.VII.1976; (mile 7): two females (dead), under squirrel nest, birch, same date. Palmer, 4.5 km NE (Clark–Wolverine Road): 23 males (eight dead), 39 females (21 dead) (also *C. adustus*), poplar, 13.IX.1975; 7 km E (Smith Road): five males (one dead), 10 females (one dead, one gravid), poplar, 13.IX.1975; 7 km N (mile 52.8 Glenn Highway): one female (dead), under squirrel nest and vole nest, poplar (NT), 30.IV.1975; 8 km N (mile 53 Glenn Highway): four males, three females (emerged from cocoons when disturbed), under nest of swallow, birch, 3.VIII.1974; 14 km NW (mile 1.5 Edgerton Park Road): 68 males, 87 females (1 dead), birch (NT), 27.IX.1975; 18.2 km SE (Knik River Road nr. Fox Lake): one male (dead), nine females (dead) (also *C. adustus*), spruce, 28.VII.1974; one female (dead), same spruce, cavities interconnected. Sterling, 7.2 km NW (Sunken Island Lake Road): 29 males, 39 females (one dead) (also *C. adustus*), birch, 30.VII.1976 (two males, six females reared 25.VIII.1976); 22.4 km N (Swanson River Road): one female (dead), under squirrel nest, spruce, 30.VII.1976. Talkeetna, 12.8 km NW (mile 121.6 Parks Highway): one male, seven females (one dead), birch (NT), 13.V.1976 (one male, six females reared 8.VII.1976); 24.1 km W (mile 12.2 Petersville Road): two males, two females, birch, 28.IX.1975. Wasilla, 5 km E (Parks Highway): one male, seven females (one dead), birch, 8.V.1975; 5.5 km E (Parks Highway nr. Black Lake): one female, birch (NT), 6.VIII.1974; 6 km NE (Lakeview Road nr. Kings Lake): one female (dead) (also *C. adustus*), birch, 6.V.1975.

Ceratophyllus zhovtyi Emel'yanova and Goncharov, 1966

Specimens totaling 28 were collected from three nests of woodpeckers in three localities in two regions. Two nests were of *C. auratus* and one was of an unidentified *Picoides* sp. that contained small red-tipped feathers. The nests were in cavities an average of 3 m above ground. All cavities were in dead stubs: two in birch and one in spruce.

Records. Chistochina, 22.5 km SW (mile 222.5 Glenn Highway): 15 males (dead), 11 females (eight dead) (also *C. adustus* and *C. rauschi*), nest of *Picoides* sp. (NT), birch, 9.IV.1976. Circle, 14 km SW (mile 151.3 Steese Highway): one female, nest of *C. auratus,* birch, 1.VII.1976. Nabesna Road, mile 31: one male (dead), nest of *C. auratus,* spruce, 9.VIII.1975.

Ceratophyllus adustus Jordan, 1932

Specimens totaling 168 (30 reared) were obtained from 15 nests of woodpeckers in 13 localities in three regions. One nest was of *C. auratus* and 14 were of unidentified *Picoides* spp. Two of the latter contained small red-tipped feathers. The nests were in cavities an average of 2.5 m above ground. All cavities were in dead stubs: eight in birch, four in spruce and three in poplar.

Records. All from nests of *Picoides* spp., except as indicated. Cantwell, 4.8 km NE (Parks Highway south of Nenana River bridge): 29 males, 31 females, spruce, 3.IX.1974 (one male reared 10.X.1974). Chistochina, 22.5 km SW (mile 222.5 Glenn Highway): seven males (dead), 13 females (dead) (also *C. zhovtyi* and *C. rauschi*), birch (NT), 9.VI.1976. Edgerton Highway, mile 10: one male (dead), poplar, 5.IX.1975. Eklutna Lake, 3 km SE, 320 m: six females (also *O. anomala*), poplar (NT), 18.X.1974. Glennallen, 53 km W (mile 4.5 Lake Louise Road): 11 males (three dead), 17 females (also *O. anomala*), spruce (probable cavity of *C. auratus*), 14.VI.1976. Gunsight Mountain, 3 km SE (mile 119 Glenn Highway): two females, nest of *C. auratus* apparently visited by *Picoides* sp., spruce, 8.VI.1976. Palmer, 4.5 km NE (Clark–Wolverine Road): one male, three females (also *O. anomala*), poplar, 13.IX.1975 (one female reared 21.X.1975); 18.2 km SE (Knik River Road nr. Fox Lake): one male (dead), one female (dead) (also *O. anomala*), spruce, 28.VII.1974. Skilak Lake, north shore: three males (dead), four females (dead), under incomplete nest of swallow, birch, 23.V.1978. Sterling, 7.2 km NW (Sunken Island Lake Road): nine males (one dead), 20 females (also *O. anomala*), birch, 30.VII.1976 (eight males, 20 females reared 25.VIII.1976). Talkeetna, 2.9 km SE: one male, birch, 21.IV.75. Wasilla, 4.6 km E (Matanuska Road): one male, three females (one dead), birch, 30.IV.1975; one female, cavity higher in same birch; 6 km NE (Lakeview Road nr. Kings Lake): one male (dead), one female (also *O. anomala*), birch, 6.V.1975; one female (gravid), cavity higher in same birch.

Ceratophyllus rauschi Holland, 1960

Specimens totaling 388 (57 reared) were obtained from eight nests of woodpeckers in six localities in two regions. Seven nests of *C. auratus* harbored 387 of the specimens. These nests were in cavities an average of 4.6 m above ground. All cavities were in dead stubs: four in spruce, two in birch and one in poplar. The last stub was part of a live tree.

Records. All from nests of *C. auratus* except as indicated. Chistochina, 22.5 km SW (mile 222.5 Glenn Highway): one male (dead) (also *C. zhovtyi* and *C. adustus*), nest of *Picoides* sp. (NT), birch, 9.IV.1976. Edgerton Highway, mile 7.5 (nr. Kenny Lake): 58 males, 106 females, poplar, 11.VIII.1974. Fairbanks, 35 km WSW (mile 336 Parks Highway): 15 males (one dead), 30 females (seven dead), birch, 29.VI.1976 (14 males and 23 females reared 9.VII–12.VIII.1976). Glennallen, 51 km W (mile 3 Lake Louise Road): four males, four females, spruce, 8.VI.1976; 47 males, 76 females, spruce, 27.IX.1976 (six males, 14 females reared 6.X–19.X.1976). Nabesna Road, mile 24.5: nine males, 34 females (one dead), spruce, 2.IX.1975; one female, cavity higher in same spruce. Nabesna Road–Glenn Highway Junction, 4.3 km W: three females (dead), under squirrel nest, birch, 16.VIII.1975.

DISCUSSION

The Northern Flicker and the Hairy, Downy, Black-backed and Three-toed Woodpeckers are the five species of the family Picidae that breed in Alaska west of the Yukon Territory (Gabrielson and Lincoln, 1959). The Hairy Woodpecker was considered as not abundant and the Downy and Black-backed Woodpeckers as uncommon, but the Three-toed Woodpecker was referred to as one of the most common yet as one that cannot be called abundant. Gabrielson and Lincoln (1959) could not cite many records of nests of the five species in western Alaska. Recent data of the Anchorage Audubon Society showed the status of the Black-backed Woodpecker as rare and the other four species as uncommon in a well-studied area of the Cook Inlet lowland (Klein et al., 1978). Only one nest of the Northern Flicker was collected in the Cook Inlet region and it was uninfested. In contrast, nests of *Picoides* spp. were easy to find in dead stubs in suitable habitat in the region. But collecting from only dead stubs probably caused the nests of the Black-backed Three-toed and Hairy Woodpeckers to be underrepresented in our data as both also nest in live trees and the latter prefers them (Scott et al., 1977).

Ornithophaga anomala. The history of this Holarctic bird flea was reviewed by Hopkins and Rothschild (1971). The original description was from one female from *P. tridactylus* in Alma Ata Oblast, USSR, and Goncharov et al. (1966) provided supplementary descriptions that Hopkins and Rothschild (1971) thought were based on two different species. The supplementary specimens consisted of seven males and nine females from the owl *Glaucidium passerinum* Linnaeus from Irkutsk Oblast, USSR, and one male and one female from *Dendrocopos* (=*Picoides*) *leucotos* Bechst from Primor'ye Kray, USSR. Goncharov et al. (1966) thought that the latter two specimens might represent a subspecies of the Alma Ata and Irkutsk species. Hopkins and Rothschild (1971) thought that *O. nearctica* Holland and Loshbaugh from *Dendrocopos* (=*Picoides*) *pubescens leucurus* (Hartlaub) in Utah (Holland and Loshbaugh, 1958) might represent a subspecies of *O. anomala.*

In Alaska, *O. anomala* was especially common in nests of *Picoides* spp. in the upper Cook Inlet region, with 366 specimens infesting 20 nests. The only infested nest (five dead fleas) not from this region was in the Copper River lowland about 53 km west of Glennallen. This flea might be more dependent than *C. adustus* on Hairy or Downy Woodpeckers. The largest population (155 specimens) infested a nest that was probably of the Downy Woodpecker.

Ceratophyllus zhovtyi. This bird flea was originally described from four specimens from the owl *G. passerinum* and seven specimens from two woodpeckers in the Irkutsk Oblast of the Soviet Union (Emel'yanova and Goncharov, 1966). One of the woodpeckers was identified as a large motley-colored woodpecker. We presume it was *Picoides major* (Linnaeus). Neither it nor *G. passerinum* occurs in North America. Two of our specimens were found alone in nests of Northern Flickers, but 26 specimens were present in a mixed population (*C. adustus* and *C. rauschi*) in a nest of a Hairy or Downy Woodpecker. This probably means that breeding can occur in nests of *Picoides* spp. More data are needed on host and nest relationships and geographic distribution.

Ceratophyllus adustus. This northern Nearctic bird flea seemed to have a slight preference for nests of *P. tridactylus.* Only two infested nests (20 and six flea specimens) could be classified as not being of either species of three-toed woodpecker, and the largest population (60 specimens) infested a nest that most likely was of *P. tridactylus.* Six of the 15 nests infested by *C. adustus* were infested by *O. anomala.* The highest proportion of these records, i.e., mixed populations in five of 10 nests, was from the Cook Inlet region.

Ceratophyllus rauschi. This northern Nearctic flea of the Northern Flicker was originally described from the nest of *Colaptes* sp. in the Yukon Territory (Holland, 1960). In Alaska it was found almost exclusively in nests of the Northern Flicker. The only exception was the dead male in a nest of a Hairy or Downy Woodpecker. Thus, all breeding populations were in nests of Northern Flickers. Five localities were in the interior Copper River lowland and one was in the Yukon River watershed (WSW of Fairbanks) about 358 km west of the US–Canada border. The type locality (Stewart Crossing) is about 215 km east of the border on a tributary of the Yukon River. In Alaska, *C. rauschi* probably infests nests of the Northern Flicker to the northern and western limits of breeding by the bird.

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LITERATURE CITED

Emel'yanova, N. D. and A. I. Goncharov. 1966. A new species of flea, *Ceratophyllus zhovtyi* n. sp., from eastern Siberia (Suctoria, Ceratophyllidae). Izvest. Irkutsk. Protivochum. Inst. 26:309–313 (tr. from Russian seen).

Gabrielson, I. N. and F. C. Lincoln. 1959. The birds of Alaska. Stackpole Co., Harrisburg, Pennsylvania, and Wildlife Management Institute, Washington, D.C.

Goncharov, A. I., V. P. Gordeyeva and V. C. Sonin. 1966. Description of the male and a supplementary description of the female of *Ornithophaga anomala* Mikulin, 1956 (Suctoria). Izvest. Irkutsk. Protivochum. Inst. 26:314–321 (tr. from Russian seen).

Haas, G. E. 1982. Fleas (Siphonaptera) from vole nests in subarctic Alaska. Can. J. Zool. 60: 2157–2161.

Haas, G. E. 1983. Anomalies of the head, thorax and abdomen in the order Siphonaptera. Adv. Biosci. (in press).

Haas, G. E., T. Rumfelt, R. E. Barrett and N. Wilson. 1980. Fleas from some Alaskan birds (Siphonaptera). Pan-Pac. Ent. 56:105–106.

Haas, G. E., T. Rumfelt and N. Wilson. 1981. Fleas (Siphonaptera) from nests of the tree swallow (*Iridoprocne bicolor*) and the violet-green swallow (*Tachycineta thalassina*) in Alaska. Wasmann J. Biol. 39:37–41.

Haas, G. E. and N. Wilson. 1982. Fleas (Siphonaptera) from nests of the red squirrel (*Tamiasciurus hudsonicus*) and burrows of the arctic ground squirrel (*Spermophilus parryii*) in Alaska. Wasmann J. Biol. 40:59–65.

Holland, G. P. 1960. Descriptions of two species of *Ceratophyllus* Curtis from Yukon Territory (Siphonaptera: Ceratophyllidae). Can. Ent. 92:787–793.

Holland, G. P. and G. Loshbaugh, Jr. 1958. Two new species of fleas from Utah, with notes on the genus *Ornithophaga* Mikulin (Siphonaptera). Can. Ent. 90:486–493.

Hopkins, G. H. E. and M. Rothschild. 1971. An illustrated catalogue of the Rothschild Collection of fleas (Siphonaptera) in the British Museum (Natural History). Vol. V. British Museum (Natural History), London.

Jordan, K. 1932. Siphonaptera collected by Mr. Harry S. Swarth at Atlin in British Columbia. Novit. Zool. 38:253–255.

Klein, J., J. Pitcher, S. Scott and G. Tans. 1978. Birds of Anchorage, Alaska (Eagle River to Portage Glacier). A Checklist. Anchorage Audubon Society, Inc., 8 pp.

Scott, V. E., K. E. Evans, D. R. Patton and C. P. Stone. 1977. Cavity-nesting birds of North American forests. U.S. Dep. Agric., Agric. Handb. 511, 112 pp.

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SYNOPSIS OF *OMMATIUS* WIEDEMANN (DIPTERA: ASILIDAE) FROM HISPANIOLA

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Abstract.—Eight species of the genus *Ommatius* Wiedemann are reported from Hispaniola in the Caribbean Islands. Seven of the species are described as new (*O. haitiensis, O. nigellus, O. russelli, O. gwenae, O. stramineus, O. cinnamomeus, O. hispaniolae*), *O. vitreus* Bigot is redescribed, and illustrations and a key are included.

The genus *Ommatius* Wiedemann is apparently more widespread among islands in the Caribbean than previously reported. Although the genus is poorly represented in collections, nine species have been reported and most appear to be endemic to a single island or in island group (Martin and Papavero, 1970; Scarbrough, 1983). For example, 2 species are found in the Bahamas, 1 on Haiti, 4 on Jamaica, and 2 on Puerto Rico and the Virgin Islands. Of these, only *O. marginellus* (Fabricius), which is reported from Cuba southward to Brazil, appears to have a wide distributional overlap with the other species. As more specimens accumulate in collections from the islands and as taxonomic problems are resolved, so too should information on species variation and distribution become more defined. This paper, one of several that will appear on the Caribbean *Ommatius,* deals with the species found on Hispaniola (Haiti and the Dominican Republic).

Specimens for study were received on loan from the following institutions: Museum of Comparative Zoology (MCZ), Cambridge; American Museum of Natural History (AMNH), New York; United States National Museum (USNM), Smithsonian Institution, Washington, D.C.; Canadian National Collection (CNC), Ottawa, Canada; Institute of Jamaica (IJ), Kingston; and Hope Department of Entomology (OX), Oxford University, Oxford, England.

The characters used in this study are well-known, traditional ones and are identified by reference to Figures 1–3. I followed the nomenclature used by McAlpine (1981). Unless otherwise stated, the paragraphs entitled "male" and "female" refer to the description of a specimen as a holotype or an allotype. Those entitled "variation" include only major characters of specimens in the type series that differ significantly from those of the type specimen(s).

KEY TO THE SPECIES OF *Ommatius* FROM HISPANIOLA

1. Upper postocular bristles long, strongly proclinate and extending far forward above eye (Fig. 1) 2
– Upper postocular bristles short, curved forward slightly only near their apices (Fig. 4) 5
2. Femora wholly black 3
– Femora with some reddish to yellowish coloration at bases 4

3. Facial bristles wholly black; 2 or 3 strong marginal scutellar bristles, 1 or 2 anepimeral bristles .... *O. haitiensis,* new species
– Facial bristles black and pale yellow; scutellar and anepimeral bristles absent .... *O. nigellus,* new species
4. Most or all femoral bases with a small reddish spot or narrow band; epandrium slender, somewhat narrowed apically (Fig. 11) .... *O. russelli,* new species
– All femora reddish to orangish on basal fourth or more; epandrium broad basally, abruptly narrowed apically (Fig. 9) .... *O. gwenae,* new species
5. Meso- and metafemora wholly black or dark brown 6
– Meso- and metafemora yellowish to orangish on basal third or more 7
6. Facial bristles wholly pale (white or yellow), costal margin with slight bulge in males; abdominal pollen yellow; epandrium with single, broad apical process (Fig. 13) .... *O. stramineus,* new species
– Several dark facial bristles above mystax; abdominal pollen yellowish gray; costal bulge absent; epandrium with two, slender, apical processes (Fig. 5); female with apical corners of tergite 9 projecting posteriorly (Fig. 6) .... *O. vitreus* Bigot
7. Large species (20 mm); fore femur with apical third black; abdomen not noticeably enlarged apically; sternite 8 with a moderately deep median apical notch and 2 lateral protuberances (Fig. 14) .... *O. cinnamomeus,* new species
– Small species (11–14 mm); fore femur entirely black or nearly so; abdomen somewhat enlarged apically; epandrium slender along its entire length (Fig. 7); sternite 8 without a deep median apical notch, lateral protuberances widely spaced (Fig. 8) .... *O. hispaniolae,* new species

Ommatius haitiensis, new species

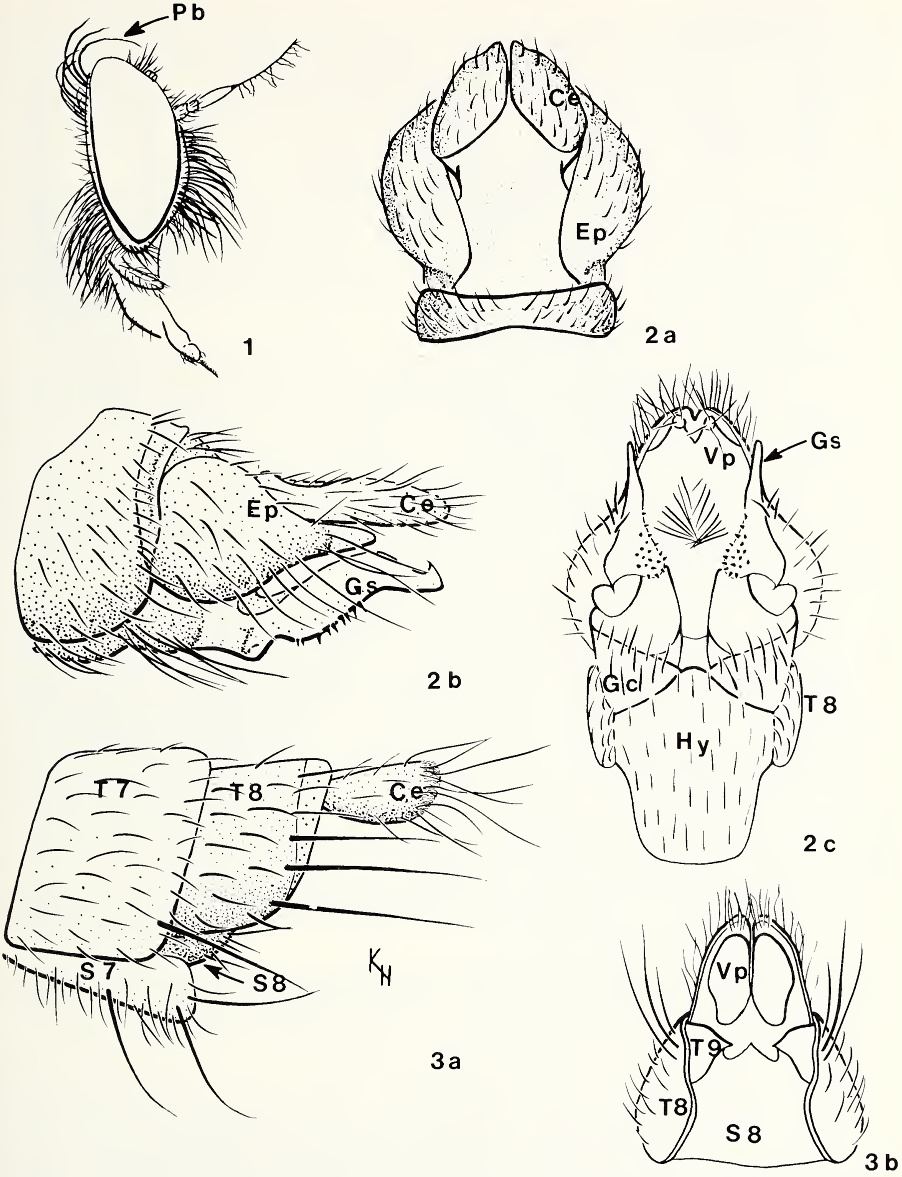
Figs. 1–3

Description. MALE (Fig. 1): 13.5 mm. Head black; face and occiput gray tomentose with traces of yellow along eye margin; tomentum of front generally brown, coppery brown at some angles. Bristles and hairs of face, front, antenna and upper half of occiput black, lower half (except 5–6 hairs below eyes) and base of proboscis with long white pile; facial pile and bristles long and slender, 4 stout black bristles on lower half, pile dense above and almost reaching base of antenna; several stiff ocellar hairs. Occipital bristles thin, straight on sides, strongly proclinate near vertex and long (ca. 3–4 times longer than those on sides), extending forward over eyes. Third antennal segment three times longer than width and as long as first two segments combined; style about one-third longer than the 3 segments combined.

Thorax black. Thoracic dorsum generally brownish pollinose; sides, grooves, prescutellum and scutellum of scutum and pleura with yellowish gray to yellowish brown pollen. Chaetotaxy of scutum black and abundant; hairs short anteriorly, much longer and stronger posteriorly; bristles consist of 2 notopleurals, 2–3 supra-alars, 2 postalars and a row of strong dorsocentrals which extend entire length of dorsum; scutellum with abundant, slender, black vestiture covering entire dorsal surface and 2 strong marginal bristles. Pleural pile abundant, long, strongest and primarily black on meta-episternum and laterotergite, sparse on anepimeron; meron bare. Row of pleural bristles almost entirely black, 1–2 pale; 1–2 black anepimeron bristles.

Wing hyaline. Veins brown, lighter basally; costal margin without a bulge; crossvein r-m at apical third of discal cell. Halter brownish, knob darkest.

Legs black. Coxae with pale yellowish gray pollen and mostly whitish bristly hairs,



Figs. 1–3. *Ommatius haitiensis,* head and terminalia. 1. Head, lateral view; Po = postocular bristles. 2. Male terminalia, dorsal (a), lateral (b) and apical (c) views. 3. Female terminalia, lateral (a) view and sternite 8 (b). Ce = cercus, Ep = epandrium, Gs = gonostylus, Gc = gonocoxite, Hy = hypandrium, Vp = ventral plates, T = tergites, S = sternites.

a few black hairs on fore and middle coxae. Femora moderately swollen and covered with appressed yellowish or whitish pile, dense dorsally and posteriorly, shorter and black apically; abundant, long, bristly hair below and apically (4–6), stronger hairs and setigerous bristles black except for a few whitish ones basally on middle and posteroventrally on fore femora. Tibiae with pale pile and long black bristly hairs and bristles. Tarsi black with black bristles.

Abdomen dark brown to black, apical borders of segments brownish. Traces of brownish pollen dorsally on most tergites, yellowish gray or gray pollen on sides and on sternites; tergites 7–8 somewhat shiny. Long whitish pile on sternites and sides of tergites, abundant and longest on first 5 segments. Abdominal bristles and appressed setae black, noticeably long and strong on tergites 1 and 7–8; tergite 2 with a midlateral patch of long black, bristly hairs.

Terminalia (Figs. 2a–c) brownish with cercus and gonostylus orangish brown. Cercus with pale weak hairs apically and stronger blackish ones laterally; black bristly hairs elsewhere on terminalia; hairs longest near apex of epandrium and base of gonocoxite. Gonostylus elongate with a flat preapical dorsal process and numerous short, thick black setae and long hairs basally. Epandrium dark and somewhat inflated basally, lighter and tapered apically. Hypandrium with rounded median point and scattered black hairs. Ventral plates below cercus with pale hair apically and stronger black bristly hairs basally.

FEMALE (Figs. 3a, b): 13.3 mm. The female differs from the male holotype as follows: darker yellowish gray facial tomentum; scutellum with some pale pile in addition to black pile. Femora slender, hind femur with pale yellow hairs and bristles ventrally in addition to black. Abdomen slightly lighter brown than male, pollen more yellow on sides of tergites; bristles and hairs of segments 1–6 pale yellow to yellow; segment 7 with several long black hairs along apical margin. Tergite 9 hidden by tergite 8, each apical corner wrapped around base of cercus, covering apical corner of sternite below. Sternite 8 shiny black with several transverse wrinkles and a few fine hairs basally; sternite paler apically with a sharp median pointed process. Cercus shiny and with abundant fine yellowish pile.

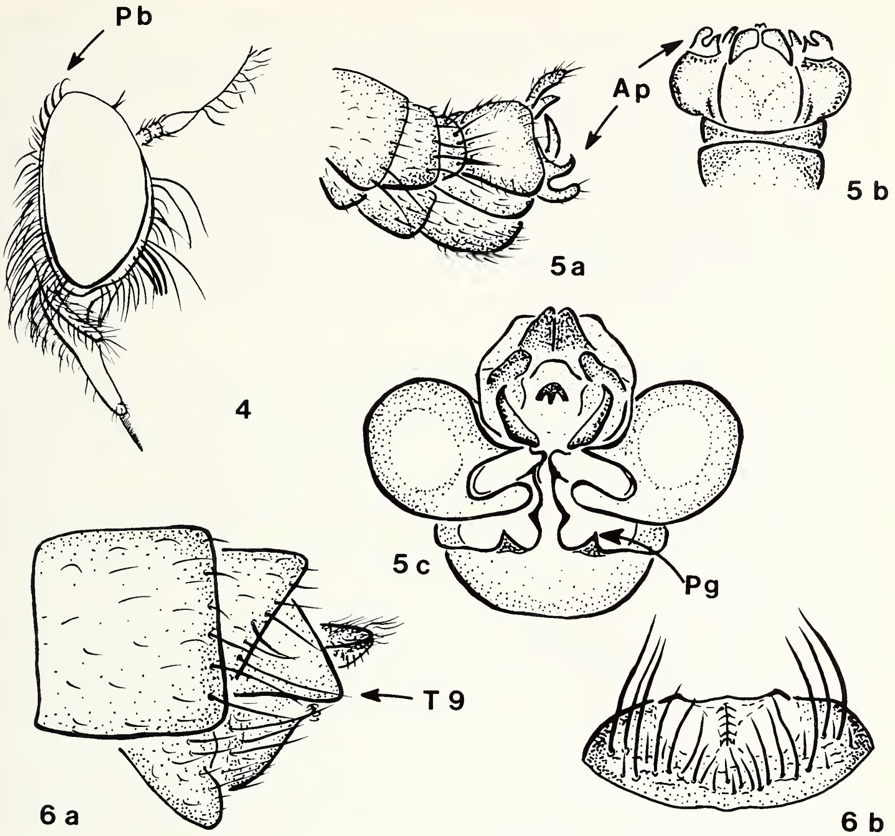
Holotype. ♂, Haiti, LaViste and Vie LaSalle Range, 5,000–7,000 ft., 16–23 Sept. 1934 (M. Bates). Allotype ♀ and paratype ♂, same data as holotype. The type specimens are deposited in the MCZ collection.

Variation. The paratype male (14.1 mm) differs from the holotype in that it has a lighter (dark brown) ground color and fewer black bristles and hairs.

Etymology. The species is named for the country from which the species was collected.

Diagnosis. This species is easily recognized by a black body and abundant black vestiture; third antennal segment 3 times longer than wide, facial hairs wholly black and abundant near base of antenna, several long black proclinate postocular bristles, 5–6 black hairs below eyes; 2 strong scutellar bristles, 1–2 anepimeral bristles, a patch of long black pile on tergite 2; male with epandrium abruptly tapered apically and an elongated gonostylus with a preapical dorsal process; female with a sharp median pointed process on the apical margin of sternite 8.

Ommatius haitiensis is quite different from other Caribbean species. It resembles *O. nigellus,* n. sp. which is also black but has black and light facial vestiture. *Ommatius haitiensis* differs from the latter species by the presence of wholly black facial



Figs. 4–6. *Ommatius vitreus* Bigot, head and terminalia. 4. Head, lateral view. 5. Male terminalia, lateral (a), dorsal (b) and apical (c) views. 6. Female terminalia, lateral view (a) and sternite 8 (b). Pg = process of gonocoxite, Ap = apical process of epandrium.

vestiture, black hairs below the eyes and on the upper half of the occiput, 2 marginal scutellar and 1–2 anepimeral bristles.

Ommatius vitreus Bigot
Figs. 4–6

Ommatius vitreus Bigot, 1875:246; type locality Haiti, ♀.

Ommatius marginellus: Hull, 1962:435; listed *O. vitreus* as a synonym *O. marginellus* (Fabricius).

Ommatius vitreus: Martin and Papavero, 1970:60; removed from synonymy.

Although Bigot (1875) indicated the existence of a female specimen in his description of *O. vitreus,* he neither designated a holotype nor indicated the number of specimens in his possession. A female and a male of *O. vitreus* from Bigot's collection presently exist in the Hope Entomological Museum, Oxford, England. Both specimens bear a label with the specimen number (#779 in coll. Bigot) and a type number (either 283½ or 283 2/2). In order to clarify the confusion in this matter, I have selected the best preserved specimen of these, a female with the type label #283½, as *Lectotype.* The specimen is partially greased and lacks only the third antennal segment and style. A description of the lectotype and the male follows.

Description. FEMALE (Figs. 4, 6a, b): 12.0 mm. Head brownish black; face yellowish tomentose, front brown to yellowish brown. Mystax yellowish, 7 brownish hairs above; 2 long brown ocellar bristles. Occiput somewhat whitish pollinose, pile white with postocular bristles dark. Antenna brown with short dark bristles on segment 1 and 2; third segment with 1 or 2 short dorsal hairs, longer than wide, slightly less than length of first and second combined; style less than twice length of all segments combined.

Thorax with sparse pale pile, pile most abundant on prothorax, humeral callus, disc of scutellum and on sides of scutum above wings. Chaetotaxy: 2 notopleurals, 1 supra-alar, 1 postalar, 4 dorsocentrals in prescutellar region; scutellar bristles absent or at least not noticeably different from pile; row of pelural bristles yellowish. Thoracic pollen mostly yellow to yellowish gray, brownish on postalar callus.

Legs. Coxae brown with yellowish gray pollen, pale bristles and pile. Femora blackish brown, tibiae yellowish with brown apically; fore and middle tibiae with narrow apical dark bands, hind tibia dark on apical half; tarsi brown with basal tarsomere lightest, that of hind tarsus darkest. Pile of legs light yellow or whitish, sparse posteriorly on fore and middle femora; some black pile dorsoapically on fore and middle femora. Femoral bristles mostly pale yellow or whitish; fore femur with black bristles and bristly hairs below and 2 short black hairs apically. Middle femur with several strong bristles below on basal half, all light but 1; 4 additional black bristles on anterior surface and 1 short black posteroapical bristle. Hind femur with 1 black bristle dorsoapically. Tibiae with appressed black setulae; tibial and tarsal bristles black except for 1–2 on fore and middle tibiae and 2 on fore tarsus; middle tibia with a ventral row of black hairs.

Wing hyaline, veins brown, lightest basally. Costal margin straight anteriorly, r-m crossvein beyond middle of discal cell. Halter yellowish brown.

Abdomen dark brown to black, posterior borders somewhat lighter in color. Gray to yellowish gray pollen and pale pile on sides of tergites and on sternites. Tergites 8 and 9 shiny black with long black hairs, apical corners of 9 extending some distance posteriorly; cercus slightly lighter in color than tergites and with light pile; sternite 8 covered with meconium.

MALE (Figs. 5a–c): 11.0 mm, differing from female as follows: dark bristles of fore tibia only at apex, dark hairs of middle tibia absent. Wing with light brown in anterior cells, r-m crossvein at or beyond middle of discal cell. Halter brownish. Abdominal tergite 7 and 8 somewhat shiny with long, dark setae along apical margin, slightly longer on sides.

Terminalia mostly dark brown. Hypandrium somewhat inflated, apically rounded. Epandrium with basal two-thirds dark brown, greatly swollen and with dark setae; base somewhat flat in apical view; apical third with two lighter colored, slender, curved processes. Gonostylus somewhat oval in cross-section, yellowish brown. Cercus brownish with fine pale pile; ventral plates with basolateral processes.

Lectotype. ♀, #779, in coll. Bigot abt. 1845-93, Type 283½, Oxford Entomological Museum.

Other specimens examined. HAITI: ♂, #283 2/2, same data as lectotype; ♂, Furcy, July 25, 1950 (A. Curtiss); 2♂♂, 2♀♀, Kenskoff (nr. Port-au-Prince), 4,000–6,000 ft., August 8, 1934 (M. Bates); 2♀♀, Furcy, 4,000 ft., 10 Dec. 1956 (B. & B. Valentine). DOMINICAN REPUBLIC: ♀, Constanze, 3,000–4,000 ft., August 1938 (Darlington); 3♀♀, Sarabacoa, Nov. (?) 1950 (N. L. H. Drauss); ♂, Constanze, 5 May 1959 (M. W. Sanderson and T. H. Farr); ♀, La Palma, 1.2 km E. El Rio, 2–13 June 1969 (Flint and Gomez). Specimens are deposited in the Oxford Entomological Museum, USNM, MCZ, AMNH, Ohio State University Museum (Columbus) and the collection of the author.

The lectotype and the male in Bigot's collection were examined.

Distribution. Hispaniola and Mona Island, Puerto Rico.

Variation. Only slight differences were noted in the series examined; ♂ 13.0–13.2 mm, ♀ 11.9–14.0 mm. The femora are invariable darker (black) and the facial tomentum is more white or gray than on the lectotype. The pleural and abdominal pollinosity is sometimes slightly darker yellow than the lectotype. The dark apical bands on the fore and middle tibiae are often absent or nearly so. In females, sternite 8 has abundant pale pile, a V-shaped row of stiff mostly black bristles and transverse wrinkles which are often covered with sparse yellowish pollen; the apical third has a low median ridge or line, a somewhat circular lighter colored (sometimes covered with pollen or bare and shiny) depression to each side of the ridge, and 2 low, laterally spaced, protuberances on the apical margin; middle of apical margin, with lateral protuberances, sometimes noticably projecting.

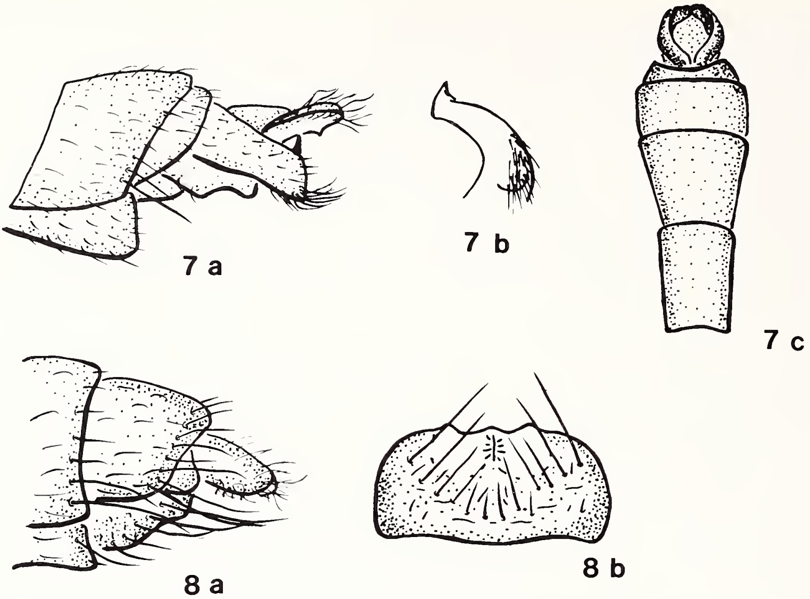
Diagnosis. Ommatius vitreus is recognized by the wholly black femur, presence of two ventral rows of whitish setigerous bristles on the hind femur, mystax light with several dark hairs above, white to grayish facial tomentum, and an apically bifurcated epandrium in males and the absence of a costal bulge and marginal scutellar bristles.

Ommatius vitreus will key to *O. alexanderi* Farr in Farr's key (1965) but can be recognized from that species by its wholly dark femora, apically bifurcated epandrium and the absence of a costal bulge and a styliform gonostylus.

Ommatius hispaniolae, new species
Figs. 7, 8

Description. MALE (Figs. 7a–c): 11.1 mm. Head brown. Tomentum of face pale yellowish white, yellow along eye margin. Front grayish or brownish gray tomentose with 6 short, fine hairs and 2 long black ocellar bristles. Facial vestiture white with 4 stout bristles and longer bristly hairs. Occipital vestiture whitish, tomentum with traces of yellow; postocular bristles straight or slightly curved near tips. Antenna segments of equal length, style about twice length of all segments combined; segments 1 and 2 whitish tomentose, third segment somewhat oval, length slightly greater than width and with 1 or 2 short hairs dorsally. Antennal bristles short, generally whitish on segment 1 and brown on 2.

Thorax dark brown. Pollen of scutum and pleuron pale yellowish gray to gray. Pile absent on scutum except on humeral callus and above wing base. Black scutal bristles



Figs. 7, 8. *Ommatius hispaniolae,* terminalia. 7. Male, lateral (a) view, gonostylus (b) and dorsal (c) view. 8. Female, lateral (a) view and sternite 8 (b).

consisting of 2 notopleurals, 1 supra-alars, 1 postalar and 6 slender dorsocentrals in prescutellar region; several short hairs anteriorly. Scutellum with fine whitish pile, none along margin conspicuously different from that on disc. Pleural pile whitish and sparse or absent. Row of whitish pleural bristles above hind coxa.

Wing hyaline with slight costal bulge. Veins brown, light basally; crossvein r-m before basal half of discal cell. Halter yellowish, knob brownish yellow.

Legs. Coxae brown with gray pollen and several whitish bristles and long pile. Femora slender, dark brown or blackish, with basal third to fourth of middle and hind femora yellow; fore femur slightly lighter brown with some yellow at extreme base. Tibiae predominately yellow, apex of fore tibia narrowly brown banded, apical fourth of midtibia and apical third to half of hind tibia brown. Tarsi primarily brown with basal segments yellow to yellowish brown. Leg segments with appressed yellowish pile, sparse on fore femur, some black pile at femoral apices; tibiae with short dark setulae. Femoral bristles and hairs yellowish to yellowish white except as follows: all femora with 2 short apical hairs; middle femur with 6 black bristles; hind femur with 5–6 setigerous black bristles in ventroposterior row. Tibial and tarsal bristles black except for 4 yellowish ones on fore tibia, 2 on middle tibia and 3 on fore tarsus.

Abdomen brown, apical margins of segments lighter. Segments 3 and 4 moderately constricted with segment 5 expanded somewhat abruptly. Sides of tergites 1–6 and all sternites with pale brownish white pollen, brown elsewhere; brown setae on darker areas of tergites, yellowish white on lighter areas with 1 slightly longer hair at apical corners of tergites 3–7; pile whitish, most abundant on basal five segments. Tergite 1 with 3 pale bristles.

Terminalia brown with weak pale pile. Epandrium slender, slightly wider basally; apical margin somewhat oblique with ventral margin longer and abundant long pile. Gonocoxite with 3 rather flat triangular processes, 2 below and 1 above. Gonostylus somewhat flattened and slightly curved forward. Hypandrium with apical margin sharply sloped toward middle. Cercus narrow with pale pile; ventral plates below cercus fused, forming a broad M-shaped process.

FEMALE (Figs. 8a, b): 12.0 mm. The female differs from the holotype as follows: tomentum and pollen of body with more yellow than male. Proclinate postocular bristles black. Leg bristles primarily orangish yellow; black bristles in ventral row of hind femur absent; 3 or 4 pale fore tarsal bristles. Crossvein r-m beyond middle of discal cell; costal bulge absent. Halter brownish yellow. Segment 8 somewhat shiny with abundant pale pile and a few hairs. Tergite 9 with only lateral corners exposed, corners only slightly projecting posteriorly. Sternite 8 with transverse wrinkles, a V-shaped row of pale bristles and a low mid-line ridge on apical third; a shiny depression on each side of ridge; apical margin with 2 lateral, slightly projecting, protuberances. Abdomen lacking constriction near middle.

Holotype. ♂, Barahona, Dominican Republic, September 1938 (Darlington). Allotype: ♀, Port-au-Prince and vic., Haiti, March 18, 1934 (N. Bates). Paratypes: ♀, Dessorces, Haiti, alt. 100 ft., March 2, 1922, F. 4639 (Collector ?); ♀, Diquini., Haiti, date ? (W. M. Mann): 3♂♂, 4♀♀, Bois Caradeux, Port-au-Prince, Haiti, September 7–10, 1936 (E. M. Ducasse), ♀, Barahona Prov., Dominican Republic, July 13, 1967 (L. H. Rolston).

The holotype and allotype are housed at MCZ; and the paratypes at AMNH, USNM, CNC, and the collection of the author.

Variation. Minor differences among the paratypes are as follows: lengths ♂ 12.1–15.1 mm. ♀ 11.0–13.5 mm; one male with pale yellow or orange facial bristles, and two black bristles in the anteroventral row of hind femur. Two females with white tomentose faces. Apical margin of epandrium sometimes more rounded than on the types.

Etymology. This species is named for the island from which the insect was collected.

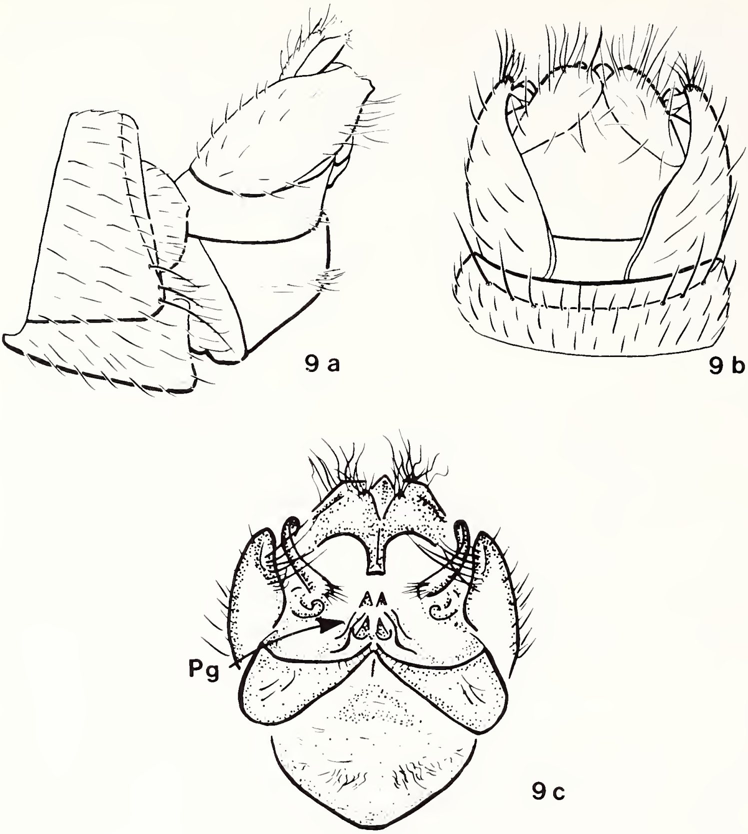
Diagnosis. Ommatius hispaniolae is easily recognized by its dark brown fore femur and an absence of marginal scutellar bristles; the slender epandrium, the slight bulge in the costal margin of the wing and the spatulate abdomen of the male.

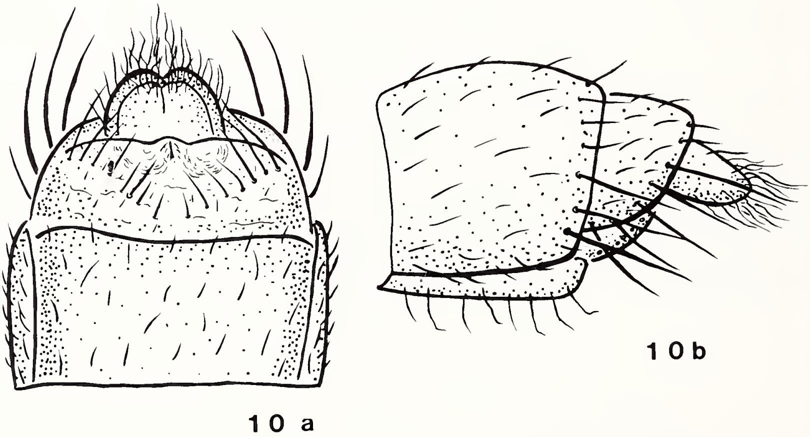
This species will run to *O. jamaicensis* Farr in Farr's key (1965), but can be separated from it by the virtual absence of orange-brown on the femora, pale to dark brown tibiae and a sickle-shaped diststylus. Males of *O. hispaniolae* also have a slender epandrium and a slightly spatulate abdomen.

Ommatius gwenae, new species

Figs. 9, 10

Description. MALE (Figs. 9a–c): 17.0 mm. Head dark brownish black. Face grayish yellow tomentose, front yellow to brownish yellow. Mystax whitish with several long, brown hairs above mystax; 4 brown ocellar bristles, 2 noticeably long. Occipital tomentum whitish, pile white; postocular bristles black and proclinate, inner 3 or 4





Figs. 9, 10. *Ommatius gwenae,* terminalia. 9. Male, lateral (a), dorsal (b) and apical (c) views. 10. Female, lateral (a) and ventral (b) views.

long, curved above eyes. Antennal segments 1 and 2 with black hair, third with 2 short hairs dorsally and length twice its width; style slightly less than twice length of all segments combined.

Thorax dark brown to black with some brown pollen. Scutum with mostly grayish or whitish pollen on sides, prescutellar region, scutellum and pleuron; pale pile abundant on prothorax, humeral callus and on anepisternum; pleural pile sparse or absent elsewhere. Scutal bristles black as follows: 2 notopleural, 1 supra-alar, 1 postalar and 8 rather stout prescutellar dorsocentrals; numerous weaker bristly hairs in prescutellar region, on side above wing and on postalar callus; several short dorsocentrals anteriorly. Scutellum with long pale pile and bristly hairs, none on margin conspicuously different in length or thickness. Vertical row of pleural bristles pale and long. Halter reddish brown.

Legs. Coxae black with gray pollen and whitish bristles and pile. Femora, hind tibia and tarsi primarily black; basal tarsomeres of fore and middle tarsi brown. Femoral bases reddish yellow on basal third to half; fore and middle tibiae with narrow apical dark bands and yellow above; hind tibia dark on apical half; reddish yellow to reddish brown above. Legs with mostly yellowish to whitish pile, some black pile on dark areas of femora and 1–2 short, black, bristly apical hairs. Fore and middle femora with anterior bristles black and yellowish bristles below; 1 black or pale preapical posterior bristle on middle femur. Hind femur with 4 whitish bristles anteriorly; setigerous bristles in ventral rows primarily black with 1–3 pale yellow apically. Fore and middle tibiae with only 1–2 black bristles beyond those at apex, others yellowish. Hind tibial and fore tarsal bristles mostly black except for 1 or 2 yellowish bristly hairs and 4 pale yellow bristles, respectively.

Wing hyaline with veins dark brown apically, lighter basally; costal margin thick, bulging greatly; anterior cells with ripples and slight brownish tint; r-m crossvein before middle of discal cell.

Abdomen dark brown to black, with margins of most segments somewhat lighter. Pollen primarily grayish to whitish with traces of brown on sternites 7–9. Pile pale, longer and more abundant on basal segments. Tergite 1 with two pale bristly hairs; segments 6–8 with black setae, longest along apical margins and corners.

Terminalia mostly black with abundant pale yellowish pile and hairs; some black hairs on basal half of epandrium. Epandrium with length twice basal width, slightly tapered on apical third, apical margin somewhat truncate. Hypandrium with numerous transverse wrinkles, its apical margin tapered abruptly before middle, forming an arched point; the latter preceded by a shallow transverse depression and a dense row of fine black hairs on each side of middle. Gonocoxite with a shallow groove leading to 2 tapered processes on each side of middle and a lateral flange. Gonostylus reddish, gently arched forward, apex slightly curved laterally. Plates below cercus fused, forming an M-shaped structure, the middle narrowly elongate and apically truncate.

FEMALE (Figs. 9a, b): 17.0 mm. Slight differences include: facial tomentum slightly darker yellow than male, pollen behind humeral callus golden in some light, yellowish brown on sides of scutum. Femora less swollen than male; middle femur with several fine black bristly hairs anteroventrally; hind femur with ventral rows of setigerous bristles mostly pale, only 1–3 black. Fore and middle tibiae with several bristly black hairs below. Wing without costal bulge; r-m crossvein beyond middle of discal cell.

Tergite 8 somewhat shiny with black setae, longer along apical margins and apices. Tergite 9 concealed by 8 above and wrapped around base of cercus. Sternite 8 with yellow gray pollen basally, white setae and long hairs (the latter in a V-shaped pattern); basal half with transverse wrinkles; apical half with a light colored, low mid-line ridge narrowed to a point in apical margin; apical margin without usual lateral protuberances, a shiny depression to each side of ridge.

Variation. Minor variations in the paratypes (♂, ♀) included; lengths 16.0 mm; female with a few brown hairs above mystax; male front with fine brown hairs along eye margin; 3 or 4 short pale or black bristles on posterodorsal surface of middle femur; hind femur with posterior row of ventral bristles all black, 1 black bristle on anterior surface. All tibiae with appressed black setulae.

Holotype. ♂, Dominican Republic, Constanza, 1–10 June 1969 (Flint and Gomez). Allotype: ♀, same data as holotype. Paratypes: ♂, Dominican Republic, La Toma, N. of San Cristobal, 9–10 June 1969 (Flint and Gomez); ♂, Santa Domingo, Dominican Republic, date ?, Williston Collection.

The holotype and allotype are in the USNM and the paratypes in the AMNH and the collection of the author.

Etymology. Ommatius gwenae is named in honor of my daughter, who developed an interest in insects at an early age.

Diagnosis. Ommatius gwenae is recognized by a dark body; facial vestiture mostly whitish with 6–7 brown hairs above mystax; inner postocular bristles black and strongly proclinate; femora and hind tibia mostly black with basal third to half reddish brown; scutellum with mostly pale pile, a conspicuous pair of scutellar bristles absent. Males with a prominent costal bulge, apical margin of epandrium somewhat truncate, a patch of fine black pile on the hypandrium, an M-shaped ventral plate and two acutely tapered gonocoxal processes.

Ommatius gwenae is most similar to *O. russelli,* n. sp. but can be quickly recognized by the characters described in the key and those discussed at the end of the section on *O. russelli,* n. sp.

Ommatius russelli, new species
Fig. 11

Description. MALE (Figs. 11a, b): 16.0 mm. Dark brown to black. Tomentum of face, front and first antennal segment yellow to brownish yellow; occiput grayish yellow tomentose. Mystax yellowish white; 6–8 brown hairs and several pale shorter ones above mystax. Hairs of antenna, front and ocellar tubercle brown to black; 2 long ocellar bristles and several smaller ones. Upper postocular bristles dark, inner 2 or 3 on each side of vertex strongly proclinate; remaining postocular bristles slightly curved or straight, shorter and pale yellowish white. First antennal segment longer than either second or third segment, third longer than wide and with 3 inconspicuous dorsal hairs; style almost twice length of all segments combined.

Thorax with mostly brownish pollen above, yellow to brownish yellow behind humeral callus; yellowish to grayish yellow pollinosity in grooves, on sides, in prescutellar region, on scutellum and on pleuron. Scutal bristles black (2 notopleural, 1 supra-alar, 1 postalar and 8–9 posterior dorsocentrals); black bristly hairs and pile on sides and in prescutellar region, short anteriorly, longer posteriorly. Scutellum with black bristly hair becoming longer toward posterior margin, 3 hairs on margin

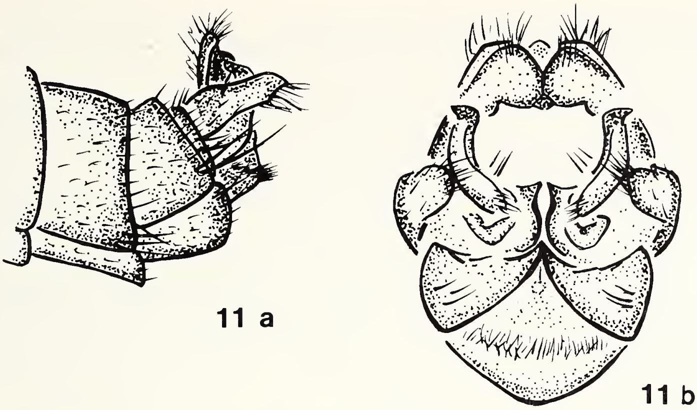


Fig. 11. *Ommatius russelli,* male terminalia; lateral (a) and apical (b) views.

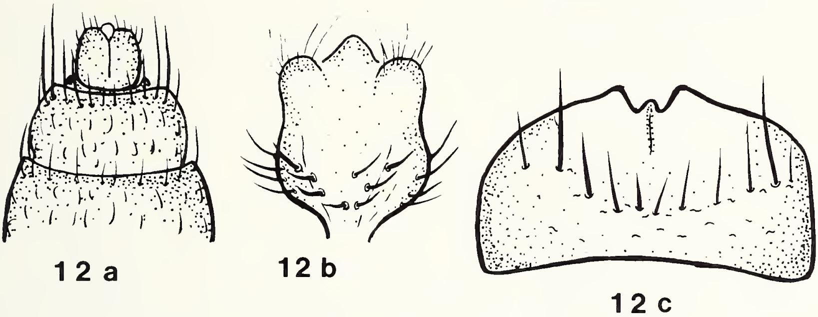


Fig. 12. *Ommatius nigellus,* female terminalia; dorsal view (a), ventral plates (b) and sternite 8 (c).

slightly longer than those on disc but otherwise not noticeably different. Pronotal and pleural pile pale. Row of pleural bristles yellowish white. Halter reddish brown.

Legs. Coxae black with grayish yellow pollen and pale yellowish white bristles and pile. Most or all femora primarily black with a narrow reddish basal ring or a small reddish basal spot; tibiae yellow to reddish yellow except for dark apical third of hind tibia and narrow dark apical ring on remaining tibiae. Tarsi dark brown with basal tarsomeres slightly lighter. Legs with mostly yellowish short pile, some black pile in dark areas; tibiae with black setulae. Black bristles on anterior surfaces of fore (1) and middle femora (5); yellowish bristles and hairs below. Middle femora with 1 brownish yellow preapical bristle and 2–3 shorter dorsoposterior bristles. Hind femur with yellowish or brownish bristles except for 3 or 4 black ones in posterior ventral row; several slender pale hairs dorsally on basal half of hind femur. Bristles of tibiae and tarsi black except for 3–4 on fore tarsus, 5 on fore tibia and 3 on middle tibia. Fore and middle tibiae with a row of fine black hairs below.

Wing hyaline; costal margin thick, bulging greatly; anterior cells brownish especially along margin of veins; r-m crossvein slightly beyond middle of discal cell.

Abdomen brownish black, margins of several segments slightly lighter. Abdominal pollen brown to yellowish gray; pale brown to brown short setae on dark areas of tergites and long slender hairs in apices of tergites 7 and 8; pile and remaining bristles pale yellow.

Terminalia mostly black with gonopods and apex of epandrium reddish; hair and pile of basal half black, that of cercus and ventroapical margin of epandrium abundant and pale. Epandrium length more than twice basal width, slightly swollen basally and tapered apically to a point with a slight constriction before the apex. Hypandrium with a dense, transverse tuft of black pile, apical margin forming a narrow, slightly arched point at middle and a shallow transverse depression posteriorly. Gonocoxite with a shallow basal groove leading to middle and connecting to a flat arched flange. Gonostylus curved sharply outward on apical third, apex somewhat blunt. Plates below cercus fused at middle forming a broad M-shaped structure, the middle short, broad with apex truncate.

Female unknown.

Holotype. ♂, Dominican Republic, La Palma, 12 km E. of El Rio, 1–13 June 1969 (Flint and Gomez). Paratype ♂, same data. The types are stored in the USNM.

Variation. The paratype male differs as follows: 18.0 mm, 3 postalar bristles, 4–5 bristly dorsocentrals on each side, fore femur wholly black.

Etymology. Ommatius russelli is named after my son, who accompanied me on numerous collecting trips.

Diagnosis. Ommatius russelli is recognized by a dark body, facial vestiture primarily yellowish white with 6–8 brown hairs above mystax; inner postocular bristles black and strongly proclinate; femora almost wholly black with only a narrow basal reddish ring or spot; scutellum with abundant black bristly pile. Males with prominent costal bulge, epandrium tapered to point, hypandrium with a complete row of fine black pile and an M-shaped ventral plate.

Ommatius russelli is most similar to *O. gwenae,* n. sp. but differs from that species by its almost wholly black femora, wholly black scutellar pile, a complete transverse row of black pile on the hypandrium, a slender epandrium whose length is at least twice or more than its widest width, and the absence of acute spine-like gonocoxal process.

Ommatius nigellus, new species

Fig. 12

Description. FEMALE (Figs. 12a–c): 15 mm. Integument black. Tomentum of face and occiput yellowish, that of front brownish. Hairs of lower half of mystax yellowish; upper half with 3 strong, short black bristles, 5 or 6 longer black hairs and abundant shorter black hairs. Hairs and bristles of antenna and front black; 9 ocellar hairs, 2 slightly longer than others. Postocular bristles black, 6 or 7 on each side of vertex proclinate with inner 2–3 strongly so; a few weaker black hairs immediately behind proclinate bristles with remaining occipital hairs white. Third antennal segment length twice its width, slightly longer than basal segment, and with 2 short dorsal hairs; style slightly more than twice length of the 3 segments combined.

Thorax dark brown to black. Pollen of scutum mostly brown; yellowish white to yellowish brown in grooves and on sides; yellowish white behind, on scutellum and pleuron. Scutal bristles and hairs black, weak pile primarily black, some pale; 2

notopleural, 1 supra-alar, and 1 postalar bristles; abundant bristly hairs above wings and between dorsocentrals; dorsocentrals extend full length of scutum, shorter anteriorly, stronger and more abundant posteriorly. Scutellum with abundant black slender hairs, somewhat shorter and weaker basally, becoming gradually longer and slightly thicker posteriorly on margin; marginal hairs not obviously different from those on disc. Pleural pile mostly pale, scattered in thin patches or absent; some weak bristly black pile on an- and katepisternum. Row of pleural bristles black on upper half and pale yellow or whitish on lower half. Halter reddish brown.

Legs black. Coxae with yellowish white pollen, and yellowish bristles and hairs. Femora and tibiae with primarily yellowish hairs and setae, bristles mostly black; femora with 1–2 short apical bristly black hairs and some black apical setae; fore femur with 1 short black bristle on basal fourth; middle femur with 4–5 black bristles on basal half; 4 additional black ones on anterior face, and 1 posteroapical setigerous black bristle. Hind femur with 1 black bristle on anterior face and most bristles on anteroventral row black. Tibiae and tarsi with black bristly hairs and bristles except for 1 yellowish one on fore tibia and tarsus and 2–3 on middle tibia.

Wing hyaline; veins dark brown, lighter basally; r-m crossvein beyond middle of discal cell.

Abdomen black, apical borders of most segments brownish. Tergites with whitish or yellowish white pollen on lateral margins and on sternites. Dark areas of tergites with traces of brownish pollen and short setae; pale yellowish setae and hairs on sides of tergites and sternite. Sides of tergites 1 and 2 with abundant pale hairs, tergite 1 with 2 black bristles. Tergite 8 shiny black with long black bristly hairs. Sternite 8 greatly arched upward on apical half and with V-shaped pattern of long black bristles; apical margins with 2 apical protuberances and a median notch, an arched ridge on apical third with shiny lateral depressions. Cercus with abundant pale pile and a few scattered short bristly black hairs dorsally and apically. Ventral plates below cercus with a short lateral lobe and several short spine-like bristles.

Male unknown.

Holotype. ♀, Haiti, Furcy, July 25, 1950 (A. Curtiss). The holotype is stored in the AMNH.

Etymology. Ommatius nigellus is named for its uniform black body.

Diagnosis. Ommatius nigellus is recognized by its black body, yellowish and black vestiture of the face and legs, several strongly proclinate postocular bristles, a row of black and white pleural bristles and abundant black scutellar hairs. This species is similar to *O. haitiensis,* n. sp. but can be separated from it by the presence of yellowish hairs in the lower half of the face, absence of anepimeral and strong marginal scutellar bristles and the presence of a row of pleural bristles of which the upper half is black and the lower half pale.

Ommatius stramineus, new species

Fig. 13

Description. MALE (Figs. 13a, b): 13.0 mm. Integument brown. Tomentum of head bright yellow, yellowish brown at some light angles. Bristles and hairs of face yellow, those of antennal segments, front, ocellar and postoculars brown, remaining

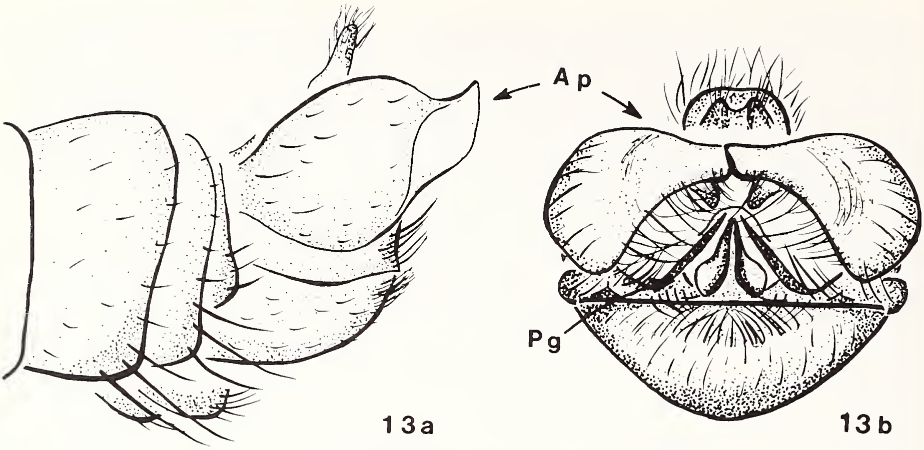


Fig. 13. *Ommatius stramineus,* male terminalia; lateral (a) and ventral (b) views.

occipital vestiture yellowish; two long ocellar bristles and several (7) shorter ones. First and third antennal segments about equal lengths and about one-third longer than second; third segment length twice its width and with 1 or 2 dorsal inconspicuous bristles; style almost twice length of the 3 segments combined.

Thorax dark brown, scutum with brownish pollen, yellow to light brownish yellow pollen in grooves, on sides, behind, on scutellum and pleura. Scutal bristles dark brown to black with 2 notopleurals, 1 supra-alar, 1 postalar and 4–5 weak yellowish posterior dorsocentrals on each side. Thoracic pile weak and pale, most abundant on prothorax, humeral callus and on anepisternum; few scattered hairs between dorsocentrals and on pleura, meron bare. Scutellum with sparse, weak and yellowish pile, bristles absent along margin. Row of yellowish bristly hairs above hind coxa. Halter brownish yellow.

Legs. Coxae brown with light yellow tomentum, yellowish bristles and hairs. Femora, tarsi and apical third of hind tibia brown, a lighter narrow apical brown band on anterior 4 tibiae. Legs with weak yellowish hairs and setae, some black on femoral apices and black setulae on tibiae. One or 2 short black bristly hairs apically on femora. Femoral bristles yellowish except black as follows: middle femur with 5 anteriorly and 1 posteriorly; hind femur with 3–4 anteriorly and all but 2 or 3 black in both ventral rows. Tibial and tarsal bristles primarily black, only 2 or 3 yellow bristles on anterior 4 tibiae and 4 on fore tarsus.

Wing hyaline. Veins brown, dark apically, lighter basally; costa slightly bulging, anterior cells rippled and with a brownish tint, especially along veins in bulge; r-m crossvein before middle of discal cell.

Abdomen yellowish brown, apical borders yellowish. Pollen yellow, abundant on basal 4 segments and traces of brown above. Hairs and setae primarily yellow, some brown on dorsum of last 3 tergites; hairs long and thin on basal segments with 2–3 bristly hairs on apical corners of tergites 5–8 and 2 yellow stiff bristles on tergite 1.

Terminalia yellowish brown to dark brown; hairs and bristles yellow. Epandrium

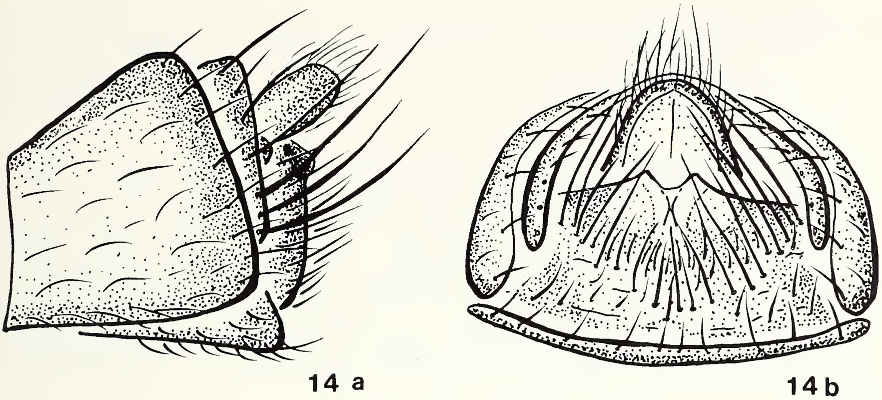


Fig. 14. *Ommatius cinnamomeus,* female terminalia; lateral (a) and ventral (b) views.

dark brown, greatly inflated on basal three-fourths; apical fourth thin, yellowish brown, strongly narrowed below, slightly truncate apically. Hypandrium dark brown, apical margin straight or nearly so. Gonocoxal with short stiff bristly hair basally and two slender projections, basally separated, apically converging. Gonostylus slightly curved, slender, somewhat flattened laterally. Ventral plates below cercus fused, forming a large single plate with two apical swollen ridges, the apex bearing yellow pile.

Female unknown.

Holotype. ♂, Haiti, Mt. Bouretta, 5,000 ft., 15 September 1934 (M. Bates). Paratype: ♂, Dominican Republic, Constanze, 3,000–4,000 ft. (Darlington). The holotype is stored in the USNM and the paratype in the MCZ.

Variation. The male paratype is identical to the holotype except as follows: length 14.0 mm; the body is darker, especially the femora, tarsi and abdomen; the proclinate bristles are yellow, and additional black bristles are on the hind femur; the apical margin of the epandrium is somewhat truncate.

Etymology. This species is named for the pale straw-colored tomentum of the face.

Diagnosis. Ommatius stramineus is easily recognized by its yellow facial tomentum and vestiture, femora wholly brown, deep yellow pollinose abdomen, a slight bulge in the costal margin, an epandrium with the apical margin somewhat truncate and an absence of marginal scutellar bristles. This species is somewhat similar to *O. vitreus* but differs from that species by a stronger body, a slight bulge in the costal margin and the absence of an apically bifurcated epandrium.

Ommatius cinnamomeus, new species
Fig. 14

Description. FEMALE (Figs. 14a, b): 20.0 mm. Head brown to black. Tomentum of face pale yellow, front yellowish brown, occiput pale yellowish to pale brownish gray; 2 long ocellar and 6 proclinate postocular bristles black, remaining occipital hairs pale yellow. Facial bristles and hairs pale yellow. Antennal basal segment slightly longer than second or third; third segment length slightly more than twice width; antennal bristles dark to pale brown, third segment with two short inconspicuous bristles dorsally; style length about one and one-half times that of all segments combined.

Thorax dark brown. Dorsum with bright brown pollen, deep yellowish brown behind humeral callus, lighter in grooves, on sides of and behind the scutum; pollen of scutellum brownish, that of pleuron brownish to yellowish gray. Scutal bristles black as follows: 2 notopleurals, 1 supra-alar, 1 postalar; 4 bristly dorsocentrals posteriorly and several short weaker ones anteriorly. Several dark bristly hairs on side above wing. Pale thoracic pile abundant on prothorax and humeral callus, less abundant and sparse elsewhere. Scutellum with long pale pile, none on margin as conspicuous pair. Row of pleural bristles whitish yellow. Halter brown with stalk lightest.

Legs. Coxae brown with yellowish gray pollen and pale yellowish bristles and hairs. Femora and tibiae mostly yellowish to brownish yellow; anterior legs lightest, dark brown as follows: apical third to half of femora; a narrow apical dark band on fore and middle tibiae and apical fourth to third on hind tibia. Tarsi dark brown to black except basal tarsomeres slightly lighter. Pile and setae of legs mostly pale yellow with 1–2 black bristly apical hairs and black dorsoapical setae on femora, black setulae on tibiae, fore tibia with a ventral row of long thin black hairs; femora with bristles pale yellowish to orangish except as follows: middle femur with 5 black bristles anteriorly, and 1 posterodorsal bristle; hind femur with 1 or 2 setigerous black, apical bristles in each ventral row. Tibial and tarsal bristles black except for 1–3 yellowish ones on fore and middle tibiae and fore tarsus.

Wing hyaline with a slight brownish tint, costal cell darker in part; costal margin without bulge; r-m crossvein beyond middle of discal cell.

Abdomen dark brown with margins of segments lighter. Segments with yellowish brown to brown pollen, sternites and sides of posterior 3 or 4 tergites somewhat lighter. Dark brown setae on dark areas of tergites; thin pale hairs on lighter pollinose areas, longest on basal 3 or 4 segments; bristles on basal segments yellowish. Apical margins of tergites 7–8 with several black bristly hairs or bristles. Most of tergite 8 and all of 9 hidden from above by preceding tergites. Cercus with yellowish pubescence, a few weak and bristly brown and yellowish hairs along margins. Sternite 8 with yellowish pubescence and a V-shaped pattern of black bristles; the apical margin with a notch and lateral protuberances; a strong elevated ridge (in lateral view) and a shallow, shiny depression on each side.

Male unknown.

Holotype. ♀, Haiti, NE foothills, La Hotte, 200–400 ft., October 10–24, 1934 (Darlington). The holotype is in the USNM.

Etymology. This species is named for the brown pollen on the thoracic dorsum.

Diagnosis. Ommatius cinnamomeus is easily recognized by its large size, pale yellow facial tomentum and hairs, brown scutal pollen and bristles, brownish tint of the wing surface, legs mostly yellowish to yellowish brown and the absence of marginal scutellar bristles. This species runs to *O. tibialis* in Curran's key (1928) but differs from that species in its larger robust body, more extensive yellow ground color of the fore femur, the presence of only brown hairs on sternite 8 and the absence of pale or yellowish scutal bristles. Females of *O. tibialis* typically have the anterior surface of the fore femur black, occipital and pleural pollen white or gray and hair of sternite 8 white or yellowish.

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LITERATURE CITED

Bigot, J. M. F. 1875. Dipteres nouveaux ou peu connus. 4e partie V. Asilides exotiques nouveaux. Ann. Soc. Entomol. France (5)5:237–248.

Curran, C. H. 1928. New species of *Ommatius* from America, with key (Asilidae: Diptera). Amer. Mus. Nov. 327:1–6.

Farr, T. H. 1965. The robber-flies of Jamaica (Diptera: Asilidae). Pt. 2. Bull. Inst. Jamaica Sci. Ser. 13:5–36.

Hull, F. R. 1962. Robberflies of the world: the genera of the family Asilidae. Bull. U.S. Nat. Mus. Pt. 2 224:443–446.

Martin, C. H. and N. Papavero. 1970. Family Asilidae. *In:* A catalogue of the Diptera of the Americas South of the United States. Mus. Zool. Univ. São Paulo (35b):1–139.

McAlpine, J. F. 1981. Morphology and terminology—adults. *In* Biosystematic Research Institute (eds.), Manual of Nearctic Diptera. Agriculture Canada, Research Branch, Ottawa. Monograph 27, Vol. 1:9–63.

Scarbrough, A. G. 1983. A new species of *Ommatius* Wiedemann from San Salvador, the Bahamas. Proc. Entomol. Soc. Wash. 85:144–151.

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PROPLEURAL TRANSFORMATIONS WITH RESPECT TO THE DISPOSITION OF PROPLEURAL SUTURE IN ORDER HYMENOPTERA

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Abstract.—A distinct propleural suture, well developed proepisternum and considerably reduced proepimeron are clearly represented in Pamphiliidae, Xyelidae, Argidae, Tenthredinidae, Diprionidae and Cimbicidae. In Cephidae, this suture has shifted slightly backward, thus, further reducing the area of proepimeron. In Xiphydridae, the backward shift is more pronounced and the posterior half of this suture has become marginal. In Siricidae, the entire propleural suture has become almost marginal and the epimeral area if any is in the form of a thickened posterior margin of propleural plate. In most of the apocritan families the same state is maintained. In Formicidae even the thickened posterior margin of propleuron is absent. These observations collectively help to establish a systematically changing pattern to which can be attached some evolutionary significance within the order Hymenoptera.

The work that follows specifically deals with the positional variations and gradual backward shifting of the propleural suture within the order Hymenoptera. The extent and magnitude of the changes pertaining to the course of this suture as well as the size of the epimeron are evolutionarily significant and bring to light some phylogenetic relationships among different families of this insect order. The available literature is completely devoid of such comprehensive studies excepting those of Snodgrass (1910) and Matsuda (1970) which cover too limited a number of hymenopteran families.

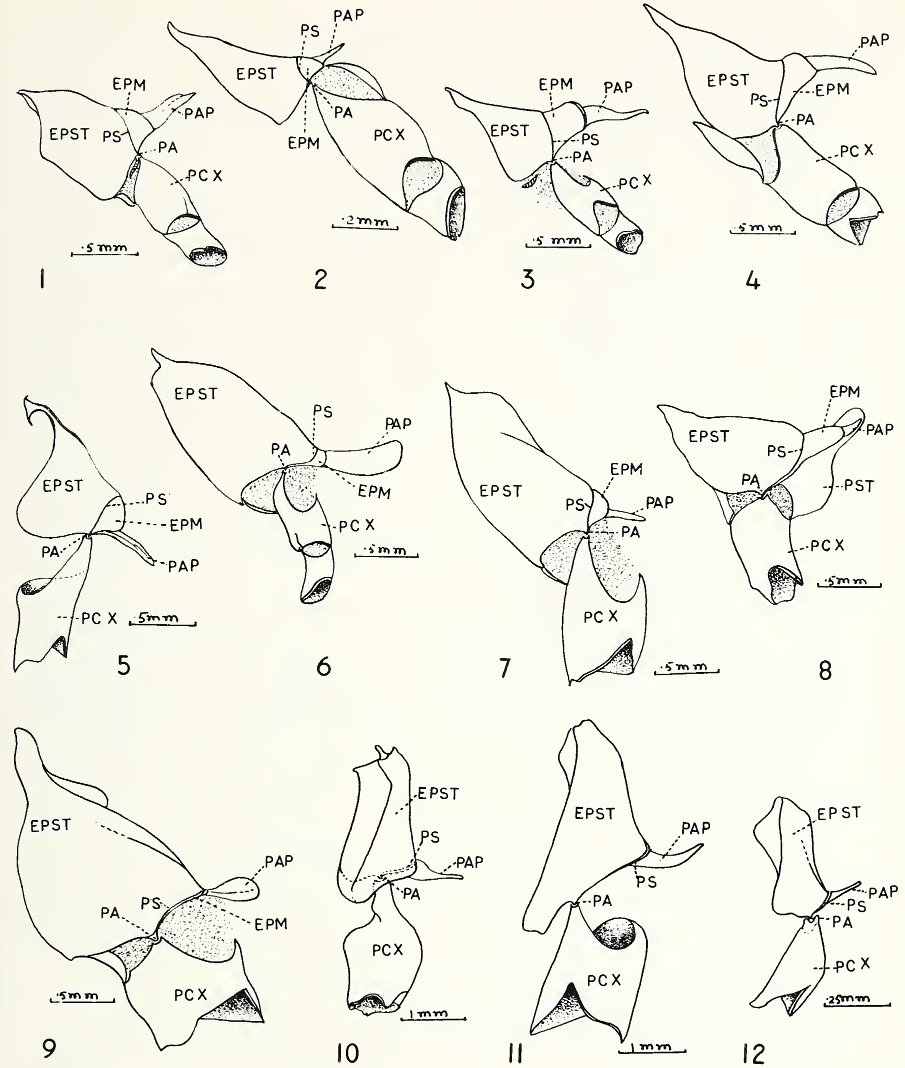
However, a good deal of literature is available concerning the hymenopteran morphology. Some important works include Crampton (1909, 1926), Snodgrass (1942), Martin (1916), Weber (1927), Duncan (1939), Alam (1951), Arora (1953), Wong (1963) and Dhillon (1966). These authors mainly worked on an ontological basis rather than on the comparative basis, which is the main objective of the present work. This work is based on the study of 22 different hymenopteran families.

MATERIALS AND METHODS

Most specimens of Apocrita were collected from the Punjab and Himachal Pradesh during September and October 1975 and preserved in 80 percent alcohol. Except for Megalodontidae, Orussidae and Pergidae, Symphyta were supplied by the Biosystematic Research Institute, Canada, and the Zoological Survey of India. Since these specimens were dry, they were softened in 2 percent KOH for 6 days. Drawings were made with the help of a binocular microscope fitted with an ocular grid.

OBSERVATIONS AND DISCUSSION

The presence of a distinct propleural suture in some lower symphytans with its gradual backward displacement among the higher symphytans till it takes up a mar-

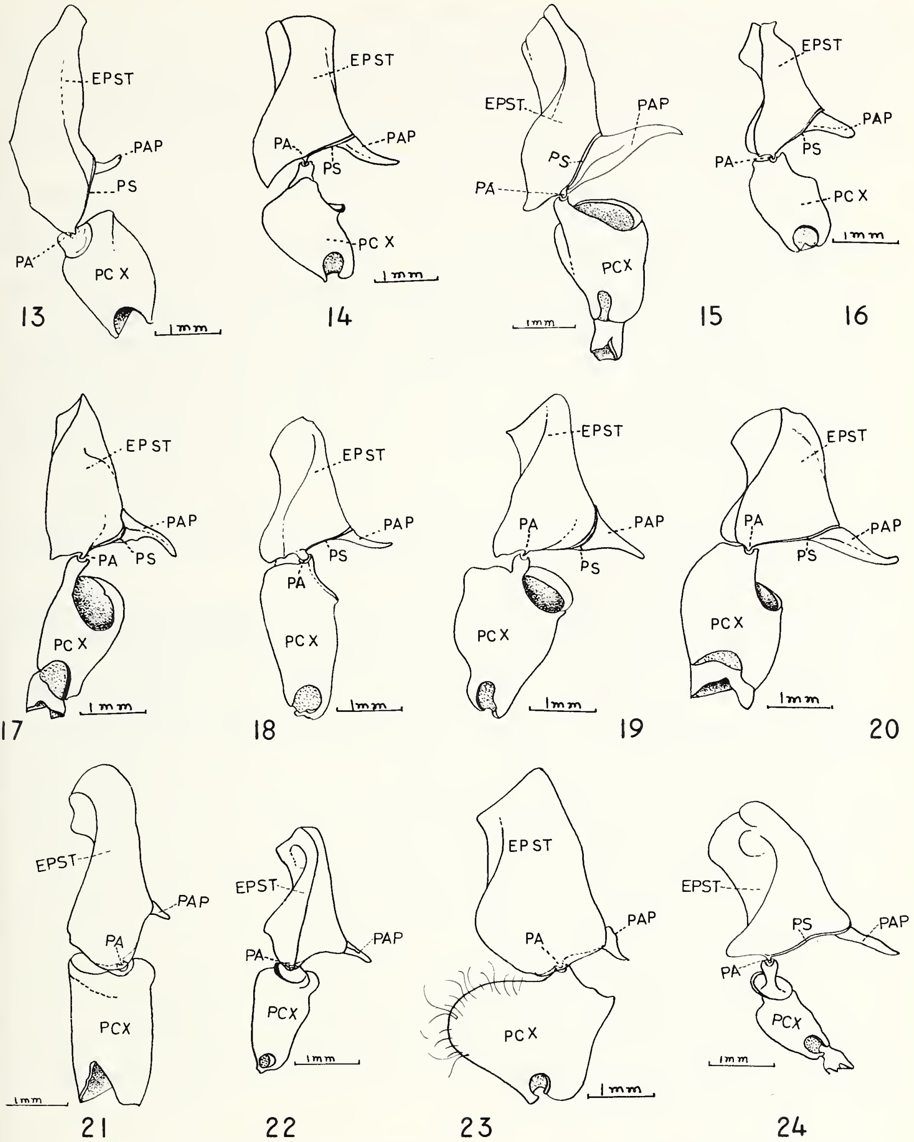


Figs. 1–12. Side view of the propleural plate of: 1. *Acantholyda maculiventris* (Pamphiliidae). 2. *Xyela bakeri* (Xyelidae). 3. *Arge clavicornis* (Argidae). 4. *Neodiprion abietis* (Diprionidae). 5. *Tenthredo verticalis* (Tenthredinidae). 6. *Xiphydria mellipes* (Xiphydridae). 7. *Cephus cinctus* (Cephidae). 8. *Cimbex americana americana* (Cimbicidae). 9. *Sirex cyaneus* (Siricidae). 10. *Netelia kashmirensis* (Ichneumonidae). 11. *Trachysphyrus* sp. (Ichneumonidae). 12. *Sycoscapter stabilis* (Torymidae). *Abbreviations* (used also in Figs. 13–24): EPM—epimeron; EPST—episternum; PA—pleural articulation; PAP—pleural apophysis; PCX—procoxa; PS—pleural suture; PST—prosternum.

ginal course in the members of family Siricidae and all of the Apocrita, indicates a trend which may have some evolutionary and phylogenetic significance. A coherent account of all these modifications is as follows.

In *Acantholyda maculiventris* (Norton) (Fig. 1) (Pamphiliidae), *Xyela bakeri* Konow (Fig. 2) (Xyelidae), *Arge clavicornis* (F.) (Fig. 3) (Argidae) *Tenthredo verticalis* Say (Fig. 5) (Tenthredinidae), *Cimbex americana americana* Leach (Fig. 8) (Cimbicidae) and *Neodiprion abietis* (Harris) (Fig. 4) (Diprionidae) the propleural suture is well represented. In all these cases this suture takes up a course which starts from the pleural articulation of the first coxa, curves around the posterodorsal angle of the propleural plate and ends up at the base of the concavity which receives the lateral tip of the furcal arm of the prosternum. Internally, this suture is represented by a distinct pleural ridge. The small area lying posterior to this suture is the proepimeron, the large dominating area anterior to this suture being the proepisternum. Similar conditions have also been observed in *Onycholyda luteicornis* (Norton) and *Cephalcia provancheri* (Huard) (Pamphiliidae), *Zarae inflata* Norton (Cimbicidae), *Pristiphora cincta* Newman, *Pachyprotasis versicolor* Cameron, *Pachyprotasis brunetti* Rohw. and *Eutomostethus assamensis* (Rohw.) (Tenthredinidae). Such a condition has also been described and similarly labelled by Snodgrass (1910), Wong (1963) and Dhillon (1966) and under the name of cervicopleuron by Crampton (1909, 1926), Martin (1916), Weber (1927) and Arora (1953).

Matsuda (1970) in *Arge* sp. took the generalized propleural suture as the anapleural suture and thus labelled the area anterior to it as the combination of pre-episternum and the kate-episternum while the small area lying posterior to this suture as the anepisternum. According to him the actual propleural suture has become marginal and consequently the area of proepimeron has been obliterated. In addition to the anapleural suture, Matsuda showed the presence of a separate submarginal propleural suture in *Schizocerus* sp. and *Dolerus* sp.—on which Weber (1927) and Crampton (1926) worked, respectively—but did not label any separate submarginal suture. However, on the basis of comparative study the present author is of the view that there exists no anapleural suture in the propleuron of Symphyta. As the anapleural suture of Matsuda (1970) bears some of the identification marks of the pleural suture, i.e., its ventral end forms the pleural articular condyl which provides the pleural articulation to the procoxa (a condition very much similar to meso- and metapleuron and its dorsal end forms an articular facet which receives the lateral tip of the furcal arm of the prosternum, a condition again similar to that usually met with meso- and metafurcasternal arms which are generally associated with the pleural suture, particularly in Symphyta), so it is proposed to take this suture as the propleural suture. To substantiate the above view it is further added that anapleural suture is not a constant feature of all the symphytans (Saini and Dhillon, 1980), whereas, the pleural suture is a constant feature within the entire range of Symphyta. Moreover, when present, the anapleural suture takes up altogether a different and variable course than that of the pleural suture (Matsuda, 1970; Saini and Dhillon, 1980). To confirm the validity of Matsuda's (1970) anapleural suture and a marginal pleural suture in *Arge* sp. the present author studied some more species of *Arge,* viz. *Arge simlaensis, A. fumipennis, A. bipunctata,* and *A. xanthogastra,* but failed to recognise any marginal suture. However, if in the insect studied by Matsuda (1970) any marginal suture is



Figs. 13–24. 13. *Chrysis indogotea* (Chrysididae). 14. *Scolia quadripustulata* (Scoliidae). 15. *Scelephron intrudens* (Sphecidae). 16. *Stizus vespiformis* (Sphecidae). 17. *Eumenes dimidiatepennis* (Eumenidae). 18. *Calicurgus* sp. (Pompilidae). 19. *Vespa orientalis* (Vespidae). 20. *Xylocopa lemuiscapa* (Xylocopidae). 21. *Camponotus camelinus* (Formicidae). 22. *Tetraponera rufonigra* (Formicidae). 23. *Dorylus labiatus* (Formicidae). 24. *Mutilla* sp. (Mutillidae).

present, that can be safely taken as the transepimeral suture as is the case in mesoepimeron of *Arge clavicornis* (Saini and Dhillon, 1980).

The next stage in the evolutionary series can be observed in the members of family Cephidae. In *Cephus cinctus* Norton (Fig. 7) due to the backward shifting of the propleural suture the area of the epimeron is further narrowed. However, the identification marks of the suture are quite prominent and distinct.

In *Xiphydria mellipes* Harris (Fig. 6) (Xiphydridae) the backward shifting of this suture is more pronounced and consequently the area of epimeron has been further reduced. At this stage the basal half of this suture has become already submarginal. This shows an inclination of this suture for becoming submarginal, a fact which is evident in siricids. The identifying features of the pleural suture are quite clear.

In *Sirex cyaneus* F. (Fig. 9) (Siricidae) the propleural suture has become submarginal and consequently the area of proepimeron has been almost obliterated. Submarginal nature of the suture can be confirmed by the presence of a distinct submarginal ridge, which on its ventral end gives rise to the pleural articular condyle, that provides pleural articulation to the procoxa. However, the dorsal half of the pleural ridge leading to the concavity which receives the furcal arm of the furcasternum has become almost inconspicuous. So, on the whole the propleural plate is entirely represented by proepisternum alone. Similar conditions have also been described by Snodgrass (1910) in *Tremex columba* (Siricidae).

In Hymenoptera Apocrita, the propleural suture has become completely marginal, thus, losing its independent identity. Its ancestral presence is indicated only by the thickened posterior margin of the propleuron. This thick margin is thought to contain the remnants of the pleural ridge. The other remnants of the disappeared pleural suture are the presence of pleural articular condyle and an association of the furcal arm of the prosternum with this thickened posterodorsal margin. The above observations have been made on different apocritans which include *Sycoscapter stabilis* (Walker) (Fig. 12) (Torymidae, Chalcidoidea), *Netelia kashmirensis* Cameron (Fig. 10) and *Trachysphyrus* sp. (Fig. 11) (Ichneumonidae), *Chrysis indogotea* Duf. et Pesr. (Fig. 13) (Chrysididae), *Mutilla* sp. (Fig. 24) (Mutillidae), *Scolia quadripustulata* F. (Fig. 14) (Scoliidae), *Scelephron intrudens* Smith (Fig. 15) *Stizus vespiformis* F. (Fig. 16) (Sphecidae), *Vespa orientalis* L. (Fig. 19) (Vespidae), *Eumenes dimidiatepennis* Sauss (Fig. 17) (Eumenidae), *Calicurgus* sp. (Fig. 18) (Pompilidae) and *Xylocopa lemuiscapa* Westwood (Fig. 20) (Xylocopidae). Similar conditions have been described by Duncan (1939), Snodgrass (1942) and Alam (1951). However, in Formicidae as seen in *Dorylus labiatus* Shuckard (Fig. 23), *Camponotus camelinus* Smith (Fig. 21) and *Tetraponera rufonigra* (Jerdon) (Fig. 22) even the thickened posterior margin of the propleuron is absent.

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LITERATURE CITED

Alam, S. M. 1951. The skeleto-muscular mechanism of *Stenobracon deesae* Cam. (Braconidae, Hymenoptera)—an ectoparasite of sugarcane and juar borers of India. Part I, Head and thorax, Alig. Musl. Univ. Publ. (Zool. Ser.) Ind. Ins. Typ. 3(1):74 pp.

Arora, G. L. 1953. The external morphology of *Diprion pini* L. (Symphyta, Hymenoptera). Res. Bull. E. Punjab Univ. Hoshiarpur. Zool. 25:1–21.

Crampton, G. C. 1909. A contribution to the comparative morphology of the thoracic sclerites of insects. Proc. Acad. Nat. Sci. Philadelphia 61:1–53.

Crampton, G. C. 1926. A comparison of the neck and prothoracic sclerites throughout the orders of insects. Trans. Amer. Ent. Soc. 52:199–248.

Dhillon, S. S. 1966. The morphology and biology of *Athalia proxima* Klug (Tenthredinidae, Hymenoptera). Alig. Musl. Univ. Publ. (Zool. Ser.) Ind. Ins. Typ. 7:165 pp.

Duncan, C. D. 1939. A contribution to the biology of North American vespine wasps. Stanford Univ. Publ. Biol. Sci. 8(1):272 pp.

Martin, J. F. 1916. The thoracic cervical sclerites in Insecta. Ann. Ent. Soc. Amer. 9:35–83.

Matsuda, R. 1970. Morphology and evolution of the insect thorax. Mem. Ent. Soc. Canada 76:431 pp.

Saini, M. S. and S. S. Dhillon. 1980. Changing course of the mesopleural suture in the order Hymenoptera. J. Anim. Morphol. Physiol. 27(1&2):1–9.

Snodgrass, R. E. 1910. The thorax of the Hymenoptera. Proc. U.S. Nat. Mus. 39:37–91.

Snodgrass, R. E. 1942. The skeleto-muscular mechanisms of the honeybee. Smith. Misc. Coll. 103(2):120 pp.

Weber, H. 1927. Die Gliederung der Sternalregion des Tenthrediniden Thorax. Ein Beitrag zur vergleichenden Morphologie des Insektenthorax. Z. Wiss. Insekt. Biol. Berlin 22: 161–198.

Wong, H. R. 1963. The external morphology of the adult and ultimate larval instar of the larch sawfly, *Pristiphora erichsonii* (Htg.) (Hymenoptera: Tenthredinidae). Can. Ent. 95: 807–921.

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TOOL USE BY THE ANT, *NOVOMESSOR ALBISETOSUS* (MAYR)

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Abstract.—Soil-dropping behavior by the arid lands ants, *Novomessor albisetosus* (Mayr), is considered as an example of tool use. Soil-dropping ceases to be a general response to any nest-threatening liquid beyond a certain distance from the nest. As petri dishes of distilled water and honey water are moved farther from the nest, ants stop dropping soil in water but continue doing so in honey water. Since soil dropped in honey water is brought back to the nest, soil-dropping serves the purpose of food retrieval. Questions concerning competitive adaptations must be considered cautiously.

Alcock (1972) has provided an excellent review of tool use in feeding and proposed the following definition: "Tool-using involves the manipulation of an inanimate object, not internally manufactured, with the effect of improving the animal's efficiency in altering the position or form of some separate object" (p. 464). In what may be the first reported case of tool use in a social insect, Lin (1964–1965) described the pavement ant's (*Tetramorium caespitum*) use of soil while attacking halictine bees. Shultz (1982) enlarged on Lin's findings, and Moglich and Alpert (1979) reported similar behavior in a study of stone dropping by *Conomyrma bicolor* Wheeler to possibly interfere with *Myrmecocystus* competition.

The first study of tool use by a social insect in retrieving food was made by Fellers and Fellers (1976). Soil was placed by *Aphaenogaster* workers on jelly bait and later retrieved to the nest. They concluded that tool using may increase the ability of *Aphaenogaster* to compete directly with dominant species. A reconsideration of their findings was presented by Fowler (1982) who found that most of the tools were not retrieved, and concluded that tool use was more important in scramble competition than in direct competitive interaction. Many years before these studies Wheeler (1910) observed that many ants "throw pellets of earth or any other debris" on a "substance that they cannot remove, such as a strong-smelling liquid." He noted that liquids more frequently evoke this behavior and that it may have evolved as a way of protecting the nest against flooding.

Given this conjecture, it is not clear whether any kind of competition was involved in the tool use response of the Feller and Feller (1976) or Fowler (1982) studies or whether tool use to retrieve food was simply the coincidental outcome of a reflexive response to a moist substance, signal of a potentially nest threatening liquid. I report here on the reaction to liquids of *Novomessor albisetosus* (Mayr), an ant closely related to *Aphaenogaster,* and the distribution of "tools" within the nest.

MATERIALS AND METHODS

Laboratory. Petri dishes of honey water (one part honey to 10 parts water) were placed in the foraging arena (61 × 61 × 30 cm). Sand was collected from various parts of the nest (3 plastic boxes joined by tubes in line from the foraging arena); it was also collected from the floor of the foraging arena, midden pile, and petri dish. Sand was analyzed for carbohydrate content by using the anthrone reaction method slightly modified from that described by Scott and Melvin (1953). There were five replications of each treatment. Two other liquids—maple sap (to test a sugar solution of natural dilution) and distilled water—both with and without red food coloring, were also placed in petri dishes in the foraging arena. Petri dishes of only one liquid was available at a time, and sand was removed from the nests after each manipulation. Lastly, water was poured directly into the nest near the exit to the foraging arena.

Field. Fifteen nests of *N. albisetosus* (Mayr) were selected within a 40,000 sq m area about 1 km west of Portal, Arizona. Each was tested with both water and honey water, once during the dry and once during the rainy season. Placement of petri dishes was at various unmeasured distances for the 1st trial during the dry season. Measurements were then taken and assigned randomly to the nests for the 2nd trial, during the rainy season.

RESULTS AND DISCUSSION

Laboratory. Analysis of sugar content in sand from the nest boxes revealed the presence of sugar in increasing quantities as the sand was sampled farther from the nest entrance and closer to the brood (Fig. 1). Sand taken from the second of three nest boxes, had the highest content of sugar (550 ± 5 μg per gram of sand). This was where the queen and brood (especially feeding larvae) remained, and where chunks of sand were first deposited by returning foragers. Although larvae were sometimes found on the sand it was being fed on by workers of all ages. Sand from a stockpile within the same nest chamber, but closer to the entrance, yielded a sugar content of 482 ± 2.2 μg. Samples taken from the next location closer to the entrance, in the first chamber, had 189.7 ± 2.6 μg. The sand pile next to the nest entrance was littered with dried mealworms, dead ants and other debris that were occassionally taken out and placed on the midden heap. This had the least sugar content within the nest (121 ± 4.3 μg). Outside the nest, in the foraging arena, sand taken from the midden heap yielded 94.3 ± 16 μg. Control samples of sand taken from three places in the foraging arena revealed no detectible sugar content. A sample used as a standard for comparison, taken from the petri dish had a sugar content of 568 μg, which was close to the sugar content of sand first deposited in the nest by returning foragers. Following a significant analysis of variance of samples taken from within the nest [$F(4,20) = 3,775.17, P < 0.0001$], comparisons of samples by the Newman-Keuls Multiple Range Test were all significant at the 0.01 level of confidence. Apparently, as the food value of the sand declined with its sugar content it was moved closer to the nest entrance, and eventually removed to the midden pile.

Sand was dropped in both petri dishes of maple sap and distilled water. Both red colored and uncolored sand from the maple sap was eventually taken into the nest, but not sand placed in the water. Sand was also brought into the nest and deposited on the water that had been spilled into the nest. As a further indication that it was considered debris, sand taken from the pile with the least sugar content within the nest was also placed on water flooding the nest.

Because of these results the field study was conducted. The possibility that the ants were responding to any liquid, or treating the foraging arena as part of their nest,

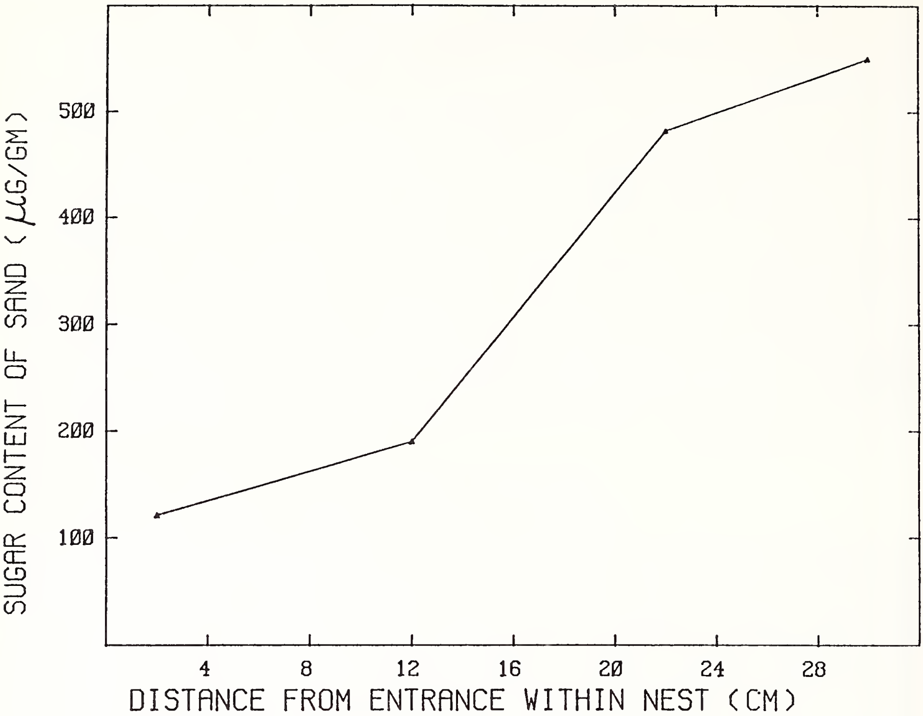

Fig. 1. The relationship between sugar content of sand and position of sand in the nest. Sand brought to the brood at a point farthest from the entrance has the highest sugar content. During stockpiling and nest maintenance, as sand is brought increasingly closer to the entrance, the sugar content of sand decreases.

hence soaking up any nest-threatening liquid with sand, could not be overlooked. Of course, this behavior itself could be viewed as tool use. However, I wanted to see if returning to the nest with sugar-coated sand was not just coincidental to the ants' dropping soil in any liquid and then discovering that the soil was sweet.

Field. The distances that water and honey water were placed from the nest entrances, both before and after the rainy season, are presented in Table 1. During the dry season soil was regularly dropped into water up to 2.13 m from the nest, though in diminishing quantities as water was placed farther from the nest. Recruitment to water was observed up to 6.1 m from the nest, through the response at this distance, 10 ants in 20 min, was about one-third the response to honey water at the same distance. No ants returned to the nest with soil (pebbles and sand) that they had dropped into the water. During the wet season (after mid-August in 1982, it usually begins early in July) soil was dropped into water up to 1.22 m from the nest but not beyond, although there was recruitment (15 ants in 30 min) up to 1.83 m from the nest. Again, no ants returned to the nest with soil from the water. The Fellers (1976) observed *Aphaenogaster* placing "tools" on jelly up to 152 cm from the nest. This is well within the 2.13 m range for dropping soil in water in the present study. What

Table 1. The occurrence of soil-dropping in and recruitment to liquid, and returning to nest with sand dropped in liquid.

Distance (m) from nest	Before rains						After rains					
	Water			Honey water			Water			Honey water		
	Soil	Recruit	Return	Soil	Recruit	Return	Soil	Recruit	Return	Soil	Recruit	Return
0.61	+	+	0	+	+	+	+	+	0	+	+	+
1.22	+	+	0	+	+	+	+	+	0	+	+	+
1.83	+	+	0	+	+	+	0	+	0	+	+	+
2.13	+	+	0	+	+	+	0	0	0	+	+	+
2.44	0	0	0	+	+	+	0	0	0	+	+	+
2.74	0	+	0	+	+	+	0	0	0	+	+	+
3.05	0	0	0	+	+	+	0	0	0	+	+	+
3.66	+[a]	0	0	+	+	+	0	0	0	+	+	+
4.27	0	0	0	+	+	+	0	0	0	0[b]	0	0
4.88	0	0	0	0[c]	0	0	0	0	0	0[c]	0	0
6.1	+[d]	+	0	+	+	+	0	0	0	0[c]	0	0
6.71	0	0	0	+	+	0[e]	0	0	0	+	+	+
9.15	0	0	0	+	+	+	0	0	0	+	+	+
12.2	0	0	0	+	+	+	0	0	0	+	+	+
15.24	0	0	0	+	+	+	0	0	0	+	+	+

[a] Placed 1 m from honey water, 6 pebbles dropped in.
[b] Undiscovered.
[c] *Camponotus* prevented access.
[d] 5 pebbles dropped in.
[e] *Camponotus* prevented return.

they observed may not have been tool use but simply a response to any moist substance.

With but few exceptions soil-dropping and recruitment to honey water, and return to the nest with the soil, was observed in both dry and wet seasons up to 15.24 m from the nest. Unless hindered by a wall of feeding ants surrounding the petri dish (many drank for long periods, up to 45 min), soil-dropping occurred shortly after discovery. At times, ants would crawl over the backs of those feeding in order to drop soil into the honey water. Even when recruitment was not heavy (sometimes as many as 60 ants would recruit to honey water within 30 min) soil-dropping was steadily pursued. Within 3 to 4 hr, petri dishes were filled with enough soil to soak up all the liquid. By dawn most of the soil would be gone and a trickle of ants could still be seen bearing pebbles and chunks of sticky sand back to their nests. (It was noted that where *Camponotus* prevented *N. albisetosus* from access to honey water, *Camponotus* did not drop soil into the liquid but fed from it and patrolled nearby). This finding differs with Fowler's (1982) study in which from 60–96 percent of the tools were not recovered. The colonies he chose may have been smaller than mine, with less of a demand for sugar.

Results from the field studies make it evident that, beyond a certain distance from the nest, soil-dropping is not simply a general response to any liquid. Foragers were selective. Within 2.13 m of the nest, however, the results were not so clear. Given the laboratory ants' behavior of dropping sand in water spilled into their nest, and given that in the field ants drop soil into water from 0.61 to 2.13 m from their nests, but with diminishing intensity as the water approaches 2 m, liquid close to the nest seems to pose a threat. A small puddle of rainwater, for instance, may become larger with more rain and eventually flow into the nest entrance. Levelling surrounding depressions indicated by small puddles may prove adaptive for nest protection. Wheeler's (1910) conjecture about the behavior evolving from a response to nest threatening liquid seems to be reasonable.

Under crowded laboratory conditions, for example when placed in a single box that serves as both nest and foraging space, many ant species, including *N. albisetosus,* will drop debris from their midden piles into honey water. Though at first glance it seems as if they are rejecting the honey water, this may be no more than a response to a nest-threatening liquid by using the closest material available. In laboratory nests, even those with foraging arenas, the debris is often not fed on for many days if at all after it has been dropped in the honey water. This is in agreement with Fowler's (1982) finding that most tools are not recovered. Unfortunately, distances from the nest are not given in his study. Further research will have to be done examining the percentage of soil retrieved with increasing distance from the nest.

Since, in the field, the soil-dropping response continued only toward the honey water as the two liquids were placed increasingly farther from the nests, it seems apparent that nest protection ceases to be a possible reason for soil-dropping behavior beyond a certain distance from the nest. The argument of chance has now been made less tenable. That is, beyond 2.13 m it is not the case that the ants are responding generally to a moist substance only to find that the soil which they drop into it becomes laden with sugar, after which they take it back to their nests. Here a better case for tool use can be made.

While the Fellers and Fellers (1976) study demonstrated the greater efficiency of food retrieval by tool use when compared with internal transport their conclusions about competition, as well as Fowler's (1982), must be considered cautiously. Their studies will have to be replicated at greater distances from the nest. Further, experimental artifact, though it seems unlikely, cannot be overlooked. Though the Fellers (1976) state that *Aphaenogaster* puts tools on squashed spiders, they do not say whether the workers retrieved the tools to the nest. I have observed *N. albisetosus* placing soil on a lizard squashed by a car, but not retrieving the soil to their nest. During two summers of studying these ants in the field, I have never observed a natural occurrence of tool use for food retrieval.

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LITERATURE CITED

Alcock, J. 1972. The evolution of the use of tools by feeding animals. Evolution 26:464–473.

Fellers, J. H. and G. M. Fellers. 1976. Tool use in a social insect and its implications for competitive interactions. Science 192:70–72.

Fowler, H. G. 1982. Tool use by *Aphaenogaster* ants: a reconsideration of its role in competitive interactions. Bull. New Jersey Acad. Sci. 27:81–82.

Lin, N. 1964–1965. The use of sand grains by the pavement ant, *Tetramorium caespitum,* while attacking Halictine bees. Bull. Brooklyn Ent. Soc. 59–60:30–34.

Moglich, M. H. J. and G. D. Alpert. 1979. Stone dropping by *Conomyrma bicolor* (Hymenoptera: Formicidae): a new technique of interference competition. Behav. Ecol. and Sociobiol. 6:105–113.

Schultz, G. W. 1982. Soil-dropping behavior of the pavement ant, *Tetramorium caespitum* (L.) (Hymenoptera: Formicidae) against the alkali bee (Hymenoptera: Halictidae). J. Kansas Ent. Soc. 55:277–282.

Scott, T. A. and E. H. Melvin. 1953. Determination of dextran with anthrone. Anal. Chem. 25:1656–1661.

Wheeler, W. M. 1910. Ants: their structure, development and behavior. Columbia University Press, New York.

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FORAGING BEHAVIOR OF THE BEES *HALICTUS LIGATUS* (HYMENOPTERA: HALICTIDAE) AND *CERATINA CALCARATA* (HYMENOPTERA: ANTHOPHORIDAE): FORAGING SPEED ON EARLY-SUMMER COMPOSITE FLOWERS

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Abstract.—Pollen foraging *Halictus ligatus* and both pollen and nectar foraging *Ceratina calcarata* were timed on early-summer flowers on Long Island in New York State. Pollen-collecting *H. ligatus* worked inflorescences of *Erigeron annuus* (Asteraceae) more rapidly (ave. time 9.7 sec) than did *C. calcarata* (ave. time 18.3 sec). Handling time by nectar foragers did not differ significantly from pollen collectors of *C. calcarata.* Handling time was longer on young inflorescences of *E. annuus* that had numerous florets presenting pollen than on older inflorescences with fewer florets. *Halictus ligatus* worked inflorescences of *E. annuus* faster than the larger inflorescences of *Chrysanthemum leucanthemum* (Asteraceae). In addition to working inflorescences faster, *H. ligatus* flew between inflorescences faster than did *C. calcarata.* This suggests that handling time reflects the general pace of bee movement, which differs among bee taxa.

The amount of time bees take to forage on flowers is currently of considerable interest to students of pollination ecology. Indeed, handling time is an important component of contemporary theoretical approaches to foraging (Schoener, 1971; Pyke et al., 1977). However, the actual determinants of handling time on flowers are not yet well understood.

Several factors that influence foraging speed have been identified. There is evidence, for example, that bees that specialize on a flower species can work that flower more rapidly than can generalists, as has been shown for *Hoplitis anthocopoides* (Megachilidae) foraging for pollen on its host plant, *Echium vulgare* (Boraginaceae) (Strickler, 1979). Even among generalized foragers, handling times vary considerably among bee species on a given flower species. This undoubtedly results, in large part, from morphological characteristics of the bees and flowers.

Some authors have suggested that nectar foraging speed is directly related to tongue-length, bees with longer tongues being faster foragers (Brian, 1954; Holm, 1966; Benedek, 1973; Inouye, 1980). Others have proposed that the fastest foragers are those whose tongue-length best matches the corolla-length of the flower (Heinrich, 1976; Ranta and Lundberg, 1980). As might be expected, there is a great deal of variability in the relationship between tongue-length and foraging speed and there are several complicating factors. One is the influence of learning on foraging speed. Individual bumble bees, for example, forage more "accurately" (Heinrich, 1979) and thus more rapidly (Laverty, 1980) as they gain experience working a flower species. Another is that bees take longer working flowers with large amounts of nectar than flowers with little nectar (Thomson and Plowright, 1980; Hodges and Wolf, 1981).

Presumably, ambient temperature can also influence the pace of foraging (Linsley, 1958).

These complicating factors may explain some of the variability in the relationship between tongue-length and handling time (Ranta and Lundberg, 1980). However, it may also be that factors unrelated to tongue-length are major determinants of foraging speed. In the case of pollen-foraging bees especially, handling time may be quite independent of tongue-length. Among pollen foragers, simple correlations of foraging speed with morphological characteristics remain elusive. In the present study, I compare foraging times of two native, nonspecialist bee species on early-summer flowers in the northeastern United States, and examine some factors that may influence handling times on these flowers.

MATERIALS AND METHODS

I timed *Halictus ligatus* Say (Halictidae), a polyphagous, primitively eusocial, soil-nesting bee (Little, 1977; Michener and Bennett, 1977), on freshly-cut daisy (*Chrysanthemum leucanthemum,* Asteraceae) flowers in soda bottles with water. I set up 5 × 5 and 7 × 7 square arrays of regularly distributed flower stalks (50 cm between stalks) on a mowed field on the State University of New York campus at Stony Brook. *Halictus ligatus* can be easily distinguished from most other local bees, but because of their rapid movements in the field I may have mistakenly included a few moves by *H. rubicundus,* a similar species. Also, the process of cutting flowers and placing them in water undoubtedly influences nectar flow and may have modified handling times. The *H. ligatus* foragers were all pollen collectors but they often probed for nectar as well.

To avoid this problem for samples on fleabane (*Erigeron annuus,* Asteraceae), I found a dense patch of flowers and clipped unneeded flower stalks, leaving a 5 × 5 array (arranged as above) of intact flower stalks, presumably with undisturbed nectar and pollen flow. This array was located in a clearing in an open woodland in Nissequogue River State Park near Smithtown, Long Island, New York. I timed *H. ligatus* and *Ceratina calcarata* foraging on this flower array, and on 18 June 1981 I used a hand lens to count the number of florets presenting pollen in each inflorescence in the array.

Ceratina calcarata Robertson (Anthophoridae) is a polyphagous, solitary species that nests in plant twigs (e.g., sumac) that are hollowed-out by the females (Daly, 1973; Kislow, 1976). Female *C. calcarata* cannot be distinguished from *C. dupla,* another local species. However, males of these species are easily distinguishable and all males collected at the study site (N = 15) were *C. calcarata.* Thus, the females I studied were probably also *C. calcarata.*

I sampled *C. leucanthemum* from 26 May to 8 June, and *E. annuus* from 13 to 26 June, 1981. I recorded times on and between flower heads to the nearest one-tenth second with a Cronus digital sports timer. Air temperatures were recorded with a Springfield outdoor thermometer, hung in the shade approximately 0.5 m above the ground near the sample site.

I collected individuals of both bee species and placed them in Dietrich's solution for tongue-length measurements. I measured the labium of each bee under a stereo microscope with an ocular scale. I also measured lengths of corolla tubes of florets from heads of *E. annuus* at Nissequogue River State Park in 1982. Voucher specimens of the bee species were placed in the Cornell University Insect Collection, lot number 1114.

RESULTS

Disc florets of both flower species open in concentric circles around the center of the inflorescence, the outermost florets opening first. Bees that are small relative to the circle of florets follow the circle around the disc collecting nectar and/or pollen. Relatively larger bees stand in the center of the disc and rotate around the central axis, collecting resources from each floret. In general, bees make one revolution, but visits of greater and of less than one revolution are common.

The *Halictus ligatus* foragers (all pollen collectors) worked *Erigeron annuus* inflorescences more rapidly (mean = 9.7 sec, SD = 5.9, N = 57) than did pollen foraging *Ceratina calcarata* (mean = 18.3 sec, SD = 12.1, N = 37) (Wilcoxon 2-sample test, ts = 3.566, $P < 0.05$). In *C. calcarata* there was no significant difference (ts = 0.717) in handling time between pollen and nectar foragers (mean for nectar foragers = 20.8 sec, SD = 14.8, N = 77). It is relevant that pollen foragers generally probed florets for nectar as well. This probing may play a role in pollen collection. On intact stalks of *C. leucanthemum* in 1982, I observed *Ceratina* foragers probing florets with their proboscides, getting pollen dusted onto their heads and mouthparts, and then grooming this pollen onto their scopal hairs. The speed of pollen collecting may thus be related to the speed of nectar foraging in this genus.

The distance from the base of the prementum to the tip of the glossa is commonly used as an estimate of effective tongue-length in bees (Heinrich, 1976; Harder, unpubl. manu.). The prementum plus glossa of *C. calcarata* (mean length = 2.53 mm, SD = 0.177, N = 10) was slightly longer ($t = 7.12$, N = 20, $P < 0.01$) than that of *H. ligatus* (mean length = 2.04 mm, SD = 0.125, N = 10). These bees also differ in labial morphology; the glossa of *C. calcarata* is elongate, while that of *H. ligatus* (a "short-tongued" bee) is short and relatively obtuse. The average corolla-length of *E. annuus* was 1.90 mm (SD = 0.155, N = 50).

Handling time was not correlated with ambient temperature for either bee species (*H. ligatus*, $r = -0.015$, N = 57, $P > 0.9$; *C. calcarata*, $r = -0.152$, N = 155, $0.1 > P > 0.05$; Rohlf and Sokal, 1981:tables 12 and 25), although visits tended to be rapid at high temperatures (Fig. 1). Temperature is probably correlated with time of day and thus with resource levels in flowers, which may have influenced foraging speed. Handling time was more directly related to the number of open florets on a flower head (Table 1). Old inflorescences had fewer florets presenting pollen than did young inflorescences, and bees (*H. ligatus* at least) worked old flower heads faster than young ones. Also, florets in old inflorescences are clustered at the center of the disc while in young inflorescences they are scattered in a circle around the periphery of the disc, so bees have to cover more ground to work a young inflorescence.

Handling time by *H. ligatus* differed on different flower species. The average time on a daisy inflorescence was 12.7 sec (SD = 10.9, N = 25) while on fleabane it was 9.7 sec (SD = 5.9, N = 57; Wilcoxon 2-sample test, ts = 3.310, $P < 0.001$). This may reflect differences in inflorescence size, resource levels, or the number of open florets in each species, but note that the flower species were sampled at different times of

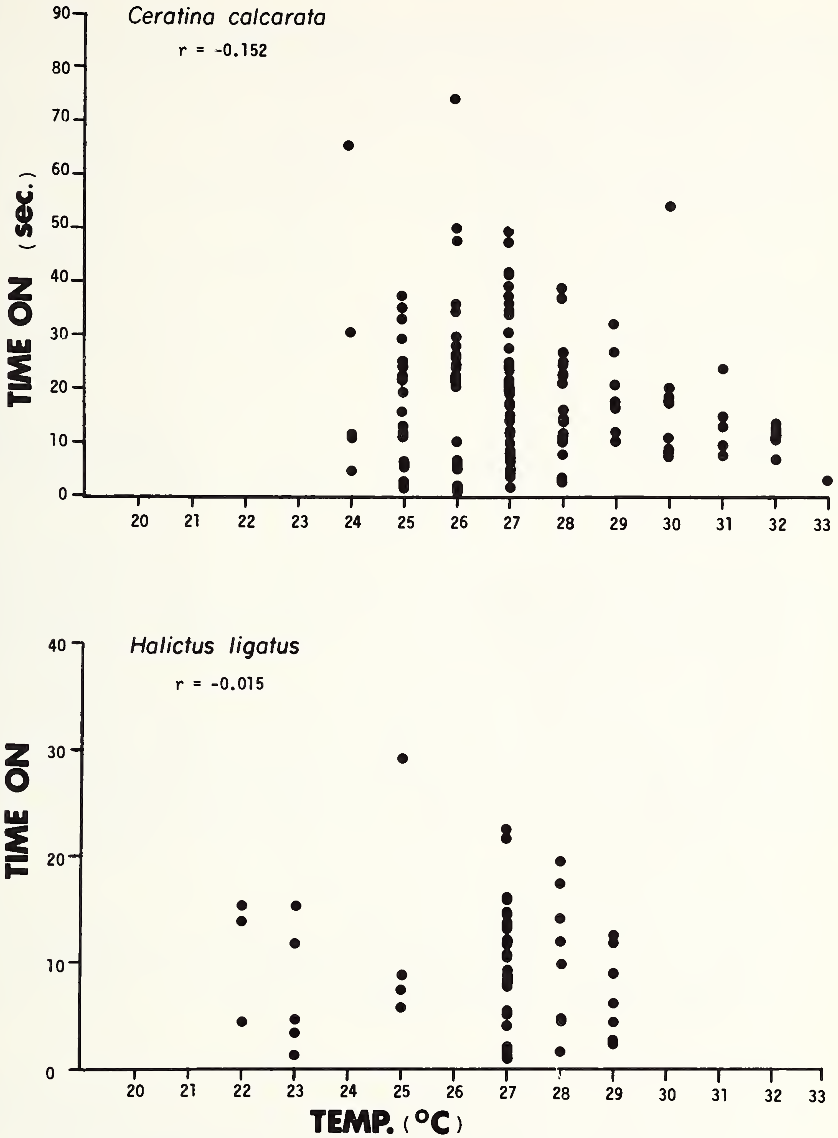

Fig. 1. Handling times on inflorescences of *Erigeron annuus* at different temperatures.

the season. Therefore, differences between overwintering gynes and later-generation workers may also have contributed to this difference in handling time.

Bees took longer to fly between inflorescences on different stalks than between inflorescences on the same stalk (Table 2). Also, in addition to working inflorescences

Table 1. Handling times of *Halictus ligatus* (Halictidae) and *Ceratina calcarata* (Anthophoridae) on *Erigeron annuus* (Asteraceae) as a function of age of inflorescence. (Time in seconds; sample sizes in parentheses. NS = not significant [Kruskal-Wallis tests].)

Age of inflorescence	*H. ligatus* ave. time on	*C. calcarata* ave. time on	Ave. # florets presenting pollen per inflorescence
Young	13.8 (13)	22.2 (37)	20.4 (61)
Intermediate	9.7 (10)	19.9 (31)	19.5 (51)
Old	3.9 (7)	12.7 (12)	8.7 (34)
Significance (alpha = 0.05)	*	NS	*

more slowly, *C. calcarata* flew between inflorescences more slowly than did *H. ligatus.* Thus handling time is correlated with the general pace of movement by the bee.

DISCUSSION

The fact that *Halictus ligatus* spent less time both on and between inflorescences than did *Ceratina calcarata* suggests that each species moves at a set pace that determines the speed of foraging on flowers. In nectar foragers, this pace may be partially set by the relationship between the tongue-length of the bee and the corolla-length of the flower (Ranta and Lundberg, 1980). However, the pace may also be set by any of a number of other factors, especially for pollen foragers. This general pace of foraging may, in fact, be a genus- or higher-level characteristic of bees. *Halictus* may move faster than *Ceratina* for physiological reasons unrelated to tongue-length. Intergeneric comparisons should therefore be made only with great care.

Halictus ligatus is larger than *C. calcarata* (Mitchell, 1960, 1962) and may thus be able to work an inflorescence more rapidly because it moves less between florets. Thus body size may be a correlate of foraging speed. Alternately, *H. ligatus* may simply work fewer florets per inflorescence than *C. calcarata.* My impression was that both species worked about the same number of florets on an inflorescence, but I have no quantitative data on this. Furthermore, this does not account for the difference in flight speed between inflorescences.

Table 2. Time spent flying between inflorescences of *Erigeron annuus* by *Halictus ligatus* and *Ceratina calcarata.* Time in seconds; standard deviation in parentheses. Significance of differences between flight times in each category by Wilcoxon 2-sample tests.

	Average time between inflorescences				
	On same stalk	N	On different stalks	N	
Halictus ligatus	0.6 (0.3)	35	1.3 (0.6)	19	$P < 0.001$
Ceratina calcarata	1.1 (0.9)	131	2.6 (1.3)	51	$P < 0.001$
	$P < 0.001$		$P < 0.001$		

The positive correlation of tongue-length with foraging speed found within the genus *Bombus* (Holm, 1966; Inouye, 1980) does not seem to apply in this case because the shorter-tongued bee in my study (*H. ligatus*) was the faster forager. *Halictus ligatus* does have a closer match of tongue-length to corolla-length of *E. annuus* than does *C. calcarata,* and this may explain its more rapid pace of foraging. However, both species collected pollen as well as nectar so tongue-length may be only marginally important. Nectar-collecting movements play a role in pollen collection by *Ceratina* on daisies, but this may not be true for other bees or on other flowers. Furthermore, my measure of tongue-length (length of prementum plus glossa) is not an accurate estimate of the effective tongue-length of these bees because they differ as to head width and labial structure. *Halictus ligatus* has elongate conjunctival thickenings basal to the prementum (Michener, 1944) that allow the mouthparts to swing forward, so its effective tongue-length may be longer than that of *C. calcarata* (which has only a short postmentum). Precise observations are needed on tongue-extension movements of these bees.

Handling time apparently does not vary with temperature, at least within the range I studied (Fig. 1), but it does differ on different flower species. It is not clear at this point to what extent the foraging pace on a given flower species varies within a bee species (in response to resource levels, etc.), and to what extent it is a fixed characteristic of that bee species. Studies of intra- and inter-taxon variability in bee foraging speeds on flowers with controlled amounts of nectar and pollen will help resolve this issue.

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LITERATURE CITED

Benedek, P. 1973. Relationship between the tripping rate and the tongue length of lucerne pollinating wild bees. Z. Angew. Ent. 73:113–116.

Brian, A. D. 1954. The foraging of bumble bees. Bee World 35:61–67, 81–91.

Daly, H. V. 1973. Bees of the genus *Ceratina* in America north of Mexico (Hymenoptera, Apoidea). Univ. Calif. Publ. Ent. 74:1–114.

Heinrich, B. 1976. Resource partitioning among some eusocial insects: bumblebees. Ecology 57:874–889.

Heinrich, B. 1979. "Majoring" and "minoring" by foraging bumblebees, *Bombus vagans*: an experimental analysis. Ecology 60:245–255.

Hodges, C. M. and L. L. Wolf. 1981. Optimal foraging in bumblebees: why is nectar left behind in flowers? Behav. Ecol. Sociobiol. 9:41–44.

Holm, S. N. 1966. The utilization and management of bumble bees for red clover and alfalfa seed production. Ann. Rev. Ent. 11:155–182.

Inouye, D. W. 1980. The effect of proboscis and corolla tube lengths on patterns and rates of flower visitation by bumble bees. Oecologia 45:197–201.

Kislow, C. J. 1976. The comparative biology of two species of small carpenter bees, *Ceratina strenua* F. Smith and *C. calcarata* Robertson (Hymenoptera: Xylocopidae). Ph.D. thesis, Univ. Georgia, Athens, Ga.

Laverty, T. M. 1980. The flower-visiting behaviour of bumble bees: floral complexity and learning. Can. J. Zool. 58:1324–1335.

Linsley, E. G. 1958. The ecology of solitary bees. Hilgardia 27:543–599.

Litte, M. 1977. Aspects of the social biology of the bee *Halictus ligatus* in New York State. Insectes Sociaux 24:9–36.

Michener, C. D. 1944. Comparative external morphology, phylogeny, and a classification of the bees (Hymenoptera). Bull. Amer. Mus. Natur. Hist. 82:151–326.

Michener, C. D. and F. D. Bennet. 1977. Geographical variation in nesting biology and social organization of *Halictus ligatus*. Univ. Kansas Sci. Bull. 51:233–260.

Mitchell, T. B. 1960. Bees of the Eastern United States. Vol. 1. N. Carolina Agr. Exp. Sta. Tech. Bull. No. 141, 538 pp.

Mitchell, T. B. 1962. Bees of the Eastern United States. Vol. 2. N. Carolina Agr. Exp. Sta. Tech. Bull. No. 152, 557 pp.

Pyke, G. H., H. R. Pulliam, and E. L. Charnov. 1977. Optimal foraging: a selective review of theory and tests. Quart. Rev. Biol. 52:137–154.

Ranta, E. and H. Lundberg. 1980. Resource partitioning in bumblebees: the significance of differences in proboscis length. Oikos 35:298–302.

Rohlf, F. J. and R. R. Sokal. 1981. Statistical Tables, 2nd edition. W. H. Freeman and Co., San Francisco, 219 pp.

Schoener, T. W. 1971. Theory of feeding strategies. Ann. Rev. Ecol. Syst. 2:369–404.

Strickler, K. 1979. Specialization and foraging efficiency of solitary bees. Ecology 60: 998–1009.

Thomson, J. D. and R. C. Plowright. 1980. Pollen carryover, nectar rewards, and pollinator behavior with special references to *Diervilla lonicera*. Oecologia 46:68–74.

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ON THE PSEUDOSCORPION-MIMICKING SPIDER *CHELIFEROIDES* (ARANEAE: SALTICIDAE)

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Abstract.—The male of *Cheliferoides segmentatus* F. O. P.-Cambridge is redescribed and the female is described for the first time; Cambridge's hypothesis that these spiders mimic pseudoscorpions is supported by the discovery of specimens living with chernetids.

Jumping spiders are well known as mimics; many genera are extremely ant-like in appearance and behavior (Reiskind, 1977), and others (such as the Neotropical genus *Cylistella*) are convincing impersonators of beetles. F. O. P.-Cambridge (1901), in describing the male of a Guatemalan jumping spider which he aptly named *Cheliferoides segmentatus,* indicated that a more unusual model might be involved: "One would suspect by its general appearance that this spider mimics one of the Pseudoscorpions." Cambridge's hypothesis has remained uninvestigated (as has the species), but it has recently gained support from the discovery of a male and juvenile specimens living together with several chernetid pseudoscorpions of similar size and appearance under the bark of mesquite in Maricopa County, Arizona; the pseudoscorpions belong to *Parachernes* (Muchmore, *in litt.*). The flatness of the spiders, the modification of the first legs into structures resembling pseudoscorpion palpal chelae, and the abdominal pigmentation, which provides a strongly segmented appearance, all contribute to the resemblance (Figs. 1, 2).

Since the original description of *Cheliferoides segmentatus,* two additional species have been placed in the genus: *C. longimanus* Gertsch (1936) from Texas and *C. planus* Chickering (1946) from Panama. These species do resemble *C. segmentatus* in having an incrassate tibia I, but such modifications occur in a number of other Neotropical genera, such as *Bellota* (see Galiano, 1972a) and *Chirothecia* (see Galiano, 1972b), where they are generally accompanied by a ventral fringe of thick setae. Comparison of the genitalia of *C. longimanus* and *C. planus* indicates that (as was indicated for the first species by Richman and Cutler, 1978) neither of them is closely related to *C. segmentatus.* Each belongs to a different (and possibly undescribed) genus of the *Bellota* complex, but the problem of their proper assignment is beyond the scope of the present paper. Both the genitalic structure and the presence of a small caudal extension of the abdomen support instead Wanless's (1978) hypothesis of a close relationship between *Cheliferoides* and *Marengo,* a genus found in central and southern Africa, Sri Lanka, Malaysia, Borneo, Java, and the Philippines in which the front legs are similarly modified.

I am indebted to Dr. W. B. Muchmore for donating the specimens that initially stimulated this paper. Further material, including the first known females of *C. segmentatus,* was obtained from the collection of the American Museum of Natural History (AMNH) and from Drs. F. Wanless of the British Museum (Natural History)

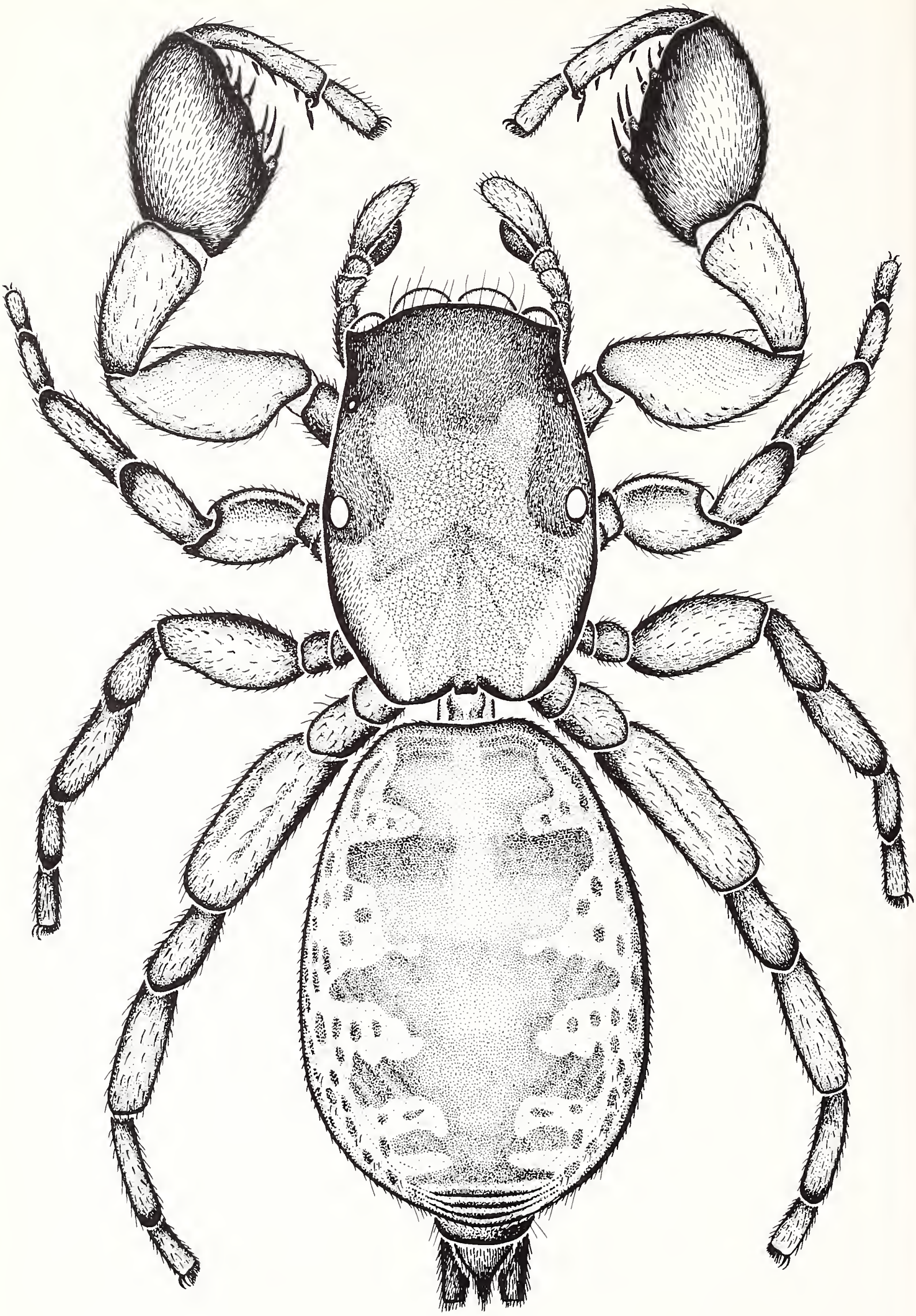
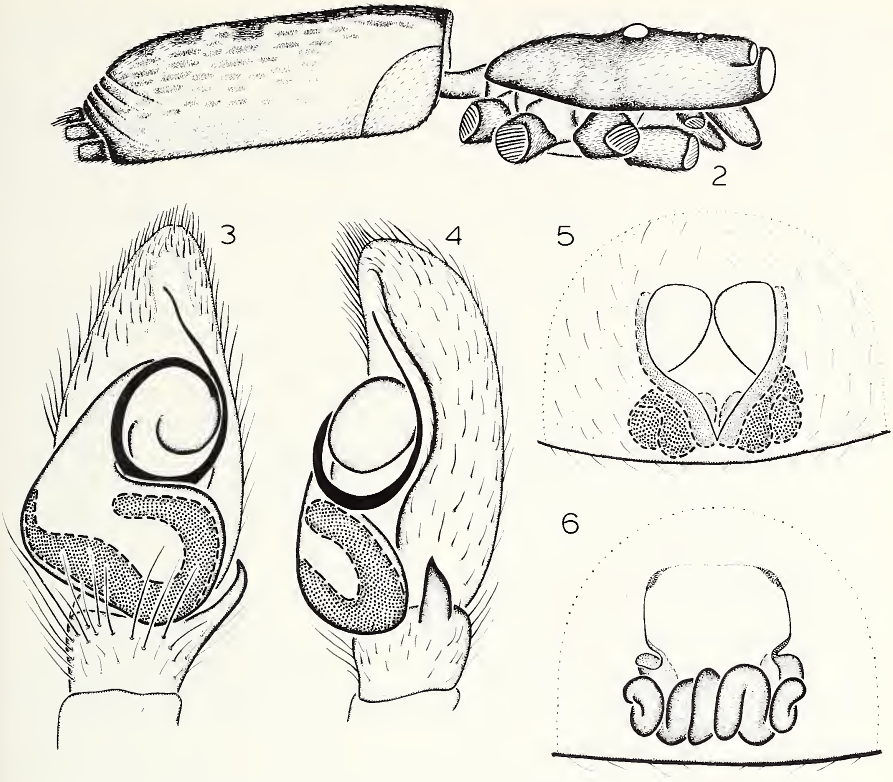


Fig. 1. *Cheliferoides segmentatus* F. O. P.-Cambridge, male, dorsal view.



Figs. 2–6. *Cheliferoides segmentatus* F. O. P.-Cambridge. 2. Cephalothorax and abdomen, lateral view. 3. Palp, ventral view. 4. Palp, retrolateral view. 5. Epigynum, ventral view. 6. Epigynum, dorsal view.

(BMNH), W. Pulawski of the California Academy of Sciences (CAS), G. B. Edwards of the Florida State Collection of Arthropods (FSCA), and H. W. Levi of the Museum of Comparative Zoology (MCZ). Drs. Wanless and Edwards, as well as Drs. B. Cutler, M. E. Galiano, C. E. Griswold, and D. B. Richman, generously shared their knowledge of salticids. The illustrations are by Dr. M. U. Shadab of the American Museum. The format of the description follows that of Wanless (1978).

Cheliferoides segmentatus F. O. P.-Cambridge

Figs. 1–6

Cheliferoides segmentatus F. O. P.-Cambridge, 1901:254, pl. 22, figs. 12a–f (male holotype from Guatemala, no specific locality, in BMNH, examined [the holotype lacks both palpi; a single palp in the holotype vial does not correspond to Cambridge's figures or to the palpi of other specimens, and belongs to some other spider]). Richman and Cutler, 1978:84.

Diagnosis. The modifications of leg I (Fig. 1), together with the basally widened bulb and spiral embolus of males (Figs. 3, 4) and the posteriorly coiled epigynal ducts of females (Figs. 5, 6), are diagnostic.

Male (Arizona). *Carapace* flattened, reticulate, with evenly distributed white setae, dark brown, with area enclosed by front two eye rows and extending back along sides of raised portion of pars cephalica to level of posterior eye row blackened, sides orangeish except for dark lateral margins (Fig. 1); thoracic groove indicated only by slight depression. *Eyes* in three rows, anteriors subcontiguous, with apices forming distinctly recurved row, middle row slightly closer to posterior row than to anterior; posterior row wider than anterior; quadrangle occupying almost half of carapace length. *Clypeus* low, sloping backwards, with fringe of white squamous setae extending back to level of coxae I. *Chelicerae* small, subvertical; promargin with two teeth, retromargin with one; anterior surface with white squamous setae proximally. *Endites* parallel, distally globose, with anterolateral serrula and anteromedian scopula. *Labium* slightly wider than long. *Sternum* oval, obtuse posteriorly, brown with scattered darker pigment. *Abdomen* flattened, without dorsal scutum, light brownish yellow, dorsum with dark brown markings providing segmental appearance, sides with scattered dark brown spots, venter gray; posterior portion of dorsum with five telescoping folds preceding elongated anal tubercle forming small caudal projection (Fig. 2); spinnerets subequal in length, anteriors robust, medians and posteriors slender; colulus apparently absent. *Legs* with first pair massive, femur, patella, and tibia grossly enlarged, tibia with robust spines on well developed socket flanges but without ventral fringe of stiff setae, metatarsus with distal prolateral spine robust, originating from distinct cuticular lobe, opposing first tibial spine; remaining legs slender, formula 1432; leg I with femur and patella light brown, tibia dark brown, metatarsi and tarsi orange, other legs yellow, femora and tibiae with prolateral dark stripes, patellae, tibiae, and metatarsi with proximal and distal dark rings; spination: femora: II, III d0-0-1, p0-0-1; IV d0-1-1; tibiae: I v0-3-3; II v0-2-1; metatarsi: I v0-2-2; II v0-1-0; claw tufts present, scopulae absent. *Palp* with slender, apically bent tibial apophysis; tegulum wide basally, with conspicuous spermophore duct and distally coiled embolus (Figs. 3, 4). *Dimensions:* total length 3.38; carapace length 1.40, width 0.90; abdomen length 1.84; eyes anterior row 0.78, middle row 0.72, posterior row 0.86, quadrangle length 0.73. *Ratios:* AM:AL:PM:PL, 13:6:2:6; AL-PM-PL, 15-13.

Female (Nuevo León). As in male, except for the following. *Chelicerae* without squamous setae. *Abdomen* with six posterior folds. *Leg* I slightly less massive than in male, with stripes and rings as on legs II–IV; spination: tibia I v0-3-3; metatarsus I v0-2-2. *Palp* yellow with prolateral dark stripes on femur and patella. Epigynum pale (Figs. 5, 6). *Dimensions:* total length 3.02; carapace length 1.30, width 0.83; abdomen length 1.69; eyes anterior row 0.71, middle row 0.69, posterior row 0.82, quadrangle length 0.70. *Ratios:* AM:AL:PM:PL, 13:6:2:5, AL-PM-PL, 13-12.

Material examined. **United States:** ARIZONA: *Maricopa Co.:* Coons Bluff, along Salt River, Tonto National Forest, Dec. 25, 1980, under bark of mesquite with pseudoscorpions (L. Merkle, AMNH), 1♂. *Pima Co.:* Forestry Cabin, Baboquivari Mountains, July 18–29, 1951, elevation 3,500 feet (W. S. Creighton, AMNH), 1♀. *Pinal Co.:* Aravaipa Canyon, Mar. 8, 1970 (K. Stephan, FSCA), 1♂. TEXAS: *Comal Co.:* Seancy Estates, New Braunfels, Apr. 12, 1936, tree trunk (S. E. Jones, MCZ), 1♂. *Frio Co.*(?): Frio State Park, Mar. 5, 1952 (W. S. Creighton, AMNH), 1♂. *Uvalde Co.:* no specific locality, May 20, 1938 (Robinson, AMNH), 1♂. **Mexico:** NUEVO LEÓN: Villa de Santiago, Hacienda Vista Hermosa, June 19, 1940 (H. Hoogstraal, MCZ), 1♀. TAMAULIPAS: Mante, Apr. 17, 1963 (W. J. Gertsch, W. Ivie, AMNH), 1♂. **Guatemala:** ESCUINTLA: San José, Apr. 3, 1955 (E. I. Schlinger, E. S. Ross, CAS), 1♂.

Distribution. Arizona and Texas south to Guatemala.

LITERATURE CITED

Cambridge, F. O. P.-. 1901. Arachnida. Araneida. *In:* F. D. Godman and O. Salvin, Biologia Centralia-Americana.

Chickering, A. M. 1946. The Salticidae (spiders) of Panama. Bull. Mus. Comp. Zool. 97:1–474.

Galiano, M. E. 1972a. Salticidae (Araneae) formiciformes. XIII. Revision del genero *Bellota* Peckham, 1892. Physis 31:463–484.

Galiano, M. E. 1972b. Revision del genero *Chirothecia* Taczanowski, 1878 (Araneae, Salticidae). Rev. Mus. Argentino Cienc. Nat., Ent. 4:1–42.

Gertsch, W. J. 1936. Further diagnoses of new American spiders. Amer. Mus. Novit. 852:1–27.

Reiskind, J. 1977. Ant-mimicry in Panamanian clubionid and salticid spiders (Araneae: Clubionidae, Salticidae). Biotropica 9:1–8.

Richman, D. B. and B. Cutler. 1978. A list of the jumping spiders (Araneae: Salticidae) of the United States and Canada. Peckhamia 1:82–110.

Wanless, F. R. 1978. A revision of the spider genus *Marengo* (Araneae: Salticidae). Bull. British Mus. Nat. Hist., Zool. 33:259–278.

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AUFEIUS IMPRESSICOLLIS (HEMIPTERA: RHOPALIDAE): EASTERNMOST U.S. RECORD, HOST PLANT RELATIONSHIPS, AND LABORATORY REARING

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Abstract.—Aufeius impressicollis Stål (Hemiptera: Rhopalidae), a mainly southwestern U.S. and Mexican species recorded only as far east as Columbus, Ohio, is reported from Baltimore, Maryland, on smooth pigweed, *Amaranthus hybridus* L. (Amaranthaceae). *A. impressicollis* was reared on smooth pigweed in the laboratory; its habits are described, and developmental times of the immature stages are given. Ecological data from museum specimens and a review of the literature support the hypothesis that amaranths (and possibly members of the related family Chenopodiaceae) serve as host plants of this little studied rhopalid.

Aufeius impressicollis Stål, belonging to a monotypic genus, is a member of the rhopalid subfamily Rhopalinae and New World tribe Harmostini, which includes one other genus, *Harmostes* Burmeister (26 species) (Göllner-Scheiding, 1978). *A. impressicollis* is easily distinguished from *Harmostes* spp. by the laterally dilated abdomen and broadly exposed abdominal connexivum (Slater and Baranowski, 1978; Hoebeke and Wheeler, 1982). It is widely distributed in the western United States from Nebraska and South Dakota west to Idaho and Washington, and south to California, Utah, Arizona, New Mexico, and Texas (Torre-Bueno, 1941; U.S. National Museum collection); it ranges south through Mexico and into Guatemala (Brailovsky and Soria, 1981). This rhopalid of probable Sonoran origin (Slater, 1974) has not been collected frequently in the eastern part of its range. Arizona and Texas records predominate in the USNM holdings, with considerable material from Colorado and California. Froeschner (1942) noted it was uncommon in Missouri; a few specimens are known from Arkansas and Iowa (USNM).

The first record of *A. impressicollis* east of the Mississippi was that of Osborn and Drake (1915), who reported "large numbers" at Columbus, Ohio. Blatchley (1926) listed single specimens from Marion and Vigo counties, Indiana. No additional Ohio records of *A. impressicollis* are available from the Ohio State University collection, and Columbus remains the easternmost record.

On 14 July 1983 I collected 3 adults of *A. impressicollis* at Baltimore, Maryland, a record that extends the distribution eastward more than 350 miles (560 km). The specimens were swept from weeds in a vacant lot on Boston Street in an industrial area along the Northwest Branch of the Patapsco River. Seven adults were observed at the same site on 6 August 1983. Specimens have been deposited in the insect collections of the Pennsylvania Department of Agriculture (PDA), Cornell University (CUIC), and U.S. National Museum of Natural History (USNM).

It is possible that the Baltimore population is the result of a natural eastward dispersal, even though no records are available for Ohio since 1915 and no specimens have been recorded east of Columbus. Knowledge of heteropteran distributions in

North America is fragmentary, even for areas of the presumed well-collected eastern states, and reports of range extensions of hundreds of miles are not uncommon. However, it is equally likely that the population at Baltimore is adventive, the result of an introduction with commerce. Oil terminals, warehouses, and numerous railroad lines are present near the collection site of *A. impressicollis.* This area of the Port of Baltimore (Canton) is notable for the large number of exotic plant species that have been collected in ballast dumps along the port (Reed, 1964).

HOST PLANTS AND HABITS

Before returning to the original collection site, I reviewed the literature to determine the host plants most likely to be used by *Aufeius impressicollis* in Baltimore. It soon became apparent that little ecological information is available for this species. Schaefer and Chopra (1982) and Schaefer and Mitchell (1983) do not list *A. impressicollis* in their review of coreoid host plants. This rhopalid has been collected by sweeping bushes (Uhler, 1877), grasses (Osborn and Drake, 1915), borders of a timothy meadow (Blatchley, 1926), and weedy fields (Froeschner, 1942). Some of the specific plants mentioned in the literature may not represent true hosts: sugar beet, *Beta vulgaris* L. (Chenopodiaceae) (Knowlton, 1933); another chenopod, Russian thistle, *Salsola iberica* Sennen & Pau (Goeden and Ricker, 1968); and alfalfa, *Medicago sativa* L. (Fabaceae) (Benedict and Cothran, 1975). Label data from western specimens in the USNM collection provided three additional records from sugar beet, two from alfalfa, and one from celery [*Apium graveolens* L.—Apiaceae], "beans" [probably *Phaseolus vulgaris* L.—Fabaceae], and the chenopod *Salsola kali* L. (cited as *S. pestifer*). A specimen from Texas in the Texas A&M collection was taken on cotton [*Gossypium hirsutum* L.—Malvaceae]. Other labels on USNM specimens suggested a preference for plants of the Amaranthaceae. Specimens from California (Chico and Lindsay) had been collected on tumbleweed or tumble pigweed, *Amaranthus albus* L.; one specimen from Victoria, Texas was labeled "amaranthus"; and two from Garden City, Kansas had been taken on "pigweed" [probably *Amaranthus* sp.].

The vacant lot had been mowed when I returned to Baltimore on 6 August, and *Aufeius impressicollis* was not collected by sweeping the cutover weeds. Various unmowed plants growing along a brick wall and a building were then sampled individually by tapping vegetation over a small tray. Seven adults of the rhopalid were collected by tapping flower spikes of smooth pigweed, *Amaranthus hybridus* L. Three early-instar rhopalids that were observed but subsequently lost may have represented this species. No other plants, including *Chenopodium ambrosioides* L. of the related family Chenopodiaceae, yielded *A. impressicollis.*

Rhopalids, when collected by sweeping or when beaten onto a sheet or tray, initially may be sluggish but usually within seconds become active. Similar behavior was exhibited by the other Rhopalidae taken at the Baltimore site: *Harmostes reflexulus* (Say), *Liorhyssus hyalinus* (F.), and *Rhopalus* (*Brachycarenus*) *tigrinus*[1] (Schilling).

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[1] Maryland is a new state record for this Old World rhopalid recently recorded in North America from New Jersey, New York (Long Island), and Pennsylvania (Hoebeke and Wheeler, 1982).

Table 1. Duration (in days) of the immature stages of *Aufeius impressicollis* reared in the laboratory at 22–26°C.

Stage	No. of observations	Range	Mean ± SE	Cumulative mean age
Egg	22	8	8.0 ± 0	8.0
Nymphal stages				
I	13	3–7	4.2 ± 0.27	12.2
II	12	2–4	2.8 ± 0.22	15.0
III	12	2–4	2.9 ± 0.15	17.9
IV	11	3–10	4.5 ± 0.58	22.4
V	7	5–8	6.3 ± 0.36	28.7

However, adults of *A. impressicollis* usually feigned death after being knocked from pigweed onto a tray or when the contents of a sweep net were emptied.

In the laboratory under conditions of natural photoperiod (window light) and room temperature (22–26°C), adults were placed in small plastic boxes with a water source and excised flower spikes of smooth pigweed that included a few leaves. Mating and oviposition readily occurred, and the biological notes that follow are based on a limited number of observations on the resulting progeny. In a forthcoming paper on immature stages of eastern Rhopalidae by E. R. Hoebeke and A.G.W., the egg and fifth-instar nymph of *A. impressicollis* will be described and illustrated.

The premating period for each of the two pairs observed was 4 days. Mating pairs assumed an end-to-end position that apparently is typical for the family (Paskewitz and McPherson, 1983) and often remained *in copula* for 4 hours or longer. One of the pairs mated 6 times; the other, 4 times. The preoviposition period was 2 days. Eggs were laid mainly on the flower spikes and on the sides and bottom of the rearing containers; a few were deposited on host foliage. One of the females laid 48 eggs over an 8-day period; the other, 34 eggs during 3 days. The incubation period was 8.0 days, and the total developmental period for the nymphal stages averaged 20.7 days (Table 1). Nymphs and adults fed only on floral structures, including seeds that had dropped onto leaves or to the bottom of the rearing containers.

The laboratory rearing of *Aufeius impressicollis* on *Amaranthus hybridus*, coupled with its collection on this plant at Baltimore and the records from amaranths in the western U.S., seems to establish members of the Amaranthaceae as host plants. In addition, I later discovered that Stegmaier (1950) collected 18 adults of *A. impressicollis* (and observed additional specimens) on redroot or rough pigweed, *Amaranthus retroflexus* L., in Kansas during June–August 1949. Collections from alfalfa, beans, celery, cotton, and other plants not closely related to the Amaranthaceae or Chenopodiaceae may reflect "sitting" records, or possibly were made from weedy amaranths growing in crop fields. Several *Amaranthus* spp., including *A. hybridus* and *A. retroflexus*, are common weeds of arable land (Muenscher, 1980). Studies on this rhopalid in western North America are needed to verify the apparent amaranth feeding trend and to determine whether chenopods serve as hosts.

Among the Coreoidea, several coreine genera are associated with plants of the order Caryophyllales, including Amaranthaceae, but no North American rhopalid is known from this order (Schaefer and Chopra, 1982; Schaefer and Mitchell, 1983). Species of *Harmostes,* the only other genus in the Harmostini, feed mainly on composites (Schaefer and Chopra, 1982; Schaefer and Mitchell, 1983). *Aufeius* is closely related to *Harmostes* but differs in several morphological characters (Chopra, 1967; Schaefer and Chopra, 1982). It appears also that the two genera differ in their host plant preferences and in one aspect of their behavior.

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LITERATURE CITED

Benedict, J. H. and W. R. Cothran. 1975. A faunistic survey of Hemiptera-Heteroptera found in northern California hay alfalfa. Ann. Ent. Soc. Amer. 68:897–900.

Blatchley, W. S. 1926. Heteroptera or True Bugs of Eastern North America, with Especial Reference to the Faunas of Indiana and Florida. Nature Publ. Co., Indianapolis, Indiana, 1116 pp.

Brailovsky, H. and F. Soria. 1981. Contribucion al estudio de los Hemiptera-Heteroptera de Mexico: XVIII Revision de la tribu Harmostini Stål (Rhopalidae) y descripcion de una especie. An. Inst. Biol. Univ. Nal. Auton. Mexico 51, Ser. Zool. (1):123–168.

Chopra, N. P. 1967. The higher classification of the family Rhopalidae (Hemiptera). Trans. R. Ent. Soc. Lond. 119:363–399.

Froeschner, R. C. 1942. Contributions to a synopsis of the Hemiptera of Missouri, Pt. II. Coreidae, Aradidae, Neididae. Am. Midl. Nat. 27:591–609.

Goeden, R. D. and D. W. Ricker. 1968. The phytophagous insect fauna of Russian thistle (*Salsola kali* var. *tenuifolia*) in southern California. Ann. Ent. Soc. Amer. 61:67–72.

Göllner-Scheiding, U. 1978. Revision der Gattung *Harmostes* Burm., 1835 (Heteroptera, Rhopalidae) und einige Bermerkungen zu den Rhopalinae. Mitt. Zool. Mus. Berlin 54: 257–311.

Hoebeke, E. R. and A. G. Wheeler, Jr. 1982. *Rhopalus* (*Brachycarenus*) *tigrinus,* recently established in North America, with a key to the genera and species of Rhopalidae in eastern North America (Hemiptera: Heteroptera). Proc. Ent. Soc. Wash. 84:213–224.

Knowlton, G. F. 1933. Notes on Utah Heteroptera. Ent. News 44:261–264.

Muenscher, W. C. 1980. Weeds, 2nd Edition Reprinted. Cornell University Press, Ithaca, New York, 586 pp.

Osborn, H. and C. J. Drake. 1915. Additions and notes on the Hemiptera-Heteroptera of Ohio. Ohio Nat. 15:501–508.

Paskewitz, S. M. and J. E. McPherson. 1983. Life history and laboratory rearing of *Arhyssus lateralis* (Hemiptera: Rhopalidae) with descriptions of immature stages. Ann. Ent. Soc. Amer. 76:477–482.

Reed, C. F. 1964. A flora of the chrome and manganese ore piles at Canton, in the Port of

Baltimore, Maryland and at Newport News, Virginia, with descriptions of genera and species new to the flora of eastern United States. Phytologia 10:321–406.

Schaefer, C. W. and N. P. Chopra. 1982. Cladistic analysis of the Rhopalidae, with a list of food plants. Ann. Ent. Soc. Amer. 75:224–233.

Schaefer, C. W. and P. L. Mitchell. 1983. Food plants of the Coreoidea (Hemiptera: Heteroptera). Ann. Ent. Soc. Amer. 76:591–615.

Slater, J. A. 1974. A preliminary analysis of the derivation of the Heteroptera fauna of the northeastern United States with special reference to the fauna of Connecticut. Mem. Conn. Ent. Soc., 1974, pp. 145–213.

Slater, J. A. and R. M. Baranowski. 1978. How to Know the True Bugs (Hemiptera-Heteroptera). Wm. C. Brown Co. Publ., Dubuque, Iowa, 256 pp.

Stegmaier, C. E., Jr. 1950. Insects associated with the rough pigweed, *Amaranthus retroflexus* L. (Amaranthaceae). M.S. thesis, Kansas State Coll., Manhattan, 113 pp.

Torre-Bueno, J. R. de la. 1941. A synopsis of the Hemiptera-Heteroptera of America north of Mexico. Part II. Families Coreidae, Alydidae, Corizidae, Neididae, Pyrrhocoridae and Thaumastotheriidae. Ent. Amer. 21:41–122.

Uhler, P. R. 1877. Report upon the insects collected by P. R. Uhler during the explorations of 1875, including monographs of the families Cydnidae and Saldae, and the Hemiptera collected by A. S. Packard, Jr., M. D. Bull. Geol. Geogr. Surv. Terr. 3:355–475.

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COMPSIDOLON (*CONIORTODES*) *SALICELLUM* (HEMIPTERA: MIRIDAE): A PREDACEOUS PLANT BUG, NEW TO THE UNITED STATES, FOUND ON FILBERT

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Abstract.—*Compsidolon* (*Coniortodes*) *salicellum* is recorded for the first time from in the United States, feeding on aphids on cultivated filberts in western Oregon and Washington.

The natural range of *Compsidolon* (*Coniortodes*) *salicellum* (Herrich-Schaeffer) extends from Great Britain east to western Russia and Norway, south to the Mediterranean region (Kiritschenko, 1951; Wagner and Weber, 1964; Wagner, 1975). Although the species is predaceous (Southwood and Leston, 1959; MacPhee and Sanford, 1961; Wagner and Weber, 1964; and Kelton, 1982), it is associated with relatively few plant species. The recorded plants include *Corylus* (Reuter, 1884; Stichel, 1933; Southwood and Leston, 1959; Wagner and Weber, 1964; Wagner, 1975; and Kelton, 1982), *Salix* (Reuter, 1884; Stichel, 1933; and Kerzhner, 1964), *Lonicera* (Stichel, 1933), *Alnus* (Southwood and Leston, 1959), *Malus* (Southwood and Leston, 1959; MacPhee and Sanford, 1961; Sanford and Herbert, 1967; and Herbert and Sanford, 1969), sallow (*Salix* spp.) and bramble (*Rubus* spp.) (Southwood and Leston, 1959) and raspberry (*Rubus* sp.) and thimbleberry (*Rubus parviflorus*) (Kelton, 1982). There are a number of other species of the subgenus *Coniortodes* in Europe. These species occur on a variety of plants including species of *Adenocarpus, Cytisus, Salvia* and *Artemesia* (Wagner, 1975).

Compsidolon (*Coniortodes*) *salicellum* overwinters in the egg stage as do most mirids (Southwood and Leston, 1959). There is a single generation per year and the adults are found from June to September (Wagner, 1975). Southwood and Leston (1959) report the prey to be mites (e.g. *Bryobia praetiosa* Koch) and other small animals. MacPhee and Sanford (1961) considered the mirid (reported as *Psallus* sp.) to be predaceous, although they did not specify the exact prey species. Sanford and Herbert (1967) in their work on the influence of spray programs for phytophagous mites, including the European red mite, *Pananychus ulmi* (Koch), the blister mite, *Vasates schlectendali* (Nal.) and the brown mite, *Bryobia arborea* (M. & A.), included *salicellum* (reported as *Coniortodes salicellus*) among the list of predators. Herbert and Sanford (1969) reported that *salicellum* (as *Coniortodes salicellus*) fed on the apple rust mite, *Vasates schlechtendali* (Nal.), and Kelton (1982) reported *salicellum* (as *Psallus salicellus*) feeding on aphids. The present paper reports *salicellum* as a predator of the filbert aphid, *Myzocallis coryli* (Goetze) in western Oregon.

Specimens of *C.* (*C.*) *salicellum* were first collected from filbert orchards in the

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[1] Oregon Agricultural Experiment Station Paper No. 7104.

vicinity of Corvallis, Oregon during the summer of 1981 when one of us (R.H.M.) undertook a study of the predator complex on commercial filbert trees. The true identity of the species was not worked out until early in 1982 (by J.D.L.). Because of confusion with other mirid nymphs, the exact date of egg hatch is not known but since the first adults appeared in early July, nymphs must have been present at least from the middle of June. During the 1982 season, Lattin, Gary M. Stonedahl (Oregon State University) and Thomas J. Henry (USDA-ARS Systematic Entomology Laboratory) collected adults and nymphs (third through fifth instars) on July 1 from filbert trees in the vicinity of Corvallis. While the peak occurrence of the adults was the end of July 1982, adults could be collected from the orchards until early October.

Adult bugs were observed feeding on the filbert aphid, and although no direct feeding observations of the nymphs were made, single second or third instar nymphs caged with aphids are believed to have consumed an average of 140 aphids each during a fifteen-day period at 24°C. In one laboratory trial, five out of six third and fourth instar nymphs reached the adult stage with only filbert leaf tissue for food. Samples taken from two untreated orchards showed that the populations of adults peaked in late July with about 5 individuals per tree sample, obtained by sharply tapping three tree limbs over a 30 × 30 inch canvas beating sheet. An orchard treated with Metasystox-R® in late April showed peak populations of less than one adult per tree sample whereas one orchard treated with Guthion® in early July showed a peak of 17 adults per tree sample at the end of July (Messing, 1983).

Compsidolon (*Coniortodes*) *salicellum* was first reported from North America from Nova Scotia, Canada, by MacPhee and Sanford in 1961 (as *Psallus* sp.). It was reported as *Coniortodes salicellum* from the same locality by Sanford and Herbert (1967) and Herbert and Sanford (1969). Kelton (1982) reported it as *Psallus salicellus,* citing the specific Nova Scotia locations referred to above and added Prince Edward Island and British Columbia, Canada, localities, thus establishing the occurrence of the species on both coasts. We have seen additional specimens from Oregon and Washington.

Specimens examined. OREGON: Benton Co., Corvallis, 3 July 81, on *Corylus avellana,* coll. R. Messing (OSU); Benton Co., 5 mi S. Philomath, 13 July 81, on *Corylus avellana,* coll. R. Messing (OSU); Corvallis, 1 July 82, on *Corylus avellana,* coll. T. Henry and J. D. Lattin (USNM: OSU); Corvallis, Oregon State University, campus, 20 July 82, on *Corylus,* coll. G. M. Stonedahl (OSU). WASHINGTON: Lewis Co., Chehalis, 110 Urquhart Rd., 22 July 79, on *Corylus* sp.) coll. G. M. Stonedahl (GMS, OSU).

The comprehensive review of the Miridae of the Mediterranean region by E. Wagner (1975) contains a thorough review of the genus *Compsidolon* Reuter including the four subgenera *Compsidolon, Apsinthophylus* E. Wagner, *Chamaeliops* E. Wagner and *Coniortodes* E. Wagner, complete with keys and many illustrations. His classification is followed here.

The taxonomic history of *C.* (*C.*) *salicellum* is complex. Carvalho (1958) presented a synonymical bibliography complete to the date of his publication. Additional work was done by E. Wagner (1952, 1975), E. Wagner and Weber (1964), and Kelton (1982). A condensed taxonomic and biological bibliography is presented below to summarize these prior contributions.

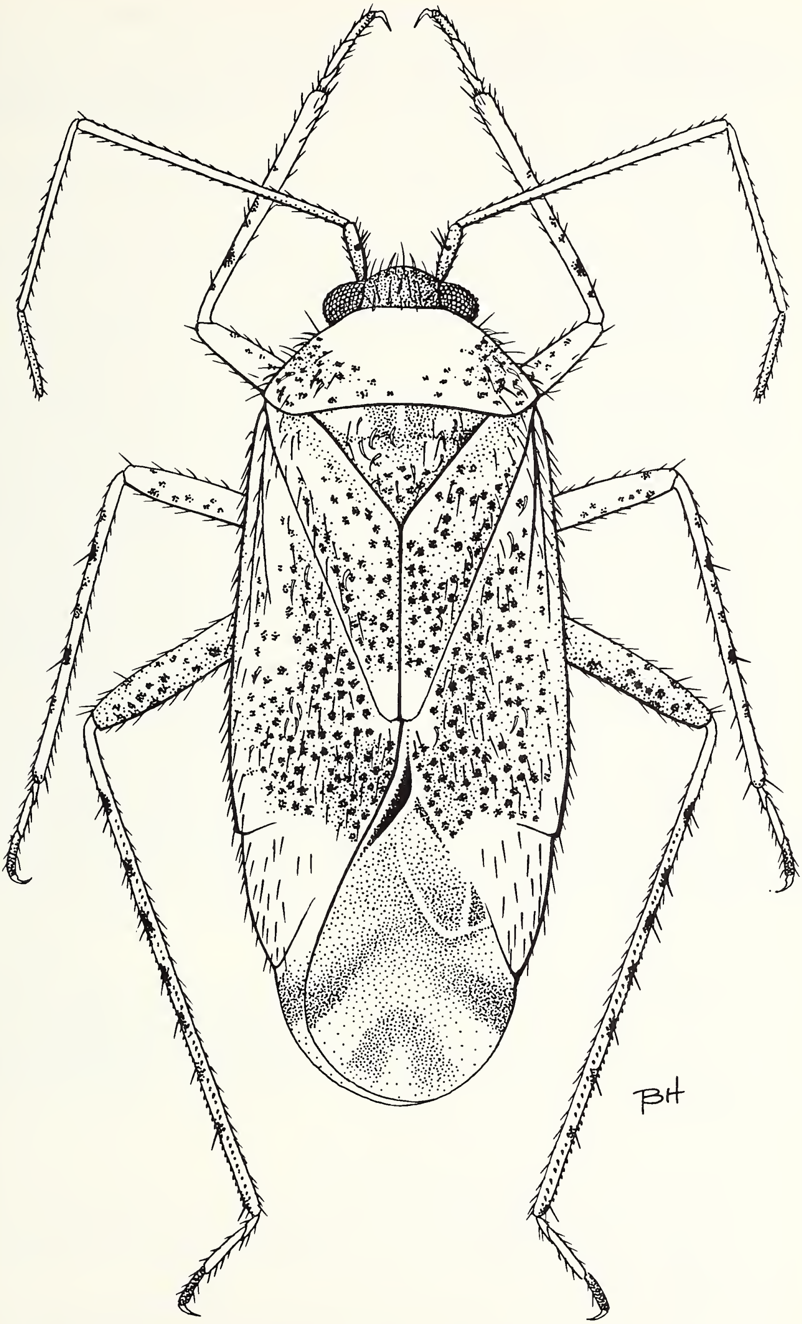

Fig. 1. Adult *Compsidolon* (*Coniortodes*) *salicellum* (Herrich-Schaeffer).

Compsidolon (*Coniortodes*) *salicellum* (Herrich-Schaeffer)

Capsus salicellus Herrich-Schaeffer, 1841:47, fig. 605.
Psallus salicellus: Fieber, 1861:305; Reuter, 1884:146; Stichel, 1933:272; Kiritschenko, 1951:206; Carvalho, 1958:130; Kelton, 1982:171–172; Kelton, 1983:140–142.
Eurymerocoris salicellus: Walker, 1873:151.
Psallus (*Coniortodes*) *salicellum:* E. Wagner, 1952:172; Southwood and Leston, 1959: 227, pl. 33, fig. 2.
Coniortodes salicellum: E. Wagner, 1954:9; Kerzhner, 1964:752, fig. 309, 328; Sanford and Herbert, 1967:693–696; Herbert and Sanford, 1969:62, 64–65.
Psallus sp., MacPhee and Sanford, 1961:671–673.
Compsidolon salicellum: E. Wagner and Weber, 1964:489, fig. 258a, 259a–e.
Compsidolon (*Coniortodes*) *salicellum:* E. Wagner, 1975:151, fig. 729a, 731, 734g.

Compsidolon salicellum keys to *Psallus* (couplet 183) in Slater and Baranowski (1978), but with some difficulty. Specimens are often badly rubbed, removing most of the pubescence, at least on the dorsal surface. The head is rather strongly deflexed downward and thus the tylus is not always visible from above. The tip of the rostrum attains the middle of the abdomen and the sexes are not dimorphic. The width of the vertex is greater than half the width of the head (4:7) and the length of antennal segment II is slightly greater than the basal width of the pronotum (12.5:11). The color pattern of small, regularly distributed brown spots on the clavi and coria of the hemelytra are distinctive, together with the pattern on the membrane. As Wagner and Weber (1964) and many others have pointed out, much work remains to be done in clarifying the generic limits of *Psallus* and closely related genera.

Compsidolon is a large genus and the host range of its known species is wide. It seems likely that additional species of this group of plant bugs will be detected in the North American fauna, either as introductions or as naturally occurring species. The western and southwestern portions of the United States, and particularly California, would seem appropriate areas for their occurrence. The planned investigations of the Phylinae of western North America by R. T. Schuh of the American Museum of Natural History should clarify the matter.

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We thank Bonnie B. Hall for the illustration of the adult, the Oregon Filbert Commission for financial assistance, M. T. AliNiazee for assistance and suggestions, Thomas J. Henry, USDA-ARS, Systematic Entomology Laboratory for the loan of some literature and specimens, and Gary M. Stonedahl for the loan of additional specimens from Washington state and for technical assistance.

LITERATURE CITED

Carvalho, J. C. M. 1958. Catalogo dos Mirideos do Mundo. Parte II. Arquivos do Museu Nacional, Rio de Janeiro 45:1–216.

Fieber, F. X. 1861. Die Europaischen Hemiptera. Halbfluger (Rhynchota Heteroptera). Vienna, 444 pp.

Herbert, H. J. and K. H. Sanford. 1969. The influence of spray programs on the fauna of apple orchards in Nova Scotia. XIX. Apple rust mite, *Vasates schlechtendali,* a food source for predators. Can. Ent. 101:62–67.

Herrich-Schaeffer, G. A. W. 1841. Die Wanzenartigen Insecten. Nurnberg. Vol. 6:1–117.

Kelton, L. A. 1982. Description of a new species of *Plagiognathus* Fieber, and additional records of European *Psallus salicellus* in the Nearctic Region (Heteroptera: Miridae). Can. Ent. 114:169–172.

Kelton, L. A. 1983. Plant Bugs on Fruit Crops in Canada. Heteroptera: Miridae. Agriculture Canada, Monograph No. 24, 201 pp.

Kerzhner, I. M. 1964. *In:* Bei-Bienko, G. Y. (ed.), Keys to the Insects of the European USSR. Volume I. Apterygota, Paleoptera, Hemimetabola. Academy of Sciences of the USSR, Zoological Institute, Moscow-Leningrad, 874 pp. (In Russian).

Kiritshenko, A. N. 1951. True Hemiptera of European USSR. Academy of Sciences of the USSR, Zoological Institute, Moscow-Leningrad, 423 pp. (In Russian).

MacPhee, A. W. and K. H. Sanford. 1961. The influence of spray programs on the fauna of apple orchards in Nova Scotia. XII. Second supplement to VII. Effects on beneficial arthropods. Can. Ent. 93:671–673.

Messing, Russell H. 1983. The biology of the predator complex of the filbert aphid, *Myzocallis coryli* Goetze, in Western Oregon. M.S. thesis, Oregon State University, 115 pp.

Reuter, O. M. 1884. Hemiptera Gymnocerata Europae. Part I. Acta Soc. Sci. Fennicae 13: 1–568.

Sanford, K. H. and H. J. Herbert. 1967. The influence of spray programs on the fauna of apple orchards in Nova Scotia. XVIII. Predator and prey populations in relation to miticides. Can. Ent. 99:689–696.

Slater, J. A. and R. M. Baranowski. 1978. How to Know the True Bugs. W. C. Brown Company, Dubuque, Iowa, 256 pp.

Southwood, T. R. E. and Dennis Leston. 1959. Land and Water Bugs of the British Isles. Frederick Warne and Company, Ltd., London, 436 pp.

Stichel, W. 1933. Illustrierte Bestimmungstabellen der Deutschen Wanzen (Hemiptera-Heteroptera). Berlin, Lieferung 9:243–274.

Wagner, E. 1952. Blindwanzen oder Miriden. Teil 41. *In:* F. Dahl, Die Tierwelt Deutschlands. Jena, 218 pp.

Wagner, E. 1954. *Psallus* Fieb. subgen. *Coniortodes* nov. subgen. (Heteroptera Miridae). Soc. Sci. Fennicae, Comm. Biol. 14(3):1–10.

Wagner, E. 1975. Die Miridae Hahn, 1831, des Mittelmeerraumes und der Makaronesischen Inseln (Hemiptera, Heteroptera). Teil 3. Entomologische Abhandlungen Staatliches Museum Tierkunde Dresden. Supplement Vol. 40:1–483.

Wagner, E. and H. H. Weber. 1964. Faune de France. No. 67. Heteropteres. Miridae. Paris, 589 pp.

Walker, F. 1873. Catalogue of the specimens of Hemiptera Heteroptera in the collections of the British Museum. London. Vol. 6:1–210.

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NOTES AND COMMENTS

NOTES ON THE DISTRIBUTION OF DERMAPTERA IN SOME COSTA RICAN CACAO PLANTATIONS

Annual cycles of wet and dry seasons in the tropical rain forest zone of eastern Costa Rica alter the distribution and abundance of leaf litter-inhabiting insects in cacao plantations (Young, A.M. 1982. J. Appl. Ecol. 19:47–63; 1983a. J. Appl. Ecol. 20:in press; 1983b. J. New York Ent. Soc. 91:in press; 1983c. Sociobiology 8:51–76). Few data, however, are available on the effects of tropical seasonality on litter-inhabiting Dermaptera. In this note I summarize some recent observations on earwigs associated with rotting sections (slices) of banana tree trunks in some Costa Rican cacao plantations.

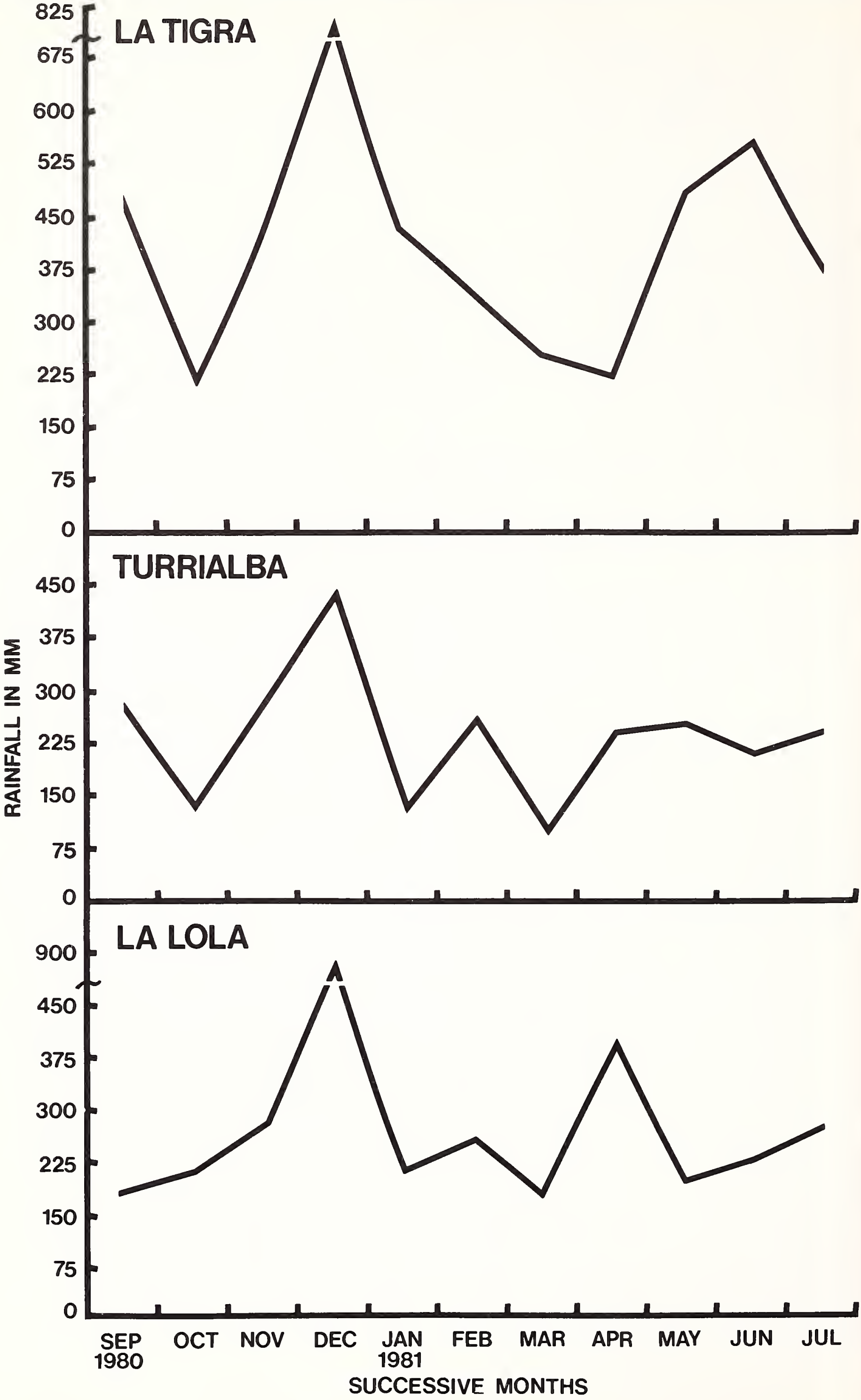
Earwigs in rotting sections of banana tree trunks distributed on the ground (each piece about 6–8 cm high × 15–18 cm dia.) were studied during 1981 and 1982 in these cacao plantations on the Atlantic or eastern watershed of Costa Rica: "La Tigra", near La Virgen (10°23′N, 84°07′W; 220 m elev.), Heredia Province; "Turrialba" or CATIE, in Turrialba (9°54′N, 83°41′W; 600 m elev.); "La Lola", near Siquirres (10°06′N, 83°30′W; 50 m elev.). Between 200 and 300 freshly-cut slices of banana tree trunks were placed in piles of 20–30 pieces each, in the leaf litter (details of these studies also given in Young, 1982, 1983a, op. cit.) three times each year. Earwigs were collected from the rotten slices along with occasional observations on these insects in leaf litter.

Two families, Carcinophoridae and Labiidae, were represented in the samples, the former by four genera and seven species, and the latter by one genus and species (*Marava triquetra* Hebard). Although a total of seven species were collected from La Lola, three from Turrialba, and two from La Tigra, no one genus or species occurred at all three localities (Table 1). *Carcinophora* was represented by three species, and all other genera by one or two species each. A total of 146 individuals (all species combined) were collected for all three plantations and dates, with three species having similar proportions in abundance, ranging from 22–27 percent. These species are: *Euborellia annulipes* Lucas (about 21.3 percent), *Anisolabis maritima* Bonelli (about 24.0 percent), and *M. triquetra* Hebard (about 27.3 percent). A fourth species, *Carcinophora gagatina* Klug, comprised another 12.3 percent of the sample, and all remaining species were far less numerous (Table 1). Interestingly, and in spite of the very small sample size and the equal sample sizes between seasons, more than five times the number of individuals (114) were collected in the dry season (Fig. 1) samples for all localities combined, and these were distributed among six species. By contrast, only 25 insects were collected in the wet season samples, representing five species. Of the very diverse dry season samples, about 35 percent were *M. triquetra,* 30 percent *A. maritima,* and 14 percent *C. gagatina,* for all three plantations combined. One species, *Isolabis howardi* Burr, was found only in the Turrialba dry season samples (Table 1). Collections of leaf litter during the wet season yielded 1–5 individuals of various species, for a total of five 1 × 1-m × 10 cm deep samples of cacao

Table 1. Distribution and abundance of earwigs (Dermaptera) in rotting cut slices of banana tree trunks at three Costa Rican cocoa plantation localities during rainy and dry seasons.

Species	Abundances of individuals in samples at each locality and at various dates					
	La Tigra		La Lola		Turrialba	
	Dates	Numbers	Dates	Numbers	Dates	Numbers
Carcinophora americana Beauvois	13-VII-76; ?-VIII-81; 30-VII-82 (all rainy season)	1-1-1	—	—	—	—
C. festiva Burr	—*	—	22-XI-81 (rainy)	3	—	—
C. gagatina Klug	—	—	10-II-81; 10-XI-81; 12-III-82 (rainy and dry resp.)	8-8-2	—	—
Anisolabsis maritima Bonelli	29-VII-82 (rainy)	1	10-II-81; 22-XI-81; 11-III-82 (rainy and dry resp.)	27-6-1	—	—
Euborellia annulipes Lucas	—	—	10-XI-80; 10-II-81; 22-XI-81; 12-III-82 (rainy and dry resp.)	2-12-12-1	17-II-81 (dry)	3
E. caribea Hebard	—	—	10-XI-80; 10-II-81 (rainy and dry resp.)	3-5	—	—
Isolabis howardi Burr	—	—	—	—	17-II-81 (dry)	8
Marava triquetra Hebard	—	—	10-II-81; 11-III-82 (rainy and dry resp.)	24-3	17-II-81 (dry)	13

* The mark "—" means that these species were not found in samples collected at the indicated locality.


LA TIGRA
825
675
600
525
450
375
300
225
150
75
0
TURRIALBA
450
375
300
225
150
75
0
LA LOLA
900
450
375
300
225
150
75
0
RAINFALL IN MM
SEP 1980
OCT
NOV
DEC
JAN 1981
FEB
MAR
APR
MAY
JUN
JUL
SUCCESSIVE MONTHS

leaves collected each time (N = 4 collections), while similar collections in the dry season produced only 0–1 earwigs.

These data strongly suggest that "diversity" of earwigs in rotting sections of banana tree trunks, that is, numbers of individuals (abundance) weighted by the number of species, greatly increases during the tropical dry season in these cacao plantations, even though the dry season is short and irregular (Fig. 1). The immature stages of Diptera such as Ceratopogonidae exhibit very high densities in rotting slices of banana tree trunks during the dry season in these cacao plantations (e.g., Young 1983a, op. cit.). Quite possibly, these microhabitats remain moist as the surrounding leaf litter dries out, thereby establishing mini-ecological refugia for insects such as earwigs.

This research is a by-product of grants from the American Cocoa Research Institute of the United States of America. I thank Drs. Gustavo A. Enriquez and J. Robert Hunter for logistical field assistance. Dr. H. Steinmann (Zoological Department, Hungarian Natural History Museum, Budapest) made the determinations of the Dermaptera cited in this paper, and voucher specimens are deposited in his collections. Tammy McCarthy prepared Figure 1.—*Allen M. Young, Invertebrate Zoology Section, Milwaukee Public Museum, Milwaukee, Wisconsin 53233.*

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Fig. 1. Monthly patterns of rainfall at three localities in eastern Costa Rica. There is a tendency for drier conditions to prevail during the period January through April each year at these localities, although the "dry season" is very variable from year to year in this region of Costa Rica.

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BOOK REVIEW

Naturalists' Handbooks.—1983. Cambridge University Press, New York. 65 pp. and $16.95 each.

1. *Insects on Nettles* by B. N. K. Davis.
2. *Grasshoppers* by Valerie K. Brown.
3. *Solitary Wasps* by Peter F. Yeo and Sarah A. Corbet.
4. *Insects and Thistles* by Margaret Redfern.

In keeping with the great tradition of British natural history, a series of handbooks has been initiated to promote original field studies of insects. Written by professional entomologists, the books are aimed at "sixth-formers" (students in their twelfth and thirteenth year who are studying to gain entrance into a university—roughly equivalent to American college freshmen and sophomores), and others without university training. They are intended to "draw attention to regions on the frontiers of current knowledge where amateur studies have much to offer" and to show that "natural history need not be a spectator sport." The Naturalists' Handbooks are of two types: guides to the fauna associated with common plants (nettles, thistles) or reviews of specific taxonomic groups (grasshoppers, solitary wasps). With the emphasis on natural history in British schools, there is a ready market for the series.

But North American entomologists should not overlook these handbooks. Because our fauna contains a substantial Old World element—naturally Holarctic species and those introduced with man's commerce—the North American reader is likely to encounter familiar insects, although some of the British common names may seem strange (e.g. "Cuckoo-spit insect" for the meadow spittlebug, *Philaenus spumarius*). Federal and state regulatory personnel and others concerned with detecting exotic insects should find useful information on habits of common British species and illustrations helpful in recognizing potential additions to our fauna. High school teachers and 4-H leaders might use the books to introduce students to fascinating field studies involving insects, and college students taking introductory courses in biology or entomology will find helpful suggestions for research projects. Even professional entomologists interested in insect-plant interactions might find information useful in conducting surveys of particular plant species.

Insects on Nettles, the first book of the series, contains introductory material on stinging nettle, *Urtica dioica* L., and small nettle, *U. urens* L., and relates them to other plants of the order Urticales. The reader is given insight into the plants' morphology and habitat preferences and is told that stinging nettle, a dioecious species, hosts seed-feeding insects that occur only on female plants and pollen feeders that are found on male plants. Small nettle has separate male and female flowers on the same plant. This first chapter also introduces the binomial system of nomenclature and briefly discusses insect orders and their identification. In tabular form the orders and numbers of species associated with nettles are summarized; of 107 nettle associates, 31 are "restricted" species more or less confined to stinging nettle and related plants. The introduction concludes with the advice that students "concentrate initially on the most common species as these are likely to be part of the true nettle fauna and not just chance visitors."

Chapter 2, "Keys to the Insects on Nettles," forms a major portion of the book. First, hints are given for using artificial, dichotomous keys. The author is well aware that "many other insects which are not included in the keys will be collected from nettles; these are probably just sheltering amongst the dense vegetation or they may be insects which are really associated with other low plants or trees growing nearby." He cautions that the reader "*must therefore be prepared to reject a specimen as being merely a casual visitor on nettles* if it does not fit any of the possibilities given, though the keys may allow you to place it in a family or genus." Notes on insect structure, size, color, seasonal occurrence, and sex differences make the keys easier to use.

The major groups of nettle insects then are keyed and separate keys are presented for Lepidoptera adults and larvae; Coleoptera; adult Heteroptera and families of heteropteran nymphs (which the British usually term "larvae"); Homoptera; free-living larvae of Diptera, Coleoptera, and Neuroptera; leafmining and gall-making Diptera; and parasites. The keys, replete with simple but effective line drawings presented with most couplets, should enable the amateur to identify most nettle-associated insects—parasites and predators as well as herbivores. For most nettle associates a summary of life history is given in the keys by indicating the months when lepidopteran and dipteran larvae can be found on the plants, and the occurrence on nettles of adults belonging to other groups. Also useful are five plates of adult or immature insects, including four color plates. The author notes that certain groups are taxonomically difficult, and includes comments on several mirid species that may be confused with those occurring on nettles.

In general the keys seem workable, although it will be apparent to specialists of certain groups that they could "break out" taxa more easily and eliminate the need to repeat certain characters. I was disappointed that anthocorids were considered as cimicids when most specialists place these heteropterans in the separate family Anthocoridae. In a few instances species are keyed and referred to by common name but no family name is indicated. For example, the name Nitidulidae is not mentioned in connection with the flower beetles *Brachypterus glaber* and *B. urticae,* and Chrysomelidae is not associated with the flea beetles listed in the key.

Chapter 3, "Biology," categorizes the nettle fauna by feeding habits (phytophagous species, parasites, predators, scavengers) and summarizes the plant parts used by plant feeders. Nettle specialists and species feeding on other plants of the Urticales in addition to nettles are listed; other tables given the principal predators and parasites found on stinging nettles. Various patterns of voltinism and interesting life cycle strategies are discussed. Several areas in which the amateur can make worthwhile contributions to the knowledge of nettle insects are suggested.

Presented in Chapter 4, "Techniques and Approaches to Original Work," are sections on collecting, keeping live insects, storing and displaying insects, drawing and dissecting specimens, sampling and experimenting, preparing the published paper, and locating books and journals. Again, suggestions for further research are made: influence of shade, soil type, and altitude on host plants and their associated fauna, and effect of temperature on numbers of insects captured in sweep-net samples. The sampling methods needed to assess the impact of such variables are briefly presented. Obviously, complex topics such as sampling theory can be given only cursory treatment, but the reader can obtain more information from "References and Further Reading." The 50 references listed include recent papers on biology and taxonomy of various British insect groups and titles of general text and reference books. A list of some British suppliers of entomological equipment and an appendix giving some snails and spiders that may occur on stinging nettles are also included. An index to common and scientific names and a glossary of 75 technical terms complete the handbook.

Insects and Thistles treats the fauna of creeping thistle, *Cirsium arvense* L., and spear thistle, *C. vulgare* L. The author notes that the different plant parts support a characteristic fauna, with flower heads (Chapter 2) representing a rich food source that contains "the most varied, specific and well-known insect fauna of any part of the plant." The biology of *Urophora stylata* (F.), a gall-inducing tephritid, is covered in some detail, including comments on adult behavior, oviposition, phenology, natural enemies, and an introduction to life table analysis. Other tephritids and the Cecidomyiidae associated with thistle heads are discussed, and a simplified food web is presented; various insects using the heads for shelter are mentioned. Chapter 3 summarizes the life cycles of stem borers and leafminers, mainly Agromyzidae, Tephritidae, and Curculionidae, and discusses mortality factors. Several nonspecific stem-boring and leaf-tying Lepidoptera are briefly noted. Sapfeeding herbivores, defoliators, and flower feeders are covered in Chapter 4. Because thistles have been accidentally introduced to North America and have become serious pests, the thistle-associated herbivores of Britain and continental Europe have been investigated to assess their potential for use in biological control. In Chapter 5 the most promising candidates for introduction to North America are discussed: tephritids, chrysomelids, and curculionids.

To identify an insect from thistle, its location on the plant must be known. Thus, in Chapter 6 keys are presented for species occurring in the heads; larvae and pupae found within stems and roots; immature stages in mines, folded leaves, or silken webs; and adults and immatures found on the outside of the plant. For species in the last category there are keys for identifying adult and nymphal Heteroptera, adult Lepidoptera and Diptera, and coleopteran adults and larvae. The author stresses that determinations of parasitic Hymenoptera and agromyzids should be checked by a specialist if the names are to be published; she also lists taxonomic works that may facilitate identifications in these groups. Chapter 7 gives a brief discussion of techniques. As further reading 75 journal articles and books are suggested.

Although the information on insect communities presented in *Thistles* is similar to that in *Nettles,* there are several differences. In addition to the emphasis on microhabitats found on the plant, author names are supplied in the keys rather than referring the reader to the checklist of British insects by Kloet and Hincks and, instead of having a terminal glossary, technical terms, as they appear in the text, are defined in marginal notes. These are welcome changes. I also approve of using "nymph" rather than "larva" to refer to young of exopterygote insects. *Thistles* also is notable for its excellent line drawings and superb color plates, including one of the host plants. A few minor points: the heteropteran family name Piesmatidae should have been used for Piesmidae (p. 45), Degeer (pp. 37, 57) should be written DeGeer, Fallèn (pp. 38, 53) should be Fallén, and both thread-like (p. 56) and threadlike (p. 57) were used.

Grasshoppers treats the 21 British members of the Acrididae, "true" or "short horn" grasshoppers, and Tettigoniidae, "bush crickets" or "long horn grasshoppers," enabling the reader to identify all common species and to learn about their habits. After an introductory chapter that gives a table of Orthoptera occurring in Britain (including author and common names and also listing species of Tetrigidae, Gryllidae, and Gryllotalpidae), there are chapters on "Life History and Reproductive Strategies," "Adaptations and Habits," "Identification," "Distribution and Habitat Preference," "Relevant Techniques," and "References and Further Reading" (101 titles). In Chapter 4 the keys to families of British Orthoptera and to species of acridids and tettigoniids are accompanied by line drawings and common names, including the curious designation "wart-biter" for the tettigoniid *Decticus verrucivorus* L., a very local species of dry heathland and dry grassland that supposedly bites off warts. The chapters on life history and habits contain numerous figures and tables, and throughout the reader is encouraged to contribute to the many poorly known aspects of acridid and, especially, tettigoniid biology. There are four excellent color plates featuring 8 species of Acrididae and 9 of Tettigoniidae.

Solitary Wasps, covering the British Sphecoidea, Scolioidea, and solitary species of Vespoidea, is intended to encourage original work on these fascinating insects and to allow the species under observation to be identified. An introductory chapter provides a glimpse into the habits of solitary wasps and compares their morphology and behavior to those of other hymenopteran groups. Chapter 2, "Natural History," discusses the behavior of species in three sphecoid genera—*Passaloecus, Cerceris,* and *Ammophila*—and demonstrates that "behavioural patterns are worth studying at two levels: the broad strategy that matters to the wasp, and the fine detail that matters to the evolutionist." A checklist reminds field workers to ask key questions about a wasp's nest site and architecture, prey selection and capture, egg-laying behavior, nest associates, and other aspects of adult behavior (mating, feeding, and possible cleptoparasitism and nest sharing). In Chapter 3 the reader is furnished several identification aids: a novel "Guessing Guide" that allows approximate generic placement of wasps observed in the field, providing their general coloration, nest site, and prey type are known; a "Quick-Check Key" that allows dead or anaesthetized individuals to be placed to genus; and keys that should enable the amateur to determine most British solitary wasps to species. Line drawings placed in the keys' margins, and 8 plates (4 in color) illustrating adult habitus facilitate the identifications; included in the keys and plates are several bee species that could be confused with solitary wasps. Chapter 4 is a short discussion of techniques and approaches to original work. Also included are further reading (29 references), an alphabetical checklist of species (without author names) and their British distribution, and an index.

In summary, all four books are well written, contain illustrated keys and color plates, and emphasize the role of amateurs in making significant contributions to our knowledge of insects. The paper quality is excellent, and the attractive covers feature color illustrations of insects. The volumes appear sufficiently durable to withstand field use; they are remarkably free of typographical errors, and in my copies only a few widely scattered broken letters mar the printing quality. These short books, although devoted to the British insect fauna, deserve a wide audience—the numerous suggestions for careful biological work by amateurs are equally relevant to studies of

North American insects. For beginning students especially, the Naturalists' Handbooks seem certain to arouse a curiosity about insects and their habits.—*A. G. Wheeler, Jr., Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania 17110.*

INSTRUCTIONS TO AUTHORS

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A REVISION OF THE BLACK GRASS BUG GENUS *IRBISIA* REUTER (HETEROPTERA: MIRIDAE)

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Abstract.—The black grass bug genus *Irbisia* Reuter is revised. Over 20,000 specimens were examined and information concerning the biology, host plant and distributional relationships of the species is compiled. In addition to external characters, the male parameres and vesica, and the female dorsal labiate plate of the bursa copulatrix and sclerotized rings are used to distinguish the species. Thirty-four characters selected from male genitalia, and external morphology are cladistically analyzed. Twenty-three species in five species groups are recognized in the genus. Two keys to the species are presented. Two new species, *Irbisia bliveni* and *I. cascadia*, are described. The following synonymies are proposed: *I. brachycera* (Uhler) = *I. gorgoniensis* Bliven, *I. paeta* Van Duzee, *I. tejonica* Bliven and *I. vestifera* Bliven; *I. californica* Van Duzee = *I. eurekae* Bliven, *I. paenulata* Bliven and *I. umbratica* Bliven; *I. elongata* Knight = *I. retrusa* Bliven; *I. mollipes* Van Duzee = *I. upupa* Bliven; *I. setosa* Van Duzee = *I. ustricula* Bliven; *I. silvosa* Bliven = *I. paulula* Bliven; *I. sita* Van Duzee = *I. neptis* Bliven; *I. solani* (Heidemann) = *I. inurbana* Bliven and *I. lacertosa* Bliven.

Irbisia species diversity is greatest in the Coastal, Peninsular, Sierra and Transverse Ranges of California and decreases northward, northeastward and eastward. Major centers of endemism are located in California and the Rocky Mountains northwest of the Wyoming Basin; a minor center is located in the Siskiyou Mountains of southwestern Oregon. The distribution of the *Irbisia* species appears to be delineated by climatic conditions; late winter and early spring precipitation is required for growth of their cool season grass hosts. Over twenty native and introduced species of grasses are utilized by nymphal and adult stages of *Irbisia* in the Pacific Northwest. Larval feeding is observed on four species of nongrass monocots, and species of *Lupinus* and *Lathyrus* (Fabaceae). There appears to be no grass host specificity among the *Irbisia* species. However, all the grass species utilized are in the subfamily Pooideae; genera from the tribes Avenae, Poeae and Triticeae predominate. *Irbisia* species are the earliest mirids to consume the grass resource, completing their life cycle before grass seed is mature. Many *Irbisia* species, upon maturity, leave grasses and congregate on conspicuous nearby shrubs and trees. Their dispersal is correlated with the blossoming of these plants; adult feeding on pollen, nectar or honeydew is suspected.

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INTRODUCTION

The species of the genus *Irbisia* Reuter are predominately Nearctic in distribution. One species, *I. sericans* (Stål), occurs on the southern coastline of the Kamchatka Peninsula, and Commander Islands of the U.S.S.R. Another species, *I. brachycera* (Uhler), is distributed in the northwesternmost region of the Great Plains. The rest of the species are found in or west of the Rocky Mountains. Within this large geographical area the species are primarily associated with grassland, steppe or open woodland situations. As a result of this study, there are 23 recognized species of *Irbisia.*

The majority of the species in the family Miridae, the largest family in the order Heteroptera, are plant associates and phytophagous. A distinct assemblage of these species comprising several lineages feeds, to a variable degree of specificity, on the plant family Poaceae. The tribes Stenodemini and Mirini, of the subfamily Mirinae contain the majority of grass-feeding mirid species in the Nearctic. The Stenodemini are exclusively phytophagous on grasses, and non-grass relatives, the rushes and sedges. The Mirini contain few exclusive grass-feeding species. The species of *Irbisia* and, its tentative sister group, *Capsus* Fabricius are the only native Nearctic grass-feeding members of the tribe Mirini. Two grass-feeding Palearctic species of the Mirini, *Stenotus binotatus* (Fabricius) and *Calocoris norvegicus* (Gmelin), were apparently introduced into the United States (Knight, 1941).

Irbisia species have long been known to attack and damage natural and cultivated native or introduced rangeland grasses (Knowlton, 1951; Haws, 1978). Under certain conditions, many agricultural crops, particularly in California, have also received injury from these bugs (Essig, 1927). Despite the fact that the most destructive species were recognized over a century ago, published life history studies of the species of *Irbisia* are absent. The mating and oviposition habits of these bugs are practically unknown.

Previous to the present study, there were three published keys to the identification of the species of *Irbisia*. Van Duzee (1921a) dealt with the complex of species which occurred primarily in California, Knight (1968) provided a key to those species with a predominately intermountain distribution and Kelton (1980) presented a key to the species of the prairie provinces of Canada. Bliven (1961, 1963) doubled the number of known species in the genus, but did not include a key or attempt to place his newly described species within any previous construct of the genus. Even though the majority of Bliven's new species are distributed in California, one species, *I. serrata* Bliven, occurs throughout the Intermountain West. This species will key to *I. brachycera* in the previous keys but has a completely different habitus.

LITERATURE REVIEW

Reuter (1875b) erected the genus *Irbisia* with *Leptomerocoris sericans* Stål 1858 the type species by monotypy. This description by Reuter was only one line in length. Reuter (1896a) published the first full diagnosis of the genus. *Leptomerocoris* Kirschbaum 1855, was placed in synonymy with the genus *Orthonotus* Stephens 1829, by Carvalho (1959). This genus is in the subfamily Phylinae and tribe Phylini.

Uhler (1872) described *Rhopalotomus brachycerus* and *R. pacificus* from specimens collected from Colorado and Idaho respectively. Reuter (1875a:21) placed the genus *Rhopalotomus* Thomas 1843 in synonymy with *Capsus* Fabricius 1803, in a paper dealing with the Miridae of Europe. He did not treat the Uhler species. He defined *Capsus* as possessing a second antennal segment which was "clavatoincrassato"; *R. brachycerus* and *R. pacificus* have cylindrical second antennal segments. Uhler (1886), in a checklist of Heteroptera of North America, placed both *brachycerus* and *pacificus* in the genus *Capsus*. Uhler (1894) erected the genus *Thyrillus* (type species, *T. pacificus*) for these two species after examining specimens of them from southern California. Reuter (1896a) placed *Thyrillus* in synonymy with *Irbisia*. The close relationship of these two genera was supported by the examination of the female and male genitalia by Slater (1950) and Kelton (1959) respectively.

Capsus solani Heidemann 1910 was placed in the genus *Irbisia* by Van Duzee (1914) and considered a variety of *I. brachycera.* Subsequently, Van Duzee (1917b) placed *solani* in the genus *Lygus,* but he (1921a) finally elevated it to species status as *Irbisia solani.*

The rest of the species placed in the genus *Irbisia* have not had extensive nomenclatorial changes. The remaining species were described by Knight (1925a, 1941), Blatchley (1934), Bliven (1961, 1963) and Schwartz and Lattin (1984). Two new species, *I. bliveni* and *I. cascadia,* are described herein.

Species of *Irbisia* were included in state or regional surveys of Heteroptera or Miridae as follows: Stål (1858), Uhler (1871, 1875, 1886, 1894), Sahlberg (1885), Cockerell (1893, 1910), Gillette and Baker (1895), Reuter (1896b), Ashmead (1898), Heidemann (1900), Breddin (1902), Oshanin (1910), Van Duzee (1914, 1917b), Knight (1921, 1968), Parshley (1922), McAtee (1923), Kiritshenko (1926), Downes (1927), Harling et al. (1977) and Kelton (1980).

There are two references to the structures of the male and female genitalia which include species of *Irbisia.* Three species were included by Slater (1950) in his investigation of the female genitalia; emphasis was placed on the posterior and dorsal wall of the bursa copulatrix and the sclerotized rings. Two species were considered by Kelton (1959) in his study of the male genitalia. There are no investigations of the nymphal stages of the Miridae which include species of *Irbisia.*

Biological studies of this genus are limited to 19 reports of an economic nature, which may include short descriptive features of the species and their feeding damage, life histories, distributions, food plants and control. These studies are: Vosler (1913), Childs (1914), Essig (1915, 1927), Herms (1926), Lockwood (1933, [1937 not verified]), Tavernetti (1933), Knight (1941), Essig and Hoskins (1944), Lange (1941), Ryan (1945 not verified), Lockwood and Glammon (1949), Knowlton (1951, 1961a, b, 1967, 1968) and Knowlton and Roberts (1971).

Irbisia brachycera, I. fuscipubescens Knight, *I. pacifica* and *I. shulli* Knight have been cited numerous times in the U.S. Department of Agriculture, Cooperative Economic Insect Report (in the years 1953, 1957, 1958, 1960–1975) and its successor the Cooperative Plant Pest Report (1976–1981). The reports estimate *Irbisia* density and economic losses to forage crops in Alberta, California, Idaho, Montana, Nevada, Oregon, Utah and Washington.

Some information on *I. brachycera* and *I. pacifica* is contained in Haws (1978), a thorough presentation of the accumulated knowledge of *Labops hesperius* Uhler on range grasses (another species of grass-inhabiting mirid). All three species frequently occur together in large numbers causing economic damage to rangeland grasses. Hewitt and Burleson (1975, 1976) studied the arthropod fauna associated with both planted and natural rangelands and found very low populations of *Irbisia brachycera.* McKendrick and Bleicher (1980), studying *I. sericans* near Homer, Alaska, provide quantitative analyses of the composition of damaged and adjacent undamaged bluejoint reedgrass plants. Hall (1959) investigated the pathology of an entomophthoraceous fungus attacking *I. solani* in Riverside County, California.

MATERIALS AND METHODS

Just over 20,000 specimens from throughout the known range of *Irbisia* were examined during the course of this study. Specimens of the *Capsus cinctus* (Kolenati) were also examined. A listing of the collections, curators, and abbreviations used in the text is contained in the Acknowledgments.

The recording of the label data for each specimen was not attempted because of the large number of specimens examined. However, each specimen received an institutional label indicating where they are retained. The specimens of *I. pacifica* were separated from the rest of the material because of their ease of identification. The two groups of material were initially sorted by country, state or province, county and locality. The next phase of the sorting process involved separating the geographically arranged specimens into species level taxa, on the basis of the types, the original descriptions and my own understanding of the aggregations of characters available. This sorting process was initiated with material representing the northern and eastern limits and proceeded toward the California specimens. Once sorted in the above manner, the geographically arranged groups of taxa were consolidated on the basis of their aggregate characters. I wrote the descriptions and redescriptions as species concepts emerged from the taxon groupings.

At this point, it was not difficult to arrange the specimens alphabetically and record the locality data. Hosts, collection dates and elevations of adult specimens were recorded and summarized. Localities that could not be located were listed after the county label data. Names of the collectors were omitted for the redescriptions. All label data were recorded in the new species descriptions. The label data accompanying each examined holotype was recorded as given. All specimens including type specimens and many paratypes, as well as critical specimens examined by Bliven, Knight and Van Duzee, that I was able to identify satisfactorily have been individually labeled with appropriate determination labels. The allotypes were treated as paratypes. All Knight, many Van Duzee, and some Bliven paratypes were conspecific with the associated holotypes. All data pertaining to these specimens were incorporated in the synonymy portion of the species treatments. For a complete accounting of the label data and depository of the holotypes placed in synonymy and their associated secondary types refer to my master's thesis at Oregon State University, Corvallis, Oregon.

In addition to intensively collecting specimens from Benton and adjoining counties of Oregon, I conducted several extended collecting excursions to: central and southwest Oregon; northwest, central and southern California; and west and central Washington. These trips were taken during the springs of 1979 and 1980 for the purpose of obtaining specimens from the localities listed in the original descriptions of Bliven (1961, 1963), and to gather information on the distribution, host plants and biology of *Irbisia.* Live nymphs and adults were collected and placed in cages containing potted sod of natural grasses. The live material was observed in the laboratory for a period of several weeks.

Biological information was gained from both field and laboratory observations. Many grass and non-graminoid hosts were collected, pressed with locality data, and identified to genus by myself and to species by the staff of the Oregon State University Herbarium. The host data contained on the labels of the specimens were corrected according to Munz and Keck (1973).

In order to plot the distributions for the species, each unique locality, for each species, was located on road maps, for each state, and a signal dot was placed on the map. Because of the great number of specimens from California, Oregon and Utah, separate maps were used for several species. At this point, because of the high resolution of the road maps, the potential natural vegetation (Küchler, 1966, 1977) and ecoregions (Bailey, 1976) were recorded and summarized for each species. Records made on the state road maps were combined by species and are summarized in the distribution maps which follow the species descriptions.

Male and female genitalia of specimens from different portions of the range of each species were examined. The number of specimens dissected varied according to the variability of the other characters, extent of the distributional range, and the availability of material. Only dried specimens were used for the study of the genitalia. Teneral specimens were avoided whenever possible. The method employed for the dissections has been established and recorded by Slater (1950) and Kelton (1959) and perfected by Razafimahatratra (1980). After dissection and study, the dissected parts were placed in a plastic microvial containing glycerin and attached to the pin bearing the appropriate specimen.

Illustrations were drawn using a Leitz Wetzler stereomicroscope with an ocular grid. The figures were drawn on grid paper and later inked on velum. Unless otherwise indicated, the illustrations were drawn to the same scale. All measurements are given in millimeters and obtained from an ocular micrometer. Various magnifications were used depending on the structure being measured, 160× or 64× for genitalia, 40× for head and thorax, 20× for body width and 10× for body length.

The description or redescription of each species takes into account the size, structural, and color variations encountered. A range is given for each measurement. These sections are therefore composite. The descriptions or redescriptions summarize specific differences or additions not found in the detailed generic description. The form of each redescription is uniform; the taxonomic characters are presented in the same order. The diagnoses will separate the species of concern from other taxa to which it is superficially similar or sympatric. Polymorphic or polytypic variation of color or structure, as well as any taxonomic consideration, is included in the discussion of each species.

A list of the abbreviations used in the specimens examined section of the species treatments is found in Appendix B.

BIOLOGY

During the spring, species of *Irbisia* are common, conspicuous inhabitants of chaparral, steppe, open woodland and certain grassland situations in North America west of approximately the 100th meridian. Although primarily grass feeders, which disperse to many non-graminoid plants late in the season, several species of *Irbisia,* in the nymphal stage, feed extensively on non-grass species of plants.

The eggs of *Irbisia* are elongate, slightly curved, with a flattened cap on one end. Oviposition occurs from late March in southern California to late May and early

June at higher elevations of the Pacific Northwest and the Intermountain states. These bugs diapause in the egg stage, protected through the summer and winter until the occurrence of the succulent regrowth of their host plants in late winter and early spring. The duration of diapause is typically nine to ten months regardless of the geographic location of the species; the initiation and termination dates, of course, are variable. The oviposition sites apparently vary according to habitat. Taylor (unpubl. data) observed that the dead and prostrate stems of blue elderberry (*Sambucus caerulea* Raf.), in the Davis area, were "... filled with thousands of insect eggs." The stems had a pithy internal structure and woody outside surface. Upon "... sticking the stems in water for a few minutes to get them wet then putting them in an incubator the eggs started development and emergence was then sure. I reared many hundreds of them to the adult stage so am sure that the eggs were of this genus [*Irbisia*]." The distributional range of blue elderberry is extensive, occupying open places up to 10,000 feet elevation in montane coniferous forests and foothills. The co-occurrence of many species of *Irbisia* within the range of this and other species of *Sambucus* may only be coincidental, but is interesting. Many other shrubby plants (listed in the following species redescriptions) may provide the necessary architecture and phenology to be utilized as oviposition substrates.

Mr. Jeff B. Knight, at the University of Nevada/Reno is conducting research on a degree-day model for *I. brachycera* in the Reno area. He successfully induced *I. brachycera* to oviposit in the laboratory in the culms of *Elymus* sp. (pers. comm., 1980). This is similar to the oviposition habits of *Labops hesperius* which lays eggs in the dry culms of *Agropyron desertorum* (Fisch.) Schult. and *Poa secunda* Presl., from the previous year (Todd, 1973). Knight (pers. comm., 1981) has also found that *I. brachycera* will oviposit in the ligule of the lower leaves of *Sitanion hystrix* (Nutt.) J. G. Sm. and the sheaths of the lower leaves of *Elymus cinereus* Scribn. & Merr. The eggs are aligned parallel to leaf veins. The eggs after a period of diapause, *in situ,* when placed at approximately room temperature will achieve peak hatch within ten days. McNeill (1971) relates that the females of *Leptopterna dolobrata* (L.) oviposit directly into the base of the present-year's grass culm.

As quoted above, Taylor found that moisture was the key to the hatching of the eggs. After winter rainfall, the bugs would emerge during the coldest period of the year, February. Refrigeration without moisture did not induce emergence in the laboratory. His observations (which are collaborated by my field collections) indicate that the species of *Irbisia* in Davis, California emerge from the egg stage in this order: *I. solani, I. californica* Van Duzee and *I. pacifica.* In Corvallis, Oregon, *I. sericans* emerges before *I. cascadia,* n. sp.

It is interesting to note that oviposition sites or physiology of *I. brachycera* and *I. pacifica* must be different. Haws (pers. comm., 1979) indicated that the harsh snowless winter of 1976 greatly reduced many populations of the latter species in traditional outbreak localities in Utah. The former species and *Labops hesperius* were largely unaffected.

Observations in the field and laboratory indicate that molting occurs directly on the grass blades. Successful molting is easily fouled by excessive moisture in rearing cages. I have no detailed data on the duration of the five nymphal instars but, after the first observation of early nymphal stages, in Benton County, Oregon, under field conditions, approximately four weeks elapse before the adult stage is reached. Males usually mature before the females; female specimens are often the only sex encountered late in the season. There is a temporal stratification of the height at which both nymphal and adult stages of *I. cascadia* and *I. sericans* feed. It is possible to collect many more specimens with the same effort by sweeping grass at night than during the day. This may indicate an adaptation to reduce desiccation by avoiding low relative humidity encountered in the higher horizons of a grass meadow during daylight hours. Further, wind speeds may be lower during the evening hours.

Although the majority of species of *Irbisia* I have observed fed on a variety of grasses as nymphs, several (*I. californica, I. cascadia, I. serrata* and *I. solani*) do feed as nymphs on the following non-graminoids: *Allium* spp., *Brodiaea* sp., *Iris tenax* Dougl., *Lathyrus* spp. and *Lupinus* spp. In Arroyo Seco, California I observed nymphal stages feeding on *Lupinus* sp. in an area that had grasses without any apparent feeding damage. This observation raises the possibility that grass may not be an obligatory host for all species in all situations. I have raised late instar *I. cascadia* nymphs to adulthood on caged *Lupinus* plants in the laboratory. The females eventually became gravid (as did female specimens from the source populations, which did not feed on *Lupinus*).

Both immature and adult stages of all species of *Irbisia* produce diagnostic feeding damage on all the species of grasses I have encountered as hosts in the field. Feeding is always located on the grass blade. The method of feeding is typical of mirids; the cells of the plant are lacerated by the stylets of the rostrum, and the cell contents are flushed out by saliva, then the resulting "soup" is sucked up. The dead cells produce the pale white or chlorotic spots on the leaf blade. In a severe infestation, the blade may appear completely white. This type of feeding may cause stunted plants and reduced forage yields (Haws, 1978). The pale spots are, in practically all cases, accompanied by dark droplets of anal exudate. Stenodemine mirids do not produce feeding damage similar to that just described. Species of tribe Stenodemini, when sympatric with species of *Irbisia,* are usually phenologically later, and tend to concentrate their feeding on the culm or seed head (Kamm, 1979). *I. cascadia* was observed to produce similar chlorotic spots and dark droplets on the flowers and young, apical leaves of *Lupinus* sp. in Skamania County, Washington.

Much of the early literature concerning *Irbisia* deals with the later phase of its feeding biology; dispersing from dried grass fields to other non-grass plants. The species *I. solani* is most often cited; it has caused damage to artichokes (Tavernetti, 1933); lettuce, radishes, onions and rhubarb (Vosler, 1913); peaches (Lockwood, 1933); and cherries and plums (Lockwood and Glammon, 1949). An interesting note by Herms (1926) states that the possibility exists for honey bee poisoning, if the bee feeds on droplets of the sap of California buckeye (*Aesculus californica* [Spack] Nutt.) exuding from punctures on the young twigs, leaves and blossom buds which were caused by *I. solani.* Besides these plants, I have collected practically all the species of *Irbisia* from the blossoms of many additional shrubs or trees including: *Ceanothus* spp., *Cercocarpus* spp., *Pinus* spp., *Quercus* spp., *Simmondsia* sp. (male) and *Yucca* spp. Many of the specimens are heavily covered with pollen grains. This demonstrates that these individuals may have been moving around the blossoms, and more significantly, that they were seeking nutrients from the plants. It is possible that the pollen grains are mixed up in saliva and sucked up (Kullenberg, 1944). It would be a simple matter to dissect the gut of freshly "pollen fed" individuals and verify this hypothesis. Many of the previous plants are also heavily covered with honeydew, another desirable insect food source. Another interesting correlation is evident; the phenology of the flowering of many of previous plants coincides with the drying of the early spring grasses upon which *Irbisia* initially develop. The species of the secondary plants that are frequented, of course, varies according to the floristic association of the surrounding area, i.e. *Pinus* at high elevations, *Ceanothus* in the chaparral, *Quercus* over a wide range, and *Yucca* in southern California.

In two excellent papers, McNeil (1971, 1973) explored the energetics and dynamics of a population of *Leptopterna dolobrata* in Berkshire, England. He concluded that this grass-feeding mirid, which does not switch to non-grass hosts, changes its feeding habits from leaf feeding on *Holcus mollis* L. (low nitrogen) to seed feeding on *H. lanatus* L. (high nitrogen) when the bug is experiencing maximum growth and the initiation of gonad development. This might be the case with *Irbisia.* The necessary nitrogen required for egg production (Mattson, 1980) may have to be supplemented by non-grass sources. In the Mediterranean climate of California, any species of grass may be nutritionally depleted too quickly to be an assured resource.

There appears to be resource partitioning between the species of *Irbisia* and the stenodemine species which are abundant in the range of *Irbisia. Irbisia* is phenologically earlier, feeds on the blades of the grass plant, and can leave the grass for nutritional supplements. The stenodemines feed on the culms of the grass plant and seek out grass seed to complete their development. McNeill (1973) pointed out that individuals of *Leptoterna* which feed only on leaves risk death by taxing already low reserves, by increased metabolic rates in warm summer weather, and dehydration at the growing grass tips during moult. *Irbisia* may avoid these dangers by completing its life cycle rapidly. I have observed that late in the season (April and May) in southern California, *Irbisia* is readily collected on grasses in the shade of surrounding trees.

Another phenomenon which I have observed in several locations is the aggregation of female *Irbisia* on prominent vegetation in grassy situations. Female *I. cascadia* were aggregated on a single *Artemisia cana* Pursh plant at Siskiyou Pass, Jackson County, Oregon; female *I. fuscipubescens* aggregate on *Lupinus* sp. in Oregon and Washington; female *I. sericans* aggregate on *Epilobium* sp. near Homer, Alaska (Bleicher, pers. comm., 1980), and female *I. shulli* and *I. fuscipubescens* aggregate on *Balsamorhiza* spp. in Oregon and Washington. The only apparent *Irbisia* feeding damage appeared on the *Lupinus.* In the Siskiyou Pass instance, female *I. serrata* occupied adjacent *Quercus* foliage, and were not on the sagebrush. Perhaps these occurrences are just simple dispersal to a prominent landmark because the males were absent. I have not observed mating in the field or laboratory. However, Oman (pers. comm., 1981) has observed *Irbisia* spp. *in copula* on balsamroot in central Washington.

In the Corvallis, Oregon area, three species of *Irbisia* are separated by an apparent habitat preference. *I. sericans* is early, and found in moist tall grass (*Festuca arundinacea* Schreb.) in low lying situations. *I. cascadia* is somewhat later, and is usually found on exposed south-facing hillsides. *I. solani* has the same phenology as *I. cascadia,* and may be found on hillsides, but is more often found at the lowest elevations in the Willamette Valley, and is associated with *Bromus* sp.

There are no quantitative studies on the distributions and abundances of *Irbisia* species coexisting in the same grassland. Gibson (1979, 1980) throughly investigated a five species complex of grass-feeding Stenodemini at Wytham Hill, England. Perhaps the relationships of the *Irbisia* species may be similar in some respects to the dynamics of this group of closely related stenodemine mirids. Gibson concluded that each of the stenodemine species fed on several foodplants at once and that this host spectrum changed seasonally and with the age of the bugs. It was also found that there was considerable overlap between the hosts of different bug species and that ecological separation was achieved by emergence timing and/or feeding on different parts of the same grass species.

Dispersal from rangeland grasses to cultivated grains has been noted by Knowlton (1951) for *I. pacifica.* Records of the Nevada Cooperative Economic Insect Report (Anonymous, 1972) implicate *I. brachycera* in dispersing to bluegrass (*Poa* sp.) lawns in the Reno area. Fuxa (1975) determined that the number of dispersing *I. brachycera* caught on sticky traps within a crested wheatgrass field decreased with the height of the trap; the most bugs were captured below 0.61 meters. The peak flight period lasted for six days and was maximal at 3 p.m. Fuxa concluded that *I. brachycera* dispersed more readily than *Labops hesperius.*

I observed few predators of the species of *Irbisia* in the field; a nabid and crab spider were the only examples. Few parasites of *Irbisia* have been confirmed; after I treated a female specimen of *I. serrata* from Modoc County, California, for genitalic dissection a dipteran larva was found within the bug's abdomen. The larva may be of the family Tachinidae. *Entomophthora erupta* (Dustan) is a known fungal parasite of *I. solani* (Hall, 1959).

DISCUSSION OF TAXONOMIC CHARACTERS

Characters discussed below have proved to be most useful in distinguishing the species of *Irbisia* and are utilized in the following keys, descriptions and redescriptions. The characters are from adult specimens of both sexes. Ratio and measurement values are presented as ranges which adequately cover the variation encountered in the specimens examined. An asterisk indicates when certain characters show value as synapomorphies of species groups; thirty-four of these characters compose Appendix A.

Total length of body. The total length is measured from the tip of the tylus to either the posterior tip of the membrane in macropterous species, or to the posterior tip of the terminal abdominal segment in brachypterous species. It is measured in dorsal view. The length varies greatly between, and within some, species. The range, in conjunction with other characters, is useful for separating some species.

Total width of body. The total width is measured across the greatest width of the hemelytra, in dorsal view. The body width alone will separate few species.

Head. The structure, ratios and measurements of the head are particularly useful in distinguishing species groups and species. MEASUREMENTS. Width across eyes—maximum width between the lateral margins of the eyes; measurement in dorsal view. *Vertex—minimum width between the interior margins of the eyes; measurement taken at posterior margin of head in dorsal view. Dorsal width of eye—maximum width in dorsal view; varies little between species. Distance from tylus to ventral margin of eye—measured in lateral view with the tip of the tylus and the ventral margin of the eye in simultaneous focus; a minimum width measurement. Height of eye—maximum measurement in lateral view (measurement of *I. pacifica* is taken in frontal view, at the junction of the eye and the frons, because of the dorsally projected lateral eye margins of this species); this measurement varies little between the species. Maximum interocular width—measured in cephalic view; placement of this measurement is dorsal of the antennal insertions in the concave portion of the eyes across the frons. RATIOS. *Length of antennal segment I : vertex. Distance from tylus to ventral margin of eye : height of eye. Maximum width of pronotum : width across eyes.

STRUCTURES. Shape of head—triangular or elongated anterior of eyes (ratio of width of head across eyes and head length is 1:0.75). Surface of head—smooth, asperate or shagreened; typically examined on the frons. Temporal areas—distinct or indistinct, may or may not be demarcated from the frons by faint sulci; the surface structure may differ from the frons; the areas may be bordered basally (at the vertex) by sulci of variable strength; the area is usually glabrous. Median depression—absent (or indistinct), broad (deep or shallow), or reduced to a longitudinal furrow. Basal carina—either abruptly produced or declivous with respect to the level of the vertex; the dorsal surface is either acute or rounded in cross section; the width may be narrow or broad; the posterior margin is either straight or arcuate posteriorly; the carina may or may not form the posterior margin of the head. Shape and insertion of eyes—either large and broadly joining the frons, or small and narrowly joining the frons; the latter type has an obvious pedunculate eye form; the posterolateral portion of the eyes are either straight or arcuate in an anterior or posterior direction. Clypeus—basal portion may be convex; standing above the frons, or not projecting above the frons; the anterodorsal surface is convex, giving a flattened appearance to the surface between the antenna insertions, or the surface is gently curved. Posterior margin of head—may or may not be formed by the basal carina, and/or the posterior margin of the eyes; regardless of the makeup, the posterior margin of the head is either straight, or arcuate in an anterior or posterior direction. COLORATION. Several species have light colored markings on the ventral portion of the head. The sutures separating the genae, juga and lora, and variable portions of these regions may be testaceous or fulvous.

Rostrum. The length is taken from the junction of the epipharynx and tylus to the apices of the stylets. The coloration is quite variable within the species ranging from testaceous to black.

Antennae. The length of segment I is measured from the center of the rounded basal insertion to the apex. The remaining segments, II–IV, are maximum measurements. The smallest measurements of segments III and IV were taken from specimens with shrivelled segments. The lengths of segments I and II are quite useful for distinguishing several species. *The ratio of the length of segment I to the width of the head across the eyes is a useful phylogenetic character. The coloration of segment I is variable between and within species, ranging from entirely testaceous to black. Most intraspecific variation involves light coloration on the apex and base of this segment.

Pronotum (and remainder of thorax). MEASUREMENTS. All are maximal. Length—measurement taken on midline, from anterior margin of collar to posterior margin of disk. Anterior width—measurement taken between the anterior angles; on species with prominent anterior angles the apices of the angles are the end points of the measurement; on species with rounded, broadly curved or obsolete anterior angles the anteromedial corners of the pronotum are the end points of the measurement. Maximum width—measurement taken at the posterior margin of the pronotal disk; the extreme posterolateral corners are the end points. STRUCTURE. The shape of the pronotum is either conical, subconical, or trapezoidal. The pronotal disk is usually broadly convex, but on some species, the disk is strongly flattened. The surface texture of the pronotal disk for the genus may be smooth, with faint, shallow, deep, or confluent punctures, rugulopunctate, rugulose, transversely rugulose or rugose. The posterior margin is either straight or arcuate posteriorly; the posterolateral margins may be slightly or broadly curved. The lateral margins are either straight, slightly or strongly concave. The junction of the propleura and pronotal disk may be slightly carinate, rounded or broadly rounded. The anterior angles of the pronotum, in dorsal and lateral view, are good diagnostic characters for species. The anterior angles range from strongly produced (rounded or broadly rounded) to indistinct (broadly rounded). The anterior angles, in lateral view, vary in the development of the sulci on the anterior portion of the propleural-pronotal lateral junction dorsal or the coxal clefts. The sulci are either strongly (the pronotum is extended "roof-like" over the ridge running dorsad of the coxal cleft) or slightly developed or absent. The calli vary in the degree of convexity, size, the degree of anterior confluence and surface texture. The width of the collar varies. The scutellum and underside of the thorax exhibit great similarity of structure among the species. Most of the species are uniformly black on the ventral surface, except for thin light "trim" surrounding the pro and mesocoxae, on the anterior ventral one quarter of the propleura, and the ostiolar peritreme. More extensive light coloration on the underside of the thorax is a good distinguishing character for several species. On these species ivory, testaceous, fulvous or fuscous coloration is prevalent on these additional regions: ventral one third to one half of the propleura, front margin of the prosternum, basalar plate, and variable portion of episternum and epimeron.

Legs. The color patterns of the femora and the tibiae display great variation between and within species. Once the range of the within species variation was determined it was possible to use leg coloration as a diagnostic character for several species. The great majority of the species have short, suberect black setae on the tibiae, and short suberect fulvous setae on the femora. Several species, additionally, have much longer erect fulvous setae on the tibiae (these setae are longer than the tibial bristles); the femoral setae are longer as well. The coxae and trochanters also show a great diversity in coloration. The tarsal structure, including the claws, is very uniform among the species.

Hemelytra. The embolar margin varies from nearly straight to arcuate and, in conjunction with the general body form, is a useful diagnostic character. The surface texture and the structure of the regions of the hemelytra are of minimal value for the separation of the species. The insertion may be lightly colored in several species. The hemelytra are either macropterous or brachypterous; the hind wings of the brachypterous species and forms are brachypterous.

Venter. The venter is uniform among the species: black, with short appressed or suberect testaceous or fulvous setae. Some species have patches of light coloration on the dorsolateral regions of the second or third sternite. The setae along the midline of the sternites may be longer in some species.

Parameres of male. *The structure of the parameres is very useful in differentiating the species groups and species of *Irbisia.* The parameres show very little intraspecific variation. I have adopted the terminology of Kelton (1959) with some additions. The regions of the left paramere used herein are: sensory lobe, outer surface of arm (region between sensory lobe and medial angle of the paramere), the angle (the outer surface of the curved, angle bearing region of the paramere), shaft (the remaining portion of the paramere apical of the angle), and apex. All five of these regions show interspecific variation useful for delimiting the species. The variation is as follows: sensory lobe—prominent or moderately developed (standing greatly or moderately above the curvature of the arm) or indistinct, either with or without stout tubercles or spines; outer surface of arm—either with or without tubercles or spines; angle—'C', 'L', 'U' or 'V' shaped; shaft—long or short tubercles; apex-sharp or distally expanded (either truncated perpendicular or parallel to the axis of the shaft). The arm, angle, and shaft may bear either single widely spaced tubercles or a series of tubercles. The tubercles (blunt) may give way to spines (sharp) on the shaft.

Vesica of male. *This structure has great utility in differentiating species groups or species. The terminology follows Kelton (1959). The membranous lobes may be simple or have several associate lobes, and are more or less rounded or greatly elongated and pointed. The sclerotized process is highly diverse: straight or curved, acute or blunt, unexpanded, expanded (and/or concave on the interior surface); with or without a surface of spicules on the outer or inner surface; with or without larger spicules on the margin of the inner surface; and with or without large curved spines on the inner concave surface. All references herein to areas on the sclerotized process are based on dissected preparations of the vesica; the vesica is oriented so the gonopore faces the observer. The species show all combinations of these character states. Only mature and fully inflated specimens can be used for comparison of the membranous lobes. It is possible, however, to determine the structure of the sclerotized process on mature totally uninflated specimens, by carefully pulling the vesica out of the phallotheca with fine forceps.

*Posterior wall of bursa copulatrix of female.*This structure is of limited value in determining species. I have followed the terminology of Davis (1955) and Slater (1950). The posterior wall consists of the wing-like inter-ramal sclerites ('A' structure of Slater) which show slight variation in height and width. The sigmoid process ('B' structure of Slater) and 'C' structures are attached to the dorsomedial portion of the 'A' structure, and show slight interspecific variation (but also great intraspecific variation).

Sclerotized rings of females. The rings and their supporting structures are very useful for some species group and species separation. The sclerotized rings vary in size and shape between species. There is some intraspecific variation, but it is usually less than the interspecific variation. Of equal importance in distinguishing species groups and species is the shape and extent of the dorsal labiate plate ('F' structure of Slater). The rings may be small, large, oval or compressed and vary in the distance between them. The dorsal wall may be narrow or broad, expanded anterior to the rings, and variably concave medially.

Coloration. As mentioned previously, the basic color for the species of the genus *Irbisia* is black. Only one species has light markings on the dorsum (the base of the cuneus of *I. cuneomaculata* Blatchley is testaceous). The light color on the ventral side of a few other species is always in the form of a light colored vitta. The specific areas of the head, thorax and abdomen of concern are described in the previous sections dealing with those regions of the body.

Vestiture. The type, length, and density of the setae on the dorsum are good taxonomic characters for species discrimination. Most of the types of setae are fulvous or fuscous; the stiff long bristles which are present in varying amounts on several species are black. The simplest vestiture, found in some species, consists of a single type of short, appressed setae. Several species have a single type of densely distributed, medium length, suberect setae. Many species possess setae of two types; densely appressed or woolly sericeous setae in combination with the previous two types. A few species have a vestiture of the last type which is intermixed with long upright bristle-like or thin setae. Because of the vexing ease with which these bugs lose their vestiture it is necessary to examine a series of specimens to accurately determine the character of the setae.

Irbisia Reuter

Irbisia Reuter, 1875b, p. 548; 1879, p. 57; 1880, p. 509; 1890, p. 253; 1896a, pp. 11–12, 347–348; 1896b, p. 157; 1909, p. 13; 1910, p. 158. Atkinson, 1890, p. 125. Hueber, 1898, p. 80. Kirkaldy, 1906, p. 142. Oshanin, 1910, p. 760. Van Duzee, 1916a, p. 207; 1916b, p. 38; 1917a, p. 324; 1921a, pp. 151–152. Slater, 1950, pp. 35–36. Carvalho, 1952, p. 89; 1955, p. 88; 1959, p. 104. Kelton, 1959, pp. 17–18; 1980, p. 83. Bliven, 1963, pp. 68–69. Knight, 1968, p. 185.

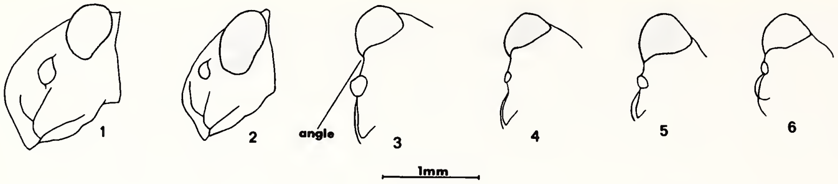
Thyrillus Uhler, 1894, p. 266 (synonymy by Reuter, 1896a, p. 11). Van Duzee, 1916a, p. 207; 1916b, p. 38; 1917a, p. 325.

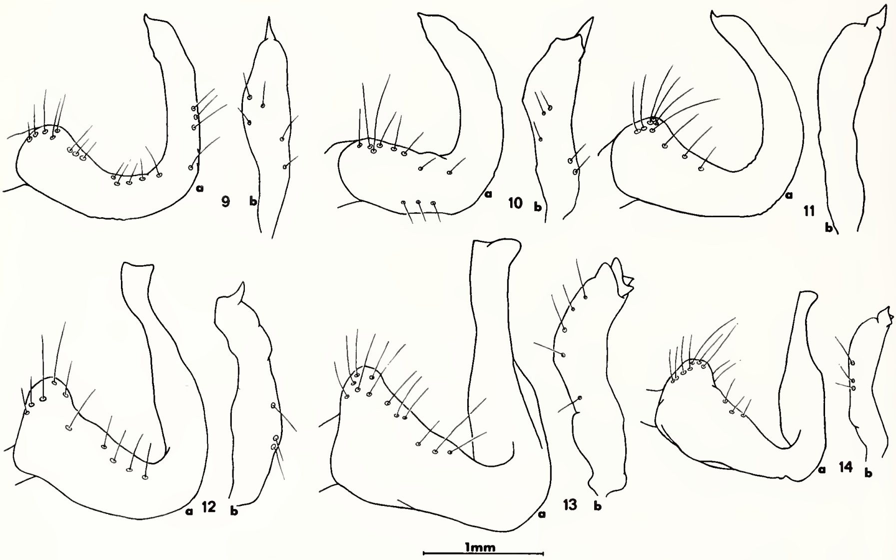
Type species. Leptomerocoris sericans Stål, 1858 (monobasic).

Diagnosis. The possession of the following characters of the subfamily Mirinae will distinguish the species of the genus *Irbisia* from the superficially similar genus *Orthocephalus* (Miridae: Orthotylinae): parempodia flattened and divergent apically; claws rather strongly bent, with sub-basal, ventral pulvilli; rounded pronotal collar strongly developed and conspicuous; vesica of male with rim of gonopore circular in outline, simulating a coiled spring; sclerotized rings of female ovoid with strongly sclerotized margins that are not infolded on the lateral margins; posterior wall of female with highly differentiated sigmoid process. Specifically, the species of *Irbisia* never possess flattened scale-like setae, and numerous stout black bristles as found on *O. coriaceus* (Fabricius) or *O. saltator* (Hahn).

Several species of *Irbisia* (*fuscipubescens, cascadia, knighti, nigripes, sericans, serrata, shulli* and *solani*) are sympatric with *Capsus cinctus* (Kolenati) in these provinces and states: Alberta, British Columbia, Colorado, Idaho, Montana, Oregon, Utah, Washington and Wyoming. All the species listed above are predominately black, but the *Irbisia* species never have any light coloration on the vertex and frons of the head, and have a light ringlet bordering the posterior margin of the eye. In addition, the second antennal segment of the *Irbisia* species always is linear and never swollen apically or pre-apically. The male and female genitalic structures of the two genera are diagnostic. The vesica of the male *Irbisia* does not possess a very long and slender spiculum, and the ductus seminis is not constricted medially. The female sclerotized rings of the species of *Irbisia* are never subrectangular and one third to one half the diameter of the sclerotized rings of *C. cinctus.* The sigmoid process of the *Irbisia* species is always attached to the sclerotized portion of the inter-ramal sclerites and never to the membranous portion. The inter-ramal sclerites of the species of *Irbisia* are never bisected by membranous sutures.

Description. SIZE: length 3.80–8.20, width 1.60–3.20. COLORATION: dorsum usually black, either polished and shining, asperate, shagreened, or with a bronze luster; propleura and pleura black, in most species ivory or testaceous narrowly bordering the pro and mesocoxae, the ventral one quarter of the propleura and the ostiolar peritreme; venter shining black. The light coloration of the ventral aspect is more extensive on several species; a light vitta extending from the head, at the tylus, posteriorly across the pleura, terminating on the second or third sternites; posterior margins of eyes bordered by narrow testaceous or ivory band. VESTITURE: usually of similar structure and density on head thorax and hemelytra; simple—consisting of either appressed short or suberect medium length, fulvous or fuscous setae; complex—consisting of a mixture of the simple type together with either upright, stiff, long, black bristles and/or appressed or woolly sericeous setae; eyes with sparse minute pubescence between facets; venter with short or long appressed or upright setae. BODY: oval, suboval or elongate, dorsum smooth, either with faint, shallow, deep or confluent punctures, or rugulopunctate, rugulose, transversely rugulose or rugose; female usually more robust than male. HEAD: triangular, or pedunculate in dorsal view, region anterior of the eyes sometimes elongated (ratio of width to length of the head ranging from 1:0.50 to 1:0.75); front moderately or strongly convex, smooth, asperate or shagreened; basal carina abruptly produced or declivous with respect to the level of the vertex, dorsal surface acute or rounded in cross section, width narrow or broad, posterior margin straight or arcuate posteriorly; posterior margin of head sometimes formed by basal carina and/or posterior margin of the eyes; collum faintly or strongly separated from carina (depending on structure of the carina); eyes either large and broadly joining the frons, or small and narrowly joining the frons; clypeus, juga, and lora slightly or greatly tumid, the sutures separating these regions always deep; bucculae, gula and genae well defined; antennal sockets either ventrad or dorsad of the eyes. ROSTRUM: barely reaching bases of mesocoxae to just surpassing apices of metacoxae. ANTENNAE: cylindrical, inserted below, above or at the level of the anterior margin of the eye; with densely distributed, fine appressed or suberect, fuscous or black, short or medium length setae; segment I with several suberect, stout, long, bristle-like black setae; segment I just reaching tylus or surpassing tylus by one eighth of the length of the segment; segment II gradually, but only slightly, thickening toward apex (thickened apex is never greatly evident). PRONOTUM: conical, subconical, or trapezoidal, broader at base than long (ratio of width to length of the pronotum ranging from 1:0.54 to 1:0.66); disk broadly convex or, in some species, strongly flattened; collar convex, well differentiated, forming a complete ring, widest dorsomedially; posterior margin either straight, slightly or strongly concave; junction of propleura and disk slightly marginate, rounded or broadly rounded;





Figs. 1–6. 1, 2. Lateral view of head. 1. *I. pacifica.* 2. *I. californica.* 3–6. Anterodorsal view of left side of head (centered at angle of frons and eye). 3. *I. pacifica.* 4. *I. brachycera.* 5. *I. california.* 6. *I. solani.*

Figs. 9–14. a. Dorsal view of left paramere. b. Dorsal view of right paramere. 9. *I. brachycera.* 10. *I. elongata.* 11. *I. pacifica.* 12. *I. sericans.* 13. *I. californica.* 14. *I. sita.*

anterior angle, in dorsal view, either indistinct, moderately or strongly produced, sulcus on anterior angle, in lateral view, either absent, slightly or strongly developed; calli slightly or strongly convex, smooth or asperate, narrowly or broadly confluent anteriorly, sometimes with one or two fovate depressions on each callus; the calli sometimes reaching the anterolateral margin of pronotum; mesoscutellum narrowly or widely exposed, smooth, gradually or steeply sloping to scutellum; scutellum weakly or strongly convex, and transversely rugulose; propleura with ventral and posterior margins sinuous. HEMELYTRA: lateral margins arcuate or subparallel; embolium explanate anteriorly; rugulopunctate or rugulose; cuneus slightly or moderately deflected; fracture deep; membrane—macropterous species and forms, surpassing the genital segments in both sexes, with two well developed areoles—brachypterous species and forms, membrane is reduced, and sometimes slightly surpassing apex of cuneus, the genital segments are exposed, areoles are either developed or

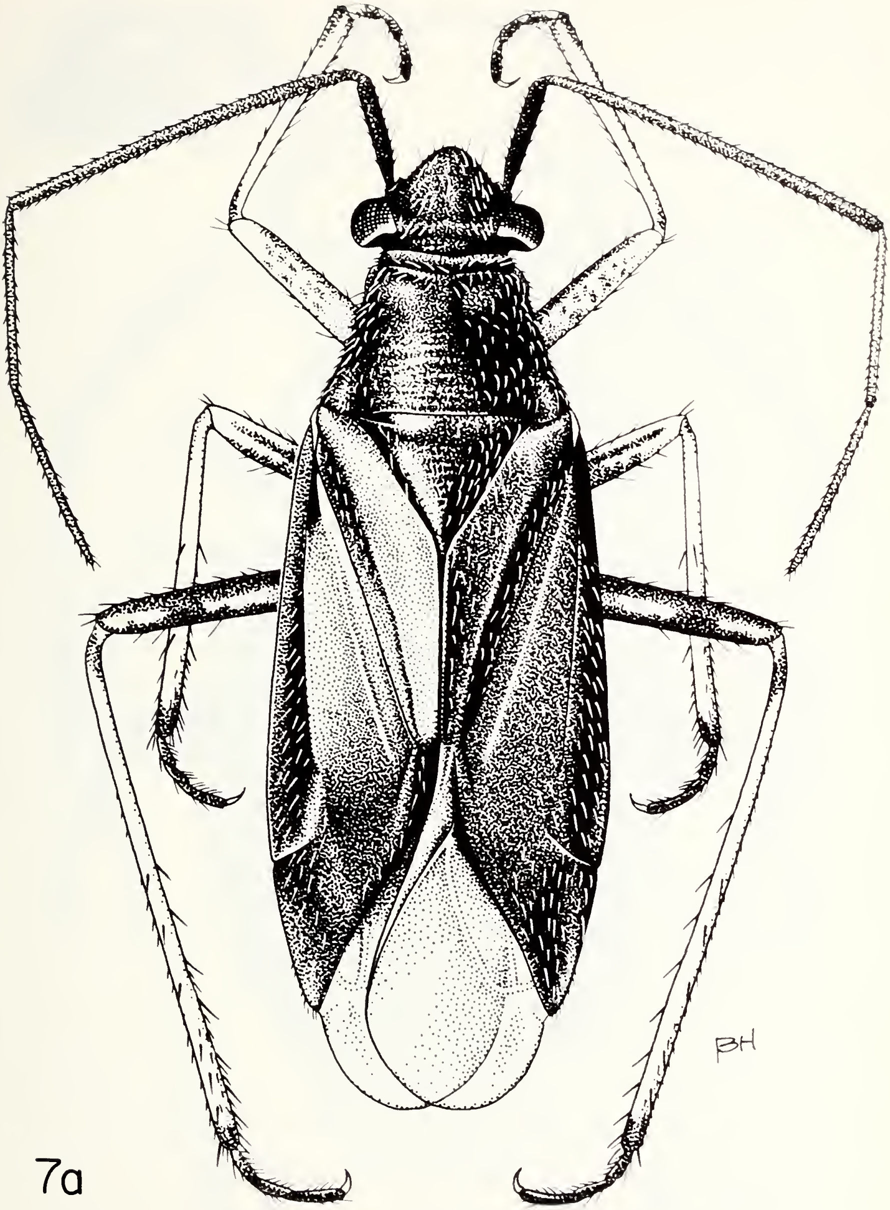


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Fig. 7a. Dorsal view of body, *I. pacifica.*

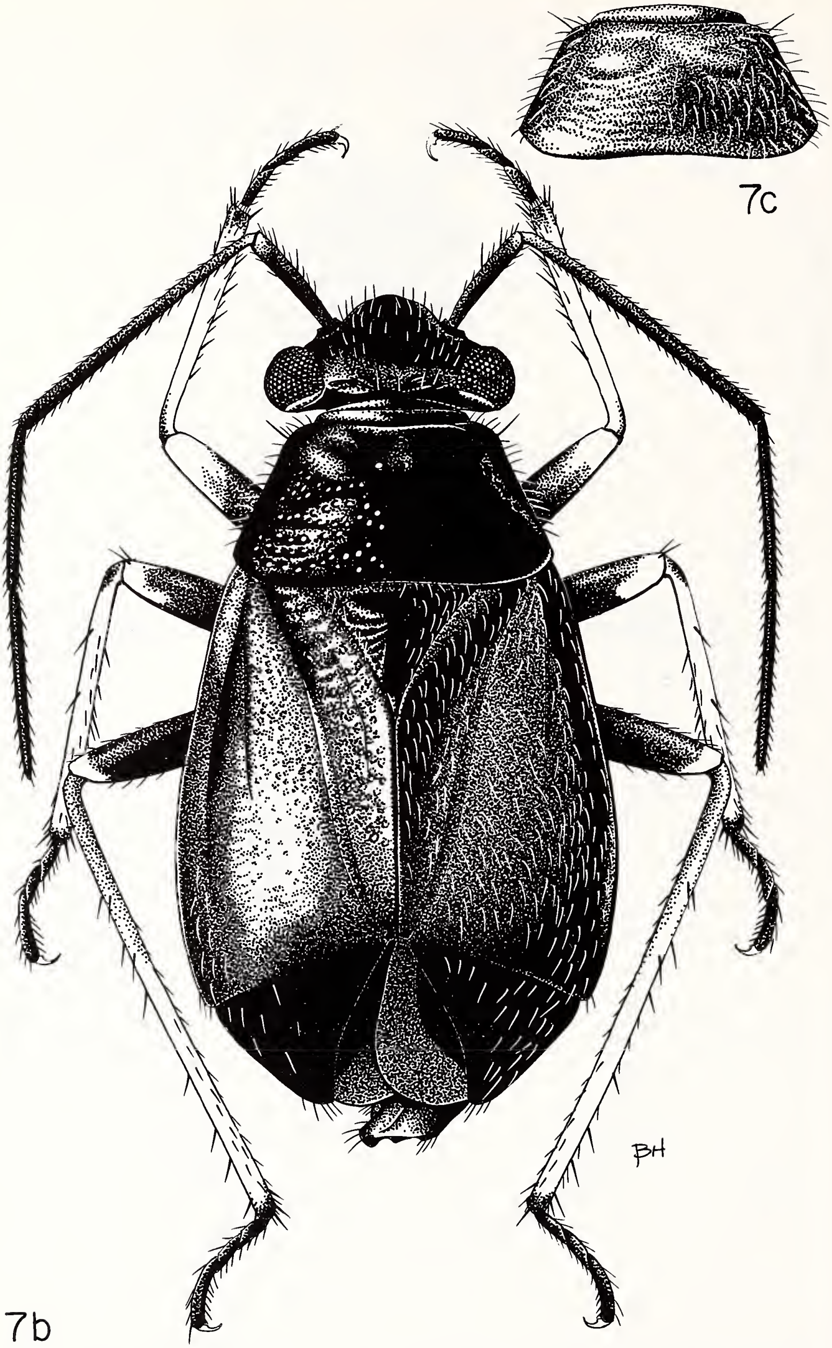

Fig. 7b,c. b. Dorsal view of body, *I. knighti.* c. Dorsal view of pronotum, *I. sericans.*

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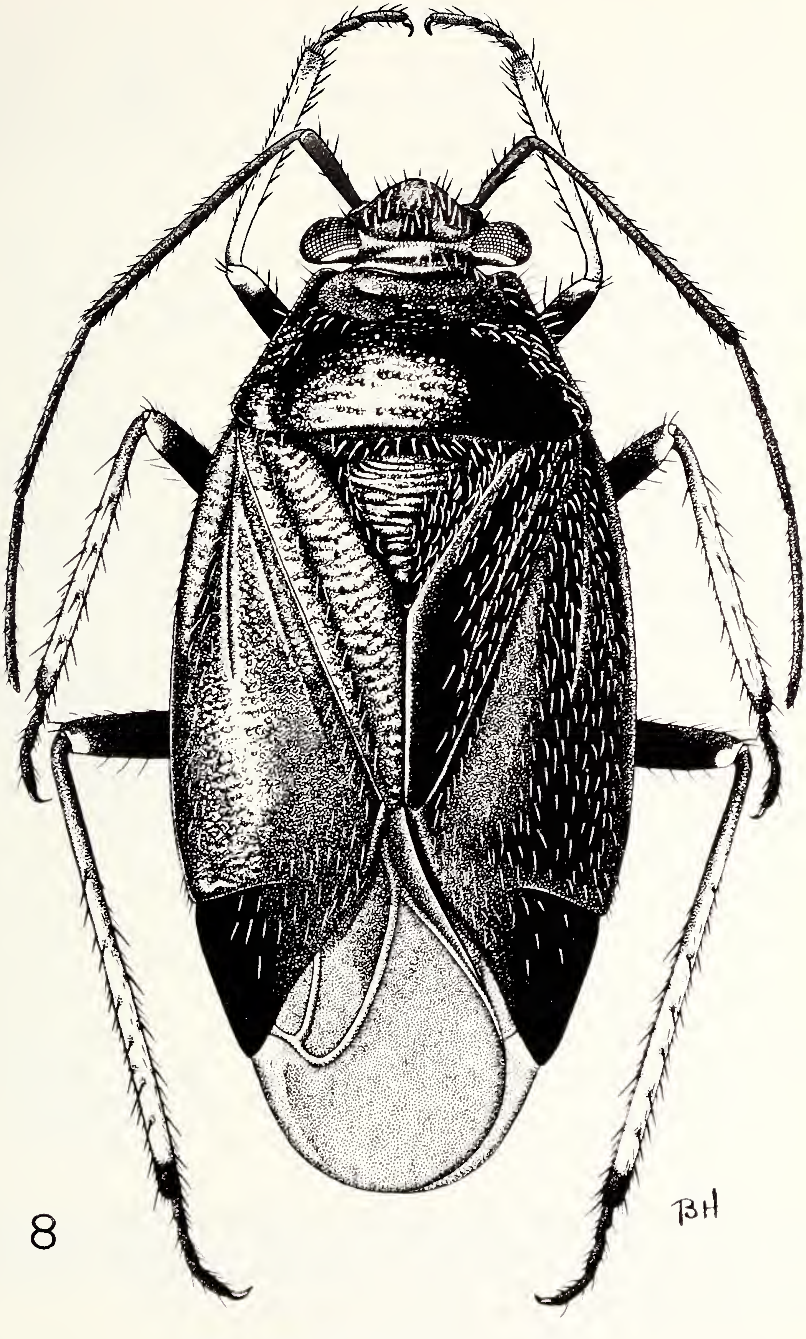
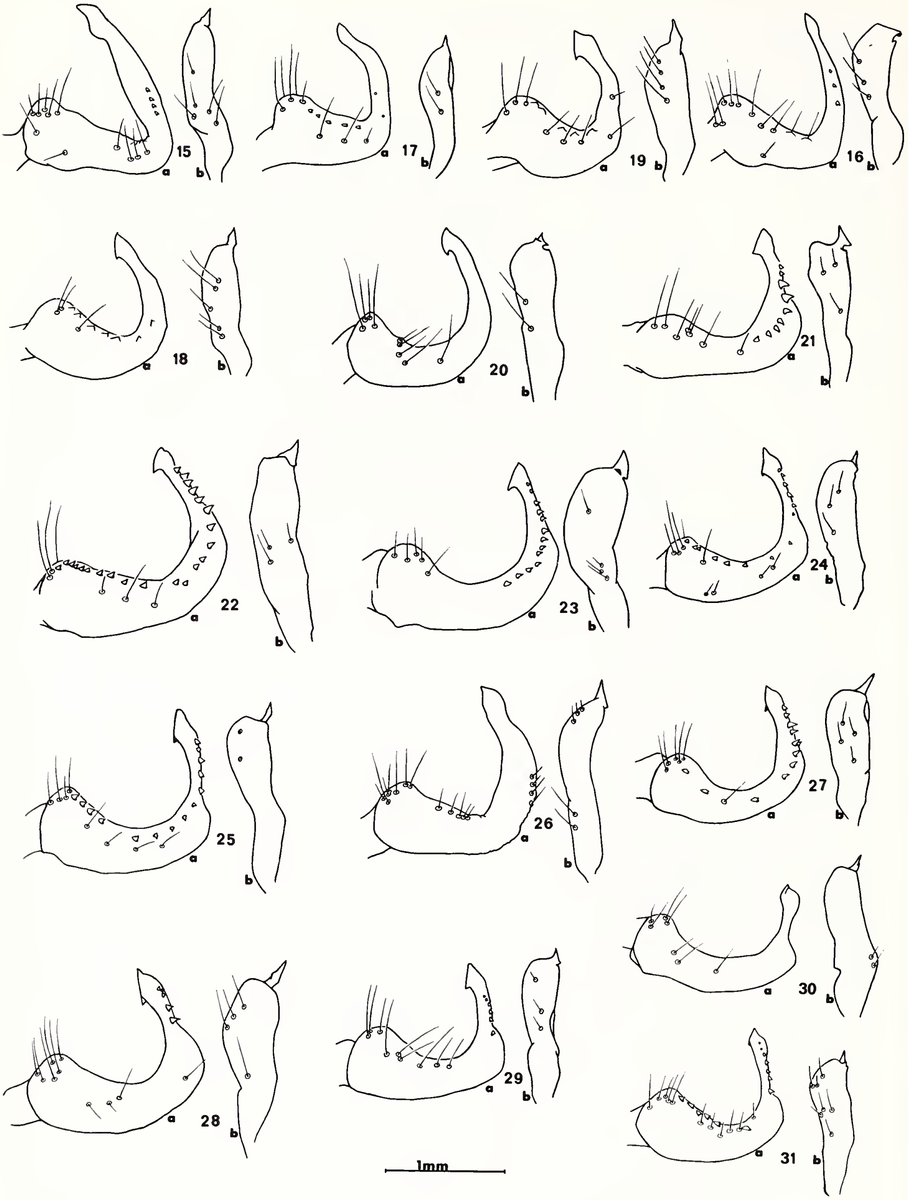
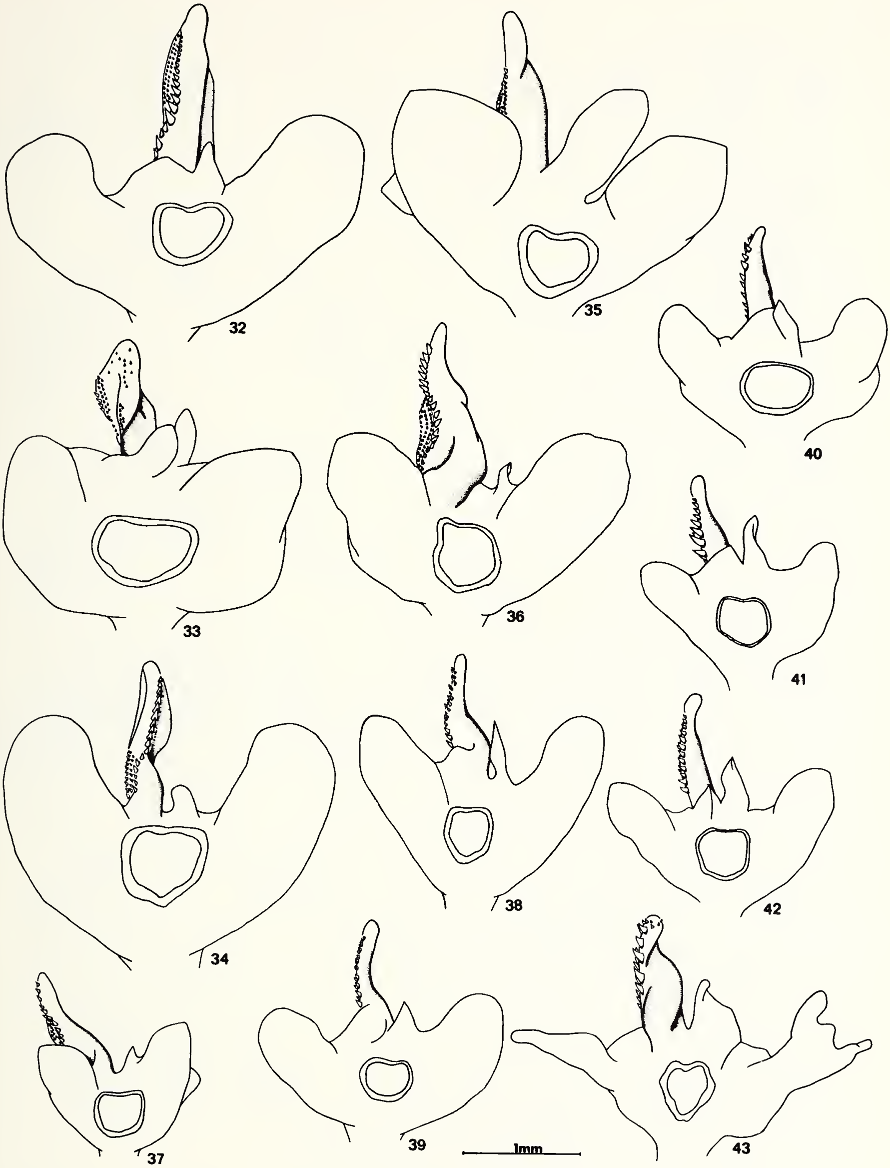


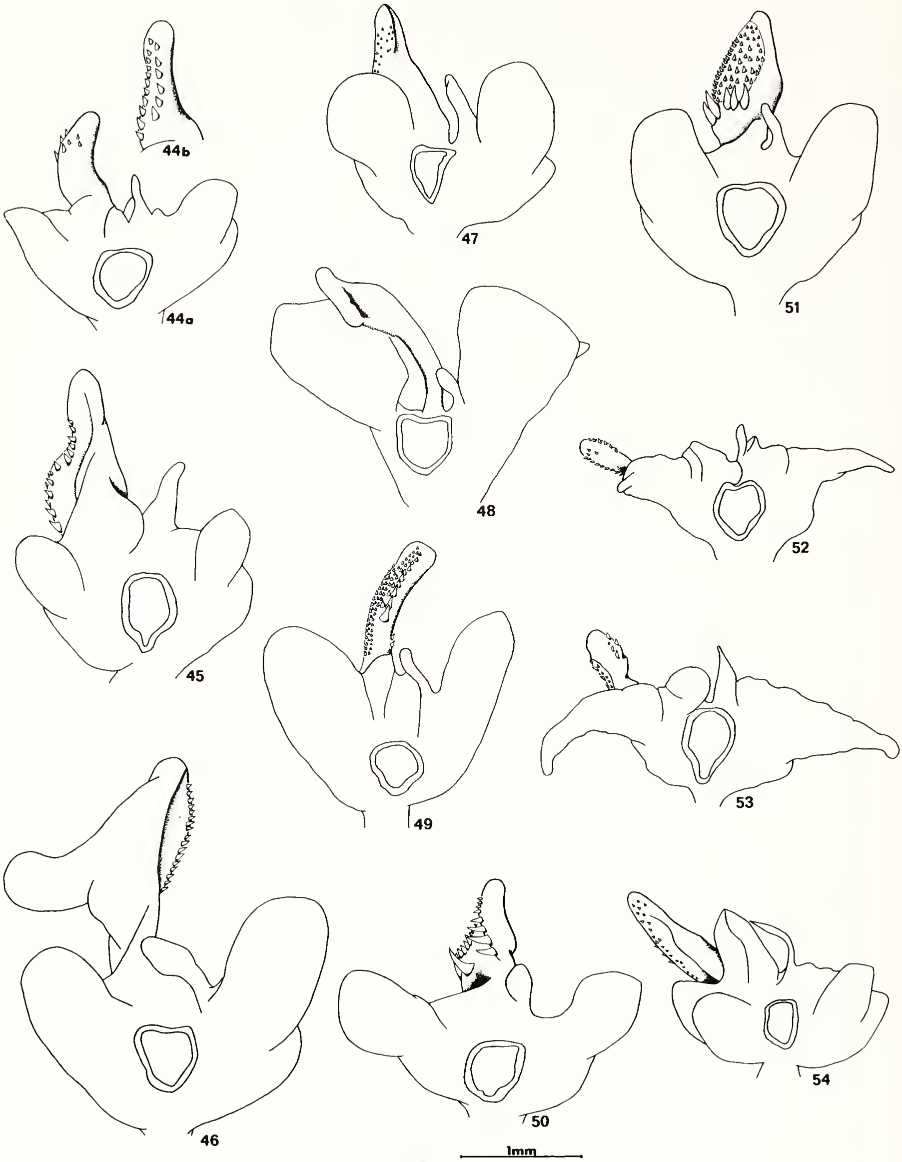
Fig. 8. Dorsal view of body, *I. cascadia.*



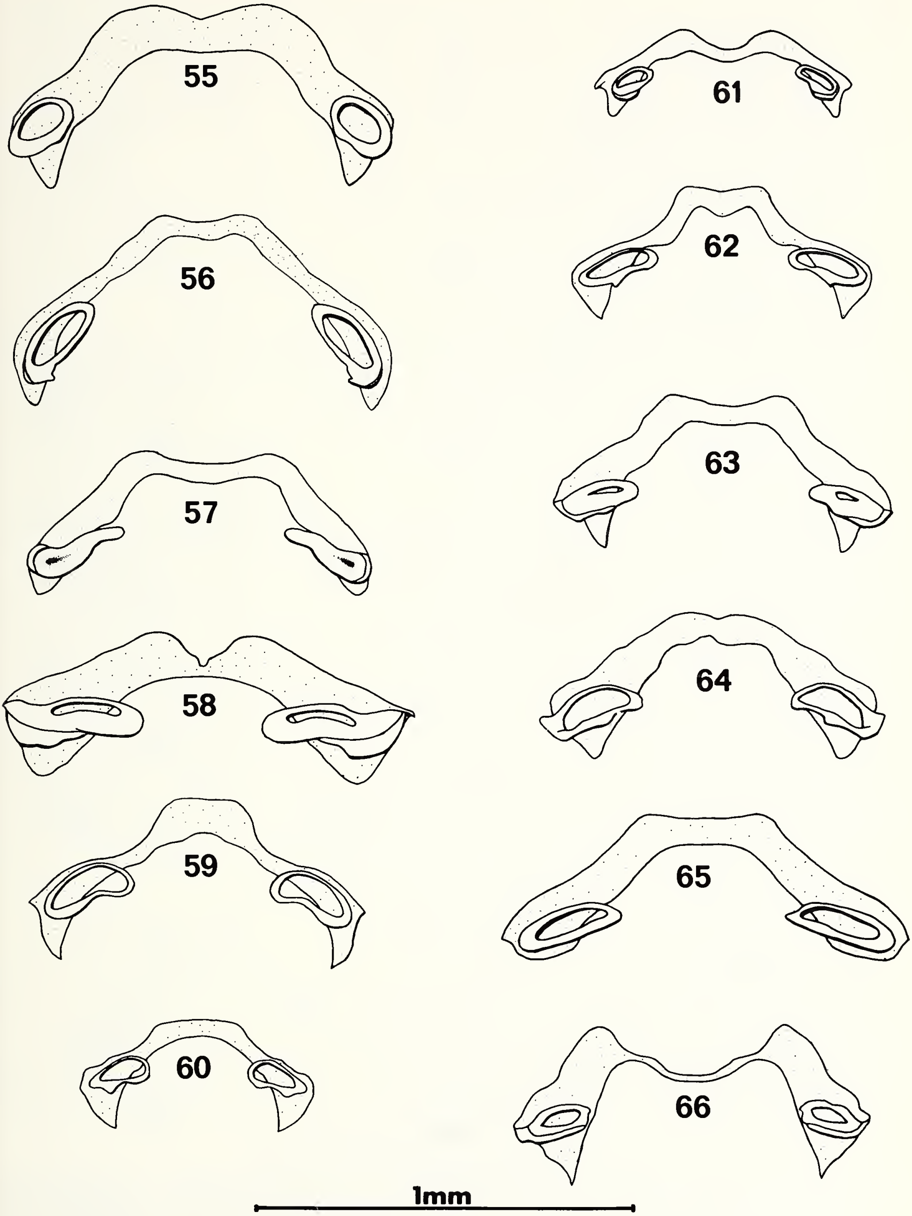
Figs. 15–31. a. Dorsal view of left paramere. b. Dorsal view of right paramere. 15. *I. cuneomaculata.* 16. *I. oreas.* 17. *I. incomperta.* 18. *I. solani.* 19. *I. knighti.* 20. *I. limata.* 21. *I. nigripes.* 22. *I. shulli.* 23. *I. serrata.* 24. *I. castanipes.* 25. *I. bliveni.* 26. *I. silvosa.* 27. *I. cascadia.* 28. *I. fuscipubescens.* 29. *I. mollipes.* 30. *I. panda.* 31. *I. setosa.*



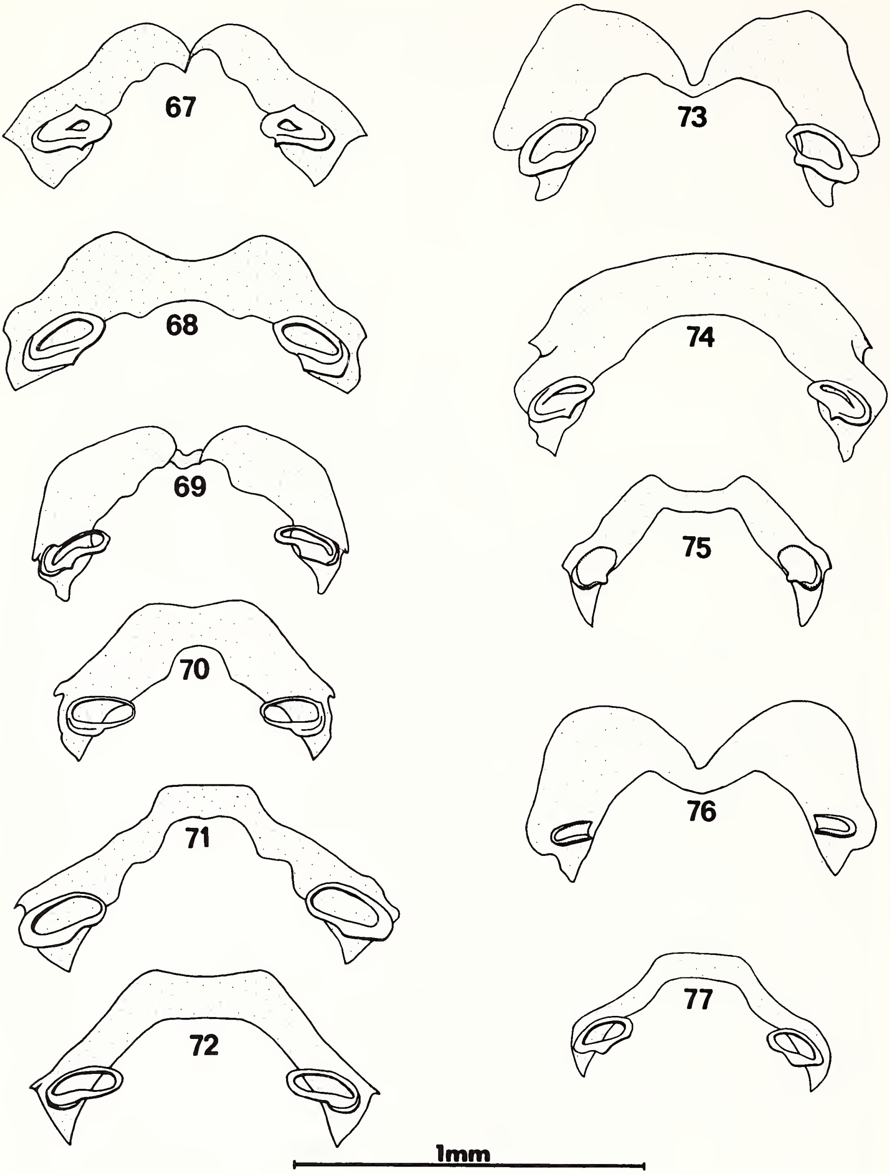
Figs. 32–43. Ventral veiw of vesica. 32. *I. brachycera.* 33. *I. elongata.* 34. *I. pacifica.* 35. *I. sericans.* 36. *I. californica.* 37. *I. sita.* 38. *I. cuneomaculata.* 39. *I. oreas.* 40. *I. incomperta.* 41. *I. solani.* 42. *I. knighti.* 43. *I. limata.*



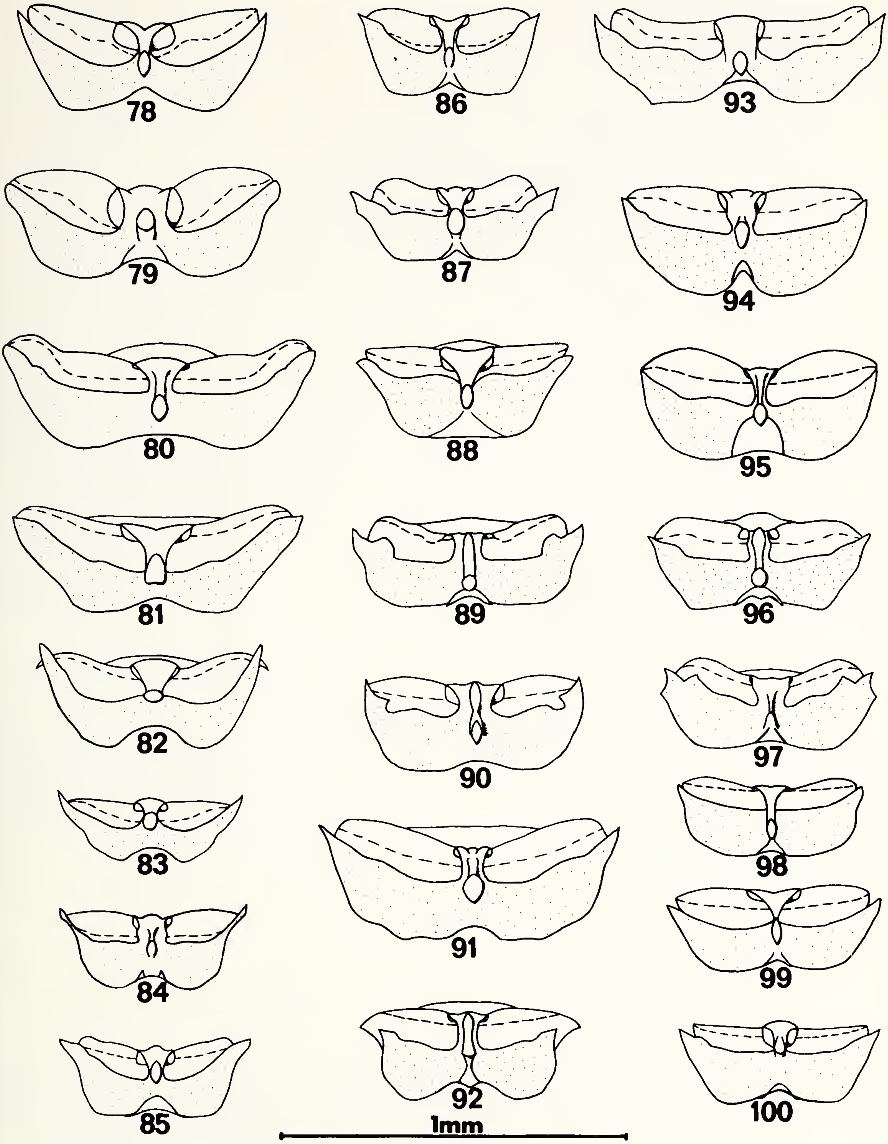
Figs. 44–54. Ventral veiw of vesica. 44. *I. nigripes.* 45. *I. shulli.* 46. *I. serrata.* 47. *I. castanipes.* 48. *I. bliveni.* 49. *I. silvosa.* 50. *I. cascadia.* 51. *I. fuscipubescens.* 52. *I. mollipes.* 53. *I. panda.* 54. *I. setosa.*



Figs. 55–66. Posterior view of sclerotized rings and dorsal labiate plate. 55. *I. brachycera.* 56. *I. elongata.* 57. *I. pacifica.* 58. *I. sericans.* 59. *I. californica.* 60. *I. sita.* 61. *I. cuneomaculata.* 62. *I. oreas.* 63. *I. incomperta.* 64. *I. solani.* 65. *I. knighti.* 66. *I. limata.*



Figs. 67–77. Posterior view of sclerotized rings and dorsal labiate plate. 67. *I. nigripes.* 68. *I. shulli.* 69. *I. serrata.* 70. *I. castanipes.* 71. *I. bliveni.* 72. *I. silvosa.* 73. *I. cascadia.* 74. *I. fuscipubescens.* 75. *I. mollipes.* 76. *I. panda.* 77. *I. setosa.*



Figs. 78–100. Posterior view of inter-ramal sclerites. 78. *I. brachycera.* 79. *I. elongata.* 80. *I. pacifica.* 81. *I. sericans.* 82. *I. californica.* 83. *I. sita.* 84. *I. cuneomaculata.* 85. *I. oreas.* 86. *I. incomperta.* 87. *I. solani.* 88. *I. knighti.* 89. *I. limata.* 90. *I. nigripes.* 91. *I. shulli.* 92. *I. serrata.* 93. *I. castanipes.* 94. *I. bliveni.* 95. *I. silvosa.* 96. *I. cascadia.* 97. *I. fuscipubescens.* 98. *I. mollipes.* 99. *I. panda.* 100. *I. setosa.*

not; hind wings are reduced in brachypterous species or forms. LEGS: moderately long, hind femora not reaching apex of abdomen; testaceous, fulvous, fuscous, rufuscent or black; femora with short suberect fulvous setae; tibiae with short suberect black setae; some species have longer erect fulvous setae on the femora and tibiae; tibiae with four rows of suberect black bristles, and numerous apical black bristles; femora with a pair of apical black bristles; tibial comb present on apices of protibiae, formed by a row of short fine setae on ventral side and bordered laterally by a pair of bristles; three tarsal segments subequal in length; claws are not cleft; puvilli present; parempodia lamellate and diverging. GENITALIA: Male: left paramere: acutely or broadly angled, with or without prominent sensory lobe; either with or without tubercles or spines on angle, arm and shaft; apex either sharp, securiform or truncated; right paramere: cylindrical; the preapical portion sometimes expanded, if not, the paramere is of equal diameter throughout; apically with a single simple spine or with a double faceted apex; vesica: with two membranous lobes either rounded or conical and with or without accessory lobes of various forms; with a furcate sclerotized process, the larger process either simple, expanded (with or without a concave furrow) or linear, this process is acute or blunt apically, and is ornate with various types of spines, the smaller process possessing a pointed membranous lobe. Female: posterior wall of the bursa copulatrix with two types of inter-ramal sclerites (that differ in shape), a prominent sigmoid process with wide and convoluted C structures; sclerotized rings are oval or compressed, and either open or closed; the dorsal labiate plate is either narrow throughout or expanded anteriorly.

KEYS TO THE SPECIES OF *IRBISIA*

I have constructed two keys to the adults of the species of *Irbisia*; the first attempts to distinguish the species on external characters alone; the second relies predominately on the structure of the male and female genitalia. The species of *Irbisia* display great similarity in practically all characters. Positive identification of some species is facilitated by the examination of the internal genitalia of both sexes.

KEY I

1. Brachypterous 2
1′. Macropterous 6
2(1). Males 3
2′. Females 4
3(2). Pronotum shagreened and transversely rugulose (Fig. 7c) .... *sericans* (Stål)
3′. Pronotum shining and shallowly punctate (Fig. 7b) .... *knighti* Schwartz and Lattin
4(2)′. Distributed west of Cascade Range in Oregon and Washington and along coast of Alaska and British Columbia (also in Columbia R. Gorge west of The Dalles, Oregon) 5
4′. Widely distributed east of Cascade Range in British Columbia, Oregon and Washington; and Rocky Mountain regions of Colorado, Idaho, Montana, Utah and Wyoming .... *shulli* Knight
5(4). Pronotum shagreened and transversely rugulose (Fig. 76) .... *sericans* (Stål)
5′. Pronotum shining and shallowly punctate (Fig. 7a)..... *knighti* Schwartz and Lattin
6(1′). Antennal socket below ventral margin of eye; eye rounded in lateral view (Figs. 1, 3, 4) 7

6′. Antennal socket above ventral margin of eye, or with at most only ventral portion of socket below eye; eye oval or reniform (Figs. 2, 5, 6) 9

7(6). Length of antennal segment II much greater than maximum width of pronotum (almost 2× as great) .... *pacifica* (Uhler)

7′. Length of antennal segment II less than 1.25× the maximum width of pronotum 8

8(7′). Tibial setae long, fulvous or white; length of antennal segment I equal to width of vertex (ratio of vertex to segment I 1:0.90 to 1:1.00) .... *elongata* Knight

8′. Tibial setae short, black; length of antennal segment I less than width of vertex (ratio of vertex to segment I 1:0.60 to 1:0.80 .... *brachycera* (Uhler)

9(6′). Distribution outside of California 10

9′. Distribution in California and Baja California Norte (or in woodlands of Maricopa, Pinal and Yavapai Counties, Arizona and Washington County, Utah) 18

10(9′). Dorsum with single type of setae; either sparsely distributed fine short, suberect or appressed fuscous to golden setae; or moderately or densely distributed woolly sericeous, recurved, longer golden setae 11

10′. Dorsum with two types of setae; mixture of moderately to densely distributed fine short setae and recurved (perhaps woolly) sericeous setae (sericeous setae most noticeable on clavus) 12

11′(10). Dorsum dull black with bronze luster, and moderately to densely distributed, woolly sericeous recurved longer golden setae .... male, *sericans* (Stål)

11. Dorsum shining black with sparsely distributed fine, short, suberect or appressed fuscous to golden setae .... *fuscipubescens* Knight

12(10′). Ostiolar peritreme (except for fuscous extreme posterior margin) and propleuron (except for very narrow fuscous trim on ventral apex) black .... *nigripes* Knight

12′. Ostiolar peritreme and ventral one quarter of propleuron ivory 13

13(12′). Ventral surface of head and pleura variably marked with testaceous or ochraceous patches; female venter light; distributed in southwestern Oregon ..... *silvosa* Bliven

13′. Ventral surface of head and pleura black with, at most, light colored trim near coxae 14

14(13′). Lateral margins of pronotum strongly concave; femora with fuscous spots; distributed in southwestern Oregon .... *californica* Van Duzee

14′. Lateral margins of pronotum straight; femora without fuscous spots 15

15(14′). Anterior angle of pronotum rounded and indistinct in dorsal view; female femora rufescent or extensively testaceous; distribution restricted to Willamette Valley in Oregon, not collected above 300 m. (1000 feet) elevation ... *solani* (Heidemann)

15′. Anterior angle of pronotum prominent and distinct in dorsal view; female femora black or fuscous; distribution widespread (including Willamette Valley, Oregon), but usually collected above 300 m. (1000 feet) elevation 16

16(15′). Pronotum shining black, with distinctly separated punctures; calli prominent, polished; distribution practically restricted to Oregon (collected in Modoc County, California and Skamania County, Washington) .... *cascadia,* new species

16′. Pronotum shagreened, with confluent punctures; calli weakly convex, asperate; distribution extensive outside of Oregon 17

17(16). Width of vertex of males 0.45 to 0.59; females macropterous .... *serrata* Bliven

17′. Width of vertex of males 0.68 to 0.75; females brachypterous .... *shulli* Knight

18(9′). Dorsum covered with one type of setae; either sparsely distributed minute appressed gray setae; or sparsely distributed short, fine, suberect, testaceous, fulvous or fuscous setae; or densely distributed long, white to golden setae 19

18′. Dorsum covered with two types of setae; mixture of moderately or densely distributed short to long, suberect to erect, light to black setae and recurved (perhaps woolly) sericeous setae (sericeous setae most noticeable on clavus) 23

19(18). Dorsum dull black, with obvious bronze luster and sparsely covered with minute appressed gray setae ... *castanipes* Van Duzee

19′. Dorsum shining or polished black, without bronze luster and minute appressed gray setae ... 20

20(19′). Pronotum with very faint, shallow punctures; dorsum sparsely covered with short, fine suberect setae ... 21

20′. Pronotum with obvious deep punctures, or confluently punctate, rugulose or rugose; dorsum with densely distributed, long setae ... 22

21(20). Antennal segment I and legs flavescent; basalar plate shining black ... *limata* Bliven

21′. Antennal segment I and legs fuscous to black; basalar plate ivory ... *panda* Bliven

22(20′). Width of vertex ranging from 0.56 to 0.64 in males, and from 0.60 to 0.70 in females; ventral femoral setae densely distributed and erect; protibial setae long and fulvous ... *bliveni,* new species

22′. Width of vertex ranging from 0.40 to 0.50 in males, and from 0.48 to 0.55 in females; ventral femoral setae usually sparsely distributed and suberect; protibial setae usually short and black ... *mollipes* Van Duzee

23(18′). Cuneus with basal margin testaceous ... *cuneomaculata* Blatchley

23′. Cuneus black ... 24

24(23′). Vestiture of apical portion of hemelytra moderately or densely distributed long (projecting far above sericeous setae), erect, bristle-like fulvous to black setae and densely distributed woolly sericeous setae ... 25

24′. Vestiture of apical portion of hemelytra never with long erect setae that project far above sericeous woolly setae ... 26

25(24). Tibiae densely covered with long (longer than tibial bristles) suberect fine white setae ... *oreas* Bliven

25′. Tibiae moderately covered with shorter (much less than length of tibial bristles) suberect fuscous setae ... *setosa* Van Duzee

26(24′). Ventral surface of head and pleura variably marked with testaceous or ochraceous; female venter light ... *silvosa* Bliven

26′. Ventral surface of head and pleura black with, at most, light colored trim near coxae ... 27

27(26′). Lateral margins of pronotum strongly concave ... 28

27′. Lateral margins of pronotum straight, or, at most, very slightly concave ... 29

28(27). Femora with fuscous spots ... *californica* Van Duzee

28′. Femora without fuscous spots ... *sita* Van Duzee

29(27′). Basalar plate with variable portion of posterior margin ochraceous; median depression of head obvious, either distinct longitudinal furrow or broad sunken area; female femora with fuscous spots ... *incomperta* Bliven

29′. Basalar plate black; median depression of head shallow or indistinct; femora without fuscous spots ... 30

30(20′). Dorsal vestiture a mixture of densely distributed, long setae that are erect on head and pronotum and suberect on hemelytra; and woolly sericeous setae; occurs in Kern County, California ... *bliveni,* new species

30′. Dorsal vestiture a mixture of moderately distributed, medium length, suberect setae; and woolly sericeous setae; occurs widely outside of Kern County, California ... 31

31(30′). Anterior angle of pronotum rounded and indistinct in dorsal view; female femora may be rufescent; distribution widespread in California ... *solani* (Heidemann)

31′. Anterior angle of pronotum prominent and distinct in dorsal view; female femora black or fuscous; distribution in northern California ... 32

32(31). Pronotum shining black, with distinctly separated punctures; calli prominent, polished . . . . *cascadia*, new species

32′. Pronotum shagreened, with confluent punctures; calli weakly convex, asperate . . . . *serrata* Bliven

KEY II

1. Antennal socket, in lateral and cephalic view, below ventral margin of eye; eye round in lateral view (Fig. 1),; ratio of distance between tylus and ventral margin of eye to height of eye less than or equal to 1:0.50; eyes narrowly joined to frons—angle at junction of frons and ventral margin of eye, in frontal view, less than or equal to 135° (Figs. 3, 4) 2

1′. Antennal socket, in lateral and cephalic view, at most with only ventral portion below ventral margin of eye; eye oval or reniform in lateral view (Fig. 2); ratio of distance between tylus and ventral margin of eye to height of eye greater than 1:0.50 (usually ratio greater than 1:0.60, only female specimens of *I. shulli* with a ratio approaching 1:0.50, but are distinguished by brachyptery); eyes broadly joined to frons—angle at junction of frons and ventral margin of eye, in frontal view, greater than 135° (Figs. 5, 6) 4

2(1). Length of antennal segment II almost 2 × maximum width of pronotum; length of antennal segment I greater than width of vertex—ratio 1:1.00 to 1:1.40; head anterior of eyes elongate—ratio of width of head across eyes to head length 1: 0.75 (Figs. 1, 3), eyes in lateral view projecting above basal carina; body length 5.75 to 8.20 . . . . *pacifica* (Uhler)

2′. Length of antennal segment II less than or equal to 1.25 × the maximum width of pronotum; length of antennal segment I, at most, equal to width of vertex—ratio 1:0.60 to 1:1.00; head anterior of eyes somewhat elongate—ratio of width of head across eyes to head length 1:0.50 to 1:0.60 (Fig. 4), eyes in lateral view not projecting above basal carina; body length 4.90 to 6.25 3

3(2′). Tibial spines long, fuscous; body elongate, parallel-sided, width 1.70 to 2.00 males, 1.08 to 2.40 females; length of antennal segment I subequal to width of vertex—ratio ranging from 1:0.90 to 1:1.00; ratio of distance between tylus and ventral margin of eye to height of eye 1:0.50; pronotum conical . . . *elongata* Knight

3′. Tibial spines short, black; body stocky, ovate, width 1.85 to 2.30 males, 2.21 to 2.78 females; length of antennal segment I less than width of vertex—ratio ranging from 1:0.60 to 1:0.80; ratio of distance between tylus and ventral margin of eye to height of eye greater than 1:0.50 (Fig. 4); pronotum trapezoidal . . . . *brachycera* (Uhler)

4(1′). Male parameres as in Figures 12a, b to 14a, b, with the following combination of characters: left paramere—sensory lobe straight, length greater than or equal to length of arm, and distally expanded with apex truncated at right angles to axis of shaft; angle sharp, 'V' shaped (less than 45°); right paramere—cylindrical throughout, slightly curved mesad; apex with double faceted spine directed at right angle to long axis of paramere. Females either: 1) brachyperous, with transversely rugose pronotal disk; distributed in Oregon and Washington west of Cascade Range, as far south as Eugene, Lane County, Oregon, and in British Columbia and Alaska in coastal grasslands as far west as Kamchatka Peninsula of U.S.S.R.; or 2) with lateral margins of pronotum transversely rugose; vestiture a mixture of long, golden to white setae and woolly sericeous white setae; femora with fuscous spots; distributed throughout California within and east of the

Coastal Ranges; or 3) dorsum polished shining black; pronotal disk distinctly and closly punctate; femora fulvous to castaneous (without fuscous spots); tibiae without long setae; venter black; vestiture without long bristle-like setae; basalar plate entirely black 5

4′. Male parameres as in Figures 15a, b to 31a, b, without above combination of characters: left paramere—sensory lobe small or indistinct, i.e. barely produced above outline of arm, shaft curved toward sensory lobe, length less than or equal to length of arm, and distally expanded with apex truncated parallel to axis of shaft; angle broad, 'U' shaped (60–90°); right paramere—cylindrical, but expanded distally; apex with simple spine directed in line with long axis of paramere. Females without the previous arrangement of characters 7

5(4). Females and some males brachypterous; pronotum trapezoidal, lateral margin straight .... *sericans* (Stål)

5′. Both sexes macropterous; lateral margin of pronotum concave 6

6(5′). Femora with fuscous spots; head long ventrad of eyes—ratio of distance between tylus and ventral margin of eye to height of eye 1:0.68 to 1:0.86 for males and 1:0.60 to 1:0.80 for females; dorsum shining black; pronotal disk rugulose or confluently punctate; femora testaceous, fulvous or fuscous; body length 4.75–7.30 .... *californica* Van Duzee

6′. Femora without fuscous spots; head shorter ventrad of eyes—ratio of distance between tylus and ventral margin of eye to height of eye 1:0.96 to 1:1.04 for males and from 1:0.85 to 1:1.04 for females; dorsum polished shining black; pronotal disk distinctly and closely punctate; femora fulvous to castaneous; body length 4.25–5.40 .... *sita* Van Duzee

7′. Dorsum shining black without obvious bronze luster; vestiture single type of long upright or short appressed setae or mixture of fine setae; woolly sericeous setae or long bristle-like setae 8

8(7′). Dorsum with very faint, shallow punctures; dorsum sparsely covered with short, fine suberect testaceous, fulvous or fuscous setae; antennal segment I flavescent, or fuscous and black with testaceous apex 9

8′. Pronotal surface sculptured with obvious, deep punctures, or confluently punctate, rugulose or rugose; dorsum black with longer single type of setae or mixture of fine setae, woolly sericeous setae, and long bristle-like setae; antennal segment I never entirely flavescent 10

9(8). Antennal segment I and legs flavescent; basalar plate shining black; left paramere without tubercles or spines (Fig. 20a); axis of sclerotized process of vesica of male roughly parallel with main axis of vesica (Fig. 43); sclerotized rings of bursa copulatrix of female oval and open (Fig. 66) .... *limata* Bliven

9′. Antennal segment I fuscous to black; legs fuscous or piceous, femora rufescent medially; basalar plate ivory; left paramere with tubercles or spines (Fig. 30a); axis of sclerotized process of vesica deflected 30° to left of main axis of vesica (Fig. 53); sclerotized rings of bursa copulatrix compressed, truncated on the medial margin and closed (Fig. 77) .... *panda* Bliven

10(8′). Cuneus with basal margin testaceous .... *cuneomaculata* Van Duzee

10′. Cuneus black 11

11(10′). Vental surface of body variably marked with testaceous or ochraceous patches; females with venter light (dorsolateral region of sternites may be infuscate); males predominately black with light coloration on jugal-loral sutures; sclerotized process truncated distally, distal one third of frontal margin with rows of large spines, decreasing in length apically, frontal surface without deep concavity (Fig. 49) .... *silvosa* Bliven

11′. Ventral surface of body of both sexes black (jugal-loral sutures black); sclerotized process rounded distally, arrangement of spines different than above (Figs. 39–42, 44–48, 52, 54); if with large spines then frontal surface with deep concavity (Figs. 19, 20) 12

12(11′). Dorsal vestiture a mixture of moderately or densely distributed long, erect fulvous to black bristle-like setae projecting above a layer of densely distributed, woolly sericeous setae; tibiae may be densely covered with long (subequal to length of tibial bristles) suberect testaceous or white setae 13

12′. Dorsal vestiture never with long erect setae projecting above sericeous woolly setae 14

13(12). Tibiae densely covered with long (subequal to tibial bristles) suberect, fine, testaceous or white setae; dorsum densely covered with long fulvous setae, erect on head, pronotum, and scutellum, suberect on hemelytra; body length—males 3.83 to 4.75, females 4.50 to 5.10; right paramere with apical spine minute, barely projecting beyond apical surface of paramere (Fig. 16b) .... *oreas* Bliven

13′. Tibiae moderately covered with shorter (length much less than length of tibial bristles) suberect fuscous setae; dorsum moderately covered with uniformly erect, long black or fuscous setae; body length greater—males 4.70 to 5.40, females 4.70 to 5.45; right paramere with apical spine prominent, projecting well beyond apical surface of paramere (Fig. 31) .... *setosa* Van Duzee

14(12′). Legs entirely black; propleura and pleura entirely black on most specimens, narrow fuscous trim present or not on ventral apex of propleura, pleura (bordering coxae) and posterior margin of ostiolar peritreme; anterior angle of pronotum very prominent in dorsal and lateral view, angle slightly explanate and directed anterad; pronotal disk somewhat flattened .... *nigripes* Knight

14′. Legs not entirely black; trim on propleura and pleura and ostiolar peritreme extensive, ivory or testaceous; anterior angle of pronotum either prominent, but rounded, or reduced in dorsal and lateral view; pronotal disk broadly arcuate 15

15(14′). Both sexes brachypterous; width of vertex of female 0.66 to 0.70; dorsum moderately covered with single type of white setae; distributed on coastal flatland of Pacific Northwest .... *knighti* Schwartz and Lattin

15′. Both sexes usually macropterous (if female brachypterous then: width of vertex of female 0.73 to 0.85; dorsum densely covered with combination of suberect white, fulvous or fuscous setae and woolly sericeous setae; distributed east of Cascade Range in Oregon and Washington 16

16(15′). Densely distributed long black tibial setae; width of vertex—males 0.68 to 0.75, females 0.73 to 0.85; females brachypterous; pronotum rugulopunctate; sclerotized process as in Figure 45, with posterior half greatly expanded to left side of the vertical axis of the process—expansion is 30 percent of height of process in posterior view (height of process measured from apex to insertion of process on vesica); spines of sclerotized process of one type, and bordering lateral margin of the lateral expansion .... *shulli* Knight

16′. Sparsely or moderately distributed short black or fuscous tibial setae; width of vertex—males, 0.40 to 0.63; females 0.48 to 0.70; females macropterous; sclerotized process either not expanded or with two types of spines (if process is slightly expanded then pronotum distinctly punctured) (Figs. 40, 41, 46–48, 50–52, 54) 17

17(16′). Dorsum densely covered with single type of suberect, long, shining pale white to pale golden setae (if long setae mixed with woolly, sericeous setae then, pronotal surface strongly rugose with distinct punctures; calli reaching antero-lateral margin of pronotum, broadly confluent anteriorly, strongly asperate; anterior angle blunt, not produced, and rounded in dorsal view) 18

17′. Dorsum moderately covered with short, fine fuscous setae, or dorsal surface moderately or densely covered with two types of setae 19

18(17). Dorsum densely covered with single type of setae; dorsum polished shining black; pronotum conical in dorsal view; width of vertex—males 0.40 to 0.50, females 0.48 to 0.55; ratio of width of vertex to length of antennal segment I—males 1:1.30 to 1:1.70, females 1:1.35 to 1:1.53; lateral membranous lobes of the vesica tapering distally (Fig. 52); sclerotized rings closed (Fig. 75) .... *mollipes* Van Duzee

18′. Dorsum with either one or two types of setae; pronotum trapezoidal; vertex of head wider—males 0.56 to 0.64, females 0.60 to 0.70; ratio of width of vertex to length of antennal segment I—males 1:1.10 to 1:1.30, females 1:0.90 to 1:1.05; lateral membranous lobes of the vesica rounded (Fig. 48); sclerotized rings open (Fig. 71) .... *bliveni,* new species

19(17′). Basalar plate of pleuron with dorsal margin, to variable degree, light colored, either ivory, testaceous, fulvous or fuscous; female femora with fuscous spots ventrally; temporal areas of head distinct, slightly flattened with obvious transverse sulcus on posterior margin; median depression of head obvious—either distinct longitudinal furrow or broad sunken area; body length, male 4.30 to 4.90, female 4.87 to 5.50; width, male 1.70 to 1.95, female 1.90 to 2.25; form of shaft of left paramere slender, slightly expanded and curved (toward sensory lobe) distally, ventral surface of apex without obvious flanges (Fig. 17a)...... .... *incomperta* Bliven

19′. Basalar plate black; female femora never with fuscous spots; temporal areas of head rounded, without obvious transverse sulcus on posterior margin; median depression of head indistinct; body length, male 3.80 to 6.10, female 4.60 to 6.00; width, male 1.70 to 2.80, female 2.10 to 3.00; shaft of left paramere stocky, strongly expanded and curved (toward sensory lobe) distally, ventral surface of apex with large flange (Figs. 18, 23, 27, 28) 20

20(19′). Anterior angle of pronotum rounded and indistinct in dorsal view; anterior angle, in lateral view, broadly rounded at junction of pronotum and dorsal-most portion of ridge posterior to coxal cleft of propleuron; female femora sometimes extensively rufescent; left paramere with weak spines (Fig. 18); dorsal labiate plate of the bursa copulatrix not strongly expanded anteriorly (Fig. 64) .... *solani* (Heidemann)

20′. Anterior angle of pronotum prominent and distinct in dorsal view; anterior angle, in lateral view, distinctly concave at junction of pronotum and dorsal-most portion of ridge posterior to coxal cleft of propleura (anterior angle overhanging the ridge); femora black or fuscous, never rufescent; left paramere with strong spines (Figs. 23, 27, 28); dorsal labiate plate of the bursa copulatrix strongly expanded anteriorly 21

21(20′). Dorsum with sparsely distributed, single type of fine, short suberect or appressed fuscous to golden setae .... *fuscipubescens* Knight

21′. Dorsum with moderately to densely distributed mixture of short or medium, suberect or erect, white, fulvous or golden setae and recurved sericeous setae .. 22

22(21′). Pronotum shining black, with punctures separate; calli prominent, polished; ratio of width of vertex to length of antennal segment I ranging from 1:0.77 to 1:0.93 for males, and 1:0.72 to 1:0.87 for females; sclerotized process with very large and prominent spines (Fig. 50) .... *cascadia*, new species

22′. Pronotum shagreened, punctures confluent; calli weakly convex, asperate; ratio of width of vertex to length of antennal segment I ranging from 1:1.10 to 1:1.24 for males, and 1:0.89 to 1:1.07 for females; sclerotized process with small spines (Fig. 46) .... *serrata* Bliven

Irbisia bliveni, new species

Figs. 25a, b, 48, 71, 94; Map 17

Diagnosis. Irbisia bliveni can be separated from most of the other species of *Irbisia* by the structure of the vestiture. Both *I. bliveni* and *I. mollipes* Van Duzee are densely covered with a single type of suberect, long shining pale white to pale goldish setae. *I. bliveni* differs from *I. mollipes* in the former species' wider vertex—vertex to antennal segment I ratio for *I. bliveni* ranging from 1:1.07 to 1:1.30 for the male, and from 1:0.88 to 1:1.05 for the female. The ratio for *I. mollipes* ranging from 1:1.29 to 1:1.70 for male and from 1:1.36 to 1:1.53 for the female. The sclerotized process of the vesica of the male *I. bliveni* is unique among the species of the genus. It is long and narrow throughout, with minute serrations on the thin frontal margin.

Description. Macropterous male. Length 5.70–6.10, width 2.20–2.60, shining black, densely clothed with long, erect light setae. HEAD: width across eyes 1.26–1.35, vertex 0.59–0.65, dorsal width of eye 0.33–0.38; triangular, smooth; temporal area glabrous; basal carina prominent, abruptly rising from vertex, sublinear; median depression broad, sometimes deep; eyes large broadly joined to frons, posterior margin straight, distance from tylus to ventral margin of eye 0.63–0.65, height of eye 0.53–0.58, maximum interocular width 0.90–0.91. ROSTRUM: length 1.95–2.03, black, reaching apex of mesocoxae. ANTENNAE: black; I, length 0.64–0.73; II, 1.79–1.93; III, 0.95–1.05; IV, 1.20–1.28. PRONOTUM: length 1.16–1.20; anterior width 0.93–0.98; maximum width 2.98–2.03; trapezoidal, disk broadly convex, rugose with distinct punctures, posterior margin straight, lateral margins straight or slightly concave, rounded at junction with propleura, anterior angles blunt or rounded, not prominent in dorsal view, but sulcate dorsad of coxal cleft; calli slightly elevated, confluent anteriorly, asperate, with fovate impression on inner anterior angle, calli reaching anterolateral margin of pronotum. LEGS: black; tibiae fuscous; apices black. VESTITURE: dorsum with dense, long, erect white to fulvous setae, intermixed (in variable degree) with fine, recurved or prostrate sericeous white setae; venter, ventral surface of femora and tibiae with long testaceous setae. GENITALIA: Left paramere (Fig. 25a): sensory lobe slightly projecting above arm; angle broad; length of shaft less than length of arm; arm and shaft with prominent spines; arm diameter with distal two thirds constricted; apex moderately securiform; with numerous bristles. Right paramere (Fig. 25b): diameter of shaft expanded distally; apical process with double faceted spine; with a few short lateral setae. Vesica (Fig. 48): two smooth distally broad membranous lobes; sclerotized process with proximal two thirds of narrow diameter, distal one third gradually expanded parallel to the axis of the sclerotized process, ventral surface with numerous small serrations.

Macropterous female. Slightly more robust than male, but similar in color, vestiture and structure. Length 5.90–6.55, width 2.25–2.95. HEAD: width across eyes 1.29–1.40, vertex 0.60–0.70, dorsal width of eye 0.35–0.38, distance from tylus to ventral margin of eye 0.65–0.73, height of eye 0.53–0.60, maximum interocular width 0.95–1.00. ROSTRUM: length 1.95–2.23, reaching or surpassing mesocoxae. ANTENNAE: I, length 0.60–0.68; II, 1.48–1.84; III, 0.90–1.13; IV, 1.02–1.08. PRONOTUM: length 1.13–1.20, anterior width 0.90–1.10, maximum width 1.85–2.28. GENITALIA: sclerotized rings (Fig. 71): area within rings oval; dorsal labiate plate uniformly narrow anterior of rings; width of one ring 0.25–0.30, maximum width across rings 0.81–1.15. Posterior wall (Fig. 94): A-structure curving, ventral margin broadly rounded; dorsal margin straight. B-structure protruding posteriorly, without indentations on ventral posterior surface; median process gradually expanded dorsad, maximum length 0.25–0.33, maximum width 0.56–0.75.

Holotype. Male. Hat Creek, California, [Shasta Co.] Lassen National Forest, 24 June 1961, S. L. Wood, J. B. Karren and D. E. Bright, BYU; CAS type no. 15182. Retained at the California Academy of Sciences, San Francisco. Two ♂♂ and four ♀♀ paratypes with the same label data, and two ♂♂ and two ♀♀ with Hat Crk., UCB are also at CAS.

Etymology. Named for Brunson P. Bliven, an avid and reclusive student of the Hemiptera. He named nineteen new *Irbisia* taxa, six of which I believe deserve the status of valid species[1].

Taxonomic consideration. The specimens from north of Kern County, California are very similar to the original description and homogeneous. Specimens from the southern part of the range of this species are slightly different from the more northern populations. In the southern populations the sclerotized rings of the female are closer together (width across the rings is 0.85 in the south and 1.10 in the north), the sclerotized process of the vesica of the male is less constricted (giving the appearance of a teneral specimen). Narrower vertices and more abundant sericeous setae on the dorsum also characterize these southern specimens. Additional material from the Tehachapi and San Bernardino ranges would aid in determining if two species are actually involved.

Remarks. I. bliveni has a distribution which is restricted to the Sierra Forest

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[1] Brunson P. Bliven, the "city entomologist of Eureka, California since 1937" in his first work (1954) published descriptions of eight new species of Miridae and Cicadellidae in the *Bulletin of the Brooklyn Entomological Society.* This article was the only one of his thirteen papers, a total of 192 pages establishing 124 "new" species, which was not published privately. "The Occidental Entomologist" (1957–1973) and its two predecessors "Insects of the Redwood Empire I" (1955) and "New Hemiptera from the Western States" (1956) were published and edited by Bliven himself. The circumstances which precipitated Bliven to publish privately surrounded the review process of his manuscript, the placing of holotypes from his first paper at the United States National Museum and the subsequent questioning of the validity of some number of these species by other hemipterists.

Apparently Bliven desired to conduct his research in private to avoid the critique of his peers. His specimens were not available for loan to other researchers during his lifetime. Kelton (1961) in his synopsis of the Nearctic species of *Stenodema* Laporte, had what may have been the only working relationship with Bliven. Kelton had his manuscript read and the included key checked with three Bliven species in the Eureka entomologist's office.

Bliven passed away in the fall of 1980 at his home. He was found, amid piles of dusty, unopened correspondence by the postal carrier delivering his mail-ordered food stuffs. Shortly after he died his research collection and library were advertised for sale by his heirs in the *Bulletin of the Entomological Society of America.* After considerable bargaining the California Academy of Sciences and California State Department of Agriculture joinly acquired Bliven's tangible legacy. The type material is now retained at the California Academy. My revision of *Irbisia* represents the first publication in which Bliven material was freely available for study. I want to personally thank Dr. Paul H. Arnaud, Jr. for allowing me to examined the type specimens, soon after their arrival to the Academy, in time to complete this revision when it was a thesis manuscript.

province, and ponderosa shrub forest section of the Intermountain sagebrush province (Bailey, 1976). Within the mixed conifer forest of the Sierras, this species occurs in floristic associations which have pines as a component. Adult specimens have been collected on *Pinus contorta* Dougl. ex Loud., *P. ponderosa* Dougl. ex P. & C. Lawson, *P. sabiniana* Dougl. and *Pinus* sp. Circumstantial evidence (specimens from Siskiyou County, California, densely covered with pollen) indicates that adults may feed on pine pollen. The primary grass hosts of this species are unknown but are probably an understory component of pine forests. Adult specimens were collected from 28 April to 10 July, and from 381 to 1676 m. (1250 to 5500 feet) elevation.

Specimens examined. 54 additional specimens were examined from the following localities [specimens from localities which typify southern populations are marked with an asterisk] (Map 17). **UNITED STATES:** CALIFORNIA: *Colusa Co.,* Wilbur Hot Spgs., CL 1622, 21 April 1980, J. T. Polhemus, JTP (♂). *Fresno Co.,* Boy Scout Cmp.—Coalinga, 19 February 1931, E. P. Van Duzee, CAS (♂); *Converse Basin—near Hume, Lake Dist., Sequoia Nat. For., 11 June 1961, E. Ball, CAS (♀); Dalton, Rgr. Stn., 5000 ft., 2 May 1920, H. Dietrich, USNM (♂). **Kern Co.,* Antelope Cyn.—Tehachapi Mts., 15 May 1976, J. D. Pinto, UCR (6♂♂, ♀); Tehachapi Mts., 4800–5000 ft., 15 May 1976, G. Clark, UCR (3♂♂, 4♀♀) and 14 May 1976 (♂); 3 mi. W Woffard Hts., 4200 ft., 28 April 1964, W. Turner, UCB (4♀♀) and R. L. Langston (♂); 4 mi. W Woffard Hts., 4200 ft., 14 April 1965, G. L. Jensen & W. J. Turner, ex *Pinus sabiniana,* UCB (♂). *Madera Co.,* Oakhurst, 19 May 1942, C. Kennett, sweeping, UCB (♀). *Mariposa Co.,* Miami Rgr. Stn., 16 May 1972, beating, ex *Pinus ponderosa,* UCB (♀); *Yosemite, 16 May 1931, 3880–4000 ft., D. W. Clancy, UCR (♀) and *27 May 1931, UCB (♀); *Yosemite Nat. Pk., 11 June 1932, USNM (♀). *Napa Co.,* N side Howell Mt.—2 mi. NNE Angwin, 1300 ft., 8 April 1980, H. B. Leech, ex foliage of *Pseudotsuga menziesii,* CAS (♂). *Plumas Co.,* Meadow Valley, 3500–4000 ft., 6 June 1924, E. C. Van Dyke, CAS (♀). **San Bernardino Co.,* S of Cmp. Angeles, 4100 ft., 11 May 1978, J. D. Pinto, UCR (2♀♀); above Mt. Home—San Bernardino Mts., 440 m., 11 May 1978, J. D. Pinto & R. T. Schuh, AMNH (♀); Wrightwood, 5000 ft., 25 May 1956, H. Ruckes, Jr. & B. J. Adelson, ex *Pinus monophylla,* UCB (♀). *Shasta Co.,* Redding, 4 April 1966, WSU (♂, ♀) and 6 April 1966, B. A. Freeman, WSU (♀). *Siskiyou Co.,* 1 mi. W Bartle, 1220 m., 7 July 1979, R. T. & J. Schuh, AMNH (♂). *Tehama Co.,* Saddle Cmp., 31 May 1951, H. H. Keiffer, ex *Pinus* sp., F&A (♂, 4♀♀). *Tuolumne Co.,* Bald Mt.—nr. Long Barn, 5600 ft., 20 April 1934, E. P. Van Duzee, CAS (♀); Pine Crest, E. P. Van Duzee, CAS (♀). *Sand Flat, 5500 ft., 7 June 1930, E. O. Essig, UCB (♀), 11 June 1930, UCB (♀) and D. W. Clancy, UCR (♀). (UCB). NEVADA: "Nev.", P. R. Uhler collection, USNM (♀). OREGON: *Jackson Co.,* Buckhorn Mineral Spgs.—11 mi. ESE Ashland, Emigrant Crk., 2800 ft., 19 May 1960, OSU (♂). *Josephine Co.,* 10 mi. W Selma, 1250 ft., 13 May 1972, J. Sawbridge, OSU (♀). WASHINGTON: *Yakima Co.,* Signal Pk.—Mt. Adams, [37 mi. W Toppenish], 10 July 1927, M. W. Stone, OSU (♀).

Irbisia brachycera (Uhler)
Figs. 4, 9a, b, 32, 55, 78; Map 1

Rhopalotomus brachycerus Uhler, 1872, p. 416 (new species); 1875, p. 319.

Capsus brachycerus: Uhler, 1886, p. 19. Atkinson, 1890, p. 105. Cockerell, 1893, p. 363 (misspelled *brachycorus*).

Thyrillus brachycerus: Uhler, 1894, p. 267. Gillette and Baker, 1895, p. 39.

Irbisia brachycerus: Van Duzee, 1916b, p. 38 (in part); 1917a, p. 325 (in part). Parshley, 1922, p. 15. Carvalho, 1959, pp. 104–105 (in part).

Irbisia arcuata Van Duzee, 1921a, pp. 148–149, 151 (first synonymized by Knight 1941, p. 79).

Irbisia paeta Van Duzee, 1921a, pp. 150–151, 152. **New Synonymy.**
Irbisia brachycera: Knight, 1941, p. 79; 1968, p. 185. Haws 1978, pp. 100, 101, fig. 34. Kelton, 1980, p. 85, map 24.
Irbisia vestifera Bliven, 1961, pp. 46–47; 1963, p. 85, pl. 7, figs. 4, 4a. **New Synonymy.**
Irbisia gorgoniensis Bliven, 1961, pp. 47–48; 1963, p. 85. pl. 7, figs. 5, 5a. **New Synonymy.**
Irbisia tejonica Bliven, 1961, p. 48; 1963, p. 85, pl. 7, figs. 6, 6a. **New Synonymy.**

Diagnosis. Regardless of the type of vestiture, surface features of the pronotum and size, all individuals of this species are readily separated from the majority of the *Irbisia* species by their "pedunculate" eye structure. Both *I. pacifica* and *I. elongata* exhibit somewhat similar eye structure to *I. brachycera. I. brachycera* may be segregated from these two species on the basis of these antennal characters: segment II does not exceed the width of the base of the pronotum (as in *I. pacifica*) and segment I is much shorter than the width of the vertex (in *I. elongata,* segment I is subsequal).

Description. Macropterous male. Length 4.90–5.90, width 1.85–2.30, shining black, covered with a combination of short to long, white, sericeous, appressed setae and short to long, white, suberect to erect setae. HEAD: width across eyes 1.23–1.45, vertex 0.64–0.84, dorsal width of eye 0.29–0.34; smooth or asperate; temporal areas distinct or undifferentiated; basal carina weakly or strongly rounded, wide, posteriorly arcuate mesad, always declivous to level of vertex; median depression shallow; eyes small, roundish, slightly pedunculate; posterior margin of head (including dorsal margin of eyes) straight in dorsal view, distance from tylus to ventral margin of eye 0.70–0.78, height of eye 0.41–0.43, maximum interocular width 0.88–1.05; lora in some specimens with pale spot at base; antennal sockets below ventral margin of eye. ROSTRUM: length 1.85–2.20, infuscated, fulvous or pale, reaching metacoxae. ANTENNAE: black; I, length 0.48–0.75; II, 1.30–1.95; III, 0.63–1.05; IV, 0.86–0.98. PRONOTUM: length 1.00–1.23; anterior width 0.88–1.03; maximum width 1.58–1.88; trapezoidal, disk convex, rugulose, rugulopunctate or mostly punctate, posterior margin nearly straight, lateral margins straight, or slightly to strongly concave, broadly rounded at junction with propleura, anterior angles blunt, evident but not prominent; calli barely produced, confluent anteriorly, smooth or asperate. LEGS: black, darkly infuscated, castaneous or fulvous; tibiae always paler; coxae pale apically on some dark legged specimens, or dark basally on some light legged specimens; tarsi always black. VESTITURE: dorsum clothed with sericeous, appressed, white setae and/or longer, suberect or erect white setae; venter with long appressed or upright setae.

Macropterous female. More robust than male, but similar in color, structure and vestiture. Length 4.90–6.20, width 2.21–2.78. HEAD: length 0.63–0.83, width across eyes 1.30–1.53, vertex 0.68–0.86, dorsal width of eye 0.30–0.35, distance from tylus to ventral margin of eye 0.71–0.90, height of eye 0.43–0.45, maximum interocular width 0.95–1.18. ROSTRUM: length 2.10–2.35, reaching metacoxae. ANTENNAE: I, length 0.44–0.69; II, 1.20–1.83; III, 0.80–1.13; IV, 0.88–1.28. PRONOTUM: length 1.08–1.40, anterior width 0.93–1.15, maximum width 1.65–2.08.

Types. Described from a series from Weld County, Colorado. In 1979, R. C. Froeschner located a female specimen, without legs or terminal antennal segments and designated it as one of the syntypes of *I. brachycera.* This female was the only specimen located from the original series; it bears these labels: PR Uhler Collection;

Thyrillus brachycerus, Weld Co., Uhler Col.; *Thyrillus brachycerus* Uhler, Weld Co., Det. Uhler; USNM type no. 1129. I have examined this specimen and designated it the lectotype of *Rhopalotomus brachycerus.* The lectotype is retained at the United States National Museum, Washington, D.C.

Taxonomic consideration. I. brachycera is a morphologically variable species with a wide geographic distribution. The following external morphological characters typify specimens from most of its range: vertex to antennal segment I ratio, males 1:0.79 to 1:0.85, females 1:0.71 to 1:0.80; pronotal surface rugulose, rugulopunctate or scabrous; dorsum covered with a preponderance of slightly thickened, long, sericeous, white setae, which are upright and antrorse on the head, and dense, woolly and appressed on the pronotum and hemelytra; legs fulvous to castaneous or darkly infuscate. This widespread form is the nominate species, *I. brachycera.* A localized form from Trinity County, California, with concave lateral pronotal margins was described by Bliven (1961) as *I. vestifica* Bliven. Specimens within and south of the Transverse Ranges in Kern, Los Angeles, Orange and Riverside Counties as well as within the Peninsular Ranges of San Diego County, California are of two forms. One form is similar to the previous type in all characters except vestiture. It possesses a predominance of thin, long, upright, white setae and is also thinly clothed with shorter, appressed, sericeous white setae; the legs tend to be quite dark on most specimens. This form was described as *I. tejonica* by Bliven (1961). The other southern Californian form is recognized by the following set of characters: vertex to antennal segment I ratio, males 1:0.71 to 1:0.75, females 1:0.64 to 1:0.67; pronotal surface punctate; dorsum covered with a predominance of thin, long, upright, white setae which overlie sparse appressed, sericeous, white setae; leg color whitish testaceous to flavous. This form has received species status twice as *I. paeta* Van Duzee (1921a) and *I. gorgoniensis* Bliven (1961).

I have synonymized all of the forms above with *I. brachycera.* This conclusion is based on all of the forms possessing identical male and female genitalia, and the existence of several populations with intermediate states of the previous characters. But, where the typical form and the smaller *paeta* form are sympatric they are apparently separated by different plant associations. In San Diego County, California specimens of the typical form were collected from isolated patches of California prairie and juniper-pinyon woodland. In Riverside County, California specimens of the form *paeta* were collected from chaparral and southern yellow pine forests.

Remarks. Short economic reports of a descriptive nature (Vosler, 1913; Child, 1914; Essig, 1915) mistakenly identified *I. solani* as *I. brachycera.* These errors were rectified by Essig (1926). The specimens upon which these reports were based have been verified as *I. solani* and correctly labeled by me. Haws (1978) notes that feeding damage by *I. brachycera* and *I. pacifica* on Intermountain range grasses is very similar to that of *Labops hesperius.* Cockerell (1893) is the only citation for which I am unable to determine if the specimens of concern are conspecific with *I. brachycera.* I have not seen specimens determined by the workers mentioned by Cockerell. Both *I. brachycera* and *I. serrata* occur in Weld County, Colorado.

This species has a wide distribution. The easternmost and northernmost records are from Sioux City, Iowa and Medicine Hat, Alberta respectively (Knight, 1941). I have not verified the identification of the former. No specimens from the states of Washington or New Mexico were located in the extensive material on hand. Although the distribution of *I. brachycera* is great, encompassing eight ecoregional provinces (Bailey, 1976), individuals of this species are restricted to open woodland and chaparral situations. Within these habitats, the occurrence of the active life stages of the bug is correlated with the availability of winter and spring moisture regenerating the cool season grass hosts.

Collection dates for the majority of the specimens are from mid May to late June. The earliest date is 10 February from Berkeley, Alameda County, California; the latest is 1 October from Monarch Pass, Gunnison County, Colorado. Specimens have been taken from sea level to 3448 m. (11,312 feet) elevation.

Adult specimens were collected from the following grass hosts: *Agropyron cristatum* (L.), *A. spicatum* (Pursh) Scribn. & Sm., *Agropyron* sp., *Avena fatua* L., *Bromus mollis* L., *B. rigidus* Roth, *B. rubens* L., *Bromus* sp., *Elymus triticoides* Buckl., *Festuca rubra* L., *Festuca* sp., *Hordeum leporinum* Link., *Hordeum* sp., *Secale cereale* L., *Sitanion hystrix* (Nutt.) J. G. Sm. and *Triticum* sp. Adult specimens were also collected from the following non-grass plants: *Artemisia tridentata* Nutt., *Balsamorhiza sagittata* (Pursh) Nutt., *Balsamorhiza* sp., *Ceanothus integerrimus* H. & A., *Chrysothamnus* sp., *C. nauseosus* (Pall.) Britton., *Erigeron* sp., *Eriodictyon* sp., *Juglans californica* Wats., *Lasthenia* sp., *Lotus* sp., *Lupinus* sp., *Medicago* sp., *Phacelia* sp., *Pinus jeffreyi* Grev. & Balf. in A. Murr., *Platystemon californicus* Berth., *Quercus chrysolepis* Liebm., *Salix* sp., *Salvia* sp. and *Sambucus caerulea* Raf. The majority of the plants in the latter list are probably casual records. However, I observed other *Irbisia* species feeding on the flowers and young leaves of *Lupinus* species. *Sambucus caerulea* is a verified oviposition site for several *Irbisia* species (E. J. Taylor, pers. comm.)

Specimens examined. 1,530 specimens were examined (Map 1). The following localities are for the typical form: **CANADA:** ALBERTA: Conrad; Coutts; Elkwater Pk.; Irvine; Manyberries; Medicine Hat; One Four; Pakouki L.—Manyberries; Walsh (all CNC). BRITISH COLUMBIA: Oliver & Seymour Lk. (CNC, USNM). SASKATCHEWAN: Assiniboia; Great Sand Hills; Lisieux; Rockglen; St. Victor; Val Marie; Wood Mt. (all CNC). **UNITED STATES:** ARIZONA: *Apache Co.,* Lukachukai Mts. (USNM). *Coconino Co.,* Bright Angel Pt.—Grand Canyon Nat. Pk. (USNM); Hualapai Indian Rsv. (USU); Oakridge (USU). CALIFORNIA: *Alameda Co.,* Berkeley (UCB). *Contra Costa Co.,* Byron (UCB); 4 mi. S Pittsburg (OSU). *El Dorado Co.,* Byron (UCB); 4 mi. S Pittsburg (OSU). *El Dorado Co.,* El Dorado (F&A); Pine Hill (UCD); 3 mi. S Shingle Spgs. (F&A). *Fresno Co.,* 12 mi. W Coalinga (UCB). *Humboldt Co.,* Dinsmores (CAS). *Kern Co.,* Antelope Cyn.—Tehachapi Mts. (UCR); 27 mi. SE & 4 mi. NE Bakersfield (OSU & UCR); Cuyama (F&A); Edison (UCR); Lebec (UCB), Tejon Pass (UCB). *Lassen Co.,* 10 mi. S Doyle (OSU); Hallelujah Jct. (UCD). *Los Angeles Co.,* Browns Flat (UCB); Claremont (LACM, UCB); Covina (F&A); Desert Spgs. (UCB); Elizabeth Lk. Cyn. (LACM); Elys Park (LACM); Glendale (LACM); Gorman (CAS); Little Harbor-Sta. Catalina Is. (UCB); Lwr. Shake Cmpgd.—L.A. Nat. For. (OSU); Mint Cyn. (CAS); Palmdale (CAS, UCR); Pine Cyn. Rd.—L.A. Nat. For. (OSU); Sta. Monica Mts. (LACM); Solemint (CNC); Westwood Hills (KU); Whittier (LACM). *Mendocino Co.,* Bell Spgs. (UCB); U.C. Hopland Exp. Sta. (CAS). *Modoc Co.,* 7 mi. NE Alturas (OSU); Buck Crk. Rgr. Stn. (UCB); 10 mi. S Canby (OSU); Rush Crk. (UCB); 20 mi. NE Tulelake (AMNH). *Monterey Co.,* 6 mi. W Greenfield (UCB); 1 mi. S Jamesburg—Sta. Lucia Mts. (UCB). *Orange Co.,* Arch Beach (CAS); 5 mi. W Irvine (UCD); Newport (LACM); Salinas (USU); Orange (CAS); San Clemente (UCR); 10 mi. E San Juan Capistrano (AMNH). *Riverside Co.,* Alberhill (UCR); Bautista Cyn. (UCR); Corona (UCB); 2 mi. N Poppet Flat (UCR); Riverside (LACM, UCB, UCR, USNM). *Sacramento Co.,* Folsom (F&A). *San Benito Co.,* Mercy Hot Spgs. (UCD); 2 mi. NE New Idria (UCB); 10 mi. S Pinnacles

Jct. (UCB); Pinnacles Nat. Mon. (OSU). *San Bernardino Co.,* Cajon Pass (OSU); Colton (UCR); Highland (UCB, UCR); 10 mi. N Fontana (UCB); 4 mi. E Mentone (AMNH); Ontario (USNM); 10 mi. SW Redlands (UCD); Sta. Ana River (UID); Scissors Crossing—Valle de San Felipe (UCR); SE Sunshine Smt. mp. 7.7 rt. 79 (OSU); Palm Cyn.—Borrego Valley (LACM). *San Joaquin Co.,* Lone Tree Cyn. (F&A). *S.L.O. Co.,* Cholane (CAS); Dune Lks.—3 mi. S Oceano (UCB); 2 mi. N Harmony (OSU); 10 mi. E Morro Bay (OSU); San Luis Obispo (OSU). *Sta. Barbara Co.,* Figueroa Mt. (LACM); Oso Cmpgd. (UCD). *Sta. Clara Co.,* Los Gatos (F&A). *Shasta Co.,* 8 mi. W Harrison Gulch Rgr. Stn. (OSU); Whiskeytown (UCD). *Siskiyou Co.,* 2 mi. SW Lava Beds Nat. Mon. HQ (OSU). *Solano Co.,* 11 mi. S Dixon (UCD). *Sutter Co.,* Marysville Buttes (CAS). *Tehama Co.,* 21 mi. NW Red Bluff (USU). *Tulare Co.,* Fairview (UCB). *Trinity Co.,* 9 mi. E Forest Glen (OSU); 6 mi. NE Hayfork (UCB); Indian Dick Rgr. Stn. (UCB); Van Duzen Rd. (CAS). *Ventura Co.,* Chuchupate Rgr. Stn.—Frazier Mt. (UCB); Grade Valley—9 mi. SW Stauffer (UCB); Piru Crk.—Alamo Mt. (UCB); Wheller Spgs. (AMNH). *Yolo Co.,* Putah Cyn. (UCD). COLORADO: *Albert Co.,* 0.5 mi. W Bijou Crk. (AMNH & JTP). *Archeluta Co.,* 17 mi. SE Pagosa Spgs. (TA&M). *Boulder Co.,* Boulder & 5 mi. S (WSU, CNC, USNM); Flagstaff Cyn.—Boulder (CNC); Sunset (CAS); Valmont Butte—Boulder (CNC). *Douglas Co.,* Chaffield St. Pk. (JTP); 1 mi. S Parker (JTP). *Eagle Co.,* State Bridge (CNC). *El Paso Co.,* Colorado Spgs. (UWY). *Grand Co.,* Berthoud Pass (USNM). *Gunnison Co.,* Monarch Pass (USNM). *Jefferson Co.,* Golden (USNM). *La Plata Co.,* Durango (USU); 9 mi. E Mancos (TA&M). *Larimer Co.,* Ft. Collins & 9 mi. NW (KU, USNM & TA&M); S Estes Pk. (USNM). *Montezuma Co.,* Mesa Verde Nat. Pk. (AMNH). *Pueblo Co.,* 12 mi. W Pueblo (JTP). Mishawauka (KU). "Colo." (KU, UN & USNM). IDAHO: *Bannock Co.,* Pocatello (USNM). *Camas Co.,* 16.5 mi. N Fairfield (UID). *Elmore Co.,* 31 mi. W Hill City (MSU); Mayfield (OSU). *Gooding Co.,* Bliss (USNM); Hagerman (USNM). *Idaho Co.,* Grangeville (UID). *Jerome Co.,* Jerome (UID); 4 & 10 mi. NE Hazelton (OSU & KU). *Nez Perce Co.,* Lenore (UID). *Oneida Co.,* Black Pine Cyn., Holbrook; Meadow Brook Crk., Rock Crk., Salyer Cow Camp., Twin Spgs. (all USU). IOWA: *Woodbury Co.,* Sioux City (CNC). MONTANA: *Cascade Co.,* Cascade (MSU); Great Falls (USU); Vaughn (MSU). *Richland Co.,* Sidney (USNM). *Stillwater Co.,* Reedpoint (MSU). *Teton Co.,* Shelby (TA&M). *Yellowstone Co.,* Custer (MSU). NEBRASKA: *Dawes Co.,* 10 mi. E Chadron (OSU). *Hooker Co.* (USNM). *Sheridan Co.,* Hay Spgs. (UN). *Sioux Co.,* War Bonnet Cyn. (UN). NEVADA: Carson City (CAS). *Douglas Co.,* Holbrook (UCD). *Elko Co.,* Carlin (KU); 10 mi. N Wells (UCB). *Eureka Co.,* Roberts Mts. (UCR). *Lander Co.,* Big Crk. Cyn. (USNM). *Lyon Co.,* 7 mi. NW Wellington (F&A). *Nye Co.,* nr. Shoshone Pk., Nevada Atomic Test Site (AMNH). *Washoe Co.,* Reno (F&A, UCD, USNM). NORTH DAKOTA: *Billings Co.,* 0.5 mi. S Medora (UCB), Theodore Roosevelt Rch. (NDS). *Bowman Co.,* (NDS). *Dunn Co.,* 5 mi. W Killdeer (NDS). *Golden Valley Co.,* Beach (USNM). *Grant Co.,* Caron (NDS). *Mercer Co.,* (NDS). *Morton Co.,* Mandan (NDS, SHF & USNM). *Mountrail Co.,* (NDS). *Sioux Co.,* (NDS). *Stark Co.,* 3 mi. NW Dickinson (UCB). OREGON: *Deschutes Co.,* Bend (KU); Deschutes R.—nr. Redmond (OSU); 2 & 3 mi. NE Sisters (OSU). *Harney Co.,* 12 mi. E Riley (CAS). *Jefferson Co.,* 10 mi. N Redmond (OSU); 2.5 mi. N Warm Spgs. (OSU). *Klamath Co.,* 9 & 13 mi. W Beatty (OSU), 4 mi. E Bly (OSU), 30 mi. E Klamath Falls (OSU). *Malheur Co.,* Jordan Valley (OSU), 3 mi. S Vale (OSU). *Marrow Co.,* 7.5 mi. N Hardman (OSU). *Wasco Co.,* 10 mi. N Warm Spgs. (OSDA). SOUTH DAKOTA: *Jones Co.,* Capa (CAS & SDSU). *Pennington Co.,* Rapid City (USNM). *Shannon Co.,* Pine Ridge (USNM). UTAH: *Box Elder Co.,* Blue Crk. (UCD); Cedar Crk., Cedar Hill, Curlew Jct.; Kelton; Kelton Pass; Park Valley; 4 mi. W & 17 mi. SW Snowville (all USU). *Cache Co.,* Beaver Dam; Blacksmith Fork Cyn.; Green Cyn.; Logan Cyn.; Paradise (all USU); Wellsville Cyn. (OSU). *Davis Co.,* Ogden (USU). *Duchesne Co.,* Indian Cyn. (USNM). *Garfield Co.,* Ruby's Inn (USU). *Grand Co.,* Moab (USNM). *Iron Co.,* Cedar City (USU); Iron Mite Site (USU); Kanarraville (USNM, USU); Summit (UCD, USU). *Juab Co.,* Levan (UCD); Mt. Nebo Loop (USU); Nephi (USNM). *Kane Co.,* Alton (SHF, USNM, USU); S Alton (SHF, TA&M); Glendale (USU); Glendale Mesa

(USU); Johnson Cyn. (USU); 20 mi. N Kanab (BYU); Long Valley Jct. (SHF, USU); Mt. Carmel (SHF, USNM). *Millard Co.,* Cove Fort (USU); Fillmore (USNM, USU); Fool Crk. Pass (USU); Meadow (UCD); Oak Crk. Cyn. (USU); Scipio (USNM). *Morgan Co.,* Porterville (USU). *Salt Lake Co.,* Dry Cyn.—S.L.C. (USU); Granite (USU); Lake Pt. (USU); Salt Lk. City (USNM). *San Juan Co.,* Pack Crk.—La Sal Mts. (USU); Monticello (USNM, USU); 11 mi. SE Monticello (TA&M). *Sanpete Co.,* Flat Cyn. (USU); Fountain Green (USU). *Sevier Co.,* Cove Mt. (USU); Monroe Mt. (USU). *Tooele Co.,* Johnson Pass (BYU, CAS). *Utah Co.,* Blackett's Pasture (USU); Lehi (ASU); Payson (ASU); Pleasant Grove (USU); Provo (USU); Rock Cyn. (BYU); Spring Lk. (USU). *Washington Co.,* Grass Valley, New Harmony; Pine Valley (all USU). Copper Mts.—Tecoma Rng. (BYU). WYOMING: *Converse Co.,* Glenrock (UWY). *Goshen Co.,* (UWY). *Laramie Co.,* High Plains Rsrh. Stn.—E Cheyenne (UWY). *Niobrara Co.,* Lusk (UWY); Manville (UWY). *Platte Co.,* Wheatland (USNM). *Weston Co.,* 1 mi. N Newcastle (OSU).

The following localities are for the small "*paeta*" form of *I. brachycera.* **MEXICO:** BAJA CALIFORNIA NORTE: 3.0 mi. S El Condor (AMNH). **UNITED STATES:** CALIFORNIA: *Riverside Co.,* Banning Hts. (UCR); de Cuir Ranch—Beaumont (UCR, CAS); 8 mi. N Deep Crk. & Horsethief Crk. (UCR); Dutch Flat—San Jacinto Mts. (CAS); Hemet Res.—San Jacinto Mts. (CAS, UCB); Herkey Crk.—San Jacinto Mts. (UCB); Idyllwild (AMNH, CAS, UCB); Keen Cmp.—San Jacinto Mts. (LACM, UCB, UCD); Pinon Flat—San Jacinto Mts. (CB). *San Bernardino Co.,* Running Spgs.—San Bernardino Mts. (UCB); Yucaipa (UCR, USNM). *San Diego Co.,* Anza-Borrego Desert St. Pk. (TA&M); Banner Grade (ASU); Couser Cyn. (UCR); Del Mar (ASU); 3 mi. SE, & El Cajon (UCB & CAS); Green Valley Mdw.—Cuyamaca St. Pk. (UCB); Julian (SDNM, UCR); Kitchen Crk.—Laguna Mts. (SDNM); Laguna Mts. (KU); Lakeside (USNM); La Mesa (USNM); Miramar (UCB); Mission Gorge (ASU, UCB, UID); Monument Pk.—Laguna Mts. (SDNM); Mt. Palomar (UCB); Pala (UCB, USNM); Pine Valley (CAS, SDNM); Ramona (CAS); San Diego (CAS); 1.3 mi. S San Felipe (OSU); 9.3 mi. NW Sissors Crossing (OSU); Warner Spgs. (SDNM); Viejas Crk. (UCB).

Irbisia californica Van Duzee
Figs. 2, 5, 13a, b, 36, 59, 82; Map 11

Irbisia sericans: Childs, 1914, p. 220. Van Duzee, 1917b, p. 264.
Irbisia brachycerus: Essig, 1915, p. 213, fig. 188.
Irbisia californica Van Duzee, 1921a, pp. 146–147, 152 (new species). Essig, 1926, p. 361. Blatchley, 1934, p. 13. Essig and Hoskins, 1944, pp. 71–72. Carvalho, 1959, p. 105.
Irbisia eurekae Bliven, 1961, pp. 45–46; 1963, p. 85, pl. 7, figs. 1, 1a. **New Synonymy.**
Irbisia paenulata Bliven, 1961, p. 46; 1963, p. 85, pl. 7, figs. 2, 2a. **New Synonymy.**
Irbisia umbratica Bliven, 1963, pp. 69–70, 85, pl. 7, figs. 7, 7a. **New Synonymy.**

Diagnosis. The material on hand adheres to the habitus of the holotype despite the great range in the size of the specimens. The characters which make *I. californica* distinctive are: dorsum densely covered with a mixture of long golden to white setae, and sericeous white setae; relatively narrow anterior pronotal width; highly concave lateral pronotal margins; straight posterior head margin; testaceous or fulvous coloration on legs with fuscous spots on the femora; robust, abruptly angled left paramere of male with a distal triangular expansion and truncated apex; series of obvious, sharply pointed spicules on the sclerotized process of the male vesica; open and oval sclerotized rings, and relatively small posterior wall of female. The previous features will adequately separate *I. californica* from *I. sericans* and *I. sita* Van Duzee; all three have superficially similar male genitalic structures.

Description. Macropterous male. Length 4.75–7.30, width 1.80–2.60, shining black densely clothed with a mixture of long suberect golden to white setae, and sericeous woolly white setae. HEAD: width across eyes 1.15–1.46, vertex 0.51–0.75, dorsal width of eye 0.28–0.38; triangular, asperate; temporal areas indistinct but smooth; median depression broad but shallow, or indistinct; basal carina straight, moderately prominent, acute and abrupt or rounded and declivous to level of vertex; eyes broadly joined to frons, but protruding laterally, posterior margin straight in dorsal view, distance from tylus to ventral margin of eye 0.58–0.80, height of eye 0.45–0.56, maximum interocular width 0.79–1.06, base of clypeus convex in lateral view. ROSTRUM: length 1.73–2.48, fulvo-testaceous, apex and base sometimes black, reaching meso- or metacoxae. ANTENNAE: black; I, length 0.58–0.99; II, sometimes fuscous medially, 1.53–2.60; III, 1.05–1.60; IV, 1.03–1.68. PRONOTUM: length 0.88–1.25, anterior width 0.80–1.09, maximum width 1.50–2.08, conical, broadly convex, rugulose or confluently punctate, posterolateral margin arcuate, lateral margins distinctly concave, broadly rounded at junction with propleura, anterior angles slightly produced but small and rounded in dorsal view, slightly or not sulcate in lateral view, disk depressed immediately posterior of calli; calli moderately convex, asperate, confluent anteriorly, reaching lateral margins of pronotum. LEGS: testaceous, fulvous or fuscous; coxae black basally; femora with fuscous spots or variably sized patches; tarsi black. VESTITURE: dorsum densely clothed with long golden to white setae, erect on head and pronotum, suberect on hemelytra; intermixed with woolly, recurved sericeous white setae; venter sparsely clothed with thin erect fulvous to white setae.

Macropterous female. More robust than male, but similar in structure, color and vestiture. Length 5.15–7.25, width 2.13–3.00. HEAD: width across eyes 1.17–1.56, vertex 0.55–0.81, dorsal width of eye 0.28–0.38, distance from tylus to ventral margin of eye 0.60–0.85, height of eye 0.48–0.56, maximum interocular width 0.82–1.10. ROSTRUM: length 1.83–2.38, reaching apices of mesocoxae. ANTENNAE: I, length 0.58–0.87; II, 1.55–2.41; III, 1.00–1.56; IV, 0.88–1.67. PRONOTUM: length 0.98–1.35, anterior width 0.88–1.20, maximum width 1.73–2.33.

Types. Male holotype. Hills back of Oakland, Cal, IV-12-08; Coll. by E. C. Van Dyke; HOLOTYPE californica, [red], CAS type no. 800. Retained at the California Academy of Sciences, San Francisco. All the paratypes I examined (39 specimens) are conspecific with the holotype and are retained at CAS and USNM.

Taxonomic consideration. A clear clinal series exists in this species. Specimens from populations north of approximately 36° 30′ north latitude are larger, and have the dorsum densely covered with a mixture of long golden setae and woolly sericeous setae. Specimens south of this line tend to be smaller, and possess shorter white vestiture. The difference in stature is most noticeable in the head measurements, i.e., for male specimens from Coos County, Oregon to Monterey and San Benito Counties, California the range of the width of the vertex is from 0.78 to 0.60 mm.; then to Baja California Norte the range is from 0.65 to 0.51 mm. The smallest specimens encountered in the material on hand occur south of the Transverse Ranges in Los Angeles, Riverside, San Diego and San Bernardino Counties, California.

Prior to the erection of the species *I. california,* specimens of the species were placed in *I. sericans* (Childs, 1914), and due to a nomenclatural error, specimens were identified as *I. brachycerus* [*a*] (Essig, 1915). The preceding action was the result of examining the specimens which precipitated the misidentifications. The specimens of concern are retained in the California Academy of Sciences, San Francisco.

I have examined the types of *I. eurekae* Bliven, *I. paenulata* Bliven and *I. umbratica* Bliven and placed all in synonymy with *I. californica.* Both of the original descriptions fit within the previous redescription of *I. californica* in all respects: structure, coloration and vestiture.

Remarks. The distribution of this species is bounded on the south, in Baja California Norte, by the Sonoran Desert; the southernmost record is San Vicente. Within California, south of the San Francisco Bay Area, the distribution of *I. californica* is restricted to the California chaparral province; no localities penetrate the Coast or Transverse Range. The northernmost portion of the distributional range is in Coos County, Oregon and is continuous south to the Bay Area within the Pacific Forest province. The vegetational associations encountered by the range of *I. californica* are: redwood, mixed evergreen, mixed hardwood, blue oak-digger pine and southern oak forests, as well as, chaparral and coastal prairie shrub mosaic.

Adult and immature stages have been collected from these grasses: *Anthoxanthum aristatum* Boiss., *Avena fatua* L., *Avena* sp., *Bromus rigidus* L., *B. rubens* L., *Bromus* sp., *Dactylis glomerata* L., *Elymus* sp., *Festuca arundinacea* Schreb., *Hordeum leporinum* Link., *Hordeum* sp., and *Poa* sp. Adult specimens have been collected from the following non-graminoid plants: *Amsinckia intermedia* F. & M., *Artemisia californica* Less., *A. douglasiana* Bess. in Hook., *Astragalus nuttalli* (T. & G.) J.T. Howell var. *virgatus* (Gray) Barneby, *Baccharis* sp., *Brassica* sp., *Cardaria* sp., *Ceanothus arboreus* Greene, *C. crassifolius* Torr., *C. integerrimus* H. & A., *Cercocarpus ledifolius* Nutt., *Citrus* sp., *Cryptantha intermedia* (Gray) Greene, *Encelia farinosa* Gray, *Lathyrus laetiflorus* Greene ssp. *alefeldii* (White) Brads., *Lotus scoparius* (Nutt. in T. & G.) Ottley, *Lupinus albifrons* Benth., *L. polyphyllus* Lindl., *L. nanus* Dougl. in Benth., *L. succulentus* Dougl. ex Koch., *Malva parviflora* L., *Marah macrocarpus* (Greene) Greene, *Medicago sativa* L., *Phacelia distans* Benth., *Prunus lyonii* (Eastw.) Sarg., *Quercus agrifolia* Nee, *Q. chrysolepis* Liebm., *Q. engelmannii* Greene, *Q. wislizenii* A. DC., *Ranunculus californicus* Benth., *Ranunculus* sp., *Ribes indecorum* Eastw. *Salix laevigata* Bebb., *Salix* sp., *Salvia apiana* Jeps., *S. mellifera* Greene, *Sambucus caerulea* Raf., *Scrophularia* sp., *Sisymbrium* sp., *Solanum douglasii* Dunal in DC., *S. xanti* Gray and *Yucca schidigera* Roezl ex Ortgies.

The earliest record of occurrence is 21 February at Riverside and the latest is 27 July. The elevational range is from 180 to 2000 m. (600 to 3600 feet).

Specimens Examined. 2,295 specimens were examined from the following localities (Map 11). **MEXICO:** BAJA CALIFORNIA NORTE: 6.3 mi. S El Condor (AMNH); 7 mi. S Maneadero (UCB)); San Vicente, & 10 mi. N (UCR & UCB). **UNITED STATES:** CALIFORNIA: *Alameda Co.* (17 localities). *Contra Costa Co.* (24). *Del Norte Co.,* mp. 14.39 on rt. 101 (OSU). *Humboldt Co.* (7). *Los Angeles Co.* (42). *Marin Co.* (16). *Mendocino Co.,* 1 mi. SE Piercy (UCB). *Monterey Co.* (24). *Napa Co.* (6). *Orange Co.* (8). *Riverside Co.* (30). *Sacramento Co.,* 1.5 mi. S Fulsom (CAS). *San Benito Co.* (6). *San Bernardino Co.* (13). *San Diego Co.* (26). *San Francisco Co.* (3). *S.L.O. Co.* (13). *Sta. Mateo Co.* (13). *Sta. Barbara Co.* (23). *Sta. Clara Co.* (17). *Sta. Cruz Co.* (2). *Solano Co.* (3). *Sonoma Co.,* Hacienda (CAS); Petaluma (UCB); Petaluma Marsh (JTP); Sonoma Co. (AMNH, CAS). *Ventura Co.* (11). *Yolo Co.* (3). Channel Islands: East, Middle & West Anacapa, San Miguel, San Nicolas, Santa Catalina & Santa Cruz. All specimens are retained at AMNH, CAS, F&A, LACM, OSU, SBNH, SDNH, UCB, UCD, UCR & USNM. OREGON: *Coos Co.,* 0.4 mi. NE of mp. 9 on rt. 42S—nr. Riverton (OSU). *Curry Co.,* Humbug Mt. St. Pk. (CAS, OSU); T34S R14W Sec. 6 on Hwy. 101 (OSU).

Irbisia cascadia, new species

Figs. 8, 27a, b, 50, 73, 96; Map 23

Diagnosis. This species is very similar to *I. fuscipubescens* but is distinguished from it by the mixed vestiture, shorter antennal segment I and genital structure of both sexes. *I. cascadia* and *I. solani* are sympatric in the Willamette Valley of northwestern Oregon. Within this region specimens of the former species are wider between the tylus and the ventral margin of the eye. The ratio of this measurement to the height of the eye for both species is: for *I. cascadia* from 1:0.74 to 1:0.86 for males, and from 1:0.70 to 1:0.78 for females; for *I. solani* the ratio ranging from 1:0.88 to 1:0.96 for males, and from 1:0.84 to 1:0.88 for females. The anterior angles of the pronotum of *I. cascadia* are broadly prominent and evident in lateral view, whereas this region of *I. solani* is rounded and indistinct. The femora of the female of the latter species are extensively rufescent. The genital structures of both sexes are quite different. The left paramere of the male of *I. cascadia* is strongly tuberculate; and the sclerotized process of the vesica is expanded preapically and strongly spined. In *I. solani,* the paramere is slightly tuberculate, and the process is not expanded and has a linear series of small spicules on the inner margin. The dorsal labiate plate of the female of *I. cascadia* is wide and broadly arcuate anteriorly near each sclerotized ring.

I. cascadia is sympatric throughout its entire range with *I. serrata.* The former species is distinguished by a smaller antennal segment I, forming a vertex to antennal segment I ratio that ranging from 1:0.77 to 1:0.93 for males, and from 1:0.72 to 1:0.87 for females. The range of this ratio for *I. serrata* is from 1:1.01 to 1:1.24 for males and from 1:0.89 to 1:1.07 for females. Additionally, *I. cascadia* is separated from *I. serrata* by the former species': more shining dorsum, distinct punctation of the pronotal disk, polished calli, and less dense vestiture. The vesica of *I. cascadia* is obviously different from *I. serrata*; the latter species does not have large, curved spines on the sclerotized process, and has a membranous lobe attached medially to the outer surface of the process. The female structures are very similar; only the sclerotized rings are subtly different between the species.

Description. Macropterous male. Length 4.70–5.60, width 2.30–2.70, shining black, clothed with recurved sericeous white to golden setae. HEAD: width across eyes 1.16–1.28, vertex 0.55–0.60, dorsal width of eye 0.28–0.31; triangular, mostly smooth; temporal area shining; median depression faint or absent; basal carina broad, moderately prominent, sometimes declivous or abrupt to level of vertex posteriorly arcuate, with lateral portion anterior of posterior margin of head; eyes broadly joined to frons, posterior margin straight in dorsal view, distance from tylus to ventral margin of eye 0.58–0.66., height of eye 0.45–0.50, maximum interocular width 0.83–0.93. ROSTRUM: length 1.60–1.85, fuscous to black, just reaching mesocoxae or, in some specimens, metacoxae. ANTENNAE: black; I, length 0.48–0.53; II, 1.35–1.60; III, 0.73–0.95; IV, 1.01–2.00. PRONOTUM: length 1.00–1.18, anterior width

0.94–1.04, maximum width 1.84–1.94; trapezoidal, disk broadly convex, distinctly punctate, posterior margin broadly arcuate, lateral margins straight, rounded or broadly margined at junction with propleura, anterior angles broadly prominent, sometimes directed anteriorly, rounded or flattened, quite evident in lateral view; calli clearly defined, convex, confluent anteriorly, polished, shining, with fovate impression on anteromedial angles, sometimes reaching anterolateral margins of pronotum. LEGS: black; tibiae in varying degree testaceous to fulvous medially. VESTITURE: head, pronotum and scutellum with suberect to erect shining golden setae, pronotum usually denuded, hemelytra with white or golden recurved or appressed sericeous and short straight setae; venter with sparse, thin, fulvous setae. GENITALIA: Left paramere (Fig. 27a): sensory lobe slightly projecting above arm; angle broad; length of shaft less than length of arm; arm and shaft with prominent spines; arm diameter with distal two thirds constricted and considerably more constricted subapically; apex strongly securiform; with numerous bristles. Right paramere (Fig. 27b): diameter of shaft expanded distally; apical process with double faceted spine; with a few short lateral setae. Vesica (Fig. 50): two smooth membranous lobes each with a small preapical side lobe; sclerotized process cone-shaped with a deep furrow and many very large spines on the left surface.

Macropterous female. Slightly more robust than male, but similar in structure, color and vestiture. Length 5.15–5.60, width 2.55–2.80. HEAD: width across eyes 1.23–1.33, vertex 0.58–0.68, dorsal width of eye 0.29–0.35, distance from tylus to ventral margin of eye 0.57–0.71, height of eye 0.48–0.53, maximum interocular width 0.90–0.98. ROSTRUM: length 1.73–1.85, attaining apex of mesocoxae. ANTENNAE: I, length 0.46–0.55; II, 1.38–1.63; III, 0.78–1.00; IV, 0.95–1.25. PRONOTUM: length 1.08–1.20, anterior width 0.98–1.05, maximum width 1.95–2.08. LEGS: apices of femora fuscous. GENITALIA: sclerotized rings (Fig. 73): area within rings broadly oval; dorsal labiate plate very broad directly anterior and anterolateral of rings; strongly constricted medially; width of one ring 0.25–0.30, maximum width across rings 0.88–0.98. Posterior wall (Fig. 96): A-structure curving, ventral and dorsal margins flattened. B-structure protruding posteriorly, without indentations on ventral posterior surface; median process gradually expanded dorsad, maximum length 0.20–0.29, maximum width 0.70–0.75.

Holotype. Male. Oregon, Benton Co., Findley National Wildife Refuge—Bald Hill, 9 May 1979, M. D. Schwartz, ex *Bromus rigidus* & *Festuca arundinacea*; CAS type no. 15183. Retained at the California Academy of Sciences, San Francisco. Paratypes same data, AMNH, CAS, CNC, OSU, USNM (17♂♂, 11♀♀).

Etymology. Named for the physiographic region in which this species is abundant.

Remarks. The main distribution of this species is in Jackson and Josephine Counties of southwestern Oregon. The vegetational associations which predominate in this area are the Oregon oakwoods (*Quercus garryana*) and mixed conifer forest (*Abies-Pinus-Pseudotsuga*). The range of *I. cascadia* extends north through the hillsides of the Willamette Valley, and to southern Skamania County, Washington. The southernmost limits of its distribution are the Warner Mountains of Modoc County, California. The vegetation associations of this southern area are marked by the intergradation of Sierran montane forest (*Abies-Pinus*) with sagebrush steppe (*Agropyron-Artemisia*). Adult and immature specimens have been collected from the following grass hosts: *Avena barbata* Brot., *Bromus mollis* L., *B. rigidus* Roth, *Elymus* *glaucus* Buckl., and *Festuca arundinacea* Schreb. (alta fescue). Other plants on which adult specimens were collected are *Abies procera* Rehd., *Artemisia cana* Pursh., *A. tridentata* Nutt., *Balsamorhiza sagittata* (Pursh) Nutt., *Chrysothamnus nauseosus* (Pall.) Britton and *Symphoricarpus* sp. This is a moderate to high altitude species with collected specimens ranging from 760 to 1860 m. (500 to 6100 feet) elevation. High altitude record is from Fandango Pass, Modoc County, California. Dates of occurrence are 29 April to 10 August.

Specimens examined. 827 additional specimens were examined from the following localities (all OSU unless otherwise noted, Map 23). **UNITED STATES:** CALIFORNIA: *Modoc Co.,* Ceder Pass, 7 mi. W Cederville, 29 June 1955, D. L. Dahlsten, UCD (♂); E Fandango Pass, 6000 ft., 22 June 1971, J. Sawbridge (♂, 5♀♀); 20 mi. NE Tulelake, 5 June 1972, ex *Balsamorhiza* sp., J. Schuh, AMNH (♂). OREGON: *Benton Co.,* all Corvallis, 13 June 1899 (♂); 27 May 1900 (♂); 6 mi. SW, 30 May 1973, L. Russell (♀); Animal Science Pasture, 0.6 mi. N Harrison on 53th rd., 12 May 1979 (43♂♂, 24♀♀) and 29 May 1979 (5♂♂, 7♀♀), M. D. Schwartz, ex *Bromus mollis* & *B. rigidus*; 0.4 mi. N on Glen Ridge Drive, 29 April 1979, M. D. Schwartz, ex *Festuca arundinacea* (8♂♂, 3♀♀); intersection of Harrison & 53th rd., 1 May 1979, M. D. Schwartz, ex *Festuca arundinacea,* reared from nymph (♀); "IV Hill", 8 May 1980, J. D. Lattin (3♀♀); McDonald Forest, 20 May 1979, M. D. Schwartz (♂) and Misty Point (Dimple Hill), 19 May 1979, M. D. Schwartz, ex *Avena barbata, Bromus mollis, B. rigidus* & *Elymus glaucus* (19♂♂, 5♀♀); Vineyard Mt., 0.6 mi. N Lewisburg Ave., 30 April 1979, M. D. Schwartz, ex *Bromus rigidus* (3♂♂, 2♀♀) and 11 May 1979 (35♂♂, 17♀♀). All Mary's Peak (14 mi. W Corvallis), R7W T12S Sec. 19 SE ¼, 3250 ft., 3 July 1979, G. M. Cooper, ex *Abies procera* (♀); Mary's Peak Road, 7.8 mi. N rt. 34, 17 May 1979, M. D. Schwartz, ex *Festuca rubra,* reared from nymphs (11 specimens) and 1 June 1979, K. West & G. M. Stonedahl (33♂♂, 21♀♀); meadow, 1 mi. below campground, on shoulder, 3350 ft., (No. 71-3), 1 July 1971, J. D. Lattin (7♂♂, 7♀♀); north spur at top, 3500 ft., 10 August 1971, J. D. Lattin (3♀♀); summit, 3700 ft., 1 July 1971, (No. 71-4) (♂, 7♀♀) and 10 August 1971, (No. 71-2) (♂, ♀), J. D. Lattin, ex sweeping meadow, picnic area, 4000 ft., 13 July 1956, J. D. Lattin (11♂♂, 5♀♀); 4000 ft., 9 June 1957, B. Malkin (4♂♂, 5♀♀), 27 June 1962, R. W. Matthews (10♂♂, 8♀♀) and 30 July 1966, W. Gagne & J. Haddock, UCB (34♂♂, 14♀♀); 3800 ft., 24 June 1970 (♀), 15 July 1969, P. Oman (2♂♂, 2♀♀) and S. Rose & J. McClay (13♂♂, 3♀♀); 3000 ft., 18 July 1968, P. Oman (♀); 6 June 1951, V. Roth (2♂♂, ♀); 24 June 1962, D. & L. May (7♂♂, 8♀♀); 30 June 1896, No. 190 (3♂♂); 4 July 1934, J. Schuh (♀); 6 July 1956, F. F. Hasbrouck (2♂♂); 12 July 1956, J. Capizzi, OSDA (2♂♂); 12 July 1958, J. D. Lattin (19♂♂); 13 July 1941 (♀); 15 July 1969, P. Oman (♀); 25 July 1959, S. Radinovsky (17♂♂, 18♀♀); 9 August 1955, R. F. Koontz (2♂♂); 10 August 1956, J. D. Lattin (♂, 3♀♀). *Douglas Co.,* Myrtle Creek, 30 May 1961, L. G. Gentner, ex sweeping (6♂♂, 6♀♀); 3 mi. N Roseburg, roadside, 18 May 1960, F. A. Michel (♂, ♀), J. D. Lattin (3♂♂, 4♀♀) and D. R. Smith (♀); 2 mi. N Tiller, 16 May 1962 (6♂♂, 4♀♀); Umpqua River—2 mi. W Tiller, 1000 ft., 22 May 1960, J. D. Lattin (♀). *Jackson Co.,* 23 mi. NE Ashland, 1 June 1972, P. Oman (5♂♂, 8♀♀); Condie Creek, 26 June 1974, SOS (♀); Dead Indian Soda Springs, 26 June 1974, R. G. Lynch, SOS (♀); near Dead Indian Soda Spring, 23 June 1978, J. Schuh, ex *Symphoricarpus* sp., AMNH (4♂♂, 7♀♀); 29 mi. ESE Eagle Point, 4450 ft., 23 June 1978, N. L. Herman, AMNH (3♂♂, 8♀♀); Medford, (S.S. 25357), 2 May 1945, ex clover (45-9842), USNM (♀); N Medford, 1 May 1970, P. Oman (2♂♂, 4♀♀); all Mt. Ashland, 4600 ft., 24 June 1971, G. Steyskal, USNM (2♂♂, ♀); 20 June 1975, L. Russell (♀); 4600 ft., 17 June 1970, P. Oman (3♂♂, 9♀♀); 4100 ft., 27 May 1970, P. Oman, ex *Chrysothamnus nauseosus* (♂, 2♀♀); 5 mi. W Pinehurst, 24 May 1958, B. Ainscough (2♂♂ 3♀♀) and 4526 ft., J. D. Lattin (4♂♂, 6♀♀); Rouge River, 16 May 1952, A. B. Black, OSDA (♀) and (no. 124), 13 May 1962, F. G. Bowes, SOS (♀); all Sam's Valley, 18 May 1968, P. Oman, ex *Arctostaphylos* sp. (♀); 1 mi. SE, 10 May 1969, M. Stock (2♀♀); 3 mi. E, 18 May 1962 (♂, 2♀♀). Shady Grove, 15 May 1972, J. Schuh, AMNH (♀); Siskiyou, 14 June 1959, Kelton & Madge, CNC (28♂♂, 28♀♀); Siskiyou

Summit, 3 June 1975, B. Summey, SOS (♀) and 24 June 1974, K. W. Beatty, C. Oakley, M. Swisher & N. Turner, SOS (5♀♀); 0.5 mi. S Siskiyou Summit on old rt. 99, 1350 m., 26 June 1979, R. T. & J. Schuh, AMNH (5♀♀); 4300 ft., 27 June 1979, M. D. Schwartz, ex *Artemisia cana* (46♀♀). *Josephine Co.,* Grants Pass, 8 May 1963, D. B. Goroon, SOS (♂); Grave Creek, 30 May 1952, B. Malkin & VER., CAS (2♂♂, 2♀♀); all Merlin, 1 May 1970, P. Oman (15♂♂, 10♀♀) and F. A. Rushmore, ex Alta fescue (2♂♂); 9 May 1969, P. Oman (13♂♂, 11♀♀); 13 May 1972, C. Musgrave, ex grasses (2♀♀) and 12 May 1972, J. Sawbridge (2♀♀); 27 May 1970, P. Oman (♂); 2 mi. E Merlin, 1480 ft., 13 May 1972, J. D. Lattin (3♀♀). *Lake Co.,* Cottonwood Reservoir, T38S R13E Sec. 18, 20 June 1980, P. Oman (3♂♂, 8♀♀). *Linn Co.,* Monument Park, 8 mi. ESE Gates Summit, 4725 ft., 16 June 1960, J. D. Lattin (♂, 2♀♀); Peterson Butte, 2.7 mi. rt. 34 on Steckley Rd., 1 May 1979, M. D. Schwartz, ex *Bromus mollis* & *B. rigidus* (7♂♂, 17♀♀) and south slope, 16 June 1977, G. Eulensen (♂). *Linn/Lane Co.,* H. J. Andrews Experimental Forest, Carpenter Mtn., access rd. 1501, 6.6 mi. N jct. FS rds. 1502-1501, 4800 ft., 6 July 1977, Eulensen & Searles, ex sweeping (♂, 2♀♀). *Yamhill Co.,* McMinnville, Peavine Ridge, 7 July 1952, J. F. Bock, OSDA (♀). WASHINGTON: *Skamania Co.,* Dog Mtn. on Pacific Crest Trail, 250–500 ft., 18 May 1979, M. D. Schwartz, ex *Balsamorhiza sagittata* & grasses (4♂♂, 6♀♀).

Irbisia castanipes Van Duzee

Figs. 24a, b, 47, 70, 93; Map 18

Irbisia castanipes Van Duzee, 1921a, pp. 145–146, 151 (new species). Carvalho 1959, p. 105.

Diagnosis. I. castanipes may be separated from all other species of *Irbisia* by the dull black color with bronze luster, and sparsely distributed short, appressed, light setae on the dorsal surface.

Description. Macropterous male. Length 5.40–6.10, width 2.10–2.60, dull black with bronze luster, sparsely clothed with minute appressed, light colored setae. HEAD: width across eyes 1.23–1.30, vertex 0.53–0.60, dorsal width of eye 0.33–0.38; triangular, shagreened, temporal area asperate, basal carina sharp in cross section, declivous to level of vertex, posteriorly arcuate mesad; vertex flattened, median depression very shallow; eyes large broadly joined to frons, posterolateral margin arcuate caudad in dorsal view; distance from tylus to ventral margin of eye 0.65–0.68, height of eye 0.53–0.58, maximum interocular width 0.85–0.95. ROSTRUM: length 2.03–2.35, black, reaching or surpassing apices of metacoxae. ANTENNA: black; I, length 0.65–0.68, base and apex sometimes fuscous; II, 1.80–2.04; III, 1.05–1.10; IV, 1.10–1.15. PRONOTUM: length 1.03–1.20; anterior width 0.84–0.96; maximum width 1.74–2.03; trapezoidal, with sparse long bristles anterolaterally; disk broadly convex, rugose or transversely rugose and/or punctate, posterior and lateral margins straight, lateral margin rounded at junction with propleura, anterior angles rounded and indistinct in dorsal and lateral view; calli inconspicuous, shagreened, confluent anteriorly, reaching anterolateral margin of pronotum. LEGS: castaneous to fuscous; apices of femora and tibiae lighter; apices of coxae and base of trochanters light. VENTER: polished black. VESTITURE: dorsum clothed with minute, sparse, appressed light setae; setae longest on head; venter with sparse, long, upright setae.

Macropterous female. More robust than male, but structure, color and vestiture are similar. Length 5.00–6.30, width 2.25–2.50. HEAD: width across eyes 1.33–1.40, vertex 0.58–0.63, dorsal width of eye 0.36–0.40, distance from tylus to ventral margin of eye 0.70–0.75, height of eye 0.56–0.60, maximum interocular width 0.95–1.00.

ROSTRUM: length 2.33–2.55, surpassing apices of metacoxae. ANTENNA: I, length 0.68–0.78; II, 1.80–2.01; III, 1.08–1.18; IV, 0.85–1.11. PRONOTUM: 1.03–1.23, anterior width 0.95–0.98, maximum width 2.00–2.10.

Types. Male holotype. Keen Camp Cal., Riverside Co., June 6–12, 1917; Pine; EP Van Duzee Collector; HOLOTYPE castanipes [red]; CAS type no. 798. I have examined the holotype and all paratypes; all are conspecific and retained at the California Academy of Sciences, San Francisco or the Canadian National Collection, Ottawa.

Remarks. This species appears to be the southern counterpart to *I. bliveni.* Both species occur in pine associations of the Sierran forest province. *I. castanipes* is also found at higher elevations in the Laguna, San Jacinto and Tehachpi Mts. within the California chaparral province. Adult specimens have been collected on *Pinus jeffeyi* Grev. & Balf. in A. Murr. and *P. ponderosa* Dougl. ex P. & C. The localities range from 1372 to 2225 m. (4500 to 7300 feet) elevation. Collection dates for adult species are 18 May to 10 July.

Specimens examined. 46 specimens were examined from the following localities (Map 18). **UNITED STATES:** CALIFORNIA: *Fresno Co.,* Florence Lk. (UCB); Huntington Lk. (CAS). *Kern Co.,* Antelope Cyn.—Tehachapi Mts. (UCR); Mt. Pinos (UCD). *Riverside Co.,* Idyllwild (UCB, UCD); Keen Cmp.—San Jacinto Mts. (CAS); Poppet Flat (UCB); Tahquitz Valley—San Jacinto Mts. (UCB). *San Diego Co.,* Green Valley Mdw.—Cuyamaca St. Pk. (UCB); Mt. Laguna (UCB). *Tulare Co.,* Kennedy Mdw. (UCD). *Tuolomne Co.,* Kennedy Mdw. (UCD).

Irbisia cuneomaculata Blatchley
Figs. 15a, b, 38, 61, 84; Map 13

Irbisia cuneo-maculata Blatchley, 1934, p. 13 (new species). Carvalho, 1959, p. 105 (misspelled *cuncomaculata*). — No!, correct spelling,

Diagnosis. This species is readily identified by the presence of pale markings on the base of the cuneus of both sexes.

Description. Macropterous male. Length 3.80–450, width 1.60–2.00, shining black densely covered with a mixture of recurved, appressed, sericeous white setae and long erect fuscous setae. HEAD: width across eyes 0.92–1.09, vertex 0.43–0.50, dorsal width of eye 0.25–0.28; triangular, asperate; tylus rounded in dorsal view; temporal areas distinct, smooth; median depression absent; basal carina prominent, rounded or acute in cross section declivous to level of vertex posteriorly arcuate, eyes broadly joined to frons, posteromedial margin posteriorly arcuate; distance from tylus to ventral margin of eye 0.45–0.50, height of eye 0.38–0.45; maximum interocular width 0.65–0.78; clypeus and juga entirely, to not at all, fulvous or fuscous ventrad of antennal insertions. ROSTRUM: length 1.28–1.45, fuscous to black, base and apex usually darkly infuscated, reaching bases and sometimes slightly surpassing apices of mesocoxae. ANTENNAE: fuscous; I, length 0.31–0.41, black, apex and, in some specimens, apical half fuscous or fulvous; II, 0.90–1.13, apex and base sometimes black, extreme apex sometimes fulvous; III, 0.53–0.70; IV, 0.53–0.71; III and IV usually darkly fuscous or black. PRONOTUM: length 0.75–0.88, anterior width 0.75–0.88, maximum width 1.43–1.68; conical, broadly convex, or slightly flattened confluently punctate or rugose, posterolateral margins arcuate, lateral margins concave to strongly concave, slightly margined at junction with propleura, anterior angles produced or slightly rounded but still evident, in dorsal view, sulcate in lateral view; calli barely convex, but distinct, asperate, narrowly confluent anteriorly, not reaching anterolateral margins of pronotum; ventral third of propleura, prosternum narrowly bordering coxae and possibly attaining front margins, basalar plate, median portion of episternum, epimeron bordering coxae, and dorsolateral portion of second and third sternites of abdomen testaceous or ivory. LEGS: fulvous, fuscous or black; apices and bases of coxae testaceous or ivory; femora with black or dark fuscous; apices and bases sometimes darkly infuscated; apices of tibia and tarsi black. HEMELYTRA: inner basal region of cuneus, in variable degree, testaceous; some specimens with black cuneus. VESTITURE: dorsum densely clothed with a mixture of recurved sericeous white setae and long fuscous setae; sericeous setae are woolly on head and pronotum, appressed on hemelytra; fuscous setae erect on head, pronotum and basal portion of hemelytra, suberect on remainder of hemelytra; venter and legs moderately covered with long testaceous setae.

Macropterous female. More robust than male, with more extensive pale coloration and somewhat oval, otherwise similar in structure, and vestiture. Length 3.80–5.23, width 1.60–2.00. HEAD: width across eyes 0.98–1.19, vertex 0.48–0.59, dorsal width of eye 0.23–0.29, distance from tylus to ventral margin of eye 0.48–0.58, height of eye 0.38–0.48, maximum interocular width 0.70–0.86; some specimens with entire ventral portion of head, below antennal insertions, excluding buccula and variable portion of gena, testaceous or fulvous. ROSTRUM: length 1.31–1.56, reaching bases and sometimes slightly surpassing apices of mesoxocae. ANTENNAE: I, length 0.33–0.46, sometimes entirely testaceous; II, 0.80–1.16 sometimes extensively testaceous or fulvous; III, 0.59–0.70; IV, 0.60–0.80. PRONOTUM: length 0.70–1.04, anterior width 0.76–1.00, maximum width 1.45–2.00. VENTER: testaceous, or fulvous, both sides with medial black line of variable thickness, vaginal exterior sometimes black.

Type. Female holotype. Los Angeles, Cal., W.S.B., 2-26-28; Purdue Blatchley Collection; TYPE [red]. No other specimens were collected by Blatchley. The holotype is deposited at the Purdue Entomological Research Collection, Purdue University, West Lafayette, Indiana. Blatchley (1934) states in the original description that the holotype was collected on a white flowered shrub near Sunland [Los Angeles]. The material on hand is within the species limits of Blatchley's description. He does state, however, that the holotype is brachypterous. All the specimens of both sexes examined are clearly macropterous. Mr. Arwin V. Provonsha, curator at the Purdue collection, has examined the holotype and verified that it is macropterous and female.

Remarks. The distribution of this species is entirely within the California chaparral and Sierran forest provinces. The floristic associations occupied are: mixed hardwoods, blue oak–digger pine, and southern oak forests as well as chaparral. Adult specimens have been collected on these grasses: *Agropyron* sp., *Bromus* sp., *Elymus* sp. and *Hordeum vulgare* L. Other non-graminoids plants on which adult specimens have been collected are: *Arctostaphylos* sp., *Artemisia* sp., *Ceanothus cuneatus* (Hook.) Nutt., *C. intergerrimus* H. & A., *C. megacarpus* Nutt., *Cercocarpus lediflolus* Nutt., *Keckiella* sp., *Quercus* sp., *Rhamnus crocea* Nutt. in T. & G., *Salvia apiana* Jeps. and *S. mellifera* Greene. The range of occurrence is 15 February (San Diego County) to 7 May, and altitudinal range is from 560 to 980 m. (1850 to 3200 feet).

Specimens examined. 92 specimens were examined from the following localities (Map 13). **UNITED STATES:** CALIFORNIA: *Alameda Co.,* Cedar Mtn. (UCB). *Butte Co.,* Oroville (CAS). *Fresno Co.,* Jacalitos Cyn.—Coalinga (CAS). *Kern Co.,* Lk. Isabella—main dam cmpgd. (OSU). *Los Angeles Co.,* Claremont (USNM); Los Angeles (USNM); Nicholas Beach (LACM); Santiago Canal & Sta. Ana (USNM). *Monterey Co.,* 5 mi. N Escondido Cmpgd.—Sta. Lucia Mts. (UCB); Paraiso Spgs. (CAS); Stone Cyn.—W Jolon (CAS). *Orange Co.,* Trabuco Cyn. (F&A). *Riverside Co.,* Bautista Cyn. (T6S R2E Sec. 18) (UCR); Keen Cmpgd.—San Jacinto Mts. (UCB); Menifee Valley (UCR); 1 mi. SE Radec (UCB); Railroad Cyn.—4 mi. E Elsinore (UCB); Riverside (UCR); Sage (UCB); 5.5 mi. & 5.6 mi. S Sage (T7S R1E Sec. 32) (UCR); Temecula (F&A); mp. 21.29 on rt. 243—S Banning (OSU). *San Benito Co.,* Panoche Pass (UCB); Pinnacles (UCB). *San Diego Co.,* Cuyanaca Lk. (UCB); Descanso Rgr. Stn., & 4 mi. NW (UCB); Jacumba (SDNM); Mc Cain Valley (SDNM); 2 mi. S Pine Valley (UCB); Pala (USNM); mp. 7.7 on rt. 79—SE Sunshine Summit (OSU). *S.L.O. Co.,* Temblor Range—12 mi. E Simmler (UCB). *Sta. Barbara Co.,* Los Prietos (UCB). *Sta. Clara Co.,* Colorado Crk. & Mines Rd. (UCB); S end Mines Rd. (CAS). *Stanislaus Co.,* W Adobe Crk. (UCB).

Irbisia elongata Knight
Figs. 10a, b, 106, 33, 56, 79; Map 2

Irbisia elongata Knight, 1941, pp. 77–78 (new species); 1968, p. 185. Carvalho, 1959, p. 105. Kelton, 1980, p. 85, map 24, 86.
Irbisia retrusa Bliven, 1963, pp. 71–72, 85 pl. 7, figs. 9, 9a. NEW SYNONYMY.

Diagnosis. Individuals of this species may be distinguished from most of the other species of *Irbisia* by the strongly pedunculate eyes, antennal sockets below the ventral margin of eye and long and narrow body form. *I. elongata* differs from *I. pacifica* and *I. brachycera* in antennal structure. The length of segment II is subequal to the width of the pronotum (much greater in *I. pacifica*), and the vertex to segment I ratio is from 1:0.96 to 1:1.04 (from 1:0.64 to 1:0.85 in *I. brachycera*). The ratios of the distance between the tylus and the ventral margin of the eye to the height of the eye also differ from *I. brachycera.* The ratio for *I. brachycera* is greater than 1:0.50; ratio for *I. elongata* is equal to or less than 1:0.50.

Description. Macropterous male. Length 5.20–5.90, width 1.70–2.00, black, shining, predominately clothed with thin, white, woolly sericeous setae. HEAD: width across eyes 1.18–1.31, vertex 0.68–0.75; dorsal width of eye 0.27–0.29; asperate; temporal areas smooth and glabrous; basal carina indistinct, posteriorly arcuate mesad; median depression broad and shallow; eyes small, roundish, pedunculate, posterolateral margin slightly arcuate anteriorly in dorsal view; distance from tylus to ventral margin of eye 0.76–0.80, height of eye 0.39–0.40, maximum interocular width 0.88–0.90, lora with pale spot at base; antennal sockets below ventral margins of eyes. ROSTRUM: length 1.98–2.13, testaceous, with dark infuscations (especially last two segments), surpassing mesocoxae, sometimes reaching apices of metacoxae. ANTENNAE: fuscous; I, length 0.73–0.80; short light setae, black, apical half sometimes light; II, 1.71–1.94; III, 1.05–1.20; IV, 0.90–1.08. PRONOTUM: length 1.08–1.25; anterior width 0.85–0.96; maximum width 1.58–1.75; somewhat conical, disk convex, rugulopunctate, posterior margin straight, lateral margins slightly concave, very broadly rounded at junction with propleura, anterior angles blunt, inconspicuous, sulcate dorsad of coxal cleft, in lateral view; calli barely produced, confluent anteriorly, with short transverse depression anteriorly, asperate. LEGS: whitish testaceous to flavous with black markings; procoxae black basally, meso- and metacoxae black in middle; femora black basally, terminating in a series of fuscous or black spots; tibia black on base and apex; tarsi black. VESTITURE: dorsum clothed with erect, long, white, shining setae, intermixed with sericeous, recurved setae; setae on head antrorse, woolly on anterior portion of pronotum, somewhat appressed on remainder of dorsum; venter with dense, shining white setae.

Description. Macropterous female. Slightly more robust than male, but similar in struture and vestiture; coxae and xyphus with more extensive white coloration. Length 5.50–6.25, width 2.08–2.40. HEAD: width across eyes 1.25–1.38, vertex 0.70–0.82, dorsal width of eye 0.28–0.30, distance from tylus to ventral margin of eye 0.80–0.88, height of eye 0.38–0.41, maximum interocular width 0.91–1.00. ROSTRUM: length 2.06–2.25, barely surpassing mesocoxae. ANTENNA: I, length 0.75–0.80; II, 1.98–2.18; III, 1.13–1.30; IV, 1.03–1.92 (a population from Grant Co., Oregon contains several specimens with smaller lengths; I, 0.68; II, 1.66; III, 1.08; IV, 0.95). PRONOTUM: length 1.06–1.25, anterior width 0.95–1.08, maximum width 1.60–1.92.

Types. Male holotype. Sundance, Crook Co. Wyoming, 30 July 1927, H. H. Knight. Retained at the United States National Museum, Washington, D.C. I have examined the holotype and paratypes (22 specimens); all are conspecific and are deposited at BYU, CNC, JCS, and USNM.

Taxonomic consideration. The junior synonym, *I. retrusa* Bliven, was described from a single specimen. I have examined this male and as mentioned in the original description the apical two thirds af the first antennal segment is orange. This antennal condition may be observed on several specimens from Alberta and Montana. *I. retrusa* is synonymized with *I. elongata* on the basis of their similar external and internal morphology.

Remarks. This species has a northern and montane distribution extending from approximately 41° to 52° 30′ north latitude between 1219 and 2438 m. (4000 and 8000 feet) elevation. In British Columbia, specimens were collected from the interior plateau and Fraser basin within the northern prolongation of the Palouse Prairie. Grassland and sagebrush steppe vegetation, which border woodland situations, characterize the floristic associations of the rest of the range of *I. elongata.* I have collected adult specimens from two grass hosts: *Agropyron desertorum* (Fisch.) Schult. and *Stipa thurberiana* Piper. Some specimens from Alberta were collected on *A. intermedium* (Host) Beauv. Collection dates are from 12 May to 3 August.

Specimens examined. 234 specimens were examined from the following localities (Map 2). **CANADA:** ALBERTA: Conrad; Cowley; Frank; Lethbridge (USNM); Spring Pt.; Waterton Nat. Pk. (all CNC). BRITISH COLUMBIA: Chase (UBC); Chilcotin (UCB, USNM); Kamloops (UBC); Lac du Bois—Kamloops (UBC); nr. Lytton (UBC); Pavilion Lk. (CNC); Soda Crk. (UBC); Vaseaux Lk. & White Lk.—Oliver (CNC, USNM). **UNITED STATES:** CALIFORNIA: *Humboldt Co.,* Dinsmores (CAS). *Modoc Co.,* Rush Crk.—9 mi. NE Adin (UCB). COLORADO: *Eagle Co.,* Muddy Pass Rd. (JTP). IDAHO: *Bonner Co.,* 4 mi. S Elmira (UID); Big Smokey Grd. Stn. (UID). *Kootenai Co.,* Farragut St. Pk. (UID). *Lemhi Co.,* 14.4 mi. N Cobalt (UID). *Oneida Co.,* Black Pine Cyn. (USU). MONTANA: *Broadwater Co.,* Winston (MSU). *Fergus Co.,* mi. SW & 6 mi. N Lewiston (MSU); Moulton (MSU). *Gallatin Co.,* Bozeman (MSU); Springhill (MSU); Willow Crk. (USNM). *Glacier Co.,* 7 mi. NW Kiowa (CAS). *Judith Basin*

Co., SW Utica (MSU). *Latah Co.,* Genesee (USNM). *Ravalli Co.,* Florence (USNM). *Teton Co.,* 25 mi. W Chateau (MSU). *Wheatland Co.,* 8 mi. N Harlowton (MSU). NEVADA: *Elko Co.,* E slope Spruce Mt. (UCB). OREGON: *Baker Co.,* 30 mi. NE Baker (OSU); Haight Rch.—Halfway (OSU); 6.5 mi. E Richland (OSU). *Crook Co.,* 5.6 mi. NE rt. 25—Ochoco Crk. (OSU); 20 mi. E Prineville (OSU); Ochoco Nat. For. (T14S R18E Sec. 11) (OSU). *Grant Co.,* 13 mi. S Dale (OSU); 11 mi. N Seneca (OSU). *Wallowa Co.,* Lone Spg.—32 mi. N Joseph (OSU). *Wheeler Co.,* 4.5 mi. S Mitchell (AMNH, OSU). UTAH: *Box Elder Co.,* Bothwell (USU). *Cache Co.,* Blacksmith Fork (OSU); East Cyn. (USU); Green Cyn. (USU); Logan Cyn. (USU); Ricks' Spg.—Logan Cyn. (USU); Smithfield Cyn. (AMNH). *Rich Co.,* Bear Lk. lookout—Smt. Logan Cyn. (USU). WASHINGTON: *Adams Co.,* 13 mi. S Ritzville (OSU). *Grant Co.,* 7 mi. NE Coulee City (OSU). *Whitman Co.,* Colton (WSU). WYOMING: *Park Co.,* Lk. Crk. Cmpgd.—13 mi. S Cooke City, Montana (AMNH). *Sheridan Co.,* Sheridan (SHF, UWY).

Irbisia fuscipubescens Knight
Figs. 28a, b, 51, 74, 97; Map 22

Irbisia fuscipubescens Knight, 1941, pp. 76–77 (new species). Carvalho, 1959, p. 105. Kelton, 1980, p. 84, map 23.

Diagnosis. I. fuscipubescens is distinguished from other species of *Irbisia* by the sparsely distributed fine, short, erect or appressed fuscous to golden setae on the polished, shining dorsum. *Irbisia cascadia* also has prostrate, sericeous white setae, but positive separation of it and *I. fuscipubescens* requires the careful examination of genitalic structures. The sclerotized rings of female *I. fuscipubescens* are strongly compressed dorsoventrally, and not completely open interiorly; *I. cascadia* has oval, open sclerotized rings. The outer edge of the concave ventral surface of the sclerotized process of the male of the former species does not have a row of strong spicules; the latter species has a clearly defined row of strong spicules on the outer edge that are separated from the major strongly curved spines of the inner edge of the frontal concavity. The left paramere of the male of these two species is diagnostic; *I. fuscipubescens* has tubercles which are confined to the shaft.

Description. Macropterous male. Length 5.20–6.10, width 2.20–2.80, polished, shining black, sparsely covered with short, thin fuscous setae. HEAD: width across eyes 1.13–1.30, vertex 0.53–0.60, dorsal width of eye 0.28–0.35; triangular, polished; temporal areas indistinct; median depression usually absent or a single faint impressed line; basal carina abruptly produced, bluntly prominent, straight or slightly posteriorly arcuate mesad; eyes broadly joined to frons, posterior margin straight in dorsal view, distance from tylus to ventral margin of eye 0.58–0.66, height of eye 0.48–0.58, maximum interocular distance 0.83–1.08. ROSTRUM: length 1.65–2.00, black or fuscous, apical half sometimes fulvous, reaching apex of mesocoxae, sometimes approaching and attain apex of metacoxae. ANTENNAE: black; I, length 0.53–0.70, apical third to quarter sometimes fulvous; II, 1.48–2.00; III, 0.90–1.10; IV, 1.03–1.25. PRONOTUM: length 1.03–1.15, anterior width 0.85–1.08, maximum width 1.73–2.01; trapezoidal, broadly convex, rugulopunctate or distinctly punctate, posterior margin broadly arcuate, lateral margins straight, rounded at junction with propleura, anterior angles bluntly prominent, usually rounded, sometimes protruding slightly anteriorly, evident in lateral view; calli clearly defined, convex, broadly confluent anteriorly, shining smooth, with fovate impression on anteromedial angles, reaching anterolateral margin of pronotum; ostiolar peritreme on some specimens black. LEGS: black; tibiae except apices and bases, and apices of femora, testaceous; metatibia frequently with basal third black. VESTITURE: dorsum covered with sparse thin fuscous to golden setae; upright on head, suberect and conspicuous on pronotum, practically appressed, inconspicuous, thin on hemelytra; basal portion of hemelytra in some specimens, with sericeous, recurved setae; venter with sparse thin fulvous setae.

Macropterous female. More robust than male, but similar in structure, color and vestiture. Length 4.90–6.00, width 2.50–2.90. HEAD: width across eyes 1.19–1.34, vertex 0.56–0.68, dorsal width of eye 0.28–0.35, distance from tylus to ventral margin of eye 0.63–0.74, height of eye 0.48–0.55, maximum interocular width 0.87–0.98. ROSTRUM: length 1.80–2.00, reaching and sometimes surpassing mesocoxae to apex of metacoxae. ANTENNAE: I, length 0.53–0.70, sometimes extensively testaceous or fulvous; II, 1.45–1.91; III, 0.73–1.13; IV, 0.98–1.25. PRONOTUM: length 1.10–1.18, anterior width 0.87–1.08, maximum width 1.85–2.10. LEGS: light areas of femora and tibiae testaceous, rufescent or fulvous.

Types. Male holotype. Tampico, [Yakima Co.], Wash., May 21, 1932, A. R. Rolfs. Retained at the United States National Museum, Washington, D.C. I have examined 38 paratypes and the holotype, all are conspecific. The paratypes are deposited at BYU, JFS and USNM.

Taxonomic consideration. Specimens from a population of *I. fuscipubescens* collected 15 miles north of Weiser, Washington County, Idaho, on *Balsamorhiza* sp., have vestiture which is similar to the condition which typifies *I. cascadia.* The specimens are typical of *I. fuscipubescens* in the vertex to antennal segment I ratio and genital structure. These two species are sister groups and are mostly allopatric. Specimens of *I. fuscipubescens* from Chelan County near Dryden, have dark ostiolar peritremes and long fuscous setae on the hemelytral border. Such specimens can be confused with *I. nigripes* Knight.

Remarks. I. fuscipubescens has a northern and montane distribution which is bordered on the west by the east slopes of the Cascade Range where the vegetational associations are an intergradation of western ponderosa pine forst and sagebrush steppe. The northern limit of its range is 50° 30′ north latitude. The vegetation associations occupied by *I. fuscipubescens,* south and east of this limit, consist of fescue–wheatgrass grassland (Palouse Prairie) and Douglas fir and western ponderosa pine forests. The far eastern limit of its range remains within the Douglas fir forest of Rocky Mountains of western Wyoming. Its elevational range is from 210 to 2570 m. (700 to 8435 feet) and dates of adult occurrence are 20 April to 25 August. Adult specimens have been collected from the following plants: *Agropyron* sp., *A. repens* (L.) Beauv., *Balsamorhiza sagittata* (Pursh) Nutt., *Betula* sp., *Chrysothamnus* sp., Poaceae, *Helianthus* sp., *Lathyrus* sp., *Lupinus* sp., *Medicago* sp., *Pinus contorta* Dougl. ex Loud., *Potentilla* sp., *Salix* sp., *Smilacina racemosa* (L.) Desf. and *Trifolium pratense* L.

Specimens examined. 860 specimens were examined from the following localities (Map 22). CANADA: ALBERTA: Banff (CNC, KU, USNM); Blairmore (CNC); Cameron Lk. Rd.—Waterton Lks. Nat. Pk. (CNC); Coleman (CNC); Frank (CNC): Gorge Crk. (UALB); Jasper Nat. Pk. (CNC); Kananaskis—Hwy. 25, Rds. 20 & 27 (CNC); Lundbreck (CNC); Waterton

(CNC, UALB). BRITISH COLUMBIA: Aspen Grove (CNC); Brand Forks (UBC); 7 mi. W Bridesville (UCB); 4 mi. E Christina Lk. (UBC); road to Copper Mt.—nr. Nelson (UBC); Eva Lk. Trl. (CNC); Fernie & Lizard Crk. (UBC); Glacier Nat. Pk. (CNC); Hall Crk. (UBC); Hedley—Nickel Plate City & mine (CNC); Hosmer (UBC); Kamloops (UBC) & Paul L. (CNC); Kootenay Prov. Pk.—Vermilion R. (CNC); Lorna (USNM); Manning Prov. Pk.—Allison Pass, Blackwall, Gibson Pass (CNC); Grand Forks (CNC); Mara (UBC); Merritt—Midday Valley (USNM), & 10 mi. S (CNC); Midway (CNC); Monaskie Pass (CNC); Mt. Revelstoke (CNC); Nicola (UBC); Oliver—7 mi. E & Meyers Flat (CNC); Osoyoos—Anarchrist Mt. (CNC); Penticton (USNM); Robson (UBC); 8 mi. W Rossland (CNC); Salmo (UBC); Sicamous (CNC); Trinity Valley (CNC); Vernon (CAS, UBC); Yoho Valley—Yoho Nat. Pk. (AMNH). **UNITED STATES:** IDAHO: *Blaine Co.,* Alturas Lk. (AMNH). *Bonneville Co.,* Palisades Dam (UCD). *Boundary Co.,* Brush Lk. (UID). *Camas Co.,* Fairfield (UID). *Caribou Co.,* 8 mi. E Wayan (UID). *Kootenai Co.,* Athol (UID); 12 mi. N Coeur d'Alene (KU). *Latah Co.,* Moscow Mt. (USNM). *Lemhi Co.,* Salmon River (KU). *Valley Co.,* No Business Lookout (UID). *Washington Co.,* 15 mi. N Weiser (OSU). MONTANA: *Glacier Co.,* 10 & 15 mi. W Babb—Glacier Nat. Pk. (OSU); Glacier N.P. (UALB); Swift Current Pass—Glacier N. P. (AMNH). *Lake Co.,* Swan Lk. (USNM). *Lincoln Co.,* 11 mi. E Libby (MSU). OREGON: *Baker Co.,* 5 mi. NW Ballards Landing (T5S R78S Sec. 31 SE ¼ SW ¼) (OSU). *Deschutes Co.,* 6 mi. NW & E Sisters (AMNH, OSU); Three Crks. Mdw. (OSU). *Hood River Co.,* Hood R. (USNM). *Wallowa Co.,* Minam St. Pk. (OSU). *Wasco Co.,* Cherry Hts. Rd.—2.5, 3.6 & 5.5 mi. S The Dalles (OSU); 5 mi. N & 11 mi. S Dufur (JS, OSU); Mayer St. Pk. (OSU); Mosier (JS); Rowena Crest (OSU); Rowena Loop Rd.—5, 5.5 & 7 mi. E Mosier (OSU); 2 mi. S & 7 mi. N Simnasho (OSU); Skyline Dr.—The Dalles (OSU); The Dalles (JS). WASHINGTON: *Chelan Co.,* 8.4 mi. SW & Dryden (OSU & USNM), 0.4 mi. W Leavenworth (OSU). *Ferry Co.,* W Fk. Sanpoil River (OSU). *Grant Co.,* Vantage (AMNH). *Klickitat Co.,* 1.4, 2 & 3 mi. E Bingen (OSU); 14 mi. W Goldendale (OSU); 3 & 4.5 mi. S Husum (OSU); 2 mi. NW & 21.7 mi. NE Lyle (OSU); Maryhill (OSU); 3.7 E Wahkiacus (OSU); 0.4 mi. E of mp. 70 on rt. 830 (OSU). *Okanogan Co.,* Nespelem (OSU). *Skamania Co.,* Dog Mt.—Pacific Crst. Trl. (OSU). *Stevens Co.,* Northport (UCB, USNM). *Yakima Co.,* Clear Lk. (SHF); 13, 13.5 mi. W & 15 mi. WNW Naches (OSU); Rimrock (WSU); Tampico (BYU); Tieton (OSU); Tieton Cyn. (SHF); 27.6 & 30 mi. S & Toppenish (OSU, USNM). WYOMING: *Teton Co.,* 11.2 mi. W Jackson (OSU); Teton Pass (USNM).

Irbisia incomperta Bliven

Figs. 17a, b, 40, 63, 86; Map 7

Irbisia incomperta Bliven, 1963, pp. 73–74, 86, pl. 8, figs. 1, 1a (new species).

Diagnosis. This species can be distinguished from allied species on the basis of these characters: slightly shagreened frons; obvious, transverse sulcus on posterior margin of temporal area; deep and broad median depression on head; narrow vertex (vertex to antennal segment I ratio: for males from 1:1.13 to 1:1.35; for females from 1:1.00 to 1:1.04); concave lateral margins of pronotum; ochraceous basalar plate; sclerotized rings and dorsal labiate plate of the female are small, compressed, barely open and narrow, respectively; the left paramere of the male is broadly curved, the outer surface with a series of moderately sized pointed tubercules, the shaft is not constricted preapically, only slightly curved toward the sensory lobe, the apex barely securiform. In addition to the above characters, *I. incomperta* differs from *I. solani,* in the female of the former with fuscous spotted femora. *I. incomperta* does not possess densely distributed long suberect fulvous setae on the tibia which additionally distinguish this species from *I. oreas* Bliven.

Description. Macropterous male. Length 4.20–4.90, width 1.70–1.95, shining black, moderately clothed with a mixture of recurved sericeous white setae and thin suberect fuscous setae. HEAD: width across eyes 1.04–1.16, vertex 0.43–0.48, dorsal width of eye 0.28–0.33; triangular, smooth or slightly shagreened; tylus rounded in dorsal view; temporal areas smooth, distinct, slightly flattened with obvious transverse sulcus on posterior margin; median depression evident, sometimes broad or a longitudinal furrow; basal carina moderately prominent, moderately acute or rounded in cross section, declivous to level of vertex, straight; eyes broadly joined to frons, protruding laterally, posterolateral margin slightly arcuate postad in dorsal view; distance from tylus to ventral margin of eye 0.48–0.54, height of eye 0.48–0.53, maximum interocular width 0.70–0.83; jugal-loral suture sometimes fulvous. ROSTRUM: length 1.60–1.68, black or piceous, medial region fulvous, reaching bases of mesocoxae, sometimes surpassing apices of mesocoxae in some specimens. ANTENNAE: black; I, length 0.51–0.65; II, 1.38–1.63; III, 0.73–0.93; IV, 0.86–1.00. PRONOTUM: length 0.83–0.95, anterior width 0.80–0.88, maximum width 1.45–1.63; conical broadly convex, distinctly punctate on disk, lateral and posterior margins confluently punctate, posterolateral margin arcuate, lateral margins slightly concave, broadly rounded at junction with propleura (sometimes appearing slightly margined) anterior angles broadly rounded in dorsal view, not sulcate in lateral view; calli slightly to moderately convex, mostly smooth, broadly confluent anteriorly, reaching anterolateral margins of pronotum; basalar plate and insertion of hemelytra ochraceous. LEGS: black; apices of coxae and margins of trochanters testaceous; apices of femora and tibiae fulvous or fuscous; apices and bases of tibiae and tarsi black. VESTITURE: moderately clothed with a mixture of recurved, appressed sericeous white setae, and thin white to fuscous setae, thin setae are erect on head, pronotum and scutellum, suberect on hemelytra; venter sparsely clothed with thin suberect white to fulvous setae; eyes very sparsely pubescent between facets.

Macropterous female. Slightly more robust than male, but similar in structure, color and vestiture. Length 4.85–5.50, width 1.90–2.25. HEAD: width across eyes 1.09–1.19, vertex 0.50–0.53, dorsal width of eyes 0.28–0.31, distance from tylus to ventral margin of eye 0.53–0.58, height of eye 0.46–0.53, maximum interocular width 0.78–0.85; clypeal, jugal and loral sutures sometimes testaceous. ROSTRUM: length 1.58–1.80, reaching bases of metaxocae. ANTENNAE: black or fuscous, I, length 0.50–0.56, sometimes entirely fulvous except for bases; II, 1.18–1.45; III, 0.70–0.95; IV, 0.90–1.03. PRONOTUM: length 0.90–1.03, anterior width 0.85–0.95, maximum width 1.63–1.81. LEGS: fulvous; medial portion of coxae, preapical one fourth of femora, bases and apices of tibiae, and tarsi, fuscous; femora with fuscous spots ventrally.

Types. Male holotype. Woody, Kern Co., California, Mar. 5, 1961; HOLOTYPE, Irbisia incomperta, 1963, B. P. Bliven [red]; CAS type no. 13853. I have examined the holotype and all 26 paratypes. All are conspecific and retained at the California Academy of Sciences, San Francisco.

Remarks. The distribution of this species is fairly widespread throughout the blue oak–digger pine forest floristic association of the Californian chaparral and Sierra forest provinces. Specimens may be found in the northern yellow pine forest floristic associations in Shasta County, and chaparral associations in Tulare and San Diego Counties. Adult specimens have been collected from the following plants: *Ceanothus* *cuneatus* (Hook.) Nutt., *Prunus subcordata* Benth., *Quercus douglasii* H. & A., *Q. wislizenii* A. D.C., *Rhamnus crocea* Nutt. ex T. & G., and *Yucca brevifolia* Engelm. in Wats. This species has also been collected from several unidentified Poaceae. The dates of adult occurrence are 10 March to 10 May. The elevational range of the collection sites is from 655 to 1070 m. (2150 to 3500 feet).

Specimens examined. 176 specimens were examined from the following localities (Map 7). **UNITED STATES:** CALIFORNIA: *Butte Co.,* Oroville (CAS). *El Dorado Co.,* Clarksville (F&A); Cool (UCB). *Fresno Co.,* 12 mi. SW Coalinga (UCB); Jacalitos Cyn.—Coalinga (CAS). *Kern Co.,* Kernville (CAS, UCB); Miracle Spgs. (UCB); 1 mi. E Woody (UCB). *Mendocino Co.,* Ukiah (USNM). *Monterey Co.,* Bryson (CAS). *Napa Co.,* Monticello (F&A). *San Benito Co.,* Big Panoche Crk. (UCB); Panoche Pass (UCB); Pinnacles Nat. Mon.—W entr. (OSU); 5 mi. W San Juan Bautista (UCD). *San Diego Co.,* 2 mi. S Pine Valley (UCB). *S.L.O. Co.,* 4 & 10 mi. S & 10 mi. SE Creston (UCB); Pozo & 3 mi. E (UCB); Temblor Rng.—12 mi. E Simmler (UCB). *Shasta Co.,* Whiskeytown St. Pk.—on rt. 299 (OSU). *Stanislaus Co.,* Del Puerto Cyn. (UCB, UCD). *Sutter Co.,* Sutter Buttes (UCD). *Tehama Co.,* 21 mi. NW Red Bluff on rt. 36 (OSU). *Tulare Co.,* 9 & 11 mi. NW Calif. Hot Spr. (UCB); Fairview (UCB); 2 mi. E Johnsondale (UCB).

Irbisia knighti Schwartz and Lattin
Figs. 7b, 19a, b, 42, 65, 88; Map 8

Irbisia knighti Schwartz and Lattin, 1984, pp. 413–417, figs. 1–8 (new species).

Diagnosis. Similar to *I. solani* in size and surface features but is consistently recognizable by brachyptery of both sexes and white vestiture. *I. knighti* is separated from the brachypterous form of *I. sericans* by the slightly punctate pronotum and white vestiture of the former species (Figs. 1, 2).

Description. Brachypterous male. Length 3.90–4.63, width 2.18–2.30, shining black, moderately covered with, shining white setae. HEAD: width across eyes 1.25–1.30, vertex 0.59–0.63, dorsal width of eye 0.35–0.36; triangular, smooth; temporal areas distinct, bordered basally by transverse short sulcus, glabrous; median depression indistinct; basal carina moderately prominent, slightly rounded, declivous to level of vertex, straight eyes broadly joined to frons, posterolateral margins arcuate posteriorly in dorsal view; distance from tylus to ventral margin of eye 0.61–0.63, height of eye 0.50–0.53, maximum interocular width (anterior view of frons) 0.90–0.95. ROSTRUM: length 1.70–1.83, black, surpassing mesocoxae to just attaining apices of metacoxae. ANTENNAE: black; I, length 0.50–0.55, apices fuscous; II, 1.45–1.55; III, 0.78–0.93; IV, 1.02–1.20. PRONOTUM: length 0.86–0.88, anterior width 0.93–0.95, posterior width 1.45–1.55; subconical, slightly flattened, distinctly or confluently punctate, lateral margins straight, broadly rounded, at junction with propleura, anterior angles rounded indistinct in dorsal view, gently sulcate in lateral view; calli slightly convex, smooth, narrowly confluent anteriorly, with transverse depression on inner, and foveate depression of outer anterior angles reaching anterolateral margins of pronotum. LEGS: black; coxae and femora with apices testaceous; tibiae testaceous with bases of bases black; tarsi black. HEMELYTRA: membrane reduced, extending slightly beyond apex of cuneus, cells not developed; apex of abdomen exposed in dorsal view. VESTITURE: dorsum clothed with suberect white setae; head and pronotum sparsely covered with thin setae; hemelytra moderately covered with sericeous setae basally, these setae grading into and being replaced by thin setae apically; venter moderately clothed with white setae; eyes with sparse minute pubescence between facets.

Brachypterous female. More robust than male, but very similar in color, structure and vestiture. Length 4.40–4.95, width 2.40–2.50. HEAD: width across eyes 1.35–1.36, vertex 0.66–0.68, dorsal width of eye 0.35–0.38, distance from tylus to ventral margin of eye 0.66–0.68, height of eye 0.50–0.54, maximum interocular width 0.96–0.98. ROSTRUM: length 1.88–1.93, barely reaching apices of metacoxae. ANTENNAE: I, length 0.55–0.58; II, 1.53–1.55; III, 0.85–1.00; IV, 1.03–1.15. PRONOTUM: length 0.93–0.96, anterior width 1.02–1.04, maximum width 1.65–1.70.

Types. Holotype male. Washington, Pacific Co., Nahcotta Oyster Research Station, 14 June 1979, M. D. Schwartz, ex *Agropyron repens*; CAS type no. 15024. Retained at the California Academy of Sciences, San Francisco. Paratypes are retained at AMNH, CAS, CNC, OSU and USNM.

Discussion. This species is narrowly distributed along the coastal flatlands of the Pacific Northwest. It occupies a very restricted portion of the Vancouveran Zone as defined by Van Dyke (1939). Adult specimens were collected from these hosts: *Agropyron repens* (L.) Beauv., *Carex* sp. (a sedge), *Festuca rubra* L., *Holcus lanatus* L., *Poa pratensis* L., and *Poa* sp. None of these grasses (*Carex* sp. is a doubtful host) are obligatorily associated with the apparent restricted habitat of *I. knighti*. Collection dates are from 15 May to 15 July. All localities are from sea level to 45 m. (150 feet) elevation.

Specimens examined. 242 specimens were examined from the following localities (Map 8). **CANADA:** BRITISH COLUMBIA: Jesse Island—Nanaimo (UBC, UCB, USMN); Mt. Douglas—Victoria (CNC); Royal Oak (CNC); Victoria (CAS, CNC, UCB, USNM). **UNITED STATES:** CALIFORNIA: *Humboldt Co.,* 5 mi. W Loleta—tidal mud flat (UALB). OREGON: *Lane Co.,* 12 mi. N Florence—Big Creek Rd.—Siuslaw Nat. For. (OSU). *Tillamook Co.,* 2.3 mi. N Neskowin on rt. 101 (OSU); 0.1 mi. N Rockway on rt. 101 (OSU); Sand Beach Cmpgrd.—2 mi. W Sand Lk. (OSU); Sand Lk. (MSU); Tierra del Mar (OSU). WASHINGTON: *King Co.,* Seattle (OSU). *Pacific Co.,* Bay Center (OSU); Nahcotta, sweeping grasses just above tide line on bay shore (AMNH, OSU); Wallapa Bay—near Nahcotta (WSU). *Skagit Co.,* Mt. Vernon (OSU).

Irbisia limata Bliven
Figs. 20a, b, 43, 66, 89; Map 5

Irbisia limata Bliven, 1963, pp. 78, 86, pl. 8, figs. 5, 5a (new species).

Diagnosis. I. limata differs from *I. solani* in these characters: polished, shining black dorsum; virtually impunctate pronotum; longer rostrum (*I. limata* ranging from 1.88 to 2.13 mm. for males and 1.65 to 2.23 mm. for females; *I. solani* ranging from 1.40 to 1.83 mm. for males and 1.60 to 1.80 mm. for females); flavescent first antennal segment; left paramere and vesica of male. *I. limata* may be separated from *I. panda* Bliven by the flavescent first antennal segment and legs of the former species. Other distinguishing characters that separate these two species are found under the diagnosis of *I. panda*.

Description. Macropterous male. Length 4.65–5.45, width 2.00–2.40, polished, shining black, sparsely covered with recurved and appressed short fine testaceous to whitish setae. HEAD: width across eyes 1.07–1.20, vertex 0.48–0.55, dorsal width of eye 0.28–0.31; triangular, polished; temporal areas indistinct; median depression lacking; basal carina small, but broad in cross section, barely higher than collum, declivous to level of vertex, straight; eyes broadly joined to frons, straight in dorsal view, distance from tylus to ventral margin of eye 0.58–0.63, height of eye 0.50–0.54, maximum interocular width 0.75–0.85. ROSTRUM: length 1.88–2.13, black to fuscous, surpassing mesocoxae, usually surpassing metacoxae. ANTENNAE: fuscous or black; I, length 0.60–0.70, flavescent, base and anterior surface, fulvous, fuscous or piceous, with appressed short black setae, and black bristles; II, 1.58–2.01, sometimes testaceous on basal third; III, 1.00–1.38; IV, 0.88–1.05. PRONOTUM: length 0.94–1.08, anterior width 0.83–0.98, maximum width 1.55–1.88; subconical, broadly convex, slightly rugulose, very slightly punctate, posterior margin arcuate, lateral margins straight, rounded at junction with propleura, anterior angles rounded, not prominent in dorsal view, with single black bristle, slightly sulcate in lateral view; calli prominent, convex, polished, confluent anteriorly, reaching anterolateral margins of pronotum, collar widest medially; ventral third of propleura and prosternum narrowly bordering coxae and attaining front margins, flavescent. LEGS: flavescent; coxae, except for apices, piceous; trochanters, basal portion (in variable degree) of femora, apices of tibiae, and tarsus sometimes piceous; femora sometimes rufescent. VESTITURE: sparsely clothed with short, fine, testaceous to white setae; recurved and appressed on hemelytra, suberect on head and pronotum; venter with sparse suberect fulvous setae.

Macropterous female. More robust than male, otherwise not differing greatly in structure, color and vestiture. Length 4.50–5.40, width 2.20–2.60. HEAD: width across eyes 1.10–1.20, vertex 0.53–0.60, dorsal width of eye 0.25–0.30, distance from tylus to ventral margin of eye 0.63–0.68, height of eye 0.50–0.54, maximum interocular width 0.80–0.88. ROSTRUM: length 1.65–2.23, reaching and usually surpassing metacoxae. ANTENNAE: I, length 0.59–0.70; II, 1.54–1.90; III, 1.20–1.40; IV, 1.00–1.13. PRONOTUM: length 1.00–1.20, anterior width 0.90–1.05, maximum width 1.73–1.95.

Types. Holotype male. Fountain Springs, [Tulare Co.], Cal., Mar. 26. 1961; HOLOTYPE ♂, Irbisia limata, 1963 B. P. Bliven [red]; CAS type no. 13856. I have examined the holotype and the 39 paratypes mentioned in the original description; all are conspecific and retained at the California Academy of Sciences, San Francisco.

Remarks. The distribution of *I. limata* is predominately contained within the blue oak–digger pine vegetation association of the Sierran forest province. This species also occurs, but to a lesser extent, in chaparral, California prairie, riparian forest and valley oak savanna vegetation associations of both the Sierran and Californian chaparral provinces. Angles Camp, Calaveras County, is the northernmost locality of the material on hand; the only record south of the Transverse Ranges is a single specimen from Coachella Valley, Riverside County. Adult specimens have been collected from: *Aesculus californica* (Spach) Nutt., *Amsinckia* sp., *Avena* sp., *Bromus* sp., *Calochortus luteus* Dougl. ex Lindl., *Clarkia cylindrica* (Jeps.) Lewis & Lewis, *C. williamsonii* (Dur. & Hilg.) Lewis & Lewis, Asteraceae, Poaceae, *Sanicula tuberosa* Torr. and *Vulpia* sp. The period of occurrence is from 20 March to 14 July, and the altitudinal range is from 240 to 1220 m. (800 to 4000 feet) elevation.

Specimens examined. 246 specimens were examined from the following localities (Map 5). **UNITED STATES:** CALIFORNIA: *Calaveras Co.,* Angles Camp (CAS). *Fresno Co.,* 12 mi. SW Coalinga (UCB); Pine Flat (UCR); Squaw Valley (UCR). *Kern Co.,* 28 mi. E Bakersfield (UCB); Fountain Spgs. (OSU); Glenville (OSU); Havilah (UCR); Hobo Cmpgd.—Kern River (UCB); 10–20 mi. S Isabella Lk. (AMNH); Miracle Spgs. (UCB); Taft (LACM); Tejon Pass—Lebec (UCB); Woody (OSU, UCB). *Madera Co.,* 2 mi. NE & 3 mi. W Bass Lks (UCB, CAS); Coarsegold (UCB, UID); Northfork (CAS, USNM). *Mariposa Co.,* 1.9 mi. W Mt. Bullion (UCB); *Mariposa Co.* (UCB). *Riverside Co.,* Coachella Valley (CAS). *Sta. Clara Co.,* Diablo Range (CAS). *Stanislaus Co.,* 1 mi. W LaGrange (UCB). *Tulare Co.,* Ash Mt. HQ—N Kaweah (AMNH, UCB); Badger (CAS); 11 mi. NW Calif. Hot Spgs. (UCB); Coffee Cmp.—5 mi. E Springville (UCB); Cold Spgs.—Sequoia N.F. (USNM); Fountain Spgs. & 8 mi. SE, (CAS & AMNH, UCR); 8 mi. NE Hammond (OSU); 5 mi. N Kaweah (UCB); Lemoncove & 4 mi. NE (UCB); Porterville (F&A), 1 mi. NE Posey (UCB), Potwisha—Sequoia N.P. (CAS); Rose Crk.—10 mi. N Columbia (UCB); Sequoia N.P. (LACM); 8 mi. NE Three Rivers (USU); Tule River Cyn. (KU). *Tuolumne Co.,* Sonora (UCB).

Irbisia mollipes Van Duzee

Figs. 29a, b, 52, 75, 98; Map 14

Irbisia sericans var. *mollipes* Van Duzee, 1917b, p. 264 (new variation).
Irbisia mollipes: Van Duzee, 1921a, pp. 147–148, 152 (new status). Essig, 1926, p. 361. Carvalho, 1959, p. 105.
Irbisia umbratica: Bliven, 1963, pp. 69–70 (in part, not holotype).
Irbisia upupa Bliven, 1963, pp. 70–71, 85, pl. 7, figs. 8, 8a. **New Synonymy.**

Diagnosis. Irbisia mollipes is the only species in the genus in which the dorsum is densely covered with suberect, long shining pale white to pale golden setae. Specimens of *I. bliveni* from Mariposa County, California, to the northern limit of its range, have vestiture similar to *I. mollipes. I. mollipes* differs from the former species in these characters: the vertex is narrower (*I. mollipes* ranging from 0.40 to 0.50 mm. males; from 0.48 to 0.55 mm. females; *I. bliveni* ranging from 0.56 to 0.64 mm. males; from 0.60 to 0.70 mm. females), the legs are usually fulvous or rufescent, and the sclerotized process is laterally inserted on the left side of the main trunk of the vesica of the male.

Description. Macropterous male. Length 4.50–5.80, width 1.88–2.20, polished, shining black clothed with dense, suberect long shining pale white to pale golden setae. HEAD: width across eyes 1.07–1.23, vertex 0.40–0.50, dorsal width of eye 0.30–0.36; triangular, polished; temporal areas indistinct; median depression usually lacking; basal carina straight, very small, but acute in cross section, scarcely higher than collum, declivous to level of vertex; eyes broadly joined to frons, but produced laterally, posterolateral margin arcuate posteriorly in dorsal view, distance from tylus to ventral margin of eye 0.53–0.63, height of eye 0.46–0.56, maximum interocular width 0.75–0.85. ROSTRUM: length 1.48–1.73, fulvous, base and apex infuscated, reaching bases of mesocoxae. ANTENNAE: black; I, length 0.59–0.73, sometimes slightly fuscous; II, 1.73–2.25; III, 0.91–1.30; IV, 0.93–1.20. PRONOTUM: length 0.91–1.15, anterior width 0.78–0.90, maximum width 1.58–1.84; conical, broadly convex, distinctly punctate, posterior margin arcuate, lateral margins slightly concave, broadly rounded at junction with propleura, anterior angles rounded, quite reduced in dorsal view, not sulcate in lateral view; calli slightly elevated, polished, confluent anteriorly, broadly attaining anterolateral margin of pronotum and curving around anterior angles. LEGS: fulvous, rufescent to piceous; apices of coxae and trochanters sometimes testaceous; apices, bases and, in some specimens, extensive areas of tibiae infuscated; tarsi infuscated or black. VESTITURE: densely clothed with long shining, pale white to golden setae, erect on head, suberect on rest of dorsum; venter moderately covered with suberect white to golden setae.

Macropterous female. More robust than male, but not differing greatly in structure, color and vestiture. Length 4.70–5.80, width 2.00–2.90. HEAD: width across eyes 1.10–1.30, vertex 0.48–0.55, dorsal width of eye 0.29–0.38, distance from tylus to ventral margin of eye 0.59–0.65, height of eye 0.48–0.55, maximum interocular width 0.85–0.93. ROSTRUM: length 1.65–1.85, barely surpassing base of mesocoxae. ANTENNAE: I, length 0.56–0.70; II, 1.48–2.13; III, 0.90–1.38; IV, 1.13–1.21. PRONOTUM: length 0.98–1.28, anterior width 0.85–1.00, maximum width 1.83–2.10.

Types. Male holotype. Santa Cruz Co., Cal. no. 2B; W. M. Giffard, 7-VI-17; TYPE mollipes [red]; CAS type no. 337. I have examined two paratypes and the holotype; all are conspecfic and retained at the California Academy of Sciences, San Francisco.

Taxonomic consideration. I. upupa Bliven, the junior synonym, meets the habitus of *I. mollipes* in structure, color and vestiture. Van Duzee (1921a) lists several specimens which he determined as *I. mollipes.* All of this material is retained in the collection of the California Academy of Sciences. I have examined these specimens and have determined that they are not all entirely conspecific. The specimens are correctly identified as: *I. mollipes:* Two males—SLObispo, Cal IV-24-19; EP Van Duzee Collector. Male—Santa Cruz Isd. Cal. V-18-1010; EP Van Duzee Collector. Male—Keen Camp Cal., Riverside Co., June 6-12, 1917; EP Van Duzee Collection. Pair—Pasadena, Cal. 5-1-09, Grinnell; EP Van Duzee Collection (yellow). Female—Pasadena, Cal. 4-9-09, Grinnell; EP Van Duzee Collection (yellow); Two females—same data, retained at USNM. *I. setosa:* Female—Ross Cal, Marin Co., iii-31-18; EP Van Duzee Collector. *I.* (sp.?), teneral: Female—Alpine San Diego Co., 3-11-1914 Cal, EP Van Duzee; EP Van Duzee Collection (yellow). *I. serrata:* Pair—Top of Las Vegas Range, VI.28'02 NM; EP Van Duzee Collection (yellow).

Remarks. I. mollipes is distributed wholly within the California chaparral province from the San Francisco Bay area to San Diego County. Throughout this range the majority of specimens were collected from three forest associations—mixed hardwood, blue oak–digger pine and southern oak. Adult specimens were found on the following plants: Poaceae, *Hordeum vulgare* L., *Juglans californica* Wats., *Lupinus* sp., *Marah* sp., *Medicago* sp., *Mimulus longiflorus* (Nutt.) Grant, *Prunus ilicifolia* (Nutt.) Walp., *Rubus* sp. and *Salix* sp. The dates of occurrence range from 3 March to 20 August. The preponderance of late summer dates suggests that this species may occur later in the season than many other species of *Irbisia.* Specimens were collected within the altitudinal range of 180 to 2300 m. (600 to 6800 feet).

Specimens examined. 320 specimens were examined from the following localities (Map 14). **UNITED STATES:** CALIFORNIA: *Alemada Co.,* Arroyo Mocho—8 mi. SE Livermore (CAS); Livermore (CAS); Niles Cyn. (CAS). *Contra Costa Co.,* Moraga (AMNH). *Kern Co.,* Frazier Mt. Pk. (UCB); Mt. Pinos (UCB). *Los Angeles Co.,* Arroyo Seco—nr. Pasadena (USNM); Burbank (USNM); Chatsworth (LACM); Claremont (UCB); Covina (F&A); Elizabeth Lk. Cyn. (LACM); Glendale (UCD); Green River Cmp.—Lwr. Sta. Ana Cyn. (CAS); Griffiths Prk. (USNM);

Los Gatos (UCD); Pasadena (CAS, USNM), Pomona (UCR); Puente Hills (UCR); San Gabriel Cyn.—nr. Dam no. 1 (LACM); Sierra Madre (USNM); Tanbark Flat (F&A, LACM, UCD, UCR), Tapia Park (LACM); Topanga Cyn. (LACM); Whittier (LACM, UCR). *Marin Co.,* Lagunitas (CAS). *Merced Co.,* Pacheco Pass Summit (F&A). *Monterey Co.,* 5 mi. NE Arroyo Seco G. Sta. (UCB); Big Sur Crk. Trl. (CAS); Bixby Crk. (OSU); Bradley (CAS); Bryson (CAS); Greenfield (F&A); Horse Bridge—1.5 mi. SW Arroyo Seco G. Sta. (UCB); Indian Rd.—2 mi. S Arroyo Seco Grd. Stn. (UCB); Paloma Crk.—5 mi. NE Arroyo Seco Grd. Stn. (UCB); Paraiso Spgs. (CAS); Pleyto (CAS); Tassajara Hot Spgs. (CAS); Ventana Wldns.—8 mi. SSE Hwy. 1 on Palo Colorado Rd. (OSU). *Riverside Co.,* Bautista Cyn.—8 mi. SE Hemet (UCR); El Cariso Rgr. Stn.—Hwy. 74, Clev. Nat. For. (UCR), Keen Cmp. (CAS); 2 mi. SE Poppet Flat—San Jacinto Mts. (CAS, KU, UCB, UCR); Sandia Cyn. (T7S R4W Sec. 25) (UCR); Temecula Cyn.—Sta. Margarita R. (UCR); Tenaga Cmpgd.—NW Murrieta (UCR). *San Bernardino Co.,* 4 mi. E Mentone (UCR); Wildwood Cyn.—5 mi. E Calimesa (UCR). *San Diego Co.,* Cuyamaca Lk. (KU); Palomar (SDNH, UCD); Pine Valley (SDNH); Ramona (ASU); Warner Spgs. (SDNH). *San Mateo Co.,* Crystal Lks. (CAS); Crystal Spgs. (AMNH); Portola Valley (CAS). *S.L.O. Co.,* Atascadero (CAS); 10 mi. SE Creston (UCB); Cuesta Cyn. Pk. (AMNH); La Panza Cmpgd. (UCB); Morro Bay (CAS); 3 mi. W Paso Robles (UCB). *Sta. Barbara Co.,* Beach—Water Cyn. (UCD), Canada del Medio (SBMN, UCD), Central Valley (UCB, UCR), Coches Prietos (UCD), Prisoner's Harbor (UCB), Ridge btw. Central Valley & Islay Cyn. (UCB), Upper Valley (UCB), Valley anchorage (UCB)—all Sta. Cruz Is.; 3 mi. SE Zaca Pk. (UCB). *Sta. Clara Co.,* Alum Rock Pk. (UALB, UCB); Mt. Hamilton (UCB); Page Mill Rd. (USNM). Independence (LACM).

Irbisia nigripes Knight
Figs. 21a, b, 44a, b, 67, 90; Map 19

Irbisia nigripes Knight, 1925a, pp. 94–95 (new species); 1925b, p. 182; 1968, p. 185. Downes, 1927, p. 12. Carvalho, 1959, p. 105. Harling et al., 1977, p. 35. Kelton, 1980, pp. 84–85, map 23.

Diagnosis. This species is unique among the species of the genus in possessing an entirely black pleural surface on most specimens. The pronotal disk is conspicuously flattened and the anterior angles of pronotum are very prominent in dorsal and lateral views. In addition to the previous characters, the structure of the sclerotized process of the vesica of the male will serve to distinguish *I. nigripes* from *I. serrata.* The process of *I. nigripes* is not preapically expanded nor does it possess a linear series of strong spicules. The basal carina of the vertex of *I. nigripes* is considerably more produced than on *I. serrata.*

Description. Macropterous male. Length 5.50–6.30, width 2.43–2.65, shining black, clothed with woolly sericeous white setae. HEAD: width across eyes 1.18–1.26, vertex 0.59–0.65, dorsal width of eye 0.28–0.31; triangular, smooth or slightly asperate; temporal area shining; median depression broadly shallow; basal carina acutely prominent in cross section, posteriorly arcuate mesad, declivous to level of vertex (declivate area asperate); eyes broadly joined to frons, posterior margin of head slightly anteriorly arcuate at junction of eye and frons in dorsal view, distance from tylus to ventral margin of eye 0.65–0.69, height of eye 0.45–0.50, maximum interocular width 0.88–0.39. ROSTRUM: length 1.70–1.89, black, just reaching apex of mesocoxae. ANTENNAE: black; I, length 0.65–0.74; II, 1.76–2.03; III, 0.88–1.05; IV, 1.03–1.21. PRONOTUM: length 1.00–1.13, anterior width 0.95–1.08, maximum width 1.83–2.00, trapezoidal, disk somewhat flattened, rugulopunctate, posterior margin broadly arcuate, lateral margins straight, rounded or broadly margined at junction with propleura, anterior angles very prominent in dorsal and lateral view, with explanate flange directed somewhat anteriorly; calli weakly developed, broadly confluent anteriorly, not reaching anterolateral margins of pronotum; pro-, meso-, metapleura and ostiolar peritreme entirely black except for narrow area bordering coxae; some specimens with extreme posterior border of ostiolar peritreme white. LEGS: black; coxae black. VESTITURE: dorsum covered with a mixture of recurved or recumbent sericeous white setae and suberect fulvous to fuscous setae, disk of pronotum, especially anterior angles and lateral margins, with prominent, conspicuous, erect fuscous setae; venter with sparse, thin fulvous setae.

Macropterous female. More robust than male, but similar in color, structure and vestiture. Length 5.60–6.40, width 2.65–2.90. HEAD: width across eyes 1.23–1.35, vertex 0.68–0.75, dorsal width of eye 0.26–0.33, distance from tylus to ventral margin of eye 0.65–0.76, height of eye 0.48–0.53, maximum interocular width 0.91–1.01. ROSTRUM: length 1.83–2.06, just attaining to barely surpassing mesocoxae. ANTENNAE: I, length 0.65–0.73; II, 1.63–1.90; III, 0.88–1.08; IV, 0.98–1.28. PRONOTUM: length 1.08–1.30, anterior width 1.03–1.18, maximum width 2.00–2.28.

Types. Male holotype. Troy Ida, 3-31; HOLOTYPE By H. H. Knight Irbisia nigripes [red]. Retained at Cornell University Collection, Ithaca, New York. I have examined 13 paratypes and the holotype; they are all conspecfic. The paratypes are deposited at CAS, CNC and USNM.

Taxonomic consideration. Male specimens from the northern portion of the range of *I. nigripes* have sclerotized processes with fewer and less prominent spines (the spines are not arranged in a linear series) as compared to the spines of the sclerotized processes of more southern specimens. The process of individuals from Wasco County, Oregon and Klickitat County, Washington typify the southern condition with a linear series of strong spicules. The single specimen from Crater Lake, Klamath County, Oregon has a process that closely resembles the northern specimens.

Remarks. Although the number of specimens on hand of *I. nigripes* are few, its distribution is similar to the northern and montane ranges of *I. elongata* and *I. fuscipubescens*. *I. nigripes* appears to be the northern counterpart of *I. shulli*. The latter is not known from Canada, whereas *I. nigripes* has a northern limit of 50° 15′ north latitude. Its range is bounded on the west by the Cascade Range where it occurs in western ponderosa pine and sagebrush steppe vegetational associations. Throughout the rest of its range both grassland and forest border situations provide suitable habitats; fescue-wheatgrass, foothill prairie (*Agropyron-Festuca-Stipa*), sagebrush steppe, western ponderosa pine and Douglas fir forests of the Rocky Mountain region of Idaho and Montana are the predominate vegetational associations. Host data are lacking, but adult specimens were collected from *Balsamorhiza* sp., *Ceanothus* sp., *Chrysothamnus* sp. and *Dactylus glomerata* L. Its elevational range is from 460 to 2130 m. (1500 to 7000 feet) and occurs from 22 March to 13 July.

Specimens examined. 167 specimens were examined from the following localities (Map 19). **CANADA:** ALBERTA: Crows Nest (CNC); Kananskis—Hwy. 25, Rds. 20 & 27 (CNC); Twin Butte (CNC); Waterton (CAS, CNC, UALB). BRITISH COLUMBIA: Cascade (CAS), Chase (CNC); Christina Lk. (UCB); Creston (UCB); 5 mi. W Creston—Hwy. 3, 49° 5′ 116° 37′ (UBC); 10 mi. E Falkland (CNC); Fife, & 5 mi. E (CNC); Grand Forks, & 9 mi. E (CNC); Rock Crk.,

& 3 mi. W (CNC); Trinity Valley (CNC); Vernon (CAS, CNC, UBC). **UNITED STATES:** IDAHO: *Bonner Co.,* 4 mi. S Elmira (UID); 2 & 7 mi. S Sandpoint (UID). *Kootenai Co.,* 4 mi. W Athol (UID); Coeur d'Alene (OSU). *Latah Co.,* Deary (UID); Julietta (BYU, SHF, UNSM); Laird Park (UID); Moscow Mt. (OSU); Troy (UID). MONTANA: *Lake Co.,* 10 mi. S Bigfork (MSU); east shore Flathead Lk. (MSU); "Lake Co." (MSU). *Missoula Co.,* Missoula (WSU). *Ravalli Co.,* Blodgtt Mt. (MSU); 15 mi. SE Hamilton (OSU); Montana Expt. Stn.—Florence (MSU). *Sanders Co.,* Camas Prairie (MSU). OREGON: *Hood River Co.,* Hood R. (USNM). *Klamath Co.,* Crater Lk. Nat. Pk. (USNM). *Wasco Co.,* 7 mi. N Simnasho (OSU). WASHINGTON: *Chelan Co.,* Leavenworth (OSU, WWU). *Klickitat Co.,* 2 mi. NW & 5 mi. NE Lyle (OSU); Satus Pass (KU); Trout Lk. (OSU). *Lincoln Co.,* 5 mi. SE Grand Coulee (OSU).

Irbisia oreas Bliven
Figs. 16a, b, 39, 62, 85; Map 6

Irbisia oreas Bliven, 1963, pp. 72–73 (new species).

Diagnosis. This species may be separated from other small species of the genus on the basis of a combination of these characters: lack of light spot on bases of cuneus (as in *I. cuneomaculata*); long erect fuscous or fulvous setae which are densely distributed throughout the dorsum (not present on *I. solani, I. sita* and *I. incomperta*); and densely distributed, long suberect testaceous or white setae on tibiae (longer and more erect than *I. setosa* Van Duzee). The right paramere of the male of *I. oreas* is diagnostic. It is elongate with a somewhat concealed small apical spine that gives the paramere a truncated appearance.

Description. Macropterous male. Length 3.83–4.75, width 1.65–1.90, shining black, densely clothed with a mixture of recurved, appressed, sericeous white setae and long erect fuscous to fulvous setae. HEAD: width across eyes 0.98–1.09, vertex 0.44–0.49, dorsal width of eye 0.26–0.30; triangular smooth or shagreened; tylus rounded in dorsal view; temporal areas indistinct and without vestiture; median depression absent; basal carina small, straight declivous to level of vertex or abruptly raised above the vertex; eyes broadly joined to frons, protruding laterally, posterior margin straight in dorsal view; distance from tylus to ventral margin of eye 0.43–0.49, height of eye 0.43–0.48, maximum interocular width 0.65–0.76; jugal-loral suture sometimes testaceous. ROSTRUM: length 1.33–1.53, black, fuscous medially, reaching apex of mesocoxae. ANTENNAE: black or fuscous; I, length 0.45–0.55; II, 1.13–1.48; III, 1.33–1.53; IV, 0.73–0.85. PRONOTUM: length 0.74–0.93, anterior width 0.70–0.83, maximum width 1.40–1.63; conical, broadly convex and slightly flattened, rugulopunctate, posteriolateral margins slightly arcuate, lateral margins concave, very broadly rounded at junction with propleura, anterior angles broadly rounded, indistinct in dorsal view, not sulcate in lateral view; calli not protruding above disk, without vestiture, asperate, broadly confluent anteriorly, not reaching anterolateral margin. LEGS: black or piceous; apices of coxae and trochanters fulvous; tibiae usually lighter shade of base color; tarsi black. VESTITURE: densely clothed with a mixture of recurved sericeous white setae, and long fuscous or fulvous setae; sericeous setae woolly on head and pronotum, appressed on hemelytra; long setae are erect on head, pronotum and scutellum, suberect on hemelytra; venter moderately covered with suberect long testaceous or white setae; legs densely covered with long suberect testaceous or white setae.

Macropterous female. More robust than male, otherwise not differing in structure, color and vestiture. Length 4.50–5.10, width 2.00–2.40. HEAD: width across eyes 1.10–1.16, vertex 0.51–0.55, dorsal width of eye 0.26–0.30, distance from tylus to ventral margin of eye 0.51–0.58, height of eye 0.33–0.35, maximum interocular width 0.77–0.83. ROSTRUM: length 1.54–1.68, attaining and sometimes surpassing apices of mesocoxae. ANTENNAE: I, length 0.47–0.55; II, 1.20–1.40; III, 0.60–0.85; IV, 0.80–0.95. PRONOTUM: length 0.90–1.00, anterior width 0.83–0.88, maximum width 1.65–1.83.

Type. Holotype female. Congress [Yavapai Co.], ARIZ, IV-6-58; HOLOTYPE ♀, *Irbisia oreas,* 1963 B. P. Bliven [red]; CAS type no. 13858. No other specimens were collected by Bliven. Retained at the California Academy of Sciences, San Francisco.

Remarks. The distribution of *I. oreas* includes the eastern and western boundaries of the Mojave Desert. The southwesternmost portion of the Rocky Mountain forest province in Washington County, Utah, and southern border of the Upper Gila Mountain forest province in Pinal and Yavapai Counties, Arizona are the eastern limits of the range. Within Arizona, specimens are found in a transition zone between oak-juniper woodland and mountain mahogany–oak scrub floristic association; in Utah juniper-pinyon woodland floristic associations are occupied.

Bliven (1963) predicted that *I. oreas* would be collected in extreme southeastern California; some specimens available to this study are from this area. Several floristic associations provide habitat for *I. oreas* in California. In the Sierran forest province of Kern County these associations are: California prairie, blue oak–digger pine forest and Joshua tree scrub. In the American desert province of Los Angeles and San Bernardino Counties Joshua tree scrub and Mojave creosote bush associations are occupied. Chaparral, coastal sagebrush, southern oak and juniper–pinyon forests are the associations within the range of *I. oreas* in the California chaparral province of Riverside and San Diego Counties.

Adult specimens have been collected from the following nongraminoid plants: *Ceanothus* sp., *Cercocarpus betuloides* Nutt. ex T. & G., *Chenopodium murale* L., *Keckiella* sp., *Larrea* sp., *Lotus scoparius* (Nutt. in T. & G.) Ottley, *Lycium* sp. nr. *panchii* Grey, *Plagiobothrys* sp., *Quercus agrifolia* Nee, *Q. chrysolepis* Liebm., *Salvia apiana* Jeps; *Simmondisa chinensis* (Link) C. K. Schneid [only the male plants], *Yucca brevifolia* Engelm. in Wats. and *Y. schidigera* Roezl ex Ortgies. The only grass record is *Festuca* sp. The period of occurrence ranges from 23 February to 23 May, and the altitudinal range is from 550 to 1580 m. (1800 to 5200 feet).

Specimens examined. 180 specimens were examined from the following localities (Map 6). **MEXICO:** BAJA CALIFORNIA NORTE: 3.4 & 6.3 mi. S El Condor (AMNH); 2 mi. W Las Encinas (UCB). **UNITED STATES:** ARIZONA: *Maricopa Co.,* Four Peaks Rd., mi. 6 (JTP); Vulture Mine Rd.—4 mi. S Wickenburg (AMNH). *Pinal Co.,* Apache Jct. (AMNH). *Yuma Co.,* Yuma (USNM). CALIFORNIA: *Kern Co.,* 20 mi. N Isabella Lk. (AMNH); Last Chance Cyn.—9 mi. N Ricardo (UCB); 2 mi. N Mojave (UALB); 3 mi. W Woffard Hts. (UCB). *Los Angeles Co.,* 3 mi. S Lancaster (OSU); 2 mi. S Palmdale (OSU). *Riverside Co.,* Lk. Mathews (UCR); Manifee Valley (hills on W end), 33° 39′ N 117° 13′ W (UCR); 2 mi. NE Moreno (UC); Murray Cyn.—Palm Spgs. (CNC); Palm Cyn.—Agua Caliente Indian Rsv. (CAB, CNC); 3.5 mi. S Palm Desert—0.8 mi. N jct. Deep Crk. & Horsethief Crk. (T7S R6E Sec. 6) (UCR); Palm Sprgs. (USNM); 2 mi. N Perris (UCD); Pinyon Flats—16 mi. SW Palm Desert (CAS, UCB); Railroad

Cyn.—4 mi. E Elsinore (UCB); 1 mi. SE & 4 mi. N Redec (UCB & AMNH); Riverside (UCR); 5 mi. S & 5.5 mi. SE Sage (UCB & UCR); 5.6 mi. S Sage on R3 (T7S R1E Sec. 32) (UCR); Snow Crk.—White Water (CNC); trail From Hwy. 74 (T7S R5E Sec. 1–6) (UCR); White Water (CNC); Wilson Valley Rd.—1 mi. N Hemet (OSU). *San Bernardino Co.,* Devil Cyn. (UCR): Granite Cove—Granite Mts.—15.8 mi. SW Kelson (UCD); Granite Mts.—3 mi. ESE Apple Valley (UCB); 4 mi. E Mentone (UCR); Yucaipa (UCD). *San Diego Co.,* 4 mi. E Campo (UCB); Jacumba (F&A, UCB). *Tulare Co.,* 2 mi. E Johnsondale (UCB). UTAH: *Washington Co.,* Dixie St. Pk. (USU).

Irbisia pacifica (Uhler)

Figs. 1, 3, 7a, 11a, b, 34, 57, 80; Map 3

Rhopalotomus pacificus: Uhler, 1871, p. 471 (name not available).
Rhopalotomus pacificus Uhler, 1872, p. 415 (new species); 1875, p. 319.
Capsus pacificus: Uhler, 1886, p. 19 (new combination). Atkinson, 1890, p. 105.
Thyrillus pacificus: Uhler 1894, p. 267 (new combination). Gillette and Baker, 1895, p. 39. Essig, 1915, p. 215; 1927, pp. 361–362. Van Duzee, 1916b, p. 38; 1917a, p. 325; 1917b, p. 264. Downes, 1927, p. 12. Slater, 1950, pp. 36, 71, pl. 2, figs. 20, 21, 75, pl. 4, fig. 9. Knowlton, 1951, pp. 74–75.
Irbisia pacificus: Van Duzee, 1914, p. 24 (new combination). Carvalho, 1959, p. 105. Kelton, 1959, p. 18, fig. 28.
Irbisia pacifica: Knight, 1968, p. 185. Haws, 1978, p. 100, fig. 33.

Diagnosis. I. pacifica is separated from all other species in the genus by its: strongly pedunculate eyes, which project above the basal carina, elongated head structure (the range of the distance between tylus and ventral margin of eye to height of eye ratio is, for males 1:0.33 to 1:0.58, and for females 1:0.37 to 1:0.49; the range for *I. elongata* is males 1:0.48 to 1:0.53 and females 1:0.48 to 1:0.50), very long antenna II which is much longer than the width of pronotum, wide collar and somewhat fine, transversely rugulose pronotal surface.

Description. Macropterous male. Length 5.75–8.20, width 2.20–3.10, black, shagreened, densely clothed with appressed, recurved, white sericeous setae. HEAD: width across eyes 1.28–1.54, vertex 0.64–0.79, dorsal width of eye 0.30–0.38; triangular, but very elongated below eyes, shagreened and asperate; temporal areas asperate and glabrous; median depression indistinct beneath vestiture, a short longitudinal furrow; basal carina very broadly rounded and declivous, barely projecting above collum, arcuate posteriorly; eyes pedunculate, projecting above basal carina in lateral view; posterior margin of head straight in dorsal view; distance from tylus to ventral margin of eye 0.85–1.13, height of eye 0.41–0.50, maximum interocular width 0.88–1.10; apical half of clypeus and clypeal-jugal-loral sutures sometimes fulvous or rufescent; antennal sockets below ventral margin of eyes. ROSTRUM: length 2.33–2.75, fulvous or rufescent, apex fuscous or black, reaching apices of mesocoxae, sometimes attaining apices of metacoxae. ANTENNAE: black; I, length 0.79–1.13, sometimes extensively rufescent; II, 2.20–3.35; III, 1.21–1.50; IV, 1.20–1.55. PRONOTUM: length 0.91–1.25, anterior width 0.93–1.18, posterior width 1.50–2.10, subconical, broadly convex, somewhat flattened, transversely rugulose, posterior margin straight, lateral margins slightly to mostly concave broadly rounded in dorsal view, slightly to obviously sulcate dorsad of coxal cleft in lateral view; collar wide; calli convex, rugulose, confluent anteriorly, broadly reaching anteriolateral margin of pronotum, episterum sometimes with a fulvous spot. LEGS: testaceous, fulvous or in some specimens rufescent; coxae fuscous preapically; trochanter with fuscous spot; femora variously streaked and spotted with fuscous; apices and bases of tibiae and tarsi black. VESTITURE: dorsum densely covered with appressed, recurved, white sericeous setae; venter moderately covered with short white setae, longer on midline.

Macropterous female. Similar in structure, color and vestiture, but with robust stature; hemelytra strongly arcuate laterally. Length 6.20–8.20, width 2.63–3.20. HEAD: width across eyes 1.38–1.56, vertex 0.70–0.85, dorsal width of eye 0.29–0.34, distance from tylus to ventral margin of eye 0.93–1.15, height of eye 0.41–0.50, maximum interocular width 0.98–1.18. ROSTRUM: length 2.30–2.85 reaching apices of mesocoxae, sometimes attaining apices of metacoxae. ANTENNAE: I, length 0.80–1.08; II, 2.50–3.13; III, 1.3–1.58; IV, 1.28–1.55. PRONOTUM: length 0.95–1.29, anterior width 0.98–1.28, maximum width 1.69–2.06.

Types. Originally described by Uhler from a series. The only specimen of this series is a male with these label data: type M, P. R. Uhler Collection; *Thyrillus pacificus*, Uhler, Snake Riv., Idaho; *Thyrillus pacificus,* Uhler, Snake Riv., Det. Uhler.; USNM type no. 100950. Retained at the United States National Museum, Washington, D.C. I have examined this specimen (legs and antennal segment four are absent) and as no other specimens of the syntype series has been located I have designated it as the lectotype of *Rhopalotomus pacificus.*

Taxonomic consideration. Little variation in characters used to separate this species from other species in the genus was noticed in this study. Both male and female genitalic structures were uniform regardless of the collection locality of the specimens.

Remarks. Irbisia pacifica has the widest distributional range of any species in the genus. It occurs at low to moderate elevations. The known northern limit of the distribution is 50° 15′ north latitude at Vernon, British Columbia, and the known southern limit is 32° 45′ north latitude at Lakeside, San Diego County, California. The easternmost specimen was collected from Laramie County, Wyoming; this species is extensively distributed in California. The majority of the distributional range is occupied by the sagebrush steppe vegetational association. In British Columbia, Idaho, Oregon and Washington the Palouse grassland associations (fescue-wheatgrass and wheatgrass-bluegrass) provide the northernmost habitat. The grassland associations of the eastern portion of the range in Montana and Wyoming are foothills prairie (*Agropyron-Festuca-Stipa*) and grama-needlegrass-wheatgrass respectively. Within the Rocky Mountain forest ecoregion of Colorado and Utah, the juniper–pinyon woodland and mountain mahogany–oak scrub vegetational associations provide *I. pacifica* habitats at slightly higher elevations. Oregon, in addition to the previous habitats, possesses ponderosa shrub forest on the east side of the Cascade Range and oak woodlands on the west side in which this species is found. Two apparently isolated populations of *I. pacifica* are known from the Willamette Valley of this state. In California, excluding the Mojave Desert, all the ecoregions have yielded specimens of this species of *Irbisia.* The vegetational associations occupied are: northern yellow pine forest, yellow pine–shrub forest, Oregon oak forest, mixed evergreen forest, blue oak–digger pine forest, southern oak forest, chaparral, valley oak, savanna and California prairie.

I. pacifica has been collected in adult and immature stages on these grass hosts: *Agropyron cristatum* (L.) Gaertn., *A. desertorm* (Fisch.) Schult., *A. repens* (L.) Beauv., *A. smithii* Rydb., *A. spicatum* (Pursh) Scribn. & Sm., *A. trichophorum* (Link) Richt., *Avena* sp., *Bromus mollis* L., *Bromus* sp., *Elymus cinereus* Scribn. & Merr., *E. condensatus* Presl., *E. triticoides* Buckl., *Festuca rubra* L., and *Hordeum* sp. Adult specimens have also been taken from these non-graminoid plants: *Amsinckia* sp., *Cirsium cymosum* (Greene) J. T. Howell, *Medicago sativa* L., *Ranunculus* sp., *Rhamnus* sp., *Rubus* sp. and *Wyethia* sp. The altitudinal range is from 168 to 2377 m. (550 to 11,000 feet) levation. The dates of occurrence are from 14 March to 11 August.

A single male specimen is known from Carnation, King County, Washington. I have not collected material from this area, but would expect that the specimen (barring a labeling error) was taken from a roadside, hedgerow or south facing hill situation. This species is often pestiferous on forage grasses in the Intermountain states (Knowlton, 1951; Haws, 1978).

Specimens examined. 3,512 specimens were examined from the following localities (Map 3). **CANADA:** BRITISH COLUMBIA: 5 mi. E Christina Lk. (UBC); Grand Forks (CNC); Hedley, & 17 mi. W (UBD & CNC); Okanagan Falls (CNC); Oliver & Meyer Flat, Vaseaux L., White R. (CNC, USNM); Osoyoos (CNC); Princeton (UBC); Summerland (CNC); Vernon (CAS, UBC). **UNITED STATES:** CALIFORNIA: *Alameda Co.* (2 localities). *Alpine Co.* (2). *Amador Co.* (2). *Butte Co.* (4). *Calveras Co.,* Angels Cmp. (CAS). *Colusa Co.,* Ramsey Cyn. (UCD). *Contra Costa Co.* (6). *El Dorado Co.* (5). *Fresno Co.* (4). *Inyo Co.,* 7 mi. N Parcher's Cmp. (CAS). *Kern Co.* (7). *Lake Co.* (1). *Lassen Co.* (8). *Los Angeles Co.* (6). *Madera Co.* (4). *Mariposa Co.* Mariposa (UID). *Mendocino Co.* (7). *Modoc Co.* (8). *Mono Co.* (4). *Monterey Co.* (7). *Napa Co.* (6). *Nevada Co.* (3). *Orange Co.* (2). *Placer Co.* (6). *Plumas Co.* (5). *Riverside Co.* (9). *Sacramento Co.* (5). *San Benito Co.* (5). *San Bernardino* Co. (2). *San Diego Co.* (14). *San Francisco Co.,* Laguno Puerco (UCB). *San Joaquin Co.* (3). *S.L.O. Co.* (6). *Sta. Barbara Co.* (2). *Sta. Clara Co.* (5). *Shasta Co.* (4). *Sierra Co.* (3). *Siskiyou Co.* (5). *Solano Co.* (2). *Sonomo Co.* (3). *Stanislaus Co.* (2). *Tehema Co.* (2). *Trinity Co.* (6). *Tulare Co.* (5). *Tuolumne Co.* (2). *Ventura Co.* (2). *Yolo Co.* (6). *Yuba Co.* (1). Most specimens are retained at CAS, F&A, OSU, UCB, UCD & UCR. COLORADO: *Chaffee Co.,* Buena Vista (CNC). *Eagle Co.,* State Bridge (CNC). *Mesa Co.,* De Beque Cyn. (JTP). *Moffat Co.,* Lay (CU); Maybell (KU). IDAHO: *Ada Co.* (5). *Adams Co.* (1). *Camas Co.* (1). *Canyon Co.* (1). *Caribou Co.* (1). *Cassia Co.* (6). *Clearwater Co.* (1). *Elmore Co.* (2). *Franklin Co.* (4). *Fremont Co.* (1). *Idaho Co.* (1). *Jerome Co.* (1). *Latah Co.* (7). *Lincoln Co.* (3). *Madison Co.* (1). *Nez Perce Co.* (13). *Oneida Co.* (16). *Owyhee Co.* (4). *Payette Co.* (1). *Twin Falls Co.* (5). *Washington Co.* (4). Most specimens are retained at UID, USU & WSU. MONTANA: *Gallatin Co.,* Bozeman (MSU). *Jefferson Co.,* "Jefferson Co." (MSU). *Madison Co.,* Montana Expt. Stn. (MSU, USNM). *Missoula Co.,* Missoula (CAS); Montana Expt. Stn. (MSU). *Park Co.,* Livingston; Park Co. (USNM). *Sweet Grass Co.,* Big Timber (MSU). *Treasure Co.,* Hysham (MSU). *Yellowstone Co.,* Huntley (MSU). Beaver Crk. (KU). "Montana 46a" (USNM). NEVADA: *Carson City,* Carson City (CAS); "Ormsby Co." (CAS). *Douglas Co.,* W Minden—Hwy. 19 (UCR). *Elko Co.,* Carlin & 5, 10 mi. W (KU, UCD); Lamorille Cyn. (UCD); Wells (USU). *Eureka Co.,* Dumphy (UCD); Humboldt R.—23 mi. W Carlin (UCB); Red House Rch. (UCD). *Humboldt Co.,* Paradise Valley (UCD). *Lander Co.,* Austin (KU). *Washoe Co.,* Reno (USNM); Sparks (CAS); Verdi, & 6 mi. E (UCB, UCD, UCR). *White Pine Co.,* Conners Pass (UCD); Ely, & 10 mi. S (KU & UCD); 17.5 mi. N Hwy. 50—Steptoe Crk. Rd. (OSU). Nev. (USNM). OREGON: *Baker Co.* (3). *Benton Co.,* Corvallis—Willamette Pk. (OSU). *Deschutes Co.* (3). *Grant Co.* (4). *Harney Co.* (7). *Hood River Co.,* Viente St. Pk. (OSU). *Jackson Co.* (5). *Jefferson Co.,* 2.5 mi. NW Warm Spgs. (OSU).

Josephine Co., 7 mi. S Grants Pass (OSU). *Klamath Co.* (13). *Lake Co.* (10). *Linn Co.,* Lost Prairie Cmpgd. (OSU). *Malheur Co.* (7). *Sherman Co.* (4). *Umatilla Co.* (3). *Union Co.* (3). *Union Co.* (8). *Wallowa Co.* (4). *Wasco Co.* (3). *Wheeler Co.* (3). *Yamhill Co.,* 6 mi. E McMinnville—Willamette R. (OSU). Most specimens are retained at OSU. UTAH: *Beaver Co.* (1). *Box Elder Co.* (14). *Cache Co.* (18). *Davis Co.* (3). *Iron Co.* (2). *Juab Co.* (2). *Kane Co.,* Long Valley (USNM, USU). *Millard Co.* (1). *Rich Co.* (1). *Salt Lake Co.* (2). *Sanpete Co.* (6). *Sevier Co.* (2). *Tooele Co.* (4). *Uintah Co.* (1). *Utah Co.* (2). *Wasatch Co.* (1). *Washington Co.,* Pinto (USNM). *Weber Co.* (3). Most specimens are retained at USU. WASHINGTON: *Adams Co.* (1). *Asotin Co.* (3). *Benton Co.* (2). *Garfield Co.* (2). *Grant Co.* (3). *King Co.,* Carnation (OSU). *Kittitas Co.* (1). *Klickitat Co.* (1). *Lincoln Co.* (1). *Okanogan Co.* (2). *Skamania Co.* (1). *Spokane Co.* (2). *Walla Walla Co.* (4). *Whitman Co.* (7). *Yakima Co.* (5). Most of the specimens are retained at WSU. WYOMING: *Albany Co.,* 23 mi. NE Bosler (KU). *Carbon Co.,* Medicine Bow Mts. (USNM). *Laramie Co.,* 40 mi. NE Laramie (KU). *Park Co.,* 27 mi. W Cody (KU). *Platte Co.,* Wheatland (UWY).

Irbisia panda Bliven

Figs. 30a, b, 53, 76, 99; Map 15

Irbisia panda Bliven, 1963, pp. 77–78, 86, pl. 8, figs. 4, 4a (new species).

Diagnosis. This species can be separated from other species of *Irbisia* by these characters: impunctate pronotum; polished, shining black dorsum; light markings on the ventral surface; sparse and short fuscous vestiture; relatively narrow vertex; black antennae; mostly rufescent femora. *I. panda* and *I. limata* are superficially similar but examination of the left paramere and vesica of the males reveals that they belong in different species groups. In the former, the left paramere is very broadly curved and the length of the shaft is small; the latter is more acutely curved with a longer shaft. The sclerotized process of the vesica of *I. panda* is small, deflected to the left of the trunk of the vesica, not expanded but preapically constricted, with the distal portion sparsely covered with small spines. The process in *I. limata* is larger, expanded on the left surface, not preapically constricted, and moderately covered with rows of spines (which decrease in height basad). In addition the base of the clypeus of *I. panda* is considerably more convex (projecting above the frons) than in *I. limata.*

Description. Macropterous male. Length 4.50–5.75, width 2.15–2.35, polished, shining black, sparsely covered with short, fine recumbent fulvous or fuscous setae. HEAD: width across eyes 1.04–1.23, vertex 0.43–0.50, dorsal width of eye 0.26–0.31; triangular, polished; temporal areas indistinct; median depression a single, slightly depressed line or lacking; basal carina very small, broadly rounded, in cross section sometimes higher than collum, declivous to level of vertex, slightly posteriorly arcuate mesad; eyes broadly joined to frons, straight in posterior view; distance from tylus to ventral margin of eye 0.55–0.63, height of eye 0.48–0.55, maximum interocular width 0.70–0.81; jugal-loral junction testaceous to variable degree, clypeus quite convex in lateral view, protruding above curvature of frons. ROSTRUM: length 1.83–2.05, piceous to fuscous, reaching apices of mesocoxae, sometimes surpassing apices of metacoxae. ANTENNAE: fuscous to black; I, length 0.53–0.65, apex usually testaceous; II, 1.50–1.79, base sometimes testaceous; III, 0.94–1.18; IV, 0.79–1.03. PRONOTUM: length 1.03–1.20, anterior width 0.85–1.00, maximum width 1.70–2.00; conical, slightly convex but with a flattened appearance, neither distinctly punctate nor rugulose, posterior margin arcuate, posterolateral margins greatly rounded, lateral margins straight, rounded at junction with propleura; anterior angles rounded, quite indistinct in dorsal view, not sulcate in lateral view; calli convex, polished, broadly confluent anteriorly, reaching anterolateral margins of pronotum, with foveate depression posteromedially of anterior angles; ventral third of propleura, prosternum narrowly bordering coxae and attaining front margins, basalar plate and posterior margin of epimeron ivory. LEGS: fuscous or piceous; coxae testaceous apically; procoxae testaceous basally; femora rufescent medially, testaceous apically; tibiae testaceous, piceous on bases and apices. VESTITURE: dorsum sparsely covered with short, fine fulvous to fuscous setae, recumbent on hemelytra, erect and coarser on head and lateral margins of pronotum; venter sparsely covered with suberect fulvous setae.

Macropterous female. Stouter than male but similar in structure, color and vestiture. Length 5.10–6.15, width 2.40–2.75. HEAD: width across eyes 1.14–1.25, vertex 0.50–0.56, dorsal width of eye 0.63–0.68, height of eye 0.50–0.54, maximum interocular width 0.78–0.88. ROSTRUM: length 1.98–2.15, reaching bases of metacoxae. ANTENNAE: I, length 0.60–0.70; II, 1.59–1.88; III, 1.00–1.13; IV, 0.81–0.95. PRONOTUM: length 1.14–1.32, anterior width 0.90–1.08, maximum width 1.85–2.18.

Types. Male holotype. Rumsey, [Yolo Co.], Cal., V.15.57; HOLOTYPE ♂, Irbisia panda, 1963 B. P. Bliven [red]; CAS type no. 13860. I have examined the holotype and all twenty-four conspecific paratypes. These specimens are retained at the California Academy of Sciences, San Francisco.

Remarks. This species occupies the same vegetational association and provinces as *I. limata.* Both species are sympatric from Calaveras County south, but the distribution of *I. panda* extends into Shasta County, the northern boundary of the blue oak–digger pine forest. *I. panda* is also much more prevalent within the California chapparal province than *I. limata.* Very few grass host records exist (*Avena* sp., *Bromus* sp. and *Vulpia* sp.), perhaps indicating a diminished reliance on graminoids. Adult specimens were collected from the following plants: *Achillea* sp., *Amsinckia* sp., Asteraceae, *Baccharis glutinosa* Pers. *Baeria* sp., *Brassica* sp., *Brodiaea laxa* (Benth. Wats.), *Calothortus* sp., *Chaenactis* sp., *Clarkia Williamsonii* (Dur. & Hilg.) Lewis & Lewis, *Cryptantha muricata* (H. & A.) Nels. & Macbr., *Delphinium* sp., *Eriodictyon californicum* (H. & A.) Torr., *Eriophyllum confertiflorum* (DC.) Gray, *Fremontia calfornica* Torr., Poaceae, *Gilia capitata* Sims, *G. tricolor* Benth., *Lavia* sp., *Lupinus densiflorus* Benth., *L. subvexus* C. P. Sm. and *Plagiobothrys* sp. Adults occur from 240 to 1220 m. (800 to 4000 feet) elevation and from 24 March to 30 May.

Specimens examined. 393 specimens were examined from the following localities (Map 15). **UNITED STATES:** CALIFORNIA: *Amador Co.,* Plymouth (F&A). *Butte Co.,* 5 mi. NW Oroville (UCB); Yankee Hill (UCB). *Calaveras Co.,* Modelumne Hill (INHS, UCB); 4 mi. S Railway Flat (UCB). *Colusa Co.,* Rumsey Cyn. (UCD); Williams (UCD). *Contra Costa Co.,* Mt. Diablo (UCB); Russelman Pk. (UCB). *El Dorado Co.,* Greenwood (UCB); Nashville (UCD); nr. Rescue (UCD); Riverton (UCB); Shingle (UCB); 6 mi. NW Shingle Spgs. (LACM). *Fresno Co.,* Coalinga, & 12 mi. W (CAS & UCB); Dunlap (LACM). *Kern Co.,* Hobo Cmp.—Kern River (UCB); Lebec (CAS); Miracle Spgs. (UCB); Tejon Pass (UCB); 1 mi. E Woody (UCB). *Lake Co.,* Clearlake Oaks, & 10 mi. E (F&A, UCD & UCB); N Frk. Cache Crk.—Hwy. 20

(UCD). *Madera Co.,* Coarsegold (UCB, UID); Oakhurst (UCB); Raymond (UCB); San Joaquin Expt. Rng. (UCB). *Mariposa Co.,* El Portal (F&A, UCB); 1.9 mi. W Mt. Mullion (UCB). *Monterey Co.,* 5 mi. NE Arroyo Seco Grd. Stn. (UCB); Horse Bridge—1.5 mi. SW Arroyo Seco Grd. Stn. (UCB). *Napa Co.,* 4 mi. NW Benyessa (UCD); 10 mi. S & 20 mi. W Monticello Dam (UCB); Samuel Spgs. (UCD). *Nevada Co.,* Grass Valley (CAS); Nevada City. *Placer Co.,* Auburn & 10 mi. E (UCD & UCB); 5 mi. W Foresthill (UCD). *Riverside Co.,* Riverside (UCD). *Sacramento Co.,* Folsom (F&A). *San Benito Co.,* Limekiln Cyn.—SW Paicines (UCB); W entr. Pinnacles Nat. Mon. (OSU). *San Joaquin Co.,* Lone Tree Cyn. (F&A). *Shasta Co.,* Redding (WSU). *Solano Co.,* nr. Dozier—11 mi. S Dixon (UCD); 8 mi. W Winters (UCD). *Sonoma Co.,* Mark West Spgs. (CAS). *S.L.O. Co.,* Adelaida—15 mi. W Paso Robles (OSU); La Panza Cmp.—12 mi. NE Pozo (UCB, UCR); Nacimiento Dam (UCB). *Sta. Barbara Co.,* Figueroa Mt. (LACM). *Stanislaus Co.,* Del Puerto Cyn.—Frank Raines Pk. (CAS, UCB, UCD). *Sutter Co.,* Maryville Butte (CAS, UCB). *Tehema Co.,* 21 mi. NW Red Bluff—rt. 36 (OSU). *Tulare Co.,* Ash Mt. H.Q. (AMNH, UCB); 4 mi. N Kaweah (UCB); 10.3 mi. N & Lemoncove (AMNH & CAS, UCB); 3 mi. NE Springville (UCR); 4.5 mi. S & 8 mi. NE Three Rivers (UCR, USU). *Tuolumne Co.,* Buck Mdws. (USNM); Jamestown (UCB); N. Frk. Tuolumne River—3 mi. NE Tuolumne (CAS). *Yolo Co.,* Cache Crk. Cyn. (UCD); Putah Cyn. (UCD); 2 mi. NW Rumsey (UCB).

Irbisia sericans (Stål)
Figs. 7c, 12a, b, 35, 58, 81; Map 10

Leptomerocoris sericans Stål, 1858, p. 188 (new species). Walker, 1873, p. 144.

Irbisia sericans: Reuter, 1875b, p. 548 (new combination); 1879a, p. 58; 1896, pp. 12–13, pl. 1, figs. 4a, 4b. Bergroth, 1885 p. 270. Sahlberg, 1885, pp. 68, 70. Atkinson, 1890, p. 125. Ashmead, 1898, p. 341 (incorrectly cited as McAtee, 1899 in Carvalho, 1959). Heidemann, 1900, p. 504. Breddin, 1902, p. 540. Kirkaldy, 1906, p. 142. Oshanin, 1910, p. 760. Van Duzee, 1916b, p. 38; 1917a, p. 325; 1921a, pp. 145, 146, 151; 1921b, p. 193. Knight, 1921, p. 110. McAtee, 1923, p. 145. Essig, 1926, p. 361. Kiritshenko, 1926, p. 16, pl. 1, fig. 2. Downes, 1927, p. 12. Lindberg, 1927, p. 22. Slater, 1950, pp. 36, 71, pl. 2, figs. 16, 17, p. 75, pl. 4, fig. 7. Carvalho, 1952, p. 89; 1959, pp. 105–106. Kelton, 1959, pp. 18, 60, figs. 27a–c. McKendrick and Bleicher, 1980, pp. 15–18, figs. 1–4.

Diagnosis. I. sericans, I. californica and *I. sita* can be separated from the remainder of the species of *Irbisia* on the basis of the structure of the male genitalia. These species are distinguished by the left paramere which is large, with a prominent sensory lobe which projects above the surface of the arm, abruptly angled, without tubercles on the outer surface, with a long preapically constricted shaft, and abruptly truncated apex. *I. sericans* is allopatric with the other species, occurring as far south as Eugene, Lane County, Oregon. *I. sericans* can be separated from the allied species by its dull bronze luster, trapezoidal pronotum, with straight lateral margins, and transversely rugose disk; black femora; densely distributed, shining, woolly, recurved vestiture; series of minute spicules on the sclerotized process of the male vesica.

Description—large form. Macropterous male. Length 5.85–6.50, width 2.40–2.60, dull black with shagreened luster, covered with shining gold, pale yellow or white setae. HEAD: length 0.63–0.70, width across eyes 1.23–1.41, vertex 0.55–0.68, dorsal width of eye 0.38; shagreened, impunctate; basal carina moderately developed, narrowly rounded in cross section, and slightly posteriorly arcuate mesad; temporal areas distinct, glabrous, with transverse sulcus on posterior margin; distance from tylus to ventral margin of eye 0.68–0.74, height of eye 0.54, interocular width maximum 0.88–0.95. ROSTRUM: length 2.09–2.23, black, reaching beyond apices of mesocoxae approaching but not attaining metacoxae. ANTENNAE: black; I, length 0.73–0.93; II, 1.85–2.23; III, 1.08–1.40; IV, 1.38–1.50. PRONOTUM: length 0.93–1.15; anterior width 0.93–1.08; maximum width 1.73–1.96; disk strongly convex, transversely rugose without distinct punctures, posterior margin broadly concave medially, lateral margin broadly concave in dorsal view, rounded at junction with propleura; calli slightly confluent anteriorly, asperate; anterior angles not greatly produced, but evident in dorsal and lateral view. VESTITURE: with densely distributed suberect, fine golden setae; setae mostly woolly on pronotal disk; venter with shining golden setae. LEGS: black; tibiae fulvous with bases and apices black.

Brachypterous female. More robust than male, but very similar in color, structure and vestiture. Length 5.20–6.20, width 2.60–3.15. HEAD: length 0.63–0.88, width across eyes 1.33–1.53, vertex 0.65–0.73, dorsal width of eye 0.39, distance from tylus to ventral margin of eye 0.75–0.88, height of eye 0.51–0.60; maximum interocular width 0.95–1.05. ROSTRUM: length 2.20–2.41, fulvous, barely reaching apices of metacoxae. ANTENNAE: I, 0.70–0.93; II, 1.80–2.40; III, 1.05–1.53; IV, 1.30–1.80. PRONOTUM: length 0.90–1.11, anterior width 1.05–1.23, maximum width 1.73–1.00, membrane reduced, extending very slightly beyond cuneus, cells developed, apex of abdomen exposed.

Description—small form. Brachypterous male. Measurements are less than or equal to the diminutive values of the male large form, but very similar in color, structure and vestiture. Length 4.70–5.00, width 2.20–2.30. HEAD: length 0.64–0.70, width across eyes 1.19–1.28, vertex 0.55–0.58, dorsal width of eye 0.34, distance from tylus to ventral margin of eye 0.63–0.68, height of eye 0.50, maximum interocular width 0.85. ROSTRUM: length 1.95–2.05, black, barely reaching apices of metacoxae. ANTENNAE: I, 0.63–0.70; II, 1.65–1.78; III, 0.90–0.93; IV, 0.95. PRONOTUM: length 0.83–0.88, anterior width 0.88, maximum width 1.51. Membrane reduced, extending slightly beyond cuneus, cells developed, apex of abdomen exposed.

Brachypterous female. Measurements are less than or equal to the diminutive values of the female of the large form, but very similar in color, structure and vestiture. Length 4.80–5.55, width 2.43–2.63. HEAD: length 0.60–0.70, width across eyes 1.25–1.28, vertex 0.60–0.68, dorsal width of eye 0.30–0.35; distance from tylus to ventral margin of eye 0.70, height of eye 0.50–0.53, maximum interocular width 0.93–0.95. ROSTRUM: length 1.98–2.18, infuscated fulvous, reaching or surpassing apices of metacoxae. ANTENNAE: I, 0.65; II, 1.60–1.63; III, 0.85–0.88; IV, 1.00 PRONOTUM: length 0.80–0.91; anterior width 0.95, maximum width 1.63–1.65.

Types. This species was described from a pair of specimens from Sitka, on Baranof Island, Alaska. These are specimens of the large form. I have not examined the holotype but have before me a pair of topotypic specimens collected during the Harriman Alaska Expedition of 1899 by T. Kincaid. These specimens are retained in the collection of the United States National Museum, Washington, D.C. The Stål types are likely to be in the collection of the Naturhistoriska Riksmuseet, Stockholm, Sweden.

Remarks. The combined distribution of both forms of *I. sericans* is strictly humid coastal Vancouveran. The Kamachatka Peninsula and Commander Islands of the

Soviet Union delimit the western boundary of this species (and the genus). Hood River and Eugene, Oregon are the eastern and southern boundary of the known distribution respectively. Adult and immature specimens were collected from these grass hosts: *Bromus carinatus* H. & A., *B. mollis* L., *B. rigidus* Roth, *Calamagrostis canadensis* (Michr.) Beauv., *Festuca arundinacea* Schreb., *F. rubra* L., *Holcus lanatus* L. and *Poa pratensis* L. Specimens were collected on *Angelica* sp. and *Rubus* sp.

The only qualitative study concerning utilization of grasses by this genus focuses on *I. sericans* and *C. canadensis* (McKendrick and Bleicher, 1980). Preliminary results indicate that the individual grass blades with the greatest feeding damage were those blades with low levels of insoluble silica. Childs (1914) and Essig (1915) reported the occurrence of this species from Santa Clara County, California. I have examined these specimens and re-identified them as *I. californica.* Collection dates for specimens from the westernmost portion of the range of the small form are from 11 July to 3 September. Large form specimens from Oregon were collected from 29 April to 21 June. Specimens were collected within an altitudinal range from sea level to 150 m. (500 feet). The lack of specimens of this species (and all other *Irbisia* species) from western Washington (particularly the Olympic penisula) probably indicates a lack of collecting effort rather than a lack of appropriate habitat.

I. sericans has a puzzling distribution. Within the material from the Canadian National Collection are four specimens of the small form from Quebec, Gatineau Park—Harrington Lake. The specimens were collected on 28 May 1958. The habitat surrounding the collecting site is coniferous and at an elevation of approximtely 152 m. (500 feet). Researchers at the Canadian National Collection, Ottawa who were on that particular expedition relate that the locality, at the time of collection, was a recently abandoned mink farm with a small clearing around it. Thirty years to the day, with the permission of the Royal Canadian Mounted Police (the adjoining property is the summer weekend residency for the Canadian Prime minister) L. A. Kelton and I intensively swept the grasses on the now overgrown plot and did not find any *I. sericans*; specimens of Stenodemini were abundant.

The period of occurrence, vegetational association and elevation appears similar to the conditions encountered in the western and main distribution of this species. There are no known intervening locality records between Quebec and the Pacific Northwest. If the collection record is accurate, the population at Harrington Lake is disjunct from the nearest known locality by 3,800 km. (2,900 miles). A recent introduction would explain the disjunction, as Gatineau Park is adjacent to Ottawa, Ontario. However, the brachypterous form of *I. sericans* is most prevalent on the Aleutian Peninsula and Islands which make an introduction a suspect scenario. Additional collection records may reveal that the distribution of this species is transcontinental at northern latitudes.

Specimens examined. 677 specimens of the large form were examined from the following localities (Map 10). **CANADA:** BRITISH COLUMBIA: Cowichnan Bay (CNC); Hevenor Inlet—Pitt Is. (UBC); Kelsey Bay—Vancouver Is. (UBC); Miracle Beach—nr. Oyster R. (CNC); Prince Rupert (AMNH, UBC) & Kaien (UBC); 0.7 mi. S Sayward—Vancouver Is. (OSU); Sugar Lk.—22 mi. SW Ocean Falls (UCD); Queen Charlotte Is.—Anthony Is., Burnaby Is., Graham Is. [Jungle Beach (UBC), Massett (CNC, UBC), Tlell (CNC)], House Is., Kunghit Is., Louis Is., Moresby Is. [Sandpit (AMNH), Slim Inlet (UBC)] all UBC; Tofino (UBC); Ucluelet (CNC); Vancouver (CAS, CU, USNM). **UNITED STATES:** ALASKA: Anton Larsen Bay—Kodiak

Is. (USNM); Atica Is. (CAS); Belkofski (USNM); Douglas (USNM); Dutch Harbor (CAS, USNM); Eagle River (USNM); Edna Bay—Dall Is. (CAS); Fox Point (USNM); Girdwook (USNM); Glacier River—Unalaska Is. (CAS); 6 mi. NW Granite Crk. Cmpgd.—Kenai Pen. (KU); Homer (OSU); Iliuliuk—Unalaska Is. (USNM); Johnson Pass—Kenai Pen. (KU); Juneau & 11 mi. N (CAS, USNM & OSU); Katmai (TA&M, USNM); Ketchikan (UBC, UCD); King Salmon—Naknek R. (CNC); Kodiak (USNM); Kukak Bay (USNM); Lk. Karluk (USNM); Little Sitkin (USNM); McNeil River Cove & Moose Pass—Kenai Pen. (OSU & CNC); Naknek (CNC); Nazan Bay—Atka Is. (CAS, F&A); Nunivak Is. (USNM); Ohison Mt. Rd.—Homer (USDA); Olga Bay—Kodiak Is. (OSU); Seward (CAS, CNC); Sitka (UBC, USNM); Skilak Lk.—Kenai Pen. (CNC); Thorne Bay & 20 mi. W—P.O.W. Is. (OSU); Trap Bay—nr. Tenakee Inlet (Chkhagof Is.) (OSU); Valdez (USNM); Virgins Bay (USNM); Wrangell (CAS, USNM). OREGON: *Benton Co.*, Corvallis (CAS, OSU, TA&M, UBC, USNM); Findley Nat. Wldf. Rfg. (OSU); Mary's Peak (OSU); Mary's River (OSU); McDonald St. For. (OSU); Monroe (OSDA); 4 mi. NW Philomath (OSU). *Clackamas Co.*, Barton (AMNH); 3 mi. SE Milwaukie (OSU). *Hood River Co.*, Hood River (CU, USNM). *Lane Co.*, Good Pasture—Eugene (OSDA, OSU). *Lincoln Co.*, Silez (USNM). *Linn Co.*, Shedd (USNM). *Multnomah Co.*, Sauvie Is. (OSU). *Siuslaw Co.*, 10 mi. W Alsea (USNM). *Tillamook Co.*, 0.1 mi. N Rockway (OSU). *Washington Co.*, Dilley (USNM). *Yamhill Co.*, McMinnville (OSU); Muddy Valley (OSU); Yamhill River—McMinnville (OSU). WASHINGTON: *Grays Harbor Co.*, Montesano (CNC, UCB, USNM).

327 specimens of the small form were examined from the following localities: **CANADA:** BRITISH COLUMBIA: Tofino (UBC); Rankin Is. (UBC); Triangle Is. (UBC). **UNION OF SOVIET SOCIALIST REPUBLICS:** Copper Is. [O. Mednyy] (USNM); Glenka [Glinka]—Copper Is. (USNM); Karaginski [O. Karaginskiy] (USNM); Lissonkoraja [Lisinskaya Bukhta]—Bering Is. (USNM); Nikolaski [Nikol'skoye]—Bering Is. (USNM); Petropaulski [Petropavlovsk—Kamchatsky]—Kamchatka Pen. (USNM). **UNITED STATES:** ALASKA: Adak Is. (CAS); Andrew Lagoon—Adak Is. (USNM); Casco—Attu Is. (USNM); Cold Bay & Russel Crk.—Aleutian Pen. (CNC, USNM); Finger Crk.—Adak Is. (USNM); Makushin Bay—Unalaska Is. (CAS); Mount Tulik & Okmok—Umnak Is. (USNM & CNC); Popof Is. (USNM); Pyramid Cove—Attu Is. (USNM); St. George Is. (CAS, OSU, USNM); St. Matthew Is. (CNC); St. Paul Is. (AMNH, CAS); Terrible Mt.—Attu Is. (USNM); Thorne Bay—P.O.W. Is. (OSU); Umuak Is. (USNM); Unalakleet (CNC); Unga Is. (OSU).

Irbisia serrata Bliven

Figs. 23a, b, 46, 69, 92; Map 20

Capsus solani: Heidemann, 1910, pp. 200–201 (not holotype).
Irbisia brachycerus [*a*]: Cockerell, 1910, p. 370. Vosler, 1913, p. 553 (in part). Van Duzee, 1914, p. 24 (in part); 1921a, pp. 149, 152.
Irbisia mollipes: Van Duzee, 1921a, pp. 147–148 (in part).
Irbisia inurbana: Bliven, 1963, p. 81–82 (in part, not holotype).
Irbisia serrata Bliven, 1963, pp. 82–83, 86, pl. 8, figs. 8, 8a (new species).

Diagnosis. I. serrata is distinguished from allied species by a combination of characters. It possesses a membranous sac which is medially attached to the left outer surface of the sclerotized process of the vesica of the male. This character is unique to the genus. The structure of the female genitalic characters is not diagnostic. The following characters of *I. serrata* will separate it from *I. sericans*: pronotum with straight lateral margins, confluent punctation, and prominent anterior angles, in dorsal and lateral view; shorter antenna; macropterous female; vastly different male parameres. *I. serrata* is distinguished from *I. solani* by: the prominent anterior angles of the pronotum, mostly shagreened dorsal surface of the head, generally more densely distributed longer vestiture, strongly spined shaft of the left paramere of the male. *I. shulli* Knight has a wider vertex and brachypterous female which distinguish this species from *I. serrata*. The preponderance of black color and flattened pronotal disk of *I. nigripes* serve to differentiate it from *I. serrata*. *I. serrata* is distinguished from *I. fuscipubescens* by the former's densely distributed much longer vestiture, mostly shagreened dorsal surface, and confluently punctate pronotum. *I. serrata* is separated from *I. cascadia* by the former's longer first antennal segment, rugulopunctate pronotum and longer vestiture.

Description. Macropterous male. Length 5.10–5.80, width 2.30–2.65, shining black, densely clothed with upright white to fulvous setae intermixed, in varying degree, with recurved sericeous white setae. HEAD: width across eyes 1.10–1.24, vertex 0.45–0.59, dorsal width of eye 0.30–0.35; triangular, shagreened or slightly asperate; temporal areas indistinct, basal carina produced, slightly declivous to level of vertex posteriorly arcuate mesad; median depression indistinct, eyes broadly joined to frons; posterior margin of head (including eyes) arcuate posterolaterally in dorsal view; distance from tylus to ventral margin of eye 0.53–0.63, height of eye 0.48–0.55, maximum interocular width 0.79–0.90. ROSTRUM: length 1.53–1.95, fuscous to black, barely reaching to slightly surpassing mesocoxae. ANTENNAE: black; I, length 0.51–0.68, apex and base sometimes fulvous; II, 1.45–1.85; III, 0.73–1.05; IV, 1.00–1.23. PRONOTUM: length 0.97–1.20; anterior width 0.88–1.03; maximum width 1.66–1.95; trapezoidal, disk broadly convex, scabrous and confluently punctate, posterior margin broadly arcuate, lateral margins straight, margined at junction with propleura, anterior angles, prominent, quite evident in lateral view, pronotal disk "shelf-like" dorsad of coxal cleft; calli slightly flattened, evident but only slightly produced, confluent anteriorly, smooth or asperate. LEGS: black; tibiae dark fuscous, sometimes testaceous to fulvous, medially. VESTITURE: head, pronotum and scutellum with upright shining white and/or fulvous setae, which become suberect or recumbent on hemelytra; dorsum covered with recurved sericeous white setae; venter with dense, thin light setae.

Macropterous female. More robust than male; however, similar in color, structure and vestiture. Length 5.10–5.90, width 2.30–3.00. HEAD: width across eyes 1.18–1.28, vertex 0.55–0.63, dorsal width of eye 0.30–0.35, distance from tylus to ventral margin of eye 0.57–0.65, height of eye 0.49–0.56, maximum interocular width 0.88–0.93. ROSTRUM: length 1.76–1.90, either reaching meso or metacoxae. ANTENNAE: I, length 0.54–0.63; II, 1.41–1.73; III, 0.75–1.00; IV, 1.10–1.23. PRONOTUM: length 1.10–1.25, anterior width 0.98–1.08, maximum width 1.90–2.10. LEGS: fuscous or rufescent, coxae black, apices testaceous, trochanter testaceous, femora with fuscous spots ventrally on some specimens, tibiae fulvous, bases and apices black, tarsi black.

Types. Male holotype. Laribee Valley, Humboldt Co., Cal. IV.26.36; B. P. Bliven, Collector, No. 615; HOLOTYPE ♂ Irbisia serrata, 1963 [red]; CAS type no. 13863. I have examined the holotype and all of the paratypes. Twelve paratypes are conspecific with the holotype, four are misidentified and are specimens of *I. solani*. All of this material is retained at the California Academy of Sciences, San Francisco.

Taxonomic consideration. Heidemann (1910), in the original description of *Capsus* *solani,* included within the distributional range of this species specimens from the Wasatch Mountains, Utah. It is my opinion that these specimens are not conspecific with *I. solani,* but are misidentified specimens of *I. serrata.* No specimens, of the material on hand, of *I. solani* occur at or near this locality, whereas the locality is within the distributional range of *I. serrata.*

Van Duzee (1914) included several specimens of *I. serrata* Bliven from Colorado, New Mexico and Utah within his treatment of *I. brachycera.* This misidentification was apparently due to his confusion of the habitus of *I. brachycera.* Van Duzee (1921a) received specimens of *I. brachycera* and the not yet described *I. serrata* from Sunset, Colorado. He mistakenly identified the specimens of *I. serrata* as *I. brachycera* and named a new species *I. arcuata*, for the true *I. brachycera* specimens. Knight (1941) made *I. arcuata* the junior synonym of *I. brachycera* after he examined the type specimen of the latter species. Knight took this action after he had misidentified many specimens of *I. brachycera* as *I. arcuata,* apparently following the example of Van Duzee. I have examined specimens of *I. serrata* identified as *I. brachycera* by both Van Duzee and Knight.

It is interesting that Knight did not describe those specimens of the not yet described *I. serrata* as a new species, at the time he synonymized *I. arcuata,* in light of the fact that he had specimens of *I. serrata,* with red marks on the labels (indicating new species) in his collection.

Van Duzee (1921a) included specimens from the Las Vegas Range, New Mexico in his treatment of *I. mollipes.* These specimens are correctly identified as *I. serrata.* In all cases, I have added my determination labels to these critical specimens.

I have cited Cockerell (1910) in *I. serrata* because he states that the identification was made by Van Duzee. The specimens of concern were taken at Steamboat Springs, Colorado. This locality is within the range of *I. serrata,* although I have no topotypic material. However, there is a good series of *I. shulli* from Steamboat Springs. The separation of the males of these two species can be difficult and the dissection and examination of the genitalia are required for positive identification.

Remarks. I. serrata has caused great difficulty in the identification of the species of *Irbisia* because of its very great distributional range, sympatry with nine other species of *Irbisia,* and the relative obscurity of its original description (which did not contain a key to the species).

I. serrata has one of the widest distributional ranges in the genus. It occurs as far south as the Upper Gila Mountain forest province of Arizona inhabiting open situations in several floristic associations: Arizona pine forest and a transition zone between oak–juniper woodland and mountain mahogany–oak scrub. Within the Rocky Mountain forest province seven forest associations contain open areas providing suitable habitat for *I. serrata*; these associations are: western ponderosa, Douglas fir, grand fir–Douglas fir, western spruce–fir, pine–Douglas fir, Arizona pine and southwestern spruce–fir. Many of these forest associations intergrade with sagebrush steppe and juniper–pinyon woodland associations in Colorado, Idaho, New Mexico, Oregon and Utah. East of the Cascade Range, ringing the Columbia Basin, in Oregon and Washington fescue–wheatgrass and wheatgrass–bluegrass grasslands also provide *I. serrata* with habitat. West of the Cascade Range in the Pacific forest province openings are found within cedar–hemlock–Douglas fir and silver fir–Douglas fir forests of Oregon and Washington. The Sierran forest province in the Klamath Mountains of northern California is essentially the southern limit of the distibution in this state; a few specimens are known from the black oak–digger pine forests of Monterey and Napa Counties.

Adult and immature specimens have been collected on these grass hosts: *Agropyron spicatum* (Pursh) Scribn. & Sm., *Dactylis glomerata* L., *Elymus glaucus* Buckl., *E. triticoides* Buckl., *Festuca arundinacea* Schreb., *F. rubra* L., *Poa pratensis* L. and *Sitanion hystrix* (Nutt.) J. G. Sm. Both adults and immature stages were observed feeding on these non-graminoid monocots: *Allium cernuum* Roth, *A. crenulatum* Wieg., *Brodiaea* sp. and *Iris tenax* Dougl. Several other plants have had adults collected from them: *Abies procera* Rehd., *Alnus* sp., *Balsamorhiza sagittata* (Pursh) Nutt., *Balsamorhiza* sp., *Ceanothus integerrimus* H. & A., *C. velutimus* Dougl. ex Hook, *Cercocarpus ledifolius* Nutt., *Eriodictyon californica* (H. & A.) Torr., *Juniperus* sp., *Lomatium dissectium* (Nutt.) Math. & Const., *Lupinus* sp., *Physocarpus capitatus* (Pursh) Kuntze, *Picea* sp., *Pinus flexilis* James, *P. ponderosa* Dougl. ex P. & C. Lawson, *Polygonum bistortoides* (Pursh), *Prunus pensylvanica* L., *Psuedotsuga menziesii* (Mirbel) Franco, *Quercus breweri* (Engelm. in Wats.) Jeps., *Q. gambelii* Nutt., *Q. garryana* Dougl., *Q. turbinella* Greene, *Ribes cereum* Dougl., *R. roezlii* Regel, *Salix* sp., *Spiraea* sp. and *Vicia* sp. The altitudinal range of *I. serrata* is 15 m. (49 feet) at Puyallup, Washington and 3660 m. (12,000 feet) at Silverton, Colorado. Its period of occurrence is 15 March at Globe, Arizona and 27 August at Blackwall, British Columbia.

Specimens examined. 972 specimens were examined from the following localities: **CANADA:** BRITISH COLUMBIA: Blackwell-Manning Pk. (UBC); Kushanook (CNC); Lytton (UBC); North Bend (USNM); Madden L. & McIntyre Crk.—Oliver (CNC); 10 mi. W & Oliver (CNC); Osoyoos—Anachrist Mt. (CNC); Salked Flats—nr. Inkitsaph (UBC); Skihist Cmp.—Fraser R. (UCB); 10 mi. W Summerland (CNC). **UNITED STATES:** ARIZONA: *Apache Co.,* Big Lk.—Apache Nat. For. (CNC). *Coconino Co.,* 9 mi. S Flagstaff (NAU); Yavapai Pt.—Grand Canyon Nat. Pk. (USNM), Grand Cyn.—Grand Cyn. Nat. Pk. (CAS), Grand View Lookout (AMNH). *Gila Co.,* Globe (OSU); 1 mi. W Miami (UCR); Parker Crk.—Sierra Ancha Mts. (USNM); nr. Roosevelt lk. (USNM). *Maricopa Co.,* Reavis Rnch., trl. (JTP). *Navajo Co.,* Lewis Cyn.—2 mi. S Pinedale (AMNH); 15–20 mi. SW Show Low (AMNH). CALIFORNIA: *Del Norte Co.,* mp. 8.25 rt. 199—Middle Fort of Smith River. *Humboldt Co.,* Blair's Rch.—Redwood Crk; Dinsmores (CAS); Iaqua (CAS); Laribee Valley (CAS). *Lake Co.,* Blue Lakes (UCD). *Lassen Co.,* Susanville (CNC). *Marin Co.,* 4 mi. E Stinson Beach (AMNH). *Mariposa Co.,* Clouds Rest—Yosemite Nat. Pk. (LACM); Yosemite (UCB). *Mendocino Co.,* 7 mi. W Eel River Rgr. Stn. (UCB); Hopland (UCD); Latonville (CAS). *Modoc Co.,* 1 mi. NW Ft. Bidwell (UCB). *Monterey Co.,* Jolon (UCD). *Napa Co.,* Castle Crag (F&A); 5 mi. S Pope Valley (UCD). *Placer Co.,* 5 mi. NE Auburn (WSU). *Sacramento Co.,* 5 mi. N Folsom (F&A). *Shasta Co.,* Castle Crag St. Pk. (AMNH). *Siskiyou Co.,* Ash Crk. Rgr. Stn.—9 mi. E McCloud (UCB); 1 mi. SE Bartle (UCB); Caribou Mt.—Trinity Alps (UCB); Young's Valley (PUC). *Sta. Clara Co.,* 3 mi. W. New Almenden (UCB). *Trinity Co.,* Buttercreek Mdw.—8 mi. W Hayfork (UBC); Carrville (CAS); Coffee Crk. Rch. (UCB); Scott Mt. Mdw.—6 mi. E Calahan (OSU); Scott Mt. Peak (UCB); South Fork Pass (UID). COLORADO: *Boulder Co.,* Boulder, 4.5 mi. N & Flagstaff Cyn. (CNC); Sunset (CAS). *Clear Creek Co.,* Chicago Crk. (CNC). *Conejos Co.,* Trujillo Mdw. Cmp.—3 mi. N Cumbres (AMNH). *Custer Co.,* Davenport Cmp. 36 mi. S Florence (AMNH). *Dolores Co.,* Lizard Head Pass (USNM). *Garfield Co.,* 2 mi. S Douglas Pass (AMNH); Glenwood (USNM). *Grand Co.,* Rabbit Ears Pass (USNM). *Gunnison Co.,* Monarch Pass (USNM). *Hinsdale Co.,* Lk. City (KU). *La Plata Co.,* La Plata (CNC); Rockwood (KU); 5 mi. N Rockwood (OSU). *Larimer Co.,* nr. Estes Pk.—Rocky Mt. Nat. Pk. (CNC, USNM); Ft. Collins (SHF). *Las*

Animas Co., Cucharas Pass (CNC); Spanish Peaks (USNM). *Mesa Co.,* East Fork Big Crk.—10 mi. S Collbran (USNM); Mesa & 8 mi. S (USNM). *Mineral Co.,* 16 mi. N Pagosa Spgs. (TA&M). *Montezuma Co.,* Mesa Verde Nat. Pk. (UCD). *Montrose Co.,* 2 mi. S Columbine Pass (JTP). *Ouray Co.,* Summit Road—Ouray (AMNH); Ouray (AMNH). *Routt Co.,* Meadows (CNC). *San Juan Co.,* Silverton (USNM). *San Miguel Co.,* Cornet Crk.—Telluride (AMNH); Trout Lk. (USNM). Glenwood (USNM); Rices Spur (USNM). IDAHO: *Adams Co.,* 7.5 & 8 mi. N Council (OSU & UID). *Boise Co.,* 3 mi. N Idaho City (UID). *Cassia Co.,* City of Rocks (UID); Elba-Basin Pass (UID). *Elmore Co.,* 13 mi. W Hill City (MSU). *Nez Perce Co.,* Lenore (USNM). *Oneida Co.,* Black Pine Cyn. (USU); Holbrook (USU). NEVADA: *Humboldt Co.,* Lye Crk.—Sta. Rosa Mts. (OSU). NEW MEXICO: *Colfax Co.,* Cimarron Cyn. (USNM). *Rio Arriba Co.,* NE Truchas Pk. (USNM). *Santa Fe Co.,* Aspen Ranch (USNM); Tesuque (USNM). *Sandoval Co.,* Jemez Spgs. (LACM, KU); Sandia Mts. (USNM). *San Miguel Co.,* Holy Ghost Cyn.—14 mi. N Pecos (UALB); Mosimann Rch.—15.7 mi. W Sapello (UALB); Panchuella Cyn.—Cowles (USNM); "Top of Las Vegas Range," (CAS). *Taos Co.,* Hondo Cyn.—7 mi. E Valdez (USNM). *Torrance Co.,* Estania (KU); Tajique (KU). OREGON: *Baker Co.,* 5.5 mi. SW Halfway (OSU), 14 mi. E Hereford (OSU). *Benton Co.,* Alsea (USNM); Fish Hatchery, Oak Crk.—both nr. Corvallis (OSU); Corvallis (OSU, UCB); MacDonald St. For. (OSU); Mary's Peak (T12S R7W Sec. 20 SE & SW ¼) (AMNH, OSU); Rock Crk.—5 mi. W Philomath (OSU). *Clatsop Co.,* Saddle Mt. St. Pk.—trail. (AMNH, OSDA, OSU). *Crook Co.,* Mark's Crk.—Crook City (OSDA, OSU); 20 mi. E Prineville (OSU); 9.5 mi. E Post (OSU). *Deschutes Co.,* Indian Ford Crk.—6 mi. W Sisters (OSU); Indian Ford Rd.—2 mi. NE Sisters (T14S R10E Sec. 27) (OSU); 4.2 & 14 mi. S Millican (AMNH, OSU); Pine Mt. Observatory (AMNH, OSU); RW Sawyer St. Pk.—1 mi. NW Bend (OSU). *Douglas Co.,* Bradley Crk—nr. Glide (OSU); *Grant Co.,* 8 & 11 mi. N Seneca (OSU). *Hood River Co.,* Dimmock St. Pk.—2 mi. SW Parkdale (OSU). *Jackson Co.,* Applegate Rd. (OSU); Ashland (SOS); Colestin (OSDA); Medford (OSU); Summit Green Spgs. Hwy. (OSU); 5 mi. W & Pinehurst (OSU); 3 mi. E Sams Valley (OSU); Siskiyou Pass (CNC, OSU); 0.5 mi. S Siskiyou Smt. (old rt. 99) (AMNH, OSU); Tubb Spgs.—6 mi. W Pinehurst (OSU). *Josephine Co.,* Rough & Ready Botanical Wysd. (OSU); Woodcock Crk.—3 mi. SW Cave Jct. (T39S R5E Sec. 31) (OSU). *Klamath Co.,* 11 mi. E & 15 mi. NW Bly (OSU); Bly Mt.—10 mi. W Beatty (OSU); 7 & 10 mi. W, 12 mi. SW Keno (OSU & AMNH); Gerry Ranch—12 mi. NW Klamath Falls (OSU); Spencer Crk. (OSU); Sprague River Pk. (OSU). *Lake Co.,* Chandler St. Pk. (OSU); Fremont Nat. For. (CAS); Quartz Crk.—16 mi. E Bly (OSU). *Lincoln Co.,* Little Grass Mt.—20 mi. N rt. 20 (OSU). *Polk Co.,* Dalles (USNM); Grande Ronde (OSU). *Lane/Linn Cos.,* H. J. Andrews Expt. For.—11 mi. N Blue River (T15S R5E Sec. 28 NW & SW ¼) (All OSU); McKenzie Pass (USNM). *Linn Co.,* Iron Mt. Trl. (OSU); Lost Prairie (OSU); Peterson Butte (OSU); Roaring R. Fish Hatchery (USNM); Tombstone Prairie (OSU). *Umatilla Co.,* 2.2 mi. N Dale (OSU); Tollgate (OSU). *Union Co.,* 12 mi. NE LaGrange (OSU). *Wallowa Co.,* Wallowa Lk. (CAS). *Wasco Co.,* Bear Spgs.—25 mi. W Maupin (OSU); Cherry Hgts. Rd.—5 mi. S The Dalles (OSU); 5.5 mi. E Mosier (OSU); 2 mi. S & 7 mi. N Simnasho (OSU); The Dalles (CU); Wapinta (OSU). *Wheeler Co.,* 4 mi. SW Fossil (OSU); 4.5 mi. S Mitchell (OSU); Slide Mt.—9.5 mi. E rt. 26 on FS Rd. 2630 (OSU). *Yamhill Co.,* Bald Mt. (OSU); Forest Grove (OSU), 1 mi. S Pike (OSU). UTAH: *Cache Co.,* Benson (USU); Blacksmith Fork Cyn. (SHF, USU); East Cyn. (UCD, USU); Green Cyn. (USU); Logan (SHF, OSU, USU); Logan Cyn. (USU); Providence Cyn. (USNM); Richmond (USU); Smithfield (USU); Wellsville (KU, USU); Wellsville Cyn. (OSU, USNM, USU). *Daggett Co.,* Elks Pk.—Ashley Nat. For. (BYU); Grizzly Rdg. (USU); Skull Crk. (AMNH). *Duchesne Co.,* Yellowstone Rgr. Stn. (BYU). *Grand Co.,* Lk. Oowah—La Sal Mts. (USU); Warner Rgr. Stn.—28 mi. ESE Moab (AMNH). *Juab Co.,* Chicken Crk. Cyn. (USU); Little Valley (USU). *Millard Co.,* Oak Crk. Cyn. (USU). *Salt Lake Co.,* Alta—Little Cottonwood Cyn. (CAS); Cowley Cyn. (OSU); Parleys Cyn. (UCD). *San Juan Co.,* Bears Ears—Elk Rdg. (BYU, USU); 3 mi. W, 10 mi. SW & Monticello (USU, BYU); Navajo Mt. (CAS). *Sevier Co.,* 20 mi. E Salina (UIS). *Summit Co.,* 20 mi. E Salt Lk.

City (KU). *Tooele Co.,* Johnson Pass (UCD). *Utah Co.,* Provo (USNM); Springvile (BYU). *Wasatch Co.,* Upper Wolf Crk. Cyn. (USNM). *Washington Co.,* Pintura (USNM); Santa Clara (BYU); 15 mi. N St. George (USNM). Anderson Rch. (BYU). Copper Mts.—Tecoma Range (BYU). Geyser Pass (USU). Warner (SHF). WASHINGTON: *Chelan Co.,* Blewett (CNC). *Kittitas Co.,* Cle Elum (CAS); Easton (USNM); 20 mi. NNW Ellensburg (OSU). *Klickitat Co.,* 5.3 mi. E Bingen (OSU). *Lincoln Co.,* 12 mi. N Davenport (OSU). *Pierce Co.,* Ft. Lewis (UCD); Graham (USNM); Mt. Rainier (USNM); Puyallup (UCB). *Skamania Co.,* Dog Mt.—Pacific Crst. Trl. (OSU). *Spokane Co.,* 8 mi. S Spokane (OSU). *Stevens Co.,* 10 mi. S Fruitland (OSU). *Thurston Co.,* Tenino (USNM); *Yakima Co.,* Toppenish (USNM). *Whitman Co.,* Kamiak Butte St. Pk. (OSU); Pullman (USNM).

Irbisia setosa Van Duzee
Figs. 31a, b, 54, 77, 100; Map 16

Irbisia mollipes: Van Duzee, 1921a, pp. 147–148 (in part).
Irbisia setosa Van Duzee, 1921a, pp. 149–150, 152 (new species). Essig, 1926, p. 361. Carvalho, 1959, p. 106.
Irbisia ustricula Bliven, 1963, pp. 79–80, 86, pl. 8, figs. 6, 6a. **New Synonymy.**

Diagnosis. Recognition of this species is not difficult because of the unique vestiture. *I. setosa* is the only species with moderately distributed uniformly long, erect bristle-like fuscous setae on the dorsum of both sexes.

Description. Macropterous male. Length 4.70–5.40, width 1.80–2.15, shining black densely clothed with sericeous woolly white setae and widely spaced long erect fuscous bristle-like setae. HEAD: width across eyes 1.03–1.15, vertex 0.46–0.50, dorsal width of eye 0.25–0.31; triangular asperate; tylus acute in dorsal view; temporal areas distinct, asperate; median depression present and distinctly smooth; basal carina prominent, declivous to level of vertex, straight; eyes broadly joined to frons, protruding laterally, posterior margin straight in dorsal view; distance from tylus to ventral margin of eye 0.48–0.53, height of eye 0.41–0.49, maximum interocular width 0.70–0.78. ROSTRUM: length 1.43–1.60, fuscous to piceous apex always dark, attaining bases, and sometimes reaching apices of mesocoxae. ANTENNAE: piceous or black; I, length 0.50–0.60; II, 1.38–1.74; III, 0.70–0.89; III, 0.83–1.00. PRONOTUM: length 0.85–0.97, anterior width 0.75–0.85, maximum width 1.50–1.73; conical, broadly convex, confluently punctate or rugose, posterolateral margins arcuate, lateral margins straight to concave, rounded or slightly margined at junction with propleura, anterior angles broadly rounded in dorsal view, not sulcate in lateral view; calli somewhat indistinct, asperate, narrowly confluent anteriorly, not reaching anterolateral margins of pronotum; extreme ventral apices of propleura, very narrowly bordering mesocoxae and posterior half of ostiolar peritreme ivory. LEGS: castaneous, piceous or black; apices of coxae whitish; tibiae usually lighter shade of base color, infuscated; apices of tibiae and tarsi black. VESTITURE: dorsum densely clothed with sericeous woolly setae and moderately distributed, uniformly long, erect, fuscous setae; suberect on posterior portion of hemelytra and cuneus; venter and legs moderately covered with long suberect testaceous setae.

Macropterous female. Similar to male in most respects, but more robust. Length 4.70–5.45, width 2.13–2.35. HEAD: width across eyes 1.06–1.19, vertex 0.49–0.58, dorsal width of eye 0.28–0.33, distance from tylus to ventral margin of eye 0.54–

0.58, height of eye 0.45–0.49, maximum interocular width 0.75–0.85. ROSTRUM: length 1.53–1.61 reaching bases and sometimes attaining apices of mesocoxae. ANTENNAE: I, length 0.50–0.60; II, 1.34–1.68; III, 0.78–0.93; IV, 0.80–1.09. PRONOTUM: length 0.88–1.00, anterior width 0.85–0.93, maximum width 1.66–1.90.

Types. Male holotype. Cazadero Cal, iv-12-18, EP Van Duzee; HOLOTYPE setosa [red]; CAS type no. 803. I have examined the holotype and six conspecific paratypes; these specimens are retained at the California Academy of Sciences, San Francisco and the Canadian National Collection, Ottawa.

Taxonomic consideration. The junior synonym fits the species concept of *I. setosa* in structure and vestiture.

Remarks. The distribution of this species occupies six floristic associations in which oak is a major or minor component (Coast Range montane, Oregon oak, mixed evergreen, mixed hardwood, blue oak–digger pine, and southern oak forests), as well as southern jeffery pine forest and chaparral association. *I. setosa* occurs as far north as Josephine County, Oregon within the Pacific forest province and follows this province south into Californian chaparral province to the San Jacinto Mountains of Riverside County. Specimens are known throughout the oak associations of the Sierran forest province. A single specimen from Umatilla County, Oregon, near the Columbia River, represents either a disjunct population or a labelling error.

Adult specimens have been collected from the following plants: *Arctostaphylos* sp., *Ceanothus cuneatus* (Hook.) Nutt., *C. intergerrimus* H. & A., *Eriogonum nudum* (Dougl. ex Benth.) S. Stokes, Poaceae, *Lupinus* sp., *Prunus subcordata* Benth., *Quercus* sp., *Rhamnus* sp., and *Rhus diversibola* T. & G. The dates of occurrence are 11 March to 15 July, and elevational range is from 270 to 2260 m. (880 to 6500 feet).

Specimens examined. 164 specimens were examined from the following localities (Map 16). **UNITED STATES:** CALIFORNIA: *Alameda Co.,* hills back of Oakland (CAS). *Butte Co.,* Butte Crk. Cyn.—nr. Chico (CAS); Oroville (CAS); Pentz (CAS). *Colusa Co.,* Wilbur Hot Spgs. (JTP). *Contra Costa Co.,* Mt. Diablo—Russellman St. Pk. (CAS, UCB, UCD, UID); Orinda (LACM). *El Dorado Co.,* Placerville (UCB). *Glenn Co.,* Black Butte (PUC). *Humboldt Co.,* Blair Rch.—Redwood Crk. (USNM). *Kern Co.,* Fort Tejon (CAS); 3 mi. W Woffard Hts. (UCB). *Lake Co.,* Anderson Spr. (UCD); Blue Lks. (UCD); 4 mi. W Finley (UCB); Kelseyville (CAS); Lakeport (CAS); 6 mi. S Middletown (UCB); 12 mi. N Upper Lk. (UCB). *Marin Co.,* Alpine Lk. (UCB); Fairfax, & hills nr. (CAS & UCB); Mill Valley (CAS); Phoenix Lk. (CAS); Ross (CAS). *Mendocino Co.,* 5 mi. N Branscomb (UCB); 40.38 mp. on rt. 23 btw. Coptche & Ukiah (OSU); 7 mi. NE & W Eel River Rgr. Stn. (UCB); 2 mi. NW Mendocino Pass (UCB); Ryan Crk.—N Willits (UCB); U.C. Hopland Exp. Stn.—upper pond & H.Q. (UCB & CAS). *Monterey Co.,* Bryson (CAS); Carmel (CAS); Chew's Rdg.—nr. White Oak Cmp. (UCB); Wiley Rch.—6 mi. W Greenfield (UCB). *Napa Co.,* Monticello Dam (UCD); 4 mi. S & 5 mi. SE Pope Valley (UCD). *Riverside Co.,* Pinyon Flat—16 mi. SW Palm Desert (UCR). *Sacramento Co.,* Carmichael (F&A). *San Benito Co.,* Pinnacles Nat. Mon.—W entr. (OSU). *S.L.O. Co.,* 10 mi. S Creston (UCB); La Panza Cmp. (UCB); Black Mt.—6 mi. NE Pozo (UCB); 3 mi. W Paso Robles (UCB). *San Mateo Co.,* Huddart Pk. (UCB); King's Mt. (UCB); Redwood City (UCD). *Sta. Barbara Co.,* Figueroa Cmp.—13 mi. NE Los Olivos (UCB). *Sta. Clara Co.,* Herbert Crk.—3 mi. W New Almaden (UCB). *Shasta Co.,* 6 mi. W Fall River Mills (UID, WSU); Harrison Gulch Rgr. Stn.—rt. 36 nr. Platina (OSU); Redding (UID); Summit City (WSU). *Solano Co.,* Green Valley (UCD). *Stanislaus Co.,* W Adoke Crk. (UCB). *Trinity Co.,* 6 mi. NE Hayford (UCB). *Tulare Co.,* Hospital Flat Cmpgd.—5.7 mi. N Kernville (UCR); 2 mi. E Johnsondale

(UCB). *Tuolumne Co.,* Buck Mdws. (USNM). *Ventura Co.,* 5 mi. SE Camarillo (OSU). OREGON: *Josephine Co.,* 3.6 mi. N Kerby (OSU). *Umatilla Co.,* Umatilla (WSU).

Irbisia shulli Knight
Figs. 22a, b, 45, 68, 91; Map 21

Irbisia shulli Knight, 1941, pp. 75–76 (new species); 1968, p. 185. Slater, 1950, pp. 36, 71, pl. 2, figs. 11, 12, 13, p. 75, pl. 4, fig. 5. Carvalho, 1959, p. 106.

Diagnosis. This species is distinguished from allied species by several characters. *I. shulli* and *I. sericans* both have brachypterous females, but the latter has a narrower vertex, longer antennal segments and fulvous tibiae. The vertex to antennal segment I ratio of *I. shulli* ranging from 1:0.84 to 1:1.00 for males and from 1:0.73 to 1:0.86 for females; for *I. sericans* the range is from 1:1.04 to 1:43 for males, and from 1:1.08 to 1:1.27 for females. *I. shulli* can be separated from the closely related *I. nigripes* by the wider vertex and brachypterey of the female of the former species. The vertex to antennal I ratio of *I. nigripes* ranging from 1:1.02 to 1:1.19 for males, and from 1:0.91 to 1:1.11 for females. The sclerotized process of the vesica of the male of *I. shulli* is preapically expanded and slightly involuted as compared to *I. nigripes. I. shulli,* by virtue of its wide vertex and brachypterous female, is also distinct from *I. serrata.* The vertex to antennal I ratio of the latter species ranging from 1:1.05 to 1:1.24 for males, and from 1:0.89 to 1:1.07 for females.

Description. Macropterous male. Length 5.20–6.15, width 2.05–2.95, moderately shining black, covered with long erect fulvous setae. HEAD: width across eyes 1.20–1.36, vertex 0.68–0.75, dorsal width of eye 0.26–0.33; triangular, smooth or slightly asperate; temporal areas poorly differentiated, smooth, shining; median depression usually not evident; basal carina blunt, moderately prominent, posteriorly broadly arcuate mesad, declivous to level of vertex; eyes broadly joined to frons, posterolateral margin arcuate posteriorly in dorsal view, distance from tylus to ventral margin of eye 0.70–0.83, height of eye 0.42–0.49, maximum interocular width 0.90–1.03. ROSTRUM: length 1.65–2.18, black, approaching but not attaining mesocoxae to reaching apex of metacoxae. ANTENNAE: black; I, length 0.55–0.73; II, 1.44–1.85; III, 0.78–1.25; IV, 1.05–1.30. PRONOTUM: length 1.00–1.15, anterior width 0.96–1.22, maximum width 1.73–2.09, trapezoidal, disk broadly convex, rugulopunctate, posterior margin practically straight, lateral margins straight, broadly rounded at junction with propleura, anterior angles prominent, rounded, slightly directed anteriorly in dorsal view, quite evident in lateral view; calli, quite convex, confluent anteriorly, with or without foveate impression on anteromedial angles, usually not reaching anterolateral margins of pronotum. LEGS: black; tibiae with variably sized fuscous areas. VESTITURE: dorsum densely clothed with suberect fulvous to fuscous or erect white setae, intermixed, in varying degrees, with recumbent sericeous setae; venter with sparse thin fulvous setae.

Brachypterous female. Similar to male in color, vestiture and structure (except membrane), but stature more robust. Length 4.30–5.4, width 2.45–2.88. HEAD: width across eyes 1.30–1.45, vertex 0.73–0.85, dorsal width of eye 0.25–0.33, distance from tylus to ventral margin of eye 0.75–0.90, height of eye 0.43–0.48, maximum interocular width 1.03–1.23. ROSTRUM: length 1.80–2.03, approaching but not reaching mesocoxae to surpassing metacoxae. ANTENNAE: I, 0.53–0.66; II, 1.33–1.75; III, 0.85–1.05; IV, 1.05–1.33. PRONOTUM: length 0.94–1.08, anterior width 1.05–1.30, maximum width 1.73–2.08; membrane reduced, not reaching beyond tip of cuneus, cells not developed, tip of abdomen exposed.

Types. Male holotype. Lenore, Ida., May 7, 1938, Alt. 1000 ft., WE Shull. Holotype retained at the United States National Museum, Washington, D.C. I have examined the holotype and 74 paratypes; all are conspecific. The paratypes are deposited at BYU, CNC, JFS and USNM.

Taxonomic consideration. Some specimens from populations collected from the westernmost portion of the range of *I. shulli* are noticeably smaller in all body measurements and possess erect thin white setae. This condition is obvious in specimens collected on the west side of the Columbia River in Okanogan and Chelan Counties, Washington, and the Osoyoos District of British Columbia. The seemingly constant brachyptery of the female in this species suggests limited dispersal ability. The location of these populations raises the possibility of isolation during pluvial periods of the Pleistocene epoch. The smaller size may be a result of the drier conditions of the Okanogan Valley.

A single macropterous female was (hind wings are still brachypterous) contained in a large sample of 106 specimens of *I. shulli* collected from 5.5 miles SW of Halfway, Baker County, Oregon. The entire series was collected from *Balsamorhiza* sp. This occurrence suggests that the genes for macroptery are still present in the species but the conditions necessary for its expression are conjectural.

Remarks. The distribution of *I. shulli* is rather wide, occupying woodland situations from the west slopes of the Rocky Mountains in Colorado to the east slopes of the Cascade Range in Washington. Several grassland, shrub, and forest vegetational associations are contained within its range. In Colorado and Utah, *I. shulli* occurs in mountain mahogany–oak scrub, sagebrush steppe and open situations within Douglas fir forests associations. Foothill prairies are inhabited in Montana. The vegetational associations for its range in Idaho, Oregon and Washington are sagebrush steppe and wheatgrass–blue grasslands. The Palouse Prairie of Washington delimits the northern border of this species. Adult specimens have been collected from: *Agropyron intermedium* Beauv., *Agropyron* sp., *Artemisia cana* Pursh, *Artemisia* sp., *Balsamorhiza sagittata* (Pursh) Nutt., *Carex* sp., *Ceanothus* sp., *Delphinium* sp., *Elymus cinereus* Scribn. & Merr., *Lupinus* sp., and *Purshia tridentata* (Pursh.) DC. Specimens range in altitude from 305 to 2903 m. (1000 to 9524 feet). The high altitude record is from Gore Pass, Colorado. Collection dates are from 23 April to 11 November. The late record is from Franklin Basin, Utah.

Specimens examined. 1,935 specimens were examined from the following selected localities (Map 21). **CANADA:** BRITISH COLUMBIA: Anarchist Mt.—Osoyoos (CNC); Kelowna (USNM); Oliver & Madden L., McIntyre Crk., Meyer Flats, Vaseaux L., White Lk. (CNC, USNM); 8 mi. E & E Osoyoos (CNC & UBC); Rock Crk. (CNC); Shingle Crk.—Penticton (CNC); Summerland (CNC). **UNITED STATES:** COLORADO: *Eagle Co.,* Muddy Pass Rd.—10 mi. NE Wolcott (JTP). *Grand Co.,* Gore Pass (CAS). *Routt Co.,* Steamboat Spgs. (KU, USNM). IDAHO: *Adams Co.,* 7.5 mi. N Council (OSU). *Blaine Co.,* 18 mi. NW Ketchum (UID). *Bonneville Co.,* 10 mi. NE Swan Valley. *Caribou Co.,* 3 & 5 mi. E Wayan (UID). *Custer Co.,* Bear Crk. Cmpgd. (UID). *Franklin Co.,* Cub River Cyn. (USU); Franklin Basin (USU); Thomas Spg.—Cub River Cyn. (USU); Weston Cyn. (UID). *Latah Co.,* Juliaetta (USNM);

Moscow (CAS, OSU, UID); 3 mi. N Moscow (UID). *Lemhi Co.,* 2 mi. E Baker (UID). *Nez Perce Co.,* Lenore (OSU, UID, USNM); Lewiston (USNM). *Oneida Co.,* Holbrook (UDU). *Twin Falls Co.,* Twin Falls (UID). *Valley Co.,* Donnelly (BSU). MONTANA: *Gattatin Co.,* Bozeman (MSU, USNM). *Powell Co.,* Garrison (UID). *Sanders Co.,* Montana Expt. Stn. (MSU). OREGON: *Baker Co.,* 30 mi. ENE Baker (OSU); 5 mi. NW Ballards Landing (T5S R78E Sec. 31 SE ¼ SW ¼) (OSU); 5.5 mi. SW & 9 mi. NE Halfway (OSU); 12 mi. ENE Keating (OSU); 6.5 mi. W & 7 mi. N Richland (OSU); Sparta (OSU). *Grant Co.,* Blue Mt. Hot Spgs. (AMNH); 0.3 mi. S Fox (OSU); Fox Valley (JS); 5 mi. S John Day (OSU); Keerin's Rch.—Izee (JS); 11 mi. N Seneca (OSU). *Umatilla Co.,* Kamela (USNM); 1 mi. N Kamela (OSU); Tollgate (USNM); nr. Ukiah (OSU); Weston (UID); 9 mi. E Weston (OSU); 0.4 mi. S jct. 244 & 395 (OSU). *Union Co.,* La Grande, 11 mi. SSE & 12 mi. NE (USNM & OSU); 25 mi. SE Pendleton (OSU); Phillips Cyn.—4.2 mi. W Elgin (OSU). *Wallowa Co.,* 40 mi. N Enterprise (OSU). *Wasco Co.,* 27 mi. S Maupin (OSU); Mayer St. Pk. (OSU); 3.4 mi. S Shaniko (OSU). UTAH: *Box Elder Co.,* Brigham City (UNSM, USU); Rosevere Crk.—Raft River Mts. (BYU). *Cache Co.,* Ant & Upper Ant Valey (USU); Blacksmith Fork Cyn. (OSU, USU); East Cyn. (USU); Elk Cyn. (USU); Franklin Basin (OSU, USU); Hodges Cyn. (USU); Logan (OSU, USNM, USU); Porcupine Res. (USU); Tony Grove Cyn. Cmpgd. (BYU, OSU, USNM, USU); Porcupine Res. (USU); Tony Grove Cyn. Cmpgd. (BYU, OSU, USU); Wellsville (CNC, USU), Wellsville Cyn. (AMNH). *Daggett Co.,* Flaming Gorge Nat. Rec. A. (UCD); Skull Crk. Cmpgrd.—Ashley Nat. For. (AMNH). *Duchesne Co.,* Yellowstone Rgr. Stn. (BYU). Juab Co., Chicken Crk. Cmpgd. (USU). *Morgan Co.,* Morgan (USU); Peterson (USU); Porterville (USU). *Rich Co.,* Allen Cyn. (SHF, USNM, USU); Bear Lk. Overlook (USU); Garden Cty (SHF, USNM); Laketown (OSU); Monte Cristo (USNM, USU); Randolph (USU); Woodruff (USNM). *Sevier Co.,* Mattsson Rch.—Salina Cyn. (USU). *Wasatch Co.,* Current Crk. (KU); 20 mi. SE Heber (UID); Strawberry Res. (UCD, USNM). *Weber Co.,* Cousey Dam (USNM); 12, 18 mi. N & Huntsville (SHF, USNM, USU); 6, 10 mi. S & 7 mi. W Monte Cristo (USNM, USU). WASHINGTON: *Asotin Co.,* 1.5 mi. S Anatone (OSU). *Benton Co.,* Snively Cyn., Rattlesnake Rdg.—Hanford A.E.C. Rsv. (WSU). *Chelan Co.,* 12 mi. SW, 13.4 mi. W Chelan (OSU). *Douglas Co.,* 4 mi. W Waterville (OSU, WWU). *Ferry Co.,* 8 mi. SE Keller (OSU). *Garfield Co.,* Pomeroy (WSU). *Grant Co.,* 1 mi. E Stratford (OSU). *Kittatas Co.,* 10 mi. NW, 14 mi. N, 20.5 mi. NNW Ellensburg (OSU); 12 mi. N Kittatas (OSU). *Klickitat Co.,* 3 mi. E Bingen (OSU); 19 mi. NE Goldendale (OSU); 5 & 21.7 mi. NE Lyle (OSU); 3.7 mi. E Wahkiacus (OSU). *Okanogan Co.,* 7 mi. NE Coulee City (OSU); 6 mi. E Elmer City (OSU); Frye Hill top—5 mi. SE Molson (AMNH); Molson (AMNH); 11 mi. W Okanogan (OSU); 3.7 mi. W Twisp (OSU). *Spokane Co.,* Turnbull Wldf. Rfg. (OSU). *Stevens Co.,* 10 mi. S Kettle Falls (OSU). *Yakima Co.,* 13.5 mi. W Naches (OSU); 27.6 mi. S Toppenish (OSU); Wenas (OSU); Yakima (TA&M, USNM). WYOMING: *Lincoln Co.,* Afton (USU); Auburn (BYU); Commissary Rdg.—Salt River Range (UWY). *Teton Co.,* Teton Cyn.—West side Teton Mts. (UID).

Irbisia silvosa Bliven
Figs. 26a, b, 49, 72, 95; Map 4

Irbisia sita Van Duzee: 1921a, pp. 150, 152 (in part, not holotype).
Irbisia silvosa Bliven, 1961, pp. 48–49 (new species); 1963, p. 85, pl. 7, figs. 6, 6a.
Irbisia upupa: Bliven, 1963, pp. 70–71 (in part, not holotype).
Irbisia paulula Bliven, 1963, pp. 75–76, 86, pl. 8, figs. 2, 2a. NEW SYNONYMY.
Irbisia inurbana: Bliven, 1963, pp. 81–82 (in part, not holotype)

Diagnosis. Both *I. silvosa* and *I. cuneomaculata* are easily separated from all other species of *Irbisia* by the presence of extensive light coloration on the ventral portion of the head and pronotum of both sexes, the venter of the female and the apical one third of the left paramere of the male. *I. silvosa* is distinguished from *I. cuneomaculata* by the lack of testaceous marking on the base of cuneus, and the markedly greater stature and measurements of the former species.

Description. Macropterous male. Length 4.50–6.20, width 1.80–2.33, shining black, densely covered with recurved, appressed sericeous white setae, sometimes intermixed with long erect white or fuscous setae. HEAD: width across eyes 1.08–1.31, vertex 0.48–0.63, dorsal width of eye 0.30–0.33, triangular, transversely asperate; temporal areas poorly differentiated, smooth, without vestiture, with transverse sulcus on posterior margin; median depression well developed, wide; basal carina large, wide and rounded, declivous to level of vertex, posteriorly arcuate mesad, projecting above eyes in frontal view; eyes broadly joined to frons, protruding laterally; posterolateral margins slightly arcuate posteriorly or straight in dorsal view; distance from tylus to ventral margin of eye 0.50–0.68, height of eye 0.45–0.54, maximum interocular width 0.73–0.95; variably marked with testaceous or ochraceous coloration on clypeal, jugal and loral sutures and gena; buccula and gula black. ROSTRUM: length 0.60–2.05, ochraceous, base and apex infuscated with black, attaining apices of mesocoxae, sometimes reaching bases of metacoxae. ANTENNAE: black; I, length 0.50–0.70; apical one to three quarters fulvous; II, 1.28–1.70, sometimes fulvous basally; III, 0.73–0.91; IV, 0.80–1.20. PRONOTUM: length 0.90–1.13, anterior margin 0.83–1.06, maximum width 1.48–2.00; subconical, broadly convex or somewhat flattened confluently punctured or rugose; posterolateral margins arcuate posteriorly, posterior margin sometimes arcuate; lateral margins very slightly to moderately concave, rounded at junction with propleura; anterior angles prominent, straight not projecting anteriorly in dorsal view, sulcate in lateral view; calli prominent, asperate, broadly confluent anteriorly, reaching anterolateral margins; ventral third of propleura, prosternum narrowly bordering coxae and attaining front margins, and variable portion of basalar plate, episternum, epimeron, and second abdominal sternite testaceous or ivory. LEGS: black or fuscous; apices and perhaps bases of coxae, and margins of trochanters testaceous or fulvous; femora sometimes extensively fulvous or testaceous medially, with fuscous spots and streaks; tibiae fulvous or testaceous, infuscated basally, apices fuscous; tarsi fuscous or black, in some specimens femora extensively castaneous and tibiae rufescent. HEMELYTRA: insertion ochraceous or testaceous. VESTITURE: dorsum densely covered with short recurved sericeous white setae, which are woolly on head, pronotum and scutellum, appressed on hemelytra; specimens sometimes densely covered with long white or fuscous setae, which are erect on head, pronotum and scutellum, suberect on hemelytra; both types of setae sometimes golden; venter moderately covered with thin suberect white to fulvous setae, these setae are long on the midline of the sternites.

Macropterous female. More robust than male, with more extensive light coloration, but similar in structure and vestiture. Length 5.00–6.30, width 2.10–2.70. HEAD: width across eyes 1.18–1.41, vertex 0.56–0.70, dorsal width of eye 0.29–0.36, distance from tylus to ventral margin of eye 0.58–0.73, height of eye 0.48–0.58, maximum interocular width 0.83–1.05; testaceous or ochraceous coloration varies from a minimum on clypeal, jugal and loral sutures, preapical portion of clypeus, infuscated juga and lora, and medial portion of gena, to a maximum on entire ventral portion of head, ventrad of antennal insertions, except for the basal half of clypeus, buccula and gula. ROSTRUM: length 1.78–2.18, reaching apices of mesocoxae, sometimes reaching apices of metacoxae. ANTENNAE: I, length 0.50–0.64, sometimes entirely fulvous; II, 1.28–1.73; III, 0.79–1.08; IV, 1.00–1.25. PRONOTUM: length 1.00–1.25, anterior width 0.91–1.13, maximum width 1.66–2.33. LEGS: fulvous, coxae and trochanters with medial fuscous or black patch, femora with ventral fuscous spots and streaks, tarsi black; in some specimens femora extensively castaneous and tibiae rufescent. VENTER: testaceous or ochraceous, dorsolateral regions of sternites sometimes somewhat infuscated or entirely black, posteriorly directed medial portion of seventh sternite sometimes black. VESTITURE: both sericeous and long types of setae sometimes golden.

Types. Male holotype. Woody, [Kern Co.], Cal., Mar. 5, 61; HOLOTYPE ♂, Irbisia silvosa, 1963 B. P. Bliven [red]; CAS type no. 13864. I have examined the holotype and twenty-four paratypes; all are conspecific and retained at the California Academy of Sciences in San Francisco, California.

Taxonomic consideration. The following specimens of the paratypic series of *I. sita* are *I. silvosa*: Atascadero, S.L.O. Co., California, 23 April 1919, V.D. (three females); Pasadena, L.A. Co., California, 30 April 1909, F. Grinnell (two males); Foster, San Diego Co., 22 April 1913, V.D. (one male); San Diego Co., 11 March 1914, V.D. (one male). *I. paulula* Bliven is the junior synonym of *I. silvosa* because of identical genitalic structures of both sexes. Specimens that would be identified as *I. paulula* differ from the typical *I. silvosa* by the former's slightly smaller size and lack of erect or suberect long white or fulvous setae. Of the material on hand, specimens that do not have long setae are from Baja California Norte, and Fresno, Kings, Los Angeles, Riverside, San Bernardino, San Diego, San Luis Obispo and Sta. Barbara Counties, California. I have collected male and female specimens of *I. silvosa* from south of El Condor, Baja California Norte, that do not have any of the light coloration characteristic of this species. The femora (especially the metafemora) are castaneous with black spots basad. The genitalia of both sexes do not differ from more characteristically colored specimens.

Remarks. The distribution of *I. silvosa* is extensive in California, occupying many floristic associations in four ecoregional provinces. Douglas County, Oregon is the known northern limit of the distribution. This area and the northwestern counties of California are in the Pacific forest province. Within this province specimens of *I. silvosa* occupy openings and roadcuts in the following floristic associations: cedar–hemlock–Douglas fir, redwood, and california mixed evergreen forests. The blue oak–digger pine and southern oak forest associations of the eastern portion of the Sierran forest province and the California chaparral province provide the majority of the habitats of this species. Chaparral, juniper–pinyon woodland, mixed hardwood, coastal sagebrush and valley oak savanna floristic associations are also occupied in the previously mentioned provinces. Specimens of *I. silvosa* have been collected in the California grassland province from California prairie (*Stipa* spp.) and riparian forest floristic associations.

Adult specimens have been collected from these graminoid hosts: *Agropyron* sp., *Avena fatua* L., *Avena* sp., *Bromus rigidus* Roth, *B. rubens* L., *Bromus* sp., *Elymus* sp., *Festuca* sp., *Hordeum* sp. and *Vulpia* sp. Other non-graminoid plants from which adults have been collected are: *Adenostoma* sp., *Amsinckia intermedia* F. & M., *Amsinckia* sp., *Arctostaphylos* sp., *Artemisia californica* Less., *Astragalus* sp., *Baeria chrysostoma* F. & M., *Baeria* sp., *Ceanothus crassifolius* Torr., *C. cuneatus* (Hook.) Nutt., *C. intergerrimus* H. & A., *Cercocarpus ledifolius* Nutt., *Chaeniactis* sp., *Cirsium occidentale* (Nutt.) Jeps., *Crypthantha intermedia* (Gray) Greene, *Eriophyllum confertiflorum* (DC.) Gray, *Lomatium dasycarpum* (T. & G.) Coult. & Rose, *Lotus scoparius* (Nutt. in T. & G.) Ottley, *Lupinus* sp., *Malvastrum fasciculatus* (Nutt.) Greene, *Nemophila* sp., *Penstemon antinhinoides* Benth., *Phacelia distans* Benth., *P. tanacetifolia* Benth., *Plagiobothrys* sp., *Platystemon californicus* Benth., *Prunus persica* Batch, *Quercus chrysolepis* Liebm., *Q. dumosa* Nutt., *Q. lobata* Nee, *Q. wislizenii* A. DC., *Rhamnus crocea* Nutt. ex T. & G. (and ssp. *ilicifolia* (Kell.) C. B. Wolf, *Ribes* sp., *Salvia mellifera* Greene, *Salvia* sp., *Trichostema parishii* Vasey, *Trifolium variegatum* Nutt., and *Yucca schidigera* Roezl ex Ortgies.Adult specimens have been colleted from 64 to 1622 m. (210 to 5322 feet) elevation and from 23 February to 27 May.

Specimens examined. 1,262 specimens were examined from the following localities (Map 4). **MEXICO:** BAJA CALIFORNIA NORTE: 12.1 mi. NE Ensenada (UCR); 3.0, 3.4 & 6 mi. S El Condor (AMNH); 3 mi. W Meling Rch. (UCB); 10 mi. S San Vicente (UCB). **UNITED STATES:** CALIFORNIA: *Alameda Co.,* Altamont (UCB); Arroyo Mocho, 22 mi. S Livermore (UCB), 11 mi. E & 11–12 mi. SE Livermore (OSU & F&A). *Amador Co.,* Ione (UCD); Volcano, & 3 mi. N (UCD). *Butte Co.,* Chico (CAS); Oroville (CAS); Yankee Hill (CAS). *Calaveras Co.,* Altaville (F&A); Angels Cmp. (CAS); Calaveras Res. (UCB); Mokelumne Hill (UCB); 4 mi. S Railway Flat (UCB). *Colusa Co.,* Wilbur Hot Spgs. (JTP). *Contra Costa Co.,* Lafayette (UCB); Mt. Diablo—Russelman St. Pk. (UCB, OSU). *El Dorado Co.,* Cool (UCB); El Dorado (F&A); Lotus (F&A); Marshall Gold Discovery St. Hist. Pk.—nr. Coloma (OSU); Nashville (UCD); Pine Hill—W Rescue (UCD); Shingle Spgs. (F&A). *Fresno Co.,* Ciervo Hills—18 mi. SW Mendota (UCB); 12 mi. W Coalinga (UCB); Dunlap (UCD); Jacalitos Cyn.—SW Coalinga (CAS). *Humboldt Co.,* Blocksburg (OSU); 2 mi. W Briceland (UCB); Bridgeville—behind cafe (OSU); W Bridgeville—mp. 40.91 on rt. 36 (OSU); Dinsmores (CAS); Ft. Seward (UCB, OSU); SW Garberville—mp. 0.28 on Co. rd. 6B (OSU); btw. Honeydew & Bullcreek mp. 0.46 (OSU); Laribee Valley (CAS); Miranda—mp. 6.52 Ave. of the Giants (OSU); Redway—Redwood Dr. (OSU). *Kern Co.,* Antelope Cyn.—Tehachapi Mts. (UCR); 27 mi. SE Bakersfield (UCB, OSU); Ft. Tejon (CAS); Glenville, & 2 mi. E on rt. 155 (UCB & OSU); Havilah, & 3 mi. NE (UCR & UCB); Hobo Cmpgd.—Kern River (UCB); Lk. Isabella Cmpgd. (OSU); Lebec (CAS & UCB); 1 mi. NE McKittrick (UCB); 5 mi. NE Mojave (UCB); Quail Rsr.—1 mi. E Keene School on Hwy. 466 (UCB); Tejon Pass (UCB); Woody (CAS, UCB); 3 mi. W & 11 mi. NW Woffard Hts. (UCB & OSU). *Kings Co.,* 8 mi. SSW & Avenal (F&A & UCD); Kettleman Hills—3 mi. E Avenal (UCB); McClure Valley (UCD). *Lake Co.,* Blue Lks. (UCB); Butts Cyn.—10 mi. SE Middleton (F&A); Clear Oaks—mp. 29.16 on rt. 20 (OSU); Herendon Crk.—Lower Lk. (CAS); Lk. Pillsburgh (UCB); Nice (UCB); 12 mi. N Upper Lk. (UCB); Walker Rdg. (UCD); rt. 20—Lake Co. line (OSU); 0.2 mi. W intrsct. rts. 20 & 53 mp. 31.21 (OSU). *Los Angeles Co.,* Bell Glen Cyn. (LACM); 3 mi. SE Calamigos (UCB); Crater Cmp.—Sta. Monica Mts. (LACM); Eagle Arch Hills (UCR); Elizabeth Lk. Cyn. (LACM); Frenchmans Flat (UCB); Ganesha Hills (CU); 5 mi. SE Gorman (F&A); Irwindale (UR); Lk. Hughes (LACM); Newhall (CAS); Los Angeles, Angeles Nat. For. (OSU, F&A, LACM, UCD, USNM); Pasadena (CAS, USNM); Pine Cyn. Rd.—San Fernado (LACM); San Gabrial Mts. (OSU); Solemint (CNC); Tanbark Flat (UCB); Tapia Park (LACM); Westwood Hills (UCD); Woodland Hills (AMNH). *Madera Co.,* Coarsegold (UCB); San Joaquin Expt. Rng. (OSU, UCB). *Marin Co.,* Fairfax (CAS); Mill Valley (CAS, SDNH); Phoenix Lk. (CAS); Pt. Reyes (CAS). *Mariposa Co.,* 6 mi. NW Mariposa (UCB).

Mendocino Co., Calif. Coast Range Prsv. 5 mi. N Branscomb (UCB); 11 mi. E Calpella (UCD); btw. Coptche & Ukiah—mp. 40.68 on rt. 223 (OSU); 6 mi. N Hopland (OSU); Hopland, Univ. Calif. Field Sta. (UCB); Longvale—mp. 0.24 on rt. 162 (OSU); 1 mi. N & 2 mi. SE Piercy (UCB); Ryan Crk. (UCB); Tooby Mem. Co. Pk. (OSU); Ukiah (CAS, USNM); 8 mi. E Yorkville (UCB); mp. 68.61 on Hwy. 101 (OSU). *Merced Co.,* Pacheco Pass (F&A). *Monterey Co.,* Arroyo Seco Cmpgd. (UCD); Bryson (CAS); Carmel (CAS); 5 mi. N Escondido Cmpgd.—Sta. Lucia Mts. (UCB); Jamesburg, & 1 mi. S—Sta. Lucia Mts. (UCB); King City (UCD); 8 mi. E Lucia (UCB); Monterey (UCB); 10 mi. W Salinas—0.5 mi. on cutoff to Carmel Valley (OSU); San Ardo (CAS); Wiley Rch.—6 mi. W Greenfield (UCB). *Napa Co.,* Angwin (PUC); Bothe—Napa Valley St. Pk. (OSU); Calistoga (WSU); nr. Conn Dam (AMNH); Lk. Berryessa (WSU); Monticello, & 11 mi. S (F&A & UCD); 3 mi. W Oakville (OSU); Pope Valley, & 5 mi. SE, 7 mi. S (UCD); 7 mi. E Rutherford (UCD); Wooden Valley (UCD). *Nevada Co.,* Alta Sierra (CAS); 8 mi. S Grass Valley (CAS); Vera Lk.—Nevada City (CAS). *Placer Co.,* Auburn, & 5 mi. NE (UCB & WSU); nr. Applegate (UCB); Newcastle (UCD). *Riverside Co.,* Banning (USNM); Cabazon (UCR); Cactus Spg. Trl.—btw. Hwy. 74 & Horsethief Crk. (T7S R5E Sec. 12) (UCR); El Cariso Rgr. Stn.—Hwy. 74, Cleveland Nat. For. (UCR); Gavilan (UCR); Hemet (USNM); H. James Rsr.—Lk. Fulmore (UCR); Lk. Mathews (UCR); Millard Cyn. (UCR); Moreno (USNM); 1.5 mi. W & 2 mi. N Perris (UCR & UCD); Pinyon Flat—16 mi. SW Palm Desert (UCB); 2 mi. N Poppet Flat on Hwy. 243 (UCR); Sage, & 5 mi. S (UCB); 5.6 mi. S Sage (T7S R1E Sec. 32) (UCR); Riverside (UCR); Wilson Valley Rd.—1 mi. N Hemet (OSU); mp. 21.29 on rt. 243 (OSU). *Sacramento Co.,* Arcade Crk. (F&A); Fair Oaks (F&A); 3 mi. N Folsom (UCD); Galt (UCD). *San Benito Co.,* Big Panoche Crk. (UCB); Hernandez (F&A); 2 mi. NE New Idria (UCB); Paicines, & 12 mi. S (F&A & UCB); Panoche Pass (UCB); Pinnicles Nat. Mon. (F&A, OSU); 10 mi. S Pinnicles Jct. on Hwy. 25 (UCB). *San Bernardino Co.,* S Camp Angeles (UCR); 4 mi. E Mentone (AMNH, UCR); Redlands, & 10 mi. SW (CAS, UCD); Yucaipa (UCR). *San Diego Co.,* Alpine (UCB); Banner Grade (ASU); Boulevard (UCB); Descanso (CAS, UCB); 3 mi. SE El Cajon (UCB); 12 mi. N Escondido (F&A; Jacumba, & Round Mt. (F&A & SDNH); Julian (UCR); Lk. Henshaw (UID); Pala (USNM); Pine Valley, & 2 mi. S (CAS, UCB); San Diego (CAS); Sta. Ysabella (UID); 9.3 mi. NW Sissors Crossing (OSU); SE Sunshine Summit—mp. 7.7 on rt. 79 (OSU); Warner Spgs.—Chihuahua Valley (SDNH); Witch Crk. (USNM). *San Joaquin Co.,* Lone Tree Cyn. (F&A). *S.L.O. Co.,* Atascadero, & 7 mi. SW (CAS, UCB); 10 mi. SE, 2.5, 4 & 10 mi. S, 4 mi. N Creston (CAS, UCB); 2 mi. NW Cuesta Pass—Sta. Lucia Rng.; (UCB); Cuyama Valley (LACM); La Panza Cmpgd., & 12 mi. NE (UCB); Morro Bay (CAS); 5 mi. SE Nacimiento Dam (UCB); 2 mi. W Paso Robles (UCB); Pozo (UCB); Sta. Margarita, & 5 mi. NE (UCB); Templeton (CAS, UCD). *San Mateo Co.,* Palo Alto (CAS, CU). *Sta. Barbara Co.,* 1 mi. S Buellton (UCB); Los Prietos (UCB); Wons Crk.—below Lk. Cachuma (CAS). *Sta. Clara Co.,* Mt. Hamilton, & 11 mi. E (UCB); San Antonio Valley (UCB); San Jose (USNM); Silver Crk. (UID); Singleton Rd. (UID). *Sta. Cruz Co.,* Sta. Cruz (UCD). *Shasta Co.,* Wiskeytown St. Pk. on rt. 299 (OSU); Shasta Co. (F&A). *Solano Co.,* Gates Cyn.—6 mi. NW Vacaville (UCD); 3 mi. SE Suisun (OSU); Vacaville (UCD). *Sonoma Co.,* 1.5 mi. S Asti (UCD); Cazadero (CU); Trinity Rd. (UCB). *Stanislaus Co.,* Del Puerto Cyn.—Frank Raines Pk., 18 mi. W Patterson (UCB, UCD). *Tehama Co.,* 2 mi. N Red Bluff—jct. of rt. 36 & I 5 (OSU). *Trinity Co.,* 8 & 9 mi. E Forest Glen Summit on rt. 36 (OSU); E Mad River St. Pk.—mp. 4.63 on rt. 36 (OSU); 3.7 mi. S rt. 36 on Van Duzen Rd. (OSU). *Tulare Co.,* Ash Mt. Rngr. Stn.—Sequioa Nat. Pk. (AMNH); Fairview (UCB); 10.3 mi. N & Lemon Cove (AMNH & UCB). *Tuolumne Co.,* Buck Mdws. (USNM); Jamestown (UCB); N. Frk. Tuolumne River—3 mi. NE Tuolumne (CAS). *Ventura Co.,* 2 mi. E Lk. Sherwood (UCB); Ojai (F&A); Quatal Cyn. (UCB). *Yolo Co.,* Cache Crk. Cyn. Pk.—7.2 mi. NW Rumsey (OSU, UCB, UCD); Davis (UCD); Putah Cyn. (UCD). *Yuba Co.,* Cherry Valley (USNM). OREGON: *Curry Co.,* 1 mi. N Agness (T35S R11W Sec. 7) (OSU). Douglas Co., Whistler's Bend—12 mi. E Roseburg (AMNH).

Irbisia sita Van Duzee
Figs. 14a, b, 37, 60, 83; Map 12

Irbisia sita Van Duzee, 1921a, pp. 150, 152 (new species). Carvalho, 1959, 106.
Irbisia neptis Bliven, 1963, p. 74. **New Synonymy.**

Diagnosis. I. sita is distinguished from other small (less than 5 mm. in length) *Irbisia* on the basis of a combination of characters. The vestiture is a mixture of dense, woolly sericeous white setae and moderately distributed long white or gray setae. The anterior width of the pronotum is narrow, from 0.71 to 0.83 mm. in males, and from 0.81 to 0.88 mm. in females, producing a ratio with the width of the head across the eyes of from 1:0.66 to 1:0.73 in males, and from 1:0.70 to 1: 0.78 in females. The basalar plate is entirely black. The femora of both sexes are mostly castaneous and may be rufescent. Positive identification of this species is facilitated when the left paramere of the male is examined. This structure is abruptly curved, with the apical half long, and the apex flattened at right angles to the axis of the shaft. No other small species of *Irbisia* has a remotely similar paramere. The structure of the sclerotized rings and dorsal labiate plate of the female are also distinctive.

Description. Macropterous male. Length 4.25–5.00, width 1.15–1.80, polished shining black, moderately clothed with a mixture of long, upright white or gray setae, and dense, sericeous woolly white setae. HEAD: width across eyes 1.06–1.16, vertex 0.45–0.51, dorsal width of eye 0.28–0.33; triangular; tylus rounded in dorsal view, smooth; temporal areas indistinct, polished; median depression indistinct or very shallowly depressed; basal carina straight, moderately prominent, acute and abrupt, or rounded or flattened and declivous to level of vertex; eyes broadly joined to frons, protruding laterally, posteriolateral margin slightly arcuate posteriorly in dorsal view; distance from tylus to ventral margin of eye 0.45–0.53, height of eye 0.45–0.51, maximum interocular width 0.71–0.83. ROSTRUM: length 1.55–1.73, fulvous to castaneous, attaining apices of mesocoxae. ANTENNAE: black; I, length 0.53–0.63; II, 1.33–1.78; III, 0.85–1.05; IV, 0.95–1.10. PRONOTUM: length 0.80–0.95, anterior width 0.71–0.83, maximum width 1.30–1.63; conical, broadly convex, distinctly and closely punctate, rugulose rear margins, posteriolateral margins arcuate, lateral margins slightly concave, rounded at junction with propleura anterior angles broadly rounded in dorsal view, slightly sulcate in lateral view; calli slightly convex, smooth or slightly asperate, confluent anteriorly, reaching anterolateral margins of pronotum. LEGS: fulvous to castaneous; bases of coxae, apices of tibiae and tarsi black; femora sometimes extensively black on basal half; tibia testaceous. VESTITURE: dorsum moderately clothed with long white or gray setae, erect on head, pronotum and scutellum, suberect and shorter on hemelytra; intermixed with dense, woolly, recurved sericeous white setae; venter sparsely clothed with thin erect white setae.

Macropterous female. More robust than male, otherwise similar in structure, color and vestiture. Length 4.70–5.40, width 1.83–2.25. HEAD: width across eyes 1.12–1.25, vertex 0.52–0.60, dorsal width of eye 0.28–0.31, distance from tylus to ventral margin of eye 0.50–0.58, height of eye 0.46–0.53, maximum interocular width 0.80–0.90. ROSTRUM: length 1.63–1.80, reaching apices of mesocoxae. ANTENNAE: I, length 0.50–0.58, II, 1.30–1.58, sometimes fuscous; III, 0.85–1.00; IV, 0.91–1.05.

PRONOTUM: length 0.91–1.08, anterior width 0.81–0.98, maximum width 1.55–1.88.

Types. Male holotype. San Diego Co., 4-11-14 Cal., EP Van Duzee; HOLOTYPE sita [red]; CAS type no. 805. I have examined twelve paratypes which are conspecific with the holotype. Seven paratypes were misidentified and are specimens of *I. silvosa*; one paratype was misidentified and is a specimen of *I. incomperta.* All of the preceding material (two conspecfic paratypes are at the Canadian National Collection, Ottawa) is retained at the California Academy of Sciences in San Francisco.

Taxonomic consideration. The original description of this species clearly describes the holotype and the paratypic series from Foster, San Diego County. These specimens are all conspecific; several other paratypes were incorrectly identified. *I. neptis* Bliven, the junior synonym of *I. sita,* fits within the habitus of this species in all aspects.

Remarks. The distribution of *I. sita* is strictly southern California. The northernmost populations occur in Pinnacles National Monument, San Benito County; the southern limit of the range is 30° north latitude, near El Rosario, in Baja California Norte. Within this range, specimens occur in southern oak forest, chaparral and blue oak–digger pine floristic associations. Adult specimens have been collected from these grasses: *Agropyron* sp., *Bromus* sp., *Elymus* sp. and *Hordeum vulgare* L.; and non-graminoids: *Amsinckia intermedia* F. & M., *Astragulus pomonensis* Jones, *Ceanothus crassifolius* Torr., *C. cuneatus* (Hook.) Nutt., *Ceanothus* sp., *Cercocarpus betuloides* Nutt. ex T. & G., *Lotus scoparius* (Nutt. in T. & G.) Ottley, *Penstemon antrirrhinoides* Benth., *Rhamnus crocea* Nutt. in T. & G., *Rhus trilobata* Nutt. ex T. & G., *Solanum xanti* Gray, *Yucca whipplei* Torr. Adult specimens have been collected from 6 March to 29 April and from 30 to 750 m. (100 to 2460 feet) elevation.

Specimens examined. 80 specimens were examined from the following localities (Map 12). **MEXICO**: BAJA CALIFORNIA NORTE: 12 mi. SE El Rosario (UCR); 4.3 mi. N Ensenada (UCR); 7 mi. SE Maneadero (UCB); 11 mi. N San Vicente (UCB). **UNITED STATES:** CALIFORNIA: *Los Angeles Co.,* Burbank (USNM); Eve Cyn.—Pomona (LACM); Frenchman's Flat (UCB); Gorman (CAS); Pasadena (USNM); San Gabriel R.—mouth of N Frk. (UCR); Sta. Monica Mts. (LACM); Tapia Park (LACM); Topanga Cyn. (LACM). *Orange Co.,* Sta. Ana (USNM). *Riverside Co.,* Gavilan (UCR); Riverside (UCR). *San Benito Co.,* Pinnacles Nat. Mon. (UCB, UCD). *San Bernardino Co.,* 4 mi. E Mentone (AMNH); Mountain Home—S. Bernardino Mts. (AMNH). *San Diego Co.,* Alpine (UCB); Fallbrook (UCR); 2 mi. E Lyons Valley (UCB); Mission Dam (USNM); San Diego (AMNH, USNM); San Susana Mts. (LACM); SE Sunshine Summit—mp. 7.7 on rt. 79 (OSU). *S.L.O. Co.,* 10 mi. S Creston (UCB); La Panza Cmp.—12 mi. NE Pozo (UCB); 5 mi. NE Sta. Margarita (UCB). *Sta. Barbara Co.,* Los Prietos (UCB). *Ventura Co.,* N end of Casitas Res. (UCB).

Irbisia solani (Heidemann)

Figs. 6, 18a, b, 41, 64, 87; Map 9

Capsus solani Heidemann, 1910, pp. 200–201, fig. 3 (new species).

Irbisia brachycerus: Vosler, 1913, pp. 551–553, figs. 331, 332. Childs, 1914, p. 220 (misspelled *Irbesia brachycerus*).

Irbisia brachyerus var. *solani:* Van Duzee, 1914, p. 24 (in part, new combination and new status); 1917a, p. 325 (in part). Carvalho, 1959, pp. 104–105 (in part).

Irbisia sericans: Essig, 1915, pp. 213–214, fig. 189.

Lygus brachycerus: Van Duzee, 1917b, pp. 265–266 (in part, new combination).
Lygus solani: Van Duzee, 1917b, p. 266 (new combination).
Irbisia solani: Van Duzee, 1916b, p. 38 (new combination); 1921a, pp. 145, 152. Essig, 1926, p. 361. Essig and Hoskins, 1944, pp. 71–72. Herms, 1926, p. 269. Tavernetti, 1933, p. 22. Lockwood, 1933, pp. 329–331. Carvalho, 1959, p. 106. Hall, 1959, pp. 48–51, figs. 1–4. Bliven, 1963, p. 68.
Irbisia setosa: Van Duzee, 1921a, p. 149 (in part, not holotype).
Irbisia incomperta: Bliven, 1963, pp. 73–74, 86, pl.8, figs.1, 1a (in part, not holotype).
Irbisia paulula: Bliven, 1963, pp. 75–76 (in part, not holotype).
Irbisia lacertosa Bliven, 1963, pp. 76–77, 84, pl. 8, figs. 3, 3a. **New Synonymy.**
Irbisia inurbana Bliven, 1963, pp. 81–82, 86, pl. 8, figs. 7, 7a. **New Synonymy.**
Irbisia serrata: Bliven, 1963, pp. 82–83 (in part, not holotype).

Diagnosis. I. solani is distinguished by: shining black, mostly smooth dorsum; mixed vestiture of white to fulvous sericeous and short, thin setae; rounded and indistinct anterior angles of pronotum; mostly smooth (with several slight spines) outer surface of the left paramere, and non-expanded, linearly spiculate sclerotized process of the male; narrow dorsal labiate plate, and sclerotized rings of the female. In the Willamette Valley of Oregon, the above features will separate this species from *I. fuscipubescens, I. cascadia, I. sericans* and *I. serrata.*

I. solani is distinguished from *I. oreas* by: the considerably less densely distributed vestiture on the dorsum, tibiae lacking long fulvous setae, more convex calli, concave lateral margins of pronotum, long shaft of left paramere and apically spined right paramere of the male, and narrow sclerotized rings of the female. Separation of *I. solani* and *I. incomperta* is difficult and requires examination of the sclerotized rings of the female; those of the latter species are small and barely open centrally. *I. incomperta* differs externally from *I. solani* by these characters: vertex narrower (vertex to antennal segment I ratio ranging from 1:1.13 to 1:1.35 in males, and from 1:1.00 to 1:1.04 in females of *I. incomperta*; the ratio ranging from 1:0.82 to 1:1.06 in males, and from 1:0.79 to 1:0.92 in females of *I. solani*); medial depression of the head is obvious; lateral margins of the pronotum are concave; and the basalar plate is ochraceous. *I. solani* differs from *I. limata* by: the punctate pronotal disk, shorter rostrum, dark antennal segment I, and rounded membraneous lobes of the vesica of the male. *I. solani* is separated from *I. panda* by the non-convex clypeal base of the former species.

Description. Macropterous male. Length 3.80–5.20, width 1.70–2.50, shining black, moderately or densely clothed with recumbent, sericeous, white to fulvous setae intermixed with suberect, thin, fulvous setae. HEAD: width across eyes 1.00–1.28, vertex 0.44–0.63, dorsal width of eye 0.25–0.33; triangular, smooth or slightly asperate; temporal areas distinct, bordered basally by transverse, short sulcus; median depression indistinct or broad but shallow; basal carina straight, moderately prominent, acute or slightly rounded in cross section, declivous to level of vertex (either steep or gentle); eyes broadly joined to frons, moderately produced laterally, posterolateral margins slightly arcuate posteriorly in dorsal view; distance from tylus to ventral margin of eye 0.46–0.60, height of eye 0.44–0.53, maximum interocular width 0.70–0.88. ROSTRUM: length 1.40–1.83, black, piceous or fuscous, reaching bases of mesocoxae, usually attaining but seldom surpassing, apices. ANTENNAE: black or fuscous; I, length 0.40–0.58; II, 1.10–1.63; III, 0.55–0.88; IV, 0.73–1.05. PRONOTUM: length 0.80–1.05, anterior width 0.75–1.03, maximum width 1.43–1.80; subconical, broadly convex, distinctly or confluently punctate, posterolateral margin arcuate, lateral margins straight or very slightly concave, broadly rounded at junction with propleura, anterior angles rounded, indistinct in dorsal view, slightly sulcate in lateral view; calli moderately convex, smooth, confluent anteriorly, reaching anterolateral margins of pronotum with transverse depressions anterior of inner angles. LEGS: black; coxae and femora testaceous apically; femora sometimes extensively rufescent; tibiae testaceous, piceous on apices and bases; metatibiae sometimes extensively piceous. HEMELYTRA: fulvous on insertion. VESTITURE: dorsum moderately or densely clothed with recumbent, sericeous white to fulvous setae intermixed with suberect, thin, white to fulvous setae; head and pronotum predominantly clothed with upright shining white setae; venter sparsely clothed with thin suberect fulvous setae.

Macropterous female. Quite similar to male in structure, color and vestiture, but with more robust stature. Length 4.60–5.50, width 2.10–2.55. HEAD: width across eyes 1.13–1.29, vertex 0.55–0.65, dorsal width of eye 0.28–0.33, distance from tylus to ventral margin of eye 0.53–0.65, height of eye 0.45–0.53, maximum interocular width 0.81–0.93. ROSTRUM: length 1.60–1.80, reaching apices of mesocoxae, sometimes reaching apices of metacoxae. ANTENNAE: I, length 0.45–0.58; II, 1.10–1.60; III, 0.70–1.10; IV, 0.83–1.05. PRONOTUM: length 0.95–1.15, anterior width 0.90–1.05, maximum width 1.70–2.00.

Types. The holotype mentioned in Heidemann's original description (USNM No. 13227) has not been located and is presumed lost. I have examined eleven specimens from the apparent paratype series and all are conspecific (see discussion under the treatment of *I. serrata*). One male specimen with these label data: Walnut Creek, [Marin Co.], Cal.; feeding on potato 1910; injurious to Irish Potatoes; Type No. 13680 USNM; *Capsus* (*Rhopalotomus*) *solani* Heidm. O.H. is now designated as the lectotype of *C. solani.* This specimen is retained at the United States National Museum, Washington, D.C.

Taxonomic consideration. Heidemann (1910) described *Capsus solani.* Van Duzee (1914, 1917a) placed it in the genus *Irbisia* as a variety of *I. brachycerus* [*a*]. Van Duzee, however, had misidentified the latter species; *I. brachycera* (by Van Duzee) is conspecific with the then undescribed *I. serrata.* Van Duzee (1917b) subsequently elevated *solani* and placed it in the genus *Lygus.* Van Duzee (1921a) finally replaced *solani* in the genus *Irbisia* with species status. Carvalho (1959) cites *I. solani* as a variety of *I. brachycera.* Knight (1941) examined the holotype of *I. brachycera* and made *I. arcuata* its junior synonym. Knight did not recognize *I. brachycera* by Van Duzee (1914, 1921) as a distinct species. However, Bliven (1963) gave *I. brachycera* by Van Duzee species status as *I. serrata.* In the same paper Bliven agreed with Van Duzee (1921a) (although he does not state this fact) in elevating *I. solani.* Herein *I. brachycera, I. serrata,* and *I. solani* are treated as distinct species.

Vosler (1913) and Child (1914) in short economic papers followed the taxonomy of Van Duzee (1914, 1917a) and placed *I. solani* as a variety of *I. brachycera.* Both applied and taxonomic workers postdating 1941 except Carvalho (1959) refer to *I. solani* as a distinct species. Many of the key specimens referred to in the above literature were examined during the course of this study.

Remarks. The distribution of *I. solani* is extensive in California, occupying ten vegetational associations within the Pacific and Sierran forest, and California chaparral provinces. This species is also found in low lying situations in the Willamette Valley of Oregon from Forest Grove to Eugene. Both sections of the range of *I. solani* are dominated by oak woodlands. The vegetational associations occupied are: mixed hardwood forest (*Arbutus-Quercus*), blue oak–digger pine forest (*Pinus-Quercus*), southern oak forest (*Quercus agrifolia*), valley oak savanna (*Quercus-Stipa*) and Oregon oakwoods (*Quercus garrayana*). In Humboldt, Mendocino and Trinity counties of northwestern California *I. solani* is distributed in mixed evergreen forests (*Arbutus-Chrysolepis-Lithocarpus-Pseudotsuga-Quercus-Rhodendron*) and coastal prairie-scrub mosaic (*Baccharis-Danthonia-Festuca*) floristic associations.

Adult specimens were colllected from these grass hosts: *Agropyron* sp., *Avena barbata* Broth., *A. fatua* L., *Bromus mollis* L., *B. rigidus* Roth, *Bromus rubens* L., *Elymus glaucus* Buckl., *Festuca arundinacea* Schreb., *F. rubra* L., *Hordeum* sp. and *Vulpia* sp. Adult specimens have been taken on the following non-graminoid plants: *Achillea millefolium* L., *Amsinkia intermedia* F. & M., *Artemisia douglasiana* Bess. in Hook., *Astragalus pomonensis* Jones, *Brassica* sp., *Carduus pycnocephalus* L., *Ceanothus cuneatus* (Hook.) Nutt., *Ceanothus* sp., *Conium maculatum* L., *Cryptantha* sp., *Cytisus scoparius* (L.) Link, *Eriodictyon californicum* (H. & A.) Torr., *Fraxinus latifolia* Benth., *Grindelia camporum* Greene, *Juglans californica* Wats., *Lupinus albifrons* Benth., *L. micranthus* Dougl. in Lindl., *Lupinus* sp., *Penstemon antirrhinoides* Benth., *Plagiobothrus nothofulous* (Gray) Gray, *Prunus ilicifolia* (Nutt.) Walp. *Quercus agrifolia* Nee, *Q. douglasii* H. & A., *Q. lobata* Nee., *Ranunculus* sp., *Rhamus californicus* Esch., *Salix* sp., *Solanum xantii* Gray, *Urtica holosericea* Nutt. and *Yucca whipplei* Torr. Several orchard and ornamental trees and agricultural crops have had adult specimens collected on them as well: artichoke, citrus, lilac, nut, peach, pear and potatoes. Specimens occur from 180 to 1420 m. (600 to 4650 feet) elevation and from 7 March to 15 July.

Specimens examined. 2,837 specimens were examined from the following selected localities (Map 9). **UNITED STATES:** ARIZONA: *Yavapai Co.,* Prescott (CAS). CALIFORNIA: *Alameda Co.* (17 localities). *Butte Co.* (3). *Calaveras Co.* (1). *Colusa Co.* (3). *Contra Costa Co.* (13). *El Dorado Co.* (6). *Fresno Co.* (5). *Humboldt Co.* (14). *Kern Co.* (15). *Lake Co.* (7). *Los Angeles Co.* (6). *Madera Co.* (4). *Marin Co.* (16). *Mariposa Co.* (1). *Mendocino Co.* (19). *Merced Co.* (1). *Monterey Co.* (24). *Napa Co.* (17). *Nevada Co.* (2). *Orange Co.* (7). *Placer Co.* (7). *Riverside Co.* (12). *Sacramento Co.* (5). *San Benito Co.* (11). *San Bernardino* Co. (8). *San Diego Co.* (12). *San Francisco Co.* (3). *San Joaquin Co.* (2). *S.L.O. Co.* (15). *Sta. Mateo Co.* (9). *Sta. Barbara Co.* (2). *Sta. Clara Co.* (14). *Sta. Cruz Co.* (2). *Shasta Co.* (6). *Solano Co.* (4). *Sonomo Co.* (15). *Stanislaus Co.* (4). *Sutter Co.* (2). *Tehema Co.* (2). *Trinity Co.* (2). *Tulare Co.* (13). *Tuolumne Co.* (4). *Yolo Co.* (3). *Yuba Co.* (10). All specimens are retained at CAS, F&A, OSU, UCB, UCD & UCR. OREGON: *Benton Co.* (5 localites) (CAS, JS, OSU & USNM); 4.2 mi. N & 6 mi. SW Corvallis (OSU); Finley Nat. Wldlf. Rfg. (OSU); Misty Pt.—McDonald St. For. (OSU); 1 mi. W Philomath (OSU). *Lane Co.,* Good Pasture Is.—Eugene (OSDA). *Linn Co.,* Peterson Butte (OSU). *Marion Co.,* Salem (USNM). *Washington Co.,* Blooming (OSDA); Cornelius (AMNH); Dilley (USNM); Forest Grove (OSDA, USNM). *Yamhill Co.,* McMinnville (OSU); Muddy Valley (OSU); Yamhill R.—McMinnville (OSU). UTAH: Ut. (USNM). WASHINGTON: *Thurston Co.,* Tenino & Olympia (USNM).

METHODS OF CLASSIFICATION

Characters for each species were compiled subsequent to the completion of the redescriptions. The characters of the male and the external morphology of the entire body were analyzed to delineate species groups. The character set was subjected to cladistic analysis using the PHYSYS program of Drs. J. S. Farris and M. F. Mickevich, State University of New York at Stony Brook. General discussions of cladistic analysis are found in Nelson and Platnick (1981) and Wiley (1981).

The options used in this algorithm produced two equally parsimonious trees of 44 steps when *Capsus cinctus* was chosen as the outgroup (see discussion of *solani* group). These trees are the minimum total length (in terms of changes in character states) arrangement of the data set. The relationships between the species are based on synapomorphies or shared derived characters. Sister groups, regardless of the number of furcations, originating from a node have a common hypothetical ancestor with certain derived characters relative to all the groups to the left of that node on a tree (Schuh and Polhemus, 1980). The PHYSYS program provided a list of the character changes leading to a node (the changes are the length of the stem) and the number of synapomorphies of each node as well as the tree itself. The presentation of the characters is found in Appendix A, the character matrix is in Table 1, and the arrangement of the characters is in Figure 101.

The data set used to determine the species groups contains characters from: the left paramere (21 characters), right paramere (4 characters), vesica (6 characters), and external morphology (3 characters). All the characters are coded as binary data.

With structures that appeared to be homologous in *Capsus cinctus* and the *Irbisia* species, characters selected were entered into the data matrix in the following manner. Where *Capsus cinctus* possessed a character it was assumed to be plesiomorphic (state '0'), and those species of *Irbisia* with that character were also coded as the state '0'. Where *C. cinctus* did not possess the characters as identified in *Irbisia, C. cinctus* was coded as state '0' as well. Those *Irbisia* species with that character (not found in *C. cinctus*) were coded as state '1', the apomorphic condition. These characters only found in the *Irbisia* species, and not *C. cinctus* are therefore coded as being present or absent. No assumptions were made as to transformation series or polarity of these characters. For example, character 3, sensory lobe strongly projecting above the surface of the arm is found in *C. cinctus* and coded state '0'. Character 1, sensory lobe not projecting above the surface of the arm, and character 2, sensory lobe slightly projecting above the surface of the arm, do not occur in *C. cinctus* and *C. cinctus* is again coded state '0' for these two characters. In another system of coding characters, characters 1 and 2 could have been represented as two states of one multistate character. This, however, would have required that one of the states be hypothesized as plesiomorphic. I have thus choosen to code such characters, not present in, but homologous to, the outgroup, as being present or absent to avoid an assumption of directionality.

This method of coding was possible for characters from the parameres and head. The structure of the male vesica is unique in both *Capsus* and *Irbisia* and therefore did not permit coding its characters as homologous. It was not practical, given the

Table 1. Matrix of Characters for *Irbisia* species.

	LEFT PARAMERE																					RIGHT PARAMERE				MALE VESICA						HEAD STRUCTURE		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
I. bliveni	0	1	1	1	0	0	1	1	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
I. brachycera	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	0
I. californica	0	0	0	0	1	0	0	1	1	0	1	1	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0
I. cascadia	0	1	1	1	0	0	1	1	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0
I. castanipes	0	1	1	1	0	0	1	1	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
I. cuneomaculata	0	0	0	0	1	0	0	1	1	0	1	0	1	0	0	1	0	1	1	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0
I. elongata	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	1
I. fuscipubescens	0	1	1	1	0	0	1	1	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	0	1	0	0	0	0	1	1	0	0	0
I. incomperta	0	1	1	1	0	1	0	1	1	1	0	0	0	1	0	1	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
I. knighti	0	1	1	1	0	1	0	1	1	1	0	0	0	1	0	1	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
I. limata	0	1	1	0	0	1	0	1	1	1	0	0	0	1	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
I. mollipes	0	1	1	1	0	0	1	1	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	1	1	1	0	0	0	0	1	0
I. nigripes	0	1	1	1	0	0	1	1	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0
I. oreas	0	1	1	1	0	1	0	1	1	0	1	0	0	1	0	1	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
I. pacifica	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	1
I. panda	0	1	1	1	0	0	1	1	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	1	1	1	0	0	0	0	1	0
I. sericans	0	0	0	0	1	0	0	1	1	0	1	0	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0
I. serrata	0	1	1	1	0	0	1	1	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
I. setosa	0	1	1	1	0	0	1	1	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0
I. shulli	0	1	1	1	0	0	1	1	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0
I. silvosa	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0
I. sita	0	0	0	0	1	0	0	1	1	0	1	1	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0
I. solani	0	1	1	1	0	1	0	1	1	1	0	0	0	1	0	1	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
Capsus cinctus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	–	–	–	–	–	0	0	0

scope of this revision, to develop homologies for the vesica considering the current state of our knowledge of the tribe Mirini.

DISCUSSION OF SPECIES GROUPS

The monophyly of *Irbisia* in the tribe Mirini is substantiated by the morphological characters presented in the generic and species descriptions. Several structures mentioned in the diagnosis of the genus *Irbisia,* pertaining to the genitalia of both sexes, that separate *Irbisia* and the genus *Capsus* have not been included in the matrix for analysis because of the autapomorphic nature of those characters. Cladistic analysis reveals five species groups of *Irbisia.* The species and synapomorphies for each are as found in Figure 101. In the cladogram characters with no homoplasy are in regular print, those with parallelism are in italics and those with reversal are in italics with a degree symbol after the number. The following discussion presents the species groups and their synapomorphies according to the characters in Table 1. The component numbers refer to Figure 101, and the numbers in parentheses are the character numbers with their states.

The *brachycera* group, component 27—*brachycera*, *elongata*, *pacifica* and *silvosa* uniquely possess: left paramere with sensory lobe not projecting above arm (1-1, 2-0, 3-1), large 'L' shaped angle (8-0), arm and shaft without spines (4-0, 17-0), arm and shaft of equal length (9-1), shaft stout and of equal diameter throughout (16-0), apex securiform with ventral and dorsal portions equally developed (18-1); right paramere, unexpanded distally (22-1), with single terminal spine parallel to long axis (24-0) and for all but *silvosa*, component 26, antennal socket with ventral margin below ventral margin of eye (32-1).

The *californica* group, component 30—*californica*, *cuneomaculata*, *sericans* and *sita* uniquely possesses: left paramere with sensory lobe strongly projecting above arm (1-0, 2-0, 3-0), sharp 'V' shaped angle (5-1), arm and shaft without spines (4-0, 17-0), shaft of greater length than arm (11-1), shaft slender and of equal diameter throughout (13-1); right paramere, unexpanded distally (22-1), with single terminal spine at right angle to long axis (23-1); vesica with sclerotized process tapering distally (29-1).

The *brachycera* and *californica* groups show parallelism in the distally unexpanded condition of the right paramere (22-1).

The remainder of the species of *Irbisia*, component 40 possess these synapomorphies: left paramere with sensory lobe slightly or moderately projecting above the arm (1-1, 2-1, 3-1), arm with tubercles and spines (4-1), apex securiform with ventral portion of blade larger than dorsal portion (19-1); right paramere with diameter expanded distally (22-0), double terminal spine (25-1).

The *solani* group, component 33—*incomperta*, *knighti*, *limata*, *oreas* and *solani* uniquely possesses: left paramere with moderate 'C' shaped angle (6-1) and shaft of equal moderate thickness throughout (14-1). Two equally parsimonious trees were derived in this analysis I have presented one (Fig. 101). In the other arrangement *oreas* and *limata* reverse positions resulting in this character arrangement: component 32 possesses character 10-1; component 31 possesses character 29-1; *oreas* possesses characters 11-1 and 29-1; *limata* posseses character 4-0.

Component 39—*bliveni*, *cascadia*, *castanipes*, *fuscipubescens*, *mollipes*, *nigripes*,

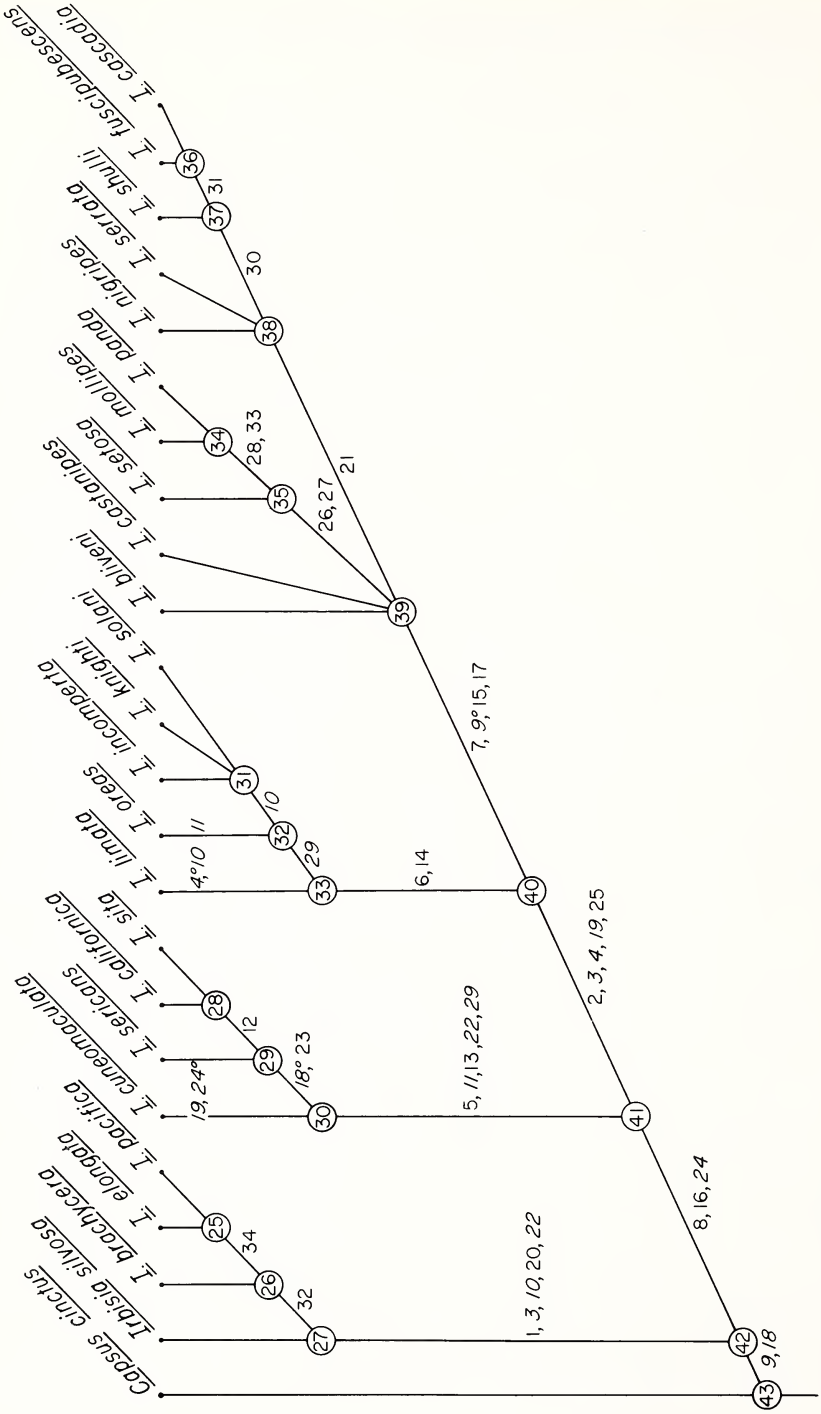


Fig. 101. Cladistically derived relationships of the species of *Irbisia* based on 34 characters.

Table 2. Relationships of cladistically derived species groups to the distribution patterns of the species of *Irbisia*.

WIDESPREAD
* *brachycera, pacifica.*
** *serrata.*

NORTHERN ROCKY MTS.
* *elongata.*
** *fuscipubescens.*
nigripes.
shulli.

SISKIYOU MTS.
** *cascadia.*

VANCOUVERAN
† *knighti.*
†† *sericans.*

CALIFORNIAN
† *limata, incomperta, oreas, solani.*
* *silvosa.*
†† *californica, sita, cuneomaculata.*
castanipes, bliveni[1].
*** *setosa, mollipes, panda.*

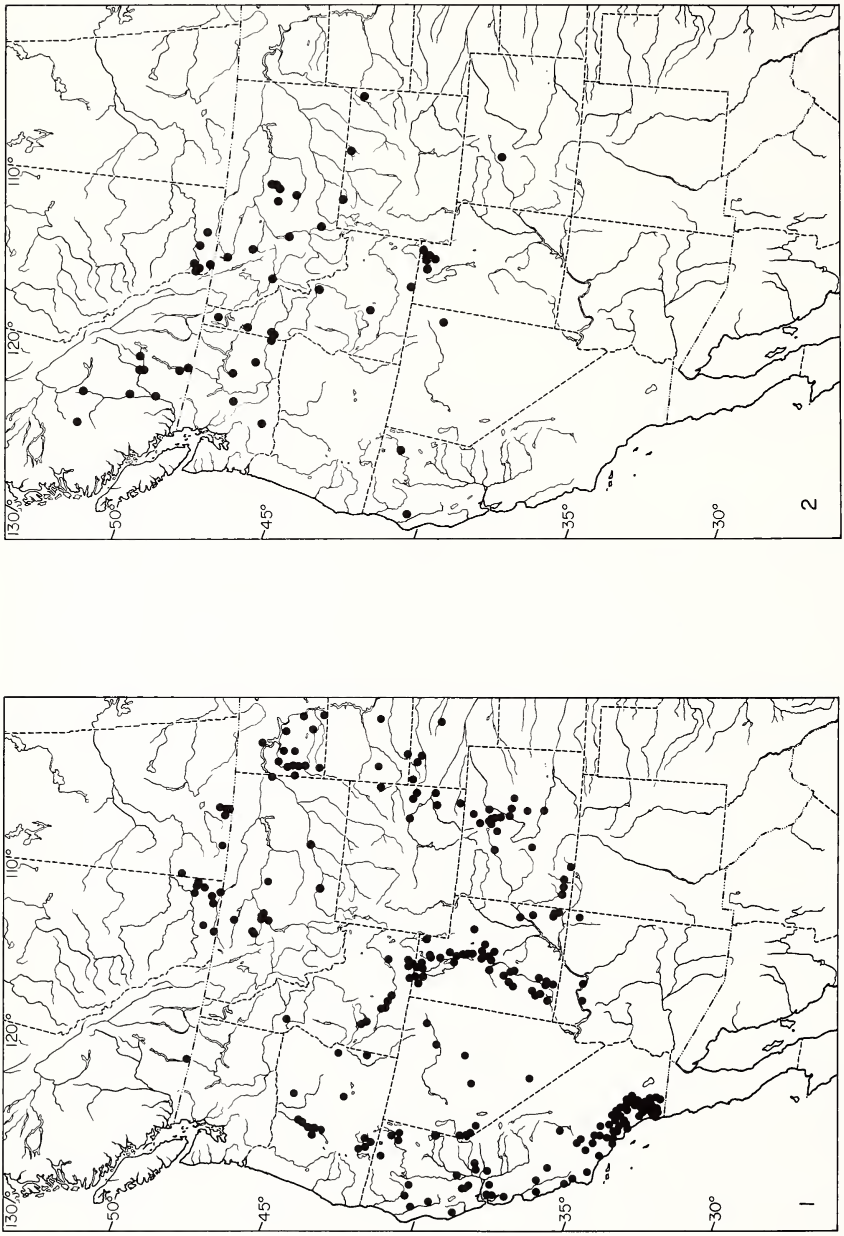
* *brachycera* group, ** *nigripes* group, *** *setosa* group
† *solani* group, †† *californica* group [1] Component 39

panda, *serrata*, *setosa* and *shulli* uniquely possesses: left paramere with broad 'U' shaped angle (7-1), length of shaft shorter than length of arm (9-0), shaft diameter constricted on apical two thirds (15-1), shaft with tubercles or spines (17-1). Within this component are two species groups. The *setosa* group—*mollipes*, *panda* and *setosa* uniquely possess: vesica with sclerotized process projecting sharply to the left (25-1) and large accessory lobe in front of sclerotized process (26-1). The *nigripes* group, component 38—*cascadia*, *fuscipubescens*, *nigripes*, *serrata* and *shulli* uniquely possesses a shaft which is subapically constricted with a 'T' shaped securiform apex (21-1). Within this species group component 37 uniquely possesses a cone shaped sclerotized process with very large spines (30-1).

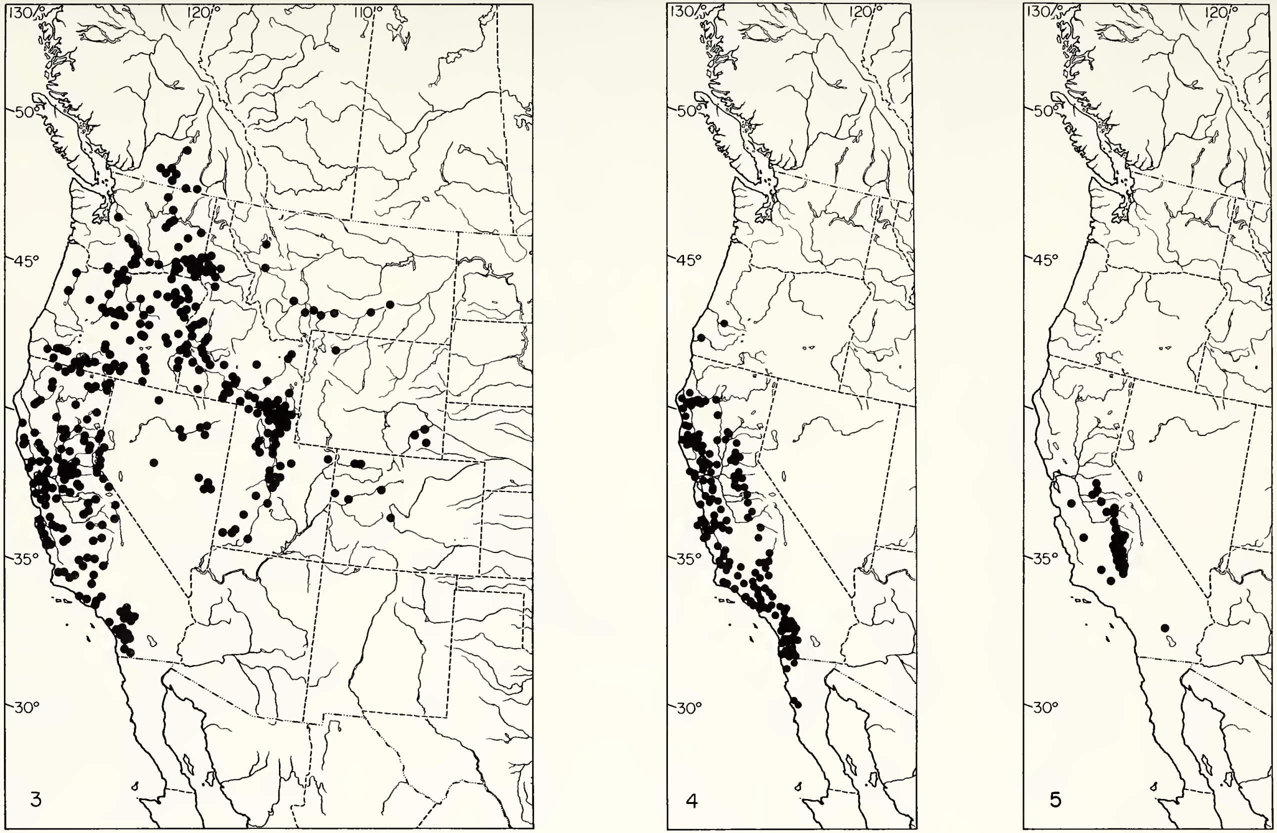
One or two species in each of these aforementioned species groups shows homoplasy in some characters. *I. silvosa*, in the *brachycera* group, lacks character 32-1. *I. cuneomaculata* has parallelism with component 40 in character 19-1, and reversal of character 24 to state '0' linking this species with the *brachycera* group. *I. limata* has a reversal of character 4 to state '0' thus showing some similarity with both the *brachycera* and *californica* species groups.

BIOGEOGRAPHY

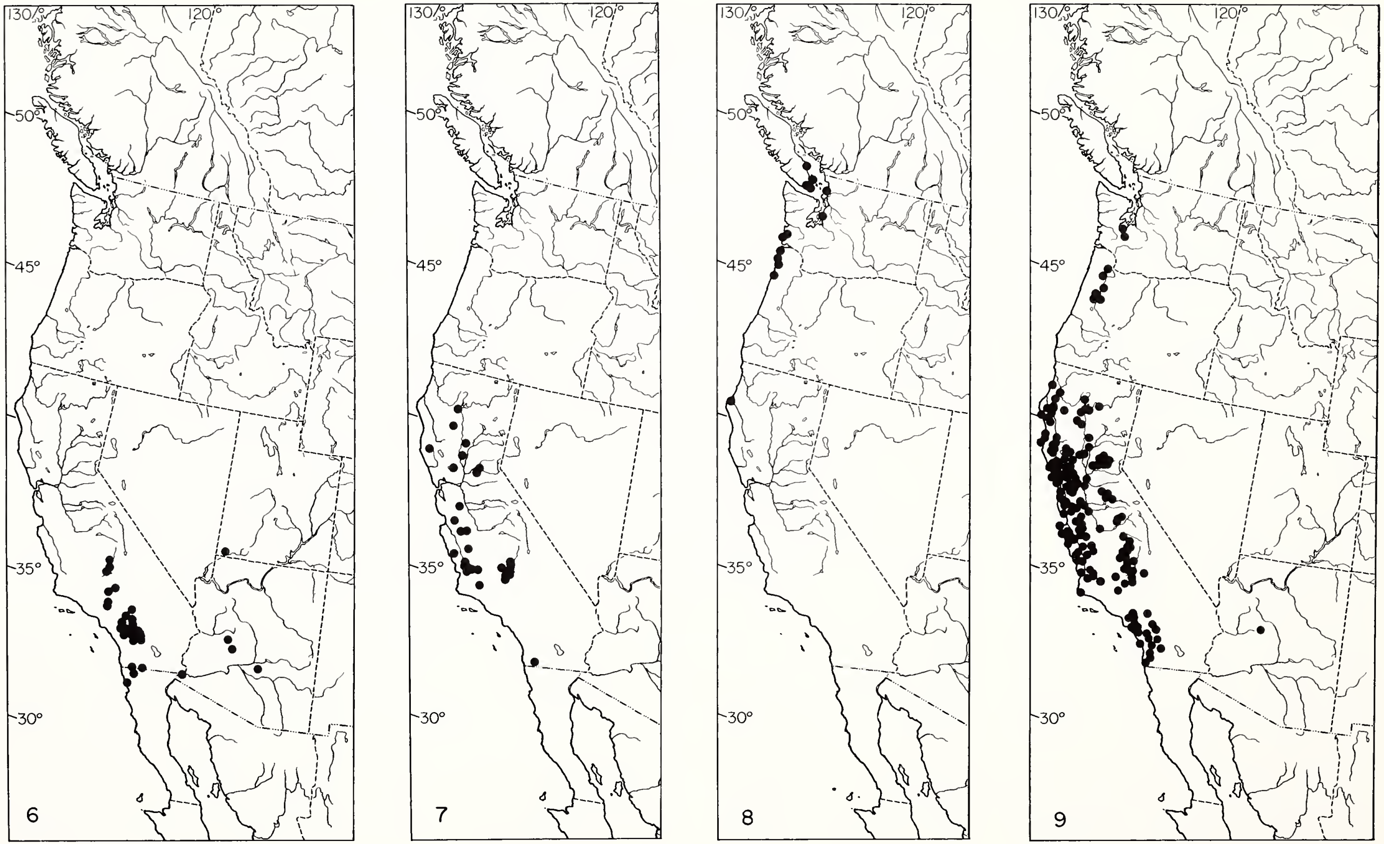
The individual species ranges of *Irbisia* reveal several distributional patterns. Table 2 lists the species of *Irbisia* within five distributional patterns. The species are also arranged according to their membership in the cladistically derived species groups. Each species group contains species which have ranges that cross distributional pattern boundaries. Within the *californica* species group the sister species *I. californica* and *I. sericans* occur in the Californian and Vancouveran pattern respectively. *I. solani* and *I. knighti* of the *solani* group display a similar relationship. Sister species connect the Northern Rocky Mountain and Siskiyou Mountain patterns; the California pattern is connected to the Northern Rocky Mountain pattern as well.



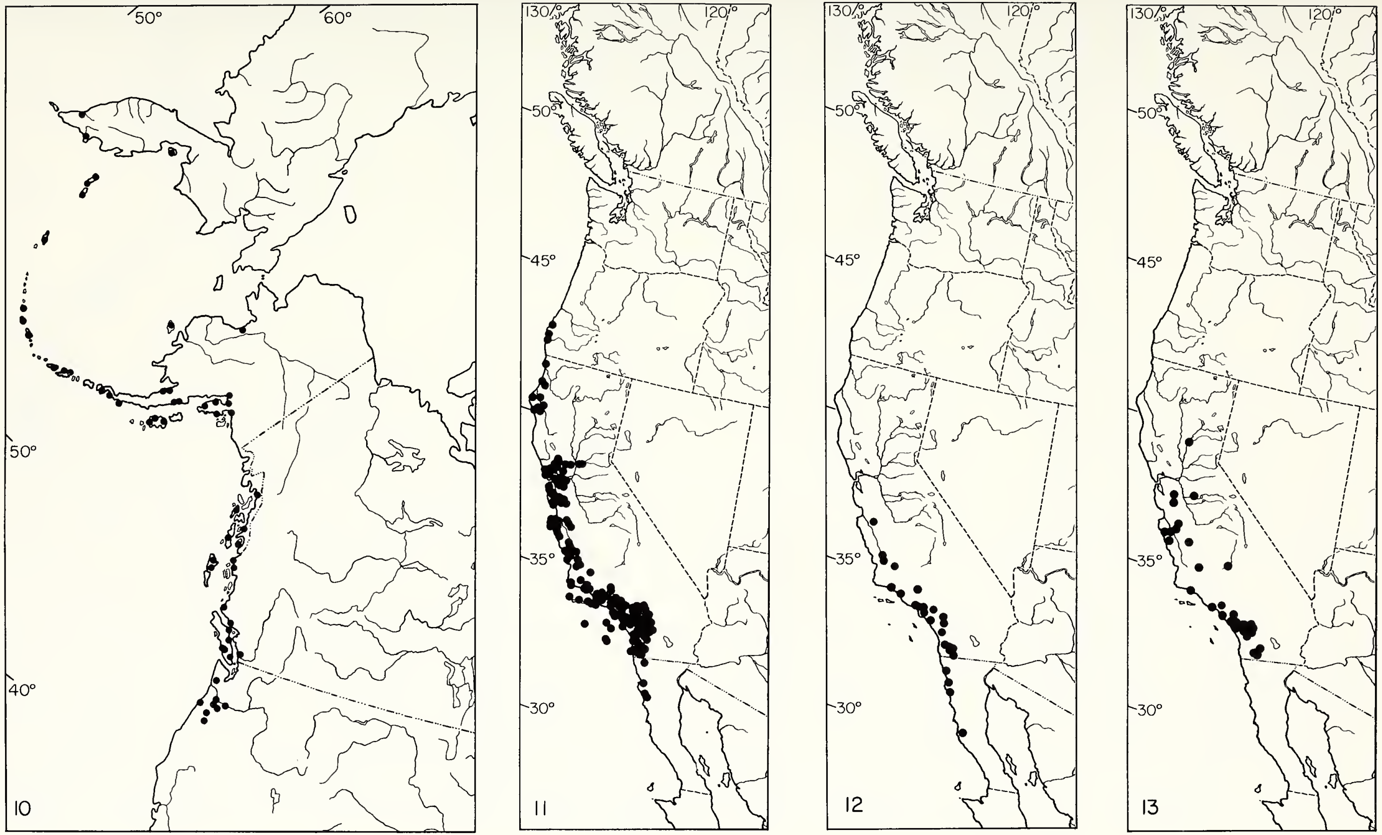
Distribution maps 1, 2. 1. *I. brachycera.* 2. *I. elongata.*



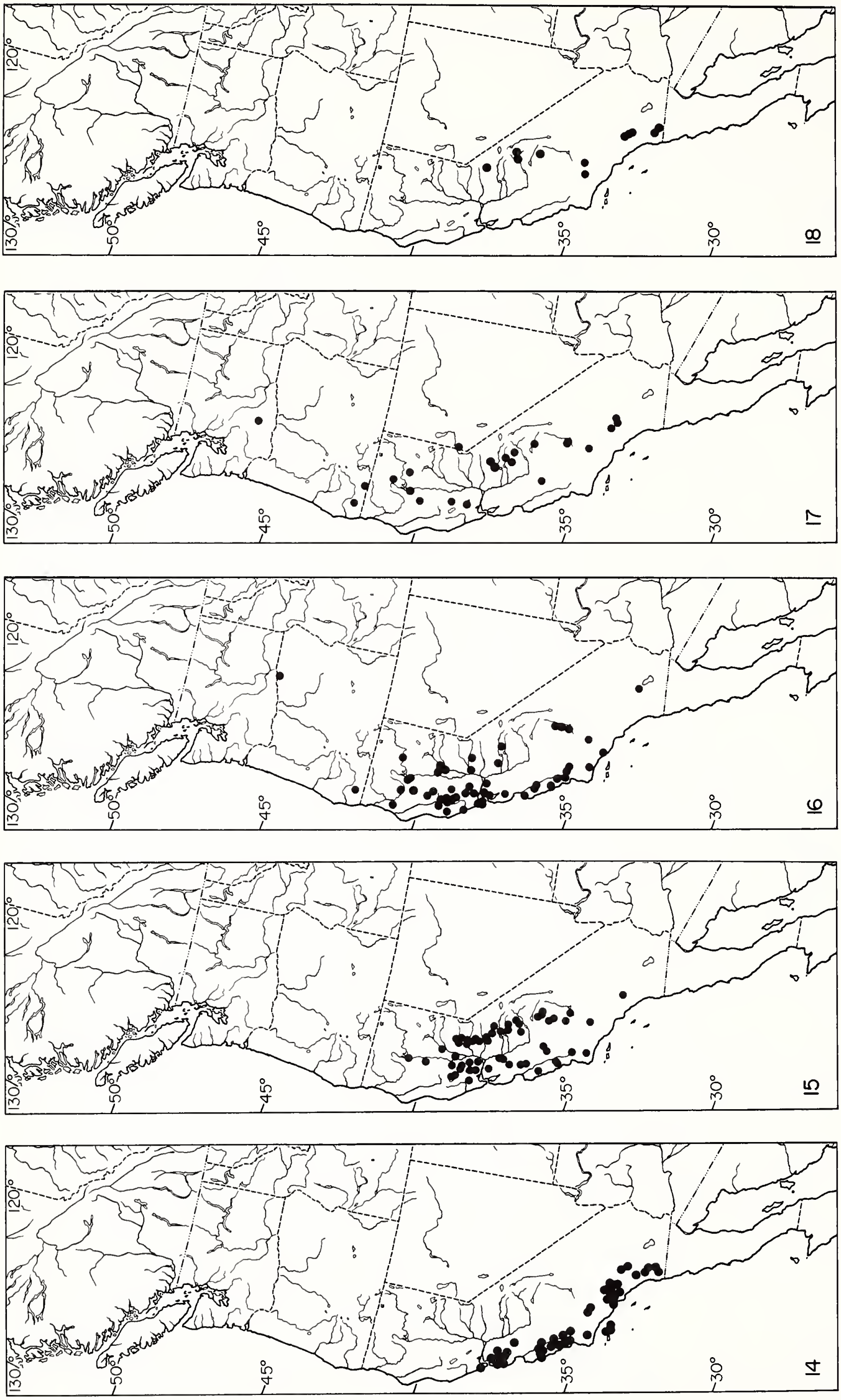
Distribution maps 3–5. 3. *I. pacifica.* 4. *I. silvosa.* 5. *I. limata.*



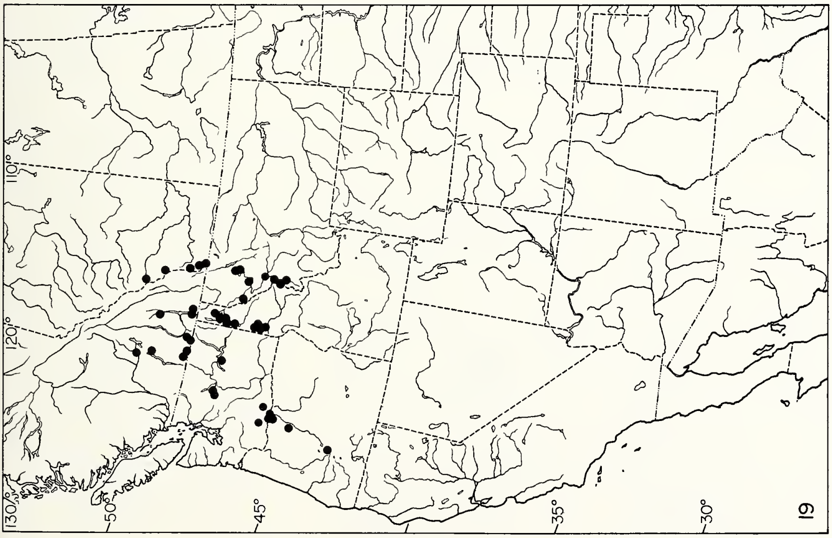
Distribution maps 6–9. 6. *I. oreas.* 7. *I. incomperta.* 8. *I. knighti.* 9. *I. solani.*

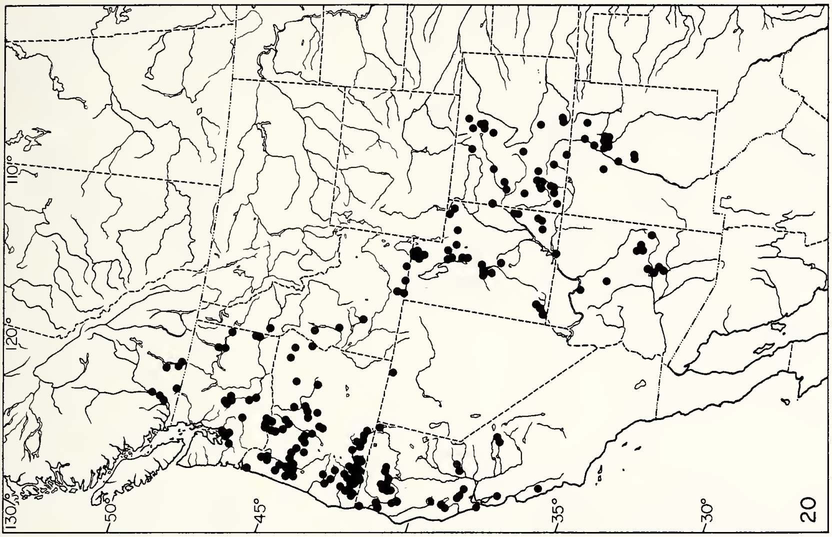


Distribution maps 10–13. 10. *I. sericans.* 11. *I. californica.* 12. *I. sita.* 13. *I. cuneomaculata.*

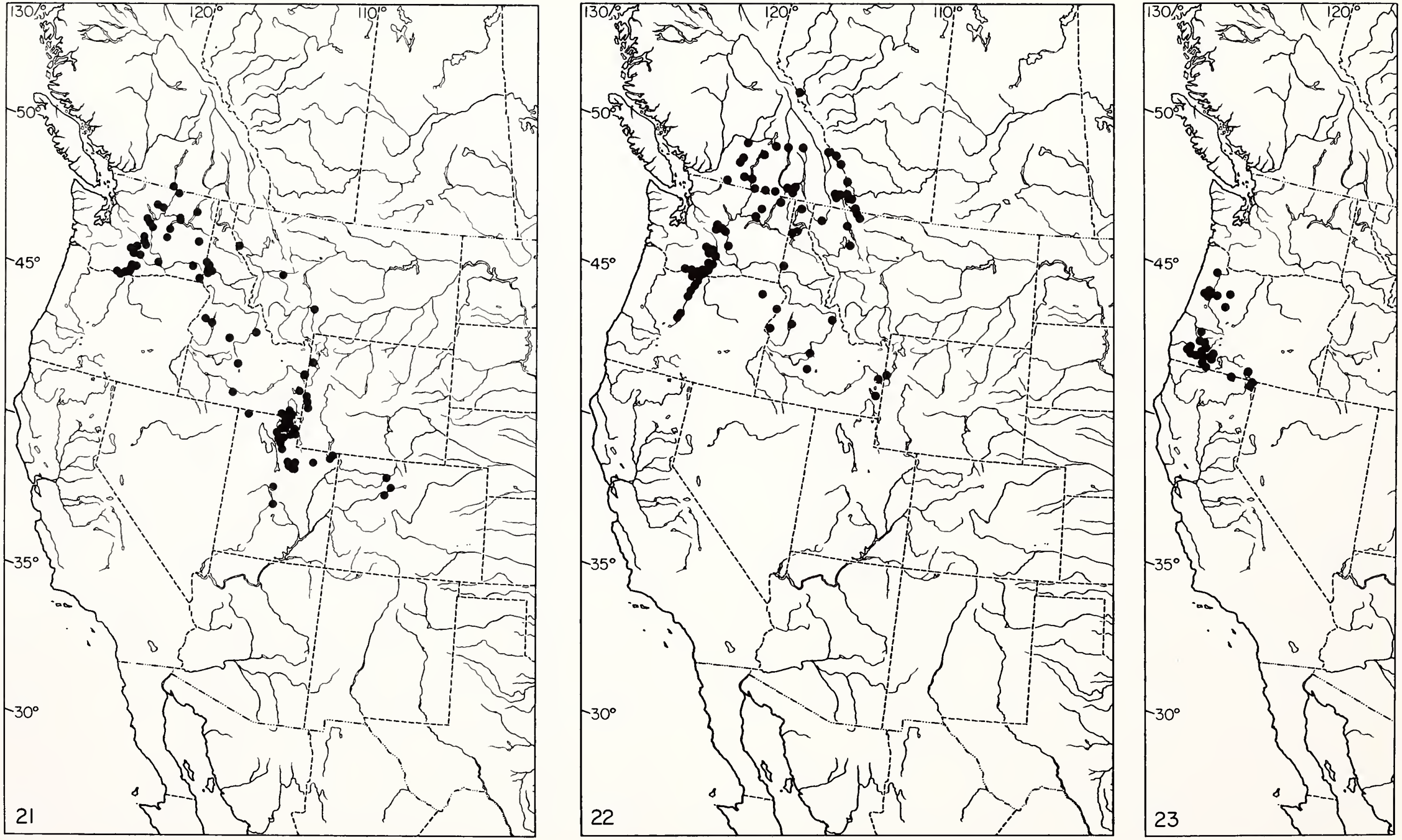


Distribution maps 14–18. 14. *I. mollipes.* 15. *I. panda.* 16. *I. setosa.* 17. *I. bliveni.* 18. *I. castanipes.*





Distribution maps 19, 20. 19. *I. nigripes.* 20. *I. serrata.*



Distribution maps 21–23. 21. *I. shulli.* 22. *I. fuscipubescens.* 23. *I. cascadia.*

Table 3. Distributional grouping of the species of *Irbisia* based on the Ecoregions of the United States (Bailey 1978) with minor modification.

Domain	*Division*	*Province*	*Species*
Polar 1 species	Tundra	Bering Tundra	*sericans*
	Subarctic	Alaska Range	*sericans*
Humid Temperate 23 species	Warm Continental 4 species	Columbia Forest	*elongata, fuscipubescens,*
	Marine 14 species	Willamette-Puget Forest	*cascadia, sericans, serrata, solani*
		Pacific Forest	
		Northwestern	*(bliveni), cascadia, fuscipubescens, knighti, sericans, serrata,*
		Northeastern	*fuscipubescens, nigripes, shulli*
		Southern	*bliveni, brachycera, californica, cascadia, pacifica, serrata, setosa, silvosa, solani,*
	Mediterranean 17 species	California Grassland	*brachycera, californica, (limata), pacifica, (silvosa), solani*
		Sierran Forest	*bliveni, brachycera, (cascadia), castanipes, cuneomaculata elongata, incomperta, limata, oreas, pacifica, panda, serrata, setosa, silvosa, solani*
		California Chaparral	*brachycera, californica, (castanipes), cuneomaculata, incomperta, limata, mollipes, oreas, pacifica, panda, setosa, silvosa, sita, solani*
Dry 10 species	Steppe 10 species	Great Plains Shortgrass Prairie	*brachycera, pacifica*
		Palouse Grassland	*(brachycera), (fuscipubescens), pacifica, serrata, shulli*
		Intermountain Sagebrush	*brachycera, cascadia, elongata, fuscipubescens, nigripes, pacifica, serrata, shulli*
		Rocky Mountain Forest	*brachycera, elongata, fuscipubescens, nigripes, pacifica, serrata, shulli*
		Upper Gila Mountains Forest	*oreas, serrata, solani*
		Colorado Plateau	*brachycera, serrata*
		Wyoming Basin	*(brachycera), (pacifica)*

( ) indicates that record within the province are few

The distribution patterns recognized in *Irbisia* roughly correspond to several distributional range types described by Monroe (1956). However, Monroe did not include heteropteran species in his scheme. Kelton (1975) presented the distribution ranges for the North American species of the mirid genus *Lygus*. Six of the species treated therein have distributional patterns which are similar to the widespread pattern found in the *Irbisia* species.

Table 3 summarizes the distribution data presented in the species redescriptions. The species are placed within the divisions and provinces of Bailey's (1978) Ecoregions of the United States. I have subdivided the Pacific forest province into northwestern, northeastern and southern regions because many of the species have distinctly delineated ranges within this province. Species with few known or peripherally arranged localities are placed in parentheses.

Vicariance biogeographic methods (Nelson and Platnick, 1981) were attempted on *Irbisia* with somewhat inconclusive results due to the extensive overlap of the distribution ranges of the species. However, I would like to point out several possible areas of endemism that appear to me to be worthy of consideration by researchers working with other taxa. These areas are: 1) coastal California including the western and eastern flanks of the Coastal range (typified by Map 11); 2) the western foothills and the pine areas of the Sierra Mountains (Map 5); 3) the northern Rocky Mountains (Maps 19, 20); 4) the Klamath and Siskiyou Mountains (Map 23).

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Museum Abbreviations

AKAS, Alaska Agricultural Experiment Station, Palmer
AMNH, American Museum of Natural History, New York
ASU, Arizona State University, Tempe
BSU, Boise State University, Idaho
BYU, Brigham Young University, Provo, Utah
CAS, California Academy of Sciences, San Francisco

CNC, Canadian National Collection of Insects, Agriculture Canada, Ottawa
CU, Department of Entomology, Cornell University, Ithaca
F&A, California Department of Food and Agriculture, Sacramento
HSU, Humboldt State University, Arcata, California
INHS, Illinois Natural History Survey, Urbana
JS, Schuh Collection (now at AMNH), Klamath Falls, Oregon
JTP, Polhemus Collection, Englewood, Colorado
KU, Snow Entomological Museum, University of Kansas, Lawrence
LACM, Los County Museum of Natural History
MSU, Montana State University, Bozeman
NAU, Northern Arizona University, Flagstaff
NDS, North Dakota State University, Fargo
OSDA, Oregon State Department of Agriculture, Salem
OSU, Oregon State University, Corvallis
PUC, Pacific Union College, Angwin, California
SBNM, Santa Barbara Museum of Natural History, California
SDNH, San Diego Natural History Museum, California
SDS, South Dakota State University, Brookings
SHF, Schaffner Collection, Texas A&M University, College Station
SOS, Southern Oregon College, Ashland
TA&M, Department of Entomology, Texas A&M University, College Station
UALB, University of Alberta, Edmonton, Canada
UAZ, University of Arizona, Tucson
UBC, University of British Columbia, Vancouver, Canada
UCB, California Insect Survey, University of California, Berkeley
UCD, Department of Entomology, University of California, Davis
UCR, Department of Entomology, University of California, Riverside
UID, University of Idaho, Moscow
UN, University of Nebraska, Lincoln
USNM, National Museum of Natural History, Washington, D.C.
USU, Department of Entomology, Utah State University, Logan.
UWY, University of Wyoming, Laramie
WSU, James Entomological Collection, Pullman, Washington
WWS, Western Washington State University, Bellingham

LITERATURE CITED

Anonymous. 1972. U.S. Department of Agriculture, Agriculture Research Service, Plant Protection Division, Cooperative Economic Insect Report 22(20):275–298.

Ashmead, W. H. 1898. Appendix C. Reports upon the insects, spiders, mites, and myriapods collected by Dr. L. Stejeger and Mr. G. E. H. Barrett-Hamilton on Commander Islands. *In:* D. S. Jordan, Fur Seals and Fur Seal Islands of the North Pacific Ocean. Part 4:328–351.

Atkinson, E. T. 1890. Catalogue of Insecta 2. Order Rhynchota, suborder Hemiptera-Heteroptera. Family Capsidae. J. Asiatic Soc. Bengal 58, part 2, suppl. 1:25–200.

Bailey, R. G. 1978. Description of the ecoregions of the United States. U.S Department of Agriculture, Forest Service, Intermountain Region, Ogden, Utah, 77 pp.

Bergroth, E. 1885. Vega-Coleoptera und-Hemiptera. Entomol. Nachr. 11:268–270.

Blatchley, W. S. 1934. Notes on a collection of Heteroptera taken in winter in the vicinity of Los Angeles, California. Trans. Amer. Entomol. Soc. 60:1–16.

Bliven, B. P. 1954. New Hemiptera from redwood (Miridae, Cicadellidae). Bull. Brooklyn Entomol. Soc. 49:109–119.

Bliven, B. P. 1961. New species of *Irbisia* from California. The Occidental Entomol. 1(5):45–49.

Bliven, B. P. 1963. New species of *Irbisia* from California II. The Occidental Entomol. 1(7): 68–86.

Breddin, G. 1902. Die Hemipteren und Siphunculaten des arktischen Gebietes. *In:* F. Romer und F. Schaudinn, Eire Zusammenstellung der Arktischen Tierformen Band 2. Fauna Arctica I. 3:529–560.

Carvalho, J. C. M. 1952. On the major classification of the Miridae (Hemiptera) with keys to subfamilies and tribes and a catalogue of the world genera. Ann. Academia Bras. Cienc. 24:31–110.

Carvalho, J. C. M. 1955. Keys to the genera of Miridae of the world (Hemiptera). Bol. Mus. Paraense Emilio Goeldi 11(2):1–151.

Carvalho, J. C. M. 1959. A catalogue of the Miridae of the world. Part IV. Arq. Mus. Nac., Rio de Janeiro, Brasil 48:1–384.

Childs, L. 1914. Insect notes. Monthly Bulletin of the California State Commission of Horticulture 3:220.

Cockerell, T. D. A. 1893. The entomology of the mid-alpine zone of Custer County, Colorado. Trans. Amer. Entomol. Soc. 20:305–370.

Cockerell, T. D. A. 1910. Some insects from Steamboat Springs, Colo. II. Can. Entomol. 42: 366–370.

Davis, N. T. 1955. Morphology of the female organs of reproduction in the Miridae (Hemiptera-Heteroptera). Ann. Entomol. Soc. Amer. 48:132–150.

Downes, W. 1927. A preliminary list of the Heteroptera and Homoptera of British Columbia. Proc. Entomol. Soc. British Columbia 23:5–22.

Essig, E. O. 1915. Injurious and beneficial insects of California. 2 ed. Monthly Bulletin of the California State Commission of Horticulture Supplement 4:1–541.

Essig, E. O. 1926. Insects of western North America. New York, Macmillan, 1035 pp.

Essig, E. O. and W. M. Hoskins. 1944. Insect and other pests attacking agricultural crops. California Agriculture Extension Series Circular 87:1–197.

Fuxa, J. R. 1975. Biological attributes and alteration of the habitat to manipulate populations of *Labops hesperius* Uhler (Heteroptera: Miridae). Unpublished master's thesis. Corvallis, Oregon State University, 119 pp.

Gibson, C. W. D. 1976. The importance of food plants for the distribution and abundance of some Stenodemini (Heteroptera: Miridae) of limestone grassland. Oecologia 25:55–76.

Gibson, C. W. D. 1980. Niche use patterns among some Stenodemini (Heteroptera: Miridae) of limestone grassland, and as investigation of the possibility of interspecfic competition between *Notostira elongata* Geoffroy and *Megaloceraea recticornis* Geoffroy. Oecologia 47:352–364.

Gillette, C. P. and C. F. Baker. 1895. A preliminary list of the Hemiptera of Colorado. Colorado Agricultural Experimental Station Technical Series, Bulletin 31 1:1–137.

Hall, I. M. 1959. The fungus *Entomophthora erupta* (Dustan) attacking the black grass bug, *Irbisia solani* (Heidemann) (Hemiptera, Miridae), in California. Journal of Insect Pathology 1:48–51.

Harling, J. M., J. M. Snyder and D. M. Coletti. 1977. Insects collected from an alpine-subalpine region in SE British Columbia. J. Entomol. Soc. British Columbia 74:34–36.

Haws, B. A. (compiler). 1978. Economic impacts of *Labops hesperius* on the production of high quality range grasses. Final report of Utah Agricultural Experiment Station to Four Corners Regional Commission. Logan, Utah State University, 269 pp.

Heidemann, O. 1900. Papers from the Harriman Alaska Expedition XIII. Entomological Results (7): Heteroptera. Proc. Washington Acad. Sci. 2:503–506.

Heidemann, O. 1910. Description of a new capsid. Proc. Entomol. Soc. Washington 12:200–201.

Herms, W. B. 1926. An analysis of California's major entomological problems. J. Econ. Entomol. 19:262–270.

Hewitt, G. B. and W. H. Burleson. 1975. Arthropod associated with two crested wheatgrass pastures in central Montana. J. Range Manag. 28:301–304.

Hewitt, G. B. and W. H. Burleson. 1976. An inventory of arthropods from three rangeland sites in central Montana. J. Range Manag. 29:232–237.

Hüeber, T. 1898. Synopsis der deutschen Blindwanzen (Hemiptera Heteroptera, fam. Capsidae). Jahreshefte des Vereins fur Vaterlandishe Naturkunde in Wurttemberg. 54:228–302.

Kamm, J. A. 1979. Plant bugs: effect of feeding on grass seed development; and cultural control. Environ. Entomol 8:73–76.

Kelton, L. A. 1959. Male genitalia as taxonomic characters in the Miridae (Hemiptera). Can. Entomol. Supplement 11, 91:1–72.

Kelton, L. A. 1961. Synopsis of the Nearctic species of *Stenodema* Laporte, and description of a new species from western Canada (Hemiptera: Miridae). Can. Entomol. 93:450–455.

Kelton, L. A. 1975. The lygus bugs (genus *Lygus* Hahn) of North America (Heteroptera: Miridae). Mem. Entomol. Soc. Canada No. 95:1–101.

Kelton, L. A. 1980. The insects and arachnids of Canada, Part 8, the plant bugs of the Prairie Provinces of Canada (Heteroptera: Miridae). Publication 1703. Agriculture Canada, Ottawa, 408 pp.

Kiritshenko, A. N. 1926. Hemiptera-Heteroptera Camtshadalica. Annu. Mus. Zool. Acad. Imper. Sci., Leningrad 27:9–19.

Kirkaldy, G. W. 1906. List of the genera of the pagiopodus Hemiptera-Heteroptera, with their type species, from 1758–1904 and also the aquatic and semiaquatic Trochalopoda. Trans. Amer. Entomol. Soc. 32:117–156.

Knight, H. H. 1921. Scientific results of the Katmai expeditions of the National Geographical Society. XIV. Hemiptera of the family Miridae. Ohio J. Sci. 21:107–112.

Knight, H. H. 1925a. Descriptions of a new genus and eleven new species of North American Miridae. Can. Entomol. 57:89–97.

Knight, H. H. 1925b. A list of Miridae and Anthocoridae from Alberta, Canada (Hemiptera). Can. Entomol. 25:181–182.

Knight, H. H. 1941. New species of *Irbisia* Reuter (Hemiptera, Miridae). Bull. Brooklyn Entomol. Soc. 36:75–79.

Knight, H. H. 1968. Taxonomic review: Miridae of the Nevada test site and the western United States. Brigham Young Univ. Sci. Bull., Biol. Ser. 9(3):1–282.

Knowlton, G. F. 1951. Bugs damage grass in Utah. Bull. Brooklyn Entomol. Soc. 46(3):74–75.

Knowlton, G. F. 1966a. Grass bugs: range and crop pests in Utah. Utah State University Extension Service, Entomology Mimeo Series 119:1–5.

Knowlton, G. F. 1966b. Black grass bug observations in Utah, p. 596. *In:* U.S. Department of Agriculture, Agricultural Research Service, Plant Pest Control Division, Cooperative Economic Insect Report 16(25):565–596.

Knowlton, G. F. 1967. Grass bugs: a serious range problem in 1966. Utah Academy of Science, Arts and Letters 43(3):20–21.

Knowlton, G. F. 1968. Range entomology. Utah State University Extension Service, Entomology Mimeo Series 133:3–4.

Knowlton, G. F. and R. S. Roberts. 1971. Grass bugs: a major range problem in Utah. Utah State University Extension Service, Entomology Newsletter No. 64, 3 p.

Küchler, A. W. 1964. Potential natural vegetation of the conterminous United States (map and manual). American Geographical Society, New York, Special Publication 36, 116 p; map scale 1:3, 180,000.

Küchler, A. W. 1977. The map of the natural vegetation of California, pp. 909–915; map scale 1:1,000,000. *In:* M. G. Barbour and J. Major (eds.), Terrestrial Vegetation of California. New York, John Wiley & Sons, 1002 pp.

Kullenberg, B. 1944. Studien uber die Biologie der Capsiden. Zoologiska Bidrag Fran Uppsala. 23:1–522.

Lange, W. H. 1941. The artichoke plume moth and other pests injurious to the globe artichoke. University of California College of Agriculture, Agricultural Experiment Station Bulletin 653:1–71.

Lindberg, H. 1927. Zur Kenntnis der Heteropteren-Fauna von Kamtschatka sowie der Amurund Ussuri-Gebiete. Acta Soc. Pro Fauna Flora Fennica 56(9):1–26.

Lockwood, S. 1933. Insect and mite scars of California fruits. California Department of Agriculture Monthly Bulletin 22:318–345.

Lockwood, S. and E. T. Gammon. 1949. Incidence of insect pests. California Department of Agriculture Bulletin 38:190–203.

Mattson, W. J. 1980. Herbivory in relation to plant nitrogen content. Ann. Rev. Ecol. Syst. 11:119–161.

McAtee, W. L. 1923. Heteroptera. *In:* A biological survey of the Pribolof Islands, Alaska, Part II insects, arachnids and chilopods. North American Fauna, No. 46:145.

McKendrick, J. D. and D. P. Bleicher. 1980. Observations of a grass bug on native bluejoint ranges. Agroborealis 12(1)15–18.

McNeill, S. 1971. The energetics of a population of *Leptopterna dolobrata* (Heteroptera: Miridae). J. Animal Ecol. 40:127–140.

McNeill, S. 1973. The dynamics of a population of *Leptopterna dolobrata* (Heteroptera: Miridae) in relation to its food resources. J. Animal Ecol. 42:495–507.

Monroe, E. 1956. Canada as an environment for insect life. Can. Entomol. 88:373–476.

Munz, P. A. and D. D. Keck. 1973. A California Flora and Supplement. University of California Press, Berkeley, 1681 pp. + 224 pp.

Nelson, G. and N. Platnick. 1981. Systematics and biogeography: cladistics and vicariance. Columbia University Press, New York, 567 pp.

Oshanin, R. 1910. Verzeichnis der palaearctischen Hemipteren mit besonderer Berucksichtigung ihrer Verteilung im russichen Reiche, Volume I. Heteroptera, Part III. Annu. Mus. Zool. Acad. Imp. Sci., St. Petersburg 14:587–1087.

Parshley, H. M. 1922. Report on a collection of Hemiptera-Heteroptera from South Dakota. Technical Bulletin of the South Dakota State College, No. 2, 22 pp.

Razafimahatratra, V. de Paul. 1980. A revision of the genus *Deraeocoris* Kirschbaum (Heteroptera: Miridae) from western America north of Mexico. Unpublished Ph.D. thesis, Corvallis, Oregon State University, 235 pp.

Reuter, O. M. 1875a. Genera cimicidarum Europae. Bihang till Svenska Vetenskaps-Akademiens Handlingar 3:1–66.

Reuter, O. M. 1875b. Remarques sur le catalogue des Hémiptères d'Europe et du bassin de la Méditerranée par le Dr. A. Puton. Petites Nouvelles Entomologiques 1:547–548.

Reuter, O. M. 1879. De Hemipteris e Sibira orientali nonnullis adnotationes criticae. Ofv. Finska Vet.-Soc. Forh. 21:42–63. Not examined.

Reuter, O. M. 1880. Hemiptera. *In:* Zoologischer Jahresbericht fur 1879. Herausgegeben von der Zoologischen Station zu Neapel. Part 1:488–543.

Reuter, O. M. 1890. Adnotationes Hemipterologicae. Rev. Ent. 9:248–254.

Reuter, O. M. 1896a. Hemiptera Gymnocerata Europae. Hémiptères gymnocérates d'Europe, du bassin de la Méditerranée et de l'Asie russe. Part V. Acta Soc. Sci. Fennicae 33(2): 1–392.

Reuter, O. M. 1896b. Dispositio generum palaearcticorum divisionis Capsaria familiae Capsidae. Ofv. Finska Vet.-Soc. Forh. 38:156–171.

Reuter, O. M. 1909. Bermerkungen über nearktische Capsiden nebst Beschreibung neuer Arten. Acta Soc. Sci. Fennicae 36(2):1–86.

Reuter, O. M. 1910. Neue Beiträge zur Phylogenie und Systematik der Miriden nebst einleitenden Bemerkungen über die Phylogenie der Heteropteren-familien. Acta Soc. Fauna Flora Fennica 37(3):1–171.

Sahlberg, J. R. 1885. Coleoptera och Hemiptera insamlade af Vega-Expeditionens Medlemmar pa Bering-on den 15–18 August 1879. Vega Expeditionens Vetanskapliga Iakttagelser bearbetade af Deltagare i resan och andra forskare utgifna af A. E. Nordenskiold 4:59–71.

Schuh, R. T. and J. T. Polhemus. 1980. Analysis of taxonomic congruence among morphological, ecological, and biogeographic data sets for the Leptopodomorpha (Hemiptera). Syst. Zool. 29:1–26.

Schwartz, M. D. and J. D. Lattin. 1984. *Irbisia knighti* a new mirine plant bug (Heteroptera: Miridae) from the Pacific Northwest. J. New York Entomol. Soc. 91:413–417.

Slater, J. A. 1950. An investigation of the female genitalia as taxonomic characters in the Miridae (Hemiptera). Iowa State State College Journal of Science 25(1):1–81.

Stål, C. 1858. Beitrag zur Hemipteren-Fauna Sibiriens und des Russischen Nord-Amerika. Entomologische Zeitung heransgegeben von dem entomologischen Vereine zu Stettin 19: 175–198.

Tavernetti, A. A. 1933. Production of the globe artichoke in California. California Agricultural Extension Series Circular No. 76:1–24.

Taylor, E. J. 1966. Letter to G. F. Knowlton, Utah State University, Logan.

Todd, J. G. 1973. *Labops hesperius* Uhler: Biology and impact in Oregon rangelands (Hemiptera; Miridae). Unpublished Master's thesis, Corvallis, Oregon State University, 91 pp.

Uhler, P. R. 1871. A list of Hemiptera collected in eastern Colorado and northeastern New Mexico, by C. Thomas during the expedition of 1869. *In:* F. V. Hayden, Preliminary report of the U.S. Geological Survey of Wyoming and portions of contiguous territories, being a second annual report of progess 4:471–472.

Uhler, P. R. 1872. Notices of Hemiptera of the western territories of the United States, chiefly from the surveys of Dr. F. V. Hayden. *In:* F. V. Hayden, Preliminary report of the U.S. Geological Survey of Montana and portions of adjacent territories; being a fifth annual report of progress 5:392–493.

Uhler, P. R. 1875. List of Hemiptera of the region west of the Mississippi River, including those collected during the Hayden explorations of 1873. *In:* F. V. Hayden, Bulletin of the U. S. Geol. Geogr. Sur. Terr. 1(5):269–361.

Uhler, P. R. 1886. Check List of the Hemiptera Heteroptera of North America. Brooklyn Entomological Society, 34 pp.

Uhler, P. R. 1894. Observations upon the Heteropterous Hemiptera of Lower California, with descriptions of new species. Proc. Calif. Acad. Sci., Ser. 2, 4:223–295.

Van Duzee, E. P. 1914. A preliminary list of the Hemiptera of San Diego County, California. Trans. San Diego Soc. Nat. Hist. 2:1–57.

Van Duzee, E. P. 1916a. Synoptical keys to the genera of North American Miridae. Univ. Calif. Publ. Entomol. 1:199–216.

Van Duzee, E. P. 1916b. Check List of the Hemiptera (excepting the Aphididae, Aleurodidae and Coccidae) of America, north of Mexico. New York Entomological Society, New York, 111 pp.

Van Duzee, E. P. 1917a. Catalogue of the Hemiptera of America north of Mexico excepting the Aphididae, Coccidae and Aleurodidae. Univ. Calif. Publ. Entomol. 1:1–902.

Van Duzee, E. P. 1917b. Report upon a collection of Hemiptera made by Walter M. Giffard in 1916 and 1917, chiefly in California. Proc. Calif. Acad. Sci., Ser. 4, 7:249–318.

Van Duzee, E. P. 1921a. A study of North American grass bugs of the genus *Irbisia.* Proc. Calif. Acad. Sci., Ser. 4, 11:145–152.

Van Duzee, E. P. 1921b. Orthoptera, Neuroptera, Hemiptera and Lepidoptera. *In:* Insects of the Pribilof Islands, Alaska. Proc. Calif. Acad. Sci., Ser. 4, 11:193–195.

Van Dyke, E. C. 1939. The origin and distribution of thecoleopterous insect fauna of North America. Proceedings of the Sixth Pacific Science Congress, Pacific Science Association. 4:255–268.

Vosler, E. J. 1913. A new fruit and truck crop pest (Irbisia brachycera Uhler). California Commission of Horticulture Monthly Bulletin 2:551–553.

Walker, F. 1873. Catalogue of the specimens of Hemiptera Heteroptera in the collection of the British Museum. Part VI. London, 210 pp.

Wiley, E. O. 1981. Phylogenetics: the theory and practice of phylogenetic systematics. John Wiley and Sons, New York, 439 pp.

APPENDIX A

Left paramere

Sensory lobe

1. 1—not projecting above surface of arm.
   0—either strongly, slightly or moderately projecting above surface of arm.
2. 1—slightly or moderately projecting above surface of arm.
   0—either strongly or not projecting above surface of arm.
3. 1—either slightly, moderately or not projecting above surface of arm.
   0—strongly projecting above surface of arm.

Arm

4. 1—with spines or tubercles.
   0—without spines or tubercles.

Angle

5. 1—sharp 'V' shaped.
   0—either 'C', 'U' or 'L' shaped.
6. 1—moderate 'C' shaped.
   0—either 'V', 'U' or 'L' shaped.
7. 1—broad 'U' shaped.
   0—either 'V', 'C' or 'L' shaped.
8. 1—either 'V', 'C' or 'U' shaped.
   0—large 'L' shaped.

Ratio of length of shaft to length of arm

9. 1—length of shaft equal to or greater than lengthof arm.
   0—length of shaft less than length of arm.
10. 1—length of shaft equal to length of arm
    0—length of shaft less than or greater than length of arm.
11. 1—length of shaft greater than length of arm.
    0—length of shaft less than or equal to length of arm.

Arm and shaft junction

12. 1—junction with flange.
    0—junction without flange.

Shape of shaft diameter

13. 1—slender throughout.
    0—either medium thickness, constricted on apical two thirds or thick throughout.
14. 1—medium thickness.
    0—either slender throughout, constricted on apical two thirds or thick throughout.
15. 1—constructed on apical two thirds.
    0—either slender throughout, medium thickness, or thick throughout.
16. 1—either slender throughout, medium thickness, constricted on apical two thirds or thick throughout.
    0—thick throughout.

Shaft

17. 1—with spines.
    0—without spines.

Apex of shaft

18. 1—securiform with either ventral portion of securiform apex larger than dorsal portion or ventral and dorsal portions equally developed.
    0—at right angle to long axis of shaft.
19. 1—securiform with ventral portion of securiform apex larger than dorsal portion.
    0—either at right angle to long axis of shaft or securiform with ventral and dorsal portions equally developed.

20. 1—securiform with ventral and dorsal portions equally developed.
    0—either securiform with ventral and dorsal portions equally developed or at right angle to long axis of shaft.
21. 1—shaft constricted subapically; securiform apex somewhat 'T' shaped.
    0—shaft not constricted subapically; securiform apex not 'T' shaped.

Right paramere

Diameter of shaft

22. 1—unexpanded distally.
    0—expanded distally.

Terminal spine

23. 1—simple spine, at right angle to long axis of shaft.
    0—either simple spine, parallel with long axis of shaft or double faceted spine.
24. 1—either simple spine, at right angle to long axis of shaft or double faceted spine.
    0—simple spine, parallel with long axis of shaft.
25. 1—double faceted spine.
    0—simple spine either at right angle to long axis of shaft or parallel with long axis of shaft.

Vesica

26. 1—sclerotized process projecting to left side.
    0—sclerotized process projecting ventrad.
27. 1—accessory lobe in front of sclerotized process large.
    0—accessory lobe in front of sclerotized process small.
28. 1—both membranous side lobes tapering distally.
    0—both membranous side lobes broadly rounded distally.
29. 1—sclerotized process tapering distally.
    0—sclerotized process not tapering distally.
30. 1—sclerotized process cone-shaped and with very large spines.
    0—sclerotized process not cone-shaped with very large spines.
31. 1—large spines in triangular arrangement.
    0—without large spines in triangular arrangement.

Head structure

32. 1—antennal socket with ventral margin below ventral margin of eye.
    0—antennal sockets with ventral margin in line or above ventral margin of eye.
33. 1—ratio of width of vertex to length of antennal segment I equal to or less than one.
    0—ratio of width of vertex to length of antennal segment I greater than one.
34. 1—length of antennal segment I greater than width of head.
    0—length of antennal segment I less than width of head.

APPENDIX B

A. = Area
A.E.C. = Atomic Energy Commission
Ave. = Avenue
btw. = between
Clev. = Cleveland
Cmp. = Camp
Cmpgd. = Campground
Crk. = Creek
Co. = County
Crst. = Crest
Cyn. = Canyon
Dr. = Drive
Entr. = Entrance
Exp. = Experiment
Expt. = Experimental
For. = Forest
Frk. = Fork
Ft. = Fort
Grd. = Guard
Hist. = Historic
HQ. = Headquarters
Hts. = Heights
Hwy. = Highway
intrsct. = intersection
Is. = Island
Jct. = Junction
L.A. = Los Angeles
Lk. = Lake
LWr. = Lower
Mdw. = Meadow
Mem. = Memorial
Mon. = Monument
mp. = milepost
Mt.(s.) = Mountain(s)
Nat. = National
nr. = near
Pen. = Peninsula
Pk. = Park
Prsv. = Preserve
Pt. = Point
R. = River
Rch. = Ranch
Rd. = Road
Rdg. = Ridge
Rec. = Recreational
Res. = Reservoir
Rfg. = Refuge
Rgr. = Ranger
Rng. = Range
Rsr. = Reserve
Rsrh. = Research
Rsv. = Reservation
rt. = route
Sec. = section
Spg.(s.) = Spring(s)
S.L.O. = San Luis Obispo
Smt. = Summit
St. = State
Sta. = Santa
Stn. = Station
Trl. = Trail
Wldf. = Wildlife
Wldns. = Wilderness
Wysd. = Wayside

INSTRUCTIONS TO AUTHORS

The *Journal of the New York Entomological Society* is devoted to the advancement and dissemination of knowledge of insects and related taxa. The costs of publishing the Journal are paid by subscriptions, membership dues, page charges, and the proceeds from an endowment established with bequests from the late C. P. Alexander and Patricia Vaurie. The Journal will consider for publication manuscripts of any length dealing with original research in entomology. Longer papers will be printed as articles, shorter ones as "scientific notes." Book reviews will be solicited by the Book Review Editor.

Manuscripts should be submitted in duplicate to: Dr. Randall T. Schuh, Editor, Journal of the New York Entomological Society, c/o Department of Entomology, American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024. All material must be double-spaced (including references, tables, captions, etc.) and prepared in the format of a recent issue of the Journal.

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ORMENARIA RUFIFASCIA (HOMOPTERA: FULGOROIDEA: FLATIDAE): DESCRIPTIONS OF NYMPHAL INSTARS AND NOTES ON FIELD BIOLOGY[1]

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Abstract.—The five nymphal instars of *Ormenaria rufifascia* (Walker) are described and illustrated. A key to instars and comparisons of the morphology of 5 genera of U.S. flatid nymphs are provided. Features useful in separating nymphal instars include spination of metatibiae and metatarsomeres, numbers of metatarsomeres and abdominal waxpads, and differences in body and wingpad sizes. One generation per year was observed in south Florida. Average developmental times ($\bar{x}$ ± SD) for the first-fifth instars are 23 ± 2.2, 20 ± 2.0, 19 ± 2.3, 24 ± 1.9, and 8 ± 1.1 days, respectively. Mean adult longevity is 12 ± 1.6 days. Of 13 palm species and one non-palm plant studied, only *Sabal palmetto* (Walt.) Lodd. and *Latania lontaroides* (Gaertn.) H. E. Moore served as breeding hosts for *O. rufifascia.*

Ormenaria rufifascia (Walker) has been recorded from Florida, Georgia, and Cuba (Metcalf and Bruner, 1948). It has been reported feeding on 9 species of palms and 3 species of other plants (Metcalf and Bruner, 1948; Mead, 1965; Table 1). Although occasionally common on palms, injury is apparently slight (Mead, 1965). Other than records of host plants, little information is available on the biology of this flatid. Mead (1965) noted that nymphs were observed feeding in conspecific groups and are present from late April–May, and adults from mid-May–July, in Florida. Moore (1961) reported that adults produce tymbal vibrations.

Information on the morphology of this flatid is very limited. Metcalf (1923) provided a color illustration of an adult's head and thorax and Metcalf and Bruner (1948) described the adult and illustrated the male genitalia. Mead (1965) briefly described the nymphal color patterns. Of the 33 species of U.S. flatids (Metcalf, 1957), only the immatures of *Anormenis septentrionalis* (Spinola), *Metcalfa pruinosa* (Say), *Ormenoides venusta* (Melichar) (Wilson and McPherson, 1981) and *Cyarda* sp. near *acutissima* Metcalf and Bruner (Wheeler and Hoebeke, 1982) have been described.

This paper presents descriptions of the five nymphal instars and notes on the field biology of *O. rufifascia* in south Florida.

MATERIALS AND METHODS

Description of immatures. Specimens to be described were obtained from field cages (see below) and preserved in 70% ethyl alcohol. The first instar is described in

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[1] Fla. Agric. Exp. Stn. Journal Series No. 5443.

detail, but only major differences are described for subsequent instars. Comparative statements refer to earlier instars (e.g., more numerous). Measurements are given in mm as mean ± SE. Length was measured from apex of vertex to apex of abdomen, width across the widest part of the body, and thoracic length along the midline from anterior margin of the pronotum to posterior margin of the metanotum. Several specimens of each instar were cleared in 10% KOH to observe obscure features such as body pits and waxpads. Twenty specimens of each instar were measured.

Field study. The development of *O. rufifascia* was studied from January to June 1983 in a small palm planting at Ft. Lauderdale, Broward County, Florida. Cabbage palm [*Sabal palmetto* (Walt.) Lodd] was used as test plant. Sleeve cages made of clear butyrate tubing measuring 22 cm long (dia: 5 cm) enclosed portions of pinnae for nymph release. Newly hatched nymphs were collected in the field and released singly into the sleeve cages. Specimens were observed and moltings recorded every 1–2 days. Daily temperature was recorded throughout the 6-month study period for comparing the nymphal developing rate.

A group of 13 species of palms including *Carpentaria acuminata* (H. Wendl. & Drude) Becc., *Veitchia merrilli* (Becc.) H. E. Moore, *Pritchardia eriostachya* Becc., *Veitchia merrilli* (Becc.) H. E. Moore, *Pritchardia eriostachya* Becc., *Ptychosperma nicolai* (Sand. ex Andre) Burret, *Livistonia chinensis* (Jacq.) R. Br. ex Mart., *Washingtonia robusta* H. Wendl., *Heterospathe elata* Scheff., *Cocos nucifera* L., *Phoenix dactylifera* L., *Phoenix roebelenii* O'Brien, *Caryota mitis* Lour, *Dictyosperma album* (Bory) H. Wendl. and Drude, and *Latania lontaroides* (Gaertn.) H. E. Moore; and one non-palm, screw pine (*Pandanus utilis* Bory), were examined bi-weekly in the same study area for the presence of *O. rufifascia.*

RESULTS AND DISCUSSION

Descriptions of Nymphs

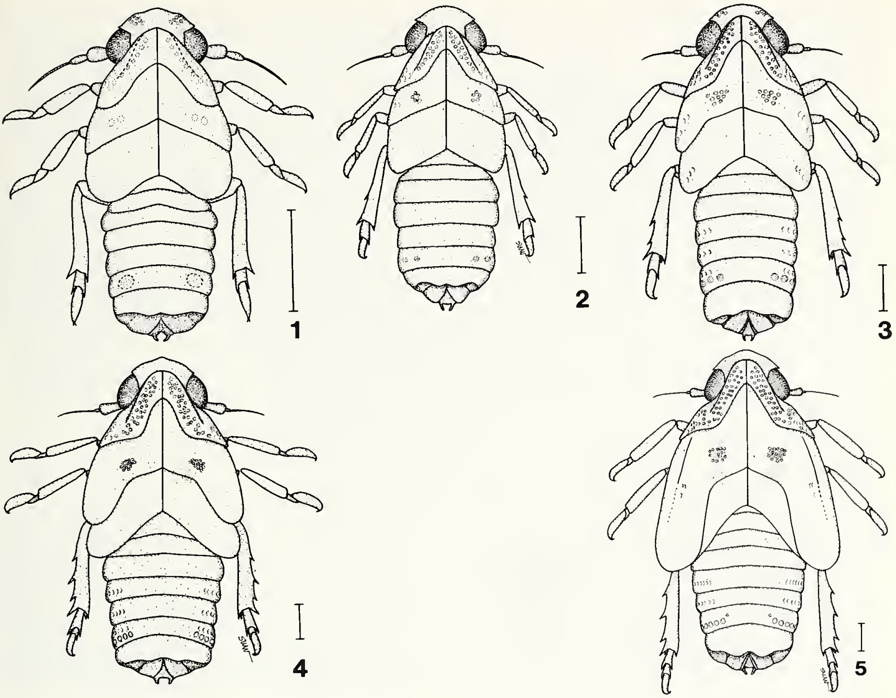
Nymphs are green with faint, longitudinal orange stripes and posterior filaments of white wax. Specimens turn white to stramineous when preserved in alcohol.

First instar (Fig. 1). Length 1.41 ± 0.018; thoracic length 0.60 ± 0.003; width 0.58 ± 0.006.

Form elongate, depressed, widest across mesothorax; body white (when preserved in alcohol), some specimens with posterior tergites tinged light brown.

Vertex rounded anteriorly, obscure pits in anterolateral corners, overlapped by pronotum posteriorly. Frons ovoid, length subequal to width; anterior margin convex, frontoclypeal juncture concave; lateral margins carinate (outer carinae), outwardly convex, and paralleled by pair of inner carinae ca. ⅔ distance from midline to outer carinae; row of pits between each inner and outer carina. Clypeus narrowing distally; consisting of subconical basal postclypeus and beaklike cylindrical distal anteclypeus. Beak 3-segmented, extending to base of metacoxae; segment 1 covered by anteclypeus, segments 2 and 3 subequal. Eyes red. Antennae 3-segmented; scape ringlike; pedicel subcylindrical, ca. 2× length of scape; flagellum whiplike distally with bulbous base slightly longer than pedicel.

Thoracic nota divided by longitudinal middorsal line into 3 pairs of plates. Pronotum rounded anteriorly, overlapping vertex, posterior margin sinuate; each plate with



Figs. 1–5. *O. rufifascia* nymphs. 1. First instar. 2. Second instar. 3. Third instar. 4. Fourth instar. 5. Fifth instar. Vertical bars = 0.5 mm.

weak, outwardly curved carina forming anterior margin then curving posterolaterally and bordered medially by row of ca. 9 obscure pits. Mesonotum with median length ca. 1½× that of pronotum, posterior margin slightly sinuate; each plate with 2 obscure pits in lateral ½. Metanotum with median length subequal to that of mesonotum, posterior margin slightly curved. Pro- and mesocoxae elongate, posteromedially directed; metacoxae globose, fused to metasternum giving appearance of being subrectangular and transverse. Metatrochanters each with row of small teeth on medial aspect. Remaining segments of legs with very fine setae. Metatibiae with transverse row of 4 black-tipped spines at apex on ventral aspect. Each tarsus with 2 tarsomeres; pro- and mesotarsomere 1 wedgeshaped; metatarsomere 1 cylindrical with transverse row of 4 black-tipped spines at apex on ventral aspect; tarsomere 2 of all tarsi subconical, curved, with pair of small claws and median pulvillus at apex.

Abdomen 9-segmented, segments 1–7 visible dorsally, segments 8–9 telescoped anteriorly. Tergites 3–7 curving around lateral margins to ventral aspect. Very obscure pits present on some tergites. Tergite 7 notched medially on posterior margin. Each segment with the following number of waxpads on either side of midline: segment 6 with 1 small, obscure, whitish-yellowish oval waxpad on tergite, segments 7–8 each with 1 elongate, oval, caudal, whitish waxpad. Segment 9 without waxpads, elongate vertically, surrounding anus, with small, ventral, fingerlike process on either side of midline.

Second instar (Fig. 2). Length 1.79 ± 0.035; thoracic length 0.83 ± 0.007; width 0.79 ± 0.007.

Frons with length ca. ⅔× its width. Antennae with bulbous portion of flagellum ca. ½× length of pedicel.

Pronotal plates each with 2 rows of obscure pits bordering carina; ca. 15–20 total pits on plate. Mesonotal median length ca. 2½× that of pronotum; each plate with group of ca. 5 obscure pits midway between midline and lateral margin and ca. 2 pits near lateral margin. Metatibiae with 1 black-tipped spine in distal ⅔ of lateral aspect of shaft and transverse row of 5 black-tipped spines at apex on ventral aspect. Metarsomere 1 with transverse row of 5 black-tipped spines at apex on ventral aspect.

Abdominal tergite 6 apparently with 2 small, very obscure, whitish, oval waxpads on each side in lateral ½.

Third instar (Fig. 3). Length 2.54 ± 0.059; thoracic length 1.22 ± 0.006; width 1.20 ± 0.010.

Frons length ca. ¾× its width.

Pronotal plates each with 2–3 irregular rows of obscure pits bordering carina; ca. 25–30 total pits on plate. Mesonotal plates each with group of ca. 10 obscure pits midway between midline and lateral margin and ca. 4 pits near lateral margin. Metanotal median length ca. ⅔ that of mesonotum, with ca. 3 pits near lateral margin. Metatibiae with 2 black-tipped spines in distal ½ of lateral aspect of shaft and transverse row of 6 (rarely 5) black-tipped spines at apex on ventral aspect.

Abdominal tergites 3–6 each with ca. 5 pits laterally on each side; tergite 6 with 3 small, obscure, whitish, oval waxpads on each side in lateral ½.

Fourth instar (Fig. 4). Length 3.89 ± 0.076; thoracic length 1.75 ± 0.013; width 1.88 ± 0.020.

Antennae with bulbous portion of flagellum ca. ⅓× length of pedicel.

Pronotal plates each with 3 irregular rows of obscure pits bordering carina; ca. 35–40 total pits on plate. Mesonotal plates each with group of ca. 12–15 obscure pits midway between midline and lateral margin; pits near margin apparently absent; wingpad distinctly lobate and covering ca. ½ of metanotum laterally. Metatibiae with 3 (rarely 2) black-tipped spines on lateral aspect of shaft. Metatarsi with 3 tarsomeres; tarsomere 1 with transverse row of 7 black-tipped spines at apex on ventral aspect; tarsomere 2 with 1 black-tipped spine on each side at apex on ventral aspect; tarsomere 3 similar to terminal tarsomere of previous instars.

Abdominal tergite 6 with 4 small, obscure, whitish, oval waxpads on each side in lateral ½.

Fifth instar (Fig. 5). Length 4.68 ± 0.117; thoracic length 2.36 ± 0.017; width 2.88 ± 0.061.

Antennae with bulbous portion of flagellum ca. ¼× length of pedicel.

Pronotal plates each with 3–4 irregular rows of obscure pits bordering carinae; ca. 40–45 total pits on plate. Mesonotal plates each with 3 obscure pits on lateral ⅓; wingpad extending to apex of metanotal wingpad and to third abdominal tergite.

Abdominal tergites 3–6 with pits generally more numerous. Tergite 6 with 5 small, obscure, whitish, oval waxpads on each side in lateral ½.

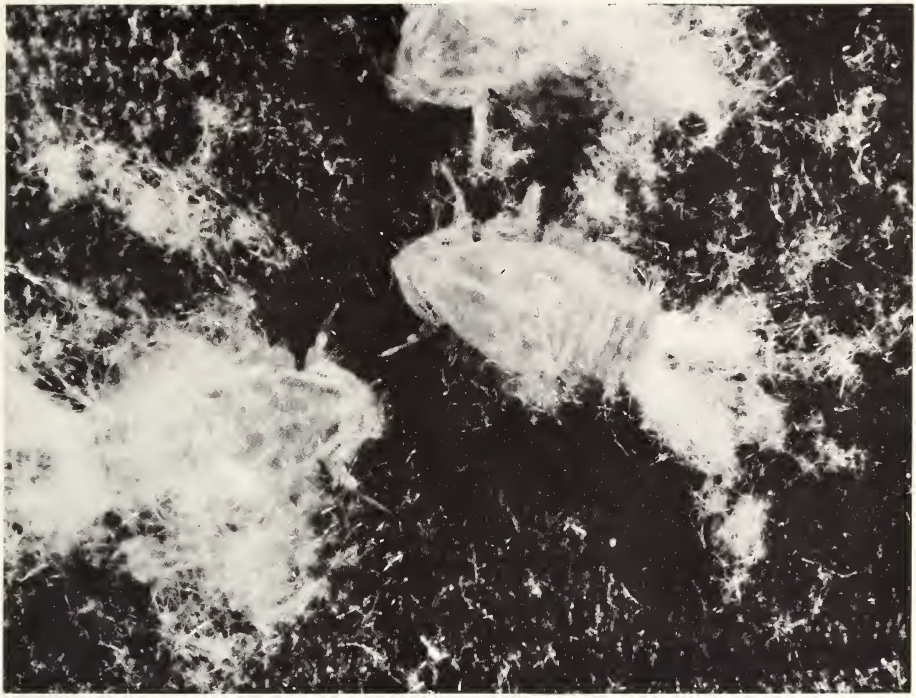


Fig. 6. Nymphs in life illustrating waxy exudate.

*Key to Nymphal Instars**

1. Metatarsi with 2 tarsomeres (Figs. 1–3) 2
– Metatarsi with 3 tarsomeres (Figs. 4, 5) 4
2. Metatibiae lacking spines on shaft, with an apical row of 4 spines; pronotal carinae bordered by 1 row of pits; abdominal tergite 6 with 1 oval waxpad on each side (Fig. 1) .... First instar
– Metatibiae with 1 or more spines on shaft and an apical row of 5–6 spines; pronotal carinae bordered by 2 irregular rows of pits; abdominal tergite 6 with 2–3 waxpads on each side (Figs. 2, 3) 3
3. Metatibiae with 1 spine on shaft; abdominal tergite 6 with 2 waxpads on each side (Fig. 2) .... Second instar
– Metatibiae with more than 1 spine on shaft; abdominal tergite 6 with 3 waxpads on each side (Fig. 3) .... Third instar
4. Mesonotal wingpads covering ca. ½ of metanotum laterally; abdominal tergite 6 with 4 waxpads on each side (Fig. 4) .... Fourth instar
– Mesonotal wingpads extending to apex of metanotum; abdominal tergite 6 with 5 waxpads on each side (Fig. 5) .... Fifth instar

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* This key will also work for nymphs of *A. septentrionalis, M. pruinosa,* and *O. venusta.*

Table 1. Plants associated with *Ormenaria rufifascia* and used in rearing experiments.

Taxon	Common name	Reference	Adults collected	Support nymphal development
Arecaceae				
Carpentaria acuminata (H. Wendl. & Drude) Becc.	Carpenter palm	This study	No	No
Caryota mitis Lour	Fish tail palm	This study	No	No
Cocos nucifera L.	Coconut palm	This study	Yes	No
Colpothrinax wrightii Griseb & H. Wendl.	Barrel palm	Metcalf and Bruner (1948)	Yes	—
Dictyosperma album (Bory) H. Wendl. & Drude	Hurricane palm	This study	No	No
Heterospathe elata Scheff.	Sagisi palm	This study	No	No
Latania loddigesii Mart.	Blue latan palm	Mead (1965)	Yes	—
Latania lontaroides (Gaertn.) H. E. Moore	Red latania palm	This study	Yes	Yes
Livistonia chinensis (Jacq.) R. Br. ex Mart.	Chinese fan palm	Mead (1965)	Yes	—
Phoenix canariensis Hort.	Canary Islands date palm	Mead (1965)	Yes	—
Phoenix dactylifera L.	Date palm	This study	No	No
Phoenix roebelenii O'Brien	Pigmy date palm	This study	No	No
Pritchardia eriostachya Becc.	Fan palm	This study	No	No
Pritchardia sp.	Fan palm	Mead (1965)	Yes	—
Ptychosperma nicolai (Sand. ex Andre) Burret		This study	No	No
Sabal etonia Swingle	Scrub palmetto	Mead (1965)	Yes	—
Sabal palmetto (Walt.) Lodd.	Cabbage palm	Mead (1965)	Yes	Yes
Serenoa repens (Bartr.) Small	Saw palmetto	Mead (1965)	Yes	—
Veitchia merrilli (Becc.) H. E. Moore	Christmas palm	This study	Yes	No
Washingtonia robusta H. Wendl.	Washington palm	Mead (1965)	Yes	—
Orchidaceae				
Cattleya sp.[a]	Cattleya orchid	Mead (1965)	Yes	—
Pandanaceae				
Pandanus utilis Bory	Screw pine	This study	No	No
Moraceae				
Ficus sp.[a]	Fig	Mead (1965)	Yes	—
Rosaceae				
Rosa sp.[a]	Rose	Mead (1965)	Yes	—

[a] Unconfirmed host record (Mead, 1965).

Table 2. Duration (in days) of the 5 nymphal instars and adults of *Ormenaria rufifascia* on *Sabal palmetto* in south Florida from January to June, 1983.

Instar	Range	Mean ± SD	# observed
1	18–28	23 ± 2.2	36
2	17–25	20 ± 2.0	28
3	15–26	19 ± 2.3	24
4	19–28	24 ± 1.9	21
5	5–10	8 ± 1.1	20
Adult	8–16	12 ± 1.6	20

Comparisons of Species of Flatid Nymphs

O. rufifascia is the fifth U.S. flatid in which the immatures have been described and illustrated. Immatures of the five species can be separated by color (in life; all turn white when preserved in alcohol) and external morphology. Identification by association with adults when collecting is risky since at least 3 species feed in mixed species feeding assemblages (Wilson and McPherson, 1980).

Live specimens of *O. rufifascia* and *O. venusta* are both green but *O. rufifascia* has orange longitudinal stripes whereas *O. venusta* has white stripes; the other 3 species are white in life. Preserved specimens can be separated by the following features. Late instar *A. septentrionalis* and *Cyarda* sp. (near *acutissima*) generally bear dark markings on the mesonotal wingpads, *A. septentrionalis* has a j-shaped waxpad on each side of abdominal segment 6 and c-shaped waxpads on abdominal segment 7. The waxpads on segments 6 and 7 are all ovoid on *Cyarda* sp. and the other species. *O. venusta* bears small, dark marks laterally on abdominal tergites 6–7, which are absent in the remaining species. *M. pruinosa* and *O. rufifascia* are the most morphologically similar. *M. pruinosa* is smaller, the vertex is truncate anteriorly, bears a weak median carina on the frons, and has ca. 6–8 weakly developed teeth on the inner margin of each metatrochanter. *O. rufifascia* is larger, has a broadly rounded vertex, lacks a median carina on the frons, and bears ca. 10 strongly developed teeth on the inner margin of each metatrochanter.

Field study. Ormenaria rufifascia adults have been collected or observed on 12 species of palms and non-palms (Metcalf and Bruner, 1948; Mead 1965; Table 1), but tests have never been conducted to determine if these or any other palms are breeding and/or feeding hosts. During a 2-year period (1982–1983), 14 species of palms and 1 non-palm species (Table 1) were examined in Fort Lauderdale and only cabbage palm, *S. palmetto* and red latania palm, *L. lontaroides,* supported nymphal development (Table 1). Cabbage palm is a native North American plant distributed throughout Florida and is a common host for *O. rufifascia.* Red latania palm is an uncommon introduced ornamental palm and is not an important host for *O. rufifascia.*

Field observations and cage rearing studies indicate that *O. rufifascia* is univoltine with five nymphal instars (Table 2). Numerous dissections of palm leaves were made in an effort to discover oviposition sites. Eggs were never found. However, females probably insert eggs in palms because they have a sawlike ovipositor similar to those of flatids known to deposit eggs in plant tissues (Wilson and McPherson, 1981). The oviposition host is probably cabbage palms, because first instars were always found on this plant. Females were dissected in order to obtain eggs however none was found. As with other North American flatids (Wilson and McPherson, 1981), eggs are probably laid in summer, and hatch in January. Neither immatures nor adults have ever been found on palms from July to December in south Florida. The average instars (1–5) durations ($\bar{x}$ ± SD) in the field were 23 ± 2.2, 20 ± 2.0, 19 ± 2.3, 24 ± 1.9, and 8 ± 1.1 days, respectively (Table 2). First instars were detected the second week of January. Adults emerged during the second week of May; mean adult longevity was 12 ± 1.6 days, with the last adults found in late June. Average monthly temperatures for January through June were 62.3, 65.0, 65.5, 65.8, 68.8, 75.1, and 77.9°F, respectively. The relatively rapid development of fifth instars may have resulted from the higher May temperatures.

Early instar nymphs exhibit gregarious and sedentary behavior near the basal portions of pinnae. Nymphs were never observed on the upper surfaces of palm leaves. The numbers of nymphs per aggregation ranged from 5 to 21. A white wax excreted by nymphs and presumed to serve a protective function (Hepburn, 1967) was always associated with nymphal aggregations. As nymphal development progressed, later instars tended to disperse and were often found singly on the undersides of leaves. Adults were often found near nymphal aggregations, but were rarely in groups of more than 3 individuals.

Occasionally large nymphs were observed with drops of honeydew attached to the posterior end. Nymphal aggregations were tended by 1 ant species, *Camponotus floridanus* Buckley. When disturbed, nymphs jumped up to 80 cm and away from aggregations, adults jumped and flew erratically while producing audible vibrations.

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LITERATURE CITED

Hepburn, H. R. 1967. Notes on the genus *Epiptera* (Homoptera: Achilidae). J. Georgia Entomol. Soc. 2:78–80.

Mead, F. W. 1965. *Ormenaria rufifascia* (Walker), a planthopper pest of palms (Homoptera: Flatidae). Fla. Dep. Agric. Entomol. Circ. 37, 2 pp.

Metcalf, Z. P. 1923. A key to the Fulgoridae of eastern North America with descriptions of new species. J. Elisha Mitchell Sci. Soc. 38:139–230.

Metcalf, Z. P. 1957. General catalogue of the Homoptera. Fasc. IV. Fulgoroidea, Part 13. Flatidae and Hypochthonellidae, 574 pp.

Metcalf, Z. P. and S. C. Bruner. 1948. Cuban Flatidae with new species from adjacent regions. Ann. Entomol. Soc. Amer. 41:63–118.

Moore, T. E. 1961. Audiospectrographic analysis of sounds of Hemiptera and Homoptera. Ann. Entomol. Soc. Amer. 54:273–291.

Wheeler, A. G. and E. R. Hoebeke. 1982. Host plants and nymphal descriptions of *Acanalonia pumila* and *Cyarda* sp. near *acutissima* (Homoptera, Fulgoroidea: Acanaloniidae and Flatidae). Fla. Entomol. 65:341–349.

Wilson, S. W. and J. E. McPherson. 1980. Mixed species feeding assemblages of planthopper nymphs (Homoptera: Fulgoroidea). Great Lakes Ent. 13:185–187.

Wilson, S. W. and J. E. McPherson. 1981. Life histories of *Anormenis septentrionalis, Metcalfa pruinosa,* and *Ormenoides venusta* with descriptions of immature stages. Ann. Entomol. Soc. Amer. 74:299–311.

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A REVISION OF THE GENUS *HORRIDIPAMERA* MALIPATIL (HEMIPTERA: LYGAEIDAE)

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Abstract.—The genus *Horridipamera* Malipatil is revised. Two new species *H. medleri* from West Africa and *H. compacta* from South India are described. A key to species, a cladogram, and discussion of phylogenetic relationships are included. All species are diagnosed. Extensive distributional data are included. A dorsal view drawing of *H. medleri* and 33 drawings with details of genitalia are given. There is a discussion of the relationships of *Horridipamera* to other genera.

The genus *Horridipamera* was erected by Malipatil (1978) for three species from Australia and the Orient. The erection of the genus was part of an effort on Malipatil's part to recognize and segregate monophyletic units from the old omnibus genus *Pachybrachius* Hahn. He selected the widespread *Plociomerus nietneri* Dohrn as type species and included two new species (*robusta*—eastern Australia, New Zealand and *cantrelli*—Queensland).

Harrington (1980) included eight additional species, several of which are African. The genus is thus represented throughout the tropics and subtropics of the Eastern Hemisphere.

Several of the species are extremely common, almost ubiquitous in tropical areas yet there is no modern work available to enable a student to readily identify species, nor is there a discussion of the intra-generic relationships.

We accept, for the present, Harrington's conclusion that *Horridipamera* is a monophyletic group although her statement that the broad base of the right conjunctival spine is a synapomorphy that distinguishes *Horridipamera* from *Paraparomius, Togo* and *Eucosmetus* is not true for some of the species that she places in the genus although it is true of *nietneri,* the type species.

Harrington (1980) erected the genus *Stalaria* with *Pamera ferruginosa* Stål as type species. She included *Pachybrachius kisseis* Linnavuori and *Pachybrachius nysias* Linnavuori in *Stalaria.* We have examined the lectotype of Stål's *Pamera ferruginosa* from the Stockholm Museum. It is not the species considered to be *ferruginosus* by Harrington. It is a species of *Horridipamera* closely related to *H. pullata* (Hesse) (see species discussion.) *Stalaria* is thus based upon a misidentified type species. The International Rules (Article 70a) state that such cases are to be referred to the commission asking either that the nominal species be designated as the type species or that the species named by the designator be selected. In the present case the specimens believed by Harrington to be *ferruginosus* are conspecific with *Pachybrachius kisseis* Linnavuori. To avoid adding an additional name to the literature (since placing

Stalaria as a junior synonym of *Horridipamera* would leave *kisseis* and *nysias* without a generic name) we are revising *Stalaria* and will be asking the commission to set aside *Pamera ferruginosa* as the type species of *Stalaria* and replacing it with *Pachybrachius kisseis* Linnavuori. The status of *Stalaria* thus will at that time become *sub judice* and it should be used in the sense of *kisseis* Linnavuori at least until the commission has acted.

Diagnosis. Horridipamera can be recognized on the basis of the following characteristics. Generally black and white or brown and white; phallic type II (see Harrington, 1980); anterior pronotal lobe somewhat globose, essentially impunctate; a deeply impressed line separating anterior pronotal collar from remainder of anterior lobe; male fore tibia usually spined; head slightly prolonged behind eyes; phallus lacking appendages or outgrowths except for one pair of conjunctival spines and two vesical marginal processes.

Harrington's cladogram separates *Horridipamera* and *Paraparomius* from such genera as *Togo, Eucosmetus* and *Paraeucomstus* on the most tenuous synapomorphies. The latter are "held together" in a clade by having the head broader than the transverse pronotal impression. However, several species of *Horridipamera* have this condition. We believe that the species we have included in *Horridipamera* do, on the basis of their derived phallic features (lack of appendages or outgrowths on phallus other than a pair of conjunctival spines and two vesical mariginal processes), form a monophyletic unit. We suggest that all members of the genera noted above need investigation to see if some may also be a part of this clade.

The abbreviations used for collectors are as follows: SS = J. and S. Slater; SSS = J. and S. Slater, Schuh; SSSS = J. and S. Slater, Schuh, Sweet; BAC = Brink, Anderson, Cederholm; HDKB = Hevel, Dietz, Karunaratne, Balasooriya; CDHHS = Cederholm, Danielsson, Hammarstedt, Hedqvist, Samuelsson. Locality: K.N.P. = Kruger National Park.

All measurements are in millimeters.

PHYLOGENETIC RELATIONSHIPS

We consider the following conditions to be derived in *Horridipamera.*

1. Asymmetrical conjunctival spines.
2. Bifid left conjunctival spine.
3. T-shaped outgrowth near proximal end of seminal duct.
4. Separation of distal and proximal vesical processes.
5. Loss of serrations on distal vesical processes.
6. Reduction of proximal vesical process.
7. Possession of long hairs on the dorsal surface.
8. Loss of spine near middle of male fore tibiae.
9. Elongation of the legs.
10. Narrow body shape.
11. Strongly produced eyes.
12. Strongly swollen anterior pronotal lobe.
13. Striped scutellum.
14. Possession of four evenly spaced spines near distal end of male fore tibia.
15. Apical vesical process saw-shaped.

16. Proximal portion of proximal vesical process broadened and plate-like.
17. Loss of distal vesical process.

In the cladogram (Fig. 1) we have relied heavily upon features of the phallus. Unfortunately many of what appear to be synapomorphies are reduction phenomena. Most of the reduction and loss is in the vesical processes. Where reduction and loss occur, the remaining portions of the vesical processes have a very similar appearance which we consider unlikely to have been the case if these reductions were homoplasies. Where the apical vesical process is completely lost homoplasy is as likely as synapomorphy.

Species of *Horridipamera* belong to Harrington's (1980) "genitalia type II." In this clade the plesiomorphic condition of the vesical processes is one in which there was a continuous tape-like sclerotization of the vesicular membrane (Figs. 10, 12, 13). A polarity sequence appears to be present in the following manner. First, separation of the tape-like vesicular sclerotization into two separate, but still elongate and twisted, processes (and subsequently into three as in species of *Pseudopachybrachius*). The next stage in the sequence, that is observable in *Horridipamera* at least, is the reduction of the distal process into a slender non-serrated strip (Fig. 8) and the subsequent complete loss of the distal process. The proximal process becomes reduced to form first an elongate slender twisted structure, then is reduced to a short somewhat "C-shaped" but still serrate-margined condition (Fig. 9).

Our other derived conditions are based largely on out-group comparison and include such features as the long hairs on the dorsal body surface, loss of the male fore tibial spines, striped scutellum, etc.

The more difficult areas to separate homoplasies from synapomorphies are in the elongation and narrowing of the body, elongation of the legs, increase in the size and globosity of the anterior pronotal lobe, and shape of the head. It is reasonably clear from out-group comparison that these are derived features but again and again in the Myodochini one sees a tendency to develop degrees of ant mimicry with which the above features are frequently associated. Thus in the cladogram we have used these chiefly as autapomorphies.

KEY TO SPECIES OF *Horridipamera*

1\. Male fore tibia lacking a distinct median spine 2

1a. Male fore tibia with one or more conspicuous spines present midway along shaft or on distal half 3

2\. No erect long hairs present on pronotum and scutellum; explanate lateral area of corium uniformly pale except for dark apex; antennal segments I, II, and III black or very dark castaneous; head width as great as or greater than width of anterior pronotal lobe; body relatively slender (Ceylon) .... *emersoni*

2a. Pronotum and scutellum with numerous conspicuous long, erect hairs present; explanate corial margin with a dark spot that reaches lateral margin at level just caudad of end of claval commissure; antennal segments I, II, and III chiefly pale yellow, only distal ends of segments II and III dark; width of anterior pronotal lobe greater than width of head across eyes; body comparatively stout (S. India) .... *compacta*

3\. Male fore tibia with 3–4 small equidistantly placed spines on distal ½ .... *cantrelli*

3a. Male fore tibia armed near middle with 1 or 2 large spines 4

4\. Hemelytra pilose, with long and erect hairs (view laterally) 5

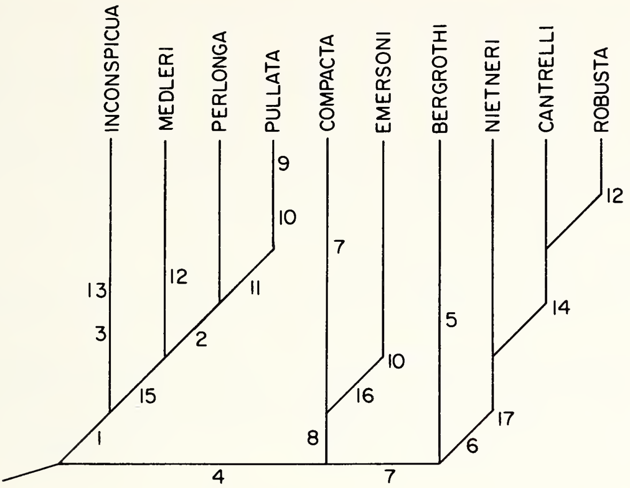

Fig. 1. Cladogram of species of *Horridipamera.*

4a. Hemelytra not pilose, without conspicuous long and erect hairs (but sometimes with elongate hairs present on pronotum and scutellum) 7

5. Anterior lobe of pronotum huge, in males at least twice as long as posterior lobe; fourth antennal segment with a pale basal annulus (Australia) .... *robusta*

5a. Anterior lobe of pronotum smaller, in males less than twice as long as posterior lobe; fourth antennal segment with or without a pale basal annulus 6

6. Hairs on antennal segments II and III twice as long as diameter of segments; decumbent hairs on hemelytra slender, silky not flattened nor somewhat scale-like; anterior lobe of pronotum more swollen and globular frequently higher than posterior lobe; fourth antennal segment uniformly dark; vesica with a reduced ridge-like distal process and an elongate proximal process fading gradually at one end (Figs. 5, 8) (Africa) .... *bergrothi*

6a. Hairs on antennal segments II and III shorter, subequal to diameter of segment; decumbent sericeous hairs on hemelytra shorter and broader, somewhat scale-like; anterior lobe of pronotum relatively narrow, rarely higher than posterior lobe; fourth antennal segment often with a pale basal annulus; vesica only with proximal process, this semi-oval, flap-like, margin inconspicuously toothed (Fig. 9) (Oriental and Australian) .... *nietneri*

7. Scutellum with a pair of oblique brown stripes. A somewhat angulate sclerotized outgrowth present on proximal part of ejaculatory duct (Fig. 7); punctures on pale macula before dark apex of corium dark, of same color as other punctures on corium (Asia and Africa) .... *inconspicua*

7a. Scutellum uniformly black or chocolate brown; ejaculatory duct without a distinct outgrowth proximally; punctures on pale corial macula either pale or dark 8

8. Fourth antennal segment with a conspicuous pale basal annulus .... *perlonga*

8a. Fourth antennal segment uniformly dark 9

9. Body relatively broad and stout, total body length less than four times width of pronotum across humeral angles; eyes not strongly protruding; width of head across eyes not greater than maximum width across anterior pronotal lobe; middle and hind

femora darkened only on distal ⅓ to ½; hind tibiae largely pale, infuscated only near proximal and occasionally extreme distal ends .... *perlonga*

9a. Body more elongate, total body length at least four times as great as width across pronotal humeral angles; eyes more prominently produced, width across eyes sometime greater than maximum width across anterior pronotal lobe, if not anterior pronotal lobe strongly swollen (*medleri*); degree of dark coloration on hind femora variable; hind femora usually entirely dark, occasionally only darkened on proximal ½ to ⅔; hind tibiae usually infuscated (dark brown) for entire length 10

10. Width across eyes less than, or subequal to, maximum width across anterior pronotal lobe; latter strongly swollen and appearing globose; ground color of hemelytra pale with infuscated dark stripes and dashes .... *medleri*

10a. Width across eyes greater than maximum width across anterior pronotal lobe; anterior pronotal lobe relatively slender and linear, not appearing globose; ground color of hemelytra dark brown with a strongly contrasting white subapical corial macula ... 11

11. Head, pronotum, and scutellum chocolate or very dark red brown; white subapical corial macula strongly contrasting with ground color of corium .... *pullata*

11a. Head, pronotum, and scutellum light reddish; subapical corial macula only weakly differentiated from ground color of corium .... *ferruginosa*

Horridipamera inconspicua (Dallas)

Rhyparochromus inconspicuus Dallas, 1852, p. 547.
Diplonotus rusticus Scott, 1874, pp. 430–431. **New Synonymy.**
Pamera spinicrus Reuter, 1882, pp. 17–18. **New Synonymy.**
Pamera ebenaui Reuter, 1887, pp. 96–97. **New Synonymy.**
Pachybrachius inconspicuus Slater, 1964a, p. 1127.
Horridipamera inconspicuus Slater, 1979, p. 22.

Diagnosis. Body relatively short and stout. Scutellum dark red-brown with a conspicuous pair of light orange to light reddish brown oblique streaks on basal half. Hemelytra chiefly pale yellow with punctures dark brown. Pale macula at inner corial angle large, very conspicuous by virtue of dark streaks extending anteriorly and posteriorly from the pale macula. Usually a dark apical corial macula and a small dark spot at edge of explanate lateral margin (but not reaching margin) at level of inner pale corial macula. Thus corium appearing largely pale and subapical pale macula not strikingly differentiated. Pronotum reddish brown with humeral angles, and often extreme posterior margin, pale yellow. Fore femora dark reddish brown, with pale distal ends. Usually middle femora pale and hind femora with a narrow subdistal dark macula. Antennae variable in color, segments II and III usually pale yellow; segment IV dark sometimes with a pale subbasal annulus present. Second labial segment white or pale yellow. Membrane pale with irregular darker spots and streaks scattered throughout.

Male fore tibiae each with a distinct spine midway along shaft. Dorsal surface lacking numerous elongate upstanding hairs but with decumbent sericeous pubescence. Width of anterior pronotal lobe slightly greater than width of head across eyes and conspicuously swollen. Labium reaching at least to middle of mesosternum.

Sperm reservoir with wedge-shaped bulb, very broad proximally, tapered distally; wings strongly bent ventrad and produced into a narrow elongate blunt projection (Fig. 7). Vesical process of phallus interconnected, elongate, complexly twisted, evenly serrated (Fig. 13). Conjunctival spines as in Figures 28, 29. Paramere with elongate acute inner projection, inner margin proximal of projection produced into a broad flap-like flange, outer projection short, broad, blade thick (Fig. 35). Ejaculatory duct with a peculiar bent, sclerotized projecting outgrowth near proximal end (Fig. 7).

As might be expected in a species with such a wide range there is considerable variation in color. The scutellar streaks while usually diagnostic may be much reduced in dark specimens and in unusually pale specimens may not be appreciably differentiated from the color of the remainder of the scutellar surface. However, the combination of pale corium in which the distal light macula is little differentiated, relatively pale membrane, stout body, etc., make this a generally readily recognizable species without recourse to the definitive differentiating characters of the male genitalia.

The correct name to apply to this species has been a matter of difficulty. We (Zheng and Slater, 1984) have selected a specimen of this species from West Africa as the neotype of *Rhyparochromus inconspicuus* Dallas (see discussion in that paper) which is the oldest available name.

First instar nymph. South Africa: Pretoria, Transvaal, 18.XII.1967 (SSS). (Reared from eggs laid by identified female.) Head and pronotum dull orange. Meso- and metanota gray with reddish borders. Abdomen dull orange red shading to red posteriorly along intersegmental sutures and laterally. Sclerotized areas about scent gland orifices on terga 3–4, 4–5, 5–6 gray with larger pigmented area posterior to suture than anterior to it. Legs uniformly dull white. Antennal segments I, II, III white tinged with reddish. Fourth segment a strongly contrasting orange-red. Length head 0.37, width 0.34, interocular space 0.24. Length pronotum 0.15, width 0.34. Length mesonotum 0.10, width 0.37. Length metanotum 0.07, width 0.39. Length abdomen 0.61. Length labium 0.73, slightly exceeding posterior margin of metacoxae. Length antennal segments I 0.10, II 0.17, III 0.17, IV 0.32. Total body length 1.20.

Second instar nymph. (As above.) Head and anterior ⅓ of pronotum dark brown. Ground color of remainder of body dull yellow with a narrow dull brown longitudinal stripe on either side of midline and an oblique irregular streak extending dorsolaterad near middle of segment on each side.

Abdominal terga 1, 2 and anterior ½ of 3 dull gray brown. Remainder of abdomen with dark central markings similar to those of instar 5. Abdomen with red striping along intersegmental sutures. Dark sclerotized areas about scent gland orifices as well developed anterior to orifices as posterior to them; sclerotization between terga 3–4 somewhat wider than that between terga 4–5 or 5–6. Femora conspicuously tinged with red on distal halves. Antennal segment I and proximal ½ of II white, former with a narrow, dark, basal annulus. Distal ½ of antennal segment II and all of segments III and IV red.

Length head 0.51, width 0.49, interocular space 0.29. Length pronotum 0.24, width 0.49. Length mesonotum 0.17, width 0.54. Length metanotum 0.10, width 0.63. Length abdomen 0.98. Length labium 0.98, reaching well between metacoxae. Length antennal segments I 0.15, II 0.24, III 0.22, IV 0.43. Total body length 1.95.

Fifth instar nymph. South Africa: 17 mi NE Pretoria, Pienaars River Dam 1.XI.1967 (SSS). General coloration bright tan, or light brown interspersed with light yellow as follows: a longitudinal stripe running completely through pronotum on either side of midline and a short longitudinal vitta on posterior pronotal lobe slightly mesad of humeral angles; a series of oblique stripes on scutellum and mesothoracic wing pads giving a striped appearance to these areas; distal ends of femora, tibiae, first tarsal segments and second and third antennal segments pale yellow.

Color of abdomen complexly variegated: ground color pale yellow, an elliptical brown macula present around dorsal scent gland openings between terga 3–4, 4–5 and 5–6, that between 3–4 broader than succeeding. Tergum 2 dark brown; tergum 3 mesally chiefly brown but this coloration extending posteriorly to scent gland macula only as a pair of narrow bars and a mesal convex extension from the main darkened central area; tergum 4 with an ovoid central dark patch, enclosed on either side by a pincer-like dark band that coalesces posteriorly with macula surrounding terga 4–5 scent gland orifices; terga 5, 6 and 7 each with a dark central macula, that on tergum 5 especially large. Oblique dark rays extending cephalo-laterad from dark central areas of each segment, sutures between segments also dark. Explanate lateral margins of pronotum and wing pads pale yellow with narrow dark brown outer edges. First antennal segment pale yellow with a strongly contrasting dark brown basal annulus. Fourth antennal segment uniformly reddish brown. Femora and second tarsal segment dull brown.

Head slightly declivent. Tylus attaining middle of first antennal segment. Vertex moderately convex. Epicranial suture with stem present but very short. Length head 0.81, width 0.90, interocular space 0.56. Lateral pronotal margins narrowing evenly but moderately from humeral angles to anterior margin; both anterior collar and transverse impression conspicuous. Anterior pronotal lobe much larger and more convex than posterior. Length pronotum 0.79 (length anterior pronotal lobe 0.59, length posterior pronotal lobe 0.20), width pronotum 1.07. Mesothoracic wing pads broad, reaching to or almost to suture between abdominal terga 3–4. Length mesothoracic wing pads 1.10. Length abdomen 1.76. Fore femur generally with 2 or 3 spines on inner rank and a single spine on outer. Labium extending posteriorly to or between mesocoxae. Length labial segments I 0.29, II 0.37, III 0.56, IV 0.59. Length antennal segments I 0.32, II 0.73, III 0.61, IV 0.88. Total body length 4.07.

We have examined 3rd and 4th instar nymphs from Meintjies Kop, Pretoria, South Africa 19.III.1968 (SSS). These closely resemble instar 5 in color.

Biology. This species is abundant in early succession stages of old fields in South Africa. It is one of the most common of the lygaeid species that comes to lights in Pretoria where it presumably lives in gardens and weed grown lots. We were unable to establish any definite breeding host, but on several occasions took adults and nymphs along roadsides below a variety of weeds and grasses. It apparently is not entirely, if at all, a grass feeder, since it often occurs on recently burned over veld with much bare ground and where only scattered forbs produce a seed crop.

Distribution. H. inconspicua is distributed throughout much of the Ethiopian Region, occurs on at least some of the islands of the Indian Ocean and through the Oriental Region to China and Japan.

It is considerably less common than *perlonga* in West Africa. By contrast *inconspicua* is an abundant, almost ubiquitous, species in South Africa. The distributions of *inconspicua* and *perlonga* in fact closely resemble those of *Pseudopachybrachius reductus* (Walker) and *P. capicola* (Stål) where the former is abundant in West Africa, but scarce in South Africa and *capicola* the reverse. Cases like these suggest former allopatry for these disturbed habitat or early succession stage insects. If so the subsequent sympatry is possibly due to disturbance by man that has led to the elimination of former ecological barriers.

H. inconspicua has previously been reported from: Senegal (Slater and Wilcox, 1973) and (Scudder, 1982–as *spinicrus* and *ebenaui*); Sierra Leone (Dallas, 1852); "Guinea" (Lethierry and Severin, 1894—as *spinicrus*); Ghana (Reuter, 1882—as *spinicrus*); Ruanda (Schouteden, 1957); Zaire (Slater, 1972); Sudan (Linnavuori, 1978—as *spinicrus*); Tanzania (Scudder, 1962a); Southwest Africa (Schumacher, 1913—as *ebenaui*?); Cape Verde Is. (Lindberg, 1958—as *ebenaui*); South Africa (Slater, 1964b); Madagascar (Reuter, 1887—as *ebenaui*); Rodriguez I. (China, 1924—as *ebenaui*); Sri Lanka (Slater, 1979); Japan (Scott, 1874—as *rusticus*); China (Horvath, 1879—as *nietneri*).

Additional material examined. SENEGAL: 4, off Senegal at sea, 25.x.1957 (Capener). 1, Guede, 1.iii.1946 (Risbec). GUINEA: 9, off coast, xii.1957 (Capener). GHANA: 1, Accra, 14.xi.1969 (Campbell). NIGERIA: 2, Ile-Ife, xi.1969 (Medler). 5, same, 27.iii.1969. 18, same, 10.iii.1969. 1, same, 25.iii.1969. 1, Keffi, B.P. State, 23.xii.1968 (Medler). 7, Bedeggi, NW State, 14.xii.1974 (Medler). 1, Lagos, Univ. Campus, ii.1975 (Hamid). ST. THOMAS IS.: 1, Neves, Cote N 25 km S Tome, 21.x.1973 (Schmitz). CAPE VERDE IS.: 3, Tiago, Sierra Pico Antonia, 10.ii.1945 (Panelius). SUDAN: 2, Blue Nile, Wadi Medari, 11–12.xi.1962 (Linnavuori). 2, Upper Nile, Malakal, 5–20.i.1963 (Linnavuori).TANZANIA: 2, Mlingano, 5.xi.1963 (Robertson). 1, same, 13.vi.1963. 2, Ukiriguru, 8.xi.1960 (Robertson). 1, same, 29.iv.1960. 1, Ilonga, 29.ix.1963 (Robertson). 2, same, 3.x.1963. 7, Tabora, 27.xi.1963 (Robertson). 2, same, 28.xii.1963. 1, same, 1.i.1964. BOTSWANA: 2, 2 mi N Gaberones, 21.x.1974 (Samuel Slater). SOUTH AFRICA: *Transvaal:* 1, 20 mi SW Rustenburg, 20.x.1974 (Samuel Slater). 1, Rustenburg, 4.xii.1950 (Capener). 2, same, 4.xii.1951. 3, 10 mi N turnoff, 19 mi E Groot Marico, 22.x.1974 (Samuel Slater). 18, Pretoria, 22.x.1967 (SSS). 79, same, 23.x.1967. 2, same, 27.x.1967. 21, same, 2.xi.1967. 2, same, 3.xi.1967. 2, same, 5.xi.1967. 1, same, 6.xi.1967. 1, same, 7.xi.1967. 1, same, 22.xi.1967. 1, same, 24.xi.1967. 3, same, 25.xi.1967. 6, same, 27.xi.1967. 3, same, xi.1967. 1, same, 4.xii.1967. 9, same, 5.xii.1967. 6, same, 9.xii.1967. 3, same, 3.i.1968. 2, Nat. Botanical Garden, 24.xi.1967 (SSS). 3, Fountains, 28.x.1968 (SSS). 2, Irene, Smut's Farm, 10.i.1968 (SSSS). 6, Meintjies Kop, Pretoria, 22.x.1967 (SSS). 1, same, 18.iii.1968. 1, same, 19.iii.1968. 1, same, 29.x.1967. 1, Lyttleton, 26.xii.1967 (SS). 1, same, 17.xii.1967. 2, same, 18.xii.1967. 1, same, 12.i.1968. 1, same, 19.i.1968. 1, same, 26.ii.1968. 2, same, 29.ii.1968. 1, same, 20.xi.1968. 1, 10 mi N Mookeetsi, 13.xii.1967 (SSS). 1, Dendron, xi.197—(van Ark). 5, Hartebeesport Dam, 20 mi W Pretoria, 30.x.1967 (SSS). 1, 14 mi NE Potgietersrus, 26.x.1967 (SSS). 3, Mariepskop nr. Klaserie, 6,300 ft, 30.xi.1967 (SSS). 1, 10 mi SSW Skukuza (K.N.P.), 26.iv.1968 (SSSS). 1, 10 mi N Satara Camp (K.N.P.), 28.iv.1968 (SSSS). 1, 3 mi E Satara Camp, Nwanedzi River (K.N.P.), 29.iv.1968 (SSSS). 2, 9 mi N Pietersburg, 26.x.1967 (SSS). 9, 15 mi SSW Pietersburg, 25.x.1967 (SSS). 1, Pietersburg, 26.x.1967 (SSS). 6, base Magoebaskopf 4,000 ft, 12.xii.1967 (SSS, Munting). 1, 6 mi N Warmbaths, 7.xii.1967 (SSS). 1, Zoutpansberg, 4,500 ft, 5 mi N Louis Trichardt, 8.v.1968 (SSSS). *Cape Province:* 1, Van Zylsrust, Kuruman River, 2.xi.1967 (Coaton). 6, Kimberley, 17–18.i.1968 (SSSS). 2, 31 mi NE Calvinia, 10.x.1974 (S. Slater & Ecker). *Orange Free State:* 10 mi Petrus Steyn to Reitz, 27.xii.1967 (SSS). 1, Lindly, xii.1951 (Weber). *Natal:* 10 mi W Paulpietersberg, 7.xi.1967 (SSS). CEYLON: 2, Anu. Dist. Wildlife

Bungalow, Hunuwilagama, Wipattu, 200 ft, 10–19.iii.1970 (Davis and Rowe). 1, Kan. Dist. 5 mi NW Maheyangana, 30.iii–1.v.1971 (Spangler). 2, Tri. Dist., China Bay, 200 ft, 9–11.ix.1976 (HDKB). INDIA: 1, Pulney Hills, Kodiakanal, 6,500 ft, v.1953 (Nathan). PHILIPPINES: 1, Mt. Maquiling, Luzon, 15.xi.1947 (Gines). JAPAN: 2, Nishinomiya, P.R. Settsu, 27.xi.1952 (Nakanishi).

We have dissected specimens from South Africa, Nigeria, Tanzania, Japan and Ceylon. No significant differences have been found.

Horridipamera cantrelli Malipatil

Horridipamera cantrelli Malipatil, 1978a, pp. 94–96.

Diagnosis. It is readily distinguishable from all species of *Horridipamera* except *robusta* by the presence of four small equidistantly spaced spines on the distal half of each male fore tibia.

H. cantrelli is closely related to *nietneri* as is indicated by the lack of the distal vesical process and the reduction of the proximal process, the quadrate sperm reservior wings that only curve moderately posteriorly and the similarly shaped parameres.

H. cantrelli has a pale basal annulus on the fourth antennal segment, pale pronotal humeri, spotted fore femora and chiefly pale hemelytra. The coloration of the hemelytra is very similar to that of *inconspicua.* The known specimens range in length from 5.5 to 6.2 mm.

Malipatil's (1978) description and figures are excellent. The spotted fore femora lack of a greatly swollen anterior pronotal lobe and the characteristic fore tibial (male) spines should enable the species to be readily recognized.

Distribution. AUSTRALIA: Known only from the type localities in Queensland.

Horridipamera perlonga (Scudder)

Pachybrachius pullatus Slater, 1964b (*nec* Hesse), p. 217.
Pachybrachius perlongus Scudder, 1969, p. 173.
Horridipamera perlongus Harrington, 1980, p. 99.

Diagnosis. Elongate, slender. Head, pronotum and scutellum piceus to reddish brown. Scutellum uniformly dark, lacking oblique reddish brown stripes. Anterior pronotal lobe impunctate. Clavus and corium lacking upright hairs. Fore femora except proximal and distal ends chocolate brown. Middle and hind femora pale yellow with a broad subdistal dark annulus. Antennal color variable from nearly uniformly dark to chiefly pale yellow on segments I, II, and III. Fourth antennal segment frequently with a yellow basal annulus. Males with a spine present near middle of each anterior tibia. Hemelytra usually with a conspicuous subdistal white corial macula, lateral explanate corial margin pale. Labium at least attaining middle of mesosternum, first segment remote from base of head, second segment usually white or pale yellow. Membrane usually dark with veins white and with a narrow white apical median stripe.

Sperm reservoir bulb wedge-shaped similar to that of *inconspicua* but slightly less narrowed distally. Wings strongly bent downward but evenly narrowed (Fig. 6) not produced into an elongate narrow projection. Vesical processes of phallus more or less connected, complexly twisted, proximal process saw-like (Fig. 10). Left conjunctival spine broad and blade-like throughout most of length, slightly bifid and terminating in an acute spine at distal end (Fig. 20). Right conjunctival spine evenly tapering (Fig. 21). Paramere with expanded margin proximad of acute inner projection subtruncate with proximal margin concave (Fig. 32).

H. perlonga is a variable species. The fourth antennal segment usually has a pale proximal annulus, but many specimens, from West Africa particularly, have the fourth segment entirely dark. The head, pronotum, and scutellum are always dark (though varying from almost black to reddish brown) whereas the hemelytra are variable in color. In some specimens the clavus and corium are almost completely pale with only the large apical corial macula, an area at the inner corial angle and some of the punctures retaining the dark brown coloration. More commonly the corium has a broad irregular dark transverse fascia (frequently incomplete), a dark patch near the base and the clavus strongly infuscated with brown so that only the proximal ½ of the cubital vein, an irregular basal area and small "dash" opposite the claval commissure is pale.

There is, as in many myodochines, considerable variation in the relative length and degree of convexity of the anterior pronotal lobe. The difference in the length of the antennae is remarkable. Thus when one compares an elongate slender, pale specimen with a short robust dark one it is difficult to believe that only a single species is involved. However, all intermediate conditions are present in the study series, and there are no differences in the male genitalia. We conclude that a single species is represented.

Biology. This is an uncommon species in South Africa where much of the African field work of the senior author has been concentrated. On May 1, 1968 we took adults and nymphs of *perlonga* under a creeping forb with many seeds present that was growing below a large Natal mahogany tree (*Trichilia emetica* Vahl.). This was a disturbed habitat, much trampled by hippopotami, near Letaba Camp, Kruger National Park, South Africa.

Fifth instar nymph. South Africa: Kruger National Park 4 mi E Letaba Camp, Letaba River, 1.V.1968 (SSSS). Very unlike *inconspicua* in general coloration. Head and pronotum dark chocolate brown, the latter nearly unicolorous, lacking any indication of pale longitudinal stripes near midline; scutellum and wing pads dark the latter very obscurely marked; a pair of faint diagonal paler streaks on scutellum and a small pale yellow macula anteriorly near lateral margin of each wing pad and a second adjacent on explanate flange of wing pad. Ground color of abdomen dull red. Dark areas in central portion of terga 3–7 similar to *inconspicua* but tending to form a broad median dull brown stripe; tergum 4 mesally with only a spot in center but with a broad dark transverse fascia that covers almost entire tergum laterad of scent gland orifices. All terga darkened laterally. Abdomen below dull reddish with a strongly contrasting pale yellow oblique band on sterna 4 and 5 running anterolaterad from meson of sternum 5. Antennae and femora dull reddish; tibiae brown; first tarsal segment pale yellow, second tarsal segment somewhat infuscated.

Head slightly more formicoid than is that of *inconspicua.* Tylus reaching middle of 1st antennal segment. Stem of epicranial suture relatively elongate. Length head 1.20, width 0.90, interocular space 0.54.

Explanate pronotal margins much less strongly developed than are those of *in-*

conspicua. Length pronotum 0.85 (length anterior pronotal lobe 0.66, length posterior pronotal lobe 0.20), width 1.02. Length mesothoracic wing pads 1.36. Length abdomen 2.32. Fore femora with 2–3 spines on inner rank, one spine on outer rank. Labium apparently attaining mesocoxae. Length labial segments I 0.71, II 0.68, III 0.49, IV 0.37. Length antennal segments I 0.43, II 0.90, III 0.78, IV 0.90. Total body length 5.18.

The nymphs of *H. perlonga* and *H. inconspicua* are extremely different in appearance. *H. perlonga* has a much more ant-like facies with its dark coloration, white banded abdominal venter and long head and legs. *H. inconspicua* on the other hand gives no suggestion of ant mimicry and the general appearance is of a pale streaked and striped insect. The median coloration of the abdominal terga is similar but the other striking differences in the nymphs suggest that these two species are not closely related.

Egg. South Africa: K.N.P., 4 mi E Letaba Camp, Letaba River, 1.V.1968 (SSSS). Egg elongate elliptical, truncate at anterior end ("typical" rhyparochromine shape); surface lacking numerous hairs. Six short closely set micropylar processes at anterior pole. Length 1.17, maximum width 0.39.

There does not appear to be a significant difference between the eggs of *inconspicua* and *perlonga.*

Distribution. H. perlonga is a widespread, ubiquitous species in West Africa. It occurs over much of tropical Africa and on Madagascar as well. In South Africa it is known only from the tropical and subtropical areas of the eastern Transvaal and Natal.

H. perlonga was originally described from Guinea (Scudder, 1969) and has been subsequently reported from Senegal by Scudder (1971, 1982) and Slater and Wilcox (1972) and from the Sudan by Linnavuori (1978). Slater's (1964b) record of *Pachybrachius pullatus* from Eranchi, Swaziland belongs here as do his (1972) records of "*Pachybrachius* nr. *pullatus*" from Zaire.

Additional material examined. SENEGAL: 7, Npak, 11 km S Ziguichor, 8.xi.1977 (CDHHS). 1, in forest 1 km NE Djibelor about 7.5 km W Ziguichor, 8.xi.1977 (CDHHS). 1, Cap Skiring, 10.xi.1977 (CDHHS). GAMBIA: 2, Tendeba Camp near River Gambia, 14.xi.1977 (CDHHS). 1, River Tanji, 3 km SW Brufut, 28.xi.1977 (CDHHS). 1, outside Abuko Nature Reserve at waterworks, 26.xi.1977 (CDHHS). 1, Abuko Nature Reserve, 18.xi.1977 (CDHHS). 1, 2 km S Kitty, 7 km SSW Brikama Road Junction, 27.xi.1977 (CDHHS). GUINEA: 2, off coast wind NNW, xii.1957 (Capener). GHANA: 181, Tafo, 4–9.x.1967 (SSS). 1, Tafo, 28.xi.1965 (Leston). 1, same, 29.xi.1965. 1, same, 9.xii.1965. 1, same, 17.xii.1965. 1, same, 1.vi.1967. 1, same, 7.viii.1967. 1, Kade, 28.v.1966 (Leston). 2, Goaso, 21.iii.1969 (Leston). 1, Kpandu, 1.xi.1969 (Leston). 1 no abd., Osiem, 24.vii.1967 (Leston). 2, Wiawso W.R., 31.iii.1969 (Leston). 5, Accra, 15.xi.1969 (Campbell). 2, same, 14.xi.1969. 1, same, 22.xi.1969. 2, same, 16.xi.1969. 1, same, 1.xii.1969. 1, Mt. Atewa, 2,000 ft, 6.x.1967 (SSS). NIGERIA: 4, Oban RH, SE State, 7.iv.1975 (Medler). 2, Ile-Ife, 10.iii.1969 (Medler). 4, same, iv.1969. 6, same, 27.iii.1969. 1, same, ix.1974. 1, same, 25.iv.1969. 1, same, 5.v.1969. 2, same, 10.iii.1969. 1, same, xi.1969. 1, same, 27.x.1969. 2, U. Ora, M.W. State, xi.1974 (Medler). 1, Sopoba FR, M.W. State, viii.1973. 9, Umuahia CRIN, EC State, 9.iv.1975 (Medler). 2, Ikom CRIN, SE State, 4.iv.1975 (Medler). 1, Obudu CR, SE State, 27.ix.1973. 6, Udo FR, M.W. State, 11.iv.1975 (Medler).

1, Ibadan, W. State, 15.iii.1969 (Medler). 1 Benin, NIFCR, M.W. State, 1.iv.1975 (Medler). CAMEROON: 1, (Carayon). UGANDA: 1, Lake George, 27.v.1940 (Stephenson). 1, Kawanda, 19.vi.1958 (Odhiambo). 1, Kassesse Busongoro, 20.v.1940 (Stephenson). TANZANIA: 3, Mlingano, 13.vi.1963 (Robertson). 1, same, 29.viii.1963. 1, same, 22.i.1966. 1, Ilonga, 14.iv.1965 (Robertson). 6, same, 8.i.1965. 4, same, 26.ii.1964. 1, same, 18.iv.1965. 4, same, 29.iv.1963. SOUTH AFRICA: *Natal:* 5, Eshowe, 15.xi.1967 (SSS). 1, St. Lucia Park, Zululand, 26.i.1968 (Brinkman). 1, Lake St. Lucia, Charters Creek, 12.xi.1967 (SSS). *Transvaal:* 1, Letsitele Valley, Gravelotte District, 18.xi.1958 (Capener). 2, base Magoebaskloof, 4,000 ft, 12.xii.1967 (SSS). MADAGASCAR: 1, E District Maroantsetra, v.19—(J. Vadon). 1, Sambirano, Nossi-Be, Foret de Lokobe, i.1960 (Andria Robinson). 1, Est. Dct. Sambava R. N. xii-Marojejy, Beondroka 1,200 m, vi.1960 (P. Soga). 1, Est. Ankalampona 130 m, Navana-Marpamtsetra, iii.1958 (Soga-Raharizonina).

Horridipamera pullata (Hesse)

Pamera pullata Hesse, 1925, p. 79.
Pachybrachius pullatus Slater, 1964a, p. 1140 (Pt.).
Horridipamera pullatus Harrington, 1980, p. 99.

Diagnosis. Very elongate, slender with unusually long legs and antennae. Head, pronotum and scutellum black to dark red-brown. All femora chiefly dark chocolate brown, pale only on proximal ⅓ to ¼ and occasionally at extreme distal ends of fore femora. Antennae chocolate brown to reddish brown nearly uniformly colored; fourth segment never with a proximal pale annulus. Scutellum lacking oblique reddish vittae, uniformly dark. Second labial segment not pale, similarly colored to other segments. Hemelytra strongly suffused with chocolate (as in dark specimens of *perlonga*), a large subapical elliptical white corial macula present. Membrane dark with veins narrowly pale and a short apical median pale vitta present.

Eyes prominent, strongly elevated above vertex and produced. Width across eyes noticeably broader than width of anterior pronotal lobe.

Male genital structures very similar to those of *perlonga.* Bulb of sperm reservoir more quadrate, not appreciably narrowing distally. Left conjunctival spine relatively shorter much more deeply bifid at distal end (Fig. 16). Right conjunctival spine is very elongate and sharply acute (Fig. 17). Flange-like area proximad of inner projection of paramere narrow, more elongate and tapered than in *perlonga.*

Although similar to *perlonga* in size, and to darker specimens of the latter in color, *pullata* is a more slender and long legged species with more "uptilted" and protruding eyes. Occasional specimens of *perlonga* may have the head slightly broader than the anterior pronotal lobe and when this condition occurs in specimens with dark fourth antennal segments identification may be difficult without comparative material. We have found two differences in color that appear to be diagnostic. In *pullata* the middle and hind femora are completely dark chocolate brown on the distal ⅔ to ¾ and the second labial segment is brown and concolorous with the other labial segments. In *perlonga* the middle and hind femora have only a small subdistal dark annulus and the second labial segment is white or dull yellow. The majority of specimens of *perlonga* may be separated from *pullata* by the pale basal annulus on the fourth antennal segment.

Distribution. H. pullata has previously been thought to be a South African species. This is not true. Hesse (1925) originally described it from Southwest Africa and Slater (1964b) reported it from Swaziland. Hesse's record was from Ovamboland in northern Southwest Africa and Slater's Swaziland record pertains to *perlonga. H. pullata* is a tropical African species. It is sympatric with *perlonga* in West Africa from where most of our study material has come. Scudder (1969) reported it from Guinea. It also occurs in Tanzania and has been reported by Linnavuori (1978) from the Sudan and Chad. Thus it will probably prove to be widespread in tropical Africa. It is appreciably less common than *perlonga* in collections from areas where the two have been taken together. See discussion under *H. ferruginosa.*

Material examined. IVORY COAST: 1, Lamto (Toumodi), 17.iii.1964. 1, same, 10.iv.1962. 1, same, 10.iii.1964. 1, same, 4.xii.1962. GHANA: 1, Accra, 1.xii.1969 (G. W. Campbell). 8, Tafo, 7.x.1967 (SSS). 3, same, 8.x.1967; 2, same, 4–9.x.1967. 1, Tafo, 7.vii.1965 (Leston). 1, same, 2.viii.1965. 1, same, 11.x.1965. 1, same, 22.vii.1967. 1, same, 14.x.1967. 1, Salt Pond, 17.ii.1966 (Leston). 1, Kade, 2.ix.1965 (Leston). 2, Obuasi, 7.ii.1966 (Leston). 1, Prestea W.R., 13.ii.1966 (Leston). 1, Legon, 29.viii.1968 (Leston). 1, Osiem, 21.x.1966 (Leston). NIGERIA: 11, Umuahia CRIN, EC State, 9.iv.1975 (Medler). 2, Ikom CRIN, SE State, 4.iv.1975 (Medler). 7, Oban RH, SE State, 7.iv.1975 (Medler). 1, Ile-Ife, 5.v.1969 (Medler). TANZANIA: 1, Mlingano, 5.xi.1963 (Robertson).

Horridipamera ferruginosa (Stål), **New Combination**

Pamera ferruginosa Stål, 1874, p. 151.

As previously noted Harrington (1980) cited *Pamera ferruginosa* as the type species of her new genus *Stalaria.* Harrington, however, had misidentified *ferruginosa,* confusing it with *Pachybrachius kisseis* Linnavuori. As noted in the generic discussion we are revising "*Stalaria*" and will be appealing to the International Commission to have *ferruginosa* set aside as the type species of *Stalaria* and asking that *P. kisseis* Linnavuori be named the type species.

P. ferruginosa Stål is actually a species of *Horridipamera.* Stål (1874) in his original description keyed *ferruginosa* into a couplet with species whose males have a spine midway along the shaft of the tibia. Harrington (1980) notes the lack of such a spine as one of the diagnostic features of *Stalaria.* Harrington's misidentification apparently resulted from her use of specimens in the senior author's collection from Upemba National Park, Zaire. These specimens had been reported by Slater (1972) as "*Pachybrachius* nr. *ferruginosus* (Stål)" with the statement: "The series reported above differs from the type of *ferruginosus* in several important characteristics and probably represents an undescribed species." The specimens are in fact *Stalaria kissei* (Linnavuori) (1978).

The status of *ferruginosa* within *Horridipamera* is a matter of some concern. The lectotype is very closely related to, if not conspecific with, *pullata* Hesse. However, it is light reddish brown, whereas all of the West African specimens that we have examined are chiefly dark chocolate brown. Scudder (1977) when selecting the lectotype noted that it was "slightly teneral." This may well be true. We are reluctant to synonymize the two species when such a striking color difference is present. We feel that study of a series from Principe Island is needed before formal synonymy is warranted.

The following measurements are from the male lectotype bearing labels as indicated by Scudder (1977). Head length 1.10, width 1.00; interocular space 0.50. Pronotum length 0.78, width 1.28. Scutellar length 0.80, width 0.70. Length claval commissure 0.52. Midline distance apex clavus–apex corium 1.14. Midline distance apex corium–apex membrane 0.90. Length labial segments I 0.64, II 0.74, III 0.44, IV 0.40. Length antennal segments I 0.50, II 1.02, III 0.94, IV 1.10. Total body length 5.36.

H. ferruginosa is not included in the preceding cladogram but has all of the derived conditions that pertain to *pullata.*

Horridipamera nietneri (Dohrn)

Plociomerus nietneri Dohrn, 1860, p. 404.
Pachybrachius nietneri Slater, 1964a, p. 1133.
Horridipamera nietneri Malipatil, 1978, p. 90.

Diagnosis. Very similar in color and structure to *bergrothi* differing chiefly in the much shorter hairs, especially those on the antennae which for the most part are scarcely longer than the diameter of the segment, the more flattened sericeous hemelytral pilosity, the (usually) less globose anterior pronotal lobe and the shorter head.

Bulb of sperm reservoir not strongly tapered distally, but bluntly rounded at distal end. Reservoir wings curving posteriorly, but less extremely so than in *perlonga* and *conspicua,* tapering evenly, blunt at distal ends. No distal vesical process present. Proximal process small, consisting of a crescentic serrated process (Fig. 9) lying on right side of ejaculatory duct immediately distad of right conjunctival spine. Right conjunctival spine much longer than left and expanded into a point distally before acute apical tooth. Both spines terminating in acute apical tooth-like points (Figs. 22, 23). Paramere with blade and prominently produced outer projection short and rounded; inner projection strongly recurved (Fig. 33).

H. nietneri and *H. bergrothi* are allopatric and probably derived from a common ancestor. The external differences as well as those of the male genitalia appear to be constant.

Malipatil (1978a) discusses the variability of *nietneri* in detail pointing out that specimens from New Caledonia, New Hebrides, Samoa, and some other Pacific islands are smaller than mainland specimens and that there is considerable variation in the conjunctival spine. This is true of the limited material we have examined from these islands and from Fiji as well. Specimens from these islands also have a very conspicuous white annulus on the fourth antennal segment and relatively short upright hemelytral hairs.

The color pattern in some of the Pacific island populations is remarkably different from those of the Asiatic mainland. In Pacific specimens the hemelytra tend to be black with broad white or pale yellow lateral margins. A very similar coloration occurs in *emersoni* on Ceylon, *Paraeucosmetus pacificus* Malipatil (Fiji, Western Samoa, New Hebrides, Tonga, Niue) and in eastern Pacific populations of *Pseudopachybrachius guttus* (Dallas). The reason for this apparent color convergence is unknown.

We have accepted the synonymy as given by Malipatil (but have not examined types) except that of *Pamera emersoni* Distant which is a quite different species.

Fifth instar nymph. Mt. Coot-Tha, Brisbane, Queensland, Australia 10.I.1972 (J. A. Slater). General shape and color pattern similar to *perlonga* but reddish brown rather than black or chocolate brown on head and pronotum. Median dark areas on abdominal terga as in *perlonga* but much lighter than dark elliptical areas around scent gland orifices. Coloration mesally on tergum 3 projecting posteriorly to sclerotization about scent gland orifices between terga 3–4 suture in the form of three "prongs" as in *inconspicua.*

Malipatil (1978b) has described and figured the 5th instar nymph in detail (from Queensland). Neither his figure nor description shows the small dark spot with a parenthesis-like mark surrounding it which is present mesally on the 4th abdominal tergum.

Egg. Described by Malipatil (1978b). Said to have 5 chorionic processes, an average total length of 1.14 and average maximum width of 0.34.

Distribution. H. nietneri is found almost throughout the Oriental Region. It also occurs in northern and eastern Australia and east into the Pacific Islands at least as far as the Carolines and Samoa. It was originally described from Ceylon. Slater (1964a) lists records from Burma, India, China, Malaya, Cambodia and Thailand on the mainland and from the following islands: Bonins, Carolines, Guam, Christmas, New Caledonia, Fiji, Japan, Ryukyus, Taiwan, Samoa, Celebes, Java, Sumatra, Philippines, Moluccas and Laccadives and Australia. Malipatil (1978a) adds New Guinea, New Hebrides and the Tonga Islands. He gives detailed information on the Australian distribution where it is chiefly confined to Queensland and Northern Territory but he states that it also occurs in New South Wales. Tomokuni (1982) reports it from Minami-Iwojima (San Agustino) Island of the Volcano Islands.

Additional material examined. PHILIPPINES: 3, Manila, (Luzon), iv.1947 (Enns). 1, Mt. Maquiling (Luzon), 18.viii.1950. 1, same, 18.i.1947 (Santas). 4, same, 19.ii.1947 (Agbozala). 3, same, 2.xi.1949, 50 ft (Uichanco). 1, same, 10.x.1949 (Hosillos). 1, same, 20.ix.1951 (Bowagan). 1, Manila (domestic airport waiting room), 29.x.1963 (McFarland). 1, IRRI Farm, Luzon, 11.x.1972 (Pawar). 1, same, 8.v.1972. 1, same, v.1972. 1, same, iv.1972. 1, same, iii.1972. 1, same, vi.1972. 2, same, 12.x.1972. 1, same, 23.xii.1972. 2, same, 3.iii.1972. 2, same, x.1972. 1, same, i.1972. 2, same, 7.xi.1972. 1, Sagada (Luzon), Mt. P., 9.iv.1972 (Pawar). 1, Ilagan (Luzon), Isabela, 25.v.1972 (Pawar). 1, Munoz, NE, 23.v.1972 (Pawar). 1, Vigan Island (S. Luzon), 28.v.1972 (Pawar). 1, Ladoy Island (N. Luzon), 27.v.1972 (Pawar). 1, St. Rosa, Laguna, Luzon, 6.iii.1972 (Pawar). 1, Malolos, Buula (Luzon), 12.iv.1972 (Pawar). 1, Apari, Cagayan (Luzon), 26.v.1972 (Pawar). 1, Legaspi, Albay, 16.i.1964 (McFarland). BORNEO: 1, Kota Kinbulu, 29.xii.1967 (Roche). 1, same, 25.xii.1967. OKINAWA (RYUKYUS): 3, Kin, 18.ix.1945 (Slater). 1, same, 7.ix.1945. 1, same, 14.vii.1945. INDIA: 5, Anamalai Hills, Cinchona, 3,500 ft, iv.1959 (Nathan). 2, same, v.1959. 1, Coimbatore, x.1951 (Nathan). 4, same, x.1953. 1, same, xi.1964. 1, same, 22.xii.1951. 1, same, ix.1951. 1, Orissa, C.E. India, Jeypore, 1,775 ft, x.1958 (Nathan). 1, Kurumbagarum, Karikal Territory, viii.1955 (Nathan). 1, same, xi.1951. 1, Nilgiri Hills, Sinpare, 3,400 ft, v.1954 (Nathan). SRI LANKA: 2, N. Centr. Prov., Polonnaruwa, 10.ii.1962 (BAC). 2, N. Centr. Prov., Kandurukanda, 20 mi NE Habarana, 8.ii.1962 (BAC). 4, Anu. Dist., Wildlife Soc. Bungalow, Hunuwilagama, Wilpattu, 10–19.iii.1970 (Davis, Rowe). 2, "Rat. Dist.," Uggalkaltota 350 ft, Irrigation Bungalow, 31.i–8.ii.1970 (Davis, Rowe). 1, Kandy District, 5 mi NW Mahiyangana, 30.iii–9.iv.1971 (Spangler). 1, "Ham. Dist.," Wirawila Wewa, 85 ft, 26.x.1970 (Flint). 2, "Kal. Dist.," Agalawatta, 13–14.x.1976 (HDKB). NEW CALEDONIA: 6, Yate (under tall grasses), 9.vii.1977 (Alex Slater). FIJI: 1, Viti Levu, Nadarivatu, 31.i.1968 (Gross). 2, Nausori Highlands 16 mi E Nandi, 16.vii.1977 (Alex Slater). 2, same, 20 mi E Nandi. NEW HEBRIDES: 3, Efate Isl., Port Villa, 10–13.vii.1977 (Alex Slater).

Horridipamera bergrothi (Horvath)

Pamera bergrothi Horvath, 1892, p. 261.
Pachybrachius bergrothi Slater, 1964a, p. 1113.
Horridipamera bergrothi Harrington, 1980, p. 99.

Diagnosis. Robust, heavy bodied. Dorsal surface including hemelytra and appendages thickly clothed with elongate upstanding hairs. Elongate hairs intermixed with decumbent, silvery, somewhat tomentose, pubescence. Head, pronotum and scutellum uniformly dark chocolate brown, scutellum lacking oblique light vittae. Hemelytra chiefly dark brown (similar to *nietneri*). Clavus either completely dark or with anterior half of cubital vein pale. Corium with explanate margin chiefly pale but this area invaded by a dark brown macula at level of distal end of claval commissure and at distal end of corium. Subdistal "white macula" often reduced to two or even three distinct spots. Corium frequently with a pale area on anterior half, but this not reaching claval suture. Membrane dark with pale veins and an apical median vitta. Antennae brown; fourth segment lacking a pale basal annulus; first segment often pale on distal half. Fore femora dark. Middle and hind femora with distal halves dark brown, strongly contrasting with pale proximal halves. Second labial segment pale.

Anterior pronotal lobe strongly globose, broader than width of head across eyes. Labium reaching nearly to mesocoxae.

Bulb of sperm reservoir subquadrate, not narrowing distally. Reservoir wings as in *nietneri*. Distal vesical process long slender non-serrated (Fig. 8). Proximal vesical process with a serrated crescent-shaped proximal portion (similar to that of *nietneri*) and an additional slender distally twisting portion (Fig. 5). Conjunctival spines short, broad, nonbifid and trianguloid (Figs. 24, 25). Paramere with a very large inner distally bifid flange; outer projection broad and rounded (Fig. 34).

This large dark species is readily recognizable from other African members of the genus by the numerous upright hemelytral hairs. The chiefly dark hemelytral surface is also distinctive. There is some variation in color. For example, the second and third antennal segments may be dull yellow. Occasionally the fourth segment is paler than the distal end of the third, but there is never a pale proximal annulus.

H. bergrothi is in general habitus and color as well as many morphological features more closely related to the Oriental *nietneri* than to any of the African species.

Distribution. Reported by Slater (1964a) from Cameroon, Ethiopia and Ghana; by Scudder (1969) from Guinea; by Scudder (1982) from Senegal; by Linnavuori (1978) from Sudan and as "nr *bergrothi*" by Slater (1972) from Zaire. It probably is distributed throughout tropical Africa.

Material examined. IVORY COAST: 1, Lamto (Toumodi), 30.i.1962. 2, same, 17.iii.1964. 1, same, 22.v.1964. 3, same, 20.ii.1962. 1, same, 11.ii.1964. 1, same, 18.ii.1964. 1, same, 6.iii.1962. GHANA: 1, Tafo, 7.x.1967 (SSS). 1, Tafo, 21.vi.1965 (Leston). 1, same, 2.ii.1966. 1, same, 8.iii.1966. 1, Sunyani, 12.xii.1965 (Leston). 1, same, 13.xii.1965. 1, Legon, 28.viii.1968 (Leston). 1, same, 30.ix.1968. 1, same, 1.x.1968. 1, Techiman, 9.xii.1965 (Leston). 1, Tokos, 6.xi.1967 (Leston). NIGERIA: 2, Umuahi CRIN, EC State, 9.iv.1975 (Medler). 1, Ile-Ife, 11.viii.1969. 1, same, 27.iii.1969. 1, same, W State, 9.iii.1975. TANZANIA: Ilonga, 29.ix.1963 (Robertson). 2, same, 3.x.1963. 2, same, 14.iv.1965. 1, same, 10.ii.1965. 1, same, 2.ii.1964. UGANDA: 1, Kassesse Busoyfora, 5.v.1940 (Stephenson).

Horridipamera robusta Malipatil

Horridipamera robusta Malipatil, 1978a, p. 92.

Diagnosis. A large dark strongly hirsute species. Coloration much as in *nietneri.* Fore femora completely black. Antennae brown, contrasting with velvety black coloration of head and pronotum. Fourth antennal segment with a prominent sub-basal pale annulus. Anterior pronotal lobe very large and swollen (twice as long as posterior lobe in males, 1½ times as long in females). Fore tibia armed with a large spine near middle and 2 or 3 smaller spines distally.

Malipatil (1978a) gives a good detailed description and figures of anatomical details, including those of the male genitalia.

Immature stages. Malipatil (1978b) has described the 4th and 5th instar nymphs and the egg.

The 5th instar nymph is said to be separable from that of *nietneri* by having the anterior pronotal lobe about 4 times as long as the posterior lobe. In *nietneri* the anterior lobe is approximately 3 times as long as the posterior.

Egg. The egg of *robusta* is said by Malipatil (*ibid.*) to have 4–6 chorionic processes, and average length of 1.23 and an average width of 0.36.

Distribution. Originally described from Queensland and northern New South Wales in Australia and from North Island, New Zealand. Malipatil (1978a) notes that it is sympatric with *nietneri* in southeastern Queensland.

Horridipamera emersoni (Distant), **New Status**

Pamera emersoni Distant, 1909, p. 491.
Pachybrachius nietneri Scudder, (*nec* Dohrn), 1962b, p. 770 (part).
Horridipamera nietneri Slater, (*nec* Dohrn), 1979, p. 22 (part).

Diagnosis. Elongate, slender, parallel-sided. Head, pronotum, scutellum, antennal segments I, II, III, and distal ½ of IV black. Humeral pronotal angles pale yellow. Basal half of fourth antennal segment with a broad white annulus. Hemelytra with much of clavus and inner portion of corium heavily infuscated with dark brown giving outer portion appearance of a pale yellow stripe which blends distally with what in many other species is a distinct subapical pale macula. Apex of corium and apical corial margin dark. Membrane chocolate brown with a broad strongly contrasting median white vitta. Second labial segment white or pale yellow. Fore femora (except distal ends) and distal half of middle and hind femora black or dark castaneous.

Pronotum and scutellum lacking numerous upright elongate hairs, but with numerous short decumbent sericeous hairs present.

Eyes relatively large and somewhat protruding. Head broader than narrow, relatively unswollen, anterior pronotal lobe. Labium extending posteriorly onto mesosternum. Both sexes lacking a prominent spine midway along shafts of fore tibiae.

Although synonymized with *nietneri* by Scudder (1962) this is a distinct species. The male genitalia of the two species are completely different. The lack of a spine on the fore tibia of the male and the lack of elongate upstanding hairs on the hemelytra will also readily separate it from *nietneri.* In addition *nietneri* is a much heavier bodied, more robust species. While, as previously discussed, *nietneri* is quite variable in color, on Ceylon where the two species are sympatric *nietneri* has the dark areas of the corium more extensively developed, often covering most of the corium except for the explanate margin, and, of course, the subapical pale macula. In *nietneri* the head is narrower than the anterior pronotal lobe, the latter being more swollen and globose than in *emersoni.*

Bulb of sperm reservoir moderately tapering distally, distal end rounded. Reservoir wings moderately curving posteriorly (similar to *nietneri*), irregularly tapering. Distal vesical process elongate and slender, relatively straight. Proximal vesical process with a broadened serrated plate-like area (Fig. 12). Conjunctival spines large, elongate, acutely pointed, nonbifid; right spine (Fig. 27) longer than left (Fig. 26). Paramere with inner projection small but with an enormous distally bifid flange projecting from it (Fig. 30).

Scudder may have considered the white margined Pacific island populations of *nietneri* to represent *emersoni* leading him to synonymize the two.

In general body shape *emersoni* most closely resembles the African species *pullata* but the latter lacks a white annulus on the fourth antennal segment, its males have a mid fore tibial spine, the subapical pale corial spot is distinct, the eyes even more strongly protruding and the genitalia are distinctive (see discussion above).

H. emersoni appears to be a member of the *perlonga-pullata* group despite the absence of the fore tibial spine.

Distribution. Known only from Sri Lanka. Slater's (1979) series of *nietneri* was mixed. Specimens he reported as *nietneri* from "Kal. District, Morapatiya near Agalawatta" and "Rat. Dist., Bultota Pass 3000 ft." are *emersoni.*

Horridipamera medleri, new species

Fig. 2

Description. Elongate, parallel-sided, with head broad and appendages elongate, slender. Body somewhat ant-mimetic. General coloration black to chocolate brown including entire head, pronotum, scutellum, antennae, fore femora (except extreme proximal and distal ends), and distal ⅔ of middle and hind femora. Hemelytra chiefly dull white but marked with dark chocolate brown as follows: an irregular band through center of clavus; a large elongate corial macula between R+M and CU at level of claval commissure; entire apical corial margin; a large apical corial macula; majority

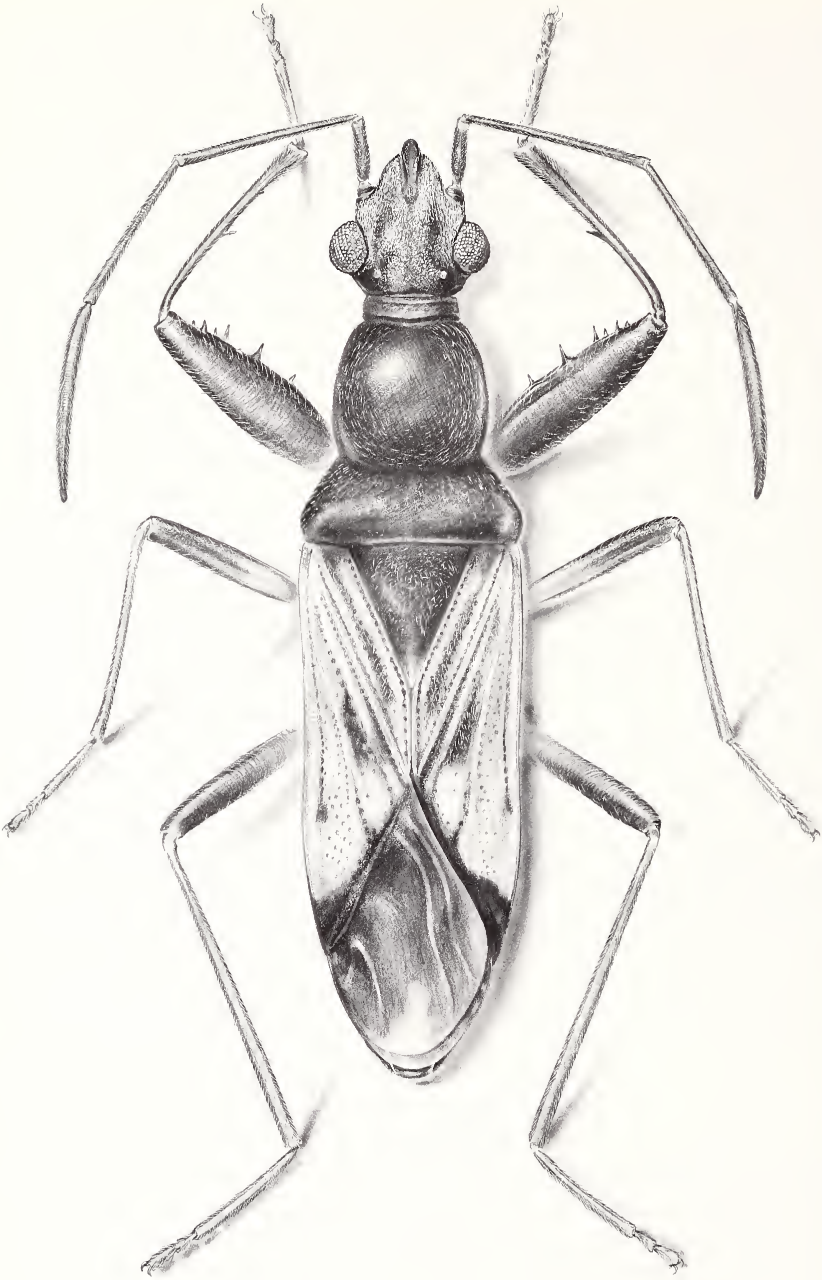

Fig. 2. *Horridipamera medleri* new species. Holotype, dorsal view.

of hemelytral punctures; membrane, except for a large apical white patch and bases of veins.

Head elongate, moderately declivent anteriorly. Tylus attaining distal ⅓ of first antennal segment. Eyes protruding. Width across head subequal to that of anterior pronotal lobe. Head considerably narrowed behind eyes, with fine, dense punctures and clothed with dense, decumbent sericeous hairs, except for a long 'S'-shaped area in front of each ocellus. Vertex moderately convex. Head length 0.92, width 1.12, interocular width 0.68, eye length 0.38, postocular distance 0.20.

Dorsal surface lacking numerous elongate upstanding hairs but clothed (including clavus and corium) with conspicuous decumbent sericeous pubescence.

Pronotum subshining. A deep transverse constriction present. Collar with distinct rows of punctures. Anterior pronotal lobe swollen, lateral margins forming a smooth evenly rounded curve. Posterior pronotal lobe with shallow, evenly separated punctures. Length anterior pronotal lobe 1.20, maximum width 1.20; length posterior lobe 0.60, width 1.48. Scutellum with a low inconspicuous median elevation. Length scutellum 0.92, width 0.84. Length claval commissure 0.56. Midline distance apex clavus–apex corium 1.20. Midline distance apex corium–apex membrane 0.88. Anterior tibiae only slightly curved proximally and each tibia with a prominent median spine. Labium extending well onto mesosternum. Length labial segments I 0.80, II 0.80, III 0.54, IV 0.42. Antennae slender, terete. Length antennal segments I 0.66, II 1.32, III 1.14, IV 0.32. Total body length 6.40.

Sperm reservoir bulb moderately narrowing distally. Reservoir wings strongly curving posteriorly and tapered (as in *perlonga*) but not produced into an elongate projection as in *inconspicua.* Vesical marginal processes more or less interconnected, elongate, twisted almost identical to conditions found in *perlonga* and *pullata.* Right conjunctival spine large, elongate and tapering to an extremely slender, acute point (Fig. 15). Left conjunctival spine with a broadened area on outer margin but not distinctly bifid and ending in a large acute spine (Fig. 14). Paramere similar to that of *perlonga* but inner flange not truncate and outer projection evident only as an evenly rounded area.

H. medleri most closely resembles *pullata* (Hesse). It is a relatively heavier, less slender species than is *pullata.* The anterior pronotal lobe is distinctly broader and more swollen. This is especially evident in lateral view. The corium is paler in color with the area of the corium laterad of the furrow (exocorium) either entirely white or at most with only a small, incomplete submedian dark macula. The fore femur has a large spine on the outer row proximad of the middle (lacking in *pullata*). The conjunctival spines are distinctive in shape.

Holotype. Male, NIGERIA: Oban RH SE State, 7.IV.1975. (J. T. Medler). In American Museum of Natural History.

Paratypes. 1 male, 2 females, same data as holotype. In J. A. Slater collection.

This species is named in honor of Dr. John Medler for his generosity and in recognition of his contributions to our knowledge of West African Hemiptera.

Horridipamera compacta, new species

Description. Relatively stout, parallel-sided. Head, anterior pronotal lobe and scutellum black. Posterior pronotal lobe, except for a yellow spot before each humeral

Figs. 3–13. *Horridipamera* spp. 3. *H. inconspicua,* apex of proximal vesical process. 4. *H. compacta,* apex of proximal vesical process. 5. *H. bergrothi,* proximal vesical process, dorsal view, right side. 6. *H. perlonga,* phallus, showing sperm reservoir conjunctival spines and vesical processes. 7. *H. inconspicua,* phallus, semilateral view, showing sperm reservoir and proximal portion of ejaculatory duct. 8. *H. bergrothi,* distal vesical process. 9. *H. nietneri,* proximal vesical process. Dorsal view, right side. 10. *H. perlonga,* vesical process. 11. *H. compacta,* vesical processes. 12. *H. emersoni,* proximal vesical process. 13. *H. inconspicua,* vesical process.

angle, castaneous. Hemelytra variegated, pale yellow and dark red brown. Dark coloration as follows: a complete but irregular transverse vitta across middle of hemelytra which broadly attains lateral corial margins; a large apical macula; streaks on distal portion of clavus; and membrane with exception of paler veins. All hemelytral punctures dark brown. Antennae chiefly ochraceous to very light brown. Base of segment I, distal ends of segments II and III and apical half of segment IV dark. Fourth segment with a prominent pale annulus. Fore femora castaneous with pale distal ends. Middle femora pale with a series of brown spots distally. Hind femora pale with a conspicuous dark annulus on distal ⅓. Head, pronotum and scutellum (but not hemelytra) thickly clothed with elongate upstanding hairs.

Head shining, moderately declivent anteriorly with dense, fine, shallow punctures. Tylus reaching to distal ⅓ of first antennal segment. Vertex only moderately convex. Eyes not strongly produced. Head length 1.08, width 1.12, interocular width 0.64, eye length 0.33, postocular length 0.19.

Pronotum subshining. Anterior lobe strongly swollen. Length pronotum 0.94, width 1.34; length posterior lobe 0.68, width 1.68. Collar with deep, irregularly arranged, punctures. Scutellar length 1.0, width 0.50. Length claval commissure 0.60. Midline distance apex clavus–apex corium 1.18. Midline distance apex corium-apex membrane 0.80. Fore femora strongly swollen, width fore femur 0.64. Front tibiae distinctly curved without a prominent spine near middle of shaft. Labium attaining middle of mesosternum, first segment remote from base of head. Length labial segments I 0.84, II 0.84, III 0.50, IV 0.44. Length antennal segments I 0.52, II 1.18, III 1.06, IV 1.20. Total body length 6.40.

Sperm reservoir bulb distinctly tapering (similar to that of *inconspicua*). Reservoir wings relatively little curved posteriorly, projecting strongly laterad, distal margin strongly convex, proximal margin nearly straight, ending in a nipple-like end.

H. compacta is a relatively stout species that most closely resembles *perlonga* in general habitus. It differs from *perlonga* and related species by the numerous elongate hairs on the pronotum and scutellum. The absence of a median spine on the fore tibia of the male suggests relationship with *emersoni* (as shown in Fig. 1), but this could be the result of independent loss. The male genitalia are distinctive. The widely separated vesical proximal and distal marginal processes (Fig. 11) will immediately distinguish *compacta* from either *inconspicua* or *perlonga*. The strongly swollen fore femora and pale antennae with the darkened distal ends of segments 2 and 3 are also useful recognition features.

Holotype. Male, INDIA (South), Shevaroy Hills, Yercaud 4,500 ft, 9.XII.1954 (P. S. Nathan). In American Museum of Natural History.

Paratypes. 1 female, INDIA (South), Annamalai Hills, Cinchona, 3,500 ft, X.1955 (P. S. Nathan). 1 female, Annamalai Hills, Cinchona, X.1955 (P. S. Nathan). In J. A. Slater collection.

Incertae sedis

Horridipamera subsericea (Breddin)

Pamera (*Entisberus*) *subsericea* Breddin, 1907, p. 205.
Entisberus subsericea Distant, 1910, p. 59.
Pamera subsericea Bergroth, 1918, p. 105.
Pachybrachius subsericea Slater, 1964a, p. 1142.
Horridipamera subsericea Harrington, 1980, p. 99.

This species was originally described from Ceylon and has had a checkered no-

Figs. 14–35. *Horridipamera* spp. 14. *H. medleri,* left conjunctival spine. 15. *H. medleri,* right conjunctival spine. 16. *H. pullata,* left conjunctival spine. 17. *H. pullata,* right conjunctival

menclatural history (see Slater, 1964a). Harrington (1980) placed it in *Horridipamera* but with an indication that she had not seen material and was unsure of its correct generic position.

We do not believe it will prove to be a species of *Horridipamera.* The body length of "3⅔ mm" is very much less than that of any known species of the genus. In fact, of the species placed in the old "omnibus" genus *Pamera* (later *Pachybrachius*), the description would seem to better "fit" *Pseudopachybrachius guttus* than any species of *Horridipamera.*

Plociomerus undulatus Dohrn

Plociomerus undulatus Dohrn, 1860, p. 404.

We have examined the type which is in Institute Zoology, Polish Academy of Sciences, Warsaw, Poland. It consists of a scutellum, meso- and metapleuron, one hind leg and one middle leg. It is not *Pseudopachybrachius gutta* as had been stated by Zheng and Slater (1984) but is a larger species of myodochine. It probably is a species of *Horridipamera* or *Paraeucosmetus* but it is impossible to know what species it is. The hind leg has the femur darkened distally but not with so sharp a contrast as have several species of both genera.

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We are indebted to the following for the loan or gift of valuable material: Dr. Adam Kedziorek (Polish Academy of Sciences); Dr. Karl Krombein (National Museum of Natural History, USNM); the late Dr. Dennis Leston; Dr. Rauno Linnavuori (Raisio, Finland); the members of the Lund University Senegal-Gambia Expedition; Dr. M. B. Malipatil (Northern Territory Museum of Arts and Sciences, Darwin); Dr. John Medler (University of Wisconsin); Dr. A. D. Pawar (International Rice Institute, Philippines); Dr. I. A. D. Robertson (formerly Cotton Research Program, Tanzania) and Dr. T. E. Woodward (Queensland Museum).

We wish to thank the late Dr. W. H. Coaton and the staff of the Plant Protection Institute of Pretoria, South Africa for assistance to the senior author in field work and facilities; Dr. Randall Schuh (American Museum of Natural History) for discussions on distribution and aid in field work; Dr. M. H. Sweet (Texas A&M University) and Mr. Samuel Slater for aid in field work in Africa; Ms. Mary Jane Spring and Mrs. Elizabeth Slater (University of Connecticut), respectively, for preparation of the illustrations and extensive help in the preparation of the manuscript.

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←

spine. 18. *H. compacta,* left conjunctival spine. 19. *H. compacta,* right conjunctival spine. 20. *H. perlonga,* left conjunctival spine. 21. *H. perlonga,* right conjunctival spine. 22. *H. nietneri,* left conjunctival spine. 23. *H. nietneri,* right conjunctival spine. 24. *H. bergrothi,* left conjunctival spine. 25. *H. bergrothi,* right conjunctival spine. 26. *H. emersoni,* left conjunctival spine. 27. *H. emersoni,* right conjunctival spine. 28. *H. inconspicua,* left conjunctival spine. 29. *H. inconspicua,* right conjunctival spine. 30. *H. emersoni,* paramere. 31. *H. compacta,* paramere. 32. *H. perlonga,* paramere. 33. *H. nietneri,* paramere. 34. *H. bergrothi,* paramere. 35. *H. inconspicua,* paramere.

LITERATURE CITED

Bergroth, E. 1918. Studies in Philippine Heteroptera I. Philipp. J. Sci. 13:2–3:D:43–126.

Breddin, G. 1907. Berytiden & Myodochiden von Ceylon aus der Sammelausbeute von Dr. W. Horn (Rhynch. het.) II. Deutsch ent. Zeit. 1907:203–220.

China, W. E. 1924. The Hemiptera-Heteroptera of Rodriguez together with the description of a new species of Cicada from that island. Ann. Mag. Nat. Hist. (9):14:427–453.

Dallas, W. S. 1982. List of the specimens of Hemipterous insects in the collection of the British Museum. Part II. Taylor & Francis, Inc., London, pp. 369–592.

Distant, W. L. 1909. LXV. Oriental Rhynchota Heteroptera. Ann. Mag. Nat. Hist. (8):3:491–507.

Distant, W. L. 1910. The Fauna of British India, Including Ceylon & Burma. Rhynchota, Vol. 5. Heteroptera: Appendix, 362 pp.

Dohrn, A. 1860. Zur Heteropteren-Fauna Ceylon's. Stettin ent. Ztg. 21:399–409.

Harrington, B. J. 1980. A Generic Level Revision and Cladistic Analysis of the Myodochini of the World (Hemiptera, Lygaeidae, Rhyparochrominae). Bull. Am. Mus. Nat. Hist. 167:45–116.

Hesse, A. J. 1925. A list of the Heteropterous & Homopterous Hemiptera of Southwest Africa. Ann. S. Afr. Mus. 23:1–178.

Horvath, G. 1879. Hemiptera-Heteroptera a. Dom. Joanne Xantus in China & in Japonia collecta. Term Tud. Fuz. 3:141–152.

Horvath, G. 1892. Hemiptera nova Africana. Term Tud. Fuz. 15:254–267.

Lethierry, L. and G. Severin. 1894. General Catalogue of the Hemiptera, Vol. II. Heteroptera. F. Hayez, Imprimeur de l'Academie Royale de Belgique, Brussels.

Lindberg, H. 1958. Hemiptera Insularum Caboverdensium Systematik, Okologie & Verbreitung der Heteropteren & Cicadinen der Kapverdischen Inseln. Comment. Biol. 19: 1:246 pp.

Linnavuori, R. 1978. Hemiptera of the Sudan, with remarks on some species of the adjacent countries 6. Aradidae, Meziridae, Aneuridae, Pyrrhocoridae, Stenocephalidae, Coreidae, Alydidae, Rhopalidae, Lygaeidae. Act. Zool. Fenn. 153:1–108.

Malipatil, M. B. 1978a. Revision of the Myodochini (Hemiptera: Lygaeidae: Rhyparochrominae) of the Australian Region. Aust. J. Zool. Suppl. Ser. no. 56:1–178.

Malipatil, M. B. 1978b. Immature Stages of Some Myodochini of the Australian Region (Hemiptera: Lygaeidae: Rhyparochrominae). Aust. J. Zool. 26:555–584.

Reuter, O. M. 1882. Ad cognitionem Heteropterorum Africae occidentalis. Ofv. Finska Vet.-Soc. Forh. 25:1–43.

Reuter, O. M. 1887. Ad cognitionem Heteropterorum Madagascariensium. Ent. Tidskr. 8: 77–109.

Schouteden, H. 1957. Contributions a l'etude de la faune entomologique du Ruanda-Urundi (Mission P. Basilewsky 1953) CXXV. Heteroptera Lygaeidae, Pyrrocoridae et Berytidae. Ann. Mus. Congo Belge. 8:58:247–268.

Schumacher, F. 1913. Ein Beitrag zur Kenntnis der Rhynchoten-Fauna Sudafrikas. *In:* Schultze zool. und anthrop. Ergebnisse and Forschungreise in Sudafrika. Denkschr. med.-naturw. Ges., Jena 17:49–88.

Scott, J. 1874. On a collection of Hemiptera-Heteroptera from Japan, descriptions of various new genera and species. Ann. Mag. Nat. Hist. (4):14:289–304, 426–452.

Scudder, G. G. E. 1962a. The World Rhyparochrominae (Hemiptera: Lygaeidae) I. New Synonymy and Generic Changes. Canad. Ent. 94:764–773.

Scudder, G. G. E. 1962b. Mission Zoologique de l'I.R.S.A.C. en Afrique orientale (P. Basilewsky et N. Leleup, 1957). Ann. Mus. Roy. Afr. Centr., Sci. Zool., 110, pp. 400–453.

Scudder, G. G. E. 1969. The Lygaeidae (Hemiptera) collected by Dr. M. Mrazek and Mrs. I. Korecka in the Republic of China. Act. Mus. Morav. 54:169–182.

Scudder, G. G. E. 1971. New Lygaeidae (Hemiptera) from the Niokolo-Koba National Park, Senegal. Bull. de l'I.F.A.N. 33:A:3:718–736.

Scudder, G. G. E. 1977. The World Rhyparochrominae types (Hemiptera: Lygaeidae) XIII. The Stål types. Ent. Scand. 8:29–35.

Scudder, G. G. E. 1982. Recherches Scientifiques dans les Parcs Nationaux du Senegal IX. Hemiptera Lygaeidae du Parc National Niokolo-Koba. Mem. de l'I.F.A.N. no. 92:150.

Slater, J. A. 1964a. A Catalogue of the Lygaeidae of the World. 2 Vol. University of Connecticut, Storrs.

Slater, J. A. 1964b. Hemiptera (Heteroptera): Lygaeidae. S. Afr. Anim. Life 10:15–228.

Slater, J. A. 1972. The Lygaeidae of Upemba National Park, Mission G. F. deWitte (Hemiptera: Heteroptera). Parc National de L'Upemba 72:2:17–77.

Slater, J. A. 1979. Hemiptera, Heteroptera: Lygaeidae from Sri Lanka (Ceylon). Report no. 45 of Lund University Ceylon Expedition in 1962, pp. 1–27.

Slater, J. A. and D. B. Wilcox. 1972 (1973). Contribution a l'etude biologique du Senegal septentrional XXII. Hemiptera Lygaeidae. Bull. de l'I.F.A.N. 34:A:4:943–965.

Stål, C. 1874. Enumeratio Hemipterorum, Pt. 4. K. Svenska Vetensk. Acad. Handl. 12:1:1–186.

Tomokuni, M. 1982. Heteroptera of Minami-Iwojima Island. Conservation Reports of the Minami-Iwojima Wilderness Area, Tokyo, Japan, pp. 335–341.

Zheng, L. and J. A. Slater. 1984. A revision of the lygaeid genus *Pseudopachybrachius*. Syst. Entomol. 9:20:95–115.

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NEW SYNONYMY AND A NEW SPECIES IN THE GENUS *MORMIDEA* (HEMIPTERA: PENTATOMIDAE)

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Abstract.—The name *Mormidea kirkaldyi* is proposed for a species described previously but misdetermined. *Mormidea bridarolli* Pirán, 1963, is placed in the synonymy of *M. montandoni* Kirkaldy, 1902.

At the time I revised *Mormidea,* the type series of *M. bridarolli* Pirán was unavailable, and the location of the syntypes of *M. montandoni* Kirkaldy was unknown to me (Rolston, 1978). Recently the private collection of the late A. A. Pirán, containing the type series of *M. bridarolli,* was acquired by the Museo Argentina de Ciencias Naturales "Bernardino Rivadavia," Buenos Aires, and by chance the syntypes of *M. montandoni* were located in the Institut Royal des Sciences Naturelles de Belgique, Brussels.

Dr. Jocélia Grazia, at the Universidade Federal do Rio Grande do Sul, kindly compared a specimen that I had determined as *M. bridarolli* with the holotype of that species and found the specimens to be conspecific. Through the courtesy of Dr. G. Schmitz, at the Musee Royal de l'Afrique Central, the syntypes of *M. montandoni* were loaned to me.

In the revision of *Mormidea* I misdetermined *M. montandoni* Kirkaldy, 1902, which proves to be a senior synonym of *M. bridarolli* Pirán, 1963. The species which I believed to be *M. montandoni* is a new species for which I propose the name *Mormidea kirkaldyi.* The synonymy of these two species is:

Mormidea kirkaldyi, new species

Mormidea montandoni: Rolston, 1978, p. 174, figs. 6–8 (misdetermination).

Mormidea montandoni Kirkaldy, 1902

Mormidea montandoni Kirkaldy, 1902, p. 165.
Mormidea bridarolli Pirán, 1963, pp. 108–109; Rolston, 1978, p. 175, fig. 9.

The type series of *Mormidea kirkaldyi* new species consists of 7♂♂ and 7♀♀. The ♂ holotype is labeled: (a) "Divisoria, Loreto, Peru, November 1947, Alt. 1500 ft." (b) "W. Weyrauch Coll. Donor Wm. Procter". Deposited in the American Museum of Natural History. Paratypes: labeled as holotype (3♂♂, 4♀♀ AMNH)[1]; labeled as ho-

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[1] Paratype deposition: American Museum of Natural History (AMNH); author's collection (LHR); National Museum of Natural History (NMNH).

lotype except "Doner" misprinted as "Coner" (♀ AMNH); (a) "Divisoria, Loreta, Peru, May 17, 194, Alt. 4500 ft." (b) "J. C. Pallister, Coll. Doner Frank Johnson" (♀ AMNH); (a) "El Partidero, Ecuador, XI.14.1935" (b) "W. Macintyre, Collector" (♀ LHR); (a) "Upper Rio Huallaga, Peru, 1.V.26, F6123" (b) "H. Bassler Collection, Acc. 33591" (♂ LHR); "Brazil-Ecuador border, Davis" (♂ LHR); "Puyo, ECUADOR, Napo-Pastaza Prov. 15 April 1958, W. R. Hodges, Elev. 2,500 feet" (♂ NMNH).

The type series of *Mormidea montandoni* Kirkaldy consists of 7♂♂ and 3♀♀. The ♂ lectotype, here designated, is labeled: (a) "Coll. R. I. Sc. N. B., Equateur, Ambato, ex. Coll. Schouteden" (purple label) (b) "Mormidea montandoni Kirkaldy. T" (c) "syntype" Paralectotypes: 5♂♂, 2♀♀ labeled as lectotype except (b) "Mormidea montandoni Kirkaldy. co-type"; ♂ labeled as lectotype except white label with locality data is pasted on purple label between "Coll. R. I. Sc. N. B." and "ex Coll. Schouteden"; ♀ labeled as above except "(Mission)" follows "ambato." The entire type series is in the Institut Royal des Sciences Naturelles de Belgique.

In the revision of *Mormidea,* a drawing intended as a front piece appears without a caption on page 212. The location suggests that this drawing pertains to *M. lunara* Rolston, but the specimen illustrated is *M. collaris* Distant.

LITERATURE CITED

Kirkaldy, G. 1902. Miscellanea rhynchotalia. No. 4. (Heteroptera) Entomol. 35:164–167.

Pirán, A. A. 1963. Hemiptera neotropica VIII. Especies nuevas o poco conocidas de las faunas de Colombia, Peru, Brazil, Bolivia y Paraguay. Physis 24(67):107–112 ("Brasil" in error for Ecuador).

Rolston, L. H. 1978. A revision of the genus *Mormidea* (Hemiptera: Pentatomidae). J. New York Entomol. Soc. 86(3):161–219.

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PELLAEA SANTAROSENSIS (HEMIPTERA: PENTATOMIDAE), A NEW SPECIES FROM COSTA RICA

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Abstract.—*Pellaea candens* (Distant, 1890) is placed in the synonymy of *Pellaea stictica* (Dallas, 1851), and *Pellaea santarosensis,* a new species from Costa Rica, is described. A lectotype is designated for *Rhaphigaster sticticus* Dallas, 1851.

The genus *Pellaea* Stål, 1872, has until recently contained three nominal species: *P. stictica* (Dallas, 1851), with the synonym *Pentatoma aspera* Walker, 1867, and an unavailable synonym, *Nezara nebulosa* Distant, 1891, whose interesting history is discussed by Froeschner (1981); *P. candens* (Distant, 1890); and *P. panamensis* (Distant, 1890), a species transferred by Rolston (1983) to *Acrosternum* Fieber subgenus *Chinavia* Orian.

Dallas (1851) described *P. stictica,* as *Rhaphigaster sticticus,* from three specimens, but only one of these can now be found in the British Museum (Natural History). This male, here designated lectotype, bears the following labels: (a) "Type" on red-edged disk, (b) "44/85" on one side of white disk and "B. Guiana" on other side, and (c) "*Rhaphigaster sticticus*" cut from Dallas's publication. The specimen lacks antennal segment 5 on the left, segments 4 and 5 on the right, left anterior and posterior tarsi, and right anterior leg.

After examining the crushed and broken female holotype of *P. candens,* described by Distant (1890) as *Nezara candens,* I conclude that this specimen is a callow example of *P. stictica.* The features by which Distant characterized *P. candens,* insofar as the condition of the holotype permits comparisons, fall within the range of variation exhibited by female specimens of *P. stictica.*

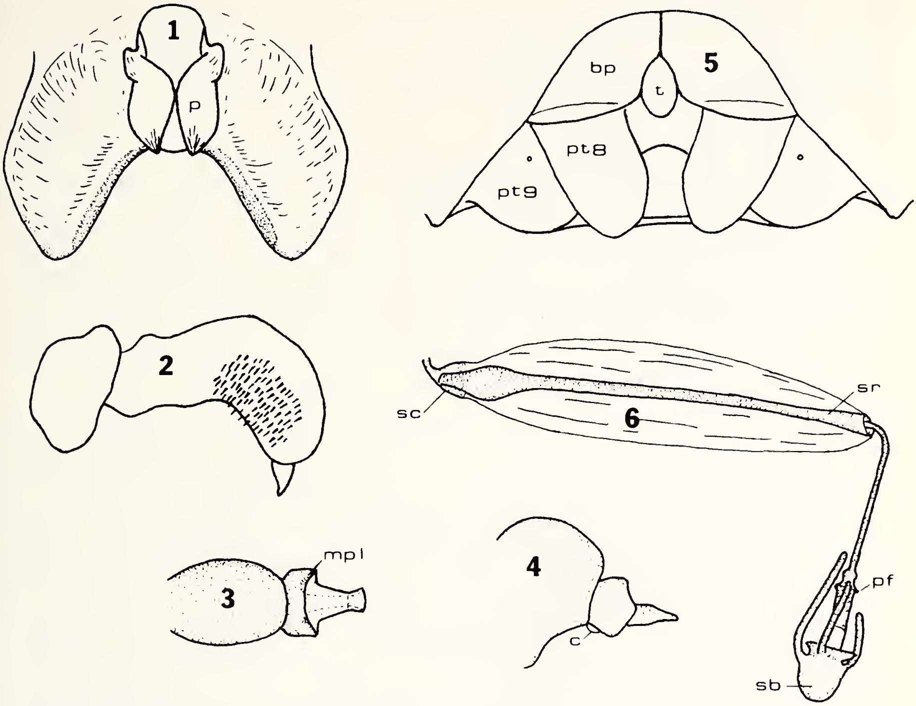
There is, however, a second species of *Pellaea,* a description of which follows.

Pellaea santarosensis, new species

(Figs. 1–10)

Description. Castaneous to light castaneous dorsally, often with rufous suffusion along anterolateral margins of pronotum and on head; connexiva sometimes rufous, usually with 2 subcircular black to metallic green macules on each segment, 1 in each lateral angle. Ventral surfaces light castaneous, usually with irregular rufous suffusion, or entirely rufous.

Punctation on head dark castaneous to black; most punctures in 2 longitudinal bands on each jugum, these bands continuing onto vertex, the lateral band on each side hooking laterad around ocellus. Width of head across eyes 3.0–3.3 mm, length 2.4–2.7 mm; interocular width 1.8–1.9 mm. Superior surface of antennifers with

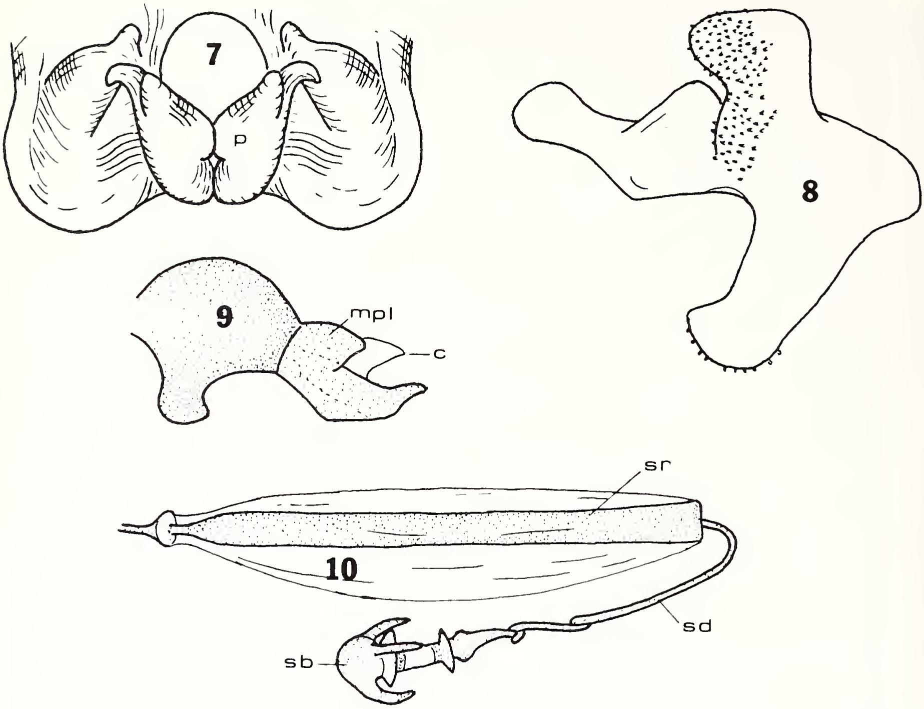


Figs. 1–6. *P. santarosensis.* 1. Genital cup; paramere (p). 2. Left paramere, lateral face. 3. Distal part of aedeagus, dorsal view; median penial lobe (mpl). 4. Same, lateral view; conjunctiva (c). 5. Genital plates, caudoventral view; basal plate (bp); 8th paratergite (pt8); 9th paratergite (pt9); triangulum (t). 6. Distal part of spermatheca; spermathecal bulb (sb); proximal flange (pf); sclerotized rod (sr); sclerotized cap (sc).

black to metallic green macule. Basal 2 segments of antennae black laterally, this mark enveloping segment 2 apically to varying extent; segment 3 black, a narrow pale ring covering basal joint; distal 2 segments fuscous to light brown, paler basally; length of segments 0.6–0.7, 1.2–1.3, 1.4–1.6, 1.4–1.5, 1.3–1.5 mm. Rostral segments 2–4 about 1.6–1.8, 1.2–1.5, 1.0–1.1 mm long; last segment fuscous, apex between metacoxae.

Most punctures on pronotum arranged in transverse, vermiform, dark castaneous lines separated by polished interstices, most of these calloused, rarely in part ivory, and contrasting strongly with remaining interstices. Humeri obtusely rounded, not produced; anterolateral margins of pronotum straight to slightly convex; densely punctate depressed line along anterior submargin interrupted mesially; pronotal width at humeri 7.0–7.8 mm, mesial length 2.7–3.0 mm.

Punctation of scutellum and coria somewhat irregularly disposed, a few subcalloused impunctate lacunae often present on coria. Scutellar width at base 4.7–5.2 mm; length 5.1–5.8 mm, 6–12% greater than basal width. Hemelytral membranes fumose.



Figs. 7–10. *P. stictica.* 7. Genital cup; paramere (p). 8. Left paramere, lateral face. 9. Distal part of aedeagus; median penial lobe (mpl); conjunctiva (c). 10. Distal part of spermatheca; spermathecal bulb (sb); spermathecal duct (sd); sclerotized rod (sr).

Ventral surface of head virtually impunctate; punctation of pleura moderate, consisting in part of minutely darkened punctures; punctation of abdominal venter fine, undifferentiated by color. Most setae on distal part of femora and along each tibial sulcus arise in black dot; some dots on superior surface of femora may be enlarged and confluent, most often on hind femora; superior femoral surface not prolonged distally into spine; each tibial sulcus usually with black macule basally, occasionally much of sulcus black. Spiracles narrowly ringed with black.

Basal plates posteriorly bent dorsad at nearly right angle; greatest dimension from bend to posterior margin subequal to ½ length of remainder of plate; mesial margin concave apically, exposing triangulum (Fig. 5). Both 8th and 9th paratergites concave basally. Spermathecal bulb bearing 3 slender diverticula of unequal lengths (Fig. 6). Spermathecal duct enlarged proximad of proximal flange; membranous dilation surrounding sclerotized rod attached proximally to sclerotized cup.

Pygophore deeply and widely emarginate ventrally; ventral margins black; inferior ridge large, exposed fully from caudal view. Parameres in form of stout hook with large apical tooth curving ventrad, their apices hanging over inferior ridge and visible from caudal view; lateral surface of each with field of stout pegs (Figs. 1, 2), invested generously with long hairs. Median penial lobes forming cup around ejaculatory duct; conjunctiva reduced to ventral remnant (Figs. 3, 4).

Holotype. ♂ labeled "Santa Rosa National Park, Guanacaste Prov. COSTA RICA. 2–4 May, 1980. D. H. Janzen & W. Hailwacks" Deposited in the American Museum of Natural History.

Paratypes. 25♀♀, 14♂♂:[1] labeled as holotype (2♀♀, ♂ in each of following institutions: AMNH, BMNH, CAS, FSCA, NR, NMNH; ♀ RNH, ♀ 2♂♂ LHR); labeled as holotype except date "7–8 May 1980" (2♀♀ LHR); labeled as holotype except date "5–7 June 1980" (♀ UP); labeled as holotype except date "16–18 Jul 1980" (♀ RNH); labeled as holotype except date 9–17 Mar 1981 (2♀♀ DBT); labeled as holotype except date 1–15 Jun 1982 (2♀♀, ♂ UFRGS, ♂ RNH, ♀ LHR, 3♂♂ UP, ♂ DBT); labeled as holotype except date "15–31 Jul 1982 (♀ UP); "Santa Rosa Nat. Pk. Prov. Guanacesta COSTA RICA 12–14 Dec 1979, D. H. Janzen (♀ UP).

Comments. This species differs notably from *P. stictica* in the form of the pygophore, parameres, genital plates, spermatheca, absence of a spine at the apex of the femora, and ventral markings. In *P. stictica* the concavity on each side of the genital cup is interrupted by an obtuse, diagonal carina (Fig. 7); the parameres are elaborate (Fig. 8); the 8th paratergite is slightly convex basally, the 9th paratergite nearly flat basally, and the margin of the basal plates usually straight with the plates contiguous, although sometimes the medial angle of each is diagonally truncated; the diverticula of the spermathecal bulb are subequal in length and the duct between the proximal flange and sclerotized rod is at least ½ longer than in *P. santarosensis* (Fig. 10); the superior surface of the femora is prolonged distally into a small, angulate tooth; and the venter has many large, black macules, with each spiracle in a large spot. The aedeagus is similar but distinctive in the 2 species (Figs. 4, 9).

In the key to genera by Rolston and McDonald (1981), couplet 14 should be replaced by the following:

14. Most punctures on pronotum arranged in transverse, vermiform lines separated by polished, calloused interstices .... *Pellaea* Stål
– Pronotal punctures rather evenly disposed, or if not interstices not calloused 15

ACKNOWLEDGMENTS

I am indebted to Daniel H. Janzen, University of Pennsylvania, for the specimens of *Pellaea santarosensis* and to W. R. Dolling, British Museum (Natural History), for the privilege of examining relevant type material.

LITERATURE CITED

Dallas, W. S. 1851. List of the specimens of Hemipterous insects in the collection of the British Museum.

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[1] Paratype Depositories: American Museum of Natural History (AMNH); British Museum (Natural History) (BMNH); California Academy of Sciences (CAS); Donald B. Thomas (DBT); Florida State Collection of Arthropods (FSCA); author's collection (LHR); National Museum of Natural History (NMNH); Naturhistoriska Riksmuseum, Stockholm (NR); Rijksmuseum van Natuurlijke Historie (RNH); Universidade Federal do Rio Grande do Sul (UFRGS); University of Pennsylvania (UP).

Distant, W. L. 1880–1893. Insecta. Rhynchota, Hemiptera-Heteroptera. *In:* F. D. Godman and O. Salvin, Biologia Centrali-Americana. London, Vol. 1.

Froeschner, Richard C. 1981. Heteroptera or true bugs of Ecuador: a partial catalog. Smithsonian Contributions to Zoology, no. 322.

Rolston, L. H. 1983. A revision of the genus *Acrosternum* Fieber, subgenus *Chinavia* Orian, in the Western Hemisphere (Hemiptera: Pentatomidae). J. New York Ent. Soc. 91(2): 97–176.

Rolston, L. H. and F. J. D. McDonald. 1981. Conspectus of Pentatomini genera of the Western Hemisphere—Part 2 (Hemiptera: Pentatomidae). J. New York Ent. Soc. 88(4), 1980: 257–272.

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KARYOTYPE OF *CONOMYRMA FLAVA* (MCCOOK) (HYMENOPTERA: FORMICIDAE)[1]

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Abstract.—The karyotype (2N = 26) of the ant *Conomyrma flava* is reported from material collected in central Texas. The chromosome numbers and morphology match those of *Conomyrma bicolor* from the western U.S.A. more closely than those of *Conomyrma* spp. from Peru and Brasil. A lactic acid dissociation, air-drying technique with Giemsa staining for ant chromosomes is described.

Conomyrma Forel and all its species were considered to belong in *Dorymyrmex* Santschi, until Kusnezov (1952) separated the two genera, *Dorymyrmex* and *Conomyrma.* He further divided *Conomyrma* into two subgenera, *Biconomyrma* Kusnezov and *Conomyrma.* Although these subgenera subsequently were elevated to generic status by Kusnezov (1959), *Biconomyrma* was later synonymized with *Conomyrma* by Snelling (1973).

The taxonomy of the North American *Conomyrma* species is uncertain, and the genus is in need of revision. Snelling (1973) synonymized all but three of the nominal taxa from the U.S.A. One species, *C. insana* (Buckley), cannot be recognized with certainty because the type material is lost (J. C. E. Nickerson and J. C. Trager, pers. comm.) and the original description (Buckley, 1866) is vague. *Conomyrma flava* (McCook) was synonymized with *C. insana* by Snelling (1973), but has since been determined to be a valid species by the late William F. Buren (J. C. Trager, pers. comm.). We use the name *C. flava* for the specimens reported here and have deposited voucher specimens, as indicated below, for later study.

Apparently unaware of the taxonomic changes proposed by Kusnezov (1952), Crozier (1968, 1970) reported the karyotypes of the following three species of *Conomyrma*: *Dorymyrmex bicolor* (Wheeler), *Dorymyrmex ?thoracius* (Santschi), and *Dorymyrmex ?pulchellus* (Santschi) (=*Dorymyrmex* sp. in 1968 paper). Two of the species reported by Crozier are from South America, whereas *C. bicolor* is from the U.S.A. We herein report the karyotype of a second *Conomyrma* sp. from North America.

MATERIALS AND METHODS

Workers and brood of *Conomyrma flava* (McCook) collected at Camp Verde, Kerr Co., Texas, were maintained in the laboratory until suitable material (last instar larvae) became available. Slides were prepared from five larvae and scored for diploid number and centromeric position.

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The larval heads were removed and opened in hypotonic solution. A 1% sodium citrate and 0.075 M KCl hypotonic solutions were used for times from 5 to 30 minutes, respectively. Although all preparations were similar in chromosome spacing among individual spreads, the best results were obtained using 0.075 M KCl solution for 15 to 20 minutes. The heads were fixed in Carnoy's fixative (3:1 absolute methanol: glacial acetic acid) for 30 minutes and then placed in a drop of dissociate solution (3:1 glacial acetic acid: 85% lactic acid) on the middle of a clean dry microscope slide. Maceration of tissues with a pin and forceps aided dissociation of cells within the dissociate solution. The dissociate solution will destroy the preparation if left in contact with the cells for more than a couple of minutes. The moment the cells became transparent to the unaided eye, three or four drops of fixative were dropped onto the dissociated cell solution, and the slides were tilted back and forth several times to spread the solution. After that, any remaining solution was poured off and the slides were air dried for 24 hours, and then stained for 10 minutes in 6% Giemsa stock solution in 15 M Sorenson's buffer (pH 6.8). The above procedure is similar to that proposed by Crozier (1968), differing mainly by the use of lactic acid dissociation and Giemsa staining. The cells were not treated with colcemid or colchicine as we, like Mehlhop and Gardner (1982), found this step unnecessary and we were concerned with possible alterations of the karyotype by these agents as indicated by Smith (1965).

Centromere classification follows that of Levan et al. (1964) as modified by Crozier (1970).

The slides are not coverslipped and are numbered TTU Prep. #32-42. A voucher series of the preserved workers and brood are deposited in the Entomological Collection, The Museum, Texas Tech University (cat. no. 6476).

RESULTS AND DISCUSSION

The normal diploid chromosome number of the somatic head cells (presumably cerebral ganglia) of five worker larvae was 2N = 26. A total of seventeen cells from the five specimens were examined with no variation in counts. The karyotype (Fig. 1) consists of a pair of large subacrocentric, two pairs of medium metacentric, and 10 pairs of submetacentrics-to-subacrocentrics ranging in relative size from medium to small.

The chromosome number of 2N = 26 for *C. flava* is identical to that of *C. bicolor* reported by Crozier (1970, Fig. 1D), both species being from western North America. By contrast, the two species from Peru and Brasil, *C. ?thoracica* and *C. ?pulchella*, respectively, have 2N = 18 (Crozier, 1970, Fig. 1E, F). The karyotypes of both South American species consist of a single pair of large metacentrics or submetacentrics (almost subacrocentrics) and eight medium-sized metacentric chromosome pairs. In contrast, the karyotypes of the two North American species consist of a pair of large acrocentric-to-subacrocentric, two or five pairs of medium-sized metacentrics, and 10 or seven pairs of acrocentrics-to-submetacentrics ranging in size from small to medium.

The differences noted here and in karyotypes by Crozier (1970) suggest two separate groupings; however, these groups do not correspond to the genera/subgenera proposed by Kusnezov (1952, 1959). Many more karyotypes and a thorough taxonomic re-

Fig. 1. Karyotype of *Conomyrma flava* (McCook), 2N = 26.

vision of *Conomyrma* spp. will be necessary to determine trends of karyotypic evolution in this genus.

ACKNOWLEDGMENTS

We would like to thank Drs. J. C. Everett Nickerson and James C. Trager for information on the taxonomy of *Conomyrma* and for reading the manuscript. Drs. M. Kent Rylander, James K. Wangberg, and Mr. Frederick B. Stangl, Jr. also commented on the manuscript. We would like to thank Dr. Rylander for allowing us the use of a microscope and camera in his care. Dr. Nobuo Tsurusaki (Sapporo, Japan) kindly shared his knowledge of chromosomal preparation techniques with the senior author.

LITERATURE CITED

Buckley, S. B. 1866. Descriptions of new species of North American Formicidae. Proc. Ent. Soc. Phila. 6:152–172, 335–350.

Crozier, R. H. 1968. An acetic acid dissociation, air-drying technique for insect chromosomes, with aceto-lactic orcein staining. Stain Tech. 43(3):171–173.

Crozier, R. H. 1970. Karyotypes of twenty-one ant species (Hymenoptera; Formicidae), with reviews of the known ant karyotypes. Can. J. Genet. Cytol. 12:109–128.

Kusnezov, N. 1952. El estado real del grupo *Dorymyrmex* Mayr (Hymenoptera, Formicidae). Acta Zool. Lilloana 10:427–448.

Kusnezov, N. 1959. Die Dolichoderinen-Gattungen von Süd-Amerika (Hymenoptera, Formicidae). Zool. Anz. 162:38–51.

Levan, A., K. Fredga and A. A. Sandberg. 1964. Nomenclature for centromeric position on chromosomes. Hereditas 52:201–220.

Mehlhop, P. and A. L. Gardner. 1982. A rapid field technique for preparing ant chromosomes for karyotypic analysis. Stain Tech. 57(2):99–101.

Smith, S. G. 1965. Heterochromatin, colchicine, and karyotype. Chromosoma (Berlin) 16: 162–165.

Snelling, R. R. 1973. The ant genus *Conomyrma* in the United States (Hymenoptera: Formicidae). Los Angeles Co. Mus., Contrib. Sci. 238:1–6.

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KEY TO THE MALES OF THE NOMINATE SUBGENUS OF *EUSCHISTUS* IN SOUTH AMERICA, WITH DESCRIPTIONS OF THREE NEW SPECIES (HEMIPTERA: PENTATOMIDAE)

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Abstract.—Keys to subgenera of the genus *Euschistus* Dallas and to the South American species and one subspecies of the nominate subgenus are provided for males. Three new species of the nominate subgenus are described: *E. carbonerus, E. incus,* and *E. rohus. Euschistus bifibulus* var. *guayaquilinus* Kuhlgatz, 1903, is placed in the synonymy of *E. taurulus* Berg, 1878. *E. lizerianus* Pennington, 1922, is transferred to the genus *Agroecus* Dallas.

Most of the South American species of the genus *Euschistus* Dallas, 1851, are contained in the subgenera *Lycipta* Stål, 1862, *Euschistomorphus* Jensen-Haarup, 1922, and *Mitripus* Rolston, 1978. Species of these subgenera may be identified from the literature.

Recent papers on *Lycipta* are a revision by Rolston (1982), a nomenclatural correction by Thomas (1983), and a description of an additional species by Hildebrand and Grazia (1983). Grazia and Hildebrand (1982) transferred *Berecynthus monrosi* Pirán, known only from females, to *Euschistus.* Although they did not place this species in a subgenus, their drawings of the head and spermatheca indicate that *E. monrosi* very likely belongs in the subgenus *Lycipta.* If this is so, there are currently 12 species in this subgenus.

Euschistomorphus, whose salient feature is the apically contiguous juga, contains the species *E. longiceps* Berg, 1891, and *E. albidus* Jensen-Haarup, 1922, both quite distinctive.

Rolston (1978) proposed the subgenus *Mitripus* to contain seven species, but he misidentified two of these species, one of them previously undescribed, for want of examining the relevant types. Grazia (pers. comm., 1983) proposes to correct these errors, raising to eight the number of species in this subgenus.

In the nominate subgenus there are 14 species and one subspecies known from South America, and another species, *E. nicaraguensis,* may occur there since its range includes Panama. Rolston (1974) described or redescribed nine of these taxa, *viz. E. agudus, E. bifibulus, E. crenator crenator, E. crenator orbiculator, E. emoorei, E. heros, E. nicaraguensis* and *E. rufimanus.*

Here keys are provided for the males of the subgenera and species-group South American taxa of the nominate subgenus. One uncommon species, *E. quadripunctatus,* is redescribed, and three new species described.

SYSTEMATIC CHANGES

Euschistus taurulus Berg, 1878

Euschistus taurulus Berg, 1878, Anal. Soc. Cient. Arg. 5:305–306.
Euschistus bifibulus var. *guayaquilinus* Kuhlgatz *in* Bayern, 1903, Berliner Entomol. Zeit. 47 (1902):247, 254–256, fig. 2, 2a. **New Synonymy.**

Kuhlgatz (1903) included two drawings in his description of *E. bifibulus* var. *guayaquilinus,* one a ventral view of a male. This drawing shows quite clearly a median, obtuse tooth on the posterior pygophoral margin, a character which in combination with the form of the humeri and widely spaced, posteriorly inclined pronotal denticles is sufficient to identify the insect as *E. taurulus,* a common species throughout South America except in the extreme northwest.

Agroecus lizerianus (Pennington), **New Combination**

Euschistus lizerianus Pennington, 1922, Physis 6:316–317.

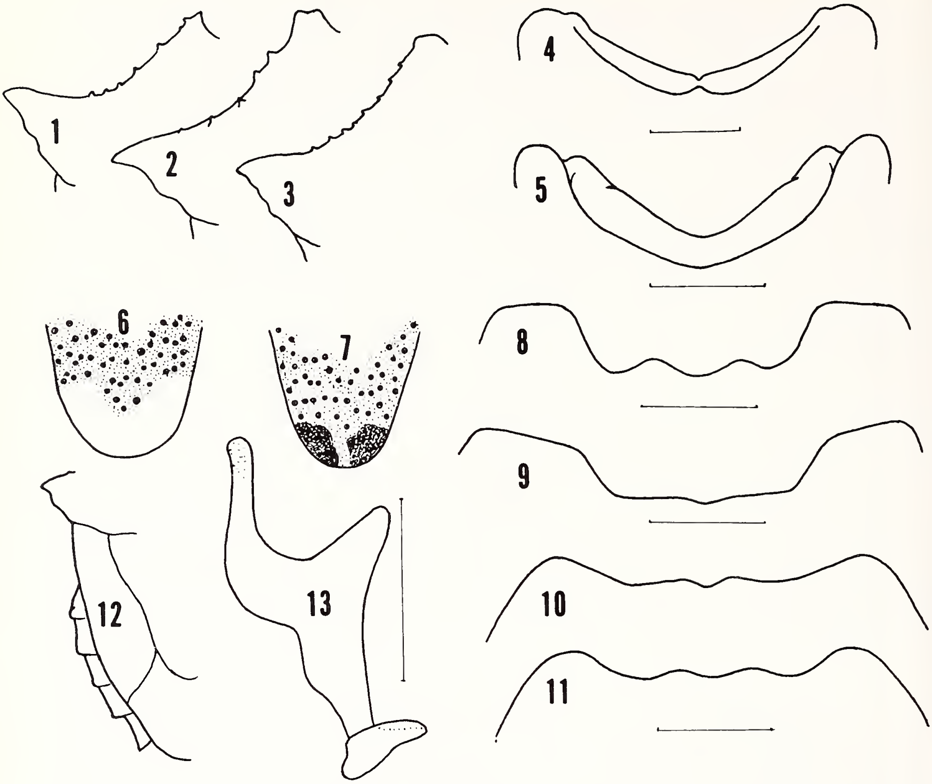
The female type in the Drake collection, National Museum of Natural History, Washington, D.C., was examined. The form of the genital plates and double row of setae on the interior femoral surfaces, with each seta arising from a small tubercle, place this species in the genus *Agroecus* Dallas, 1851. The species is apparently distinct from those already in *Agroecus.*

KEY TO SUBGENERA FOR MALES

1. Juga contiguous or nearly so before tylus for distance subequal to or greater than diameter of eye .... *Euschistomorphus*
– Juga often convergent but usually well separated apically, rarely briefly contiguous 2
2(1). Genital cup with pale membranous cushion on each lateral wall, this cushion running just beneath anterolateral portion of rim then bending ventrad near anterior wall of genital cup .... *Lycipta*
– Genital cup with dark rigid carinae or denticles on lateral walls 3
3(2). Pair of proctigeral tubercles located about midway between apex and base of proctiger or nearer base than apex; rim of genital cup interrupted on each side of superior ridge by diagonal depression (excepting *E. convergens*) .... *Mitripus*
– Proctigeral tubercles located on distal half of proctiger; anterolateral and anterior portions of genital cup rim continuous .... *Euschistus*

KEY TO SPECIES AND SUBSPECIES FOR MALES OF NOMINATE SUBGENUS

1. Evaporative areas with dark punctures 2
– Evaporative areas lacking dark punctures, occasionally with small reddish spots 5
2(1). Denticles on pronotum widely spaced (Fig. 1); tylus usually acute apically .... *rufimanus* Stål
– Denticles on pronotum closely spaced, most separated by distance no greater than length of denticle (Fig. 22); tylus rounded apically 3



Figs. 1–13. 1–3. Anterolateral pronotal margin and humerus. 1. *E. rufimanus.* 2. *E. quickua.* 3. *E. taurulus.* 4, 5. Posterior margin of pygophore and inferior ridge, caudal view. 4. *E. taurulus.* 5. *E. bifibulus.* 6, 7. Scutellar apex. 6. *E. heros.* 7. *E. quadripunctatus.* 8, 9. Posterior pygophoral margin, caudal view. 8. *E. atrox.* 9. *E. nicaraguensis.* 10, 11. Variation in posterior pygophoral margin of *E. emoorei,* caudoventral view. 12. Connexival margin of *E. quickua.* 13. Paramere of *E. quickua.* Dimensional lines equal 0.5 mm.

3(2). Scutellar apex with pale macule or broad border (Fig. 6); sutures between sternites black except laterad of spiracles . . . . *heros* (Fabricus)

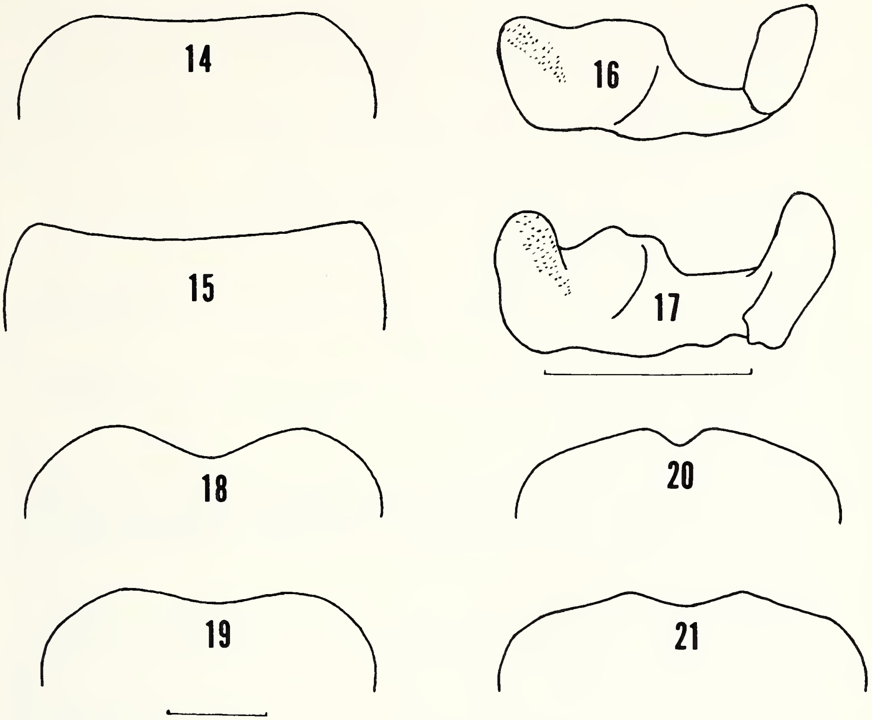
– Scutellar apex usually unmarked, occasionally with narrow pale border; sutures between sternites usually concolorous with sternites 4

4(3). Anterior disk of pronotum convex in profile; posterior margin of pygophore from caudal view with moderately deep emargination slightly sinuous at bottom (Fig. 9) . . . . *nicaraguensis* Rolston

– Anterior disk of pronotum an inclined plane in profile; posterior margin of pygophore trisinuately emarginate from caudal view (Fig. 8) . . . . *atrox* (Westwood)

5(1). Pair of brown calluses on apex of scutellum separated by small pale area (Fig. 7) . . . . *quadripunctatus* Stål

– Apex of scutellum not so calloused 6



Figs. 14–21. 14, 15. Posterior pygophoral margin, caudoventral view. 14. *E. agudus*. 15. *E. backhauseni*. 16, 17. Parameres. 16. *E. agudus*. 17. *E. backhauseni*. 18, 19. Variation in posterior pygophoral margin of *E. crenator crenator*, caudoventral view. 20, 21. Variation in posterior pygophoral margin of *E. crenator orbiculator*, caudoventral view. Dimensional lines equal 0.5 mm.

6(5). Humeri produced into short spine usually directed anterolaterad (Fig. 25) .... *incus* new species
– Humeri produced laterad, obtuse to spinose 7
7(6). Most denticles on pronotum separated from each other by distance equal to or greater than length of denticle (Figs. 2, 3) 8
– Most denticles on pronotum closely spaced, adjacent denticles usually contiguous basally or separated by distance less than length of denticle 10
8(7). Lateral margins of abdomen strongly serrate (Fig. 12); tylus surpassing juga, separated apically from each jugum by small incision; parameres with long stout process (Fig. 13) .... *quickua* Pirán
– Lateral margins of abdomen weakly serrate; tylus and juga subequal in length, not separated apically by distinct incisions; parameres lacking process 9
9(8). Posterior margin of pygophore smoothly concave from caudal view (Fig. 5); rim of genital cup on each side of superior ridge smoothly rounded; serrated carina within genital cup on each lateral wall .... *bifibulus* (Palisot de Beauvois)
– Posterior margin of pygophore with small protuberance mesially (Fig. 4); rim of

genital cup on each side of superior ridge with thin black carina which bends into genital cup near its termination about midway between superior and inferior ridges; carina within genital cup on each lateral wall entire, with one denticle anteriorly .... *taurulus* Berg

10(7). Slight medial protuberance on posterior margin of pygophore minutely notched from caudoventral view (Fig. 34) .... *rohus,* new species

– Posterior margin of pygophore without median tubercle 11

11(10). Conspicuous ivory macule on apex of scutellum; humeri stout, spinose, almost entirely black laterad of hemelytra; width across humeri usually 7.0 mm or more, rarely less 12

– Any ivory mark on apex of scutellum confined to narrow border; humeral shape varies, black usually marginal or absent; width across humeri rarely as great as 7.0 mm 14

12(11). Antennae uniformly sordid yellow to rufous .... *agudus* Rolston

– Each of last 2 antennal segments dark brown to black with broad pale band basally 13

13(12). Pronotal denticles black .... *carbonerus,* new species

– Pronotal denticles brownish yellow .... *backhauseni* Berg

14(11). Dorsal punctation on pronotum nearly uniform in density; black punctures if any not concentrated along denticular margin; emargination in posterior margin of pygophore broad, shallow, sinuous to subquadrate from caudoventral view (Figs. 10, 11) .... *emoorei* Rolston

– Punctures along denticular margin usually crowded, black; posterior margin of pygophore either sinuous and mesially concave, or convex with shallow concavity mesially 15

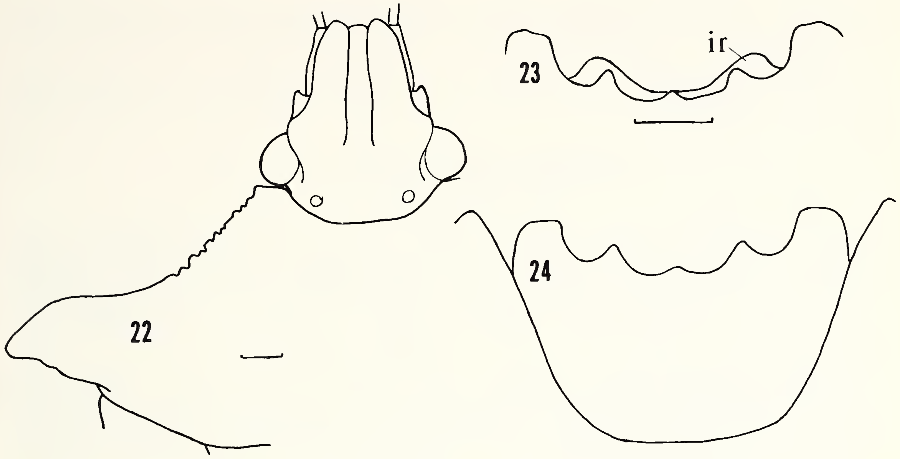
15(14). Posterior margin of pygophore sinuous, concave mesially from caudoventral view (Figs. 18, 19) .... *crenator crenator* (Fabricius)

– Posterior margin of pygophore convex with narrow shallow concavity mesially from caudoventral view (Fig. 20); rarely sinuously convex with broad shallow concavity mesially .... *crenator orbiculator* Rolston

Euschistus quadripunctatus Stål, 1860
Figs. 7, 22–24

Euschistus quadripunctatus Stål, 1860, p. 20

Description. Head as long as wide across eyes, 2.3–2.5 mm. Margins of head obtusely angular before eyes, briefly subparallel before apex of antenniferous tubercles, 1.1–1.2 mm wide here, slightly incised at apex, dorsally bronze black blending to dark brown on disk (Fig. 22). Slight submarginal impression before eyes, base of tylus somewhat elevated, disk otherwise rather flat; punctation even (excepting impunctate area mesad of each eye) deep, coarse, black or fuscous. Distance between outer margins of ocelli 1.2–1.3 mm. Antenniferous tubercles largely visible from above. Basal segment of antennae not quite reaching apex of head, sordid yellow with fuscous streak laterally; segments 2–5 fuscous, superior surface of 2 sometimes pale, 3–4 narrowly and 5 broadly annulated at base with sordid yellow; length of segments 0.6–0.8, 1.1–1.2, 1.1–1.4, 1.6–1.7, 1.8 mm. Head sordid yellow beneath with black streak from eyes along suture above antenniferous tubercles; punctation concolorous with sclerites, moderately coarse along buccalae, finer elsewhere. Bucculae obtusely lobed anteriorly, evanscent at base of head, subequal in length to basal



Figs. 22–24. *E. quadripuntatus,* holotype. 22. Head and pronotum in part. 23. Posterior pygophoral margin and inferior ridge (ir) caudal view. 24. Pygophore, caudoventral view. Dimensional lines equal 0.5 mm.

segment of rostrum; remaining rostral segments 1.8–1.9, 1.2–1.4, 0.9–1.0 mm in length.

Pronotum 7.7–8.4 mm wide at humeri, 2.4–2.7 mm long at meson; punctation on disk moderately dense and strong, becoming fine, dense, confused along anterolateral margins and on humeri. Humeral angles produced laterad, elevated, ivory at very apex and on posterolateral margin. Denticles small, closely spaced, black. Ivory spot toward meson on posterior border of cicatrices, disk otherwise yellowish brown deepening to black where punctation confused. Scutellum longer than wide at base, 3.8–4.0 mm wide basally, 4.1–4.5 mm long; frena reaching about ⅔ distance from base to apex; disk somewhat rugose; punctation uniform; fovea in each basal angle small, black; pair of finely rugose dark brown calluses on apex of scutellum separated by small pale area. Punctation on coria less dense than that on scutellum; white callus at end of radial vein; membrane brown, veins simple or branched. Connexiva partially exposed; punctation fine, shallow, dense; each segment sometimes with narrow transverse ivory line at base, otherwise not conspicuously alternated.

Venter sordid yellow, concolorously punctate. Thorax with 4 black spots, one on each subcoxae, one on each mesopleuron near distal end of supracoxal cleft. Evaporative areas matte, rugose, reaching nearly half way from ostiole to lateral thoracic margins. Mesocoxae and metacoxae each with single dark spot on anterior surface; femora and tibiae with many black spots; basal tarsal segments, and sometimes others, darkest apically. Spiracles black; elongated black spot at anterolateral angles of all sternites bearing spiracles.

Posterior margin of pygophore broadly emarginate, emargination containing 4 concavities (Figs. 23, 24). Inferior ridge largely visible from caudal view.

Length 11.5–12.5 mm.

Distribution. Brazil (Guanabara, before 1960 the Federal District coextensive with Rio de Janeiro).

Comment. Redescribed from 2 males, one the holotype in the Naturhistoriska Riksmuseet, Stockholm.

Euschistus incus, new species

Figs. 25–30

Description. Dorsum light brown to light castaneous or gray; punctation light castaneous to black, somewhat fine, often in aggregations on pronotum. Brownish yellow beneath, sometimes finely flecked, tinted or blotched with orange or red; punctation almost entirely concolorous, very fine on aciculate abdominal venter. Length 9.7–10.9 mm.

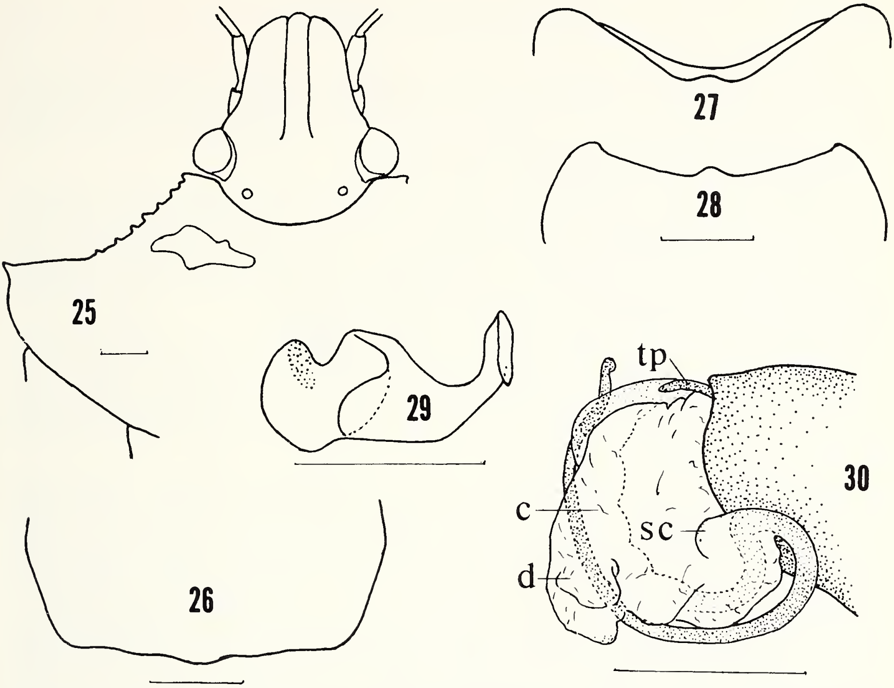
Width and length of head subequal, 2.1–2.3 mm wide across eyes; lateral jugal margins briefly parallel or subparallel above apex of antennifers; tylus as long as or slightly longer than juga (Fig. 25). Basal 3 segments of antennae nearly concolorous with ventral surface of head, last 2 segments darker, usually basal segment and sometimes basal 3 segments fuscous dotted; basal segment not reaching apex of head; length of segments 0.5–0.6, 0.7–0.9, 1.1–1.3, 1.1–1.3, 1.1–1.2 mm. Rostral segments 2–4 about 1.6–1.8, 0.7–1.0, 0.8–0.9 mm.

Pronotum 2.2–2.5 mm long at meson, 2.6–2.8 times as wide across humeri. Denticles on anterolateral margins of pronotum concolorous with adjacent disk, sometimes with black punctures on base, nearly always discrete and sometimes widely separated, occasionally as few as 5 denticles on a side. Humeri moderately produced; apex acute, usually spinose, directed anterolaterad or rarely laterad.

Scutellum usually a little longer than wide at base, 3.3–3.9 mm across base; fovea in basal angles small, shallow, blackish; disk rather smooth, moderately convex; narrow margin of apex impunctate, occasionally conspicuously paler than disk. Membranes of hemelytra hyaline; veins simple or branched, brown. Connexiva moderately exposed, dark with pale marginal spot in middle of each segment; punctation close, coarse, pale.

Evaporative areas unicolorous. Small fuscous dots on femora and tibiae least numerous on hind legs. Basal angles of sternites each with black macule; apical angles immaculate. Spiracles concolorous with supporting sclerite.

Broad emargination in posterior margin of pygophore sloping on each side to low median protuberance of varying width (Figs. 27, 28); median protuberance sometimes inapparent from caudal view, rarely absent; posterior pygophoral margin sinuously truncate from dorsal view (Fig. 26). Anterolateral angles of inferior ridge each bearing compressed black denticle oriented diagonally, its anterior limit laterad of posterior limit. Lateral rims of genital cup roughened by low black carinae, these variable in number, directed diagonally cephalad from within cup toward rim; larger carina, mesially concave in profile, located entad and cephalad of row of lesser carinae along each lateral rim. Parameres strongly cupped; oval area of fine denticles on lateral face at apex (Fig. 29). Apex of conjunctiva on each side with or without lightly pigmented spot; lateral diverticulum on each side entirely hyaline (Fig. 30). Large sclerotized cap present at base of penisfilum. Thecal processes short; median thecal lobe weakly developed, lateral thecal lobes absent.



Figs. 25–30. *E. incus.* 25. Head and pronotum in part. 26. Posterior pygophoral margin, dorsal view. 27. Posterior pygophoral margin and inferior ridge, caudal view. 28. Posterior pygophoral margin, caudoventral view. 29. Paramere. 30. Aedeagus, lateral view; conjunctiva (c); diverticulum (d); sclerotized cap (sc); thecal process (tp). Dimensional lines equal 0.5 mm.

Types. Holotype: male, labeled (a) "No. 53, Lima, Peru, IV-1965" (b) "F. Asneros, M. Tello." Deposited in National Museum of Natural History, Washington, D.C. Type No. 72132. Paratypes: 11 males, 10 females. "Cuenca, Ecuador, June 1939, Lucio Vivar, preying on lep. larva" (♀ LHR); "Peru, Chira Valley, V-1953, on cotton" (♂ NMNH); "Paila, Peru" remainder illegible (♂ NMNH); "Cañete, Mch. 4, 1941, E. J. Hambleton" (♂ LHR); same data except date "Mch. 13, 1941" (♀ NMNH); same data except date "Mch. 10, 1942" (♂ UNLP); same data except date "Mch. 17, 1942" (♀ UNLP); "Cañete, Feb. 11, 1941, E. J. Hambleton, on cotton (♀ NMNH); same data except date "Mch. 17, 1941" (♀ NMNH); same data except date "Mch. 6, 1941" (♂ NR); "No. 23-39, Piura, 31-V-1939, Schaefer Coll," (2♂♂, ♀ NMNH: ♀ NR): "Piura, Peru, May 1, 1941, E. J. Hambleton, on cotton" (♂ LHR); "Huacachima Yea, E. Escomel" (♂ AMNH); (a) "Lobitos, H. P. Manton" (b) "Brit. Mus., 1939, 489" (3♀♀, 2♂♂ BMNH)

Distribution. Western Peru and southern Ecuador.

Comment. The peculiar humeri will immediately identify most specimens. The male genitalia suggest an affinity with *E. crenator* (F.).

Euschistus rohus, new species
Figs. 31–37

Description. Light brown dorsum usually tinted with red, becoming light castaneous on head and anterior portion of pronotum; head thinly edged in black, anterolateral margins of pronotum and apex of humeri black bordered. Brownish yellow beneath, concolorously punctate. Length 7.9–9.4 mm.

Head 1.8–1.9 mm across eyes, subequal in length; lateral jugal margins sigmoid, tapering to apex; tylus slightly exceeding juga (Fig. 31). Antennae light brown with tiny dark dots on 3 basal segments; each of last 2 segments usually castaneous with pale but not clearly annulated base; basal segment reaching apex of head; length of segments 0.5–0.6, 0.9–1.0, 1.0–1.1, 1.3–1.5, 1.4–1.5 mm.

Pronotum 2.2–2.4 mm long at meson, 2.8–3.2 times as wide at humeri. Anterolateral margins evenly concave, closely and rugosely denticulate; narrow black border toward apex consisting of black punctures, toward humeri involving entire margin. Humeri acutely produced laterad, neither turned forward nor much elevated above disk.

Scutellum 3.0–3.4 mm wide at base, subequal in length; each basal angle with 2 or 3 confluent punctures, scarcely foveate; color and punctation of apex as on disk. Punctation of hemelytra darker and stronger on costal margins at base than on disks; impunctate lacuna at distal end of radial vein neither calloused nor differentially colored; membranes lightly fumose, veins simple or branched. Connexiva little or not at all exposed, darker than coria, at least along margin, with small pale marginal spot in middle of each segment; punctation close, coarse, pale.

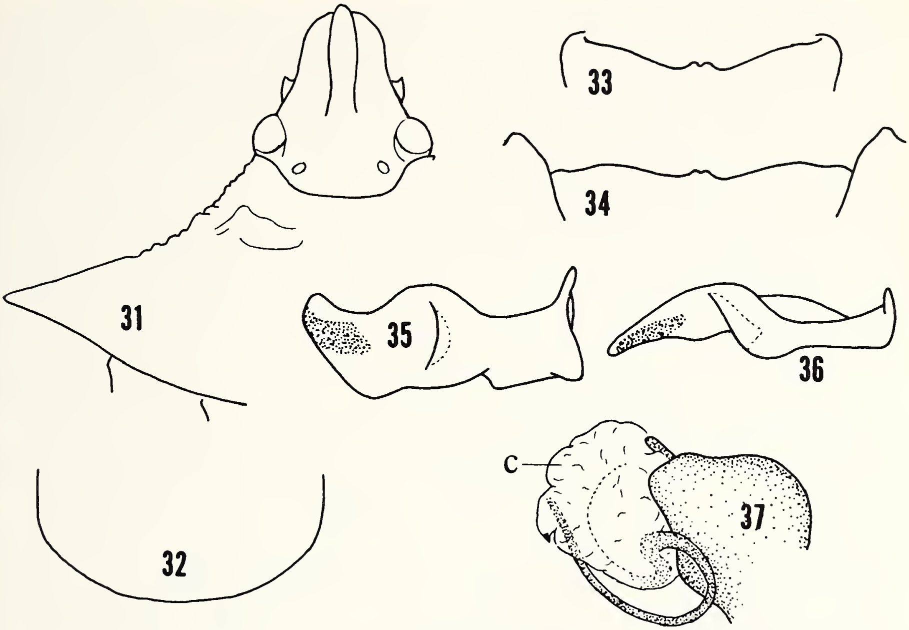
Pleural surfaces of thorax with 5 small black dots as usual for genus; evaporative areas unicolorous. Small fuscous dots scattered on femora and tibiae. Spiracles concolorous with sternites; basal angle of sternites black spotted, apical angles immaculate.

Posterior margin of pygophore convexly arcuate from dorsal view (Fig. 32), sinuously concave from caudal view and sinuously truncate from caudoventral view, a low median minutely notched truncate protuberance apparent from both caudal and caudoventral views (Figs. 33, 34). Small black denticle on each lateral wall of genital cup just visible above paramere. Parameres quite thin apically with reticulated area on lateral surface (Figs. 35, 36). Conjunctiva on each side terminating in hook with acute black apex (Fig. 37); lateral lobes of theca strongly developed, extending posteriorly well beyond median lobe.

Type. Holotype: male, labeled (a) "Paramba, Ecuador" (b) "Collection Rosenburg." Deposited in National Museum of Natural History, Washington, D.C. Type no. 75557. Missing last antennal segment on right, last 2 on left, mesothoracic and metathoracic legs on left, tarsi of these legs on right. Paratypes: 4 males, 4 females. Same data as holotype (♀ LHR); "Cachabé, low c, XII-96 (Rosenburg) (♂♀ BMNH, ♂ UNLP); same data plus second label "Ecuador, Rosenburg, 99-104" (♂ LHR); "Paramba, 3500′, II 97, dry season, Rosenburg" (♀ BMNH); "60 K NW Cali, Colombia, 29-VI-1972" (♀ HDE); "Pipe Line Rd, Canal Zone, 22-X-1972, L. H. Rolston" (♂ LHR).

Distribution. Ecuador, Colombia, Panama (Canal Zone).

Comments. This species closely resembles *E. vetus* Rolston from Costa Rica. The



Figs. 31–37. *E. rohus.* 31. Head and pronotum in part. 32. Posterior phygophoral margin, dorsal view. 33. Same, caudal view. 34. Same, caudoventral view. 35. Paramere. 36. Same, rotated 90 degrees. 37. Aedeagus, lateral view, conjunctiva (c). Dimensional lines equal 0.5 mm.

males are readily identified by the genitalia, but the females of these 2 species cannot be separated with confidence. The ranges of these species are not known to overlap, but they may do so in western Panama.

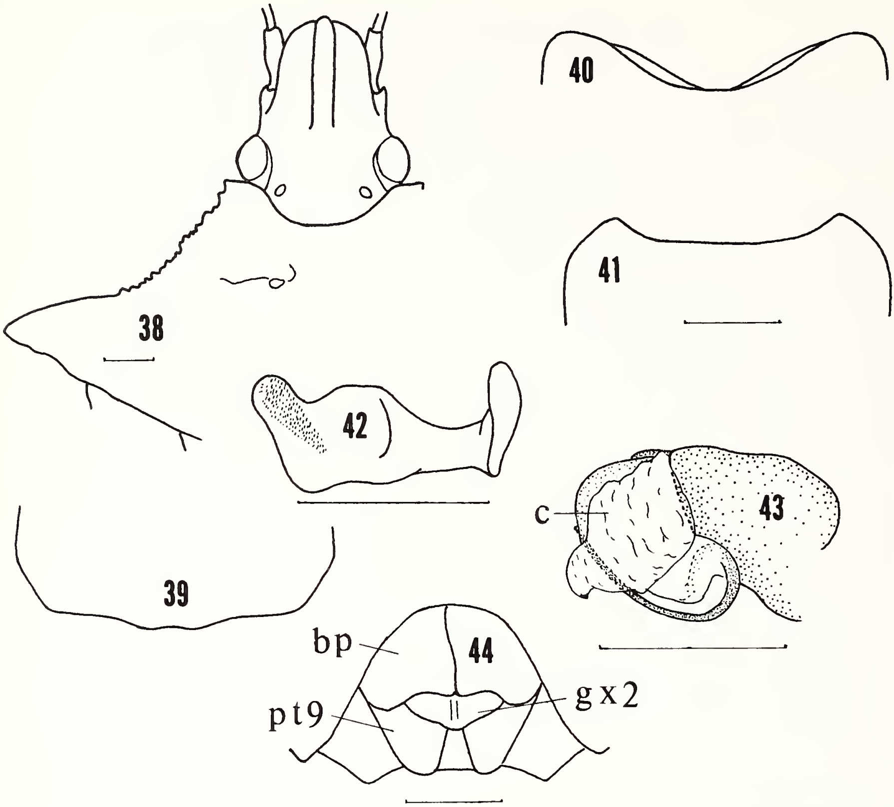
Euschistus carboneurs, new species

Figs. 38–44

Description. Dorsum dark brown to fuscous becoming black on humeri, with apex of scutellum ivory; punctures black, evenly distributed excepting scattered subcalloused spots. Venter brownish yellow, concolorously punctate. Length 9.5–10.7 mm.

Width of head across eyes 1.9–2.0 mm, length subequal. Lateral margins of head tapering sinuously from eyes to rather narrowly rounded apex; tylus a little longer than juga (Fig. 38). Antennae brownish-yellow to fuscous with darker dots on basal or basal 3 segments and pale ring on proximal fourth of last two segments; basal segment reaching apex of head; length of segments 0.6–0.7, 0.9–1.1, 1.3–1.8, 1.4–1.8, 1.4–1.6 mm.

Pronotum 2.3–2.6 mm long at meson, 2.9–3.3 times as wide at humeri. Anterolateral margins concave from dorsal view, denticulate nearly to base of humeri; denticles closely spaced, black. Humeri acutely produced laterad, apically elevated



Figs. 38–44. *E. carbonerus*. 38. Head and pronotum in part. 39. Posterior pygophoral margin, dorsal view. 40. Posterior pygophoral margin and inferior ridge, caudal view. 41. Posterior pygophoral margin, caudoventral view. 42. Paramere. 43. Aedeagus, lateral view; conjunctiva (c). 44. Genital plates; basal plate (bp); 2nd gonocoxae (gx2); paratergite 9 (pt9). Dimensional lines equal 0.5 mm.

above pronotal disk. Small subcalloused spot near posteromesial margins of each cicatrice little or no paler than cicatrice.

Scutellum as wide as or slightly wider than long, 3.3–3.8 mm across base; a few black punctures in each basal angle forming shallow fovea. Membranes of hemelytra fuscous; veins simple or branched. Connexiva narrowly exposed; punctation dense, pale; small pale spot usually present submarginally in middle of each segment.

Evaporative areas unicolorous. Femora black dotted, more sparsely so than tibiae. Anterolateral and posterolateral angles of abdominal sternites minutely marked in black. Spiracles concolorous with surrounding surface.

Broad emargination in posterior margin of pygophore concave to moderate depth from caudal view (Fig. 40), shallowly concave from caudoventral view (Fig. 41), truncate and slightly sinuous from dorsal view (Fig. 39). Small black denticle on each lateral wall of genital cup obscured by parameres. Conjunctiva on each side terminating in apically pigmented hook (Fig. 43). Lateral lobes of theca large, extending posterolaterad beyond median lobe. Parameres as in Figure 42.

Basal plates overlapping along basal portion of medial margin; posterior margin sinuous, convexity at lateral angle appressed to basal concavity of 9th paratergites (Fig. 44). Second gonocoxae longitudinally grooved mesially.

Types. Holotype: male, labeled "Brazil, Para, Jacareacanga, Dec. 1968, M. Alvarenga." Deposited in American Museum of Natural History. Paratypes: 6 males, 2 females. Same data as holotype (♀ AMNH, ♂ LHR, ♂ NMNH); same data as holotype except date and collector "Feb. 1969, F. R. Barbosa" (♂ AMNH); "Santarem, Acc. No. 2966" (♂ CMNH, ♂ UNLP); "Rio de Jan. Brazil. Acc. No. 2966" (♀ LHR); "Brazil, Rondonia" on white paper pasted on purple museum label (♂ IRSNB). The last paratype listed and both female paratypes have the binomen hand lettered on the paratype label; it is printed on the other paratype labels.

Distribution. Apparently widely distributed in Brazil, although all but one specimen came from along the Amazon River and one of its tributaries, the Guapore River, which marks part of the eastern Bolivian border.

Comments. This species belongs in a group of six species that are similar in size, appearance and genitalia: *E. atrox, E. heros, E. nicaraguensis, E. agudus, E. backhauseni* and *E. carbonerus.* The first three species have dark punctures in the evaporative areas and the last three species have unicolorous evaporative areas. The color of the pronotal denticles, black in *E. carbonerus,* separate this species from *E. agudus* and *E. backhauseni,* both of which have ivory colored denticles. Each of these three species differ somewhat in the shape of the posterior pygophoral margin and parameres (Figs. 14–17, 40, 42).

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The following abbreviations are used in the text for paratype depositories: American Museum of Natural History (AMNH); British Museum (Natural History) (BMNH); Carnegie Museum of Natural History (CMNH); H. Dodge Engleman collection (HDE); Institut Royal des Sciences Naturelles de Belgique (IRSNB); Author's collection (LHR); National Museum of Natural History (NMNH); Naturhistoriska Riksmuseet (Stockholm) (NR); Universidad Nacional de La Plata (UNLP).

LITERATURE CITED

Berg, C. 1878. Hemiptera Argentina: essayo de una monographia de los Hemipteros Heteropteros y Homopteros de la Republica Argentina. An. Soc. Cient. Arg. 5(6):297–314.

Grazia, J. and R. Hildebrand. 1982. Revisao do genero *Berecynthus* Stål, 1862 (Heteroptera, Pentatomidae, Pentatomini). Rev. Bras. Entomol. 26(2):173–182.

Hildebrand, R. and J. Grazia. 1983. Uma nova especie de *Euschistus* Dallas, 1851 (Heteroptera, Pentatomidae) Iheringia, ser. Zool., Porto Alegre 62:81–88.

Kuhlgatz, T. *in* T. von Bayern. 1903. VI Rhynchoten. Berliner Entomologische Zeitschrift 47(1902):243–278, pls. 4, 5.

Pennington, M. S. 1922. Hemipteros nuevos para la Republica Argentina (primera parte). Physis (Buenos Aires) 6:315–319.

Rolston, L. H. 1974. Revision of the genus *Euschistus* in Middle America (Hemiptera, Pentatomidae, Pentatomini). Entomol. Am. 48(1):1–102.

Rolston, L. H. 1978. A new subgenus of *Euschistus* (Hemiptera: Pentatomidae). J. New York Entomol. Soc. 86(2):102–120.

Rolston, L. H. 1982. A revision of *Euschistus* Dallas subgenus *Lycipta* Stål (Hemiptera: Pentatomidae). Proc. Entomol. Soc. Wash. 84(2):281–296.

Stål, C. 1860. Bidrag till Rio Janeiro-traktens Hemipter-fauna. Kongliga Svenska Vetenskaps Akademien 2(7):1–84.

Thomas, D. B., Jr. 1983. On the homonymy of *Euschistus luridus* Dallas, 1851 (Hemiptera: Pentatomidae) Proc. Entomol. Soc. Wash. 85(1):182.

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CHEMICAL ANALYSIS OF THE MALE AEDEAGAL BLADDER IN THE FIRE ANT, *SOLENOPSIS INVICTA* BUREN[1]

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Abstract.—The aedeagal bladder in the male reproductive system of the fire ant *Solenopsis invicta* Buren lies within the external genitalia. The lumen is lined by a single layer of squamous epithelium surrounded by heavy musculature. In mature, sterile and mated males it contains a milky substance but no fluid is found in newly eclosed males. The fluid in the bladder consists of fatty acid esters (glycerol monodecanoate and glycerol monododecanoate) in a proteinaceous matrix. The function of the secretion remains unknown.

The male reproductive system in the imported fire ant, *Solenopsis invicta* Buren consists of the testes, vas deferens, seminal vesicles, accessory gland, ejaculatory duct, wedge, and external genitalia (Ball and Vinson, 1984). An additional organ, the aedeagal bladder, has been described in many species of male ants but its function is unknown and no chemical analyses of its contents have been reported.

The aedeagal bladder was first described by Clausen (1938). Forbes (1954) discussed the anatomy and histology of the aedeagal bladder in *Camponotus pennsylvanica* DeGeer in considerable detail. Forbes (1958) also described the aedeagal bladder in the army ant, *Eciton hamatum* F. Later, Forbes and Do-Van-Quy (1965) investigated the histology of the bladder in the legionary ant, *Neivamyrmex harrisi* (Haldeman). Ford and Forbes (1980) showed that the bladder is present in several species of doryline ants and Hagopian (1963) has described an aedeagal bladder in the ponerine ant, *Rhytidoponera metallica* F. Smith. In each case, the aedeagal bladder was found to be an ovoid muscular sac lined with squamous epithelium, filled with a basophilic granular mass and emptying posteriorly into the region of the ejaculatory duct between the inner genitalic valves.

Trakimas (1967) described an aedeagal bladder in *Myrmica rubra* L. but she stated that the granular material in the lumen stains acidophilicly and is found in a greater amount in mature males with degenerated testes. Tice (1967) did an extensive study on the male reproductive system of the black imported fire ant, *Solenopsis saevissima richteri* Forel, and also reported a muscular aedeagal bladder with a granular acidophilic substance in the lumen. Ball and Vinson (1984) found an aedeagal bladder lined with a single layer of squamous epithelium in the male reproductive system of the red imported fire ant, *S. invicta* Buren, and determined that the material in the lumen contains a small amount of protein. They also determined that the bladder material is found in approximately equal amounts in mature, mated and sterile males.

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The purpose of this investigation was to determine the chemical composition of the contents of the aedeagal bladder in the fire ant, *S. invicta.*

MATERIALS AND METHODS

Dissection and collection procedures. Newly eclosed (one day old) males and sterile males (Hung et al., 1974) at least two weeks old were collected from laboratory colonies. Sterile males lack testes and are, therefore, incapable of sperm production. Additional males, collected as they flew from the surface of the mound prior to mating (preflight) and after they returned (postflight) were also examined.

Males were pinned through the ventral surface of the thorax, the terminal gastral segments were grasped with microforceps and pulled apart exposing the external genitalia, the claspers were carefully pulled and the accessory glands were severed from the claspers. The claspers were then quickly positioned with the posterior end of the genital valves pointing upward and the muscular contractions within the claspers caused the expulsion of the aedeagal bladder material which was collected by capillary action using a flame-drawn pipette.

Chemical analysis. A variety of chemicals was used to test the solubility of the aedeagal bladder material. Samples were collected from 5 mature males and placed into sterilized glass tubes containing either acetone, ethanol, pentane, 0.1 N NaOH, 0.1 N HCL or distilled water (pH 7).

During dissection of the aedeagal bladder, the expelled material appeared as a white particulate material resembling deposits of uric acid. Therefore, the material was collected from 20 mature males, placed into 0.1 N NaOH and tested concurrently with a standard uric acid sample on thin layer chromatography (TLC) on cellulose using 0.1 N NaOH as the solvent. The plate was then examined under ultraviolet light. The material also appeared to have droplets of suspended oil indicating lipid-like substances. To determine the presence of free lipids, the aedeagal bladder material was collected from 40 males and placed into ethyl ether. Standard samples (Sigma Chem. Corp., St. Louis, Mo. 63178) of glycerides (distearin, triolein, and monopalmitin), a fatty acid (oleic acid), a steroid (stigmasterol) and an ester (palmitic acid ethyl ester) were mixed with chloroform to obtain final concentrations of 1 μg/μl. Five and 10 μl drops of the sample and standards were spotted onto a silica gel TLC plate and air dried. The plate was then placed in a chromatography tank with a hexane: ethyl ether solvent (50:50). The solvent front was allowed to migrate to within 10 mm of the top and the plate was then transferred to an iodine developing tank. Aedeagal bladder material and standard spots were then compared and RF values computed.

As a further analysis, the material, collected from 40 mature males, was dissolved in pentane as previously determined and injected onto a column gas chromatograph (GC). The samples were analyzed on a Tracor 550 GC with a flame ionization detector modified with an all glass variable split ratio collection system. Separations were obtained on a 1.83 M × 4 mm i.d. column of 3% OV-101 on Chromosorb 750, 100–120 mesh at a nitrogen flow rate of 60 ml/min programmed from 50 to 270°C at 10°C/min. Standard monoglycerides were analyzed under the same conditions. Mass spectral (MS) analyses were performed on a Finnigan 1020 OWA quadrupole GC-

Table 1. RF values for TLC lipid analyses of standard and gland extract samples. Solvent—ethyl ether/hexane (50:50), iodine vapor visualization on silica gel F254 plate.

Sample	RF value
Monoplatmitin	0.05
Distearin	0.39
Triolein	0.61
Oleic acid	0.45
Stigmasterol	0.67
Palmitic acid ethyl ester	0.67
Gland extract	0.05

MS unit using a 12 M × 0.33 mm i.d. BPI column, 6 psi, temperature programmed from 60 to 220°C at 20°C/min. Monoglyceride standards (Sigma Chem. Corp., St. Louis, Mo. 63178) were used, with RT 9.41 min for C_{10} and 10.65 min for C_{12} under the above conditions. Hexane gland extracts were subjected to GC-MS analysis without preliminary purification.

The polyacrylamide disc gel electrophoresis procedure described by Davis (1964) was used for verification of the presence of lipoproteins. A 7.5% separating gel was allowed to polymerize in glass tubes (i.d. 4.5 mm, length 75 mm) precleaned in chromic acid followed by the addition of a 3.3% stacking gel to the top of the separating gel. The aedeagal bladder material from 20 males was collected and placed in 100 μl of an aqueous 1% mercaptoethanol/1% SDS disruption buffer solution. Standards (Sigma Chem. Corp., St. Louis, Mo. 63178) consisting of 100 μg each of phosphorylase A (330 K), IgG (150 K), bovine serum albumin (67 K), ovalbumen (43.5 K) and cytochrome C (12.5 K) were also placed in 100 μg of disruption buffer. Standards and the aedeagal bladder sample were heated for 15 min at 60°C before applying 30 μl aliquots per tube. Electrophoresis proceeded at 8 mA per gel tube for ca. 4 hr.

A Cahn gram electrobalance was used to determine the percent composition of proteins and/or lipids in the aedeagal bladder material. The contents of the bladder from 30 mature males were extracted, placed on aluminum foil pans, weighed and moved to a desiccator. Once a constant weight was obtained, the material was immersed 3 times in hexane and returned to the desiccator. After reaching a constant weight again, the material was placed 3 times in chloroform : methanol (50:50) for 5 min each. Two samples and a control (empty pan) were analyzed concurrently.

Transmission electron microscopy was used to observe the ultrastructure of the bladder material. The claspers with the intact aedeagal bladder were removed from several mature males and fixed in 2% glutaraldehyde/2% acrolein/1.5% DMSO in 0.133 M sodium cacodylate buffer (pH 7.4) at room temperature for 6 hr. The specimens were then rinsed 3 times in buffer and post-fixed in 2% osmium tetroxide in 0.1 M buffer and 0.2 M sucrose for 3 hr. The samples were rinsed 3 times in 0.1 M buffer, 2 times in distilled water and transferred to 1% aqueous uranyl acetate overnight. After dehydration in an ethanol series, the specimens were embedded in

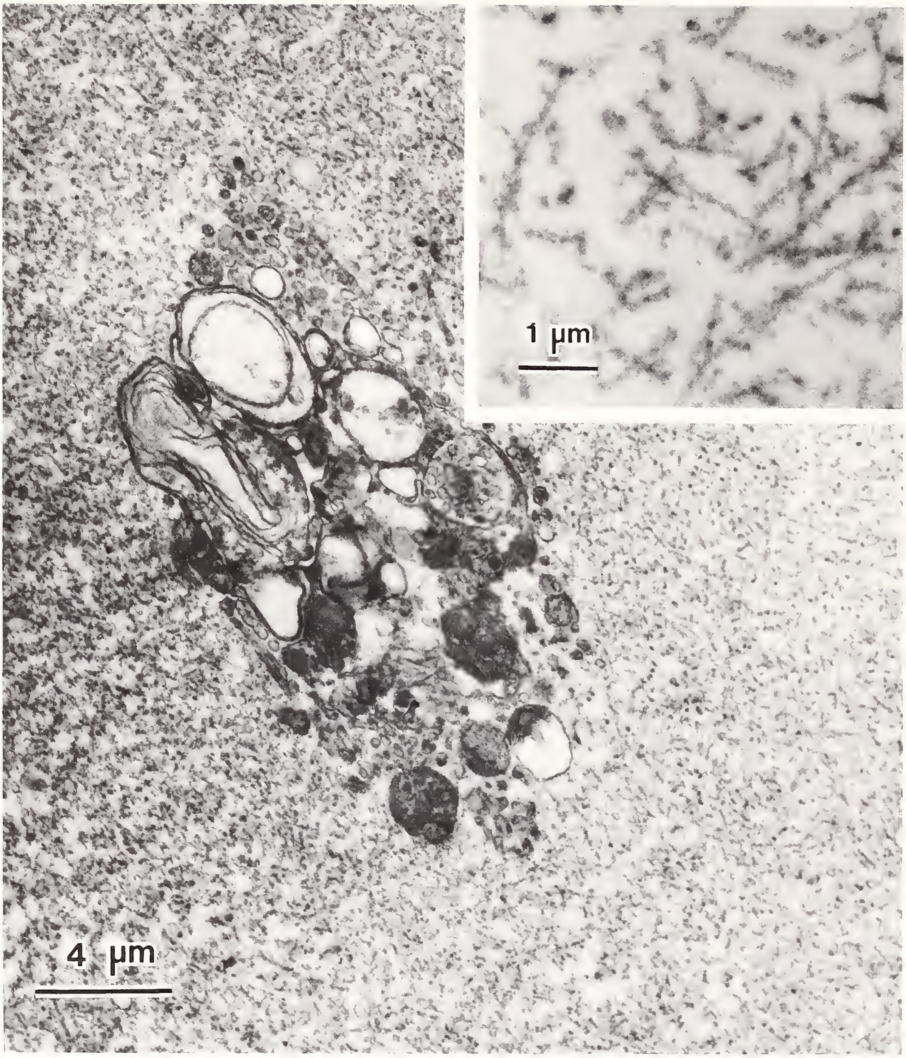

Fig. 1. Transmission electron micrograph of the aedeagal bladder material surrounding a lysed cell. Insert: Magnification of the fibrillar material.

Epon araldite resin, vacuum aspirated and allowed to polymerize for 24 hr at 40°C and then 48 hr at 60°C. The blocks were sectioned at 500 Å, stained with Toluidine blue and viewed on a Ziess 10C/CR transmission electron microscope at 80 kV.

RESULTS AND DISCUSSION

Chemical analysis. Upon dissection in distilled water, the aedeagal bladder material appeared as a white, granular substance and was insoluble in water, although a few suspended oil droplets were observed. Only slight dissolution occurred when the extract was placed in acetone and ethanol. However, the material completely dissolved in 0.1 N NaOH but not in 0.1 N HCL.

TLC analysis for uric acid was negative for the gland extract. Additional TLC analysis for the presence of free lipids showed that the material contained monoglycerides as shown by equal RF values (Table 1).

GC analysis of several samples showed gland contents to be variable perhaps due to contamination during dissection but most samples (4 out of 6) showed the presence of peaks with retention times equal to those of monodecanoyl and/or monododecanoyl glycerol. These samples were subjected to GC-MS analysis. Materials with retention times equal to those of the monoglyceride standards had mass spectra identical to those of the standards. Monododecanoyl glycerol was present in 4 of the 6 samples; monodecanoyl glycerol was in 1 sample in a 1:10 ratio. Other unidentified highly variable materials made up from 10 to 80% of the samples containing monoglycerides. Monoglyceride spectra were in excellent agreement with those given in the EPA/NIH Mass Spectral Data Base (Heller and Milne, 1978).

Polyacrylamide gel electrophoresis showed the separation of one large band with a molecular weight of ca. 40–90 K indicating the presence of lipoprotein(s).

The results using the gram electrobalance showed that nearly all of the aedeagal bladder material was composed of polar lipids since the material was insoluble in hexane but completely dissolved in chloroform : methanol.

Transmission electron microscopy showed the presence of several lysed cells surrounded by slender fibrillar material in the bladder substance (Fig. 1). Closer examination revealed miniscule branching with dark, round globules adhering to the surface of the fibrils (Fig. 1, insert).

This study has shown that the aedeagal bladder in the male fire ant, *S. invicta,* consisted of two monoglycerides in a protein matrix. The source of this material is unknown, and does not appear in the bladder until 5 to 7 days post emergence. No change in the epithelial cells of the aedeagal bladder in preflight or postflight males was observed nor did the cells appear to be secretory. The function of the gland also remains unknown. Since the aedeagal bladder material has been found in approximately equal amounts in preflight and mated, postflight males, it seems unlikely that it is used primarily during mating.

Several studies have shown that lipids play a major role in the biology of the fire ant. Vinson et al. (1967) demonstrated that the triglyceride of linoleic acid was the most active phagostimulant for workers. Vander Meer et al. (1982) analyzed several glands in mated queens of various ages and found large amounts of triacylglycerols in the crop and oesophagus which declined rapidly until 25 days following mating coinciding with the first brood production. Nelson et al. (1980) reanalyzed the cuticular methylalkanes in the cuticle of *S. invicta* and *S. richteri* Forel and determined that the triglycerides originally found by Lok et al. (1975) had different structures than were reported, although no function was demonstrated. However, the fatty acids listed in these reports were not the same as we found in the aedeagal bladder material.

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LITERATURE CITED

Ball, D. E. and S. B. Vinson. 1984. Anatomy and histology of the male reproductive system of the fire ant, *Solenopsis invicta* Buren (Hymenoptera: Formicidae). Int. J. Morph. and Embryol. 13:283–294.

Clausen, R. 1938. Untersuchungen über den mannlichen Copulationsappart der Ameisen, Speciell der Formicinae. Mitteil. Schweizer. Entomol. Gesells. 17:233–346.

Davis, B. J. 1964. Disc electrophoresis. II. Method and application to human serum proteins. Ann. New York Acad. Sci. 121:404–427.

Forbes, J. 1954. The anatomy and histology of the male reproductive system of *Camponotus pennsylvanicus* DeGeer (Formicidae, Hymenoptera). J. Morph. 95:523–556.

Forbes, J. 1958. The male reproductive system of the army ant, *Eciton hamatum* Fabricius. Proc. Tenth Internat. Congr. Entomol. 1:593–596.

Forbes, J. and D. Do-Van-Quy. 1965. The anatomy and histology of the male reproductive system of the legionary ant, *Neivamyrmex harrisi* (Haldeman) (Hymenoptera, Formicidae). J. New York Entomol. Soc. 73:95–111.

Ford, F. C. and J. Forbes. 1980. Anatomy of the male reproductive systems of the adults and pupae of two Doryline ants, *Dorylus* (Anomma) *wilverthi* Emery and *D.* (A.) *nigricans* Illiger. J. New York Entomol. Soc. 88:133–142.

Hagopian, M. 1963. An anatomical and histological study of the male ponerine ant, *Rhytidoponera metallica* F. Smith (Formicidae, Hymenoptera). Ph.D. dissertation, Fordham Univ., Univ. Microfilms, Ann Arbor, Michigan, 124 pp.

Heller, S. R. and G. W. A. Milne (eds.). 1978. "EPA/NIH Mass Spectral Data Base." U.S. Gov. Printing Office, Washington, D.C.

Hung, A. C. F., S. B. Vinson and J. W. Summerlin. 1974. Male sterility in the red imported fire ant, *Solenopsis invicta* Buren. Ann. Entomol. Soc. Amer. 67:909–912.

Lok, J. B., E. W. Cupp and G. J. Blomquist. 1975. Cuticular lipids of the imported fire ants *Solenopsis invicta* and *richteri.* Insect Biochem. 5:821–829.

Nelson, D. R., C. L. Fatland, R. W. Howard, C. A. McDaniel and G. J. Blomquist. 1980. Reanalysis of the cuticular methylalkanes of *Solenopsis invicta* and *S. richteri.* Insect Biochem. 10:409–418.

Tice, M. C. 1967. The anatomy and histology of some of the systems of the male of the imported fire ant, *Solenopsis saevissima richteri* Forel (Hymenoptera: Formicidae). Ph.D. dissertation, Fordham Univ., Univ. Microfilms, Ann Arbor, Michigan, 122 pp.

Trakimas, W. B. 1967. An anatomical and histological study of the male myrmicine ant, *Myrmica rubra* L. (Hymenoptera: Formicidae). Ph.D. dissertation, Fordham Univ., Univ. Microfilms, Ann Arbor, Michigan, 125 pp.

Vander Meer, R. K., B. M. Glancey, and C. S. Lofgren. 1982. Biochemical changes in the crop, esophagus and post-pharyngeal gland of colony-founding red imported fire ant queens (*Solenopsis invicta*). Insect Biochem. 12:123–127.

Vinson, S. B., J. L. Thompson and H. B. Green. 1967. Phagostimulants for the imported fire ant, *Solenopsis saevissima* var. *richteri.* J. Insect Physiol. 13:1729–1736.

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REVISION OF THE HARVESTMAN GENUS *LEPTOBUNUS* AND DISMANTLEMENT OF THE LEPTOBUNIDAE (ARACHNIDA: OPILIONES: PALPATORES)

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Abstract.—The harvestman genus *Leptobunus* Banks is revised. *Leptobunus californicus* Banks and *Leptobunus borealis* Banks are redescribed, and *Leuronychus parvulus* Banks is transferred to *Leptobunus* and redescribed. Lectotypes for *L. borealis* and *L. parvulus* are designated. *Leptobunus aureus* n. sp. and *Leptobunus pallidus* n. sp. are described from California, U.S.A. and Bering Island, U.S.S.R., respectively. *Leptobunus atavus* Cockerell, *Leptobunus koreanus* Roewer, *Leptobunus mexicanus* Goodnight and Goodnight, and *Leptobunus spinulatus* Banks are all excluded from the genus *Leptobunus.* The North American Tertiary fossil species is maintained as *Amauropilio atavus* (Cockerell), whereas all Recent species excluded from *Leptobunus* are reported in the following new combinations: *Mitopus koreanus* (Roewer), *Paranelima mexicana* (Goodnight and Goodnight), and *Metopilio spinulatus* (Banks). In conjunction, the Mexican species *Diguetinus raptator* Roewer is removed from synonymy with "*Diguetinus*" *spinulatus* (Banks). All the species are illustrated, including the male and female genitalia, for which new anatomical terminology is presented. A dichotomous key to the species and many new distributional records from western North America and northeast Asia are provided.

The history of the family-group name Leptobunidae is discussed and the name is attributed to Banks (1901). The family is abandoned and morphological characters traditionally used for the classification of "Leptobunidae" are discussed. The type genus of the Leptobunidae, *Leptobunus* Banks, is transferred to the Phalangiidae, subfamily Phalangiinae. The genera *Cosmobunus* Simon, *Leuronychus* Banks, and *Homolophus* Banks are transferred to the Gagrellidae, subfamily Leiobuninae, and *Trachyrhinus* Weed is maintained in the Gagrellidae, subfamily Gagrellinae. The North American genus *Protolophus* Banks is tentatively placed in the Gagrellidae, subfamily Sclerosomatinae. The South American genus *Thrasychirus* Simon is retained in the Neopilionidae, subfamily Enantiobuninae. The North American genus *Globipes* Banks is maintained in an assemblage that is as yet unnamed. The New World members of the genera *Homolophus* and *Cosmobunus* are not congeneric with Old World members referred to those genera.

Attempts to establish phylogenetically meaningful classifications of the Phalangioidea have been hindered by the confusion regarding the Leptobunidae. Until the present, apparently no worker has studied examples of all genera assigned to this family. Nathan Banks described several Nearctic species and genera but apparently never studied any Old World members of the group. Carl-Friedrich Roewer examined and described examples of all the genera assigned to the Leptobunidae except for *Leptobunus* Banks, the type genus. Without knowing the true nature of *Leptobunus,* Roewer could not have arrived at a reasonable classification for the Leptobunidae. The lack of comparative material of *Leptobunus* spp. in European museums has also hindered the study of the family. Most classifications by European authors involving the Leptobunidae have been based on the North African, southern European genus *Cosmobunus* Simon, which is not closely related to *Leptobunus*. To clear the confusion regarding this family, I examined examples of all nominal species ever referred to the Leptobunidae, and this is one of a series of papers dealing with those genera. In the present contribution *Leptobunus,* the type genus, is revised. Furthermore, the polyphyletic Leptobunidae is dismantled and placed in synonymy of the Phalangiidae.

MATERIALS AND METHODS

All anatomical measurements are in millimeters and were obtained using a binocular dissecting microscope equipped with an ocular micrometer (Cokendolpher, 1981a). Descriptions are based on all available specimens, but measurements were taken only on a maximum of 10 specimens per sex. Measurements are reported as ranges when more than one specimen was available. No measurements were taken of the relatively unsclerotized genital operculum. The chelicera, palpus, and penis were removed from the body and immersed in 100% glycerol for study, and then placed in microvials within the specimen vials. A tuft of cotton placed in the glycerol was used to support the structure when lateral views were desired. The female genitalia were first dehydrated with absolute ethyl alcohol and then examined in 100% clove oil. Ovipositors were soaked in absolute ethyl alcohol (to remove all traces of clove oil) prior to rehydration and placement in microvials. All illustrations were prepared with the aid of a camera lucida. The morphological terminology and description format essentially follows Cokendolpher (1981b).

The following terminology relating to the anatomy of the genitalia is being adopted.

Penis. In situ, the penis lies in a dorsoventral plane, thus the orientation of the truncus corresponds to that of the abdomen. As the penis truncus is attached to the gonads and related structures on the end opposite the glans, this attachment region becomes the basal or proximal portion of the truncus, and the basal portion of the glans is attached to the truncus. As the glans is not rigidly fixed to the truncus, it can be bent at any angle from 0° to about 160° to the plane of the truncus. This lack of rigidity results in the need to define the glans orientation surfaces. As the glans generally is at or near 135° to the truncus in preserved material, the glans surface that is more anterior (distal) is hereby considered the dorsal surface. The dorsal surface of the glans is generally straight, whereas the ventral surface is rounded. The paired primary setae are located laterad or laterally on the glans. The stylus, like the glans, is not rigidly attached (see Figs. 8, 9), but as no structures of taxonomic importance have been discovered on the stylus, the use of basal, or proximal, and distal (tip) will suffice.

Ovipositor. In situ, the ovipositor lies in a dorsoventral plane, and its orientation follows that of the abdomen. The distal end of the ovipositor consists of a three segmented furca. In the present descriptions, the furcal joints are numbered from the basal attachment, the distal joint being the 3rd. The setae bearing lobes on the 3rd furcal joint are the apical sensilla. The slit sensilla are located distally on the dorso- and ventromedial surfaces of the 2nd furcal joint. When specific sensilla numbers (#) are reported, they are given in the following formula: dorsal left # − dorsal right #/ventral left # − ventral right #. The 1st furcal joint lacks sensilla. The ovipositor segments or rings are numbered from the distal end. The seminal receptacles are located within the 2nd and 5th ovipositor rings, with the basal portions generally located within the 2nd or 3rd ring, and the receptacles extend to about the 4th or 5th ring. Thus, the distal and proximal portions of the ovipositors and seminal receptacles are opposite. Each seminal receptacle consists of a large distal loop (=primary loop) and one to many basal loops or coils on the basilateral margin; the basal loops or coils are actually the extreme basilateral portion of the primary loop. The basimesal margin often has a small tube in which the termination is indistinct. This small tube is used as a marker for the region in which the basal loops should occur when the loops are less convoluted (see Figs. 31–33).

ACRONYMS FOR COLLECTIONS, LOCATIONS, AND CURATORS

AMNH	American Museum of Natural History, New York, N. I. Platnick
ARM	A. R. Moldenke, Corvallis
BMM	Thomas Burke Memorial Washington State Museum, Seattle, R. L. Crawford
BMNH	British Museum (Natural History), London, F. R. Wanless and P. D. Hillyard
CAS	California Academy of Sciences, San Francisco, D. H. Kavanaugh, W. J. Pulawski, and V. F. Lee
CNC	Canadian National Collections of Insects, Arachnids and Nematodes, Ottawa, C. D. Dondale and J. H. Redner
EP	Exline-Peck Collection, Warrensburg, W. B. Peck
JCC	J. C. Cokendolpher, Lubbock
LACM	Los Angeles County Museum of Natural History, Los Angeles, C. L. Hogue
MCZ	Museum of Comparative Zoology, Cambridge, H. W. Levi and J. M. Hunter
NHR	Naturhistoriska Riksmuseet, Stockholm, T. Kronestedt
NMB	Naturhistorisches Museum, Basel, E. Sutter
OSU	Oregon State University, Systematic Entomology Laboratory, B. B. Frost and G. M. Stonedahl
PDB	P. D. Bragg, Vancouver
RGH	R. G. Holmberg, Edmonton
ROM	Royal Ontario Museum, Toronto, D. Barr
SMF	Senckenberg Natur-Museum und Forschungsinstitut, Frankfurt, M. Grasshoff
UCB	University of California Berkeley, Essig Museum, Berkeley, C. E. Griswold
UCR	University of California Riverside Entomological Teaching and Research Collection, Riverside, S. E. Frommer
USNM	National Museum of Natural History (U.S. National Museum), Washington, R. E. Crabill, Jr.
ZIZM	Zoologisches Institut und Zoologisches Museum, Hamburg, G. Rack

SYSTEMATICS

PHALANGIIDAE SIMON

PHALANGIINAE SIMON

Leptobunus Banks

Liobunum: Banks, 1894a:160 (in part).

Leptobunus Banks, 1893:209 (in part), 1894a:163, 1894b:40 (misidentification), 1894c:146 (misidentification), 1898:182 (misidentification), 1899:350, 1900a:199, 1900b:484, 1901:674, 1904:362, 1911:420, 1923:238; Simon, 1902:45; Cockerell, 1907a:605 (in part), 1907b:620 (misidentification); Roewer, 1910:270, 1923:877, 1952:268, 1957:355 (misidentification); Kishida, 1930:55; Redikorzev, 1936:33; Comstock, 1940:71; Goodnight and Goodnight, 1942b:13 (in part); Staręga, 1965:5 (misidentification), 1978:209; Šilhavý, 1976:296 (misidentification); Cokendolpher, 1980:134, 1981b:309; Cokendolpher and Cokendolpher, 1982:1216.

Leptobrunus: Myers, 1921:19 (*lapsus calami*).

Leuronychus: Banks, 1901:675 (in part), 1911:420 (in part); Roewer, 1910:271 (in part), 1923:878 (in part), 1957:356 (in part); Comstock, 1940:73 (in part); Holmberg et al., 1981:19 (in part).

Liomitopus Schenkel, 1951:49; Forcart, 1961:53.

Type species. Leptobunus californicus Banks, by original designation.

Diagnosis and comparisons. Leptobunus is similar to *Mitopus* Thorell, *Tchapinius* Roewer, and *Liopilio* Schenkel. These four genera differ from other phalangiid genera by lacking large spines or tubercles on the preocular area and the ventral surfaces of the palpal femora, by having the supracheliceral lamellae short and smooth, palpi without apophyses (juveniles included), and generally by having a tooth on the basal segment of the chelicerae. *Leptobunus* and *Liopilio* differ from *Mitopus* and *Tchapinius* by having the palpal claws denticulate, penis glans convex beneath, glans primary setae very large and often bifurcate, and by lacking strong spines or tubercles anywhere on the body (except occasionally on appendages). *Leptobunus* differs from *Liopilio* by having the palpal tarsi of males globular proximally and devoid of denticles ventrally. The palpal femora and patellae of *Liopilio* are expanded distally and densely covered with setae medially. The paired primary setae of the penis glans are located near the stylus junction in *Liopilio,* whereas in *Leptobunus* they are centrally located. The stylus-glans junction membrane is dorsally expanded in *Liopilio,* ventrally expanded in *Leptobunus.* The 2nd furcal joint of the ovipositor of *Liopilio* has one or two slit sensilla per side, whereas *Leptobunus* has one to six (rarely one) sensilla per side.

Description. Medium to small sized phalangiids with soft smooth bodies (Figs. 1–5); dorsum and venter with only scattered setae; last abdominal sternite indented. Ocular tubercle low, canaliculate, round to slightly wider than long, with scattered setae. Chelicerae not enlarged, with tooth on ventral surface of basal joint; moveable finger with or without apophysis (Figs. 40–50). Supracheliceral lamellae short and smooth. Scent gland pores visible from above, elongate. Palpi (Figs. 36–39) covered only with setae, except for one or two tubercles on distodorsal surface of female femora; distomesal margins of femora and patellae not expanded (not even in juveniles); distal ends of femora with lyriform organs on dorsolateral margins, dorsomedial campaniform sensilla lacking; male tibiae and tarsi modified, proximal portion of tibiae extended on mesal margin, proximal end of tarsi globular, expanded slightly on mesal margin, ventral rows of denticles lacking; claws with small pointed teeth at base. Legs relatively short; all articles round in cross-section. Penis truncus not grooved on distodorsal margin, glans round with large primary setae medially, stylus-glans junction membrane ventrally expanded (Figs. 6–21). Ovipositor often darkly pigmented with 19–35 rings plus 3 segmented furca; 1–6 slit sensilla per side on 2nd furca joint, seminal receptacles consisting of paired loops (Figs. 22–35).

INCLUDED SPECIES

Leptobunus consists of five species in two species groups. The *californicus* group contains *Leptobunus californicus* Banks, *Leptobunus borealis* Banks, and *Leptobunus pallidus,* new species. The *parvulus* group contains: *Leptobunus parvulus* (Banks), new combination, and *Leptobunus aureus,* new species.

Members of the *californicus* group can be easily recognized by the details of the genitalia and lack of a distinct apophysis on the moveable finger of the male chelicerae. The primary setae of the penis glans in members of the *californicus* group are often pointed or round and always much shorter in length than the stylus. *Californicus* group members have the primary loops of the seminal receptacles more than four times as long as wide. Members of the *parvulus* group often have tibiae IV with one or two pseudosegments. The male chelicerae in *parvulus* group members have a distinct apophysis on the moveable finger. The primary setae of the penis glans in members of the *parvulus* group are bilobed and equal to or slightly longer than the stylus. The primary loops of the seminal receptacles in members of the *parvulus* group are less than three times as long as wide.

EXCLUDED SPECIES

Amauropilio atavus (Cockerell)

Leptobunus atavus Cockerell, 1907a:605, fig. 2; 1907b:620.
Amauropilio atavus: Cokendolpher and Cokendolpher, 1982:1216–1217, fig. 1.

This species is known from one Tertiary fossil. The holotype female from the Florissant Formation, Teller Co., Colorado, U.S.A. (AMNH cat. no. FI-49 18834 Paleontology coll.) was not reexamined for the present study.

Mitopus koreanus (Roewer), **New Combination**

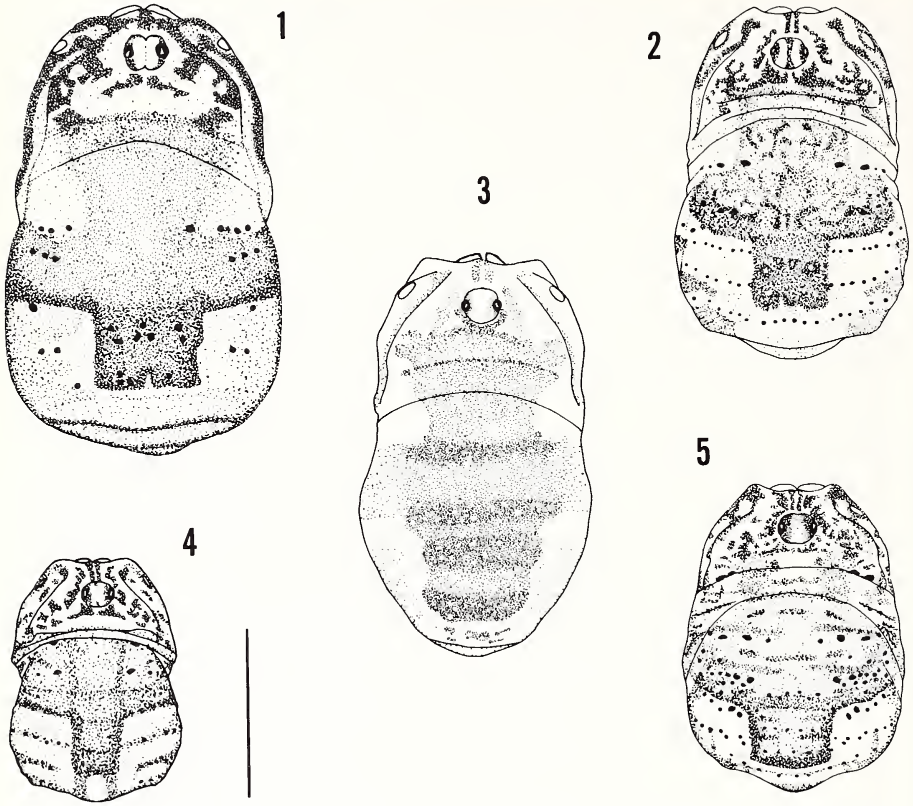
Leptobunus koreanus Roewer, 1957:355, pl. 26, fig. 23; Staręga, 1965:5; Šilhavý, 1976:296.

Female holotype from Korea (date, collector, and specific locality unknown), SMF cat. no. RII/3694/8, examined. This species conforms to *Mitopus* Thorell and is hereby transferred to that genus. A redescription is in preparation.

Paranelima mexicana (Goodnight and Goodnight), **New Combination**

Leptobunus mexicanus Goodnight and Goodnight, 1942b:13, fig. 31.

Female holotype from mountain meadow at Cerro Tancítaro, Michoacán, México,



Figs. 1–5. Dorsal views of *Leptobunus* spp. 1. *L. californicus* male. 2. *L. borealis* male. 3. *L. pallidus* female. 4. *L. aureus* male. 5. *L. parvulus* male. Scale line = 2.0 mm.

16 July 1941 (H. Hoogstraal), AMNH, examined. This species is related to other North American species of *Paranelima* di Caporiacco and Mexican species referred to *Nelima* Roewer. Until the mesoamerican species of these genera are revised, the affinities of *P. mexicana* will remain unresolved. Further material of both sexes of several species needs to be collected before such a revision can be realized.

Metopilio spinulatus (Banks), **New Combination**

Leptobunus spinulatus Banks, 1898:182; Pickard-Cambridge, 1905:585; Roewer, 1910: 257.

Hadrobunus spinulatus: Roewer, 1923:920.

Diguetinus spinulatus: Goodnight and Goodnight, 1942b:11 (in part), 1945:13 (in part), 1947:45 (in part); Roewer, 1956:252 (misidentification).

Female holotype from Tepic, Nayarit, México (date and collector unknown), MCZ, examined. Comparisons of the holotype of *L. spinulatus* and paratypes of *Diguetinus* *raptator* Roewer (2 males, 3 females, Guadalajara, Jalisco, México, SMF cat. no. RI/623) reveal they are not conspecific with one another as Goodnight and Goodnight (1942b) had indicated. *Leptobunus spinulatus* is properly a member of *Metopilio* Roewer. *Metopilio* and *Diguetinus* Roewer are quite similar, but are currently considered separate genera (Cokendolpher, 1984a).

KEY TO THE SPECIES OF THE GENUS *Leptobunus*

1a. Male chelicera with distinct apophysis on moveable finger (Figs. 46–50); stylus of penis equal to or shorter than primary setae of glans (Figs. 16, 18); primary loop of seminal receptacle short, less than three times as long as wide (Figs. 31–34) (*parvulus* group) 2

1b. Chelicera without apophysis on moveable finger (Figs. 40–45); stylus of penis much longer than primary setae of glans (Figs. 8, 12); primary loop of seminal receptacle long, more than four times as long as wide (Figs. 23, 29) (*californicus* group) 3

2a. Body color golden, legs speckled; primary setae of glans separated more than the length of the stylus (Fig. 16) .... *L. aureus,* new species

2b. Body color brown, gray or bronze, legs banded; primary setae of glans closely spaced (Fig. 18) .... *L. parvulus* (Banks)

3a. Tibiae II with 1–4 pseudosegments; male palpal tibiae expanded on ventral and mesal surfaces (Figs. 57–60); dorsum of abdomen with a well defined pattern (Figs. 1, 2) ... 4

3b. Tibiae II without pseudosegments; male palpal tibiae not expanded or enlarged (Figs. 51, 52); dorsum with faint pattern at most (Fig. 3) .... *L. pallidus,* new species

4a. Male palpal tibiae and tarsi noticeably expanded on mesal margins (Figs. 59, 60); dorsum of penis glans slightly depressed (Figs. 8, 9); basal loops of seminal receptacles consisting of three coils or loops (Figs. 23, 24) .... *L. californicus* Banks

4b. Male palpal tibiae and tarsi only slightly expanded (Figs. 57, 58); dorsum of penis glans straight (Fig. 12); basal loops of seminal receptacles consisting of two coils or loops (Figs. 26, 27) .... *L. borealis* Banks

Distribution. Aleutian and Bering Sea Islands, southern Alaska, and south along coastal states to central California and western Nevada in western North America.

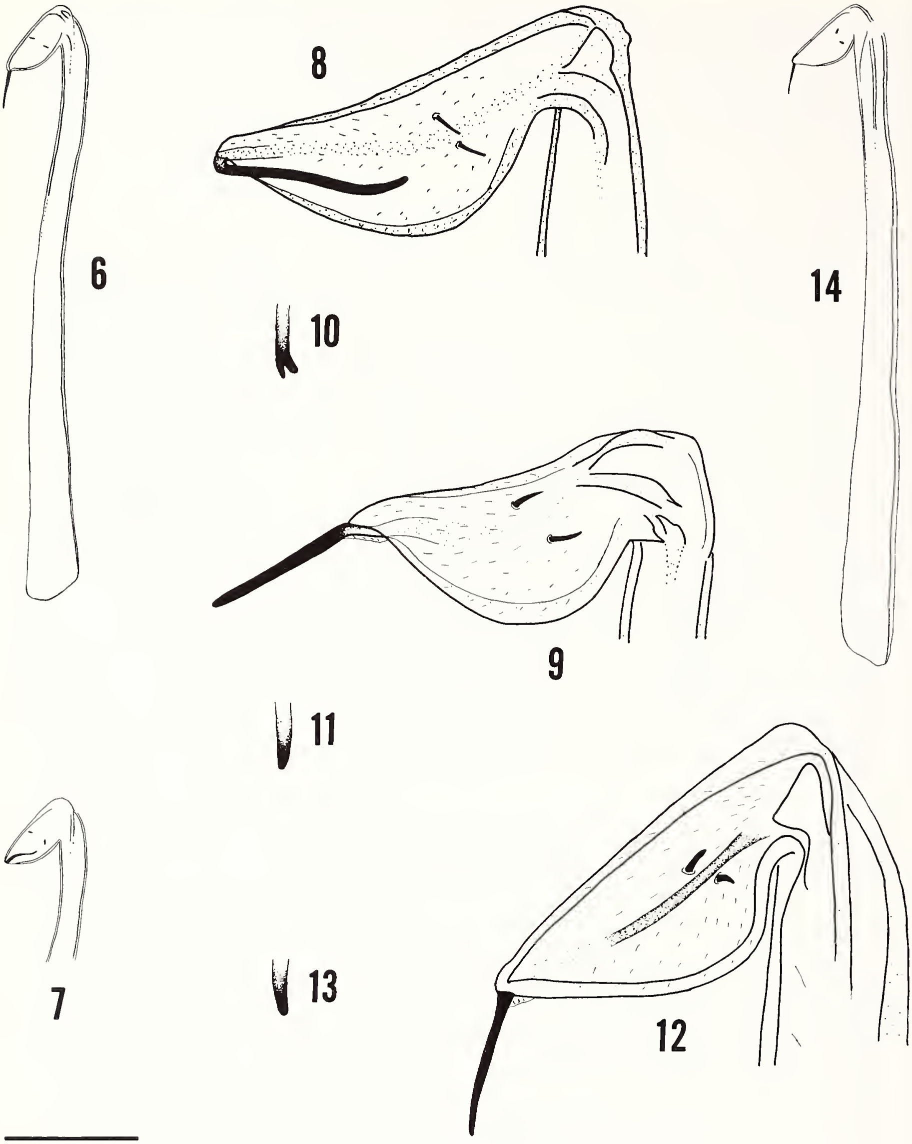
Leptobunus californicus Banks
Figs. 1, 6–10, 22–24, 36–41, 59, 60, 63

Leptobunus californicus Banks, 1893:210, 1901:674, 1904:362, 1911:420; Roewer, 1910:270, 1923:877; Comstock, 1940:72; Goodnight and Goodnight, 1942b:14; Cokendolpher, 1980:134.

Leptobrunus californicus: Myers, 1921:19 (*lapsus calami*).

Liomitopus laevis Schenkel, 1951:49, fig. 47; Forcart, 1961:53.

Types. Female holotype of *Leptobunus californicus* in Nathan Banks Coll., MCZ, examined. Banks (1893) stated that the specimen was collected by Davidson in southern California and later (1904) stated that Davidson collected the specimen but restricted the locality to Los Angeles. As no further material of this species has been collected in southern California, and because the type vial is simply labeled "Cal.," I believe the type locality was erroneously designated and restricted. As *Liomitopus laevis* is the only synonym, I choose its type locality as that of *L. californicus.* Male



Figs. 6–14. Male genitalia of *Leptobunus* spp. 6–11. *L. californicus.* 6. Lateral view penis. 7–9. Distal ends of penes, lateral views. 10, 11. Glans setae. 12–14. *L. borealis.* 12. Distal end of penis, lateral view. 13. Glans seta. 14. Lateral view penis. Scale line = 0.50 mm for Figs. 6, 7, 14; 0.12 mm for Figs. 8, 9, 12; 0.03 mm for Figs. 10, 11, 13.

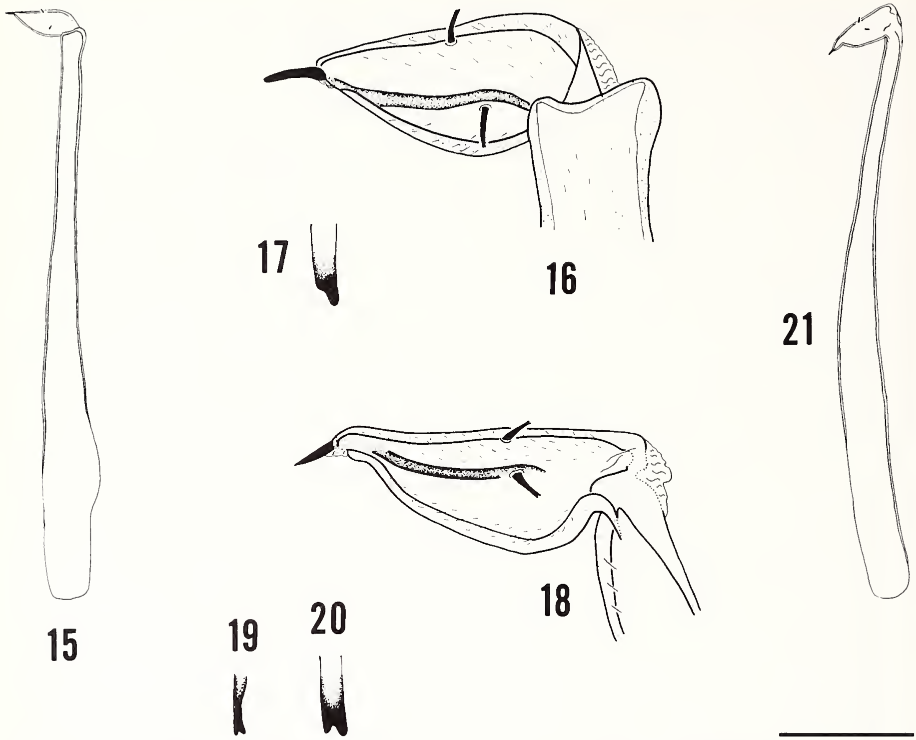
lectotype and female paralectotype of *Liomitopus laevis* from Yosemite, Mariposa Co., California, 29 Dec. 1938 (H. Schenkel-Rudin), NMB no. 81-a, examined.

Diagnosis and comparisons. Leptobunus californicus can be separated from *L. borealis* and *L. pallidus,* the other members of its group, on the basis of differences in genitalia and male palpi and number of tibiae II pseudosegments.

Distribution. Eastern portion of central California and adjoining Nevada (Fig. 63).

Description. Males: Total length 3.34–5.41, greatest width 2.75–3.82, maximum height 1.80–2.50; body creamy white to light yellowish-brown (rarely silvery white) with brown central pattern; central pattern with considerable spotting and splotches (Fig. 1). Ocular tubercle length 0.43–0.51, width 0.46–0.55, height 0.20–0.24, distance from anterior edge of cephalothorax 0.32–0.40; concolorous with dorsum of cephalothorax, except anterior border shaded dark brown; black ring encircling eyes, ring extended slightly anteriorly. Venter creamy white, always lighter than dorsum; with some brown mottlings on lateral margins posteriorly; anal operculum brown with white splotches. Chelicerae (Figs. 40, 41) yellow brown with no marking, teeth and tips of fingers dark brown to black; moveable fingers lacking apophyses. Palpi light yellow brown with light brown shading on distal ends of femora; faint longitudinal brown line on dorsum and brown splotches (often lacking on lateral surfaces of patellae); tibiae with (at most) a dark spot on dorsoproximal tip; tarsi darkened on distal tip; tibiae and tarsi noticeably enlarged ventrally and ventromesally (Figs. 36, 37, 59, 60). Palpal segment lengths: femora 0.96–1.22, patellae 0.48–0.65, tibiae 0.70–0.81, tarsi 1.24–1.35. Legs yellowish-brown to creamy light brown. Coxae unmarked. Femora with extreme basal end, dorsal and lateral distal tips, and subdistal region white; area between subdistal and distal white regions dark brown; basal ¾ shaded brown distally. Patellae subdistally shaded dark brown, extreme distal end white, basal end yellowish-brown. Tibiae I, III, IV with subbasal and subdistal dark brown bands; II with subdistal dark brown band and brown shading on proximal sides of pseudosegment junctions. Tarsi shaded brown at pseudosegment junctions. Metatarsi I with single pseudosegment; tibiae II with 2–3 (commonly 3) pseudosegments; tibiae IV lacking pseudosegments. Femora I–IV lengths (respectively): 3.77–4.06, 7.90–8.20, 4.30–4.46, 5.64–6.20; tibiae I–IV lengths (respectively): 3.27–3.52, 6.03–6.41, 3.40–3.50, 4.09–4.70. Penis (Figs. 6–11) with glans slightly concave dorsally; glans primary setae simple or bifurcate, spaced approximately one setal length apart or slightly more, setae much shorter than stylus length.

Females: Total length 5.31–7.31, greatest width 3.50–4.53, maximum height 2.00–4.18; generally larger and more robust than males, with more distinct and darker color patterns, except basal bands on leg femora and basal bands on tibiae II absent or greatly reduced. Leg coxae often with mottlings, lacking distal band; palpal tibiae rarely with brown line (faint when present). Ocular tubercle length 0.38–0.50, width 0.45–0.60, height 0.18–0.26, distance from anterior edge of cephalothorax 0.30–0.42. Palpal segment lengths: femora 0.90–1.02, patellae 0.51–0.65, tibiae 0.69–0.84, tarsi 1.21–1.50. Metatarsi I with 0–2 (rarely 0) and tibiae II with 2–4 (averaging 3) pseudosegments, tibiae IV lacking pseudosegments. Femora I–IV lengths (respectively): 2.72–4.19, 6.60–8.50, 3.00–4.53, 4.53–6.67; tibiae I–IV lengths (respectively): 2.45–3.48, 4.65–6.80, 2.49–4.51, 3.19–4.42. Ovipositor (Fig. 22) with considerable variation in ring segment counts: the five examined with 19, 23, 30, 32, and 35 rings



Figs. 15–21. Male genitalia of *Leptobunus* spp. 15–17. *L. aureus.* 15. Lateral view of penis. 16. Distal end of penis, lateral view. 17. Glans seta. 18–21. *L. parvulus.* 18. Distal end of penis, lateral view. 19, 20. Glans setae. 21. Lateral view penis. Scale line = 0.50 mm for Figs. 15, 21; 0.12 mm for Figs. 16, 18; 0.03 mm for Figs. 17, 19, 20.

each; furca 3 segmented (one female from Norden, California, with 4 segmented furca; distal two joints normal, first joint split in two on both sides). Slit sensilla generally 2–2 (range 1–2 to 4–4) per side on furca segment II. Seminal receptacles with long, often convoluted, primary loops and three basal loops (Figs. 23, 24).

Immatures: As adult females, except leg femora II and IV lacking proximal brown bands; palpi often white to light yellowish-brown, generally without markings.

Natural history. Adults are known from late June to late September, and a single collection on 29 December. The majority of collections are from August. Juveniles (later instars) are known from late June to late September. Several of the females collected during August are filled with eggs. A dozen eggs from two different individuals average 0.54 mm in size (range 0.40–0.68 mm). Specimens have been collected at altitudes from 1,850 to 3,350 m, almost all from 2,350–2,450 and 2,900–3,100 m. In general, the more northern localities are at lower elevations. The few collections that were labeled as to habitat indicated that adults and immatures were beneath rocks, from crevices in large granite rocks, and were on snow at night (during

June). This species appears to be restricted to the Sierra District (Schick, 1965) of the Sierra Nevadan Biotic Province.

Specimens examined. **U.S.A.** CALIFORNIA: *Placer Co.,* Norden, 5 Aug. 1951 (J. F. Gustafson), 3 females (AMNH); *Tuolumne Co.,* Sonora Pass, 26 Aug. 1965 (V. Lee), 2 immatures (CAS), Sonora Pass Summit, 26 Aug. 1965 (V. Lee), 1 female (CAS), 4.8 km W Sonora Pass, 14–16 Aug. 1966 (R. R. Snelling), 1 immature (LACM), Tioga Pass, Yosemite Park, 8-10-1931 (W. Ivie), 3 females (AMNH); *Madera Co.,* Lake Ediza, 2 Aug. 1951 (P. Raven), 1 female (CAS); *Inyo Co.,* South Lake, Bishop Creek, 17 Aug. 1941 (W. M. Pearce), 3 females (AMNH), Mirror Lake, 14 Aug. 1953 (W. McDonald), 1 female (AMNH); *Mono Co.,* E slope White Mountain, 27 June 1979 (D. H. Kavanaugh), 1 female, 3 immatures (CAS), E shore Silver Lake, 8 Aug. 1957 (R. Casebeer), 1 female (LACM), Sawmill Campground, 6.5 km N of Tioga Pass, 30 July 1980 (C. Griswold), 1 immature (UCB), Big Bend Campground, 8 km W Lee Vining, 21 Sept. 1961 (W. Ivie and W. J. Gertsch), 1 female (AMNH); Wildyrie, Mammoth Lakes, 18 Aug. 1941 (W. M. Pearce), 2 males, 2 females (UCR); *Mariposa Co.,* Yosemite, 29 Dec. 1938 (H. Schenkel-Rudin), lectotype male, paralectotype female (NMB), Yosemite Creek Camp, Yosemite Park, 18 Sept. 1941 (W. Ivie), 1 immature (AMNH); *Nevada Co.,* Sagehen Creek, 12.9 km N Truckee, 21 July 1966 (G. B. Wiggins), 1 female (ROM); *Alpine Co.,* Silver Creek, 14.5 km SW Markleeville, 26 July 1980 (T. C. Meikle and C. Griswold), 1 male, 2 females (UCB); *Fresno Co.,* Inyo National Forest, John Muir Wilderness, Cascade Valley, 7 Aug. 1972 (V. F. Lee), 1 male, 1 female (CAS); *Fresno Co.,* Graveyard Meadows, 12 Aug. 1959 (B. Firstman), 13 males, 3 females, 4 immatures (AMNH), Graveyard Lakes, 13 Aug. 1959 (B. Firstman), 1 male, 1 female, 2 immatures (AMNH), Anne Lake, 15 Aug. 1959 (B. Firstman), 1 female (AMNH), Olive Lake, 16 Aug. 1959 (B. Firstman), 3 females, 2 immatures (AMNH), locality uncertain—"Southern California," pre-1893 collection (Davidson), holotype female (MCZ). NEVADA: *Washoe Co.,* Mt. Rose, 2.4 km W Pass Summit, 27 Aug. 1969 (H. B. Leech), 3 males, 2 females (CAS).

Leptobunus borealis Banks
Figs. 2, 12–14, 25–27, 42, 43, 57, 58, 61

Leptobunus borealis Banks, 1899:350, pl. a, fig. 7, 1900b:484, 1901:674, 1911:420, 1923:238; Roewer, 1910:271, 1923:877, fig. 1,039; Redikorzev, 1936:33; Comstock, 1940:72; Staręga, 1978:209; Strand, 1906:473.

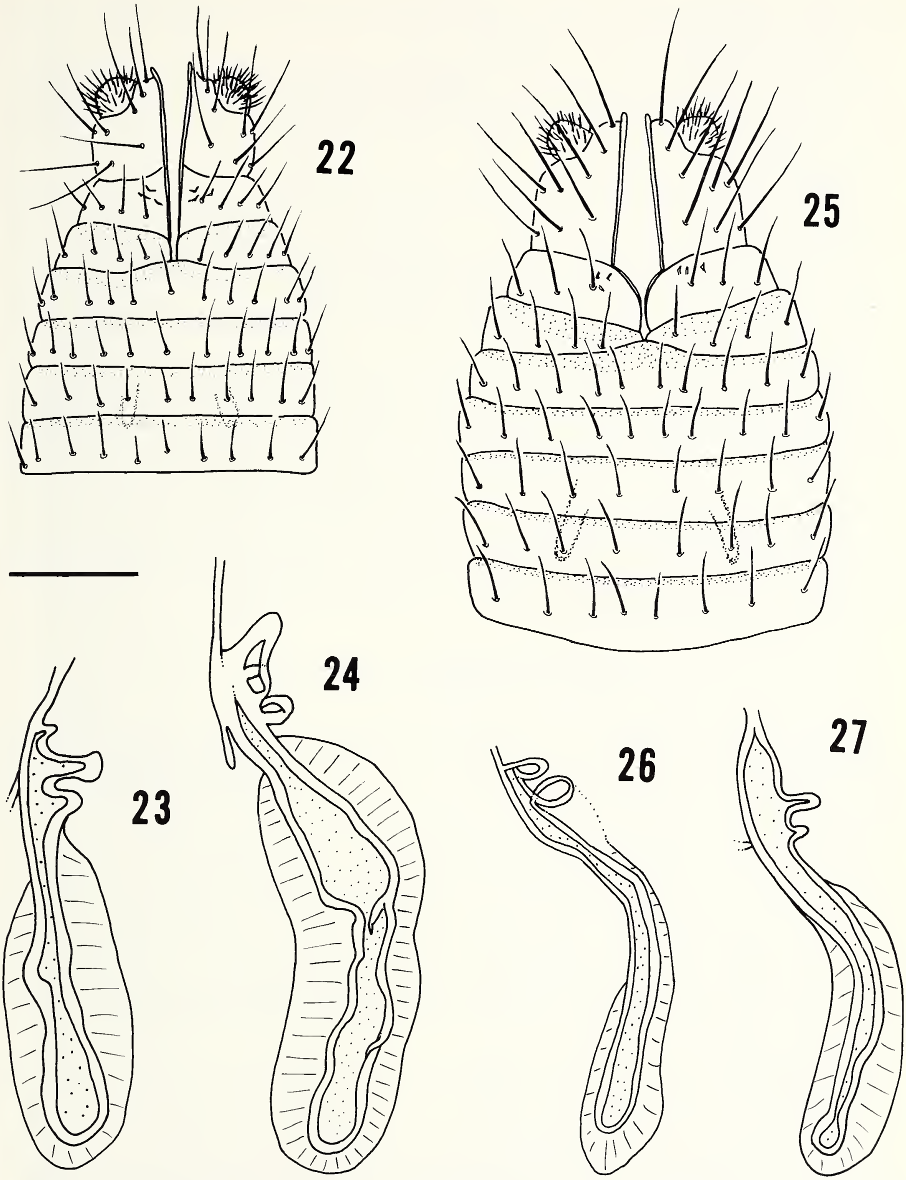
Types. Banks (1899) based his description on "several specimens" collected on Bering Island and Copper Island. In the description he attributes measurements to a male and female, but from his description of the palpi and his illustration there is no doubt he examined only females and immatures. Only a female and three immatures of the original type series are still available. This series collected on Bering Island, July–Aug. 1897, by Barrett-Hamilton is clearly labeled in Banks' handwriting "*Leptobunus borealis* Bks Type." The vial also contains a label "Type No. 4060 U.S.N.M." which corresponds to the data given by Banks. As no single specimen was designated as the holotype, I hereby designate the adult female as the lectotype and three immautres as paralectotypes.

Diagnosis and comparisons. In addition to differences in the genitalia and male palpi noted in the key, *L. borealis* can be distinguished from *L. californicus* by its shorter legs.

Distribution. Komandorskiye Ostrova of U.S.S.R., Aleutian Islands, Pribilof Islands and southern Alaska of U.S.A. (Fig. 61).

Description. Males: Total length 3.56–4.12, greatest width 2.89–3.50, maximum height 2.07–2.27; dorsum white to creamy white with extensive dark brown markings, those on cephalothorax appearing velvety; abdomen with pattern of cross with many white spots and splotches, area surrounding cross mottled with brown splotches and rows of brown dots (Fig. 2). Ocular tubercle length 0.35–0.40, width 0.37–0.42, height 0.18–0.19, distance from anterior edge of cephalothorax 0.30–0.31; brown with dark ring encircling eyes, paler half ring on areas dorsal to dark eye ring. Venter white to light tan, with two dark brown spots at base and posterior to base of genital operculum; row of brown spots on anterior areas of sternite junctions (less distinct on the most posterior sternites) and lateral margins of all sternites shaded brown (lighter in color than spots). Leg coxae yellowish-brown, mottled with brown, distally shaded to indistinct brown band. Chelicerae (Figs. 42, 43) with basal segment creamy yellowish-white; distal segment light yellow brown; both segments with light brown mottlings on lateral surfaces; teeth and tips of fingers black; moveable fingers lacking apophyses, rarely with slight "bump" (Fig. 43). Palpi yellow brown with darker brown markings on distodorsal surfaces of femora, lateral and mesal surfaces of patellae and tibiae, and semidistinct line down patellae and proximal ⅔ to ¾ of tibiae dorsally; basal portion of tarsi enlarged (Figs. 57, 58). Palpal segment lengths: femora 0.90–0.94, patellae 0.56, tibiae 0.68–0.73, tarsi 1.18–1.23. Legs yellowish-brown to tan; femora with distal dark brown leg bands, extreme distal ends white dorsally on lateral regions, often with indistinct subdistal white band; patellae mottled with brown except for thin light line dorsally; all tibiae with brown bands (often indistinct) distally, I, III, IV with a second brown band on proximal ⅓, extreme proximal end tan to yellowish-white; dorsa of tibiae I, III, IV (rarely II) with faint light brown lines; tarsi and metatarsi pseudosegment junctions shaded brown; metatarsi I and tibiae II both with single pseudosegments, tibiae IV lacking pseudosegments. Femora I–IV lengths (respectively): 2.63–2.67, 4.62–5.18, 2.94–3.10, 4.25–4.57; tibiae I–IV lengths (respectively): 2.30–2.42, 3.92–4.16, 2.42–2.48, 3.15–3.25. Penis with glans dorsum straight to slightly convex (Figs. 12–14); primary setae of glans simple, approximately one setal length apart; setae much shorter than stylus.

Females: Total length 5.27–6.02, greatest width 3.20–4.28, maximum height 2.60–3.27; similar to males except ocular tubercle lighter in color, creamy white; leg femora and tibiae have more brown splotches; leg coxae and trochanters of some females with considerable amount of brown splotches and mottlings. Ocular tubercle length 0.40–0.46, width 0.40–0.41, height 0.19–0.23, distance from anterior edge of cephalothorax 0.28–0.41. Palpal segment lengths: femora 0.82–1.00, patellae 0.51–0.60, tibiae 0.59–0.75, tarsi 1.11–1.28. Metatarsi I with single pseudosegment (one specimen had 2), tibiae II with one pseudosegment (rarely 2 or 3), tibiae IV lacking pseudosegments. Femora I–IV lengths (respectively): 1.92–2.48, 3.80–4.46, 2.30–2.80, 3.21–4.11; tibiae I–IV lengths (respectively): 1.90–2.33, 3.19–4.00, 1.98–2.54, 2.58–3.08. Ovipositor (Fig. 25) with considerable variation in furca II slit sensilla counts; range 2–6 per side, counts of 3–3/6–4 and 5–4/5–4 not uncommon; the single



Figs. 22–27. Female genitalia of *Leptobunus* spp. 22–24. *L. californicus.* 22. Distal end ovipositor. 23, 24. Seminal receptacles. 25–27. *L. borealis.* 25. Distal end of ovipositor. 26, 27. Seminal receptacles. Scale line = 0.22 mm for Figs. 22, 25; 0.05 mm for Figs. 23, 24, 26, 27.

ovipositor examined with 29 rings, 3 segmented furca. Seminal receptacles (Figs. 26, 27) with long primary loop and two basal loops.

Immatures: Essentially as in adult females, except body more gray than brown; leg femora with distinct dark band on distal end and single dark band at midpoint; chelicerae uniformly grayish-yellow brown; leg coxae and chelicerae lacking splotches and mottlings.

Natural history. Specimens from the present study were all collected during July and August. Banks (1923) reported that this species was common on the Pribilof Islands from the first of June until "fall." Five females collected during the later part of July were filled with large eggs. Collections from Homer, Alaska, were from "drift" on beach at high tide along with juveniles of the harvestman *Sabacon* sp. *Leptobunus borealis* is apparently restricted to the maritime subarctic, occurring from sea level to approximately 300 m in elevation.

Specimens examined. **U.S.S.R.** KOMANDORSKIYE OSTROVA: Bering Island (=Behrings om̃), 14–19 August 1879 (Vega Expedition no. 1079), 1 female (NHR), July–August 1897 (Barrett-Hamilton), lectotype female, 3 immature paralectotypes (USNM type no. 4060). **U.S.A.** ALASKA: Andreanof Islands, Atka Island, 28 July 1907 (E. C. VanDyke), 3 males, 5 females (CAS); Adak Island, 4 July 1948 (I. Newell), 1 penultimate male (AMNH); Pribilof Islands, St. Paul Island, 1899 (T. Kincaid), 2 subadults (BMM), 10 August 1919 (G. D. Hanna), 3 females (CAS); Homer, 20–25 July 1945 (J. C. Chamberlin), 3 females, 1 immature (AMNH).

Leptobunus pallidus, new species
Figs. 3, 28, 29, 44, 45, 55, 56, 61

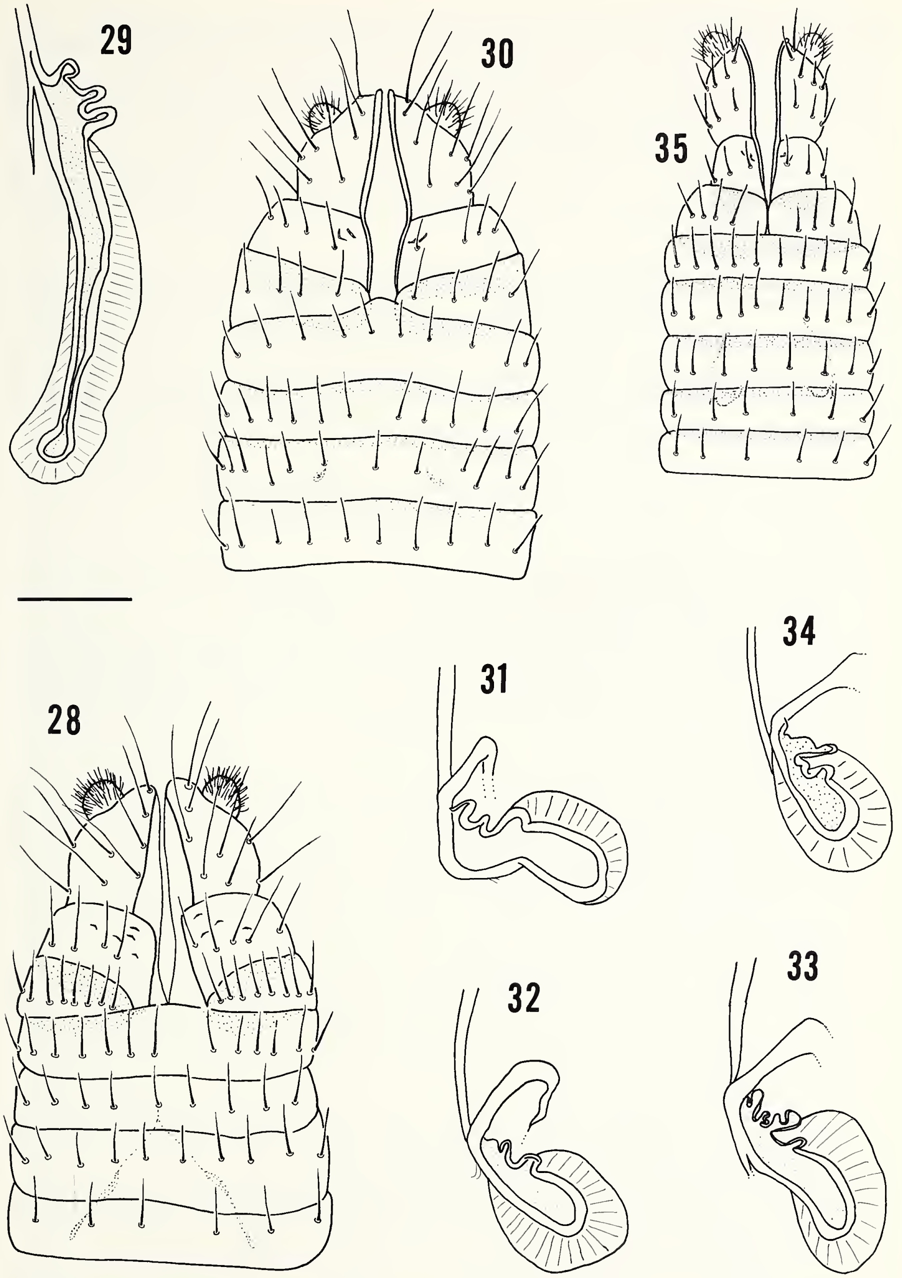
Types. Female holotype and two immature (female? and male) paratypes from Bering Island, Komandorskiye Ostrova, U.S.S.R., 14–19 August 1879 (Vega Expedition), NHR.

Etymology. The specific epithet from Latin, referring to the pale color of the body.

Diagnosis and comparisons. Leptobunus pallidus is a member of the *californicus* group. In addition to the differences in the genitalia noted in the key, *L. pallidus* differs from other *Leptobunus* spp. by the increased number of setae on the 1st furcal joint of the ovipositor. The lack of pseudosegments on metatarsi I and tibia II will also serve to separate *L. pallidus* from other members of the genus, but the lack of pseudosegments on metatarsi I is also characteristic of many immatures of other species in the genus.

Distribution. Known only from Komandorskiye Ostrova of U.S.S.R. (Fig. 61), where *L. borealis* also occurs.

Description. Female: Total length 5.35, greatest width 2.86, maximum height 2.90; body creamy white to yellow white; dorsum with light brown pattern, interrupted with scattered white spots (Fig. 3). Ocular tubercle length 0.40, width 0.45, height 0.15, distance from anterior edge of cephalothorax 1.27; white with light brown rings around eyes. Coxae, genital operculum, and abdominal sternites creamy white. Chelicerae light yellow brown with dark brown teeth. Palpi whitish-yellow to light yellow brown, without markings. Palpal segment lengths: femur 0.80, patella 0.51, tibia 0.69, tarsus 1.26. Legs whitish-yellow to light yellow brown with faint bands of brown on distal ends of femora, dorsum of patellae, and subdistal portions of tibiae; metatar-



Figs. 28–35. Female genitalia of *Leptobunus* spp. 28, 29. *L. pallidus.* 28. Distal end of ovipositor. 29. Seminal receptacle. 30–33. *L. parvulus.* 30. Distal end of ovipositor. 31–33. Seminal receptacles. 34, 35. *L. aureus.* 34. Distal end of ovipositor. 35. Seminal receptacle. Scale line = 0.22 mm for Figs. 28, 30, 35; 0.05 mm for Figs. 29, 31–34.

si I and tibiae II lacking pseudosegments. Femora I–IV lengths (respectively): 2.31, 3.90, 2.51, 3.69; tibiae I–IV lengths (respectively): 2.00, 3.85, 2.18, 2.69. Ovipositor consisting of 25 rings; furca 3 segmented, first furcal joint with greatly increased number of setae (Fig. 28), second joint with 3–5 slit sensilla per side. Seminal receptacles with three basal loops (Fig. 29).

Immatures: Similar to adult female, except dorsal pattern faint or lacking. Leg bands more distinct than in adult female. Subadult male (total length 3.60) with palpi only slightly modified (Figs. 55, 56). Moveable finger of chelicerae without apophysis (Figs. 44, 45).

Natural history. The only known specimens were collected during the middle of August on Bering Island. According to Danks (1981) the Commander Islands are steep mountainous islands of volcanic origin with peaks reaching nearly 1,000 m. The islands are very wet, and due to marine influences the climate is relatively mild for the latitude (55°N). The islands are primarily covered by forest-tundra vegetation.

Specimens examined. Only the type series.

Leptobunus parvulus (Banks), **New Combination**

Figs. 5, 18–21, 30–33, 46–48, 53, 54, 62

Liobunum parvulum Banks, 1894a:163.

Leuronychus parvulus: Banks, 1901:675, 1911:420; Roewer, 1910:273, 1923:879, 1957:356; Comstock, 1940:73; Holmberg et al., 1981:19.

Leuronychus pacificus: Roewer, 1910:273 (misidentification in part), 1923:879 (misidentification in part). Of the three male and two female *L. pacificus* (Banks) reported from Puget Sound (Tacoma, Washington) by Roewer, one is a male *L. parvulus* (Banks).

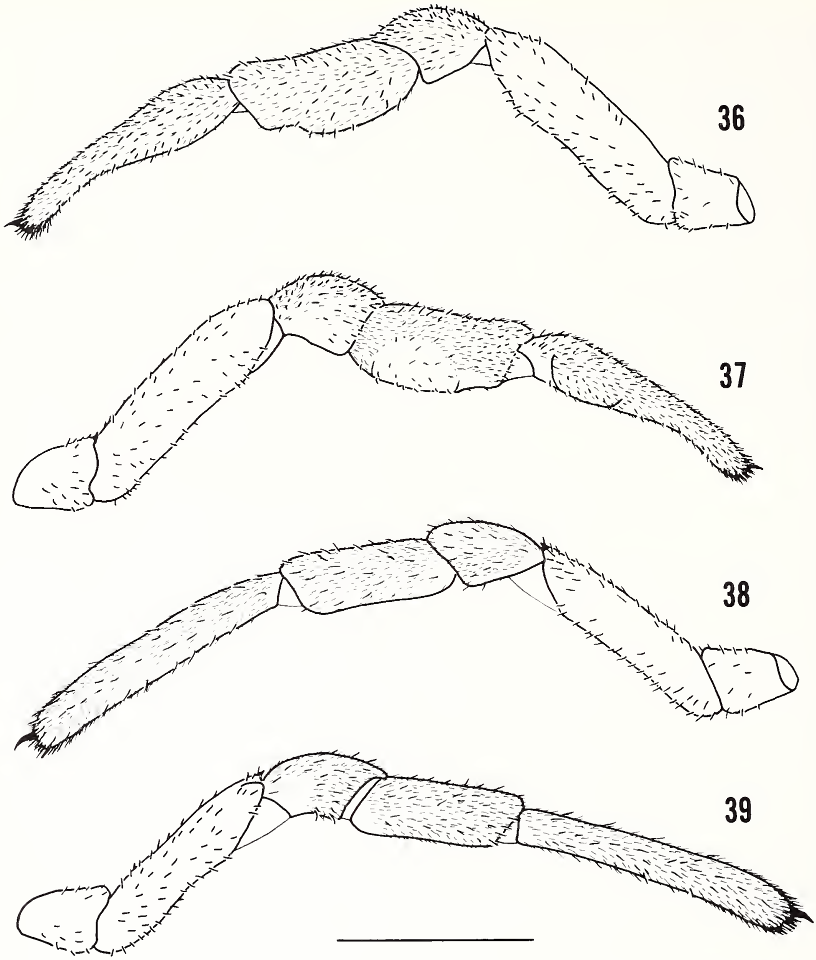
Types. The two male and one female syntypes from Olympia, Washington, described by Banks (1894a) in the Nathan Banks Coll., MCZ, examined. I designate the larger male (total length 3.72) as the lectotype and the smaller male (total length 3.45) and female as paralectotypes. The lectotype has been placed in a separate vial and labeled accordingly. The lectotype is missing both first legs whereas the male paralectotype is missing legs II and IV. I do not regard the female from Puget Sound (SMF no. 174), reported by Roewer (1923, 1957) as a cotype, as part of the original type series. When Banks described this species he mentioned only two males and one female from Olympia, none from Puget Sound. The vial with the female from the SMF bears the label: "*Leuronychus parvulus* 1 Expl. Banks Puget Sound Roewer det. 1910 No. 174."

Diagnosis and comparisons. Leptobunus parvulus is similar to *L. aureus*; these two form the *parvulus* group. In addition to the differences in the genitalia, *L. parvulus* can be distinguished from *L. aureus* by its larger size.

Distribution. Southeastern Alaska, western British Columbia, Washington, Oregon, and northern California in western North America (Fig. 62).

Description. Males: Total length 3.35–4.78, greatest width 2.43–3.18, maximum height 1.85–2.60; body generally whitish-yellow, but ranges from golden tan to opalescent white; often with many tiny white specks and larger white splotches. Abdomen with faint cross pattern of brown spots and splotches; pattern most distinct posteriorly with some opalescent spotting (Fig. 5). Some individuals with faint line indicating posterior edge of cross. Areas on each side of line are essentially the same, small brown mottlings with some opalescent spots. Posterior and lateral areas of abdomen often shaded dark brown with many white opalescent spots. Cephalothorax with many brown maculations. Scent gland pore often dark blue, encircled by black. Ocular tubercle length 0.37–0.41, width 0.40–0.43, height 0.13–0.22, distance from anterior edge of cephalothorax 0.22–0.32; whitish-yellow to opalescent white with black rings around eyes. Venter of abdomen yellowish-white to opalescent white with some light brown spots; few specimens with spots fused, forming line across sternite. Anal operculum generally brown without white spot. Coxae ranging from yellowish-white with no marks to yellowish-brown with many white reticulations, and broad subdistal brown bands, covering approximately ⅓ of coxae length; bands sometimes replaced by faint brown splotches on anterior and posterior margins distally. Chelicerae (Figs. 46–48) yellowish-brown with black teeth, noticeable spur on moveable finger. Palpi yellowish-brown; femora with either two subdistal brown splotches on sides or with subdistal dark brown band with distal white patches; patellae often with distodorsal brown splotches and two small brown specks on sides, occasionally with faint brown median line dorsally and less distinct brown lines on dorsolateral and dorsomesal margins; tibiae dark brown at base, shaded to yellow brown distally; tarsi unmarked, only slightly swollen basally (Figs. 53, 54). Palpal segment lengths: femora 0.88–1.16, patellae 0.47–0.62, tibiae 0.68–0.80, tarsi 1.13–1.39. Legs yellowish-white to light yellowish-brown with white rings on distal ends of all femora and tibiae, subdistally on patellae and a light stripe on dorsal surfaces of patellae; femora with broad subdistal rings of dark brown (varies from ⅓ to almost ¾ length), when brown rings are short followed by second white ring and lighter brown band (approximately ⅓ to ½ length from basal end); tibiae (except for II) banded as on femora, II with subdistal brown band ¼ to ⅛ its length and dark rings on basal half of each pseudosegment; patellae dark brown on median portion, yellowish-brown basally. Tarsi with brown rings on basal half of each pseudosegment; metatarsi I with 1 or 2 (rarely 2) pseudosegments, tibiae II with 2–6 (see comments under variation) pseudosegments, tibiae IV with 0–2 (generally lacking) pseudosegments. Femora I–IV lengths (respectively): 3.02–4.93, 5.78–9.88, 3.00–5.90, 4.36–8.30; tibiae I–IV lengths (respectively): 2.33–4.62, 4.63–6.80, 2.63–5.00, 3.18–6.62. Truncus of penis not noticeably enlarged basally (Figs. 18–21); primary setae of glans bilobed, approximately one setal length apart, setae subequal in length to stylus; distal end of glans constricted.

Females: Total length 4.59–6.82, greatest width 2.79–4.62, maximum height 2.50–3.84; body similar to male, more robust with darker colors and more distinct dorsal pattern. Some specimens bronze to silvery gold with dark brown patterns, and specks of gold on dorsum. Ocular tubercle length 0.40–0.46, width 0.39–0.50, height 0.11–0.20, distance from anterior edge of cephalothorax 0.24–0.40. Generally, brown dorsal lines distinct on palpal patellae and tibiae. Palpal segment lengths: femora 0.80–0.97, patellae 0.40–0.58, tibiae 0.59–1.00, tarsi 1.19–1.37. Legs as on males except basal portion of femora often light yellowish-brown and characteristic bands of males mottled with brown splotches; tarsi and metatarsi speckled with brown, often lacking bands. Metatarsi I with 1–3 (rarely lacking) pseudosegments, tibiae II with 3–7 (see comments under variation), tibiae IV without pseudosegments (rarely



Figs. 36–39. *Leptobunus californicus* palpi. 36. Male, lateral view. 37. Male, mesal view. 38. Female, lateral view. 39. Female, mesal view. Scale line = 1.0 mm.

one present). Femora I–IV lengths (respectively): 2.81–3.94, 6.18–9.40, 3.18–4.24, 4.89–6.80; tibiae I–IV lengths (respectively): 2.52–3.55, 5.20–6.42, 2.60–4.06, 3.68–4.64. Ovipositor with 24–30 darkly pigmented rings (N = 3); furca 3 segmented, 2nd joint with 1–4 (averaging 2, N = 14) slit sensilla per side (Fig. 30). Seminal receptacles (Figs. 31–33) with very short primary loop; basal loops very irregular (see comments under variation).

Immatures: Similar to adult females, except with body ranging from opalescent white with few marks to pale yellowish-white with dark brown patterns. The distinctive abdominal cross pattern is present on juveniles as small as 1.0 mm total length.

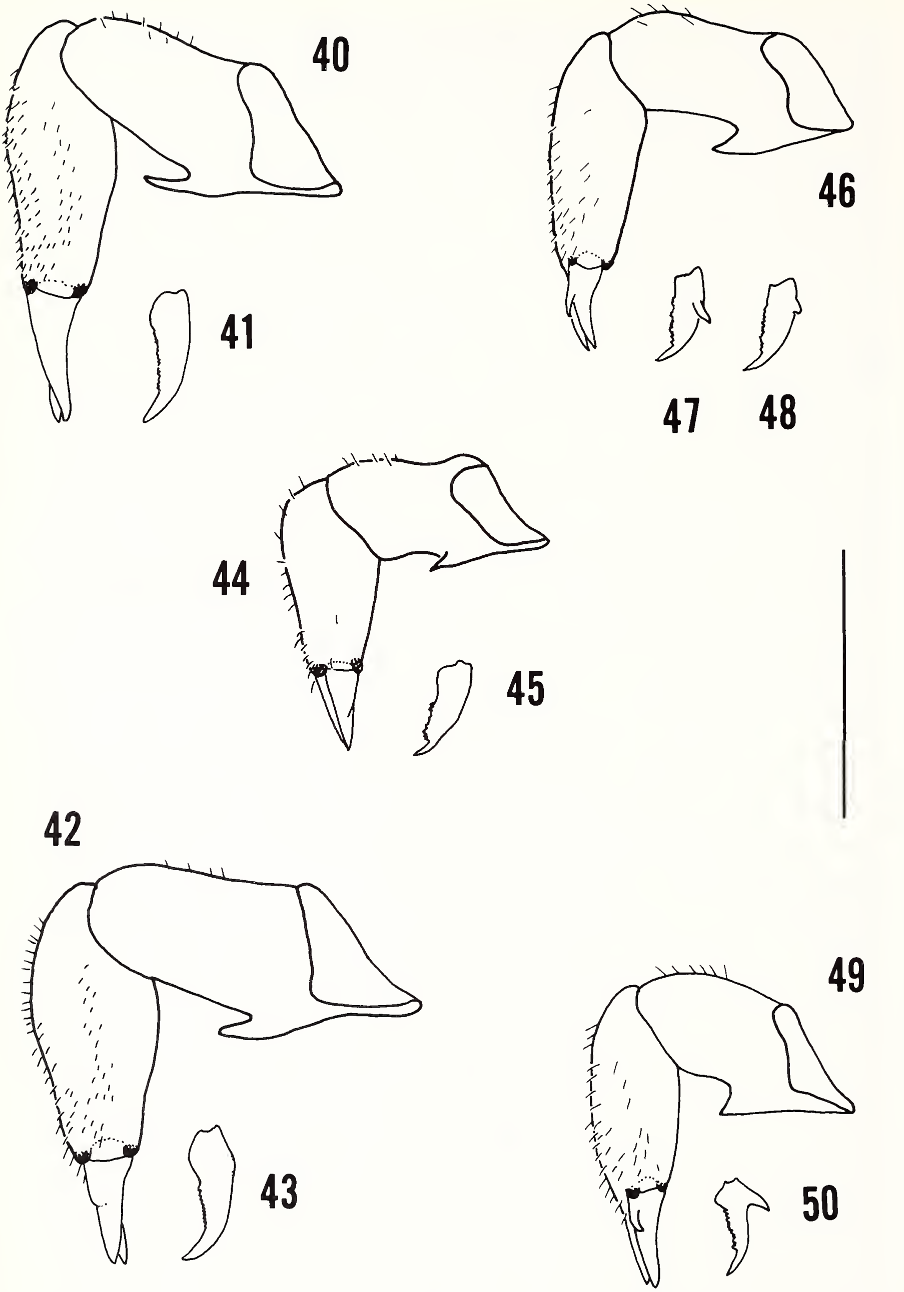
Variation. Throughout its range this species exhibits considerable variation in color and size. Leg pseudosegment counts and male chelicerae also differ between populations. Specimens from northern California, particularly Siskiyou Co., generally have slightly higher tibiae II pseudosegment counts: range 3–7, averaging 5. Specimens from central California, Oregon, and northwards average 3, range 2–5, tibiae II pseudosegments. The moveable finger of the chelicera is equipped with a large apophysis on males from Washington and Canada (Figs. 46–47), whereas males from Oregon and California generally have smaller apophyses (Fig. 48). The female seminal receptacles also vary considerably, but no geographical trends were noted except for the more convoluted basal loops on some females from central California (Fig. 33). It must be stressed, though, that these are only trends and cannot be relied upon for specific locality identifications. Specimens from Siskiyou County are particularly problematic and may represent a relict population.

Natural history. The majority of the collections of juveniles (all stages) and adults were made during August and September. Latitude does not seem to affect significantly the seasonal abundance of *L. parvulus.* A few collections are known from April to July, and October to December. Some females collected during September (California and British Columbia) were filled with eggs. A female collected and caged on 28 September (by PDB at Vancouver) laid 21 eggs (letter dated 8 June 1982 from Robert G. Holmberg, Athabasca University, Edmonton, Alberta).

Leptobunus parvulus appears to be restricted to the Sierra Nevadan Biotic Province of California (Schick, 1965) and the Vancouveran Province of Van Dyke (see Leech, 1972). Specimens have been collected from sea level (Alaska, Oregon, and British Columbia) to ca. 2,700 m elevation (central California). Throughout the range in California *L. parvulus* occurs under 2,700 m, Oregon under about 1,800 m, and under about 100 m further north. These are only general trends, though, as exceptions are known (i.e., Mt. Blunt, Alaska at 760–1,020 m).

Holmberg et al. (1981) reported that this species has been taken from the tops of 29 m tall cedar, fir, and hemlock trees. Those specimens were all juveniles and were collected during June, July, and August in British Columbia. The juveniles were collected at 20, 23, 26, and 29 m heights in Western Red Cedar (*Thuja plicata* Donn), Douglas Fir (*Pseudotsuga menziesii* (Mirb.) Franco), and Western Hemlock (*Tsuga heterophylla* (Raf.) Sarg.), and additional juveniles were also obtained at 17 m height in cedar (letter dated 8 June 1982 from Robert G. Holmberg, Athabasca University, Edmonton, Alberta). This species is commonly encountered on low branches and shrubs and on Alder trunks in forests of southern British Columbia (letter dated 8 June 1982 from Robert G. Holmberg, Athabasca University, Edmonton, Alberta). Specimen labels indicate that adults and immatures were also collected from the leaves or branches of *Abies grandis* (Dougl.) Lindl., *Picea* sp., *Pinus contorta* Dougl., *Quercus garryana* Dougl., *Gaultheria shallon* Pursh, and *Vaccinium occidentale* Gray. Two immatures were also collected from the fern *Polystichum,* and one of these had mature sporangia attached to two different leg tarsi.

Labels accompanying museum specimens indicate this species is active at night and is attracted by UV light. Specimens from Haines, Alaska, were found under “drift” on beach, whereas specimens in the Trinity Alps, California, were at snowfield edges.



Figs. 40–50. *Leptobunus* spp. male chelicerae. 40, 42, 44, 46, 49. Mesal views. 41, 43, 45, 47, 48, 50. Anterior views of moveable fingers. 40, 41. *L. californicus.* 42, 43. *L. borealis.* 44, 45. *L. pallidus,* subadult. 46–48. *L. parvulus.* 49, 50. *L. aureus.* Scale line = 1.0 mm.

Specimens examined. **U.S.A.** ALASKA: Glacier Bay Natl. Mon., Lituya Bay, Mt. Blunt, 8–9 Aug. 1979 (D. H. Kavanaugh), 1 immature (CAS); Haines, 20–24 Aug. 1945 (J. C. Chamberlin), 8 males, 3 females, 34 immatures (AMNH). WASHINGTON: *Thurston Co.,* Olympia, pre-1894 collection (T. Kincaid), lectotype male, male and female paralectotypes (MCZ), Tacoma, Puget Sound, 9 Sept. 1906 (Kpt. R. Paessler), 1 male (ZIZM); *Jefferson Co.,* Port Ludlow, Puget Sound, 12 Oct. 1907 (Kpt. R. Paessler), 1 female (ZIZM), Puget Sound, pre-1910 collection (Kpt. R. Paessler ?), 1 female (SMF); *Grays Harbor Co.,* Moclips, 25 Aug. 1981 (A. Moldenke), 1 immature (JCC). OREGON: *Polk Co.,* 12.8 km W Grande Ronde, 27 Nov. 1940 (W. Ivie), 1 female (AMNH); *Hood River Co.,* Mt. Hood, Still Creek, Still Creek Forest Camp, 28–29 Sept. 1966 (Wiggins, Yamamoto, Odum), 11 males, 4 females (ROM); *Benton Co.,* Parker Creek, Mary's Peak, 24 Sept. 1966 (Wiggins, Yamamoto, Odum), 5 males, 6 females, 1 immature (ROM), McDonald Experimental Forest, 13 Sept. 198?, 29 July 1981, 1 Sept. 1981, 16 Oct. 1981, 25 June 1982, 15 Sept. 1982, 24 Nov. 1982 (B. Fichter and A. Moldenke), 14 males, 9 females, 17 immatures (JCC), Lewisberg Saddle, 30 May 1981, 29 July 1981, 27 Aug. 1981, 16 Oct. 1981, 1 Nov. 1981, 25 June 1982 (B. Fichter and A. Moldenke), 13 males, 3 females, 61 immatures (ARM), Ballards Bay State Park, 24 Nov. 1981 (B. Fichter and A. Moldenke), 5 males, 3 females (JCC), Corvallis Chip Ross Park, 25 June 1982, 16 Aug. 1982 (A. Moldenke and B. Fichter), 4 immatures (ARM), Mary's Peak summit, 2 Oct. 1981 (B. Fichter and A. Moldenke), 1 female (ARM), Mary's Peak subsummit, 2 Sept. 1981, 2 Nov. 1981, 6 Aug. 1982, 2 Sept. 1982 (B. Fichter and A. Moldenke), 3 males, 8 females, 20 immatures (ARM); *Jefferson Co.,* head Metolius River, Riverside Forest Camp, 19–23 Sept. 1966 (Wiggins, Yamamoto, Odum), 4 males, 1 female (ROM), Spring Creek, 19–20 April 1952 (V. Roth), 1 female (CAS); *Lane Co.,* Honeyman State Park, 20 June 1966 (T. Briggs and V. Lee), 1 immature (CAS); Fairview Peak summit, 28 May 1981 (A. Moldenke), 17 immatures (ARM), Mutton Meadow, SE of Rigdon, 14 July 1981 (A. Moldenke), 2 immatures (ARM), Rujada Campground, 26 May 1981 (A. Moldenke), 1 immature (ARM), Neptune State Beach, 5 Aug. 1982, 10 Oct. 1982, 24 Nov. 1982 (B. Fichter and A. Moldenke), 2 males, 2 females, 9 immatures (JCC), Willamette National Forest, Sacandaga Campground, 15 July 1981, 21 Aug. 1982 (B. Fichter and A. Moldenke), 5 immatures (ARM), West Lake, 23 June 1982, 10 Oct. 1982 (B. Fichter and A. Moldenke), 7 males, 8 females, 12 immatures (ARM), Washburn State Park, 24 Oct. 1981, 24 June 1982, 5 Aug. 1982, 10 Oct. 1982 (B. Fichter and A. Moldenke), 6 females, 19 immatures (JCC), Andrews Experimental Forest, 11 July 1981, 2 Aug. 1981, 3–5 Sept. 1981, 13 Oct. 1981, 10–12 July 1982, 12–18 Aug. 1982 (B. Fichter and A. Moldenke), 11 males, 18 females, 62 immatures (JCC); *Deschutes Co.,* South Sister, 31 Aug. 1941 (B. Malkin), 1 female (AMNH), 32 km S of Sisters, 11 Sept. 1948 (Roth), 1 female (AMNH), Sisters Mtns., Green Lake, 28–30 Aug. 1952 (V. Roth), 1 male (CAS), Crescent Lake, 22 Aug. 1982 (A. Moldenke), 1 male (JCC); *Jackson Co.,* 32 km NE of Ashland, 1 Sept. 1959 (W. J. Gertsch and V. Roth), 1 immature (AMNH); *Klamath Co.,* Odell Lake, 30 Aug. 1981 (B. Fichter and A. Moldenke), 6 immatures (JCC); *Tillamook Co.,* Cascade Head, 5 Aug. 1982 (B. Fichter and A. Moldenke), 2 immatures (JCC); *Linn Co.,* Rooster R. Rock, 24 Oct. 1981 (B. Fichter), 1 female (JCC); *Coos Co.,* Brandon, 24 Nov. 1981 (B. Fichter and A. Moldenke), 1 male (JCC); *Lincoln Co.,* Gleneden Beach, 13 Sept. 1981, 24 June 1982, 5 Aug. 1982 (B. Fichter and A. Moldenke), 6 males, 5 females, 25 immatures (JCC), Cascade Head, N of Lincoln City, 18 June 1981, 13 Sept. 1982 (B. Fichter and A. Moldenke), 1 male, 2 females, 6 immatures (ARM); *Marion Co.,* Silver Creek Falls, July 1941 (J. C. Chamberlin), 1 immature (AMNH), Ochoco National Forest, Summit Campground, 11 June 1982 (B. Fichter and A. Moldenke), 1 immature (JCC). CALIFORNIA: *Del Norte Co.,* Middle Fork Smith River, 4 Sept. 1963 (J. and W. Ivie), 1 immature (AMNH); *Siskiyou Co.,* Trinity Alps, Caribou Basin (south rim), at snowfield edges, 12 Aug. 1980 (D. H. Kavanaugh), 1 immature (CAS), Panther Meadows, Mt. Shasta Ski Bowl, 2 Sept. 1959 (V. Roth and W. J. Gertsch), 5 males, 5 females (AMNH), Tule Lake, 14.4 km SW Tulelake, 15 Sept. 1965 (J. and W. Ivie), 6 immatures (AMNH), Paynes Creek, 8 km by road SE of Medicine Lake, 22 Aug. 1966 (H. B. Leech), 3 males, 1 female, 1 immature (CAS); *Plumas Co.,* S side Lake Almanor, 5 Sept. 1959 (V. Roth and W. J. Gertsch), 3 females, 2 immatures (AMNH); *Butte Co.,* Little Butte Creek, Toadtown, 4 April 1977 (C. L. Hogue), 1 female (LACM); *Sierra Co.,* 3.2 km N Calpine, 6 Sept. 1959 (W. J. Gertsch and V. Roth), 1 male, 1 female, 2 immatures (AMNH); *Placer Co.,* Squaw Valley, 20 Sept. 1961 (W. Ivie and W. J. Gertsch), 2 females (AMNH); *Eldorado Co.,* Fallen Leaf Lake, 9 Sept. 1959 (W. J. Gertsch and V. Roth), 1 male, 1 female (AMNH); *Tuolumne Co.,* Pinecrest, 10 Sept. 1959 (W. J. Gertsch and V. Roth), 1 male, 2 females (AMNH), Tamarak Flat, Yosemite Natl. Park, 11 Sept. 1959 (W. J. Gertsch and V. Roth), 1 male (AMNH); *Mariposa Co.,* 1.6 km S Fish Camp, 23 Sept. 1961 (W. Ivie and W. J. Gertsch), 1 female (AMNH). **CANADA.** BRITISH COLUMBIA: Queen Charlotte Islands, Masset, 1891-7-2-16-26 (J. H. Keen), 4 females (BMNH), W of Dawson Inlet, 29 Aug. 1961 (J3=), 1 immature (CNC), Alleford Bay (=Alliford Bay), 26 Aug. 1961 (collector unknown), 1 female (CNC), Vancouver Island, Coombs, spring 1979 (D. Salter), 1 male (JCC), Golden Ears Prov. Park, 2 Sept. 1973 (C. Holmberg), 1 female (RGH), Alouette Lake, 24 Aug. 1973 (R. G. Holmberg), 1 immature (RGH), Burnaby Mountain, Simon Fraser University, 16 Oct. 1971 (R. G. Holmberg), 1 male (JCC), 1 Oct. 1973 (R. G. Holmberg), 1 female (RGH), Point Gray, Vancouver, 18–28 May 1973 (J. R. Vockeroth), 1 immature (CNC), Vancouver, 25 Sept. 1965 (P. D. Bragg), 1 female (PDB), 14 Sept. 1968 (P. D. Bragg), 1 male (PDB), 28 Sept. 1968 (P. D. Bragg), 1 male (PDB), 28 Oct. 1968 (P. D. Bragg), 3 males (PDB), 23 Nov. 1968 (P. D. Bragg), 1 male (PDB).

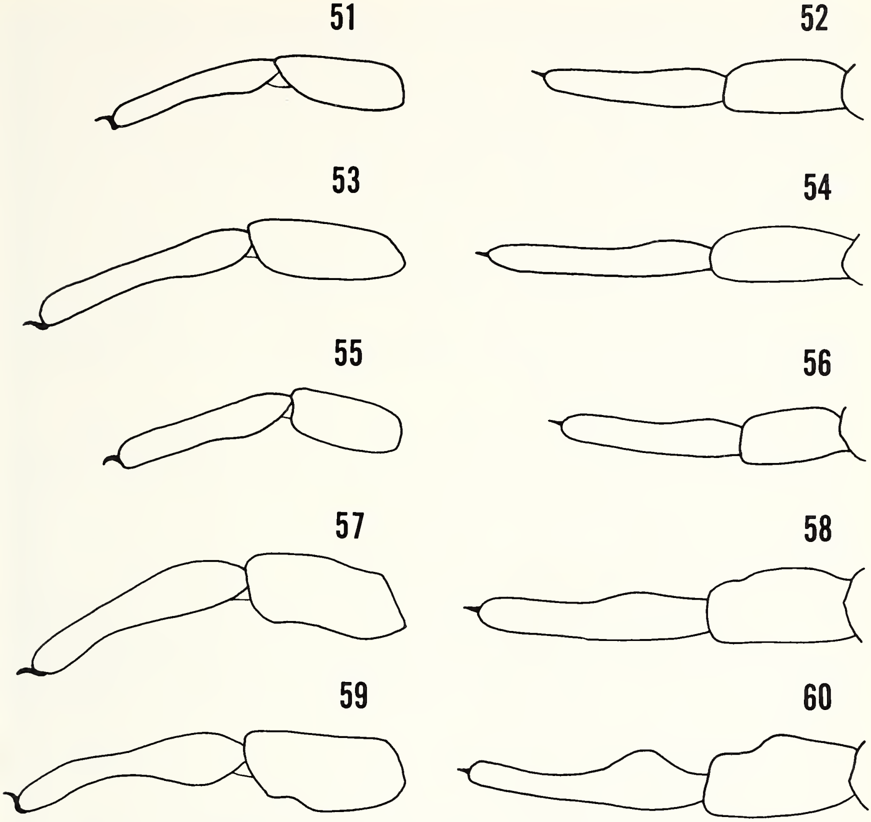
Leptobunus aureus, new species
Figs. 4, 15–17, 34, 35, 49, 52, 63

Types. Male holotype from Inverness, 60 m elev., Marin Co., California, 11–13 Jan. 1964 (P. H. Arnaud, Jr.), CAS; seven paratypes (listed under specimens examined).

Etymology. The specific epithet from Latin, referring to the golden color of the body.

Diagnosis and comparisons. Leptobunus aureus is one of two species in the *parvulus* group. In addition to differences in the genitalia, *L. aureus* can be distinguished from other *Leptobunus* spp. by its small size and golden color.

Distribution. Known only from Santa Cruz, Marin, and Mendocino Counties in California (Fig. 63).



Figs. 51–60. Tibiae and tarsi of male *Leptobunus* spp. palpi (semi-diagrammatic). 51, 53, 55, 57, 59. Lateral views. 52, 54, 56, 58, 60. Dorsal views. 51, 52. *L. aureus.* 53, 54. *L. parvulus.* 55, 56. *L. pallidus,* subadult. 57, 58. *L. borealis.* 59, 60. *L. californicus.*

Description. Males: Total length 2.90–3.15, greatest width 2.00–2.30, maximum height 1.56–1.77; dorsum light golden brown with dark brown velvety reticulations on cephalothorax, faint cross pattern on abdomen which is invaded by many golden brown and white spots, and last 4 to 5 distal tergites and anal operculum with creamy white stripe (Fig. 4). Ocular tubercle length 0.34–0.35, width 0.37–0.39, height 0.15–0.17, distance from anterior edge of cephalothorax 0.23–0.25; white with dark brown to black rings around eyes, rings thicker anteriorly and appearing elliptical. Coxae, genital operculum, and abdominal sternites creamy white to light yellow brown with numerous white blotches. Chelicerae silvery white to yellow brown, lateral surface of basal segment and proximal half of distal segment mottled with brown; basal portions of fingers yellow brown, tips of fingers and teeth dark brown to black; moveable finger with conspicuous spur (Figs. 49, 50), concolorous with finger. Palpi creamy white to light yellow brown; dark brown mottlings on femora dorsally; dark brown stripes on dorsum and basolateral half of patellae, proximal half of dorsum and basolateral ⅛ of tibiae; basal portion of tarsi only slightly enlarged (Figs. 51, 52). Palpal segment lengths: femora 0.73–0.79, patellae 0.37–0.40, tibiae 0.50–0.60, tarsi 0.94–0.98. Legs creamy white to light golden brown; femora with many randomly spaced brown splotches and irregular margined dark brown band on distal ends; patellae golden dorsally, margined on both sides with dark brown stripes interrupted by brown splotches; tibiae with dark brown bands distally, less distinct subbasal bands on I, III, IV; tarsal and metatarsal elements shaded brown basally; metatarsi I with one pseudosegment; tibiae II with 4 or 5 pseudosegments; tibiae IV with one pseudosegment (rarely lacking). Femora I–IV lengths (respectively): 3.00–3.25, 6.25–6.71, 3.30–3.50, 4.89–5.00; tibiae I–IV lengths (respectively): 2.58–2.70, 5.63–5.70, 2.56–2.67, 3.81–3.86. Penis (Figs. 15–17) with truncus slightly enlarged on subbasal surface ventrally; glans primary setae bilobed (often asymmetrically), spaced much further apart than stylus length, subequal in length to stylus; distal end of glans not noticeably constricted.

Females: Total length 5.00–6.81, greatest width 3.26–3.61, maximum height 3.11–3.21; body similar to male, darker with less golden color; dorsal cross pattern obscured by extensive brown splotching, white stripe on posterior end of abdomen and anal operculum much thinner but extends to base of cross pattern (stripe absent on Santa Cruz female). Ocular tubercle length 0.40–0.42, width 0.42–0.45, height 0.18–0.22, distance from anterior edge of cephalothorax 0.28–0.30. Palpal segment lengths: femora 0.81–0.83, patellae 0.42–0.48, tibiae 0.70–0.73, tarsi 1.17–1.20. Femora of legs with fewer brown splotches than male; distal brown bands distinct, margins less irregular. Leg pseudosegments as in males, except single female with 6/4 tibiae pseudosegments. Femora I–IV lengths (respectively): 3.15–3.75, 6.64–7.34, ?–3.74, 5.12–5.74; tibiae I–IV lengths (respectively): 2.80–2.94, 5.80–6.20, ?–2.87, 3.98–4.29. Ovipositor darkly pigmented, difficult to clear in clove oil, with 24–29 rings; furca 3 segmented, second joint with 1–3 (rarely 3) slit sensilla per side (Fig. 34). Seminal receptacle (Fig. 35) with very short primary loop; basal loops very irregular, loop constricting in size basally; basimesal tube undetected (lacking ?).

Immatures: Similar to adult female, except abdominal cross pattern distinct. One specimen with 1 and 3 pseudosegments in metatarsi I, all others have single pseudosegment; tibiae II with 3 pseudosegments; tibiae IV occasionally with 1 pseudosegment.

Natural history. Juveniles are known from late June and August, whereas adults are known from September to November. The majority of specimens were collected at 60 m elevation, but others are from 150 and 460 m. This species appears to be restricted to lowland forests of the lower Humboldtian and Santa Cruzian biotic districts of the Pacific Maritime Province (Schick, 1965). A female from Santa Cruz was captured by beating the branches of redwoods.

Specimens examined. Male holotype and female paratypes. **U.S.A.** CALIFORNIA: *Mendocino Co.,* Mendocino, 20 June 1955 (J. R. Helfer), penultimate female (UCB); *Marin Co.,* Inverness, 19 Oct. 1946 (E. S. Ross), 2 males (CAS), 11–31 Jan. 1964 (P. H. Arnaud, Jr.), 1 male (CAS), Lagunitas, 15 Sept. 1946 (E. S. Ross), 1 female (CAS), North Toll Bridge, Bolinas Ridge, 3.2 km NW Bolinas, 13 Aug. 1965 (V. Lee and T. Briggs), 2 immatures (CAS); *Santa Cruz Co.,* University of California, Santa Cruz Campus, 26 Nov. 1981 (A. Moldenke), 1 female (JCC).

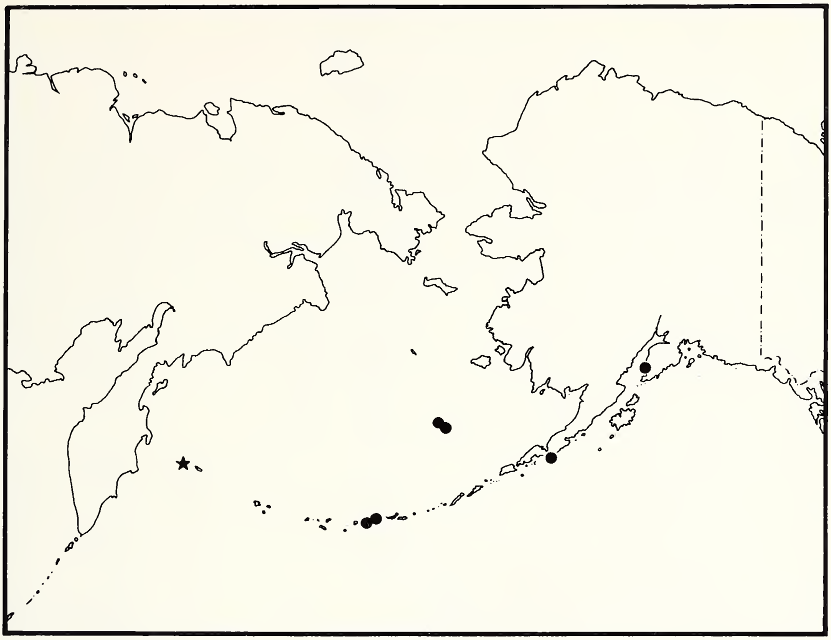


Fig. 61. Distribution of *Leptobunus* spp. in Mainland Alaska, and Aleutian and Bering Sea Islands. Circles = *L. borealis,* star = *L. borealis* and *L. pallidus.*

SYSTEMATIC RELATIONS AND HIGHER CATEGORIES

There has been confusion regarding the date of publication of the family-group name Leptobunidae in the past. Banks described *Leptobunus* in 1893 and placed it in the tribe Liobunini Banks. Roewer (1910, 1923) cited Banks (1894a) as the author of Leptobunini, and stated that it appeared on page 165. Šilhavý (1960) claimed Banks described it in 1893, and Rambla (1967) listed "Banks 1894." Nowhere in Banks (1893, 1894a) does the name Leptobunini appear; furthermore the latter article ends on page 164. Likewise, Banks (1894b, 1894c, 1898, 1899, 1900a, 1900b) did not mention the Leptobunini. The first reference to the tribe Leptobunini is Banks (1901). In that paper, Banks did not discuss the name, simply listing it in the key to the Phalangiidae. Nonetheless, Banks (1901) is to be credited with the establishment of the family-group name Leptobunini (Stoll, 1961, art. 16). Roewer (1910) was the first to diagnose and describe the "Leptobunini" as a subfamily. The following classification, proposed by Roewer (1910, 1923), has been essentially followed up to the present:

Family Phalangiidae Simon
Subfamily Leptobuninae Banks
Leptobunus Banks
Cosmobunus Simon

Protolophus Banks
Trachyrhinus Weed
Leuronychus Banks
Homolophus Banks

Recent studies of the harvestman subfamily Leptobuninae Banks (Leptobunidae of Rambla, 1977; Staręga, 1978; and Leiobunidae of Šilhavý, 1960, 1965, 1976) reveal that it is polyphyletic. This problem appears to be largely due to the hesitancy of recent workers to give up the use of some of the traditional characters used by Banks and Roewer to define taxa (see Roewer, 1923). Also the lack of comparative material of North American species in European museums has slowed progress towards a more natural classification. As noted by Cokendolpher (1981b), the "catch all" Leptobuninae must be dismantled with the type genus (*Leptobunus* Banks) being placed in the Phalangiidae (Phalangiinae). The complex species synonymies must await the publication of much needed generic revisions.

Traditionally, members of the "Leptobuninae" have been reported as having smooth palpal claws. Examination of numerous specimens reveals this is not entirely true. Apparently denticles are often overlooked (Asian species referred to *Homolophus* Thorell, some *Protolophus* Banks, *Leptobunus* Banks, and New World species referred to *Cosmobunus* Simon) or the claws reported as having only a few minute denticles on the base of the claw (*Leuronychus* Banks). In the genus *Protolophus,* palpal claw teeth may be present or absent in individuals of a single species. In some other cases, the immatures have well developed palpal claw teeth which presumably wear down or break off with age (see Suzuki, 1973). Additionally, two genera (*Trachyrhinus* Weed and *Cosmobunus*) have bare palpal claws but agree in all other details with members of the Gagrellidae (Leiobuninae and Gagrellinae), which characteristically have denticulate claws. "Atypical" palpal claws are also known in other subfamilies. Lawrence (1962) remarked on some of the problems with the African genus *Cheops* Soerenson. The North American genus *Liopilio* Schenkel (see Cokendolpher, 1981b) and the South American genus *Thrasychirus* Simon also have atypical palpal claws. The "Dentizacheinae" (=Phalangiinae) of Šilhavý (1960) likewise suggest the use of alternate characters as pointed out by Staręga (1973). Therefore, the presence or absence of denticles on the ventral surface of the palpal claw is of limited taxonomic use.

Traditionally, the lack of a cheliceral hook was used to characterize the subfamily Phalangiinae, but this character appears to be plesiomorphic. Martens (1978) maintained two species in the genus *Paroligolophus* Lohmander: *P. agrestis* (Meade) with a cheliceral hook, and *P. meadii* (Pickard-Cambridge) without it. Cokendolpher (1981b) pointed out the similarity of *Leptobunus* to *Liopilio,* but noted that *Leptobunus* always has a cheliceral hook, whereas in *Liopilio* the hook varies in size due to age and sex of the specimen, and may be entirely lacking. Thus, the presence or absence of a hook or tooth ventrally on the first joint of the chelicera is of restricted value.

The angle of insertion of the endites of coxa II is often difficult to ascertain. All genera referred to the Leptobuninae are reported as having the endites straight, parallel to the lip of the genital operculum. In reality, several of these genera have the endites slanted anteriorly as in the Phalangiinae. As the angle of insertion of the

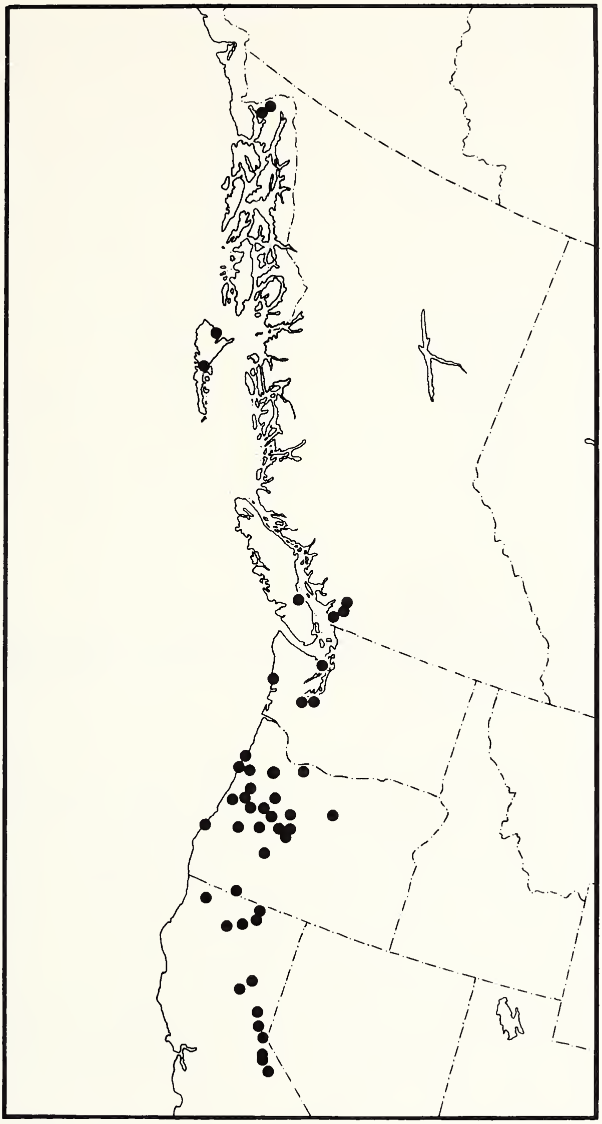


Fig. 62. Distribution of *Leptobunus parvulus* in western North America (Alaska to California).

endites is altered, to some extent, by the method of preservation and the age and sex of the animal, it should be used with great caution.

Comparative lengths of the legs has been used to distinguish genera in the Phalangioidea. Although often useful in verifying identifications, it should not be used as the

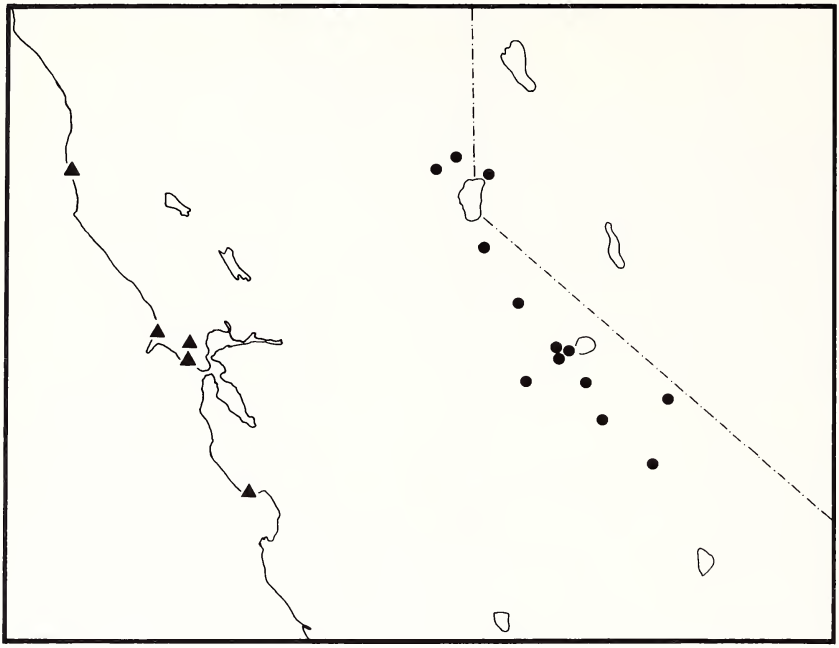


Fig. 63. Distribution of *Leptobunus* spp. in central California and western Nevada. Circles = *L. californicus,* triangles = *L. aureus.*

sole character to delineate taxa. Particularly problematic is the ratio of leg lengths to the body length. Although not as variable in males, female total length is greatly influenced by enlargement of the abdomen during feeding and reproductive periods. Traditionally, *Leptobunus* and *Leuronychus* have been separated by the lengths of the legs. As *Leptobunus* is now known to be a member of the Phalangiidae and *Leuronychus* a member of Gagrellidae, the use of leg lengths seems trivial. Unfortunately, up to now *Leuronychus parvulus* Banks has remained in the wrong genus, and, even though it has relatively long legs it is clearly a species of *Leptobunus.*

The following placements are tentative and may be altered after thorough taxonomic revisions have been completed. The family classification is essentially that of Šilhavý (1960), modified slightly based on descriptions of genital morphology by Martens (1978).

As already noted the genus *Leptobunus* is a member of the Phalangiinae (Phalangiidae). Members of the genus, as well as others incorrectly placed in the genus, are discussed earlier in this paper in the context of a generic revision.

Cokendolpher (1981b) reported that the monotypic East Asian genus *Tchapinius* Roewer is most similar to *Mitopus* Thorell. A revision of *Mitopus* currently underway will further document this affinity. Both genera are members of the Phalangiinae (Phalangiidae).

Leuronychus Banks is a member of the Leiobuninae (Gagrellidae). The Gagrellidae is equivalent to the Leiobunidae of some authors, but as noted by Staręga (1972), the latter name is a junior synonym. Presently, *Leuronychus pacificus* (Banks) is the only described species correctly placed in that genus. As pointed out by Cokendolpher (1980) *Leuronychus gertschi* Schenkel is a junior synonym of *Leiobunum exilipes* (Wood). Examination of the female type of "*Liobunum*" *fulviventris* O. Pickard-Cambridge revealed that Roewer (1910, 1923) erroneously referred this species to *Leuronychus*. This species is known only from two females which have been pinned and dried, so information on the genitalia is not available. Ultimate placement will have to await revisions of the New World species referred to *Leiobunum* C. L. Koch, *Nelima* Roewer, and *Paranelima* di Caporiacco. As already noted, *Leuronychus parvulus* Banks is properly a member of *Leptobunus*. At least two undescribed western North American *Leuronychus* species await formal description.

The genus *Homolophus* Banks is polyphyletic. Unfortunately, I have been unable to examine any specimens of the type species, *Homolophus arcticus* Banks. The New World *Homolophus biceps* (Thorell) is not congeneric with the Asian *Homolophus iranus* Roewer and *Homolophus afghanus* Roewer. Levi and Levi (1955) correctly synonymized *Togwoteeus granipalpus* Roewer with *H. biceps*. The *Homolophus* species known to me are properly members of the Leiobuninae (Gagrellidae).

Goodnight and Goodnight (1942a) revised the western North American genus *Protolophus* Banks; however, a new revision is needed because large series of additional specimens are now available. The genital morphology, presence of low abdominal tubercles and the position of the scent gland pores place it in the Sclerosomatinae (Gagrellidae). As this taxa differs some from typical Sclerosomatinae, the Protolophinae of Banks (1893) may have to be resurrected. Traditionally, the members of *Protolophus* have been diagnosed by the pedipalp segment lengths. *Protolophus longipes* Schenkel and often *Protolophus niger* Goodnight and Goodnight have the male palpal tarsus longer than the tibiae, whereas the male tarsus is shorter than the tibiae on all other *Protolophus* species. All immatures and females of *Protolophus* spp. examined have the palpal patellae extended on the inner margin, as well as a slight to moderate swelling on the inner distal margin of the palpal tibiae.

The Old World *Cosmobunus granarius* (Lucas) is not congeneric with New World species referred to *Cosmobunus*, but all are members of the Leiobuninae (Gagrellidae). New World species appear to be congeneric with a large complex of species presently referred to *Leiobunum*. Ultimate placement of Nearctic "*Cosmobunus*" must await a thorough taxonomic revision of New World species referred to *Leiobunum*. The Old World *Cosmobunus* were revised and redescribed by Rambla (1970).

Trachyrhinus was recently revised, and although Cokendolpher (1981a) did not state to which family *Trachyrhinus* belongs, the presence of pseudoarticulary nodules of femora II was noted. *Trachyrhinus* was subsequently transferred to the Gagrellinae (Gagrellidae) by Cokendolpher (1984a).

Staręga (1978) suggested that the North American genus *Globipes* Banks may be a member of the Leptobuninae. *Globipes* is properly a member of an assemblage of phalangioid genera which is as yet unnamed (Cokendolpher 1984b; Cokendolpher and Cokendolpher 1984).

The South American genus *Thrasychirus* Simon was referred to the Leptobuninae by Canals (1935). However, Šilhavý (1970) noted Ringuelet's (1959) synonymy of

Enantiobunus Mello-Leitão with *Thrasychirus,* and transferred *Thrasychirus* to the Enantiobuninae (Neopilionidae).

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LITERATURE CITED

Banks, N. 1893. The Phalanginae of the United States. Can. Entomol. 25:205–211.

Banks, N. 1894a. Washington Phalangida, with descriptions of a new southern *Liobunum.* Can. Entomol. 26:160–164.

Banks, N. 1894b. The Phalangida of New York. J. New York Entomol. Soc. 2:40–41.

Banks, N. 1894c. Notes on Phalangidae. J. New York Entomol. Soc. 2:145–146.

Banks, N. 1898. Some Mexican Phalangida. J. New York Entomol. Soc. 6:181–182.

Banks, N. 1899. Arachnida. Pages 347–350, pl. A *in:* W. H. Ashmead (ed.), Reports Upon the Insects, Spiders, Mites and Myriopods Collected by Dr. L. Stejneger and Mr. G. E. H. Barrett-Hamilton on the Commander Islands. Report on Fur-Seal Investigations 1896–1897, Pt. IV, Washington, D.C.

Banks, N. 1900a. New genera and species of American Phalangida. J. New York Entomol. Soc. 8:199–201.

Banks, N. 1900b. Papers from the Harriman Alaska expedition. XI. Entomological results (5): Arachnida. Proc. Wash. Acad. Sci. 2:477–486.

Banks, N. 1901. Synopses of North-American Invertebrates. XVI. The Phalangida. Am. Nat. 35:669–679.

Banks, N. 1904. Some Arachnida from California. Proc. Calif. Acad. Sci., 3rd ser. Zool. 3(13): 331–376; pls. 38–41.

Banks, N. 1911. The Phalangida of California. J. Entomol. Zool., Pomona College 3:412–421.

Banks, N. 1923. Arachnids. Pages 237–239 *in:* A Biological Survey of the Pribilof Islands, Alaska. II. North Am. Fauna No. 46.

Canals, J. 1935. Los Opiliones de Chile. Rev. Chil. Hist. Nat. 39:68–71.

Cockerell, T. D. A. 1907a. Some fossil arthropods from Florissant, Colorado. Bull. Am. Mus. Nat. Hist. 23:605–616.

Cockerell, T. D. A. 1907b. Some Coleoptera and Arachnida from Florissant, Colorado. Bull. Am. Mus. Nat. Hist. 23:617–621.

Cokendolpher, J. C. 1980. Comments on Opiliones described from western North America by Schenkel. Entomol. News 91(4):133–135.

Cokendolpher, J. C. 1981a. Revision of the genus *Trachyrhinus* Weed (Opiliones, Phalangioidea). J. Arachnol. 9:1–18.

Cokendolpher, J. C. 1981b. The harvestman genus *Liopilio* Schenkel (Opiliones: Phalangiidae). J. Arachnol. 9:309–316.

Cokendolpher, J. C. 1984a. A new genus of North American harvestmen (Arachnida: Opiliones: Palpatores). Pages 27–43 *in:* N. V. Horner (ed.), Festschrift for Walter W. Dalquest in Honor of his Sixty-sixth Birthday. Midwestern State Univ., Wichita Falls.

Cokendolpher, J. C. 1984b. Clarification of the Colombian harvestman genus *Carmenia,* with a review of the New World Gagrellinae (Opiliones: Gagrellidae). Florida Entomol. 67: 471–478.

Cokendolpher, J. C. and J. E. Cokendolpher. 1982. Tertiary harvestmen from the Florissant Formation, Colorado (Arachnida: Opiliones: Palpatores). J. Paleontol. 56:1213–1217.

Cokendolpher, J. C. and J. E. Cokendolpher. 1984. A new genus of harvestmen from Costa Rica with comments on the status of the Neotropical Phalangiinae (Opiliones, Phalangiidae). Bull. Br. Arachnol. Soc. 6:167–172.

Comstock, J. H. 1940. (Rev. and edited W. J. Gertsch.) The Spider Book. Comstock Publ. Co., Ithaca, 729 pp.

Danks, H. V. 1981. Arctic Arthropods. A Review of Systematics and Ecology with Particular Reference to the North American Fauna. Entomol. Soc. Can., Ottawa, 608 pp.

Forcart, L. 1961. Katalog der Typusexemplare in der Arachnida-Sammlung des Naturhistorischen Museums zu Basel: Scorpionidea, Pseudoscorpionidea, Solifuga, Opilionidea und Araneida. Verh. Naturforsch. Ges. Basel 72:47–87.

Goodnight, C. J. and M. L. Goodnight. 1942a. The genus *Protolophus* (Phalangida). Am. Mus. Novit. no. 1157, pp. 1–7.

Goodnight, C. J. and M. L. Goodnight. 1942b. Phalangida from Mexico. Am. Mus. Novit. no. 1211, pp. 1–17.

Goodnight, C. J. and M. L. Goodnight. 1945. Additional Phalangida from Mexico. Am. Mus. Novit. no. 1281, pp. 1–17.

Goodnight, C. J. and M. L. Goodnight. 1947. Phalangida from Tropical America. Fieldiana Zool. 32:1–58.

Holmberg, R. G., P. D. Bragg and J. Belicek. 1981. Opiliones (Arachnida) of western Canada: a progress report. Proc. Entomol. Soc. Alberta 28:19.

Kishida, K. 1930. A new system of the classification of the order Opiliones, with a key to the families. Lansania (Tokyo), 2(14):53–58.

Lawrence, R. F. 1962. LXXIV.—Opiliones. Resultats scientifiques des missions zoologiques de l'I.R.S.A.C. en Afrique orientale. (P. Basilewsky et N. Leleup, 1957). Ann. Mus. R. Afr. Cent. Ser. Zool. No. 110, pp. 9–89.

Leech, R. 1972. A revision of the Nearctic Amaurobiidae (Arachnida: Araneida). Mem. Entomol. Soc. Can. no. 84, pp. 1–182.

Levi, L. R. and H. W. Levi. 1955. Spiders and harvestmen from Waterton and Glacier National Parks. Can. Field-Nat. 69(2):32–40.

Martens, J. 1978. Spinnentiere, Arachnida. Weberknechte, Opiliones. Die Tierwelt Deutschlands. Gustav Fischer, Jena, Teil 64, 464 pp.

Myers, L. 1921. A list of California Arachnida. V. Phalangida or harvestmen. J. Entomol. Zool., Pomona College 13:19–22.

Pickard-Cambridge, F. O. 1905. Arachnida. Araneida and Opiliones. Biol. Cent. Am., Zool. 2:1–610.

Rambla, M. 1967. Opiliones de Portugal. Rev. Biol. (Lisb.) 6(1/2):1–34.

Rambla, M. 1970. La especie *Cosmobunus granarius* (Lucas 1847) en la Península Ibérica y Norte de Africa. Publ. Inst. Biol. Apl. Barcelona 48:81–105.

Rambla, M. 1977. Opilions (Arachnida) de les Cavitats de Sant Llorenç del Munt-Serra de l'Obac. Comun. 6^{e}Simpos. Espeleol. (Bioespeleol.), Terrassa pp. 9–16.

Redikorzev. V. 1936. Beiträge zur Opilioniden-Fauna von USSR. Tr. Zool. Inst. Akad. Nauk SSSR 3:33–57.

Ringuelet, R. A. 1959. Los Aracnidos Argentinos del Orden Opiliones. Rev. Mus. Argent. Cienc. Nat. Bernardino Rivadavia Inst. Nac. Invest. Cienc. Nat. Zool. 5:125–439; pls. I–XX.

Roewer, C. F. 1910. Revision der Opiliones Plagiostethi (=Opiliones Palpatores). 1. Teil: Familie der Phalangiidae (Subfamilien Gagrellini, Liobunini, Leptobunini). Abh. Naturwiss. Ver. Hamb. 19(4):1–294.

Roewer, C. F. 1923. Die Weberknechte der Erde, Systematische Bearbeitung der bisher bekannten Opiliones. Gustav Fischer, Jena 1,116 pp.

Roewer, C. F. 1952. Einige Phalangiiden aus dem Vereinigten Staaten von Nord-Amerika. Zool. Anz. 149(11/12):267–273.

Roewer, C. F. 1956. Über Phalangiinae (Phalangiidae, Opiliones, Palpatores). (Weitere Weberknechte XIX.). Senckenb. Biol. 37(3/4):247–318.

Roewer, C. F. 1957. Über Oligolophinae, Caddoinae, Sclerosomatinae, Leiobuninae, Neopilioninae und Leptobuninae (Phalangiidae, Opiliones, Palpatores). Senckenb. Biol. 38(5/6):323–358.

Schenkel, E. 1951. Spinnentiere aus dem westlichen Nord-amerika, gesammelt von Dr. Hans Schenkel-Rudin. Verh. Naturforsch. Ges. Basel 61:28–62.

Schick, R. X. 1965. The crab spiders of California (Araneida, Thomisidae). Bull. Am. Mus. Nat. Hist. 129:1–180.

Šilhavý, V. 1960. Die Grundsätze der modernen Weberknechttaxonomie und Revision des bisherigen Systems der Opilioniden. Verh. XI. Internat. Kongr. Ent. Wien 17–25 Aug. 1960 1:262–267.

Šilhavý, V. 1965. Die Weberknechte der Unterordnung Eupnoi aus Bulgarien; zugleich eine Revision europäischer Gattungen der Unterfamilien Oligolophinae und Phalangiinae (Arachnoidea, Opilionidea). Acta Entomol. Bohemoslov. 62:369–406.

Šilhavý, V. 1970. Nouvelles recherches sur la famille des Neopilionidae Lawrence. Bull. Mus. Nat. Hist. Nat., 2^{e} Sér. 41(1):171–175.

Šilhavý, V. 1976. Two new opilionids of the family Leiobunidae from Korea (Arach., Opiliones). Věstn. Česk. Spol. Zool. 40(4):296–299.

Simon, E. 1902. Arachnoideen, excl. Acariden und Gonyleptiden. Ergeb. Hamb. Magalh. Sammelr. 2:1–47.

Staręga, W. 1965. Einige Weberknechte (Opiliones) aus Nordkorea (Materialien zur Kenntnis der ostasiatischen Weberknechte, V). Ann. Zool. (Warsaw) 23(2):5–14.

Staręga, W. 1972. Bemerkungen über die Verbreitung einiger Familien der Weberknechte (Opiliones). Proc. 5th Intern. Congr. Arachn., Brno 1971:59–64.

Staręga, W. 1973. Bemerkungen über einige westpaläarktische Weberknechte (Opiliones). Revision der Phalangiidae, II. Ann. Zool. (Warsaw) 30(12):361–373.

Staręga, W. 1978. Katalog der Weberknechte (Opiliones) der Sowjet-Union. Fragm. Faun. (Warsaw) 23:198–241.

Stoll, N. R., chairman. 1961. International code of zoological nomenclature adopted by the XV International Congress of Zoology. Int. Comm. Zool. Nomenclature, London, XX + 176 pp.

Strand, E. 1906. Die arktischen Araneae, Opiliones und Chernetes. *In:* Fauna Arctica 4:431–478. Gustav Fischer, Jena.

Suzuki, S. 1973. Opiliones from the South-west Islands, Japan. J. Sci. Hiroshima Univ. Ser. B., Div. 1 (Zool.) 24:205–279.

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NOTES AND COMMENTS

OVIPOSITION BEHAVIOR OF *CHRYSOPS ATLANTICUS* (DIPTERA: TABANIDAE)

The salt marsh deer fly *Chrysops atlanticus* Pechuman is an annoying blood-seeking pest of man and animals along the Atlantic coast, where it often has a negative impact in recreational and agricultural industries (Hansens, 1980). Egg masses and oviposition sites of *C. atlanticus* have previously been reported by Jamnback and Wall (1959) and Magnarelli and Anderson (1979). Although these authors reported finding egg masses on *Spartina alterniflora* Loisel., there have been no previous observations of oviposition other than in the laboratory.

We observed oviposition by 12 female *C. atlanticus* (Table 1) at a salt marsh near Cedarville, New Jersey. Oviposition was observed in early evening, from 1912 hr (EDT) to 2040 hr (mean ± SE = 36 ± 8 min before sunset). Ten females (83%) oviposited on *S. alterniflora,* but oviposition was also observed on *Spartina patens* (Ait.) and *Distichlis spicata* (L.). In each case the eggs were laid over wet depressions which supported little or no vegetation, as reported by Magnarelli and Anderson (1979).

Female *C. atlanticus* were oriented in a head up position prior to oviposition, then turned 180 degrees (head down). As the female walked down the blade of grass, she repeatedly touched the leaf surface with the tip of her abdomen. When oviposition was initiated, the fly slowly moved down the blade of grass, depositing the eggs for approximately 20 min. The females were easily disturbed if approached by an observer, and left the immediate area. Freshly deposited eggs were white and turned dark brown after several hours. Larvae hatching from the egg masses possessed the exertile stigmatic spine characteristic of *C. atlanticus.*

These data show that *C. atlanticus* oviposits exclusively during the early evening hours. We have observed other fresh egg masses (i.e., white) during the early evening hours but not during the morning or afternoon despite extensive searching. Graham and Stoffolano (1983b) reported oviposition in *Tabanus simulans* Walker over an eight hour period with peak activity during midday. We have frequently observed *Tabanus lineola* F. and *Hybomitra daeckei* (Hine) ovipositing during the early afternoon and late morning, respectively. The ecological significance of temporal partitioning of oviposition among salt marsh tabanid species is unknown, as are the stimuli for ovipositioning. The narrow time span for oviposition of *C. atlanticus* (only 88 min) appears to be unusual for salt marsh tabanids.

In previous reports, *S. alterniflora* was the only plant on which the eggs of *C. atlanticus* were found. While *C. atlanticus* oviposited predominantly on this plant in our study, other plants were also suitable. The dominance of *S. alterniflora* around wet depressions may account for the number of ovipositions observed on this plant. Stimuli associated specifically with wet depressions are probably more important in the choice of an oviposition site for *C. atlanticus* than stimuli associated with a specific plant. *Tabanus simulans* oviposited almost exclusively on *S. alterniflora* and

Table 1. Date, time (EDT), and plant substrate of oviposition by *C. atlanticus* on a salt marsh near Cedarville, New Jersey.

Date	Time	Plant
16 June 81	2010	*S. patens*
1 July 82	2033	*S. alterniflora*
7 July 82	2018	*S. alterniflora*
15 June 83	1931	*S. alterniflora*
16 June 83	1927	*S. alterniflora*
16 June 83	2009	*S. alterniflora*
23 June 83	1948	*S. alterniflora*
23 June 83	2001	*S. alterniflora*
23 June 83	2022	*S. alterniflora*
29 June 83	1912	*D. spicata*
30 June 83	2040	*S. alterniflora*
13 July 83	2021	*S. alterniflora*

may have been responding to plant specific stimuli (Graham and Stoffolano, 1983a, b).

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LITERATURE CITED

Graham, N. L. and J. G. Stoffolano, Jr. 1983a. Relationship between female size, type of egg mass deposited, and description of the oviposition behavior of the sibling species *Tabanus nigrovittatus* and *T. simulans* (Diptera: Tabanidae). Ann. Entomol. Soc. Amer. 76:699–702.

Graham, N. L. and J. G. Stoffolano, Jr. 1983b. Oviposition behavior of the salt marsh greenhead, *Tabanus simulans* (Diptera: Tabanidae). Ann. Entomol. Soc. Amer. 76:703–706.

Hansens, E. J. 1980. Review: Tabanidae of the east coast as an economic problem. J. New York Entomol. Soc. 87:312–318.

Jamnback, H. and W. Wall. 1959. The common salt-marsh Tabanidae of Long Island, New York. New York State Mus. Sci. Serv. Bull. 375, 77 pp.

Magnarelli, L. A. and J. F. Anderson. 1979. Oogenesis and oviposition in *Chrysops atlanticus* (Diptera: Tabanidae). Ann. Entomol. Soc. Amer. 72:350–352.

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CARRION AS AN ATTRACTANT TO THE AMERICAN DOG TICK, *DERMACENTOR VARIABILIS* (SAY)

The American dog tick, *Dermacentor variabilis* (Say), is a three-host tick with larvae and nymphs that feed on small mammals, and adults that feed and mate on larger ones. Discovery of hosts is usually facilitated by dispersal to areas where the probability of contacting vertebrates is maximized, that is, near runways, trails or roadsides frequented by the appropriate host species. At these places ticks typically climb vegetation where they wait for a host to brush by (Smith et al., 1946; Sonenshine, 1979).

The purpose of this report is to document a newly discovered behavior of *D. variabilis* that could be important in describing its ability to locate large mammalian hosts. The following observations were made while studying the consumption of mouse carrion in a closed-canopy mixed woodland near Chapel Hill, North Carolina, U.S.A. The area has been described earlier by Kneidel (1984).

Six mouse carcasses (*Mus musculus* L.) were exposed in plastic dishes placed 20 m apart along a transect through the woodland on 1 July 1982. The objective of the experiment was to deter colonization by blowflies (Calliphoridae) by covering the openings of the dishes with fiberglass window-screening. Large vertebrate scavengers were also kept from the mice by fixing an additional cover of hardware cloth over the dishes. This extended approximately 12 cm over the dishes and 8 cm around them, and was held in place with three aluminum stakes.

Unlike unprotected carcasses, which are almost completely consumed within 1 week and do not have a strong smell, the protected mice became bloated, decomposed slowly and developed a very strong offensive odor. After 5 days the window-screening over two carcasses was removed, and after 7 days for another. These carcasses still decomposed slowly and retained their strong odor. Although small arthropods fed on the carcasses all were largely intact when collected from the field (after 10 or 11 days) and none were colonized by blowflies.

Two additional carcasses were exposed on 7 July. These had been kept at room temperature indoors for 5 days before being moved to the field and were not covered by window-screening. These also were not colonized by calliphorids, decomposed slowly and had a very strong odor.

On 11 July I noticed adult ticks crawling near some of the carcasses. Subsequently, I carefully inspected each one, including all leaf litter and vegetation over approximately a 0.50 m^2 area around each mouse. I counted 23 non-engorged adult ticks among the eight carcasses (4 had none, 1 had 1, 1 had 4, and 2 had 9).

To determine whether the ticks were actually being attracted by the carrion or whether their presence was independent of it, I also sampled an equivalent area to that surveyed around the mice at eight sites without carcasses on 11 July. These were located at 20 m intervals along a parallel transect, 20 m distant from the one with the mouse carcasses. No ticks were found at any site, so the presence of individuals around the mouse carcasses must be attributed to their attraction to them, and not to chance.

Given the length of time the carcasses had been in the field and the fact that one of the two that had been kept indoors for 5 days yielded nine ticks, it can be concluded further that the attractant must have been the odors of decomposition and not lingering odors of the living mice. Also, the mice were kept frozen before being used in the experiment and had no unusual odor when placed in the field.

A likely explanation for the ticks' movement toward decomposing carcasses is that by being near carrion, discovery and colonization of large mammalian scavengers is facilitated. Interestingly, none of the ticks were found directly on the carcasses. Instead they were climbing about the protective screen of hardware cloth over them. Apparently the ticks climb vegetation surrounding carrion (or in this case hardware cloth) to contact scavengers when they come near.

From 1979 through 1981 I exposed 94 dead mice and cotton rats, but observed only four ticks near one carcass. Their attraction to the eight mice discussed above could be explained by the fact that these carcasses were unique in having such a strong odor. Possibly, larger carcasses are visited more frequently by ticks. This prediction, however, remains to be verified. Most studies of carrion-arthropod associations have dealt primarily with Diptera, Coleoptera, and Hymenoptera, with limited discussion of other taxa. Reed (1958), however, in a thorough survey of the arthropod fauna attracted to dog carrion in Tennessee, reported no ticks visiting the carcasses.—*Kenneth A. Kneidel, Curriculum in Ecology, University of North Carolina, Chapel Hill, North Carolina, USA 27514.*

LITERATURE CITED

Kneidel, K. A. 1984. The influence of carcass taxon and size on species composition of carrion-breeding Diptera. Amer. Midl. Nat. 111:57–63.

Reed, H. B., Jr. 1958. A study of dog carcass communities in Tennessee, with special reference to the insects. Amer. Midl. Nat. 59:213–245.

Smith, C. N., M. N. Cole and H. K. Gouck. 1946. Biology and control of the American dog tick. USDA Tech. Bull. 905, 74 pp.

Sonenshine, D. E. 1979. Ticks of Virginia. Res. Div. Bull. No. 139, V.P.I., Blacksburg, Virginia.

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A MORPHOLOGICAL DISTINCTION BETWEEN THE LARVAE OF *CHEUMATOPSYCHE CAMPYLA* AND *C. PETTITI* (TRICHOPTERA: HYDROPSYCHIDAE)

Thirty-nine Nearctic species of the caddisfly genus *Cheumatopsyche* Wallengran have been described, illustrated, and keyed (Gordon, 1974). Most *Cheumatopsyche* larvae are distinctive in having a median notch on the anterior margin of the frontoclypeal apotome (a median cephalic sclerite) (Wiggins, 1977). Although adult–larval associations have been made for several species, characters distinguishing larvae have been difficult to find (Ross, 1944; Wiggins, 1977).

Of the two species used in this study, *C. campyla* larvae prefer larger rivers, seldom inhabiting small streams (Ross, 1944). This species is most abundant through the Corn Belt states but is found over most other parts of the continent as well. *Cheumatopsyche pettiti* (=*analis* Banks, sensu Ross, 1944) show a preference for small streams but also occur in larger rivers (Ross, 1944). This species exhibits a wide geographical distribution, from the Atlantic to the Pacific through the northern states, and south to Oklahoma and Georgia.

Described below is a qualitative morphological distinction between the larvae of *C. campyla* and *C. pettiti.* This distinction is based on the comparative examination of 40 associated specimens of *C. campyla* and 21 associated specimens of *C. pettiti.* As supporting evidence, comparisions were also made with associated specimens from the scientific collection of the Illinois Natural History Survey.

MATERIALS AND METHODS

From May through August 1978, and April through June 1979, weekly field collections of caddisfly larvae and pupae were made by handpicking rocks in riffle areas at two locations; Horse Creek, 0.8 miles from its confluence with the Kankakee River near Custer Park, Illinois, and the Kankakee River between Custer Park and Resthaven, 0.1 miles downstream from the mouth of Horse Creek. The pupae were placed in 3-dram vials which were approximately half-filled with stream water and then placed on ice for transport to the laboratory for rearing (Smith, 1984). The larvae were preserved in 70% ethyl alcohol (EtOH) for later study.

Laboratory-reared adults were identified and preserved in 70% EtOH with their pupal cases, which contained the hard parts of their larval exuvia. The "metamorphotype method" of identification (Milne, 1938) was employed for those pupae which did not emerge. With this procedure, associations between larva, pupa, and adult can be made by using the imaginal genitalia for adult species identification, and removing the larval sclerites from the case for identification of the larva. However, most of the non-emerging pupae in this study were not mature enough for species determination. Of those pupae which were identified, the larval sclerites and mandibles were slide mounted in polyvinyl lactophenol and examined.

The following larval characters were compared:

1. The number of teeth on the left and right mandibles. A "mandibular formula"

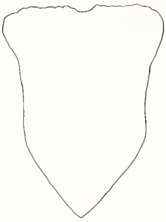

Figure 1

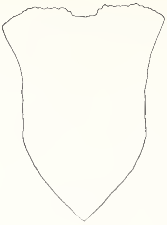

Figure 2

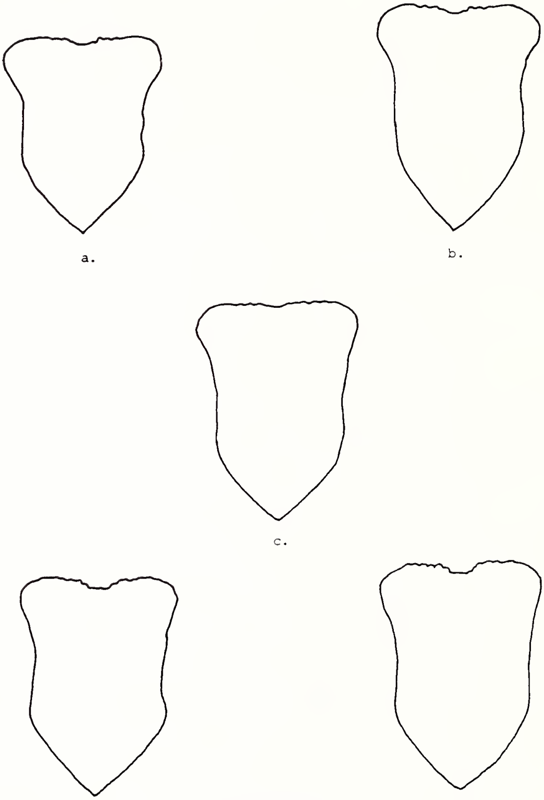

Figure 3

Figs. 1–3. 1. Frontoclypeal apotome of *Cheumatopsyche pettiti* showing the shape of the notch on the anterior margin. 2. Frontoclypeal apotome of *Cheumatopsyche campyla* showing the shape of the notch on the anterior margin. 3. Frontoclypeal apotome of specimens from the scientific collection of the Illinois Natural History Survey showing the difference in the

was used in making this comparison: (number of teeth on outer margin of mandible) + (number of teeth on inner margin of mandible) (e.g., 2 + 6).
2. Presence, or absence, and relative length and position of mandibular brushes.
3. Setal arrangement on setal areas 1, 2, and 3 (SA1, SA2, and SA3) (Wiggins, 1977), on the meso- and metathoracic sclerites.
4. Presence or absence of setae and setal patterns on the head capsule.
5. Length/width ratio of the frontoclypeal apotome. The length was taken to be the distance from the base of the median notch on the anterior margin of the frontoclypeus to the posterior tip of the apotome. The distance between the parallel sides of the apotome was taken as the width.
6. Bristle patterns on the frontoclypeal apotome (Krafka, 1923).
7. Structural comparison of the shape of the anterior notch on the frontoclypeal apotome.

The length/width measurements were taken with an ocular micrometer at 63×, all other characters were examined at 63× and 160×.

The only morphological distinction observed between the larvae of *C. campyla* and *C. pettiti* was a difference in the shape of the notch on the anterior margin of the frontoclypeal apotome. The other six characters examined gave no information useful in distinguishing between the larvae of these two species. Based on results from 21 associated specimens, the anterior notch of *C. pettiti* was found to be a shallow, crescent-shaped depression (Fig. 1). In contrast, the notch on all of the 40 associated specimens of *C. campyla* was larger and deeper, the lateral margins were more angled, and the base of the depression was straight (Fig. 2). This character difference was found to be consistent for all of the reared specimens during this study, and also for the associated museum specimens which were examined (Fig. 3). The fact that the museum specimens were collected from a wide range of geographical locations lends further support to this character.

The *Cheumatopsyche* spp. larvae which were collected and preserved were also compared. By using the above described character, as a general observation, it was possible to separate the larvae as to the site where they had been collected, Horse Creek or the Kankakee River. These results coincided with the distinction observed between the associated specimens and with the locations where the associated specimens were collected. Thirty-nine of the associated specimens of *C. campyla* were collected from the Kankakee River location, and one was collected from Horse Creek. Of the 21 associations made for *C. pettiti,* 19 were collected from Horse Creek and two were taken from the Kankakee River.

The median notch on the anterior margin of the frontoclypeal apotome could be an important character in further studies involving the larval taxonomy of the genus *Cheumatopsyche,* although there is no doubt that variations within a population do

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shape of the anterior notch. a. *C. pettiti,* Burton Creek, Quincy, Illinois, 1940. b. *C. pettiti,* Piney Grove, Maryland, 1938. c. *C. pettiti,* South River, Palmyra, Missouri, 1938. d. *C. campyla,* Devils River, Devils River, Texas, 1939. e. *C. campyla,* Indian Creek, Serena, Illinois, 1938.

exist. Due to the qualitative nature of this distinguishing feature, it is suggested that it be used only as a supporting character, providing one or more additional, possibly quantitative, characters can be found.

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LITERATURE CITED

Gordon, A. E. 1974. A synopsis and phylogenetic outline of the Nearctic members of *Cheumatopsyche.* Proc. Acad. Nat. Sci. Philad. 126(9):117–160.

Krafka, J., Jr., 1923. Morphology of the head of Trichopterous larvae as a basis for the revision of family relationships. J. New York Ent. Soc. 31:31–52.

Milne, M. J. 1938. The "metamorphotype method" in Trichoptera. J. New York Ent. Soc. 46:434–437.

Ross, H. H. 1944. The caddis flies, or Trichoptera, of Illinois. Bull. Illinois Nat. Hist. Surv. 23(1).

Smith, M. H. 1984. Laboratory-rearing of stream-dwelling insects. Antenna 8(2):67–69.

Wiggins, G. B. 1977. Larvae of the North American Caddisfly Genera (Trichoptera). University of Toronto Press, Toronto and Buffalo, 401 pp.

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BOOK REVIEW

A Field Guide to the Beetles of North America.—Richard E. White. Houghton-Mifflin, Boston. 368 pp. $10.95 (paper).

White has produced a masterful field guide to the Coleoptera, brimming with more than six hundred illustrations of the quality we have come to expect from the co-author (with Donald J. Borror) of *A Field Guide to the Insects* (also of the Peterson series by Houghton-Mifflin). White's book could not have been more timely. It is a first, surpassing other attempts at North American field guides for the beetles, and is a badly needed source of information for amateurs who now cannot purchase copies of Arnett's *Beetles of the United States* or Crowson's *A Natural Classification of the Families of Coleoptera*. It cannot be said to replace either, but it serves an immediate identification need by non-specialists and students in college courses, as well as offering a useful pocket guide for the professional entomologist. Before extolling any more virtues of the tome, let me dispense with the problems I have found in it.

Some of my complaints are genuine errors, pulled from some groups of special interest to me, and I can only assume that comparable ones exist in treatments of other taxa. Others, however, including the families chosen and the taxa included in them, are more a matter of preference. In the book, White adopts a conservative classification that overlooks many relations that now seem well established. For example, the genus *Dasycerus* is included in the Lathridiidae (as was traditionally the case, e.g., Leng, 1920), ignoring its placement in the Staphylinoidea by Crowson (1955) and masking its fascinating relationships that almost certainly lie within Staphylinidae (Wheeler, 1984).

The discussion of the numbers of North American species and biological habits of the major genera of Leiodidae are essentially correct in the text (the "powdery fungus" being Myxomycetes: Blackwell, 1984), but the figures are mislabeled. A drawing of what appears to be *Anisotoma discolor* (Melsheimer) is labeled as "*Leiodes*" and a *Leiodes* sp. as "*Anisotoma*." The nomenclatural problems of these two genera are sufficiently monumental to justify White's mistake, and I suspect that the national collection may still be organized in the outmoded classification (see Hatch, 1929).

The family name Lymexylonidae is used instead of the grammatically correct Lymexylidae (Barber, 1952). Just as in the case of Cerylonidae (cf. Cerylidae; Kuschel, 1979) the root does not include the -on ending on the genus name (*Lymexylon, Cerylon*). This, like the previous problem, is with published precedent and is not a serious problem. I found that I could key out the lymexylid genus *Hylecoetus* in the picture key on the front and rear endpapers, but its antennal structure is at odds with the text description (p. 214). *Melittomma,* on the other hand, agrees with the text, but does not easily key out. Also, the lymexylids are described simply as wood-boring, overlooking their fascinating symbiotic relationship with ambrosia fungi that predates comparable habits in scolytine weevils and may well represent the earliest evolution of truly fungus-growing habits in the Coleoptera (Wheeler, ms; Wilson, 1971).

The literature cited at the end of the book excludes Roy A. Crowson's classic *Biology of the Coleoptera* (1981, Academic Press). I realize that Crowson's book probably appeared after the "guide" had gone into production, but a note in proof of so important an addition to the literature on beetles would have been fully justifiable. And finally, I was a little amused and disappointed by the drawing of a compound microscope boldly crossed out in the book. While it is not advisable for an aspiring amateur beetle collector to run down to her local department store and purchase a compound microscope, no one interested in beetles should be turned from compound microscopy. Much of the detailed work necessary to adequately describe small external structures, many genitalia and mouthparts, and many larvae can only realistically be done with compound microscopy, and the general quality of beetle taxonomy would only benefit from more widespread application of compound microscopy by professional taxonomists and their user community.

I guess that many years have gone by since I purchased my last copy of Borror and White's insect field guide, and I was shocked to learn that the paperback edition has more than doubled to nearly eleven dollars.

Most of the complaints that I have can be mitigated by an honest look at the size of the project that White has completed. In North America alone there are more than 30,000 species of beetles, and there is no way that the brief write-ups possible in a field guide can do justice to all of them. Also, the field of coleopterology is rapidly changing and no truly "up to date" publication of this scope is possible. As an illustration, the associations of Eucinetidae with fungi were largely assumed at the time of White's writing, and in the interval North American species have been associated with boletes, wood-rotting Basidiomycetes, and slime molds, confirming and adding to our knowledge of mycophagy in that primitive polyphagan family (Wheeler and Hoebeke, 1984). The illustrations are superb. The blurbs on each family are concise and largely accurate. The introductory chapters are helpful, and the discussion of collecting methods includes more than the standard, general techniques. An expanded treatment of the morphology of beetles would have been helpful, but given the scope and goals of the volume, the existing balance seems reasonable. Finally, the physical production of the book is good, surpassing that of some competing field guide series.

I consider this the best available book for the beginning student of beetles. It is extremely valuable in its own right, and will always be a useful companion to other books (such as Arnett and Crowson, when these again become available). My copy is already showing a little wear, and I suspect that a new generation of coleopterists will benefit from this professionally prepared volume. I recommend the book highly, and offer a thanks to Dr. White for his timely contribution.—*Quentin D. Wheeler, Department of Entomology, Cornell University, Ithaca, New York 14853.*

LITERATURE CITED

Barber, H. S. 1952. Notes on *Telegeusis* and some relatives (Coleoptera: Lymexylidae). Pan-Pac. Ent. 28:163–170.

Blackwell, M. 1984. Myxomycetes and their arthropod associates. Pp. 67–90 *in:* Q. Wheeler and M. Blackwell (eds.), Fungus-Insect Relationships: Perspectives in Ecology and Evolution. Columbia University Press, New York, 514 pp.

Crowson, R. A. 1955. The natural classification of the families of Coleoptera. Lloyd, London.

Hatch, M. H. 1929. Leiodidae *in* Coleopterorum catalogus, vol. pars 105.

Kuschel, G. 1979. The genera *Monotoma* Herbst (Rhizophagidae) and *Anommatus* Wesmael (Cerylidae) in New Zealand. N.Z. Entomol. 7:44–48.

Leng, C. W. 1920. A catalog of the Coleoptera of America, north of Mexico. Sherman, Mount Vernon, New York, 470 pp.

Wheeler, Q. D. 1984. Notes on fungus hosts of Dasyceridae of the Appalachian Mountains. Coleopt. Bull. (in press).

Wheeler, Q. D. ms. Revision on the genera of Lymexylidae (Coleoptera, Cucujiformia). In prep.

Wheeler, Q. D. and E. R. Hoebeke. 1984. A review of mycophagy in the Eucinetoidea, including an association of the eucinetid beetle, *Eucinetus oviformis,* with a Coniophoraceae fungus (Coleoptera). Proc. Ent. Soc. Wash. 86:274–277.

Wilson, E. O. 1971. The Insect Societies. Harvard University Press, Cambridge, 548 pp.

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