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" 289–352	"	August	10, 1909.
" 353–368	"	September	23, 1909.
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EDWARD J. NOLAN, M.D.,
Recording Secretary.

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PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1909.

January 5.

Philip P. Calvert, Ph.D., in the Chair.

Eleven persons present.

The reception of a paper intended for publication under the title "A Contribution to the Comparative Morphology of the Thoracic Sclerites of Insects," by G. C. Crampton, Ph.D. (December 18, 1908), was reported by the Publication Committee.

The Council reported that the following Standing Committees had been appointed to serve during the ensuing year:

Finance.—John Cadwalader, Edwin S. Dixon, Ellingham B. Morris, William D. Winsor and the Treasurer.

Publications.—Henry Skinner, M.D., Witmer Stone, Henry A. Pilsbry, Sc.D., William J. Fox, and Edward J. Nolan, M.D.

Library.—Dr. C. Newlin Peirce, Thomas Biddle, M.D., Thomas H. Fenton, M.D., George Vaux, Jr., and Henry Tucker, M.D.

Instruction and Lectures.—Benjamin Smith Lyman, Henry A Pilsbry, Sc.D., Charles Morris, Witmer Stone and Dr. C. Newlin Peirce.

Committee of Council on By-Laws.—Arthur Erwin Brown, Sc.D., Thos. H. Fenton, M.D., John Cadwalader and Chas. B. Penrose, M.D.

The President is, *ex-officio*, a member of all Standing Committees.

John W. Harshberger, Ph.D., made a communication on the vegetation of the West Indies as contrasted with that of Mexico and Central America, illustrated by lantern slides. (No abstract.)

January 19.

Arthur Erwin Brown, Sc.D., Vice-President, in the Chair.

Thirty-eight persons present.

The deaths of the following were announced:

Lewis Haehnlen, a member, November 26, 1908; Joseph Wharton, a member, January 11, 1909, and Jean Albert Gaudry, a correspondent, November 29, 1908.

Philip P. Calvert, Ph.D., made a communication on the power of flight in dragon-flies and its relation to geographical distribution, illustrated by lantern slides. (No abstract.)

The following were elected members: Charles M. B. Cadwalader, George H. Clapp, Herbert Fox, M.D., Lewis W. Steinbach, M.D., and William Redwood Wright.

The following were elected correspondents: Albert Calmette, Ph.D., of Lille; John Mason Clarke, LL.D., of Albany; Sven A. Hedin, Ph.D., of Stockholm; Robert F. Scharff, Ph.D., of Dublin.

The following was ordered to be printed:

A CONTRIBUTION TO THE COMPARATIVE MORPHOLOGY OF THE THORACIC SCLERITES OF INSECTS.

BY G. C. CRAMPTON, PH.D.

Although the thoracic sclerites are much used factors in insect classification and myology, there exists a most confusing lack of uniformity in the homologizing and terminology employed by the various writers upon these subjects. This confusion, it would appear has largely arisen from the fact that each investigator has been content to confine his attention to one or two groups of insects, applying his own terminology as occasion arose, or, more frequently, naming the sclerites without sufficient comparison with intermediate forms to determine their true homologies.

As would be naturally expected, many new and important points have been brought to light in each of the orders, but they stand as isolated facts, rather than as generalities applying to the Hexapoda as a whole. It is with the purpose of applying this knowledge to insects in general that a comparative morphological study has been here attempted.

Material.

The insects for study were collected in the United States, Europe and North Africa. With these I was able, through the kindness of Prof. R. Heymons, to compare a number of rare specimens in the Berlin Museum, not otherwise accessible. However, in so far as was possible, the commonest insects have been chosen to illustrate the types discussed, in order that any one wishing to verify the results might have no difficulty in procuring the necessary material.

Technique.

The binocular microscope was found indispensable to the performing of dissections, which were always made and studied under a liquid medium, the rays of an artificial light being concentrated upon the object by means of a bull's-eye condenser. Glycerine or oil proved to be the most favorable medium for the examining of small objects, since they more readily remain in the position in which they are placed, when a denser medium is used.

In studying the musculature to determine the homology of the sclerites, the so-called "Halbierungs methode" was largely employed. Usually a series of dissections was prepared, in each case an additional layer of muscles being removed, beginning at the mesal surface of the bisected insect. The preparations thus made were fastened upon thin strips of mica, by means of photoxylin, and preserved in 80% alcohol. Since both mica and photoxylin are transparent, the specimen may thus be easily studied from either side.

Only in the case of very small insects, or when it was difficult to follow the course of certain muscles, was it necessary to have recourse to reconstructions from microtome sections.

In dealing with strongly chitinized material, good preparations could be obtained only by the celloidin-paraffin embedding method, and even then it was frequently necessary to paint the upper face of the block with a thin film of mastix collodion before cutting each section.

For general purposes, staining with Grenacher's hæmotoxylin, differentiating with picric acid, and counterstaining with eosin gave good results.

Literature.

The works of Swammerdam, Linné, and all authors before Illiger's time have but little interest other than from an historic point of view. On the other hand such of the later publications as those of Chabrier, '20; Strauss-Dürkheim, '28; Kirby and Spence, '28; Westwood, '39; Burmeister, '32, etc., although very thorough and painstaking, are too confusingly varied in their homologizing and terminology to have any very great practical worth.

The most scientific handling of the subject is to be found in the work of Audouin, '24, upon whose researches the modern terminology is based. Since the appearance of this article, but little has been added to our knowledge of the comparative morphology of the thorax.

Of the more modern publications the following were found very useful in the preparation of this paper: For the homologizing of the sclerites, Kleuker, '83; Kolbe, '93; Brauer, '88; Amans, '85; Börner, '03; Verhoeff, '03; Janet, '98; Comstock, '02; Walton, '00, and Voss, '04. For the terminology of the musculature, Luks, '83; Petri, '99; Breed, '03; Voss, '04, and Durken, '07. For the wing venation, Adolph, '80; Redtenbacher, '86; Comstock, '98, and MacGillivray, '06.

Such of the works as are of a more particular interest will be discussed under those headings to which they especially refer.

Terminology.

The modern terminology for the thoracic sclerites is based upon the epoch-making work of Audouin, '20. Discarding the then prevalent conception of a binary division of the thorax according to the function of its organs of locomotion (as, for example, the collum and pectus of Knoch, 1801, the corselet and segment alifère of Chabrier, '20, or the mani- and ali-truncus of Kirby, '28) this author demonstrated that the thorax is composed of three similar segments. These three he designated as the pro-, meso-, and meta-thorax—terms variously attributed to Kirby, Latreille and Audouin, but which appear to have been first proposed by Nitzsch, '18. Nitzsch, however, used the slightly different form protothorax instead of prothorax.

Each segment Audouin considered as composed of four regions, namely, a dorsal region or tergum, two flanks or "pleuræ," and a ventral region called the sternum. The sternum he regarded as consisting of a single piece, but for the flanks and tergum he described a number of subdivisions.

In the flank or "pleura," he recognized the following parts: two large lateral plates, the anterior of which he termed the episternum, and the posterior the epimeron; a narrow strip along the anterior margin of the episternum called the parapleuron; a small plate containing the spiracle, called the peritreme; and a triangular sclerite articulating with the coxa, called the trochantine.

The tergum he considered as composed of four regions, lying one behind the other. Beginning with the most anterior he termed these the præscutum, scutum, scutellum and postscutellum.

Some entomologists employ the word dorsum to designate the tergal region of a single segment, but it is far preferable, as Audouin has done, to apply this term to the whole dorsal surface of the insect.

The expression stigma is frequently used as synonymous with spiracle, especially in the German publications; but, as used by systematists, the word stigma denotes the chitinized cell in the costal region of the wings of certain Hymenoptera, etc. It would, therefore, be preferable to use only the more exact and suitable term spiracle to denote the tracheal opening.

In most of the modern works there is a very great laxity in the use of the singular and the plural form of the word pleura. For example, some authors speak of one flank as the pleuron and both together as the pleura, while others, following Audouin's example, choose the latinized forms pleura and pleuræ. One cannot employ the term pleura in both a singular and plural sense without creating confusion, and as the words are of Greek origin it would seem advisable to use only the etymologically correct forms, pleuron and pleura.

Recently the terms tergite, pleurite and sternite have been used interchangeably with tergum, pleuron and sternum. One form of the word appears to be amply sufficient for all ordinary purposes, and it would be far more practical to use the term tergite for a subdivision of the tergum, pleurite for a part of the pleuron, and sternite for a sclerite of the sternum. Thus the præscutum, scutum, etc., would be tergites, the epimeron and episternum pleurites, and so on. It is in this sense that these terms have been used in the text.

Theoretical Discussion.

Before taking up the subdivisions of the segments in detail, a brief review of the theories dealing with the formation of the thorax will serve to give a clearer idea of the nature of the sclerites.

Despite Newport's, '39, statement to the contrary, Audouin seems to have regarded the thorax as consisting of but three simple segments. MacLeay, '30, however, and after him Newport, '39, proposed that each of the pro-, meso-, and meta-thoracic segments is in reality composed of four subsegments or annuli, which have become more or less completely fused together in the formation of the compact, highly specialized thorax. The præscutum, scutum, scutellum and post-scutellum, according to this theory, are the tergal portions of the four annuli, which are more closely fused in the pleural region and completely consolidated in the sternal region.

Hagen, '89, on the other hand, holds the view that each segment is composed not of four, but of three subsegments, each bearing a characteristic appendage. The most anterior he terms the leg-bearing, the next following the wing-bearing, and the last the spiracle-bearing subsegment.

The more modern theories are founded upon the work of Patten, '90, who claims that the thoracic segments are composed of but two annuli. From a comparison with the nervous system of Scolopendra, which he takes as a type, he concludes that in all Anthropoda the neuromeres, and consequently the segments themselves, are in reality double. In support of this view, he states that "in all anthropods carefully studied two cross commissures have been found in each neuromere," thus indicating the double nature of these structures. Furthermore, "in *Acilius* the median furrow between the cross commissures is similar to that found between the successive neuromeres." "In *Scorpio* the neuromeres are distinctly double," and in such forms as *Julus* not only the neuromeres, but also the cardiac ostia, arteries, tracheæ and legs plainly show the double nature of the somites. Other indications of segmental fusion are two pairs of tracheal invaginations in each segment of *Acilius*, the bifurcated appendages of many Crustacea, and the bifid maxillæ of insects, in which latter group monsters with double pairs of legs are of frequent occurrence.

All of the subsequent theories, though differing greatly in their point of view, lay great stress upon the fusion of segments traceable in the Myriopoda as an indication of what has taken place in the Hexapoda.

Banks, '93, regards the suture between the episternum and epimeron as the boundary between two leg-bearing subsegments. Of these, the anterior or episternal subsegment, has retained its appendage fully developed, while the leg of the posterior or epimeral subsegment occurs only in a vestigial condition (the so-called styli found on the meso-, and meta-thorax of *Machilis* and other insects) or is completely fused with the episternal leg.

Walton's, '00–'01, theory differs from that of Banks only in the fact that he regards the epimeral leg as represented by the so-called meron or posterior portion of the coxa, and in that he believes that each subsegment originally bore a wing. According to this author, only the epimeral wing is fully developed, while that of the episternal subsegment exists only as a wing "fundament," and is represented by the squamulæ, tegulæ, etc., designated under the common term pterygoda.

Kolbe, '93, whose book appeared contemporaneously with Banks', '93, first publication, differs from Banks and Walton, in regarding the epimeron and episternum as parts of the same segment, and in addition he finds traces of other "complementary" segments in such forms as *Locusta*, *Œdipoda*, etc. These complementary segments are especially well developed in the larvæ of *Lampyris*, and here show a great similarity to the condition found in *Scolopendrella*—which Kolbe considers as an intermediate form between the rest of the myriopods and insects.

Verhoeff, '02–'04, accepted Kolbe's theory, which he enlarged and worked out more in detail. Believing that traces of three "Vordersegmente" or complementary segments (one in front of the pro-, meso-, and meta-thorax respectively) are to be found in such insects as *Japyx*, *Embia*, etc., he proposes that the typical hexapod thorax is composed of six primitive segments. To the "Vordersegmente" he gives the names micro-, steno- and crypto-thorax. Of these, the microthorax (the complementary segment in front of the prothorax) is the best developed, and occurs in a large number of insects. In

Japyx, etc., between each chief segment and its corresponding "Vordersegment," and also in front of each Vordersegment, are found certain minute sclerites which Verhoeff interprets as the remains of two "intercalary" segments. Under these conditions, each of the three commonly accepted thoracic regions would in reality be composed of four subsegments (*i.e.*, a chief and a complementary segment, each with its corresponding intercalary segment), thus giving a total of twelve subsegments for the thorax as a whole.

In this connection it may be remarked that Banks, '04, is entirely incorrect in stating that his theory is supported by the views of Verhoeff. In reality the two are not at all alike, for, while Banks considers that the epimeron and episternum represent two annuli, Verhoeff expressly states that these two sclerites are parts of one and the same segment, in front of which he finds the additional so-called complementary and intercalary segments.

If then, with Banks, we consider the epimeron and episternum as representing two subsegments, a combination of Banks' and Verhoeff's theories would give five subsegments in each thoracic region, or a total of fifteen for the entire thorax. On the other hand, if MacLeay's, '30, contention, that the præscutum, scutum, scutellum and postscutellum represent four annuli, be correct, a combination of this with Verhoeff's theory would raise the total number of thoracic subsegments to twenty-one. This *reductio ad absurdum* only serves to show to what extremes it may lead if we regard each of the sclerites which chance to be serially arranged as the remains of a vestigial segment. Then, too, in view of the marked tendency toward the formation of separate chitinous plates which, as will be later discussed, takes place largely through mechanical causes, and for the most part without reference to any segmental arrangement, one cannot be too cautious in attributing to them a segmental value.

While it must be admitted that the "compound-segment" theory is a most attractive and not wholly groundless one, the following serious objections to the above cited theories may be made. Thus, the mere occurrence of four regions in the tergum, or the fact that the pleuron is divided into epimeron and episternum, is not sufficient proof that the segment is compound, since such divisions frequently occur from purely mechanical causes, and wholly without reference to any segmental arrangement—as, for example, the division of each segment into tergum, pleura and sternum.

Again, one should not lay too great stress upon the conditions found in Myriopoda as an indication of what has occurred in Insecta. A similar mode of life frequently leads to a remarkable convergence in structure, which would, however, have no value in a genetic homologization. Furthermore, it must be borne in mind that insects are not descended from myriopods, but that recent Myriopoda, Crustacea, Insecta, etc., are groups of equal rank; and modifications in any direction may occur in each of the groups, quite independently of what occurs in any of the others.

Patten's argument, that the presence of two cross commissures in each neuromere is indicative of its double nature, loses its force when we consider that in many insects the last abdominal ganglion—which is regarded as the fusion product of a number of neuromeres—likewise contains but two cross commissures; whereas, if Patten's argument were correct, there should be as many commissures present as there are neuromeres entering into its composition. With regard to the bifurcated maxillæ of insects, it would appear far more reasonable to explain this condition as a secondary development, rather than the persistence of a primitive condition in such highly specialized appendages as the mouth parts; and Patten's other argument, that insect abnormalities with double pairs of legs are of frequent occurrence, has no weight when one considers the fact that there are likewise many vertebrate monsters with double appendages—yet no one considers this as a reversion to the primitive condition.

With regard to Kolbe's, '93, conclusions based upon the thorax of the larva of *Lampyris*, etc., it must be remembered that the larval form by no means represents the most primitive condition, but is rather an adaptation to its mode of life, as is so well shown in the hypermetamorphosis of *Sitaris humeralis*. Again, in certain lepidopteran larvae—*Sphinx* for example—it is very easy to observe a marked tendency toward the formation of intrasegmental rings; and this suggests that the extra constrictions in the soft larval bodies of *Lampyris*, *Rhaphidia*, etc., are probably some such superficial modifications, especially since no indications of any subdivision is indicated in such important segmental structures as the ganglia, tracheæ, etc.

Banks', '93, theory, that the meso- and metathoracic styli of *Machilis* are rudimentary legs, has no support either from an embryological or a structural point of view, and he seems to have been unaware of Haase's, '89, far more probable explanation of these structures as modified setæ. Furthermore, Börner, '03, and Henneguy, '04, recently homologize these organs with the exopodite of the Crustacea, while Verhoeff, '03–'04, following Haase, '89, compares them to the coxal organs of Myriopoda.

The theory of Walton, '00, who considers the "meron" as a vestigial leg, seems likewise highly improbable. From an examination of a large number of insects, it would appear that the meron is merely a portion of the coxa. In such generalized forms as the Blattidæ, it is not at all, or only partially, distinguishable from the remainder of the coxa; but in less generalized forms, as for example the Lepidoptera, it becomes more separated from the coxa, and in the highly specialized, swiftly-flying Diptera it is drawn quite into the pleural region, doubtless as the result of muscular tension.

Walton's other theory, that the pterygoda represent a pair of epimeral wings, is fully as improbable as his meron hypothesis. The pterygoda bear absolutely no resemblance to wings in structure or in development, and, furthermore, no fossil remains show any traces of more than one pair of wings to each thoracic segment. Walton has tried to evade these facts by suggesting that the tegulæ, etc., are wing "fundaments." With regard to this supposition, all that can be said is, that, so far as our present knowledge extends, the tegulæ have fundamentally nothing in common with wings, and any attempt to discuss what they might develop into belongs wholly to the realm of speculation.

If, as Patten, '90, states, two pairs of tracheal invaginations occur in each segment of *Acilius*, this would indeed be a strong proof of segmental fusion. In the adult *Acilius*, however, this is certainly not the case. Embryos of this insect were not accessible, but in the embryos of *Chrysopa*, and the far more primitive *Forficula*, there are no traces of more than one tracheal invagination to the segment. Furthermore, in all illustrations of other insect embryos that I could find, only one tracheal invagination is indicated in each segment, and there are no evidences of a double nature in the ganglia or any other important segmental structures.

This lack of embryological evidence is the chief argument against the hypothesis of segmental fusion, and until proof more convincing than that brought forward in support of the above cited theories can be offered, it would seem preferable to adopt a mechanical explanation —as, for example, muscular tension, etc.—to account for the origin of the separate sclerites.

In attempting to apply this thery it must be borne in mind that the sclerites are not produced in a more or less haphazard fashion, as such extremists as Graber seem to think, but one can trace the systematic following out of a ground plan common to all three of the thoracic segments.

Lowne, '90, is quite incorrect in his statement that the prothoracic sclerites cannot be homologized with those of the other two segments, as a glance at the thorax of any Blattid would have convinced him. His criticism of Audouin, '20, for taking as a type so "specialized" a segment as the wing-bearing one, is likewise wholly unjustified; for a comparative study can lead to no other conclusion than that the segment bearing the functional wing has undergone the least modification. The prothorax in many cases has been reduced to a mere collar, and, indeed, Brongniart, '90, finds that in certain fossil insects this segment bore a wing-like appendage which has since been lost. The prothorax, then, cannot be chosen as a type, and in the segment which does not bear the functional wing—as for example the metathorax of the diptera—it is convincingly apparent that there has been a great fusion and reduction of both sclerites and muscles. It is the wing-bearing segment, therefore, that more nearly represents the primitive condition, and if Lowne had not confined his attention to a specialized species of the highly specialized dipteran order, he would have seen how illogical are his conclusions for insects in general, based upon so modified a form.

General Description.

The Tergum.—As has been previously stated, the structure of the prothorax is essentially the same as that of the other two segments. This principle, however, may lead to a mistaken interpretation of the condition exhibited in the prothoracic tergum (or the pronotum, as Burmeister, '32, terms it) of certain insects. Thus most text-books state that in the grasshopper's pronotum, the ring-like areas, produced by a series of transverse furrows, represent the præscutum, scutum, scutellum and postscutellum—as is figured by Brooks, '82, for example. Theoretically this sounds very plausible, but a comparison with a large number of Saltatoria shows that these wrinklings are largely of a secondary nature. Not only is the musculature quite different, but it is likewise the case that the four subdivisions of the meso- and metathoracic terga never occur as such regular, parallel rings. In addition to this, in certain Acrididæ (*Dictyophorus* for example) there are even more than four rings, and in some cases the transverse furrows which mark off these rings are interrupted, thus showing their secondary character.

The præscutum and postscutellum usually form what Kirby, '28, terms a phragma—that is to say an inward projecting process of the tergum. Such a præscutum or postscutellum has never been described for the prothorax, and it would appear that if such structures ever existed in the pronotum they have since been lost through reduction or fusion with the scutum and scutellum.

The Præscutum.—As has been stated, it is impossible to distinguish a præscutum in the prothorax, but in the mesothorax this sclerite is frequently represented by a well developed phragma (fig. 1, N_1). This phragma is apparently a portion of the tergum drawn inward and downward by muscular tension, and is separated from the scutum by the line of attachment of the intersegmental membrane, beneath which the phragma projects into the body cavity.

Fig. 1.—Macroxyela.—Dorsal view of the mesothorax, showing the subdivisions of the tergum or notum. For reference letters, see list at end of the paper.

In his earlier works Audouin did not distinguish between the phragma and the triangular portion of the scutum immediately behind it (N_{2a}), terming both together the præscutum. In this usage he has been followed by Packard, '98; but most authors use the word præscutum as synonymous with Kleuker's protophragma—in other words the præscutum is only the anterior phragma of the tergal region.

The præscutum of the metathorax is frequently fused with the postscutellum of the preceding segment or it may be greatly reduced. On this account Kleuker, '83, terms the second phragma the deuterophragma, whether it is composed of the mesothoracic postscutellum, the metathoracic præscutum, or of both together. It would seem preferable, however, to use Audouin's terminology, which is not only more exact, but also has the right of priority.

On either side of the mesothoracic præscutum of such insects as *Myrmeleon*, *Mantispa*, etc., are two bridge-like plates lying just in front of the wings, and connecting the tergum with the upper portion of the episternum. These plates appear to represent the so-called præsegmental lamellæ described by Voss, '04, in the thorax of *Gryllus*. Since these plates are not internal lamellæ, in most insects, but occur usually as external sclerites, they will be here referred to as the præsegmental sclerites.

The Scutum.—The thorax of *Dytiscus*, which Audouin, '24, chose as his type for insects in general, is too greatly modified to show the normal relations of the tergal subdivisions, but fortunately Audouin, '32, has given a more serviceable description in his translation of MacLeay's article on *Polistes*. By comparing the thorax of *Polistes* with that of certain other less specialized Hymenoptera, such for example as *Macroxyela*, *Tenthredo*, etc., in which the mesonotum has retained a comparatively primitive condition, it is an easy matter to apply Audouin's terminology to insects in general.

In the mesothorax of *Macroxyela*, *Chrysopa*, *Myrmeleon*, etc., the portion of the tergum just behind the præscutum is composed of two regions: a median portion triangular in shape, with its apex directed caudad (fig. 1, N_{2a}), and a larger portion surrounding the first laterally and posteriorly (N_{2b}). The triangular median region of the scutum may be termed the mediscutum, and the remainder the parapsidoscutum (from MacLeay's, '30, parapsides, applied to two pieces separated off from this region in *Polistes*).

In his description of *Dytiscus*, Audouin regards the mediscutum as part of the præscutum, while in his translation of MacLeay's work he speaks of the region corresponding to the mediscutum as the scutum proper, and likewise reckons the parapsides to the scutellar region. The latter division is the only natural one, and has consequently been adopted in this discussion.

In the Hymenoptera, one can trace an extremely interesting series of changes in the scutellar region of the mesothorax. Thus, if one examine the thorax of *Macroxyela*, *Abia*, *Odynerus* and *Chrysis*, in the order given, it will be seen that the apex of the triangular mediscutum (figs. 1 and 2, N_{2a}) becomes gradually lengthened out, and pushes through that portion of the parapsidoscutum (N_{2b}) behind it until it reaches the scutellum (N_3). Its sides then begin to open out, and become nearly parallel. By this process the formerly triangular mediscutum assumes a rectangular form (fig. 2, N_{2a}), and divides the parapsidoscutum into two widely separated halves (N_{2b} and N_{2b}), the parapsides of MacLeay, '30.

Fig. 2.—EUMENES.—Dorsal view of the mesothorax. A comparison with fig. 1 shows that the mediscutum (N''_{2a}) has pushed through the parapsidoscutum (N''_{2b}) and divided it into the two "parapsides" (N''_{2b} and N''_{2b}).

As shown by MacGillivray, '06, the wing veins of the Xyelidæ show that this family is the most generalized of the Hymenoptera. Consequently the thorax of *Macroxyela* is more primitive than that of *Polistes*—an opinion which is confirmed by a comparison with certain lower insects, such as *Myrmeleon*, etc. If this be true, one is justified in assuming that the "parapsides" of *Polistes* are but portions of the mesothoracic parapsidoscutum. MacLeay's suggestion, that the mesothoracic parapsides are but the prothoracic paraptera(!) pushed back from their original position, must, therefore, be regarded as entirely untenable.

The parapsidoscutum is very closely connected with the organs of flight; and indeed its caudal portion appears to merge into the membranous anal region of the wing.

Along the sides of the scutum lie a number of small plates which are usually free, but may be more or less fused with one another or with the scutum. Jurine, '20, has described six of these for Hymenoptera, but only three are of particular importance. The first of these is found at the base of the costal region of the wing, and has been termed the antesigmoid by Amans, '85; the second, which Amans terms the "piece quadrilatere" (sigmoid), is situated at the base of the median region of the wing; and the third or dorso-terminal lies at the base of the anal region of the wing. The structure and mechanism of these sclerites has been described in detail by Amans, '85, and Voss, '04, and need not, therefore, be further discussed here.

In addition to the above-mentioned sclerites, there occur two plates (one at the base of each wing) which have been variously termed squæmula, tegula, paraptera, pterygoda, etc. Of these terms, Latreille's, '20, "pterygodes" or pterygoda appears to have the right of priority, and on this account has been here adopted. In *Gryllus*, Voss, '04, has described a structure which he terms a "Hautpolster," but does not compare it with other insects. This structure is beyond a doubt homologous with the pterygoda, and bears the characteristic hairs. In the Trichoptera, although still somewhat "Polster"-like, it is more strongly chitinized, and in the Hymenoptera it forms a horny scale, covering the base of the wing. In certain Lepidoptera the pterygoda are greatly developed and are densely beset with hairs. Westwood, '39, has confused these with the patagia of the Lepidoptera, but they are doubtless quite different structures.

The Scutellum.—Behind the scutal region lies a small, medianly-situated scutellum (fig. 1, N_3). In form it may be somewhat semicircular, oval, shield- or wedge-shaped. In the latter case its anterior end is embedded in the parapsidoscutum. Its posterior margin is usually drawn out into a narrow strip on either side, and is continued in the posterior margin of the anal region of the wing. This character is frequently very useful in determining the boundaries between the mesoscutellum and phragma, or to distinguish the mesoscutellum from the metanotum when these are partially fused.

Voss, '04, appears to consider the scutellum as part of the scutal region, and terms it the "unpaares mittelfeld." This terminology, however, would be incorrect for three reasons: in the first place, because the sclerite in question does not belong to the region which Audouin, '24, calls the scutum, but is what he terms the scutellum; furthermore, the unpaired median region of the scutum, if such existed, would be the triangular mediscutum; and, lastly, there is no "unpaired" region, strictly speaking, in either scutum or scutellum, as the whole tergum was originally divided into two symmetrical halves by a median longitudinal suture.

This suture, according to Comstock, '02, represents the line of closure of the embryo, and it is along this line that the cuticle is ruptured at the time of moulting. The median dorsal suture may be spoken of as the mid-dorsal suture, while the corresponding median ventral suture (which may represent traces of the neural groove) will be referred to as the mid-ventral suture.

The mid-dorsal suture is easily seen in such insects as the Sialidæ, Perlidæ, Tenthredinidæ, Psocidæ, Tipulidæ, Trichoptera, etc. In certain other insects, and some of these are very primitive, as, for example, the roaches and earwigs, one can find scarcely any traces of this suture in the mesothorax, since the tergal subregions have united to form a simple undivided notum. However in the metathorax of some Blattidæ, etc., one can distinguish faint traces of these parts. This leads to the conclusion that the simple notum is the result of non-usage of the wings, or the peculiar mode of life of these insects, and would hence be a tertiary modification rather than a retention of the primitive condition.[1]

An examination of the inner ridges, which serve as points of insertion for certain muscles, suggests that the tergum at one time may have been a single piece, but, though muscular tension, ridges were drawn inward, thus creating corresponding furrows or sutures on the exterior surface. It is possible that the so-called parapsidal furrows, or sutures separating the medi- from the parapsido-scutum, were formed in this way, as is likewise the case with the furrow which separates the parapsidoscutum from the scutellum. The latter furrow may be spoken of as the scutellar suture.

The Postscutellum.—Behind the scutellum lies the postscutellum (fig. 1, N_4), which usually occurs as a phragma projecting more or less into

[1] In the Apterygota, however, the simple, undivided notum doubtless represents the primitive condition.

the body cavity, or, as is the case in the Diptera, it may be largely external (see figs. 7 and 8, N_4).

The postscutellar phragma is usually much larger than the præscutal phragma, and, while the latter is always closely connected with the scutum, the postscutellum may become almost completely separated from the remainder of the tergum.

As has been stated, the præscutum and postscutellum usually occur as phragmas, and between them extend the dorsal longitudinal muscles. It would appear that the arching of the mesothoracic region in such swift-flying insects as the Hymenoptera, Diptera, etc., is caused by the tension of these muscles. In the Diptera, the mesothoracic postscutellum is greatly developed to furnish an attachment for these powerful muscles, and the whole mesothorax appears to have grown at the expense of the metathorax, which shrinks away, as it were, thus exposing the huge mesothoracic postscutellum. Muscular tension is doubtless another factor causing the mesothoracic postscutellum to become external, since it would give rise to an arching upward of the tergum and the shifting forward of certain of the sclerites, as will be later discussed. This external character and unusual development of the mesothoracic postscutellum in the Diptera caused Latreille, '20, to mistake it for the notum of the metathorax. He consequently homologized the metathorax of the Diptera with the first abdominal segment (the "segment mediaire") of the Hymenoptera. MacLeay, '30, committed a somewhat similar error in considering the first abdominal segment (which is closely connected with the thorax in pedunculate Hymenoptera) as part of the metanotum. Consequently, that portion which he terms the postscutellum in *Polistes* belongs to the abdominal region.

The postscutellum[2] (fig. 7, N_4) of the Tipulidæ is greatly developed and is distinctly divided into three regions—a median region which may be termed the mediophragmite (N_{4a}), and two lateral regions which will be spoken of as the pleurophragmites (N_{4b}). Each of the pleurophragmites may be subdivided into a superior (N_{4bs}) and inferior (N_{4bi}) region, and the mediophragmite likewise may be divided into symmetrical halves by a continuation of the mid-ventral suture.

In certain insects in which the pleurophragmite is not connected with the pleura, it would appear that a portion of the pleurophragmite

[2] Snodgrass, '08, frequently states that the Orthoptera have no postscutellum. This is not the case in the Gryllidae, for example, as the postscutellum of *Gryllus domesticus* is quite well developed.

becomes separated off and remains connected with the epimeron. This piece has been termed by Kolbe, '93, the "parapleure" in the Coleoptera, but this term is quite differently applied by other investigators. Thus Voss, '04, considers "parapleura" as synonymous with episternum. On the other hand Cuvier, '23, states that the "parapleuræ" are the "epimeres." According to MacLeay, '30, the "parapleuræ" are the episterna. Latreille, '20, considers the parapleuræ as the "epimeres du metathorax." Lacordaire, '54, speaks of the epimeron and episternum together as the "parapleures," and erroneously ascribes this usage to Audouin. According to Knoch, 1801 (who introduced the term), "parapleururum" would refer to the episternum; while the episternum and epimeron together were termed "parapleururum duplum." If we are to abide strictly by the rule of priority, the term parapleuron would apply only to the episternum, in which sense it is used by Knoch, 1801, Kirby, '28, MacLeay, '30, Burmeister, '32, Fieber, '61, Voss, '04, and others. However, in the sense used by Kolbe, '93, it is a very useful term, if so used that there would be no danger of confusion with the above cited usages.

Amans, '85, gives a terminology for the tergal subdivisions entirely different from that here accepted. Thus he proposes the names prodorsum, dorsum, postdorsum and sub-postdorsum for exactly the same sclerites which Audouin, '24, had previously termed the præscutum, scutum, scutellum and postscutellum. Enderlein, '03, has recently adopted Amans' usage, but there appears to be no just cause for thus arbitrarily changing Audouin's terminology, which not only has the right of priority, but also has the advantage of widespread acceptance, and is not open to the objection mentioned by Audouin himself, namely, the term dorsum should be applied only to the entire dorsal surface of the insect, in contradistinction to the venter, ventrum or ventral surface.

As has been previously mentioned, Kleuker's, '83, terminology is inexact, in that he does not distinguish between the postscutellum of the mesothorax and præscutum of the metathorax, but terms them indiscriminately the deuterophragma. Moreover, Voss', '04, substitution of the term postscutum for postscutellum is quite unwarranted, and it would appear far preferable to employ only the simple and appropriate terminology of Audouin, '24.

The Wing.—The wing, as we have seen, is very closely connected with the parapsidoscutum, and indeed Packard, '98, believes that the wing fundaments are scutal structures. They usually arise as sack-like folds of the body wall, and in insects with incomplete metamorphosis appear as lateral outgrowths of the caudal margin of the tergum. This is well shown in the development of the male Blattid, in which the elytron-like fore wings project from the posterior margin of the tergum, becoming more and more elongate at each moult, and finally develop into chitinous structures in which the characteristic venation of the wings is clearly shown. This has led to the theory that the wings arose as lateral outgrowths of the margin of the notum, originally acting as a sort of parachute, but later developing into functional wings. Another theory is that the wings and legs have a similar origin. In a third theory, it is claimed that the wings develop from tracheal gills; and in yet another, it is held that the wings are modified spiracles. It is not proposed to discuss these theories here at length, but, in objection to Gegenbauer's, '78, tracheal-gill theory, it may be remarked that Palmen, '77, has clearly demonstrated that the closed tracheal system is only a secondary adaptation to the aquatic life of the larva, and that aerial respiration was doubtless the primitive one. On this account, it is hardly probable that wings have developed from tracheal gills.

Walton, '01, believes that the tegulæ or pterygoda are rudimentary wings, but, as has been previously discussed, there is absolutely no proof for the statement that these structures are wing fundaments, either from an embryological or a structural point of view. Comstock, '95, suggested that "the wing covers or elytra of earwigs and beetles probably correspond to the tegulæ . . . . . that is, they are a pair of side pieces of the mesothorax, the parapleura, greatly enlarged." Walton has followed out this suggestion in his theory, and likewise adopts the view that the alulet-like structures under the elytra of *Hydrophilus*, etc., represent extra wings. Comstock, '98, however, has shown that the elytra are the modified wings, and that the membranous structures beneath them are quite comparable to the alulæ of Diptera, etc., and are even bordered by the "spring vein" characteristic of the alulæ.[3]

In the most generalized insects the tracheation follows the path indicated by the chief cuticular thickenings, which later become the veins for stiffening the wings. The tracheation, therefore, is frequently of great value in determining the homology of the principal wing veins, and was much used by Comstock, '98, in the comparison of the venation throughout the orders. The principal veins recognized by him are the costa, subcosta, radius, media, cubitus, and the anals.

[3] See Sharp, '96.

This terminology, based upon that of Redtenbacher, '86, is the one usually accepted by modern systematists, and has consequently been here adopted.

The Pleuron.—The two principal sclerites of the pleuron are the episternum and epimeron of Audouin, '24. The later terms, antepleuron (episternum) and postpleuron (epimeron) of Amans, '85, or the coxopleure (episternum) and anopleure (epimeron) of Verhoeff, '03, since they are applied to exactly the same sclerites, must be regarded as superfluous synonyms. The pleurit and subcoxa of Heymons, '99, will be later discussed under the heading Hemiptera. However, it may be remarked of these sclerites—which have given rise to a great deal of discussion—that the pleurit is merely the epimeron, while the greater part of the subcoxa corresponds to the episternum.

The pleurites of the Blattidæ are interesting from the fact that the epimeron and episternum appear to be merely portions of a single plate separated into two regions by a deep pocket-like infolding of the integument. This suggests that the episternum and epimeron may originally have been one piece, but became separated by such an infolding of the integument—possibly due to muscular tension. In this way there would be formed an external furrow, the so-called pleural suture, and a corresponding hollow ridge, the entopleuron or apodeme. This would account for the fact that the apodemes of insects are hollow processes, and it is conceivable that the apodemes would thus arise as hollow invaginations of the body wall of the embryo, even though the muscular tension which originally developed the apodemes were not strongly operative at this stage.

There is a greal lack of uniformity in the usage of the terms apodeme and apophysis in referring to the internal or "entothoracic" processes. As here used, the expression apodeme is applied solely to internal processes of the pleuron (*i.e.*, the "entopleura"); while the term apophysis refers only to the internal processes of the sternum—the "entosterna."

The entopleuron may bear four inward projecting processes as follows: above, a pivot, or articulating process for the wing, which may be termed the alar process of the apodeme; and below this a process serving for muscle attachment (in such insects as *Panorpa*, etc.), which may be termed the intermedian process. The third is usually quite a large process. It may or may not extend as far as the furca (or forked apophysis of the sternum), but frequently abuts against the end of the furcal arm, and may even fuse with it. This process will be referred to as the adfurcal process. The process just below it, which forms an articulation with the coxa, has been termed the coxal process. These processes will be discussed more at length in a later article dealing with the comparative myology of insects.

The Epimeron.—It is generally taken for granted that the epimeral and episternal regions of the thorax are not subdivided into smaller sclerites, but a glance at the mesothorax of *Cicada* (fig. 5) and *Tipula* (fig. 7) or the metathorax of *Myrmeleon* (fig. 4) and *Chrysopa* (fig. 3) will readily convince one that this is an error.

To illustrate, let us examine the thorax of the widespread insect *Chrysopa*. For this purpose *Chrysopa vulgaris* is preferable to the somewhat commoner form *Chrysopa perla*, as the black bars and markings upon the thorax of the latter insect tend to obscure the sutures between the subregions.

In the epimeral region of *Phassus* (fig. 6), and most winged insects as well, one can readily find an elongate plate embedded in the softer cuticule directly under the posterior portion of the wing (EM_c). This sclerite doubtless corresponds to the plate which Lowne, '90, designates as the "costa" in the blow-fly. The term costa, however, has been applied to one of the wing veins, and this usage has been everywhere adopted. It would, therefore, seem preferable to substitute the expression costal sclerite in referring to the above mentioned plate.[4] The costal sclerite bears an internal process, which serves as

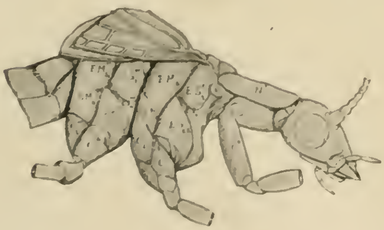


Fig. 3.

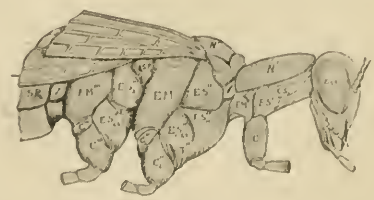


Fig. 4.

Fig. 3.—Chrysopa.—Lateral view of right flank. Abdomen, legs, wings and antennæ partially removed.

Fig. 4.—Myrmeleon.—Side view of right flank. Abdomen, legs, wings and antennæ partially removed.

the point of insertion for the epimeral wing muscles. This process may be termed the endocostal process. Behind the costal sclerites there frequently occurs a smaller sclerite which likewise serves as an attachment for the epimeral muscles. This will be spoken of as the

[4] Snodgrass, '08, terms this sclerite the "postepimeron," but since the plate in question is normally "supraepimeral" rather than "postepimeral," Lowne's term, slightly modified, has been here retained.

posterior costal sclerite (EM_{2c}). It is usually very small and relatively unimportant.

In the metathorax of *Chrysopa* and *Myrmeleon*, and in the mesothorax of Cicada, etc., the epimeron is distinctly divided into an upper and lower portion. The upper region will be referred to as the anaepimeron[5] or anepimeron (fig. 3, EM_a) and the lower region may be termed the kataepimeron or katepimeron (EM_k). In the Raphidians, the suture between the anepimeron and katepimeron is partly obliterated, and in many other insects all traces of it have disappeared. In *Phassus schamyl* (fig. 6), the upper portion of the epimeron is membranous, thus suggesting that in other insects the anepimeral region may have originally arisen as a softening of the chitin, to give greater freedom of motion to the wing, and thus become differentiated from the remainder of the epimeron.

In the Muscinæ, there is an arching of the mesothorax and a shifting forward of the sclerites—probably the result of muscular tension—so that the upper region of the epimeron (EM_a) is bent forward and lies upon the episternum (fig. 8). It would appear that Lowne, '90, and other dipterologists have not been aware of this fact, for Lowne, Hewitt, '07, and a number of others mistake the anepimeron (EM_a) for the episternum and consequently designate the katepimeron (EM_k) as the entire epimeron. A comparison with one of the Tipulidæ—in which group the sclerites are in their normal positions—readily shows the error of such a homologization. In the Tipulidæ, and less distinctly in the Ephemeridæ, the pleurophragmite (or lateral region of the postscutellar phragma) is so closely connected with the pleuron that it appears to be a part of the pleural region (fig. 7, N_{4bn}); but, with the "parapleure" of the Coleoptera, it should be classed as a portion of the postscutellum.

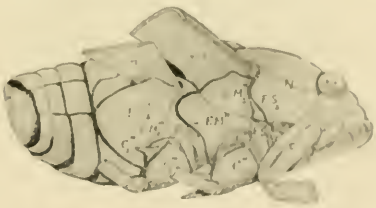


Fig. 5.—CICADA.—Lateral view of right flank. Abdomen, legs, and wings shortened.

Connected with the lower portion of the epimeron in *Chrysopa* and a number of other insects is a sclerite termed the meron (fig. 3, C_2).

[5] In an earlier publication (Crampton, '08) the term hyper- and hypo-epimeron were employed to designate these regions, but, upon further consideration, it has seemed preferable to substitute the designations ana- and kata-epimeron, which are not so confusingly similar as the former terms.

This sclerite is of a variable nature, being entirely coxal in some insects, while in others it is entirely pleural. The origin and nature of this sclerite will be more fully described in the discussion of the sclerites of the leg.

The Episternum.—While the division into ana- and kata-epimeron is shown in but few hexapods, a subdivision of the episternum into an upper and lower region is evident in a great number of insects. Among these may be mentioned *Sialis, Hepialus, Corydalis, Phassus, Bittacus, Cicada, Tipula, Mantispa, Hemerobius, Raphidia, Chrysopa, Myrmeleon,* the Nemoptera, Trichoptera, and a large number of other insects from different families. Beyond a doubt, if enough material could be examined, it would be found that indications of this division occur in some genera of every family.

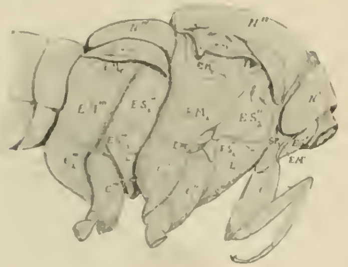


Fig. 6.

Fig. 7.

Fig. 6.—PHASSUS.—Lateral view of right flank. Head completely removed; wings, abdomen and two posterior legs shortened.

Fig. 7.—TIPULA.—Lateral view. Head entirely removed. Wings, abdomen and legs shortened.

The epimeral subdivisions are best shown in *Mantispa*, but *Chrysopa* serves the purpose almost as well, and is a much commoner insect. In *Chrysopa*, the upper region of the episternum—which will be termed the anepisternum (fig. 3, ES_a), is separated from the lower or "katepisternum" (ES_k), by a narrow strip which may be spoken of as the median region of the episternum (ES_m). In the thorax of *Chrysopa* this strip is very narrow, but in the thorax of *Myrmeleon* it is quite broad (fig. 4, ES_m). In the metathorax of the Forficulidæ, the upper portion of the anepisternal region is frequently cut off by a white, scar-like softening of the chitin of the episternum. Verhoeff, '03, terms this piece the pteropleure.[6]

While the anepisternum in most insects is in its normal position, the

[6] The musculature of the anepisternum clearly shows that it is not to be homologized with the "pteropleure" alone.

previously mentioned shifting forward of the anepimeral region in the Muscidæ (fig. 8, EM_a) has displaced the anepisternum (ES_a) in the mesothorax. This phenomenon has led to a great variety of interpretations of these sclerites in the Diptera. Thus Brauer, '82, refers to the anepisternum (fig. 7, ES_a) as the entire episternum, and the katepisternal region (ES_k) as the sternum. Lowne, '90, mistakes the anepimeron (fig. 8, EM_a) for the entire episternum, and, therefore, terms the anepisternum (ES_a) the "lateral plate." Hammond, '81, commits the same error and terms the anepisternum the parapteron. The latter term, however, cannot be used in this connection, as Audouin, '32, made it synonymous with squamula, *i.e.*, the tegula or pterygodum. As first employed by Audouin, '24, the designation parapteron was applied to the anterior margin of the episternum. Audouin himself seems to have had a great deal of trouble in homologizing this region with that of other insects, and finally solved the difficulty by applying the terms hypopteron and parapteron to MacLeay's, '32, squamula—with which they are therefore synonyms, and are so used by most authors.

On the inner surface of the anepisternum of *Chrysopa*, *Corydalis*, and a number of other insects, one can distinguish a lobe-like structure which is apparently formed by the inrolling of the anterior margin of the anepimeron, and serves as an attachment for the muscles extending to the trochantin and leg. It is quite easy to follow the modification of this structure in various insects, as it gradually becomes more separated from the anepisternum, assumes a conical form, and is finally connected with the upper portion of the episternum by its apex alone. This plate will be spoken of as the conus.

Fig. 8.—Musca.—Lateral view. Head entirely removed; wings, abdomen and legs shortened. A comparison with fig. 7 shows that in the Muscinæ there is a shifting forward of the parts, as is indicated by the arrow.

The Laterale.—If one compare the mesothorax of a Blattid with that of a Forficulid, it will be seen that the so-called episternum is not the same in both. In order to better understand the relation of the sclerites in these insects a hypothetical type (fig. 20) has been taken as a basis for comparison. In the stage here represented, the epimeron (EM) is indicated as a distinct region, while the remainder of the pleuron

($ES' + L$) consists of a single piece which may be designated by Heymon's, '99, term subcoxa.[7] However, it should not be taken for granted that in adopting Heymon's terminology, his theory of the origin of the subcoxa is likewise accepted; for, as will be later discussed, it is very improbable that the subcoxa is the basal portion of the leg.

Fig. 9.

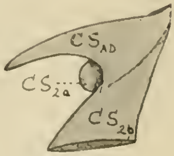


Fig. 10.

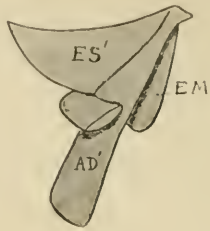


Fig. 11.

Fig. 9.—Dolerus.—External view of the right cervico-pleuron (*i.e.*, union of the cervicals with the prothoracic pleuron). This region is usually termed the prothoracic episternum.

Fig. 10 represents the anterior portion of fig. 9, seen from within to show the apodeme-like structure (CS_{ad}) separating the anterior lateral cervical (CS_{2a}) from the posterior lateral cervical (CS_{2p}).

Fig. 11 represents the posterior portion of fig. 9 seen from within; showing the apodeme (AD') between the prothoracic episternum (ES') and epimeron (EM').

The trochantin (T) is represented as a portion of the subcoxa, though it is quite possible that it was originally a portion of the coxa, separated off by muscular tension, and united with the subcoxa as a secondary modification. For the present, however, this point may be left out of consideration.

The first division of the subcoxa doubtless occurred along the line *a c* (fig. 20), thus separating the subcoxa into the episternum (ES) and a region which may be termed the laterale (L). The further divisions in the laterale may occur in either of two directions—longitudinally or transversely. A longitudinal division (*i.e.*, along the line *c i g*) would produce the condition found in the cockroach (fig. 21, compare also pl. III): that is, there would be a separation into an anterior region, which may be termed the anterior laterale[8] (L_a), and a posterior one, which may be termed the antecoxal laterale (L_b). The latter term is a slight modification of Walton's, '00, "antecoxal piece," which has priority over Verhoeff's, '03, "katopleure." If, on the other hand, the laterale be divided, not longitudinally (as in the

[7] According to Enderlein, the "subcoxa" represents the trochantin; Börner considers it the equivalent of his merosternum; and Verhoeff homologizes it with his coxopleure and trochantin.

[8] In a former publication this sclerite was termed the "pleuro-laterale."

cockroach), but transversely, *i.e.*, along the line *f c* (fig. 20), we would have the condition found in the earwig (see fig. 19, compare also pl. II). The region nearest the episternum (*ES*) may be termed the episternal laterale (L_1), and that next the sternum (*S*) the sternal laterale (L_2). In *Forficula* there is a third piece, the "hyposternal laterale" (L_3), which is not so deeply pigmented as the other two. It is usually covered by the sternum, and in *Anisolabis* it appears to be fused with the sternal laterale.

The interpretation of the relations of these sclerites as given by Verhoeff, '03, differs very widely from the one just discussed. This investigator homologizes the episternum of the earwig (fig. 19, *ES*) with the episternum plus the anterior laterale in the cockroach (fig. 21, $ES + L_a$). The earwig's episternal laterale (fig. 19, L_1) he homologizes with the antecoxal laterale of the cockroach (fig. 21, L_b); and as the earwig's sternal laterale (fig. 19, L_2) would then have no corresponding sclerite in the cockroach, Verhoeff seeks to explain the sternal laterale as a "Vorplatte" or anterior plate which lies in front of the sternum in the prothorax (*i.e.*, a lateral cervical?), but in the meso- and metathorax it is supposed in some way to become drawn around to the side of the sternum and take up a position between the latter and the antecoxal laterale (or "katopleure"). The musculature gives no indication of such a caudad migration of the lateral cervicals, or of any other "Vorderstück," and it is difficult to see how such a theory can be supported. On the other hand, it is quite comprehensible that a transverse, as well as a longitudinal division might occur, since a similar division is clearly traceable in the prothoracic trochantin of the Blattidæ.

In the metathorax of the Dermaptera (or Euplexoptera) the sternal laterale has apparently fused with the sternum (pl. II). In the prothorax of *Anisolabis* (pl. II) the episternal laterale (L_1) has partially fused with the episternum, but traces of its outlines are still preserved. The sternal laterale may be readily observed as a distinct sclerite (L_2), but both it and the episternal laterale (L_1) are greatly reduced in size. The prothoracic sternal laterale (L_2) is entirely distinct from the cervical sclerites (CS_{2x}), which lie in a plane below it; yet Börner, '03, confuses it with the cervicals, and homologizes it

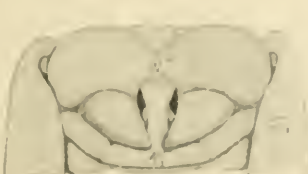


Fig. 12.—Pteronarcys.—Dorsal view of the metathorax, showing the sternellum (S'''), partially covered by two flaps of the parapsidoscutum.

(the prothoracic sternal laterale) and one of the cervicals with the mesothoracic episternal laterale of the same specimen. The remaining sclerites of the posterior lateral cervicals (CS_{2x}) he homologizes with the sternal laterale of the mesothorax. Börner likewise considers that the mesothoracic sternal laterale (pl. II, L''_2) and episternal laterale (L''_1) are subdivisions of the antecoxal laterale (pl. III, L_b). These views however seem quite untenable.

The longitudinal division of the laterale into the anterior and antecoxal regions is best shown in the cockroach (pl. III), although it is clearly traceable in a number of insects. In many Neuroptera, as for example *Corydalis* (fig. 17), *Chrysopa* (fig. 3), etc., the antecoxal laterale appears as a narrow strip (L_b) connecting the katepimeral complex[9] (Es_{kx}) with that portion of the sternum which will be later spoken of as the furci-sternum (S_3). The anterior laterale (L_a) is usually quite large, filling the region between the episternum and the "Basi-sternum" (S_2).

In the thorax of *Gryllus*, Voss, '04, has described a sclerite which seems to correspond in part to the laterale. He terms this sclerite the coxosternum, upon the ground that it represents the region so designated by Börner, '03. This homologizing, however, is quite incorrect, for, as may be readily seen in his figures, Börner's "coxosternum" includes the epimeron, episternum and laterale. Furthermore, Verhoeff had long before employed the term "coxasternum" to designate the fusion product of the coxæ with the sternum. The laterale, therefore, can hardly be termed the "coxosternum."

The Trochantin.—The small, somewhat triangular-shaped sclerite articulating with the coxa is designated as the trochantin, trochantine or trochantinus. In the Blattidæ (fig. 21 and pl. III) the trochantin (T) is quite large, and in some species it is united for a short distance with the episternum. In the Trichoptera (fig. 18) it would appear that the trochantin has fused with the katepisternal complex almost completely, its extreme tip alone remaining free. The trochantin may thus completely fuse with the katepisternal complex, or, according to certain coleopterologists, it may fuse with the coxa.

In the prothorax of all the Blattidæ that the writer could obtain the trochantin is transversely divided into two regions, the larger of which may be termed the trochantinus major and the smaller one the trochantinus minor. This condition seems to be a characteristic of the Blattidæ alone, and may prove to be of systematic value.

[9] *I.e.*, fusion product of the katepimeron, part of the trochantin, and a portion of the antecoxal laterale.

If one compare the mesothoracic trochantin of a Blattid (pl. III) with that of *Chrysopa* (fig. 3) and *Corydalis* (fig. 17), it appears that the so-called trochantin of *Chrysopa* and *Corydalis* correspond only to the "minor" region in the cockroach. The condition in *Corydalis* indicates that the minor region may become constricted off and form what is usually considered the entire trochantin in certain insects, while the major region fuses with the episternum—as it partially does in the prothorax of the Blattidæ.

In the cockroach this breaking of the prothoracic trochantin into two pieces is so evident that it is difficult to see how Sharp, '95, could have so confused these sclerites in his figure of *Blabera gigantea* (*Cambridge Natural History*, Vol. I, p. 222). He has turned the figure upside down, thus making it more difficult to see what he is trying to show, but it is quite plain that the portion he terms the entire trochantin is only the minor region, while his "epimeron(?)" is the major region of the trochantin. The true epimeron is the sclerite he designates as a fold of the pronotum.

Fig. 13.—Lyda. Ventral view of the cervicals and prothorax.

In the mesothorax of *Forficula* (pl. II) the trochantin is not transversely, but longitudinally divided into separate pieces (T_a and T_b). In the Blattidæ (fig. 21 and pl. III) this division is indicated by a longitudinal suture—the trochantinal suture—which is present not only in the meso- and meta-thoracic trochantin (T'' and T'''), but also in the major and minor portions of the prothoracic trochantin (T'_1 and T'_2), thus clearly indicating that the latter are but parts of a single piece. Of the two regions marked off by the trochantinal suture, the posterior one will be termed the coxal trochantin[10] (pl. III, T_b) and the anterior region will be referred to as the antecoxal trochantin (T_a).

Comstock, '02, terms the antecoxal trochantin (T_a) the antecoxal piece, and refers to the antecoxal laterale (T_b) as the second antecoxal piece. In using the terms antecoxal trochantin and antecoxal laterale an attempt has been made to retain Comstock's terms, and yet make it clear to what region the parts so designated belong. It must be borne in mind that Comstock's, '02, antecoxal piece (*i.e.*, the antecoxal trochantin) is not the same as Walton's, '00, antecoxal piece (the antecoxal laterale), and neither of these sclerites corresponds to

[10] With reference to the designation of this sclerite, the term "accessory trochantin plate" (Snodgrass, '08), of which the writer was not aware at the time the above given terminology was proposed, has the right of priority.

the piece termed the "antecoxal piece" in Comstock's, '95, figure of *Euchroma gigantea* (page 503). In the latter case, the antecoxal piece corresponds to that portion of the sternum which will be later referred to as the furci sternum. The writer was not able to discover the original use of the expression, but as early as 1861, Leconte, in his classification of the Coleoptera of North America, states that a pair of "horny plates" is found embedded in the membrane of the neck, and terms these the "antecoxal plates." The plates here referred to are evidently the cervical sclerites.

As has been mentioned, Comstock, '02, designates the antecoxal trochantin (pl. III, T_a) the antecoxal piece. On the other hand, he refers to the coxal trochantin as the entire trochantin. The latter usage, however, is quite incorrect, for the coxal- and antecoxal-trachantin together form the trochantin, and it is in this sense that the term will be used in the following discussion.

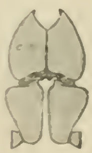


Fig. 14.—Streblognathus (after Janet).—A comparison with fig. 13 shows the way in which the cervico-propleura (*C–Pl*) become approximated on the ventral surface, and completely conceal the prosternum.

Corresponding to the external (trochantinal) suture, dividing the trochantin into the coxal and antecoxal regions, is an internal ridge which may be termed the endotrochantinal lamella, and the thorn-like process near it may be termed the endotrochantinal process.

Synonyms for the term trochantin are Voss', '04, præcoxal plate, and Strauss-Durkheim's, '28, rotule. The term præcoxal plate has little to recommend it, but it would have been much preferable if entomologists had adopted the term rotule; for the latter term better expresses the function of this sclerite, is not borrowed from vertebrate anatomy, and is not so confusingly similar to the term trochanter, as is the case with Audouin's trochantin. However, the name trochantin, or the latinized form trochantinus, given it by MacLeay, '30, is a very useful term and has received too wide an acceptance to attempt to change it.

Between the trochantin and the coxa lies a very small chitinous plate, the complementary coxal sclerite,[11] or "complementary plate" (Börner, '03), which bears an internal process, the complementary process, to which are attached certain muscles extending to the episternum. This small sclerite is frequently fused with the coxa, and the complementary process then appears as a process of the coxal margin.

[11] The accessory coxal plate of Snodgrass, '08.

THE LEG.—The coxa is very closely connected with the pleuron in certain insects, and indeed Miall and Denny, '86, consider that the pleural sclerites are "two basal leg-joints which have become adherent to the thorax." From his embryological studies, Heymons, '99, also adopts this view in designating the "subcoxa" as the basal portion of the leg. Börner, '03, at first considered the pleural sclerites as plates which have become separated from the sternum, but he later adopted Heymons' view.

The theory that the pleural sclerites are basal leg-joints appears hardly tenable. In those insect larvæ which have long, well-developed legs (as for example *Corydalis*, *Carabus*, etc.) it is necessary that the muscles have some firm support, and it is doubtless the stimulus of the muscular tension which causes the formation of certain sclerites in the soft integument of the larva. This is certainly a far more reasonable supposition than that the epimeron and episternum would be drawn up from a hard chitinized leg region into a soft pleural region, before the latter region were sufficiently resistant to furnish the needed support for the muscles. In the above mentioned insects, the pleural sclerites first appear near the base of the leg, and it is quite possible that these would appear to arise from the basal region of the embryonic leg mass, as it is impossible to say just where the leg begins and the pleuron ends in the embryonic stages. There is such a shifting, flattening, and distorting of the parts in those forms upon which Heymons bases his conclusions, that he was deceived into considering that the mesothoracic subcoxa (fig. 16) represents the epimeron and episternum together, whereas, in reality, it represents the mesothoracic episternum, laterale, and perhaps the trochantin. On the other hand, the "pleurit," which he considers as representing the metathoracic pleurites, does not belong to the metathorax at all, but is merely the *mesothoracic* epimeron (fig. 15, *EM''*). This mesothoracic epimeron is thrown into a fold by the shifting forward of the region behind it and overlaps the metathoracic epimeron (*EM'''*), which escaped Heymons' attention altogether. These facts serve to illustrate how easily the embryonic regions may be confused; and when one takes into consideration that even in the larval stages of the above mentioned insects, the pleural sclerites are first formed so near the base of the leg, it is readily comprehensible that Heymons could have been misled into considering the pleurites as basal leg-joints, since in the embryonic stages (upon which he bases his conclusions) there is no sharp distinction between the leg and pleural region.

It is perhaps worth mentioning in this connection that the katepisternal complex, the antecoxal laterale, the furci-sternum (described later), and the katepimeron form a closed ring about the base of the leg, and might consequently be taken for a portion of the leg region; but, for the reasons above stated, this view would be extremely improbable.

Hansen, '93, compares the trochantin to the coxopodite of the Malacostraca, and homologizes the coxa with the basipodite. He likewise adopts the views of Wood-Mason, '79, and Jourdain, '88, who propose that the styli on the meso- and meta-thoracic coxæ represent the exopodite of the crustacean leg. In a recent article Börner has again brought this theory into prominence. Henneguy, '04, who likewise compares the insect leg with that of the Crustacea, differs from the above-mentioned investigators in that he maintains that the stylus corresponds to the epipodite—not to the exopodite. He argues that if the coxa corresponds to the basipodite, the stylus or coxal appendage must correspond to the epipodite or basipodite appendage, and not to the exopodite, which is the appendage of the coxopodite.

The above-mentioned views seem hardly probable, for all indications point to the fact that insects are not descended from aquatic, but from terrestrial ancestors. Palmèn, '77, has demonstrated that the open tracheal system for aerial respiration is the primitive one, and it may be added that in the development of the Ephemerid embryo, the primordia (or fundaments) of the spiracles may be observed even in the germinal streak. The aquatic life of the larvæ, then, must be regarded as a secondary adaptation; and, therefore, one can hardly attempt to homologize the styli of the insect leg with the exopodite or the epipodite of the aquatic Crustacea.

Banks', '93, theory that the styli are vestigial legs has no foundation other than the extremely improbable supposition that each segment is double. In all probability these structures are modified sensory hairs, or they may be comparable to the movable spine-like structures found upon the legs of certain insects. Verhoeff, who adopts Haase's, '89, view regarding the styli, homologizes them with the coxal organs of the Myriopoda.

As has been stated, Walton, '00, believes that the meron is a vestigial leg, but serious doubt is cast upon this theory by the fact that one can trace the formation of the meron as a coxal sclerite, which is either not distinguishable from the rest of the coxa, or at most indistinctly traceable, in the lower forms, but becomes detached by muscular tension in the highly specialized insects. The view that the tension of the muscles attached to it causes the meron to become detached is strengthened by the fact that it occurs as a distinct sclerite only in the segments which bear functional wings. Thus it seems to be absent in the prothorax of all the insects which the writer has studied, and no traces of it are to be found in the metathorax of the Diptera, although it is well developed in the mesothorax of these insects.

Since the mode of life is the same among insects and myriopods, and as the legs of both are used in the same manner, it is but natural that there should be a very marked convergence in the structure of these organs. This, however, is not sufficient ground for attempting to change the terminology applied to the segments of the insect leg, as Verhoeff, '03–'04, has done. Even if it could be demonstrated that the joints of the insect leg can be homologized with corresponding ones in the myriopods, the terminology for the leg segments of the myriopods should be adapted to that of insects, as the latter has the right of priority and of widespread acceptance.

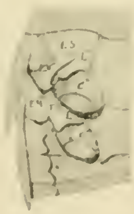


Fig. 15.

Fig. 16.

Fig. 15.—NEPA. Ventral view showing half of the sternum and the corresponding pleuron of the meso- and meta-thorax and the first three abdominal segments. The flap-like mesothoracic epimeron (*EM''*) is raised up and bent forward to show the metathoracic epimeron (*EM'''*) which lies under it and was overlooked by Heymons. The corner of the metathoracic epimeron (*EM'''*) is likewise slightly raised to show the first abdominal segment which is hidden by the epimeron, and does not appear in Heymons' figure of *Nepa* (fig. 16).
Fig. 16.—Heymons' figure of *Nepa*, slightly modified. The dotted lines indicate the region corresponding to that shown in fig. 15.

Of the leg segments only the coxa and trochanter need be here considered. The coxa is frequently divided into two regions, as has been previously described. Verhoeff's, '03, term eucoxa (fig. 3, C_1), applied to the anterior coxal region, seems preferable to Walton's, '00, "coxa genuina," but for the posterior coxal region Walton's term meron has been here adopted. A narrow marginal area, the "coximarginal" sclerite, is frequently separated from the rest of the coxa by a suture, as is well shown in the Blattidæ (pl. III, C_m), *Corydalis* (fig. 17), etc. It is questionable whether this region corresponds to the area designated as "C_m (?)" in fig. 18 of the Trichopteran thorax, but the matter is of relatively slight importance.

That portion of the furci-sternum later spoken of as the pedal region (fig. 18, S_{3a}) frequently occurs as an elongate wedge-shaped process extending into the coxal region. In such cases the furci-sternum is so closely connected with the coxal region that the coxa usually loses much of its freedom of motion. This loss, however, is usually compensated by the greater mobility of the trochanter. Although the trochanter appears to consist of but one joint in many insects, the second joint is frequently hidden within the coxa, so that the "ditrochleate" condition is much commoner than is generally supposed. This fact has led to the formulation of the theory that one of the segments of the trochanter represents a second joint of the "meral" leg. As the author of this theory has not yet published his results, the improbability of such a hypothesis will not be discussed here.

The question as to whether or not the trochanter (or any part of it) is the upper portion of the femur, and the different theories regarding its homology, have but little bearing upon a study of the thoracic sclerites, and need not be further gone into here.

The Sternum.—MacLeay, '30, as has been stated, proposes that each segment is composed of four subsegments or annuli. Arguing from the fact that the tergum is divided into four regions, he states that the sternum likewise "ought to be" divided into four regions, and proposes for these the names præsternum, sternum, sternellum, and poststernellum. He has not figured, described or even seen these regions, but merely assumes their existence because of the condition found in the tergum. Indeed, Newport, '39, who adopts MacLeay's theory, states that these regions cannot all be found in any living insect, as the specialization and fusion of the subsegments have gone too far to leave any traces of the subdivisions in the sternum.

Despite Newport's statement to the contrary, four distinct subdivisions of the sternum are to be found in certain insects, as for example in the thorax of *Nemura* (pl. I). The terminology proposed by MacLeay has not been adopted for the following reasons: the names præsternum, sternum, sternellum, and poststernellum imply a relation between these subdivisions of the sternum and the præscutum, scutum, scutellum and postscutellum, as MacLeay intended that they should. This relation, however, does not exist, for these subdivisions do not represent four annuli, as assumed by MacLeay. Furthermore, there is this very serious objection to MacLeay's terminology, that the designation sternum cannot be applied to a subdivision of the sternal region, since Audouin employed the name sternum to designate the whole ventral region of the segment, and it is in the latter sense that the term is everywhere used. Lastly, since MacLeay has neither seen, figured nor described these regions, but merely assumes their existence based upon a fallacious hypothesis, his terminology is not binding.

Comstock, '02, although he makes no mention of MacLeay, has attempted to apply MacLeay's terminology to the sternal region. Un-

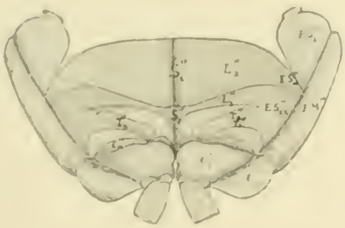


Fig. 17.

Fig. 18.

Fig. 17.—Corydalis.—Ventral view of mesothorax. Sternum and pleura spread out in one plane. Legs shortened.

Fig. 18.—Hydropsyche.—Ventral view of pro- and meso-thoracic sterna and pleura, spread out in one plane. Only the basal portions of the coxæ represented.

fortunately both of Comstock's figures (pp. 24 and 25) are of the metathoracic segment, and what he terms the sternellum is the first abdominal sternum. This accounts for the fact that he found no "poststernellum."

The Præsternum.—The name præsternum is the only one of Comstock's and MacLeay's terms here adopted, since only the præsternum in Comstock's figure of *Pteronarcys* (p. 24) has a corresponding region in the sternum of *Nemura* (pl. 1, S_1). This term, however, has been adopted without reference to Meinert's, '67, præsternum, mentioned in his description of *Japyx*.

The Japygidæ are such rare insects that the writer was unable to procure a specimen for dissection, and it is therefore impossible to state here, with any degree of certainty, to what extent the præsternum and poststernum of Meinert correspond to the regions here designated as the spini- and furci-sternum. Meinert gives no description of his præ- and post-sternum, other than the brief statement that they are chitinized double folds lying between the segments. Verhoeff, '04, and Börner, '03, make no attempt to employ Meinert's terms in their figures, but from a study of these illustrations one might hazard the opinion that Meinert's præsternum does not correspond to Comstock's, '02, præsternum at all, but is probably the furci-sternum, later described.

In all probability the præsternum is merely a portion of the large sternite lying behind it, and exists as a separate piece in but few insects. It is usually the first sternite to disappear, and its small size makes it of relatively little importance.

The Basi-sternum.—Just behind the præsternum is a large sternite forming the greater part of the sternal region. This sclerite, which may be termed the basi-sternum (pl. I, S_2), is frequently fused with the anterior laterale and katepisternal complex to form the "sterno-pleura" of Osten-Sacken, '84. The basi- and furci-sternum are usually symmetrically divided by a longitudinal furrow—the "mid-ventral" suture.

The Furci-sternum.—Immediately caudad of the basi-sternum is a somewhat smaller sternite, which bears the furca or internal forked process of the sternum. On this account the sclerite in question has been termed the furci-sternum. In the swiftly flying insects there is usually an internal "mid-ventral lamella," or ridge corresponding to the mid-ventral suture, and as this is frequently continuous with the shaft of the furca, it may appear as though the base of the furcal shaft arises in the basi-sternum. This, however, is only a secondary modification, for in the primitive forms the furci-sternum alone bears the paired apophyses. Externally it is a comparatively easy matter to distinguish between the basi-sternum and the furci-sternum, even when these are not entirely separate sclerites, as traces of the "intrasternal" suture (which separates the basi-sternal from the furci-sternal region) are retained in a great number of insects.

In the Gryllidæ the furci-sternum (which is very closely connected with the basi-sternum) is bent inward, so that its surface forms an angle with that of the basi-sternum. This bending inward of the furci-sternum causes it to be concealed by the sclerites which follow it and this doubtless accounts for the fact that Voss, '04, did not mention this region in his description of the thorax of Gryllus. The furci-sternum has been figured in the Coleoptera, but no attempt has been made to designate it by any especial term, except that Comstock, '04, terms it the antecoxal piece. This, however, is not the antecoxal piece of Comstock, '02, nor of Walton, '00, and most assuredly does not represent the antecoxal plates of Leconte, '61.

In the Blattidæ (pl. III), the furci-sternum of the meso- and meta-thorax is somewhat "T"-shaped, and the internal paired apophyses are borne one at the end of each arm of the "T". Each of the outer openings of the hollow apophyses is covered by a sclerite which may be termed the "tegmentary sclerite" (pl. III, *Tg*). The function of these "tegmentary" sclerites is doubtless to keep dust, etc., from collecting in the hollows of the apophyses. Miall and Denny, '86, state that there is no ante-furca (*i.e.*, prothoracic furca) in the cockroach; nevertheless paired apophyses which correspond to the meso- and meta-thoracic furca are to be found in the prothorax, if sufficient care be taken in searching for them. The specimen should be slit along the mid-dorsal suture, placed in 10% caustic potash, and left in the paraffin oven until the soft parts can be easily washed away by driving currents of water against them with a pipette. If the soft parts are removed with forceps the apophyses, which are very delicate and somewhat transparent, are usually plucked off before one discovers them. This doubtless accounts for the fact that these structures were not found by Miall and Denny.

The prothoracic furci-sternum of *Nemura* (pl. I, S'_3) is divided into two pieces; in the Trichoptera (fig. 18, S'_3) it is a single plate, drawn out longitudinally, while in the Blattidæ (pl. III, S'_3) it is a somewhat oval transverse sclerite.

In the meso- and meta-thorax, the furci-sternum is frequently separated from the basi-sternum merely by the "intra-sternal" suture. The furci-sternum is usually connected with the katepimeral complex by the narrow antecoxal laterale (fig. 3, L_b), and may likewise be connected with the epimeron by a bridge-like strip extending behind the leg. In the Trichoptera (fig. 18) this strip (S''_3-Em'') dips below the surface of the body, and reappears just before it is joined with the epimeron. In those insects in which the coxal cavity is enclosed posteriorally the coxæ are frequently closely approximated, and that portion of the furci-sternum between them is folded together. This is well shown in the Trichoptera (fig. 18), and in these insects the "pedal region" of the furci-sternum (S''_{3p}) extends along the mesal surface of the coxa, with which it is very closely connected.

It is perhaps of some interest to note that in the Trichoptera the pleural suture is continued in the "coxal suture" (between the meron and eucoxa), and is extended through the pedal region of the furci-sternum (*i.e.*, the "furcal suture") and up the other side of the insect. With the "intertergal" space (between the postscutellum and the remainder of the tergum) it may separate the segment into two rings, but, from reasons previously given, it is not at all probable that this indicates that the segment is double.

Behind the furci-sternum (S'_3) in *Nemura* (pl. I) are two plates (S'_{3pf}) which may be termed the post-furcal sclerites. These occur in but few insects, and are relatively unimportant.

The Spini-sternum.—Behind the furci-sternum is a smaller sternite, which bears an internal unpaired apophysis, the "spina," and may hence be termed the spini-sternum. This sclerite varies greatly in size and shape, and is never very large.

The prothoracic spini-sternum is the most constant, and occurs in a large number of insects. In the Blattidæ (pl. III, S'_4) it is very long and narrow, while the prothoracic spini-sternum of *Nemura* (pl. I, S'_4) is drawn out transversely into two wing-like processes. In the Trichoptera (fig. 18, S'_4) and Xyelidæ it is very small, and in many insects it is represented only by the endoskeletal "spina" or unpaired pophysis.

The prothoracic spini-sternum (pl. III, S'_4) usually lies just in front of the basi-sternum of the mesothorax, being much nearer to the mesothorax than to the prothorax. Again, in certain insects (*Corydalis* for example) the mesothoracic spini-sternum is united with the metathorax, but in each case the musculature clearly indicates to which segment the sclerite in question belongs.

In the Blattidæ (pl. III, S'''_4) the metathoracic spini-sternum is a distinct sclerite, but in *Nemura* (pl. I, S'''_4) it is united with the furci-sternum, and in most insects it is indistinguishably fused with the latter sternite. As has been mentioned, the præsternum is usually fused with the basi-sternum (except in a few insects such as *Nemura*, *Ectobia*, etc.) and the spini-sternum frequently lies directly in front of the basi-sternum. On this account it would seem very probable that Meinert's, '67, præsternum corresponds to the spini-sternum, rather than the præsternum of Comstock, '02, and the writer. This, however, is mere supposition, and cannot be determined until specimens of *Japyx* can be obtained for dissection.

Amans, '85, divides the sternum into two regions, the ante- and post-sternum. The former of these two regions may possibly correspond to the præ- and basi-sternum, and the latter to the furci- and spini-sternum, but it is impossible to determine this from Amans' descriptions, as he gives no boundaries for his two regions, other than the statement that they are separated by the coxal cavities. His post-sternum is apparently not the same as Meinert's, '67, and is surely not the poststernum of Petri, '99, as the latter sclerite is the meron. Amans' division of the sternum would be of no service in such insects as *Nemura*, or in the Blattidæ, where the coxal cavities do not divide the sternum at all. On this account, and because the sternum is not divided into two but into four sternites, Amans' terminology will not be further considered.

Voss, '04, states that the spini-sternum corresponds to Comstock's, '02, sternellum; but, as we have seen, Comstock's, '02, sternellum is the first abdominal sternum—except in the neck region, where his sternellum and sternum are doubtless detached portions of the præsternum. If Comstock had found the four sternal regions, he would doubtless have termed the spini-sternum the poststernellum, as he states (p. 25), "A poststernellum corresponding to the postscutellum has not been observed."

The Intersegmentalia.—In front of the laterale, on either side of the mesothorax of such insects as the Trichoptera, Xyelidæ, etc., is a sclerite which is doubtless a detached portion of the laterale. This sclerite may be termed the prælaterale (fig. 18, I_1). Surrounding the spiracle is a number of small plates, the "peritremal sclerites," and between them and the pleuron of the preceding segment is a detached portion of the pleuron, which may be termed the post-pleural sclerite (I_p). All of the above-mentioned sclerites will be included under the general term intersegmentalia, as they lie in the intersegmental membrane, more or less separated from the segment to which they belong.

Voss, '04, claims that the musculature of the first and second thoracic spiracles indicates that they belong to the segment behind which they are situated—that is, that the first is the prothoracic spiracle, and the second is the mesothoracic one. The third spiracle Voss assigns to the first abdominal segment, as do most other investigators.

Heymons, '95, concludes from his embryological studies that the spiracle does not belong to the segment preceding it, but to the segment in front of which it is located. He states that in the early embryonic stages, the primordia of the spiracles lie in the anterior portion of their corresponding segments; as development proceeds, the spiracle may migrate forward and become attached to the segment in front of it, but this is only a secondary modification.

Palmèn, '77, proposed the theory that the first thoracic spiracle may

Fig. 19.

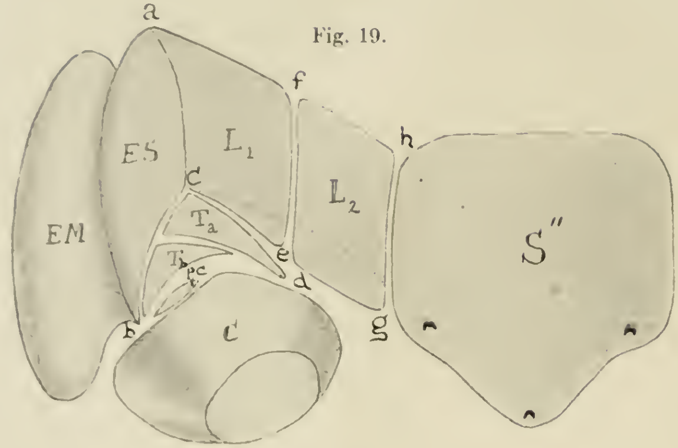
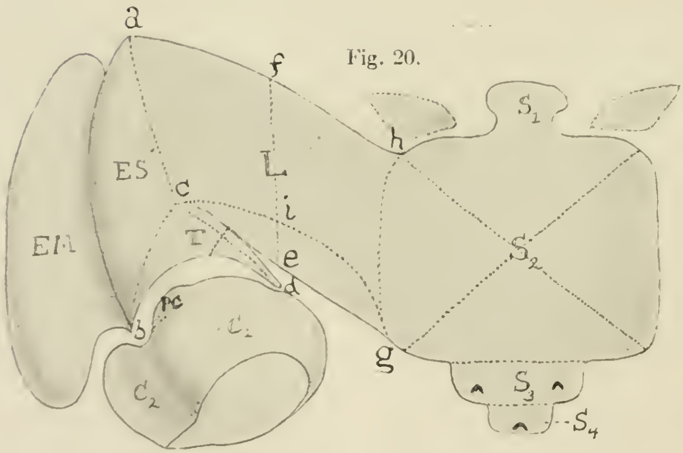
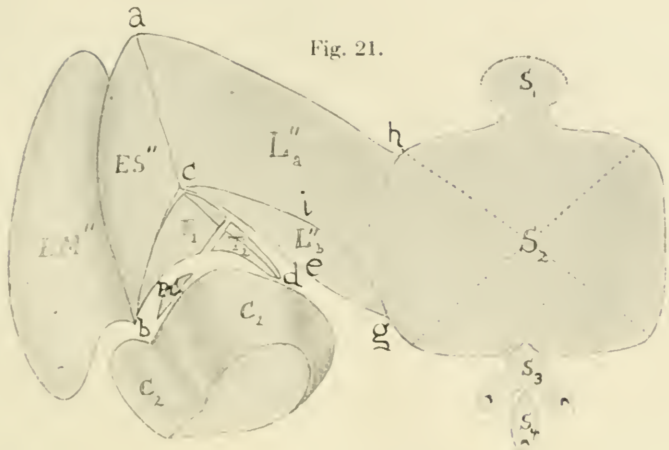


Fig. 20.



Figs. 19, 20 and 21.—Represent the ventral and lateral sclerites of a segment of the Cursoria (Orthoptera) spread out in one plane. Fig. 20 represents a hypothetical starting point in the formation of the pleural and sternal sclerites of these insects. The dotted lines indicate where divisions may occur. Fig. 19 represents the modification found in the Forficulidæ, and Fig. 21 that found in the Blattidæ. The diagonal lines in the basi-sternum (fig. 21) illustrate the condition found in the prothorax of Ectobia.

Fig. 21.



be prothoracic in some insects and mesothoracic in others, but this view does not seem to have a very wide acceptance.

The embryological proof seems to be in favor of Heymons view, and it is certainly the case that the musculature of such insects as the Blattidæ indicates that the spiracles belong to the segment behind them rather than to the preceding one. It is possible, however, to designate the spiracles as the first thoracic spiracle, second thoracic spiracle, etc., without specifying to which segment they belong, and this usage has been here adopted.

In the thorax of *Japyx* there occurs an extra spiracle, which has given rise to much discussion, but all speculation as to its homology can be of no value until the musculature and embryology of *Japyx* have been carefully studied with a view to determining this point.

In insects other than *Japyx,* most investigators now agree in designating the third spiracle as the first abdominal one. It would appear that Latreille's, '20–'22, designating the first abdominal segment the "segment mediaire" is responsible for much of the dispute which later arose concerning this segment, especially in the Diptera and aculeate Hymenoptera; and it is hard to understand why certain modern systematists—Schmiedeknecht, '07, for example—persist in using Latreille's confusing terminology. The first abdominal segment is the first abdominal segment, no matter where it is located, and if it be designated by its proper name, there can be no dispute as to its homology or that of its spiracle.

The Cervicum.—Between the head and the prothorax is a narrower neck region whose softer walls give a greater freedom of motion for the head. Embedded in the membranous integument of this region are a number of plates which serve to strengthen its walls, and furnish an articulation for the head (pl. III, C_{s1}, C_{s2}, etc.). The number of these sclerites varies greatly, being the most numerous in the Orthoptera, while in certain Coleoptera they are entirely wanting.

The neck region has been designated as the "Mikrothorax" by Verhoeff, '02, who at first considered this as a fourth segment of equal rank with the pro-, meso- and meta-thorax. There appear to be very grave doubts as to the correctness of this view, and since every investigator who has dealt with this subject terms the region in question the "neck," "Nacken," "cou," etc., according to the language in which the article is written, it seems preferable to designate the neck by the Latin term cervicum—a purely typographical designation, and one which is already implied in the expression "cervical plates," applied to its sclerites for more than eighty years. As has been stated, Verhoeff, '02, terms the cervicum the "Mikrothorax," and at first considered it a fourth thoracic segment similar to the pro- meso-, and meta-thorax. Later, however, he designated this "Mikrothorax" as one of the so-called complementary segments ("Vordersegmente") which he states can be found in front of each chief segment of the thorax; and, in addition, he described the remains of an intercalary segment in front of each of the above-mentioned thoracic segments.

In the earlier works there has been much speculation as to the origin of the cervical sclerites, and the question is still a very hotly debated one.

The first of these theories is that of Strauss-Durkheim, '28, who states that in the neck region of the Forficulidæ, one can find traces of the sterna and pleura of two segments formerly existing between the prothorax and the head. He had thus long ago expressed exactly the same theory, founded upon the same insects, that Verhoeff uses to illustrate his microthorax theory, yet Verhoeff states that "es klingt zwar sonderbar, dass bei den von Hunderten von Forschern studierten Insekten dergleichen (d. h. ein vorn am Thorax befindliches bisher übersehenes segment) noch gefunden werden soll, ist aber tatsächlich so."

The second theory is that of Huxley, '85. In describing the neck plates he says: "I think it is probable that these cervical sclerites represent the hindermost of the cephalic somites"—in other words, he regards the cervicum as the labial segment. Comstock, '02, adopts this view, and proposes that the appendages of the cervicum are the second maxillæ which leave their segment and, migrating forward, fuse to form the labium. He likewise makes use of Carriere's, '98, theory, that the salivary glands are modified tracheæ, to explain the fact that the prothorax has no spiracles. Comstock claims that the prothoracic spiracles are drawn along with the migrating maxillæ and, becoming united, form the opening of the salivary glands, into which their corresponding tracheæ have changed. He regards the lateral cervicals as the episternum and epimeron of the labial segment, and the internal process between these he explains as the endopleural apodeme of this "segment." Voss, '04, arrived at much the same conclusion from his study of the musculature, and Riley likewise considers that the cervical sclerites belong to the second maxillary segment, from his embryological investigations.

The third theory is that of Newport, '39, who proposes that the cervical sclerites are detached portions of the prothorax, and represent the paraptera (laterale?) of the meso- and meta-thorax. Börner, '03, likewise considers that the cervicals are prothoracic plates which have become detached from the sternal region of that segment.

In an earlier paper (Crampton, '08) it was suggested that the cervicals possibly correspond to the "intersegmentalia" found between the pro- and meso-thorax, and that the internal hollow process between the lateral cervicals might represent the remains of the trunk of a prothoracic trachea. It is quite comprehensible that a strongly chitinized tracheal stem, such for example as that of a Perlid, could serve as a muscle support, and, furthermore, it is possible for muscles to become attached to the tracheæ without interfering with their respiratory function, as is shown in certain Arachnoidea. In the case of the prothoracic tracheæ, it was proposed that their trunks, being in a favorable position to serve as a support for the head muscles, were preserved by a change of function, while the remaining portion of the tracheæ would be subjected to the same influences which caused the disappearance of the tracheæ in the buccal somites.

This theory would seem no more improbable than Comstock's, '02, view that the apodemes of the pro-, meso- and meta-thorax are tracheal vestiges, and is by no means so startling as Carriere's, '98, theory that the salivary glands are modified tracheæ. Indeed, the views of Palmèn, '77, Hatschek, '77, Wheeler, '89, and Carriere, '98, who claim that the tentorium (which likewise serves as a muscle support) is composed of modified tracheæ, render the theory that the cervical apodeme is a modified trachea all the more probable; and Palmèn's, '77, statement that there are traces of a tracheal invagination in the neck region of the embryo likewise lends weight to the above-mentioned theory. However, upon looking into the subject more carefully, it would appear that these theories dealing with a change of function have not been sufficiently well established, and it would be much simpler to explain the origin of the cervical apodeme as a drawing inward of a portion of the integument (or a corner of one of the sclerites) due to muscular tension.

Even if the theory of the tracheal nature of the cervical apodemes be rejected, this does not preclude the possibility that the peritremal sclerites which lay in front of the prothorax, may have taken part in the formation of the cervical sclerites. The musculature of these plates could admit of such an interpretation, and it would be only natural that such sclerites should be the most developed in the cervical region, where they would serve not only as supports for the attachment of the head muscles, but also as strengthening plates for the membrane of the neck.

Verhoeff's, '02, theory seems very improbable from the fact that no traces of a "mikrothoracic" segment are to be found in the embryo, and none of the segmental structures show any indications of a duplication. On the other hand, if the theory that the cervical sclerites represent the labial segment be accepted, how can one account for the occurrence of similar plates in front of the meso- and meta-thorax, for these surely cannot be likewise interpreted as labial segments?

Voss, '04, attempts to show from the musculature that the cervicum is the labial segment, but it would appear that the cervical muscles are for the most part attached to the occiput, and not to the labium. Furthermore, Riley, '04, himself states that the pleura of the labium are in the occiput region, yet he speaks of the lateral cervicals as the pleurites of the second maxillæ, without giving any reason for thus assigning them to the labial segment.

It is possible that certain detached portions of the labial segment may enter into the formation of the cervical sclerites, but it is not any more correct on this account to designate the cervicum as the labial segment, than it would be to term the intersegmentalia between the first two thoracic segments, the prothorax. The ventral cervical sclerites, termed by Comstock, '02, the labial sternum and sternellum, appear to be detached portions of the prothoracic sternum, while the lateral cervicals may possibly correspond to the "intersegmentalia" between the pro- and meso-thorax, and the dorsal cervicals are probably detached portions of the pronotum.[12]

[12] In assuming that the cervicals are formed partially from prothoracic sclerites, it must be borne in mind that certain other factors, such as mechanical friction, etc., may have produced certain of these sclerites.

In most Hymenoptera, the prothoracic pleura are very closely connected with the cervical sclerites, and in many insects of this family the pleura of the prothorax are almost indistinguishably fused with the lateral cervicals. On this account the term cervico-propleura has been here applied to the lateral portions of this region in the Hymenoptera.

If one observe a *Macroxyela* (or a *Tenthredo*), a wasp and an ant, in the order above mentioned, it may readily be seen that the cervico-propleura (fig. 13, *C.Pl*) gradually approach one another on the ventral surface, and almost completely conceal the small prosternum (fig. 14, *S'*). In such a case, the ventral portion of the cervico-propleura is almost without exception incorrectly termed the "prosternum," and even so careful an observer as Janet, '98, has been deceived in this respect. Indeed, Rheinhard, '65, terms the entire cervico-propleuron the prosternum, as does Schmiedeknecht, '07, and a number of others.

As has been stated, the cervical sclerites may represent the "intersegmentalia," and, in addition, certain of the neck plates doubtless owe their origin to mechanical friction. This brings us to the question of the formation of sclerites in general. The prevalent opinion is that the segments originally consisted of chitinized rings, which became split between the pleura and tergal region to accommodate the wing; and the pleura became separated from the sternal region to make room for the leg. This view, however, is not borne out by the facts of ontogenetic development, nor by the results of comparative morphological study. In all of the very active larvæ studied, the sclerites of the sternum and pleura form as islands (pl. IV) which later unite to form the chitinous integument. Again, in the adult stages of the lowest insects, such as *Japyx* for example, even though there are no wings present, the segments are not solid rings interrupted only at the base of the leg; but consist for the most part of small individual sclerites. It is likewise the case that within the same family the sclerites of the generalized forms are more numerous and distinct, while in the more specialized forms there is a marked tendency toward a fusion of the sclerites to form a solid ring; and even the segments themselves tend to become closely united.

With regard to the origin of the sclerites, there are a number of factors which might give rise to such chitinous plates. Among the chief of these causes is doubtless the stimulus of muscular tension, which would serve to produce a chitinized thickening of the integument at the points of origin and insertion. The sclerites thus formed would not only serve as firmer supports than the softer yielding integument about them, but would likewise serve as protective plates. Contact with external objects and mechanical irritation, such, for example, as the rubbing of one part upon another, doubtless play no inconsiderable rôle in the production of the sclerites. This was well illustrated in the case of a young cricket, whose developing wing pads, by rubbing on the tergum upon which they rested, left their outlines distinctly imprinted in its integument.

In addition to the formation of chitinous areas in the integument, by the stimulus of its tension, muscular stress may likewise bring about the breaking up of the large chitinous plates, or cause their division into smaller regions by producing the infolding of hollow ridges, as is shown in the tergum[13] and pleura. Again, it is quite evident that portions of chitinous regions may become detached by muscular tension and drawn into another region, as is shown in the case of the "migration" of the meron; such instances, however, are very rare, and this method would consequently play an unimportant rôle in sclerite formation.

However, the method of sclerite formation, the theories of segmental duplication, etc., are questions of minor interest, as the purpose of this paper is to deal with the comparison of the sclerites in the adult insect. With regard to the homologizations and terminology at present in vogue, it may readily be seen that entomologists are by no means agreed in these matters. Furthermore, the views here set forth frequently differ very radically from those of other investigators, and on this account the following list, which to some extent anticipates certain points which will be brought out in a subsequent publication, may be of some service, not only to furnish a résumé of the synonyms, etc., applied to the various sclerites, but also to give a brief outline of the results here reached:—

The Thorax.

THORAX—THORAX (Nitzsch, '18).

It is composed of the pro-, meso- and meta-thorax.

The "thorax" of Strauss-Dürkheim, '28, is the meso- plus the meta-thorax. Kirby, '28, following Fabricius, Linné and the other earlier writers, restricts the term thorax to the notum or tergum, but these obsolete usages need not be further discussed here.

PROTHORAX (′)[14]—PROTHORAX (Audouin, '20).

= Protothorax (Nitzsch, '18).

[13] It is quite uncertain whether the postscutellum was separated from the remainder of the tergum by muscular tension, or whether the postscutellum was originally itself a distinct sclerite.

[14] The signs given in parentheses refer to the method of indicating the region in question in the different figures.

= Collum (Knoch, 1801).
= Corselet (Strauss-Dürkheim, '28).
= Collier (Chabrier, '20).
= Manitruncus (Kirby, '28).
Verhoeff's, '04, "proterothorax" is the prothorax plus the cervicum.

MESOTHORAX (″)—MESOTHORAX (Nitzsch, '18).

METATHORAX (‴)—METATHORAX (Nitzsch, '18).
The meso- plus metathorax = Knoch's, 1801, pectus.
= Chabrier's, '20, trone alifère.
= Kirby's, '28, alitruncus.
= Strauss-Dürkheim's, '28, "thorax."
Verhoeff's, '04, "deuterothorax" = the mesothorax plus the metathorax and intersegmentalia.

THE SEGMENT.

TERGUM (*N*)—TERGUM (Audouin, '24).
= Notum (Burmeister, '32).
Escherisch's ('06) "mesonotum" (which, according to Burmeister, '32, means the notum or tergum of the mesothorax) is the mesothoracic scutum.

PLEURON (*Pl*)—PLEURON (Amans, '85).
= Pleura (Audouin, '24).
Kirby's, '28, "pleura" is the epimeron.
Burmeister's, '32, "pleura" is the episternum.

STERNUM (*S*)—STERNUM (Audouin, '24).
The sternum of Comstock, '05, is the basisternum. That of Comstock, '02, is the basi- plus furci-sternum, except in the cervical region, where it is doubtless a portion of the præsternum.

THE TERGUM.

(For example, that of the Mesothorax.)

PRÆSCUTUM (N''_1)—PRÆSCUTUM (Audouin, '32).
(The other uses of the word præscutum are given under the heading Mediscutum.)
= Proterophragma (Kleuker, '83).
= Antedorsum (Amans, '85). In the Diptera, Amans', '85, and Petri's, '99, antedorsum is the mediscutum.

SCUTUM (N''_2)—SCUTUM (Audouin, '32).
Voss', '04, scutum is the scutum plus the scutellum. The scutum of Hammond, '81, Künkel, '75–'81, Brauer, '82, Lowne, '90–'92, Packard, '98, Hewitt, '07, a. o., is the parapsidoscutum.
= Dorsum (Amans, '85).
(According to Audouin, '32, the term dorsum refers to the whole dorsal surface of the insect.)
In the Diptera, Amans', '85, and Petri's, '99, "dorsum" is the parapsidoscutum.

MEDISCUTUM (N''_{2a})—MEDISCUTUM (Crampton, '08).
= The præscutum of Hammond, '81, Künkel, '75–'81, Brauer, '82, Lowne, '90–'92, Packard, '98, Hewitt, '07, a. o.
= Escherisch's, '06, "mesonotum."

PARAPSIDOSCUTUM (N''_{2b})—PARAPSIDOSCUTUM (Crampton, '08).
= In part the parapsides of MacLeay, '30.
= The scutum of Hammond, '81, a. o.
= Escherisch's, '06, proscutellum of the mesothorax (but according to Audouin, '24, the term proscutellum refers to the prothoracic scutellum alone).
= Emery's, '00, "paratteri" (*i.e.*, parapsides?).

PTERYGODA (*Pt*)—"PTERYGODES" (Latreille, '20–'22).
= Tegulæ (Kirby, '28).

= Squamulæ (MacLeay, '30).
= Hypoptere (Audouin, '25).
= Paraptere (Audouin, '25).
Hammond's parapteron is the anepisternum.
= "Hautpolster" (Voss, '04).
SCUTELLUM (N''_3)—SCUTELLUM (Audouin, '24).
= Postdorsum (Amans, '85).
POSTSCUTELLUM (N''_4)[15]—POSTSCUTELLUM (Audouin, '24).
= Subpostdorsum (Amans, '85).
= Part of Kleukers, '83, deuterophragma.
= "Postscutum" (Voss, '04).
Brauer, '82, regards the upper portion of the dipteran postscutellum as the entire postscutellum, and terms its lower portion the "phragma."
MEDIOPHRAGMITE (N''_4a)—MEDIOPHRAGMITE (Crampton, '08).
PLEUROPHRAGMITE (N''_4b)—PLEUROPHRAGMITE (Crampton, '08).
The mesothoracic pleurophragmite is Lowne's, '90–'92, "lateral plate of the metathorax."
The mesothoracic pleurophragmite is Brauer's, '82, "? Episternum des Metathorax"—"wahrscheinlich der Rest des Præscutums des Metathorax und zwar homolog mit der Ecke vor der Flügelwurzel."
= Hammond's, '81, "uncertain plate."
= Petri's, '99, metathoracic antepleura (*i.e.*, episternum). The piece in question, however, belongs to the mesothorax.
= Osten-Sacken's, '64, "metapleura" (the term metapleura refers to the pleura (*i.e.*, epimera and episterna) of the metathorax).
PARAPLEURON (N'''_4bb)—PARAPLEURE (Kolbe, '93).
Knoch's, 1801, "parapleurum" is the epimeron.
Cuvier's, '28, "parapleure" is the epimeron.
Kirby's, '28, "parapleura" is the epimeron.
Burmeister's, '32, "parapleura" is the episternum.
Fieber's, '61, "parapleurum" is the epimeron.
Voss, '04, "parapleura" is the episternum.
Lacordaire's, '54, "parapleures" are the epimera and episterna.

THE PLEURON (OF THE MESOTHORAX).

EPIMERON (*Em''*)—EPIMERON (Audouin, '24).
= Pleurit (Heymons, '99).
= Parapleura (Kirby, '28, a. o.).
= Pleura (Burmeister, '32, a. o.).
= Anopleure (Verhoeff, '03).
= Postpleuron (Amans, '85).
Petri's, '99, mesothoracic "postpleura" is the anepimeron. On the other hand, his metathoracic "postpleura" is the anepisternum. Lowne's, '90–'92, epimeron is the katepimeron. Brauer's, '82, epimeron is the anepimeron.
Hammond's, '81, epimeron is the meron.
Sharp's, '95–'99, "epimeron?" in his figure of *Blabera*, is the trochantinus major.
ANEPIMERON (*EM''*a)—ANEPIMERON (of this paper).
= Hyperepimeron (Crampton, '08).
= Lowne's, '90–'92, episternum.
= Brauer's, '82, entire epimeron. The anepimeron of the mesothorax, Petri, '99, terms the postpleura (*i.e.*, epimeron), but his metathoracic postpleura is the anepisternum.
KATEPIMERON (*EM''*k)—KATEPIMERON (of this paper).
= Hypoepimeron (Crampton, '08).
= Lowne's, '90–'92, entire epimeron.
The katepimeron of the mesothorax, Petri, '99, terms the metathoracic antesternum.

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[15] According to Snodgrass, '08, Verhoeff's pseudonotum and Berlese's acrotergite of the first abdominal segment are homologous with the postscutellum.

EPISTERNUM (ES'')—EPISTERNUM (Audouin, '24).
= Parapleura (Burmeister, '32).
= Pleura (Kirby, '28).
= Coxopleure (Verhoeff, '03) in *Forficula*. In the Blattidæ, Verhoeff's coxopleure is the episternum plus the anterior laterale.
Comstock's, '02, and Walton's, '00, episternum in the Blattidæ is the episternum plus the anterior laterale.
Lowne's, '90–'92, episternum is the anepimeron.
Brauer's, '82, episternum is the katepisternum.

ANEPISTERNUM (ES''_a)—ANEPISTERNUM (of this paper).
= Hyperepisternum (Crampton, '08).
= Lowne's, '90–'92, "lateral plate."
= The episternum of Brauer, '82, a. o.
= Hammond's, '81, parapteron.
= Petri's, '99, antepleura of the mesothorax. On the other hand, his metathoracic antepleura is the mesothoracic pleurophragmite.

KATEPISTERNUM (ES''_k)—KATEPISTERNUM (of this paper).

KATEPISTERNAL COMPLEX (ES''_x)—KATEPISTERNAL COMPLEX (of this paper).

LATERALE (L'')—LATERALE (Crampton, '08).
= Voss, '04, coxosternum.
Börner's, '03, coxosternum is the epimeron, episternum and laterale.
Verhoeff's, '97, coxasternum is the fusion product of the sternum and coxæ.

ANTERIOR LATERALE (La)—ANTERIOR LATERALE (of this paper).

ANTECOXAL LATERALE (L_b)—ANTECOXAL LATERALE (Crampton, '08).
= "Antecoxal piece" (Walton, '00).
Comstock's, '02, "antecoxal piece" is the antecoxal trochantin.
Comstock's, '05, "antecoxal piece" is the furci-sternum.
Leconte's, '61–'62, "antecoxal plates" are the lateral cervicals.
= Second antecoxal piece (Comstock, '02).
= Verhoeff's, '03, katopleure in the Blattidæ. On the other hand, his katopleure in the Dermiptera is the episternal laterale. In the prothorax of Echinosoma, his katopleure is the sternal laterale. Börner's, '03, katopleure in the mesothorax of *Anisolabis* is the episternal and sternal laterale. In prothorax of *Anisolabis* it is the sternal laterale and the posterior lateral cervicals. In the Blattidæ his katopleure is the antecoxal laterale.

EPISTERNAL LATERALE (L''_1)—EPISTERNI-LATERALE (Crampton, '08).
= Verhoeff's, '03, katopleure in the Dermiptera. In the Blattidæ, however his katopleure is the antecoxal laterale.

STERNAL LATERALE (L''_2)—STERNI LATERALE (Crampton, '08).
= Verhoeff's, '03, "Vorplatte" of the mesothorax in the Blattidæ. In the Blattid prothorax his "Vorplatte" is a lateral cervical.

TROCHANTINUS (T)—TROCHANTINUS (MacLeay, '30).
= Trochantine (Audouin, '24).
= Rotule (Strauss-Dürkheim, '28).
= Præcoxal plate (Voss, '04).

ANTECOXAL TROCHANTIN (T_a'')—ANTECOXAL TROCHANTIN (Crampton, '08).
= Antecoxal piece (Comstock, '02).
The other usages of the term antecoxal piece are given under the term antecoxal laterale.

COXAL TROCHANTIN (T_b'')—COXAL TROCHANTIN (Crampton, '08).
= Comstock's, '02, entire trochantinus.

TROCHANTINUS MAJOR (T'_1)—TROCHANTINUS MAJOR (Crampton, '08).
= Sharp's "epimeron?" in Blabera.

TROCHANTINUS MINOR (T'_2)—TROCHANTINUS MINOR (Crampton, '08).
= Sharp's entire trochantinus in *Blabera*.

EUCOXA (C'''_1)—EUCOXA (Verhoeff, '04).
= Coxa genuina (Walton, '00).

MERON (C'''_2)—MERON (Walton, '00).
Börner's, '03, meron is the epimeron, episternum and laterale.
= Metacoxa, Verhoeff, '04.
The term metacoxa means the coxa of the metathorax.

Petri's, '99, poststernum of the mesothorax is the meron. On the other hand, his metathoracic poststernum is the katepimeron.

Brauer's, '82, Lowne's, '90–'92, and Hewitt's, '07, sternum of the dipteran metathorax is the mesothoracic meron.

According to Packard, '98, the meron is the trochantinus, while Sharp, '95–'99, designates it as a fold of the epimeron.

STERNUM (S'')—STERNUM (Audouin, '24).

The sternum of Comstock, '02, is the basi- and furci-sternum, except in the cervical region where it is doubtless a detached portion of the præsternum.

Comstock's, '05, sternum is the basi-sternum.

Brauer's, '82, mesosternum is the mesothoracic katepisternal complex, the laterale and the basisternum. On the other hand, his metasternum is the mesothoracic meron.

Petri's, '99, antesternum of the mesothorax is likewise the katepisternal complex, laterale and basisternum (as in the case with Lowne's, '90–'92, "plastron," and Osten-Sacken's, '64, "sternopleura"); his metathoracic antesternum, however, is the mesothoracic katepimeron.

PRÆSTERNUM (S''_1)—PRÆSTERNUM (Comstock, '02).

Meinert's, '67, præsternum is probably the spinisternum.

BASISTERNUM (S''_2)—BASISTERNUM (Crampton, '08).

FURCISTERNUM (S''_3)—FURCISTERNUM (Crampton, '08).

= Comstock, '04, "antecoxal piece."

SPINISTERNUM (S_4)—SPINISTERNUM (Crampton, '08).

CERVICUM (Cs)—CERVICUM (Crampton, '08).

= Mikrothorax (Verhoeff, '02).

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Reference Letters.

—′, —″, or —‴—Indicates that the sclerite in question belongs to the pro-, meso- or meta-thorax.

—⁗, —′⁗, etc.—Indicates that the sclerite is abdominal.

AD .... Apodeme.
AP .... Apophysis.
C .... Coxa.
C_1 .... Eucoxa.
C_2 .... Meron.
C_m .... Coximarginal sclerite.
CS .... Cervical sclerites.
CS_1 .... Ventral cervicals.
CS_2 .... Lateral cervicals.
CS_{2x} .... Posterior lateral cervicals.
CS_3 .... Dorsal cervicals.
$C.Pl$ .... Cervico-propleuron.
EM .... Epimeron.
EM_c .... Costal sclerite.
EM_a .... Anepimeron.
EM_k .... Katepimeron.
ES .... Episternum.
ES_a .... Anepisternum.
ES_m .... Median region.
ES_k .... Katepisternum.
ES_{kx} .... Katepisternal complex.
F .... Furca.
I .... Intersegmentalia.
I_{pl} .... Praelaterale.
I_{pp} .... Postpleural sclerite.
I_{pt} .... Peritremal sclerites.
L .... Laterale.
L_a .... Anterior laterale.
L_b .... Antecoxal laterale.
L_1 .... Episternal laterale.
L_2 .... Sternal laterale.
L_3 .... Hyposternal laterale.
N .... Notum or tergum.
N_1 .... Præscutum.
N_2 .... Scutum.
N_{2a} .... Mediscutum.
N_{2b} .... Parapsidoscutum (or parapsides).
N_3 .... Scutellum.
N_4 .... Postscutellum.
N_{4a} .... Mediophragmite.
$N\ b$ .... Pleurophragmites.
N_{4bs} .... Superior region of the pleurophragmite.
N_{4bi} .... Inferior region of the pleurophragmite.
N_{4bp} .... Pleurophragmal sclerite or parapleuron.
PC .... Complementary coxal plate.
Pl .... Pleuron.
S .... Sternum.
S_1 .... Præsternum.
S_2 .... Basisternum.
S_3 .... Furcisternum.
S_{3p} .... Pedal region of furcisternum.
S_{3pf} .... Postfurcal sclerites.
S_4 .... Spinisternum.
SP_1, SP_2 .... First and second thoracic spiracles.
SP_a .... Abdominal spiracle.
T .... Trochantin or trochantinus.
T_a .... Antecoxal trochantin.
T_b .... Coxal trochantin.
T_1 .... Trochantinus major.
T_2 .... Trochantinus minor.
TG .... Tegmentary sclerites.
TR .... Trochanter.

Explanation of Plates I–IV.

Plate I.—Nemura(?). Ventral view of thorax and first two abdominal segments. Head removed. Legs, abdomen and wings shortened.

Plate II.—Anisolabis and Forficula.—Combination figure. Three-quarters view showing venter, flank, and edge of the dorsum. Head and greater portion of the legs and abdomen removed. Prothorax based on Anisolabis; meso- and meta-thorax as in Forficula.

Plate III.—Periplaneta.—Three-quarters view of thorax and first abdominal segment. Prepared and oriented as fig. XXIII.

Plate IV.—Carabid Larva.—Three-quarters view of metathorax and first two abdominal segments. The sclerite labelled "parapleurite" should be designated "paratergite."

FEBRUARY 2.

ARTHUR ERWIN BROWN, Sc.D., Vice-President, in the Chair.

Twenty-eight persons present.

The Publication Committee reported that a paper entitled "Action of Chemical Solutions on Bud Development: An Experimental Study of Acclimatization," by John W. Harshberger, Ph.D., had been presented for publication (January 28, 1909).

THOMAS H. MONTGOMERY, Ph.D., made a communication on the architecture of spiders. (No abstract.)

FEBRUARY 16.

The President, SAMUEL G. DIXON, M.D., in the Chair.

One hundred and thirty-nine persons present.

The Publication Committee announced the reception of a paper entitled "An Orthopterological Reconnoissance of the Southwestern United States: Part II, New Mexico and Western Texas," by James A. G. Rehn and Morgan Hebard (February 4).

The special business of the meeting being the commemoration of the centenary of the birth of CHARLES DARWIN and of the fiftieth year of the publication of the ORIGIN OF SPECIES, the President spoke of the influence of the doctrines of Natural Selection and Evolution on the development of thought and the progress of humanity.

DR. ARTHUR ERWIN BROWN referred to the fact that the Academy had been the first society in America to recognize the importance of Darwin's work and quoted from his letter to Lyell of May 8, 1860, in which he says: "This morning I got a letter from the Academy of Natural Sciences of Philadelphia, announcing that I am elected a Correspondent. . . . . It shows that some naturalists there do not think me such a scientific profligate as many think me here."[1]

[1] *Life and Letters of Charles Darwin*, including an Autobiographical Chapter. Edited by his Son, Francis Darwin. 1887. Vol. II, p. 100.

Dr. Brown also read a letter addressed by Darwin to Dr. Joseph Leidy under date of March 4, 1860, acknowledging receipt of publications, expressing appreciation of Dr. Leidy's paleontological work, and returning thanks for his support of the doctrine of Natural Selection.

Edwin G. Conklin, Ph.D., then read a memoir of Darwin, dwelling on the importance of his work in science and on the relation of the doctrine of Natural Selection to modern thought.

A collection of Darwin's works and his letter of acknowledgment of election as Correspondent of the Academy were exhibited.

The following were accepted for publication:

ACTION OF CHEMICAL SOLUTIONS ON BUD DEVELOPMENT: AN EXPERIMENTAL STUDY OF ACCLIMATIZATION.

BY JOHN W. HARSHBERGER, PH.D.

The phenomena of vegetation lend themselves to experimental study. This experimentation is necessary, because the laws which control the periodicity of plants can be determined only by altering the conditions under which such plants grow. Interest in the periodic growth of plants is perhaps keenest in the Spring, when everyone is observing, in a more or less detailed manner, the gradual awakenment of vegetation. The opening of shrub and tree buds has, as a result of this human interest, long engaged the attention of botanists. The phenomena of bud opening, and the laws to be deduced therefrom, have not been studied experimentally. Every student has been struck by the orderly sequence of the process in any particular district or climate. Each species seems to fill its allotted place in the line of bud development. The question arises, is this sequence due to heredity, to the character of the reserve food, or the disposition of this reserve food in the buds and twigs of the plant, or is it due solely to the climatic conditions, such as temperature and humidity? The experiments which follow will furnish data which it is hoped will contribute to the answer of the above questions. The only other experiments of a similar nature that have come to the writer's knowledge are those of DeCandolle, mentioned by Schimper[1] as follows: "Zweige von Holzgewächsen zeigen das gleiche Verhalten wie Samen. A. de Candolle trieb Zweige von Populus alba, Carpinus betulus, Catalpa bignoniaefolia [bignonioides?] und Liriodendron tulipifera die sich theils in Montpellier theils in Genf entwickelt hatten vom 4 Februar an in einen Raume dessen Temperatur während der Dauer des Versuches zwischen + 7° und + 10° schwankte. Die Genfer Zweige entwickelten ihre Laub-knospen früher als die aus Montpellier stammenden."

Experiments of the First Year.

Eight species were studied the first year in which the experiments were conducted. Twigs from *Liriodendron tulipifera*, *Quercus palustris*,

[1] Schimper, A. F. W., *Pflanzengeographie auf physiologischer Grundlage*, p. 56.

Populus monilifera, *Tilia americana*, *Magnolia conspicua*, *Æsculus hippocastanum*, *Salix babylonica* and *Forsythia viridissima* were placed in various chemical solutions described below, and at the same time plants near the University were observed under more normal conditions out of doors. Twigs cut from these trees were placed in the chemical solution on March 1, 1907. Under each species will be mentioned the chemical solutions used and the reaction which took place. The date of the reaction will be given in each particular case. The species of the first year's experimentation are arranged in the order of their response. The plants were kept in a greenhouse where the temperature range was about 25 degrees. At night the temperature descended to 65° F., while on sunny middays it rose as high as 90° F.

Forsythia viridissima.—The following chemical solutions were used with this species. One per cent. chromic acid filled several of the bottles; ordinary stock picric acid diluted four times with water; ammonium nitrate (two grams) dissolved in 200 cubic centimeters of water; five decigrams of sodium chloride in fifty cubic centimeters of water; five drops chemically pure nitric acid in fifty cubic centimeters of water; menthol water; two bottles filled with 800 cubic centimeters of filtered water; two grams ammonium sulphate in 600 cubic centimeters of water; 100 cubic centimeters of ether in 500 cubic centimeters of water; 200 cubic centimeters of chemically pure ammonium hydrate in 1,000 cubic centimeters of water; a saturated solution of corrosive sublimate in 1,000 cubic centimeters of water; ten drops of chemically pure hydrochloric acid in fifty cubic centimeters of water.

One week after the experiments were begun buds of this species showed a reaction. The most marked was with the ammonium hydrate solution when, on March 8, it was found that all of the buds above the middle ones were well opened, but the leaves remained tightly folded. There was a steady advance in this solution until March 20. On March 11 the flower buds were ready to open, and on March 15, four days later, the buds were expanded, while on March 18 the flowers had withered and a few green leaves had appeared. After March 25 there was no advance, and on March 28 the twigs were dead. Response was shown on March 8 by the twigs in picric acid, ammonium nitrate, sodium chloride, hydrochloric acid, ammonium sulphate, ether water, corrosive sublimate and pure water. The most marked response was in the solution with five drops of hydrochloric acid, where the buds had burst, and in the picric acid, where the three topmost buds had burst. The response in the other cases was shown by an easement of the buds. In the pure water the buds were green. On March 8 no reaction was shown by the twigs in the chromic acid, nitric acid, menthol water and one bottle of filtered water. In fact the twigs in the nitric acid did not respond and were dead by March 20. The buds, however, in the menthol water, chromic acid and filtered water had responded on March 11. The subsequent history of the twigs in the different solutions is as follows:

Chromic Acid.—March 11: The buds of the two upper nodes were developed. March 15: The two topmost buds were expanded, but the leaves were still folded. March 18: The leaves of the top pair of buds were fully expanded, with the terminal bud one and a half inches long. March 25: No advance.

Picric Acid.—March 11: Upper buds were green. March 15: A few end buds were green, but not opened. March 18: Upper buds burst, leaves green. March 20: Leaves hardly unfolded. March 25: No advance. March 28: Leaves hardly unfolded. March 25: No advance. March 28: Twigs dead.

Ammonium nitrate.—March 11: All of the buds were burst and some of the leaves were expanded. March 15: Nearly all of the buds showed leafy branches one and a half inches long, with two to three pairs of leaves expanded. March 18: All of the green leaves were spotted and unhealthy looking. March 20: All of the expanded leaves were dead, and on March 28 all of the twigs were dead.

Sodium chloride.—March 11: The three upper buds were enlarged and ready to burst. March 15, March 18, March 20, March 25: No advance in the development of these buds took place, and on March 28 the twigs were dead.

Hydrochloric Acid (five-drop solution).—March 11: The buds were burst open, but the leaves were still folded together; only the lowermost leaf was expanded. March 15: The upper two pairs of buds had grown to a branch two inches long, with four pairs of opposite leaves unfolded. March 18, March 20: All leaves of the branches expanded. March 25, March 28, April 1: No advance. April 5: Twig dead.

Menthol Water.—March 11: Middle buds burst. March 15: Three buds were green, but not fully opened. March 18, March 25, March 28, April 1: No advance. April 5: Twig dead.

Filtered Water (A).—If the twig in this experiment is contrasted with the twig in the other bottle of water, it is evident that its vitality must have been impaired in some way before the experiments began, hence the results obtained. On March 8 there was no response, as in the other case March 11. The middle and lower buds had burst, the leaves were flat but still erect. March 15: All of the buds had developed into leafy branches two and a half inches long. March 18: All of the branches measured two and a half inches long. March 20: Slow advance. March 25, March 28, April 1: No advance. April 5: Twigs withered.

(*B*) March 11: Leaf buds eased, two flower buds were ready to open. March 15: All of the flower buds were open, leaf buds one-half inch long. March 18: All of the branches were green and two inches long. March 20: The green branches were slowly growing. March 25, March 28: The twigs and leaves were making rapid growth. April 1, April 5, April 13: The growth continued.

Ammonium sulphate.—March 11: One flower bud showed signs of opening. March 15: Three flower buds advanced to stage of the first, but still tightly closed, no leaf buds open. March 18, March 20, March 25: No advance. March 28: Twig dead.

Corrosive sublimate.—March 11: Lower pair of leaves in each of the leaf buds were expanded. March 15: Branches were two inches long and three pairs of leaves expanded. March 18: Branches two to two and one-half inches long, flowers all withered. March 20: Leaves of twig all flat. March 25: Leaves were all expanded and had grown in size. March 28: Leaves began to wither. April 1: Twigs unhealthy.

Hydrochloric Acid (ten-drop solution).—March 11: Middle buds of twig eased. March 15: Buds were three-quarters of an inch long, leaves were not unfolded. March 18: Three buds were burst, but on March 20 no advance in these buds was shown. March 25, 28, April 1: No advance in twig. April 5: Twig dead.

MAGNOLIA CONSPICUA.—Only two solutions were used in experimenting with the twigs of this tree. Two grams of ammonium nitrate were dissolved in 200 cubic centimeters of water. Filtered water was also used as a control. On March 8 the twigs did not show response in either liquid. The first response was shown on March 11.

Ammonium nitrate.—March 11: The large terminal bud was burst, white petals shown at the base. March 15: Bud opened, but no additional development. March 18: No advance. March 20: Terminal buds unhealthy. March 20: All the buds were dead.

Filtered Water.—March 8: No response. March 11: Flowers fully open with the petals reflexed, but the stamens still closed. March 15: Flower buds withered. March 18: First foliage leaf expanded. March 20: The twig was a little more advanced. March 25, March 28, April 1: Twig was dead.

ÆSCULUS HIPPOCASTANUM.—Five solutions were used with the horse chestnut, viz., five drops of hydrochloric acid in fifty cubic centimeters of water; five drops of chemically pure nitric acid in fifty cubic centimeters of water; three bottles contained filtered water.

Hydrochloric Acid.—March 11: Buds not burst, but resin abundant and more fluid. March 15, March 18, March 20: No change reported in the record of this branch. March 25: Bud burst at tip. March 28: Bud nearly fully burst, leaves still tightly folded. April 1, April 5: No change. April 13: Twig dead.

Filtered Water (*A*).—March 11: Terminal bud very resinous. March 15: Terminal buds well expanded. March 18: Large buds well expanded, but leaves still tightly folded. March 20: Terminal buds with leaves still erect. March 25: Leaves of terminal bud distinct and horizontal, but segments still folded together, covered with rusty hairs. March 28: Leaflets beginning to separate. April 1, April 5: No advance. April 13: Twig dead.

(*B*) No response on March 8 and March 11. March 15: One lateral bud with woolly leaves showing. March 18: Leaves of two lateral buds flattened out horizontally. March 20: All of the leaves of the lateral buds placed horizontally. March 25: Leaves began to lose their tomentum. March 28: Leaflets began to separate. April 1, April 5: No change. April 13: Twig dead.

(*C*) March 11: Buds became sticky, resinous, inner scales began to show between the outer scales. March 15: Buds well expanded, but not fully burst. March 18: Buds burst, young leaves still folded together. March 20: Bud fully open, one leaf horizontal. March 25: Leaves all horizontal, covered with tomentum. March 28: Leaflets still folded together. April 1: Leaves somewhat withered.

POPULUS MONILIFERA.—The following chemical solutions were used in experimenting with the twigs of the Carolina poplar: Chromic acid, one per cent.; filtered water; five decigrams of sodium bicarbonate in fifty cubic centimeters of water; five decigrams of sodium chloride in fifty cubic centimeters of water; five drops of chemically pure sulphuric acid in 100 cubic centimeters of water; ten drops of chemically pure hydrochloric acid in fifty cubic centimeters of water; twenty drops of chemically pure sulphuric acid in 100 cubic centimeters of water; menthol water; filtered tap water; 100 cubic centimeters of ether in 500 cubic centimeters of water; 200 cubic centimeters chemically pure ammonium hydrate in 1,000 cubic centimeters of water; two grams of ammonium sulphate in 600 cubic centimeters of water; saturated corrosive sublimate solution diluted in 1,000 cubic centimeters of water.

No response was noticed in any of the twigs on March 8 and March 11, except in the case of the twig in ether water which showed a slight easement of the upper buds. This stimulus was only a temporary one, because on March 11 no enlargement was noticeable. On March 15, the twigs in water, menthol water, ether water, ammonium hydrate, ammonium sulphate and corrosive sublimate had responded and the extent of this response will be indicated in what follows. It should be noted, however, that the buds on the twigs on March 15 in the ammonium hydrate solution had burst and the leaves were about to unfold, while the buds of the twigs in the filtered water, in the corrosive sublimate and in the ammonium sulphate were just beginning to burst open.

Chromic Acid (one per cent).—No response whatever on any of the dates.

Water (*A*).—March 15: Buds enlarged and green, but not open. March 18: Large buds burst, leaves about to unfold. March 20: Lateral buds open, one leaf began to unfold. March 25: Lateral buds with first leaves partly unfolded, terminal buds burst. March 28: Terminal buds fully expanded, one or two leaves unfolded. April 1: Two leaves of lateral bud expanded. April 5: No advance. April 13: Leaves broad, bright green, twig fresh.

Sodium bicarbonate.—No reaction.

Sodium chloride.—No response, twigs eventually killed.

Sulphuric Acid (five-drop solution). No response until March 18 when the buds were slightly enlarged. March 20: A slight additional enlargement. March 25, March 28, April 1: No advance. On April 13 the twig was dead.

Hydrochloric Acid.—No response.

Sulphuric Acid (twenty-drop solution).—No reaction, eventually killed.

Menthol Water.—March 15: Terminal bud enlarged, but not open. March 18: Terminal bud burst, but the leaves are tightly folded. March 25: Terminal bud with bud scales separated, leaves not expanded. March 28, April 1, April 5: No advance. April 13: Twigs dead.

Filtered Water (*B*).—March 15: Buds enlarged. March 18: Buds burst. March 20: Buds well open, first leaf about to expand. March 25: Leaves of terminal bud all fully expanded. March 28: Leaves of upper two buds flattened. April 1: Green leaves fully developed. April 5: Adventitious roots appeared, leaves fully matured.

Ether Water.—March 15: Buds large and very green, about to burst.

March 18: Two lateral buds with leaves expanded, most advanced developed in all the solutions. March 20: Some buds fully open, with one or two leaves flattened horizontally. March 25: No advance. March 28: Majority of twig leaves beginning to unfold. April 1: Leaves were all fully expanded. April 13: Twig dead.

Ammonium hydrate.—No response until March 15 when one of the lateral buds had burst and leaves were about to unfold. March 18: Leaves nearly unfolded. March 25, March 28: No advance. April 1: Twigs dead.

Filtered Water (*C*).—No response until March 15 when buds were found enlarged. March 18: Buds expanded and leaves flattened out. March 25: Terminal and lateral buds with leaves fully expanded. Rapid growth of this twig continued until April 13 when the experiments were concluded.

Ammonium sulphate.—March 15: Large buds about to open. March 18: Leaves pretty well expanded. March 20: One leaf of lateral bud fully expanded, three others almost so. March 25: Leaves of topmost lateral bud nearly expanded. March 28: No advance. April 1: All of the twigs had gone bad.

Corrosive Sublimate.—March 15: Buds enlarged. March 18: Buds burst and about to unfold. March 20: Leaves of terminal bud well unfolded. March 25: Some of the leaves expanded. March 28: Buds fully burst, two or three of the leaves were green and flat. April 1: Not much advanced, twig still fresh. April 1: Leaves fresh and green, broadly expanded. April 13: Twig dead.

Liriodendron tulipifera.—The chemicals used in the experiments with the tulip poplar were as follows: Five decigrams of sodium chloride dissolved in fifty cubic centimeters of water; filtered water; five drops of chemically pure sulphuric acid in 100 cubic centimeters of water; five drops of chemically pure hydrochloric acid in fifty cubic centimeters of water; five drops chemically pure nitric acid in fifty cubic centimeters of water; twenty drops chemically pure sulphuric acid dissolved in 100 cubic centimeters of water.

The twigs did not respond in any of the above-mentioned solutions until March 11, when those in the twenty-drop solution of sulphuric acid and in one bottle of filtered water showed a slight separation of the two outer bud scales. The record for the other twigs is somewhat unusual and is here given.

Sodium chloride.—Absolutely no response.

Filtered Water (*A*).—The twigs did not respond until March 18.

when two of the lateral buds split open, the inner pair of green stipules visible. March 25: A lower lateral bud with one leaf expanded, another leaf was folded. March 28: Another lower lateral bud with two leaves out, one only expanded. April 5: Terminal bud casting off the outer brown stipules, one leaf unfolded. April 13. Twig dead.

(*B*).—Twig dead, no response.

(*C*).—March 11: Bud split open. March 15: First inner pair of green stipules visible. March 18: Buds well opened, but first leaf not unfolded. March 20: First leaf expanded. March 25: Terminal and lateral buds each showing one green leaf. March 28: Leaves flat, buds rapidly expanding. April 1: Twig gone bad.

Sulphuric Acid (five-drop solution).—No response.

Sulphuric Acid (twenty-drop solution).—March 11: Two upper buds with outer stipular scales slightly eased apart. March 15: Scales more eased apart. March 18: Buds burst. March 20, March 25, March 28, April 1: No advance. April 13: Twig dead.

Hydrochloric Acid (five drops). No response.

Nitric Acid (five drops).—No response.

Salix babylonica.—The chemicals used with the weeping willow were: Chromic acid, one per cent.; two grams ammonium nitrate in 200 cubic centimeters of water; five decigrams of sodium bicarbonate in fifty cubic centimeters of water; five decigrams of sodium chloride dissolved in fifty cubic centimeters of water; ten drops of chemically pure hydrochloric acid in fifty cubic centimeters of water; filtered water; 100 cubic centimeters of ether mixed with 500 cubic centimeters of water; 200 cubic centimeters of chemically pure ammonium hydrate in 1,000 cubic centimeters of water; picric acid; saturated solution of corrosive sublimate. The results obtained in this series of experiments possess considerable interest.

Chromic acid, ammonium nitrate, sodium bicarbonate, sodium chloride, ether water, ammonium hydrate, picric acid, corrosive sublimate gave no response.

Filtered Water (*A*).—No response was shown until March 18 when the buds of the female spike opened. March 20: Roots well developed, pistillate spikes one inch long. April 1, April 5: Twig still continued its growth. April 13: Twig withered.

(*B*) First response on March 11 when secondary roots began to form, no bud reaction. March 15: Pistillate spikes one inch long; roots pink, three inches long, numerous. March 18: Leaf buds open, first green leaves expanded. March 20: Pistillate spikes two inches long, root four inches long. March 25: Roots long and curved about the bottom of the bottles, leaves elongated, dark green, three to four inches long. March 28: Green branches four inches long, leaves flat, roots numerous. April 1: Two lateral branches green and four inches long. April 5: Shoots eight inches long. April 13: Twig dead.

(*C*) March 11: Secondary roots appeared; no bud reaction. March 18: Leaf bud burst. March 20: Leaves well expanded, roots well developed. March 25: Leaves advancing rapidly to maturity. March 28: Leafy branches, rapidly growing. April 1, April 5: Growth continued. April 13: Leaves were sere.

Tilia americana.—The chemical solutions used in experimenting with the twigs of the linden were: chromic acid, one per cent. solution; stock picric acid in four times its volume of water; five decigrams of sodium bicarbonate dissolved in fifty cubic centimeters of water; filtered water as a control; ten drops of hydrochloric acid in fifty cubic centimeters of water; 100 cubic centimeters of ether in 500 cubic centimeters of water; saturated corrosive sublimate in one liter of water. There was no response shown in any of the twigs until March 15. The twigs in the chromic acid, ten-drop hydrochloric acid solution and in ether water showed no response during the entire course of the experiments. The record obtained from the other twigs is as follows:

Picric Acid.—March 15: Bud scales slightly eased apart. March 18: Terminal bud burst, three-quarters of an inch, green. March 20: Terminal bud expanded, upper part of the folded leaves seen within. March 25: Terminal bud burst, leaves out of the bud, but folded together. March 28: Leaves brown and nearly dead. April 1: Twig dead.

Sodium bicarbonate.—March 15: Inner scales of terminal bud pushed beyond the outer scales one-sixteenth of an inch. March 18: One-fourth of an inch beyond, terminal bud burst, no leaves expanded. March 25, March 28: No further advance.

Filtered Water (*A*).—March 15: Two larger bud scales eased apart. March 18: Buds burst, green spire one-fourth of an inch long. March 25: Terminal bud green, spire-shaped. March 28: Same condition as on previous day. April 1: No further advance, water later evaporates, ending the development of this twig.

(*B*) March 15: Terminal bud nearly burst. March 18: Buds expanded, three-quarters of an inch green. March 20: Upper bud burst, sides of folded leaves seen. March 25: Two leaves of the terminal bud fully expanded. March 28: The twig was found dead, because the water had evaporated from the jar.

Corrosive Sublimate.—March 15: Bud scales eased. March 18: Buds nearly all burst. March 20: Half of the folded green leaves seen in the partially open bud. March 25: One to three leaves were found fully expanded. March 28: All of the buds were burst, with one to three leaves fully expanded, flat and large. April 1: Twigs gone bad.

Quercus palustris.—The chemicals used were: Two grams of ammonium nitrate dissolved in 200 cubic centimeters of water; five decigrams of sodium bicarbonate dissolved in fifty cubic centimeters of water; five decigrams of sodium chloride dissolved in fifty cubic centimeters of water; 200 cubic centimeters of chemically pure ammonium hydrate dissolved in one liter of water; saturated solution of corrosive sublimate in one liter of water; two water control experiments were inaugurated.

The twigs placed in the ammonium nitrate, sodium bicarbonate, sodium chloride, ammonium sulphate, and ammonium hydrate solutions made no response by the opening of the buds. Those, however, in the solution of corrosive sublimate showed signs of response on March 25, when the terminal bud showed signs of elongation. On March 28, three days after, the terminal bud had burst and the leaves were ready to unfold. On April 1 the twigs began to show signs of going bad. In water the response was more marked than in the corrosive sublimate solution, for on March 25 the terminal bud had burst, bu⁺ the leaves were still enclosed in the stipular scales. On March 28 the leaves had nearly expanded, and on April 1 the leaves were fully expanded and the new shoots 100 to 127 millimeters long.

Summary of the Experiments of the First Year.

The experiments conducted the first year with twigs in various solutions throw considerable light upon the conditions which influence the flow of sap in plants. Strasburger set the cut ends of trees in tubs containing copper sulphate solution. He found that the poison ascended to the leaves a distance in the tallest trees of twenty-one meters. If such a violent protoplasmic poison ascends the trunks of trees, it is clear that they must kill all of the cells lying in the path of its ascent. Strasburger concluded that the living cells of the stem were not necessary to the ascent of the sap, as a result of the above-mentioned experiment with copper sulphate. Strasburger also killed portions of the stems of living trees by heat, and yet the upper living and leafy portion was found to remain turgid for a few days. Another experiment, which was held to negative the theory of protoplasmic activity, was that in which boiling water was poured on the root, when the plant continued to respire in spite of the roots having been killed.

These experiments of Strasburger are negatived by the experiments with the twigs in the various chemical solutions previously described. As before indicated, the response of the twigs in the most susceptible instance did not take place until a week after the twigs were placed in the chemical solutions. After the first response, the opening of the buds progressed steadily until the leaves had fully expanded. In some instances the branch grew considerably in length after the opening of the buds had started. As the experimental data prove, many twigs did not respond but were killed outright, as illustrated by the twigs of the Carolina poplar, *Populus monilifera*, in the ten-drop hydrochloric acid solution, or as in the case of *Quercus palustris* in the sodium bicarbonate, sodium chloride and ammonium hydrate. Many twigs which responded at first by the enlargement or even bursting of the buds afterwards made no advance and were eventually killed, and ultimately most of the twigs not in water, but with their ends immersed in the chemical solutions, died after the buds had dried up or the leaves had wilted. This seems to indicate that the chemicals first acted as a stimulus on the twigs; this was followed by the ascent of water, by the suctional activity of the living cells of the twig and bud, while the poisons lagged behind. As long as any of the cells remained alive in the upper part of the twigs and in the buds they maintained their suctional activity. Bose,[2] by a series of elaborate and painstaking experiments, has shown after the administration of a poison at the cut end of a branch or petiole that successive zones are killed one after another, and that the death of a point below does not stop the suction above. He says: "It is evident that the application of poison at the root or cut end of a stem does not in general arrest suction until the whole plant is killed." The records of his newly devised shoshungraph indicate that the final arrest occurs after an appropriately long period. That a poison can easily pass through killed tissue owing to the suctional response of cells higher up, Bose proved in his experiments on *Desmodium*, when he placed the cut end of a petiole in copper sulphate solution. In this case there are areas which during the ascent of the poison react visibly by the motile indications of the

[2] Bose, Jagadis Chunder, *Plant Response as a Means of Physiological Investigation*, 1906, p. 385.

pulvini of the inserted lateral leaflets. Bose by his experiments proved that the ascent of sap is brought about, not by any localized group of cells in a particular region, but by cells which extend throughout the length of the plant. Even after some of these have died, therefore, by the access of the poison, those above are still active, and will continue to exhibit suction until they in their turn are finally killed. It is thus evident that the movement of ascent cannot be completely abolished until the poison has reached effectively the very top. As all the living cells are actively concerned in the work of suction, this conveyance of poison to the top of the plant is what was to have been expected. Only after such conveyance indeed could permanent arrest possibly take place. Bearing these facts in mind, the action of the chemicals on the various twigs used in my experiments become very much simplified, and, instead of being very complex and unintelligible phenomena, became reducible to one or two simple kinds of activity.

Another important principle to be deduced from the experiments of the first and also of the second year is, that the experimenter is unable to disturb the natural sequence of bud opening by the stimulus imparted to the twigs by the various chemical solutions. In only one or two instances did the chemical seem to react upon the buds and cause their enlargement out of the usual sequence. These cases were with *Forsythia viridissima* twigs in the ammonium hydrate solutions and in the five-drop hydrochloric acid solution. The response was appreciably earlier and greater than with the twigs in filtered water alone, or in the chemical solutions. The *Populus monilifera* twigs in the ether water responded seven days in advance of the other twigs placed under various experimental conditions. The results obtained seem to indicate that the chemicals do not influence either the time or the order of the response, but that this time and sequence depend upon some factor not directly influenced by the environment or by the experimental conditions. One then looks to the hereditary influence which determines the time and the sequence of bud development. Under hereditary influence we may include the minuter structure of the plant which determines what the character of the response must be. Perhaps it is a structural preparedness and the character of the reserve food which determines the sequence of bud development. To determine this point a study was made of the microscopic anatomy of the experimental twigs. These are described in the order in which the twigs responded in their bud development. The twigs were cut on March 13, 1907, before the advent of Spring, which occurred on March 30 and 31.

(1) Forsythia viridissima.—The iodine test showed the pith cells crowded with starch, as also the cortex cells between the bast fibers, as also the medullary ray cells. Fehling's test gave no reaction.

(2) Magnolia conspicua.—On treating the sections with iodine starch was found in the medullary ray cells and not any in the cortex. Fehling's test for sugar gave no reaction.

(3) Æsculus hippocastanum.—Starch occurs in the protoxylem region, in the inner part of the medullary rays. No starch was found in the cortex cells and no reaction was produced with Fehling's solution.

(4) Populus monilifera.—The iodine test showed the presence of starch in the cortex. Fehling's test for sugar gave no result.

(5) Liriodendron tulipifera.—Starch is present in the younger and older portions of the stem in the cortex cells. No sugar reaction.

(6) Salix babylonica.—Iodine showed the presence of starch in the cortex cells and medullary ray cells. No starch was found in the pith. Fehling's sugar test was negative.

(7) Tilia americana.—Small starch grains were found in the cortex of a one-year old stem. No starch was seen in the cortex of old stems. In water the sections became strongly mucilaginous. Fehling's solution gave no reaction.

(8) Quercus palustris.—Starch was found in the pith, medullary ray cells and in the wood-parenchyma cells. No starch was detected in the cortex. Fehling's solution gave no starch reaction.

As far as these microscopic studies throw light upon the state of the plant's preparedness, they seem to support the view that the more prepared a plant is and the more responsive its protoplasm is to the influence of external conditions the earlier is its response. For the response of *Quercus palustris* with deep-seated starch is much more sluggish than the response of the twigs where the starch occurs in the cortex. This relationship of response to the position of the reserve food should not, however, be pushed too far, as the protoplasm of the twigs and that of the cells of the preformed buds may be influenced without any transformation of the reserve supplies of food. We do find, however, a sequential development of the buds and, as far as the experiments go to show, that sequential development is not disturbed by the chemicals that are used. The course of bud development, therefore, depends upon the state of preparedness of the twig and bud, and not on the environmental conditions which surround the plants. Heat is the great factor which determines the opening of the buds. If the plant has the requisite supply of moisture, heat will accelerate the opening of buds; but buds of different species of plants if exposed to the same temperature preserve the order of their bud development; but the time interval is very much lessened if the amount of heat is increased. This was exemplified by a double climbing white rose growing against the side of a house with a chimney placed in the outside wall. The heat of the chimney caused the buds over the chimney bricks to open at least a week or ten days before those on the rest of the bush showed any signs of development. All of the buds in the rosebush were equally prepared to open, but only those did so which received the stimulating effect of the heated brick surface.

Experiments of the Second Year.

The second year of experimentation began with a plan for the enlargement of the scope of the work of the previous year. In order to test the question whether chemical solution could alter the sequence of bud development if the buds were obtained from different geographic localities, and in order to test whether the twigs obtained from southern latitudes would or would not respond more or less quickly than the twigs from northern latitudes to the new environmental conditions, a circular letter was addressed to all of the agricultural experiment stations and to a few private individuals in the forest-covered portion of the eastern United States from the Gulf States to Maine. The letter read as follows:

My dear Sir:—In continuation of a study which I have begun on the influence of chemicals on the opening of buds, I write to ask if you will supply me with twigs of one or several of the following varieties of fruit trees: *apple*: Baldwin, Early Harvest, Maiden Blush, Red Astrachan, Winesap, York Imperial; *cherry*: Black Heart, Governor Wood, Morello; *peach*: Early Crawford, Late Crawford, Oldmixon (free); *pear*: Duchess de Angouleme, Bartlett, Clapp Favorite, Flemish Beauty, Kieffer, Seckel. These twigs I should like cut so as to show the last three years of terminal growth. In addition I should like twigs of the same age of *Quercus palustris* (the pin oak), *Liriodendron tulipifera* (the tulip poplar), *Populus monilifera* (the Carolina poplar), *Acer rubrum* (the red maple), *Æsculus hippocastanum* (the horse chestnut), *Forsythia viridissima*, *Tilia americana* (the linden), *Magnolia conspicua* (Yulan magnolia). If not too much trouble please send them so as to reach me on January 15, 1908, when I expect to start all of the twigs received.

This letter is printed in full because it describes the character of the material upon which the experiments were made. Replies were received from eleven institutions widely enough separated from each other, so as to make the results obtained of interest in connection with the acclimatization of plants and with regard to the influence of heredity on the general method and time of bud development. The institutions which made reply and the names of the tree twigs sent from

	Auburn, Alabama	Lexington, Kentucky	Lafayette, Indiana	Lansing, Michigan	Amherst, Massachusetts	Storrs, Connecticut	Geneva, New York	Ithaca, New York	New Brunswick, New Jersey	College Park, Maryland	Pennsylvania State College	University of Pennsylvania
Baldwin Apple			×	×	×	×	×		×		×	
Early Harvest Apple.	×						×			×	×	
Maiden Blush Apple.	×		×	×		×	×			×		
Red Astrachan Apple.	×					×	×			×	×	
Winesap Apple.	×		×				×					
York Imperial Apple.	×		×		×	×	×			×		
Black Heart Cherry.												
Governor Wood Cherry.										×		
Morello Cherry.					×				×		×	
Early Crawford Peach.	×						×			×		
Late Crawford Peach.			×							×		
Oldmixon Free Peach.		×	×							×		
Duchess de Angouleme Pear.				×		×	×			×		×
Bartlett Pear.				×	×	×	×		×			
Clapp Favorite Pear.				×		×			×			
Flemish Beauty Pear.			×	×		×			×			
Kieffer Pear.	×		×	×		×		×	×	×	×	
Seckel Pear.				×	×		×	×	×	×		×
Quercus palustris (Pin Oak).				×							×	×
Liriodendron tulipifera (Tulip Poplar)	×	×	×	×		×					×	×
Populus monilifera (Carolina Poplar).	×	×	×	×		×		×	×		×	×
Acer rubrum (Red Maple)	×		×	×		×	×	×	×		×	
Æsculus hippocastanum.		×	×	×				×	×		×	×
Forsythia viridissima.				×		×	×	×	×	×	×	×
Tilia americana.		×	×			×		×	×		×	×
Magnolia conspicua.			×						×			×

each station are given in the accompanying table. It will be seen that the material came from as far south as Alabama and as far north as Massachusetts, and that the twigs sent by the correspondents were abundant enough to represent, in many cases, the entire geographic range of the variety studied. Thus the Red Astrachan apple twigs came from Pennsylvania State College; College Park, Maryland; Geneva, New York; Storrs, Connecticut, and Auburn, Alabama.

Bundles of twigs were sent by express in boxes or protected by burlap. Upon their receipt at the University they were kept in a light, cool, airy cellar until all of the packages had been received. The experiments, as far as practicable, were started at the same time, viz., on the afternoon of January 22, 1908, and on the morning of January 23, 1908. The bottles with chemical solutions had been prepared previously. The jars with the twigs were placed in a greenhouse the temperature of which ranged from about 70° F. at night to 90° or 95° in the daytime. The latter temperature was reached with a bright midday sun. The observation continued uninterruptedly from January 23, 1908, to March 14, when the experimentation virtually stopped. Only one change was made in the fluids, viz., on February 14, 1908, when the evaporated water was resupplied, without the addition of any fresh chemical substance.

The chemical solutions used were made as follows:

Corrosive sublimate.—Strong solution: Ten grams in 850 cubic centimeters of water. Weak solution: Five grams in same amount of water.

Copper sulphate.—Strong solution: Ten grams in 850 cubic centimeters of water. Weak solution: Five grams in same amount of water.

Sodium chloride.—Strong solution: Ten grams in 850 cubic centimeters of water. Weak solution: Five grams in same amount of water.

Ammonium nitrate.—Strong solution: Ten grams in 600 cubic centimeters of water. Weak solution: Five grams in 600 cubic centimeters of water.

Ammonium oxalate.—Strong solution: Ten grams in 600 cubic centimeters of water. Weak solution: Five grams in same amount of water.

Ammonium oxalate.—Strong solution: Ten grams in 600 cubic centimeters of water. Weak solution: Five grams in same amount of water.

Potassium chloride.—Strong solution: Ten grams in 900 cubic centimeters of water. Weak solution: Five grams in same amount of water.

Sodium bicarbonate.—Strong solution: Ten grams in 900 cubic centimeters of water. Weak solution: Five grams in the same amount of water.

Potassium bisulphate = Acid sulphate.—Strong solution: Ten grams in 850 cubic centimeters of water. Weak solution: Five grams in the same amount of water.

Hydrochloric Acid.—Strong solution: Ten cubic centimeters in 800 cubic centimeters of water, only one-half of this liquid being used in the experiment. Weak solution: Five cubic centimeters in 800 cubic centimeters of water, only one-half of this liquid was used.

Acetic Acid.—Strong solution: Ten cubic centimeters in 800 cubic centimeters of water, one-half this quantity of liquid was used. Weak solution: Five cubic centimeters in 800 cubic centimeters of water used in one-half the amount of liquid.

Nitric Acid.—Strong solution: Ten grams used prepared as above. Weak solution: Five grams as above.

Chromic Acid.—Strong solution: Ten cubic centimeters of four per cent. acid in 500 cubic centimeters of water, one-half of the amount of liquid being used. Weak solution: Five cubic centimeters of four per cent. acid in 500 cubic centimeters of water, liquid used in half amounts.

Besides the use of chemical solution water controls were instituted, the twigs from each station being placed in a separate jar of water. Thus there were jars for the twigs from the agricultural experiment stations mentioned above. Each of the twigs (some 900 in all) was labelled with a tag on which the locality and the name of the twig were recorded by a selected abbreviation, thus Pas A^2 indicated that the branch was from an Early Harvest Apple sent from Pennsylvania State College, and that NYI W 25 was a twig of the linden (*Tilia americana*) from Ithaca, New York. The results obtained with the twigs from the northern and southern States in the water and in the various chemical solutions, with the date and the character of the response, may be given as follows:

APPLE (Baldwin).—

Corrosive sublimate.—Twigs from Geneva, New York, showed no response in strong corrosive sublimate solution. Twigs from Amherst, Massachusetts, in weak corrosive sublimate responded on January 31 by the easing of the leaf buds; on February 3 the leaf buds had burst;

on February 4 the first leaf had unfolded; on February 11 all the leaves had unfolded; on February 14 the first leaf had withered, and on February 21 all the leaves had withered. The twigs from Lafayette, Indiana, responded by the bursting of the buds on February 3; on February 5 the first leaf had unfolded; on February 8 all the leaves had unfolded; on February 11 the first leaf had withered; on February 14 all the leaves had withered.

Copper sulphate.—Twigs of this apple from Storrs, Connecticut, did not respond. Those from Amherst, Massachusetts, responded by the bursting of the buds on February 7; on February 8 the first leaf had unfolded; on February 15 all the leaves had unfolded, while on February 18 all the leaves had withered. The twigs from Lafayette, Indiana, in weak copper sulphate solution responded on February 8 by the bursting of the buds; on February 11 the first leaf had unfolded; on February 24 the twig had gone bad.

Sodium chloride.—Twigs of the Baldwin Apple in a weak solution of common salt responded on February 1 by an easing of the buds; on February 3 the buds had burst; on February 4 the first leaf had unfolded, while by February 14 all of the leaves had withered. The twigs obtained from Lafayette, Indiana, made no response.

Ammonium nitrate.—The twigs from Lafayette, Indiana, in a strong solution of this chemical made response on February 5 by the bursting of the buds. No other response was noted.

Ammonium oxalate.—The twigs of this apple sent from New Brunswick, New Jersey, responded by the easement of the buds on January 29. No other response was noted. In weak ammonium oxalate the apple twigs from Lafayette, Indiana, made no response.

Potassium chloride.—The apple twigs from Storrs, Connecticut, in weak potassium chloride eased their buds on February 3. The buds burst on February 4; on February 5 the first leaf had unfolded; on February 11 all the leaves had unfolded, while on February 11 the first leaf had withered.

Sodium bicarbonate.—The Baldwin Apple twigs from Pennsylvania State College did not respond in a strong solution of sodium bicarbonate. The New Jersey grown twigs responded on February 3 and on February 7 the buds had burst. On February 14 all the leaves had withered; January 29 the flower buds had eased. The weak solution of this salt acted more favorably. On February 3 the leaf buds of a Connecticut twig had burst, while a Michigan grown twig responded first on January 30; while on January 31 the leaf buds and a first leaf had unfolded. January 29 witnessed the bursting of the first flower bud.

Potassium bisulphate.—The twigs from Storrs, Connecticut, kept in weak potassium bisulphate responded by the easing of the buds on February 4; on February 5 the buds had burst, and on February 7 the first leaf had unfolded. The twigs from Michigan made a slight response in this weaker solution by the bursting of the buds on February 1.

Hydrochloric Acid.—The Baldwin Apple twigs from Michigan in the weak acid solution made no response.

Acetic Acid.—No response in the strong acetic acid solution. Twigs from Storrs, Connecticut, responded by the buds easing on January 31. After the buds had burst on February 11 no other response was noted.

Nitric Acid.—No response.

Water.—The Baldwin Apple twigs from Pennsylvania State College responded on January 29 by the easement of the flower buds; on February 3 the flower and leaf buds had burst; on February 4 the flower buds had protruded from the winter bud scales. On February 18 all of the flowers were found withered. The twigs from New Brunswick, New Jersey, responded on February 1 with the easement of the leaf buds; on February 3 the leaf buds had burst; on February 5 the flower buds burst; while on February 7 the first leaf was unfolded, and on February 21 all of the leaves had unfolded. The flowers made no further response. The twigs from Geneva, New York, responded on January 31 by an easement of the buds. On February 4 the leaf buds had burst. The twigs from Storrs, Connecticut, responded as follows: February 1 leaf and flower buds eased; February 3 leaf and flower buds burst; February 4 first leaf unfolded. From this time until death no other developments were noted. The development of the twigs from Massachusetts showed a more steady course. On January 31 the buds had eased; on February 4 the buds had burst; on February 5 the first leaf had unfolded; on February 8 all the leaves had unfolded; on February 14 the first leaf had withered. The Michigan twigs responded first on January 29 with the easing of the buds; on January 31 the buds had burst; on February 1 the first leaf had unfolded; on February 4 all of the leaves had unfolded, while on February 11 the first leaf had withered and on February 18 all of the leaves had withered. The Baldwin apple twigs from Lafayette, Indiana, made response on February 4 with the bursting of the buds. On February 6 the first leaf had unfolded and on February 14 all of the twigs were dead.

APPLE (Early Harvest).—

Corrosive sublimate.—The twigs from College Park, Maryland, in strong corrosive sublimate solution responded on February 5 with the easing of the buds; on February 7 the leaf buds had burst; on February 11 the first leaf had unfolded, while on February 14 all of the leaves had expanded. The leaves had all withered by February 21. In weak solution the buds of the twigs from Auburn, Alabama, had eased on January 31; on February 4 the leaf buds had burst, and on February 11 the first leaf had unfolded.

Copper sulphate.—The twigs from College Park, Maryland, in strong solution showed response on February 1 when the leaf and flower buds had eased; on February 4 the flower buds had burst. No other response followed. The twigs from Pennsylvania State College responded on February 18, seventeen days later than those from Maryland, but the buds remained closed without bursting. In weak solution the twigs from Auburn, Alabama, responded February 1 by the easing of the flower buds and leaf buds on February 5, and by February 15 the first leaf had unfolded. No other response.

Sodium chloride.—The buds on twigs from College Park, Maryland, in strong solution responded slightly on February 5 without any advance.

Ammonium nitrate.—The twigs from College Park, Maryland, in weak solution responded on February 1 by the easing of the buds. No other response.

Ammonium oxalate.—Twigs from College Park, Maryland, and Geneva, New York, in strong solutions of this chemical made no response. In a weak solution the twigs from Auburn, Alabama, responded by the bursting of the leaf buds on February 14 and by the expansion of the first leaf on February 15.

Potassium chloride.—In strong solutions the branches from College Park, Maryland, and Geneva, New York, made no response.

Sodium bicarbonate.—The twigs from College Park, Maryland, made no response in strong solution.

Potassium bisulphate.—Twigs from Pennsylvania State College made no response in strong solution, neither did those from Auburn, Alabama, in weak chemical.

Acetic Acid.—The twigs from Auburn, Alabama, in weak acid showed no change and eventually died.

Nitric Acid.—The buds on twigs from Auburn, Alabama, showed a slight response in weak acid by the easing of the buds. Eventually the twig died.

Chromic Acid.—The specimens from Auburn, Alabama, in weak acid made no response.

Water.—The Early Harvest apple twigs from Pennsylvania State College made a slight response by the easing of the buds on January 31. Those from Maryland burst their flower buds on February 4 and their leaf buds on February 14. The twigs from Geneva, New York, showed a more steady course of development. On February 4 the buds had eased; on February 5 the buds had burst; on February 11 the first leaf had expanded, and on February 24 all of the leaves had unfolded, some of which remained green until March 14. The only responses of the twigs from Alabama were on January 29 when the flower buds had eased, and on February 18 when the leaf buds had burst.

Apple (Maiden Blush).—

Corrosive sublimate.—In weak solution the twigs from Storrs, Connecticut, responded on February 4 when the leaf buds showed signs of swelling. On February 5 the leaf buds had burst and on February 7 the first leaf had unfolded. The twigs from Lafayette, Indiana, responded on February 4 and on February 7 the leaf buds had burst.

Copper sulphate.—The twigs from Lansing, Michigan, burst their buds on February 1 without other response.

Sodium chloride.—The buds on twigs from Storrs, Connecticut, responded on February 7 without other change. Those on twigs from Lafayette, Indiana, burst on February 14, with the expansion of the first leaf on February 15.

Ammonium nitrate.—In strong solutions of this chemical the leaf buds burst on February 3; the first leaf unfolded February 4, and the first flower bud burst on February 1 on twigs from Lansing, Michigan. The only response of twigs from Lafayette, Indiana, was on January 31 when the leaf buds burst.

Ammonium oxalate.—The buds on twigs from College Park, Maryland, responded on February 5, and on February 7 the first leaf bud had burst in strong solution. In weak solution the Connecticut twigs made no response. Those from Lafayette, Indiana, responded by the easing of the buds on January 31; bud bursting on February 3 and leaf unfolding February 11.

Potassium chloride.—No response in strong solution. The Storrs, Connecticut, twigs in weak solution responded on February 3 and the leaf buds burst on February 5. The buds of the Lafayette, Indiana, twigs responded January 29 and had burst by February 1.

Sodium bicarbonate.—The twigs in a weak solution of this chemical responded on February 5, but after that date they were at a standstill. The twigs from Indiana and Alabama made no response.

Potassium bisulphate (strong and weak).—No response of any of the twigs.

Hydrochloric Acid.—In strong acid the twigs from College Park, Maryland, made no response; those from Geneva, New York, did not. In weak solution those from Storrs, Connecticut, and Lansing, Michigan, showed no response. Those from Lafayette, Indiana, responded on February 4; on February 5 the buds had burst and on February 7 the first leaf had expanded.

Acetic Acid.—The buds on twigs from College Park, Maryland, responded on February 1 in strong acid. In weak acid the buds on twigs from Storrs, Connecticut, had burst on February 4, and by February 7 the first leaf had unfolded. The first leaf withered on February 14.

Nitric Acid.—In strong solution the twigs from College Park, Maryland, had responded by February 1. No other advance was made. In weak acid those from Lafayette, Indiana, responded on February 3 and the first leaf burst on February 4. No other change was shown.

Chromic Acid.—In strong chromic acid the twigs of the Maiden Blush apple from College Park, Maryland, responded on January 29. February 1 marks the response of the flower buds; February 3 the bursting of the leaf buds; February 7 the opening of the flowers; February 14 the opening of the first leaf and the withering of the flowers. By February 18 all the leaves had withered. In dilute chromic acid, the flower buds on twigs from Lansing, Michigan, showed response on January 29. On January 29 the flower buds had burst and on January 31 they were all closed. On February 8 the first leaf bud had burst and on February 11 the first leaf was unfolded. The leaf buds on twigs from Lafayette, Indiana, responded on January 29. The leaf buds burst on February 1 and the flower buds on February 7. The leaf buds on twigs from Auburn, Alabama, responded on February 4. The first leaf and flower buds burst simultaneously on February 11. The first leaf unfolded on February 14 and all the leaves on February 21. The first leaf withered on March 4.

Water.—The leaf buds on twigs from College Park, Maryland, responded on January 29; the leaf buds burst on February 3 and the first leaf unfolded on February 4. The first flower bud burst on February 7. The flower buds on twigs from Geneva, New York, responded on January 29. On February 3 the flower buds had burst. On January 31 the first leaf had unfolded. No other change was recorded. The leaf buds of twigs from Connecticut responded on February 4, the buds burst on February 5 and the first leaf unfolded February 11. By February 24 all the leaves had withered. The flower buds on twigs from Michigan responded on January 29 and burst on February 3. The leaf buds responded February 1, burst February 11 together with the unfolding of the first leaf. The leaf buds on twigs from Lafayette, Indiana, responded February 1, burst on February 3; the first leaf unfolded February 4; all the leaves expanded February 6. By February 14 all the leaves had withered. The twigs from Auburn, Alabama, responded poorly by the unfolding of the first leaf on February 21.

Having described the course of development of the buds and twigs from three different varieties of apple, we may tabulate the remainder of the observations in order to shorten the descriptive account.

Apple (Red Astrachan).—

Corrosive sublimate (strong).—College Park, Maryland: Leaf buds eased February 4; leaf buds burst February 5.

Corrosive sublimate (weak).—Auburn, Alabama: Leaf buds burst February 7; first leaf unfolded February 14; all leaves unfolded February 24; first leaf withered February 15.

Copper sulphate (strong).—College Park, Maryland: No response.

Copper sulphate (weak).—Auburn, Alabama: Leaf buds eased February 7; leaf buds burst February 8; first leaf unfolded February 11; all leaves unfolded February 21; first leaf withered March 7; all leaves withered March 11.

Sodium chloride (strong).—College Park, Maryland: Leaf buds eased January 30; leaf buds burst January 31. Pennsylvania State College: First leaf unfolded February 5.

Sodium chloride (weak).—Storrs, Connecticut: Leaf buds eased January 31; leaf buds burst February 3; first leaf unfolded February 4; all leaves unfolded February 7; first leaf withered February 14; all leaves withered February 18.

Ammonium nitrate (weak).—College Park, Maryland: Leaf buds eased February 5; leaf buds burst February 7; first leaf unfolded February 11; all leaves withered February 24.

Ammonium oxalate (strong).—College Park, Maryland: Leaf buds eased February 3; flower buds eased January 29; flower buds burst February 5; flowers open February 7.

Ammonium oxalate (weak).—Storrs, Connecticut: No response.

Potassium chloride (strong).—College Park, Maryland: No response.

Potassium chloride (weak).—

	Storrs, Conn.	Lansing, Mich.
Leaf buds eased	February 3.	January 30.
Leaf buds burst	February 5.	February 1.
First leaf unfolded	February 11.	February 11.

Sodium bicarbonate (strong).—No response of twigs from College Park, Maryland, and Geneva, New York.

Sodium bicarbonate (weak).—

	Storrs, Conn.	Lansing, Mich.	Auburn, Ala.
Leaf buds eased	February 1.	....	....
Leaf buds burst	....	February 3.	February 7.
First leaf unfolded	February 4.	February 7.	February 21.

Potassium bisulphate (weak).—Storrs, Connecticut: Leaf buds eased February 1; leaf buds burst February 7; first leaf unfolded February 11. Auburn, Alabama: No response.

Hydrochloric Acid (strong).—Storrs, Connecticut: Leaf buds burst February 4.

Acetic Acid (strong).—Pennsylvania State College: No response.

Acetic Acid (weak).—

	Auburn, Ala.	Lansing, Mich.	Storrs, Conn.
Leaf buds eased	February 5.	....	....
Leaf buds burst	February 7.	January 31.	February 3.
First leaf unfolded	February 14.	....	February 4.
All leaves unfolded	February 18.	....	....
First leaf withered	February 24	....	....

Nitric Acid (weak).—

	Storrs, Conn.	Auburn, Ala.
Leaf buds eased	February 4.	February 7.
Leaf buds burst	February 5.	February 11.

Chromic Acid (weak).—Storrs, Connecticut: Leaf buds burst February 3; first leaf unfolded February 4; all leaves unfolded February 11; first leaf withered February 21; all leaves withered February 24.

Water.—

	Pennsylvania State College.	College Park, Maryland.	Geneva, New York.	Storrs, Connecticut,	Lansing, Michigan.	Auburn, Alabama
Leaf buds eased	....	Feb. 5.	....	Feb. 3.	Feb. 4.	Feb. 6.
Leaf buds burst	Jan. 30.	....	....	Feb. 4.	Feb. 6.	Feb. 11.
First leaf unfolded	Feb. 1.	Feb. 11.	Jan. 31.	Feb. 7.	....	Feb. 14.
All leaves unfolded	Feb. 7.	Feb. 18.	....	Feb. 8.	....	Feb. 21.
First leaf withered	Feb. 7.	Mar. 17.	Feb. 18.	Feb. 14.	....	Feb. 21.
All leaves withered	Feb. 21.	....	....	Feb. 24.		Feb. 28.
Flower buds eased	Jan. 29.	....	....	....		....

APPLE (Winesap).—

Corrosive sublimate (weak).—Lafayette, Indiana: Leaf buds eased February 5; leaf buds burst February 7.

Twigs from Lafayette, Indiana, in copper sulphate (weak), sodium chloride (weak), ammonium nitrate (strong), ammonium oxalate (weak), showed no response.

Those from Auburn, Alabama, in potassium chloride (weak) and sodium bicarbonate showed no response. The twigs from College Park, Maryland, in strong hydrochloric acid did not respond. Neither did those from Geneva, New York, in strong nitric acid and strong chromic acid.

Acetic Acid (strong).—College Park, Maryland: Leaf buds eased February 3; leaf buds burst February 4; first leaf unfolded February 11.

Water.—Twigs from Auburn, Alabama, did not respond.

	College Park, Maryland.	Geneva, New York.	Lafayette, Indiana.
Leaf buds burst	February 14.	February 3.	February 11.
Leaf buds unfolded	February 15.		
All leaves withered		February 18.	
Flower buds burst		February 4.	

APPLE (York Imperial).—

Corrosive sublimate (weak).—Storrs, Connecticut: Leaf buds burst February 4.

Copper sulphate (weak).—Storrs, Connecticut: Leaf buds eased February 4; leaf buds burst February 5.

Sodium chloride (weak).—Storrs, Connecticut: Leaf buds eased February 4; leaf buds burst February 5; first leaf unfolded February 7. Amherst, Massachusetts: Leaf buds eased January 31; leaf buds burst February 4; first leaf unfolded February 5; all leaves unfolded February 11; first leaf withered February 14; all leaves withered February 21; flower buds eased February 11.

Ammonium oxalate (weak).—Storrs, Connecticut: No response.

Potassium chloride (weak).—

	Storrs, Conn.	Amherst, Mass.	Lafayette, Ind.	Auburn, Ala.
Leaf buds eased	February 1.		February 7.	February 11.
Leaf buds burst	February 3.	February 5.	February 11.	February 15.
First leaf unfolded		February 11.	February 14.	
All leaves withered		February 14.	February 21.	

Sodium bicarbonate (strong).—College Park, Maryland: No response.
Sodium bicarbonate (weak).—Auburn, Alabama: No response.

	Storrs, Conn.	Lafayette, Ind.	Amherst, Mass.
Leaf buds eased	February 3.	February 6.	January 31.
Leaf buds burst	February 4.	February 7.	....
First leaf unfolded	....	....	February 3.
First leaf withered	....	....	February 14.
All leaves withered	....	....	February 21.

Potassium bisulphate (weak).—Storrs, Connecticut, and Auburn, Alabama: No response. Lafayette, Indiana: Buds burst February 8; first leaf unfolded February 14; all leaves withered February 24.

No response was obtained in twigs from Storrs, Connecticut; Auburn, Alabama; College Park, Maryland, and Geneva, New York, in hydrochloric acid (strong and weak), acetic acid (strong) and nitric acid (strong and weak).

Acetic Acid (weak).—

	Storrs, Conn.	Lafayette, Ind.
Leaf buds eased	February 5.	
Leaf buds burst	....	February 11.
First leaf unfolded	....	February 14.

Chromic Acid (strong),—College Park, Maryland: Leaf buds eased February 14.

Chromic Acid (weak).—Auburn, Alabama: No response. Storrs, Connecticut: Leaf buds eased February 3; leaf buds burst February 4; first leaf unfolded February 7; all leaves unfolded February 14; all leaves withered February 21.

Water.—Lafayette, Indiana: Twigs gave no response.

	College Park, Maryland.	Auburn, Alabama.	Geneva, New York.	Storrs, Connecticut.	Amherst, Massachusetts.
Leaf buds eased	....	Feb. 11.	Jan. 30.	Feb. 1.	Feb. 1.
Leaf buds burst	Feb. 11.	Feb. 15.	Jan. 31.	Feb. 4.	Feb. 3.
First leaf unfolded	....	Feb. 18.	Feb. 3.	....	Feb. 7.
All leaves unfolded	....	....	Feb. 7.	....	Feb. 11.
First leaf withered	....	....	....	....	Feb. 14.
All leaves withered	Feb. 21.	....	Feb. 14.	....	Feb. 18.

CHERRY (Governor Wood).—

No response of twigs from College Park, Maryland, in strong potassium chloride, strong sodium bicarbonate, and in water.

Cherry (Napoleon Bigarreau).—

No response of twigs from Pennsylvania State College in strong ammonium oxalate and strong hydrochloric acid. In water the flower buds were eased on January 30.

Cherry (Morello).—

No response of the twigs from New Brunswick, New Jersey, in strong copper sulphate; of those from Pennsylvania State College in strong potassium bisulphate; of those from Amherst, Massachusetts, in weak potassium bisulphate; of those from Pennsylvania State College in strong hydrochloric acid.

Sodium chloride (strong).—New Brunswick, New Jersey: Leaf buds eased January 28.

Ammonium nitrate (weak).—Pennsylvania State College: Leaf buds eased January 28; flower buds eased January 29.

Ammonium oxalate (weak).—Amherst, Massachusetts: Leaf buds eased February 8; flower buds eased January 29; flower buds burst February 3.

Potassium chloride (strong).—New Brunswick, New Jersey: Leaf buds eased January 30; flower buds eased January 30.

Sodium bicarbonate (weak).—Amherst, Massachusetts: Flower buds eased January 29; flower buds burst February 3.

Nitric Acid (strong).—Pennsylvania State College: Leaf buds eased January 31; flower buds eased January 29.

Water.—

	Pennsylvania State College.	New Brunswick, N. J.	Amherst, Mass.
Leaf buds eased	..	January 28.	January 28.
Leaf buds burst	February 5.		February 1.
First leaf withered			February 11.
All leaves withered			February 21.
Flower buds eased	January 29.	January 30.	January 29.
Flower buds burst	February 1.	February 5.	February 1.

Peach (Early Crawford).—

No response as tabulated below:

Corrosive sublimate (strong).—College Park, Maryland.

Copper sulphate (strong).—College Park, Maryland.

Sodium chloride (strong).—College Park, Maryland.

Ammonium nitrate (weak).—College Park, Maryland.

Water.—College Park, Maryland.

Copper sulphate (weak).—Auburn, Alabama.

Ammonium oxalate (weak).—Auburn, Alabama.

Water.—Auburn, Alabama.

Hydrochloric Acid (strong).—Geneva, New York.

Water.—Geneva, New York.

Ammonium nitrate (strong).—Auburn, Alabama: Leaf buds eased January 29; leaf buds burst January 31; first leaf unfolded February 7.

PEACH (Late Crawford).

Twigs from the stations indicated in a previous table were placed in solutions of corrosive sublimate (weak), copper sulphate (weak), sodium chloride (weak), ammonium nitrate (strong), ammonium oxalate (weak), potassium chloride (strong and weak), sodium bicarbonate (strong and weak), potassium bisulphate (strong), hydrochloric acid (strong), acetic acid (strong), without showing any response. The twigs in water eased their flower buds on January 31 and on February 5 the flower buds had burst.

PEACH (Oldmixon Free).—

No response of any description of the twigs from the various stations noted in the table at the beginning of the experimental record in any of the various experimental fluids except water. This and the immediately preceding series indicates that the peach is peculiarly sensitive to the action of such chemicals as were used. In water the twigs from College Park, Maryland, responded as follows: Leaf buds eased February 1; leaf buds burst February 7; flower buds burst February 3.

PEAR (Duchess de Angouleme).—

Corrosive sublimate (weak).—Storrs, Connecticut: Leaf buds eased February 1.

Sodium chloride (weak).—Storrs, Connecticut: Leaf buds burst February 1; flower buds burst February 4.

Potassium chloride (strong).—College Park, Maryland: Flower buds burst January 29.

Potassium chloride (weak).—Storrs, Connecticut: Leaf buds eased February 4; flower buds eased January 29.

Sodium bicarbonate (strong).—College Park, Maryland: Leaf buds eased February 4.

Potassium bisulphate (strong).—College Park, Maryland: Leaf buds burst January 29.

Acetic Acid (strong).—New Brunswick, New Jersey: Flower buds eased January 29.

Chromic Acid (strong).—New Brunswick, New Jersey: Leaf buds burst February 3; flower buds burst January 29.

Water.—

	College Park, Maryland.	New Brunswick, New Jersey.	Geneva, New York.	Storrs, Connecticut.	Lansing, Michigan.
Leaf buds eased	Jan. 31.	Feb. 3.	Jan. 31.	....	Feb. 1.
Leaf buds burst	Feb. 4.	Feb. 4.	Feb. 1.	....	Feb. 3.
First leaf unfolded	Feb. 7.	Feb. 5.	....	....	Feb. 6.
All leaves withered	....	Feb. 14.	....	....	....
Flower buds eased	....	....	....	Jan. 29.	....
Flower buds burst	....	Jan. 29.	....	....	....

Pear (Bartlett).—

No response was observed in twigs from stations as follows: Geneva, New York, twigs in strong corrosive sublimate; New Brunswick, New Jersey, twigs in strong copper sulphate; Storrs, Connecticut, twigs in copper sulphate (weak), and in weak ammonium oxalate; Lansing, Michigan, twigs in weak sodium bicarbonate.

Corrosive sublimate (weak).—Storrs, Connecticut: Leaf buds eased January 31; leaf buds burst February 4; first leaf unfolded February 7; first leaf withered February 11.

Copper sulphate (weak).—Amherst, Massachusetts: First leaf unfolded February 5; first leaf withered February 11.

Sodium chloride (strong).—New Brunswick, New Jersey: Leaf bud burst February 7.

Sodium chloride (weak).—Storrs, Connecticut: Leaf buds eased February 1; leaf buds burst February 5. Lansing, Michigan: Leaf buds burst January 31; first leaf unfolded February 4; all leaves withered February 24; flower buds eased January 29; flower buds burst February 3; flowers closed February 13.

Potassium chloride (weak).—Storrs, Connecticut: Leaf buds eased February 4; leaf buds burst February 5. Lansing, Michigan: First leaf unfolded February 3.

Sodium bicarbonate (strong).—University of Pennsylvania: Leaf buds eased February 4; leaf buds burst February 5.

Sodium bicarbonate (weak).—Amherst, Massachusetts: Leaf buds eased January 21; leaf buds burst February 3.

Potassium bisulphate (weak).—Lansing, Michigan: Leaf buds eased

February 1; leaf buds burst February 3; flower buds burst January 28.

Acetic Acid (strong).—University of Pennsylvania: Leaf buds eased February 1; leaf buds burst February 3; first leaf unfolded February 4; all leaves withered February 8.

Nitric Acid (strong).—University of Pennsylvania: Leaf buds eased January 29; leaf buds burst January 31; first leaf unfolded February 3; all leaves withered February 8.

Chromic Acid (strong).—University of Pennsylvania: First leaf unfolded February 3; all leaves unfolded February 4; first leaf withered February 8; all leaves withered February 14; flower buds eased January 29; flower buds burst January 30; flowers closed January 31; first flower withered February 11.

Water.—

	University of Penna.	New Brunswick, N. J.	Geneva, N. Y.	Storrs, Conn.	Lansing, Mich.	Amherst, Mass.
Leaf buds eased	....	....	....	....	Feb. 3.	....
Leaf buds burst	....	....	....	Feb. 3.	....	....
First leaf unfolded	Feb. 3.	Feb. 1.	....	Feb. 7.	....	Feb. 1.
All leaves unfolded	....	....	....	....	....	Feb. 3.
First leaf withered	....	....	....	....	....	Feb. 14.
All leaves withered	Feb. 11.	....	....	Feb. 24.	....	Feb. 18.
Flower buds eased	....	....	Jan. 29.	....	....	....
Flower buds burst	Jan. 29.	Jan. 28.	....	....	....	Jan. 29.
Flowers closed	Jan. 31.	Jan. 29.	....	....	....	Jan. 31.
Flowers open	Feb. 4	....	....	....	....	Feb. 3.
First flower withered	Feb. 5.	....	....	....	....	Feb. 7.
All flowers withered	Feb. 7.	....	....	....	....	Feb. 7.

Pear (Clapp Favorite).—

No response was observed with twigs from New Brunswick, New Jersey, in strong copper sulphate; with twigs from Storrs, Connecticut, in weak ammonium oxalate.

Corrosive sublimate (strong).—New Brunswick, New Jersey: Leaf buds eased February 1; leaf buds burst February 3; first leaf unfolded February 7; all leaves unfolded February 11; first leaf withered February 14; all leaves withered February 24.

Sodium chloride (strong).—New Brunswick, New Jersey: Leaf buds eased February 1.

Sodium chloride (weak).—Storrs, Connecticut: Leaf buds eased January 31; leaf buds burst February 3.

Ammonium nitrate (weak).—New Brunswick, New Jersey: Leaf buds eased February 3; leaf buds burst February 5; first leaf unfolded February 7; first leaf withered February 11; all leaves withered February 21.

Potassium chloride (weak).—Storrs, Connecticut: Leaf buds eased February 5.

Sodium bicarbonate (weak).—Storrs, Connecticut: Leaf buds eased January 31; leaf buds burst February 3; first leaf withered February 8; flowers buds burst January 25. Lansing, Michigan: Leaf buds burst February 1; flower buds eased January 27.

Potassium bisulphate (weak).—Storrs, Connecticut: Leaf buds eased January 30; leaf buds burst February 1; first leaf unfolded February 4; first leaf withered February 7; all leaves withered February 8. Lansing, Michigan: Leaf buds eased January 30; first leaf unfolded February 3; flower buds burst January 29; flowers closed January 29; flowers open January 31; all flowers withered February 5.

Hydrochloric Acid (strong).—Storrs, Connecticut: Leaf buds eased February 1; leaf buds burst February 4.

Acetic Acid (weak).—Storrs, Connecticut: Leaf buds eased February 3; leaf buds burst February 4; first leaf unfolded February 8; first leaf withered February 8; all leaves withered February 11.

Nitric Acid (weak).—Storrs, Connecticut: Leaf buds burst February 5.

Chromic Acid (weak).—Storrs, Connecticut: Leaf buds eased February 1; leaf buds burst February 3; first leaf unfolded February 7; all leaves unfolded February 8.

Water.—

	New Brunswick, New Jersey.	Storrs, Connecticut.	Lansing, Michigan.
Leaf buds eased	January 30.	January 31.	January 30.
Leaf buds burst	February 4.	February 5.	January 31.
First leaf unfolded	February 7.	February 7.	
All leaves unfolded	February 8.	February 11.	
First leaf withered		February 14.	
All leaves withered	February 24.		

PEAR (Flemish Beauty).—

Corrosive sublimate (weak).—Storrs, Connecticut: Leaf buds eased February 1; first leaf unfolded February 4; all leaves withered February 14. Lafayette, Indiana: Leaf buds eased February 3; leaf buds burst February 5; first leaf unfolded February 8; all leaves unfolded February 11; all leaves withered February 14.

Copper sulphate (weak).—Storrs, Connecticut: Leaf buds eased February 3; leaf buds burst February 4.

Sodium chloride (weak).—Lafayette, Indiana: Leaf buds burst February 3; first leaf unfolded February 7; all leaves withered February 24.

Storrs, Connecticut: Leaf buds eased January 31; leaf buds burst February 3; first leaf unfolded February 7; first leaf withered February 11; all leaves withered February 14.

Ammonium oxalate (weak).—Storrs, Connecticut: No response. Lansing, Michigan: Leaf buds eased February 4.

Potassium chloride (weak).—Storrs, Connecticut: Leaf buds eased February 4. Lansing, Michigan: Leaf buds burst February 3; first leaf unfolded February 5; all leaves withered February 11; flower buds eased January 29. Lafayette, Indiana: No response.

Sodium bicarbonate (weak).—Storrs, Connecticut: Leaf buds burst February 1; first leaf unfolded February 7; all leaves withered February 21. Lafayette, Indiana: Leaf buds eased February 1.

Potassium bisulphate (weak).—Storrs, Connecticut: No response. Lafayette, Indiana: Leaf buds eased January 31; leaf buds burst February 1.

Hydrochloric Acid (strong).—Storrs, Connecticut: No response.

Acetic Acid (weak).—Lafayette, Indiana: No response.

Water.—New Brunswick, New Jersey: No response. Storrs, Connecticut: Leaf buds eased January 31; leaf buds burst February 3. Lansing, Michigan: Leaf buds eased February 1; leaf buds burst February 3. Lafayette, Indiana: Leaf buds eased February 1; leaf buds burst February 3; first leaf unfolded February 4; all leaves unfolded February 21; first leaf withered February 21.

PEAR (Kieffer).—

Corrosive sublimate (weak).—Storrs, Connecticut: Leaf buds eased February 4; leaf buds burst February 7. Lansing, Michigan: First leaf unfolded January 31; all leaves unfolded February 4; first leaf withered February 8; all leaves withered February 11; flower buds eased January 27; flower buds burst January 28; flowers open January 29; first flower withered February 3. Lafayette, Indiana: Leaf buds eased January 31; leaf buds burst February 3; first leaf unfolded February 5; all leaves unfolded February 8; first leaf withered February 11; all leaves withered February 14.

Copper sulphate (weak).—Storrs, Connecticut: No response. Lansing, Michigan: Leaf buds eased January 31; leaf buds burst February

1. Lafayette, Indiana: Leaf buds burst February 1; first leaf unfolded February 4.

Sodium chloride (weak).—Storrs, Connecticut: No response. Lafayette, Indiana: Leaf buds eased February 4; leaf buds burst February 7.

Ammonium nitrate (strong).—Lafayette, Indiana: Leaf buds eased January 30; leaf buds burst January 31; first leaf unfolded February 4; first leaf withered February 8; all leaves withered February 21. Auburn, Alabama: Leaf buds eased January 31; leaf buds burst February 4; first leaf unfolded February 7; all leaves unfolded February 11; first leaf withered February 14; all leaves withered February 24.

Ammonium nitrate (weak).—State College, Pennsylvania: Leaf buds eased January 31; leaf buds burst February 1; all leaves withered February 24. Ithaca, New York: No reaction.

Ammonium oxalate (strong).—New Brunswick, New Jersey: Leaf buds eased January 30; leaf buds burst February 3. Ithaca, New York: No reaction.

Ammonium oxalate (weak).—Lafayette, Indiana: Leaf buds eased January 31; leaf buds burst February 3; first leaf unfolded February 4; first leaf withered February 7; all leaves withered February 24.

Potassium chloride (strong).—College Park, Maryland, and Ithaca, New York: No response.

Potassium chloride (weak).—Twigs from Storrs, Connecticut, Lafayette, Indiana, and Auburn, Alabama, showed no response.

Sodium bicarbonate (strong).—Twigs from College Park, Maryland, and Ithaca, New York, showed no response. Those from New Brunswick, New Jersey, responded by easement of leaf buds on January 30.

Sodium bicarbonate (weak).—Storrs, Connecticut: No response. Lafayette, Indiana: Leaf buds eased January 29; leaf buds burst January 31; first leaf unfolded February 1; all leaves unfolded February 3.

Potassium bisulphate (strong).—Twigs from College Park, Maryland, and Ithaca, New York, showed no response.

Potassium bisulphate (weak).—Storrs, Connecticut: No response. Lansing, Michigan: Leaf buds burst January 29; first leaf unfolded February 3. Lafayette, Indiana: Leaf buds burst February 3; first leaf unfolded February 5; all leaves unfolded February 8; first leaf withered February 11; all leaves withered February 21.

Hydrochloric Acid (strong).—Twigs from College Park, Maryland, Ithaca, New York, Storrs, Connecticut, showed no response in this chemical.

Hydrochloric Acid (weak).—Lansing, Michigan: Leaf buds eased January 29; leaf buds burst January 31. Lafayette, Indiana: Leaf buds eased January 30; leaf buds burst January 31: first leaf withered February 7; all leaves withered February 8.

Acetic Acid (strong).—College Park, Maryland: No response. New Brunswick, New Jersey: Leaf buds eased February 1; leaf buds burst February 4; first leaf unfolded February 7.

Acetic Acid (weak).—Storrs, Connecticut: No response. Lafayette, Indiana: Leaf buds eased February 1; leaf buds burst February 4.

Nitric Acid (strong).—Storrs, Connecticut: No response.

Chromic Acid (strong).—State College, Pennsylvania: Leaf buds eased January 30; leaf buds burst February 3; leaf buds unfolded February 4; first leaf withered February 14; all leaves withered February 24.

Water.—Pennsylvania State College: Leaf buds eased February 1; burst February 3; unfolding of first leaf February 8. New Brunswick, New Jersey: Leaf buds eased February 1; leaf buds burst February 4; first leaf unfolded February 8; all leaves unfolded February 11; first leaf withered February 14; all leaves withered February 18. Ithaca, New York: Leaf buds eased February 3; leaf buds burst February 4. Storrs, Connecticut: Leaf buds eased February 1; leaf buds burst February 4; first leaf unfolded February 11. Lansing, Michigan: Leaf buds eased January 29; leaf buds burst February 1. Lafayette, Indiana: Leaf buds burst February 6. Auburn, Alabama: Leaf buds eased February 3; leaf buds burst February 4. College Park, Maryland: Leaf buds eased February 1; leaf buds burst February 3; first leaf unfolded February 7; flower buds eased January 28; flower buds burst January 29.

PEAR (Seckel).—

Corrosive sublimate (strong).—University of Pennsylvania: Leaf buds burst February 1; first leaf unfolded February 4. College Park, Maryland: Leaf buds eased February 3; leaf buds burst February 4; first leaf unfolded February 7; all leaves unfolded February 11; first leaf withered February 14; all leaves withered February 24. Ithaca, New York: Leaf buds burst February 14; first leaf unfolded February 18.

Corrosive sublimate (weak).—Lafayette, Indiana: No response. Lansing, Michigan: Leaf buds eased January 31; leaf buds burst February 1; first leaf unfolded February 3; all leaves unfolded February 7; first leaf withered February 7; all leaves withered February 11.

Copper sulphate (strong).—No response shown in twigs from the University of Pennsylvania; College Park, Maryland; Ithaca, New York.

Copper sulphate (weak).—Amherst, Massachusetts: Leaf buds eased February 1; leaf buds burst February 4; all leaves withered February 14.

Sodium chloride (strong).—No response in twigs from University of Pennsylvania and Ithaca, New York. College Park, Maryland: Leaf buds eased February 3; leaf buds burst February 7.

Sodium bicarbonate (weak).—Amherst, Massachusetts: Leaf buds eased February 5; leaf buds burst February 7. Lafayette, Indiana: No response.

Potassium bisulphate (strong).—New Brunswick, New Jersey: Leaf buds eased January 31; leaf buds burst February 1.

Potassium bisulphate (weak).—Amherst, Massachusetts: Leaf buds burst February 5. Lafayette, Indiana: No response.

Acetic Acid (strong).—New Brunswick, New Jersey: Leaf buds eased January 31; leaf buds burst February 1.

Acetic Acid (weak).—Lansing, Michigan: Leaf buds burst January 30; first leaf unfolded February 1; all leaves unfolded February 4. No response of twigs from Lafayette, Indiana, University of Pennsylvania, Ithaca, New York, New Brunswick, New Jersey, in ammonium nitrate (strong), weak ammonium nitrate, strong and weak ammonium oxalate, weak and strong potassium chloride and strong sodium bicarbonate.

Water.—

	University of Penna.	College Park, Md.	New Brunswick, N. J.	Ithaca, N. Y.	Geneva, N. Y.	Lansing, Mich.	Amherst, Mass.
Leaf buds eased	Jan. 31.	Feb. 4.	Feb. 1.	......	Feb. 3.		
Leaf buds burst	....	Feb. 5.	Feb. 3.	Feb. 28.		Jan. 29.	
First leaf unfolded	Feb. 3.	Feb. 8.	Feb. 8.			Feb. 1.	Feb. 7.
All leaves unfolded	Feb. 4.		Feb. 11.				Feb. 8.
First leaf withered	Feb. 11.		Feb. 14.				Feb. 14.
All leaves withered	Feb. 14.		Feb. 18.				Feb. 18.

The twigs from Amherst, Massachusetts, further showed the easement of the flower buds on January 29; burst on January 31; were open February 4 and withered by February 5.

PIN OAK (*Quercus palustris*).—

The twigs of the pin oak from Pennsylvania State College, College Park, Maryland, University of Pennsylvania, and Lansing, Michigan, showed no response in strong sodium chloride, weak ammonium nitrate, strong potassium chloride, strong sodium bicarbonate and weak nitric acid, while those in weak chromic acid burst their leaf buds on February 15.

Water.—University of Pennsylvania: First leaf unfolded February 24; flower buds burst January 27; flowers opened January 28. Pennsylvania State College: No response, as also the twigs from Lansing, Michigan.

Tulip Poplar (*Liriodendron tulipifera*).[3]—

No response in any of the solutions, with the following few exceptions: Potassium bisulphate (weak)—Leaf buds eased February 5. Acetic acid (weak) with twigs from Auburn, Alabama—Leaf buds burst February 7.

Water.—Lansing, Michigan: Leaf buds eased February 4; leaf buds burst February 6; first leaf unfolded February 18. Lafayette, Indiana: Leaf buds eased February 7; leaf buds burst February 8.

Carolina Poplar (*Populus monilifera*).—

Corrosive sublimate (strong).—No response in twigs from University of Pennsylvania, New Brunswick, New Jersey, and Ithaca, New York.

Corrosive sublimate (weak).—Lansing, Michigan: Leaf buds eased February 4. Auburn, Alabama: No response.

Copper sulphate (strong).—University of Pennsylvania: Leaf buds eased February 7; leaf buds burst February 14. New Brunswick, New Jersey: First leaf unfolded February 11.

Copper sulphate (weak).—Storrs, Connecticut: Leaf buds eased February 7; leaf buds burst February 8. Auburn, Alabama: Leaf buds eased February 7; leaf buds burst February 8; first leaf unfolded February 11; all leaves unfolded February 21; first leaf withered March 7; all leaves withered March 11. The twigs from Lansing, Michigan, and Lafayette, Indiana, showed no reaction.

Sodium chloride (strong).—University of Pennsylvania: Leaf buds eased February 7; leaf buds burst February 11. Twigs from Ithaca, New York, showed no response.

Sodium chloride (weak).—Storrs, Connecticut: Leaf buds eased February 7. Lansing, Michigan: Leaf buds eased February 4.

[3] The localities are given in the table at the beginning of the experimental data

Ammonium nitrate (strong).—Lansing, Michigan: No response. Lexington, Kentucky: Leaf buds eased February 7; leaf buds burst February 8. Auburn, Alabama: Leaf buds eased February 3; leaf buds burst February 4; first leaf unfolded February 7; all leaves unfolded February 18; first leaf withered February 15; all leaves withered February 24.

Ammonium nitrate (weak).—University of Pennsylvania: Leaf buds eased February 7; leaf buds burst February 15. Ithaca, New York: Leaf buds eased February 4; leaf buds burst February 7. Twigs from College Park, Maryland, and Ithaca, New York, showed no response.

Ammonium oxalate (weak).—No response in twigs from Storrs, Connecticut, Lansing, Michigan, and Auburn, Alabama.

Potassium chloride (strong).—University of Pennsylvania: Leaf buds eased February 4; leaf buds burst February 8; first leaf unfolded February 14; all leaves unfolded February 24; first leaf withered February 24. Pennsylvania State College: Leaf buds eased February 3; leaf buds burst February 5. New Brunswick, New Jersey: No response.

Potassium chloride (weak).—Storrs, Connecticut: Leaf buds eased February 3; leaf buds burst February 4; first leaf unfolded February 14; all leaves unfolded February 18; first leaf withered February 21; all leaves withered February 24. Lexington, Kentucky: Leaf buds burst February 3. Auburn, Alabama: First leaf unfolded February 4; first leaf withered February 14; all leaves withered February 15. Twigs from New Brunswick, New Jersey, Lansing, Michigan, Storrs, Connecticut, Lafayette, Indiana, Auburn, Alabama, Lexington, Kentucky, showed no response in strong sodium bicarbonate, weak potassium bisulphate, weak hydrochloric acid.

Sodium bicarbonate (weak).—Storrs, Connecticut: Leaf buds burst February 1. Lexington, Kentucky: Leaf buds eased February 7; leaf buds burst February 7. Auburn, Alabama: Leaf buds burst February 14; first leaf unfolded February 14; first leaf withered March 14.

Acetic Acid (weak).—Auburn, Alabama: Leaf buds burst February 8; first leaf unfolded February 8.

Nitric Acid (weak).—Storrs, Connecticut: Leaf buds eased February 7. Auburn, Alabama: No response.

Chromic Acid (weak).—Storrs, Connecticut: Leaf buds eased January 30; leaf buds burst January 31; first leaf unfolded February 11; all leaves unfolded February 21; first leaf withered February 28; all leaves withered March 4. Auburn, Alabama: No response.

Water.—University of Pennsylvania: Leaf buds eased February 7; leaf buds burst February 14; first leaf unfolded February 28; first leaf withered February 24, while this branch showed green leaves on March 14. Pennsylvania State College: Leaf buds burst February 14; first leaf unfolded February 14. New Brunswick, New Jersey: Leaf buds burst February 7; first leaf unfolded February 8; all leaves unfolded February 28; roots appeared on March 14 and the branch was still green. Lansing, Michigan: Leaf buds eased February 4. Lexington, Kentucky: Leaf buds eased February 6, as also those from Auburn, Alabama.

Red Maple (*Acer rubrum*).—

The only responses obtained with branches of the red maple from the localities noted in the table at the beginning of the experimental data were with those from Lansing, Michigan, placed in sodium bicarbonate. The flower buds eased on January 25; flower buds burst on January 27; first flower withered on January 29; all the flowers withered on January 30.

The twigs from New Brunswick, New Jersey, in water show their leaf buds burst on February 11; on February 15 the first leaf had unfolded. The leaf buds on branches from Ithaca, New York, burst on February 18.

Horse Chestnut (*Æsculus hippocastanum*).—

Corrosive sublimate (weak).—Storrs, Connecticut: Leaf buds eased January 31; leaf buds burst February 21.

Copper sulphate (weak).—Storrs, Connecticut: Leaf buds eased January 30; leaf buds burst February 4.

Sodium chloride (strong).—University of Pennsylvania: Leaf buds eased February 1; leaf buds burst February 11. Pennsylvania State College: Leaf buds eased January 31; leaf buds burst February 7; first leaf unfolded February 8; all leaves unfolded February 14; first leaf withered February 18; all leaves withered February 24.

Sodium chloride (weak).—Storrs, Connecticut: Leaf buds eased January 31; leaf buds burst February 3; first leaf unfolded February 7; first leaf withered February 14; all leaves withered February 18.

Ammonium nitrate (weak).—Ithaca, New York: Leaf buds eased February 1; leaf buds burst February 7.

Ammonium oxalate (strong).—University of Pennsylvania: Leaf buds eased January 31; leaf buds burst February 11. Ithaca, New York: Leaf buds eased February 14.

Ammonium oxalate (weak).—Storrs, Connecticut: Leaf buds eased January 31; leaf buds burst February 3. Lansing, Michigan: Leaf buds eased February 3; leaf buds burst February 4; first leaf unfolded February 7; flower buds burst February 5; first flower withered February 14; all flowers withered February 18.

Potassium chloride (strong).—University of Pennsylvania: Leaf buds eased February 1; leaf buds burst February 8.

Potassium chloride (weak).—Storrs, Connecticut: Leaf buds eased January 29; leaf buds burst January 31; first leaf unfolded February 7; all leaves unfolded February 18; all leaves withered February 21. Lansing, Michigan: Leaf buds eased February 4; leaf buds burst February 7.

Sodium bicarbonate (strong).—University of Pennsylvania: Leaf buds eased February 1; leaf buds burst February 7. Pennsylvania State College: Leaf buds eased January 30; leaf buds burst January 31; first leaf unfolded February 11. New Brunswick, New Jersey: Leaf buds eased February 4; leaf buds burst February 7; first leaf unfolded February 11; first leaf withered February 14; all leaves withered February 18.

Sodium bicarbonate (weak).—Lansing, Michigan: Leaf buds eased February 4; leaf buds burst February 7; first leaf unfolded February 11; all leaves withered February 18. Lexington, Kentucky: Leaf buds eased February 3; leaf buds burst February 7; first leaf unfolded February 11; all leaves unfolded February 21; first leaf withered February 21; all leaves withered February 24.

Potassium bisulphate (strong).—New Brunswick, New Jersey. Leaf buds eased February 4; leaf buds burst February 5; first leaf unfolded February 7. Geneva, New York: Leaf buds eased January 30; leaf buds burst February 3.

Potassium bisulphate (weak).—Lansing, Michigan: Leaf buds eased February 3; leaf buds burst February 7; first leaf unfolded February 11. Lexington, Kentucky: Leaf buds eased February 4; leaf buds burst February 7; first leaf unfolded February 11; all leaves unfolded February 21; all leaves withered February 24.

Hydrochloric Acid (weak).—Lansing, Michigan: Leaf buds eased February 3; leaf buds burst February 11.

Acetic Acid (strong).—New Brunswick, New Jersey: Leaf buds eased February 5; leaf buds burst February 8.

Acetic Acid (weak).—Lexington, Kentucky: Leaf buds eased February 4; leaf buds burst February 7.

Water.—

	University of Penna.	Penna. State College.	New Brunswick, N. J.	Ithaca, N. Y.	Geneva, N. Y.	Storrs, Conn.	Lansing, Mich.	Lexington, Ky.
Leaf buds eased	Fb. 1.	Fb. 1.	Fb. 1.	Ja. 31.	Fb. 1.	Ja. 31.	Fb. 4.	Fb 4.
Leaf buds burst	Fb. 7.	....	Fb. 7.	Fb. 4.	Fb. 4.	Fb. 4.	Fb. 8.	
First leaf unfolded	Fb. 11.	Fb. 4.	Fb. 8.	Fb. 7.	Fb. 7.	Fb. 8.	Fb. 11.	Fb. 11.
All leaves unfolded	Fb. 21.	Fb. 14.	Fb. 14.	Fb. 11.	....	Fb. 14.	....	Fb. 14.
First leaf withered	Fb. 21.	Fb. 18.	Fb. 15.	Fb. 18.	Fb. 14.	Fb. 14.	....	
All leaves withered	Fb. 24.	Fb. 24.	Fb. 18.	Fb. 24.	Fb. 18.	Fb. 21.	....	

The flower buds of twigs from the University of Pennsylvania and Geneva, New York, in water burst on February 15 and February 5 respectively.

Golden Forsythia (*Forsythia viridissima*).—

Corrosive sublimate (strong).—Pennsylvania State College: Leaf buds eased January 31; flower buds burst February 3; flowers open February 7; first flower withered February 8.

Corrosive sublimate (weak).—Storrs, Connecticut: No response. Lexington, Kentucky: Leaf buds eased January 30; flower buds eased January 30; flower buds burst January 31; flowers opened February 1; first flower withered February 5; all flowers withered February 7. No response with twigs from Pennsylvania State College, Lexington, Kentucky, and Ithaca, New York, in weak and strong copper sulphate and strong sodium chloride.

Sodium chloride (weak).—Storrs, Connecticut: Flower buds eased January 27. Lansing, Michigan: Flowers opened January 28; first flower withered February 3.

Ammonium nitrate (strong).—Lexington, Kentucky: Leaf buds eased January 29; leaf buds burst January 31.

Ammonium nitrate (weak).—Pennsylvania State College: Leaf buds eased January 29; leaf buds burst January 31; first leaf unfolded February 3; all leaves unfolded February 5; first leaf withered February 7; all leaves withered February 24.

Ammonium oxalate (strong).—Pennsylvania State College: Leaf buds eased February 13; leaf buds burst February 4. Branches from College Park, Maryland, and Ithaca, New York, gave no reaction.

Ammonium oxalate (weak).—Storrs, Connecticut: No response. Lexington, Kentucky: Leaf buds eased February 3.

Potassium chloride (strong).—University of Pennsylvania: Leaf buds eased February 1. Branches from College Park, Maryland and Ithaca, New York, gave no response.

Potassium chloride (weak).—Storrs, Connecticut: No response. Lansing, Michigan: Leaf buds eased February 1; leaf buds burst February 4; first leaf unfolded February 11; all leaves withered February 18.

Sodium bicarbonate (strong).—University of Pennsylvania: Leaf buds eased January 31. Ithaca, New York: No response.

Sodium bicarbonate (weak).—Storrs, Connecticut: No response. Lexington, Kentucky: Leaf buds eased January 31. No response was obtained with branches from New Brunswick, New Jersey, Ithaca, New York, Storrs, Connecticut, Lexington, Kentucky, and Geneva, New York, in weak sodium bicarbonate, strong potassium bisulphate, weak potassium bisulphate, strong hydrochloric acid, strong and weak acetic acid, strong and weak nitric acid, weak chromic acid.

Hydrochloric Acid (strong).—University of Pennsylvania: Leaf buds eased February 1.

Acetic Acid (weak).—Lansing, Michigan: Leaf buds eased January 29; leaf buds burst February 8.

Nitric Acid (weak).—Lansing, Michigan: Leaf buds eased January 29; leaf buds burst January 31.

Chromic Acid (weak).—Lansing, Michigan: Leaf buds burst January 29; first leaf unfolded January 30; all leaves unfolded February 18.

Water.—

	University of Penna.	Penna. State College.	New Brunswick, N. J.	Lansing, Mich.	Ithaca, N. Y.	Geneva, N. Y.	Lexington, Ky.
Leaf buds eased	...	Jan. 30.	Jan. 28.	Jan. 29.	...	Jan. 28.	...
Leaf buds burst	Jan. 27.	Feb. 1.	...	...	Feb. 11.	...	Jan. 29.
First leaf unfolded	Jan. 29.	Feb. 1.	Jan. 29.	Feb. 1.	...	Feb. 7.	...
All leaves unfolded	Jan. 31.		Jan. 31.			Feb. 8	Feb. 3.
First leaf withered	Feb. 21.		...			...	....
All leaves withered	Feb. 28.		Feb. 24.		Feb. 24.	Feb. 24.	Feb. 24.
Flower buds eased			Jan. 27.			Jan. 29.	
Flower buds burst				Jan. 25.	Jan. 29.	Jan. 31.	Jan. 30.
Flowers closed	Jan. 31.				Jan. 29.		...
Flowers opened	Jan. 31.			Jan. 27.	Jan. 30.	Feb. 1.	Jan. 31.
First flower withered	Feb. 4.			Jan. 28.	Feb. 5.	Feb. 5.	Feb. 7.
All flowers withered	...			Jan. 31.	Feb. 7.		Feb. 8.

LINDEN (*Tilia americana*).—

Corrosive sublimate (strong).—University of Pennsylvania: Leaf buds eased February 4.

Copper sulphate (strong).—No response in twigs from University of Pennsylvania.

Copper sulphate (weak).—No response exhibited by Storrs, Connecticut; Lansing, Michigan; Lexington, Kentucky.

Sodium chloride (strong).—Ithaca, New York: No response. University of Pennsylvania: Leaf buds eased February 7; leaf buds burst February 11.

Sodium chloride (weak).—Storrs, Connecticut: No response.

Ammonium nitrate (strong).—Lansing, Michigan: Leaf buds eased February 7. Lexington, Kentucky: Leaf buds eased February 18. No response of twigs from University of Pennsylvania; Ithaca, New York; Storrs, Connecticut; Lexington, Kentucky; Lansing, Michigan; Lafayette, Indiana; Pennsylvania State College; New Brunswick, New Jersey, and Geneva, New York, in weak ammonium nitrate, strong and weak ammonium oxalate, strong and weak potassium chloride, strong and weak sodium bicarbonate, strong potassium bisulphate, strong hydrochloric acid, weak acetic acid, strong and weak nitric acid, strong chromic acid.

Ammonium oxalate (weak).—Lexington, Kentucky: Leaf buds eased February 7; leaf buds burst February 11.

Potassium chloride (strong).—University of Pennsylvania: Leaf buds eased February 3; leaf buds burst February 7.

Sodium bicarbonate (weak).—Leaf buds eased February 5.

Acetic Acid (strong).—University of Pennsylvania: Leaf buds eased February 4.

Water.—University of Pennsylvania: Leaf buds eased February 4; leaf buds burst February 7; first leaf unfolded February 11; all leaves unfolded February 14; first leaf withered February 14; all leaves withered February 24. New Brunswick, New Jersey: Leaf buds eased February 7; leaf buds burst February 11. Ithaca, New York: Leaf buds burst February 7. Storrs, Connecticut: Leaf buds eased February 7. Lansing, Michigan: Leaf buds eased February 4; leaf buds burst February 6. Lexington, Kentucky: Leaf buds eased February 4.

Yulan Magnolia (*Magnolia conspicua*).—

Corrosive sublimate (strong): University of Pennsylvania: Flower buds eased January 27. No response of twigs from University of Pennsylvania or New Brunswick, New Jersey, in strong ammonium oxalate, potassium chloride, sodium bicarbonate (strong), potassium bisulphate (strong) and chromic acid (strong).

Water.—University of Pennsylvania: Leaf buds burst January 31; first leaf unfolded February 3; all leaves unfolded February 7; all leaves withered February 18; flower buds eased January 25; flowers opened January 27; first flower withered January 29; all flowers withered January 30. New Brunswick, New Jersey: Leaf buds eased February 3; leaf buds burst February 5; all leaves withered February 14. Lafayette, Indiana: No response.

Conclusions Based on Experiments.

The experiments of the second year corroborate those of the first year in many particulars. First, it will be noticed that in every case where the twigs responded, they followed the sequence already established among the branches from the same locality. In the first experiments, the phenologic sequence was established by contrasting the development of plants out of doors with those treated experimentally in the greenhouse, and it was found, as before emphasized, that the bud development in chemical solutions followed the same order as out of doors. The experiments of the second year go to prove the same thing. However, we know that in general pear trees blossom earlier than apple trees; that *Forsythia* flowers earlier than the horse chestnut; that the male catkins of the Carolina poplar appear earlier than the flowers of the linden and the oak throughout the Eastern United States at large.

By correspondence with the stations from which the twigs were obtained the following phenologic data was secured that shows the sequence of bud development:[4]

Amherst, Massachusetts.—1, Morello Cherry; 2, Baldwin Apple; 3, York Imperial Apple; 4, Bartlett Pear; 5, Seckel Pear.

Ithaca, New York.—1, Red Maple; 2, Forsythia viridissima; 3, Carolina Poplar; 4, Kieffer Pear; 5, Seckel Pear; 6, Horse Chestnut.

Geneva, New York.—1, Early Crawford Peach; 2, Duchess de Angouleme Pear; 3, Maiden Blush Apple; 4, Seckel Pear; 5, York Imperial Apple; 6, Baldwin Apple; 7, Red Astrachan Apple; 8, Bartlett Pear; 9, Winesap Apple.

Pennsylvania State College (average for ten years).—1, Forsythia viridissima; 2, Horse Chestnut; 3, Morello Cherry; 4, Carolina Poplar; 5, Tulip Poplar; 6, Kieffer Pear; 7, Pin Oak; 8, Linden.

College Park, Maryland.—1, Forsythia viridissima; 2, Early Crawford Peach; 3, Oldmixon Peach; 4, Late Crawford Peach; 5, Kieffer Pear; 6, Duchess de Angouleme Pear; 7, Seckel Pear; 8, Red Astrachan

[4] Replies were obtained from Lafayette, Indiana, and New Brunswick, New Jersey, but these stations were unable to furnish any phenologic data. No replies were obtained from the stations in Connecticut, Michigan and Alabama.

Apple; 9, Early Harvest Apple; 10, Maiden Blush Apple; 11, York Imperial Apple.

Lexington, Kentucky.—1, Tulip Poplar; 2, Oldmixon Free Peach; 3, Carolina Poplar; 4, Horse Chestnut; 5, Linden.

This general sequential development is preserved in the experimental liquids. The same phenomenon with reference to the action of poisons was emphasized in the experiments of the second year. As the data will show, buds were eased and many burst by the stimulating action of the various chemicals. In some instances the leaves unfolded, flower buds opened and such leaves and flowers reached their normal size. This was notably the case with flowers of *Forsythia viridissima* (Pennsylvania State College) in strong corrosive sublimate solution, with the leaves of the Seckel pear (College Park, Maryland) in the same solution, with the leaves and flowers of the Kieffer pear (from Michigan) in the weak corrosive sublimate, with the leaves of *Populus monilifera* (Auburn, Alabama) in weak copper sulphate solution, with the Bartlett pear flowers (Amherst, Massachusetts) in weak copper sulphate, with the York Imperial apple (Amherst, Massachusetts) in weak sodium chloride, with the horse chestnut (Pennsylvania State College) leaves in strong sodium chloride, with the York Imperial apple (Amherst, Massachusetts) leaves in weak sodium chloride, with the red maple (Lansing, Michigan) flowers in weak sodium chloride, with the *Forsythia* (Lexington, Kentucky) flowers in strong ammonium nitrate, with the *Populus monilifera* (Auburn, Alabama) leaves in the same solution. In the weak ammonium nitrate solution, the leaves of the *Forsythia* twigs from Pennsylvania State College reached full size, as did those of *Populus monilifera* from Philadelphia in strong potassium chloride and the flowers of the Bartlett pear (Lansing, Michigan) in weak potassium chloride. The flowers of Clapp Favorite and Kieffer pears opened when the twigs were placed in weak potassium bisulphate, as also the leaves of the Kieffer pear twigs from Lafayette, Indiana. In weak acetic acid solution, the leaves of the Red Astrachan apple (Auburn, Alabama) opened fully wide. The flowers of the Maiden Blush (College Park, Maryland) opened when the twigs were placed in the weak chromic acid solution. But eventually, with but few exceptions, all of the twigs succumbed, many after the first green leaf had been formed. The strong solutions of copper sulphate, potassium bisulphate, hydrochloric and nitric acids seemed to be arrestive and deadly, because very few of the twigs even responded when placed in these solutions.

These results, it seems to the writer, are corroborative of the principle that response is not arrested until the poison has actually penetrated and killed the living cells, thus putting a stop to the suctional activity and responsive power of the living cells. The poisons enumerated, being perhaps more easily conducted, act at once in killing the cells, which with other poisons are stimulated long before they are eventually killed. Bose (*loc. cit.*, 383) has demonstrated this differential activity of poisonous solutions in a number of his experiments. Among various solutions of salt, some are physiologically neutral in their effects; of these potassium nitrate may be taken as an example. Others, again, like a strong solution of sodium chloride, act as excitatory agents. The application of this last reagent is known to initiate rhythmic excitation in animal tissues. Similar effects have been shown to be brought about by this reagent in the case of *Biophytum* and *Desmodium*. Thus in a strong solution of potassium nitrate we have a reagent whose physiologic action is more or less neutral, while its osmotic action is pronounced, and in a strong solution of common salt we have an agent which is both excitatory and osmotic at the same time. If, then, we apply $K\,NO^3$ solution to the base of a cut stem, placed in the shoshungraph (Bose's apparatus), water will be osmotically withdrawn from the plant in opposition to normal suction, and the normal suctional rate will be somewhat reduced. On the application of copper sulphate, the suctional movement, Bose found, was quickly arrested, and this was followed almost immediately by a slight movement in the negative direction; showing that by some spasmodic contraction water was expelled from the tissue. This phase was succeeded by an almost complete arrest of suction, there being now only the feeblest ascensional movement. Within a short period after this, on washing off the poisonous reagent, it was found that the arrest had been temporary only, suction being renewed at the rate of eleven instead of the normal fifteen cubic mm. per minute. The poison was applied once more and allowed to act for thirty-six hours. The arrest was then found to be permanent—that is to say, the substitution of fresh water induced no revival of response, the plant being killed throughout. It is interesting to note that the twigs experimented with at the University of Pennsylvania responded after a much longer time interval than thirty-six hours, as noted in the experimental data above.

It will be noted also that the sequence between northern and southern grown twigs was preserved in the experimental liquids. If the results obtained in the chemical solutions are contrasted with those in the water, it will be found that the buds on branches obtained from northern localities responded much more quickly than did those from southern localities. Thus in water the leaf buds of the Red Astrachan apple from Storrs, Connecticut, burst on February 4; those from Lansing, Michigan, on February 6, and those from Auburn, Alabama, on February 11—a difference of a week between the more northern and the more southern localities. The leaf buds of the York Imperial apple burst in water on January 31 from Geneva, New York;[5] February 3 from Amherst, Massachusetts; February 4 from Storrs, Connecticut; February 11 from College Park, Maryland, and February 15 from Auburn, Alabama. A reference to the experimental data will show practically the same sequence throughout, the buds on northern grown twigs always opening before those on southern grown ones. The sequence of the bud development in the chemical solutions proceeded as above indicated for the twigs in water. The buds on twigs of the same species, where comparison is possible, from northern localities opened first in the same chemical and those of southern localities followed as indicated below:

Weak Corrosive sublimate (Kieffer Pear).—

	Storrs, Conn.	Lafayette, Ind.
Leaf buds eased	February 4.	January 31.
Leaf buds burst	February 7.	February 3.

Weak Copper sulphate (Maiden Blush Apple).—

	Lansing, Mich.	Auburn, Ala.
Leaf buds eased	....	February 7.
Leaf buds burst	February 1.	February 8.

Weak Sodium chloride (York Imperial Apple).—

	Amherst, Mass.	Storrs, Conn.
Leaf buds eased	January 31.	February 4.
Leaf buds burst	February 4.	February 5.
First leaf unfolded	February 5.	February 7.

Strong Ammonium nitrate (Kieffer Pear).—

	Lafayette, Ind.	Auburn, Ala.
Leaf buds eased	January 30.	January 31.
Leaf buds burst	January 31.	February 4.
First leaf unfolded	February 4.	February 7.

[5] Geneva, New York, although geographically south of Amherst, Massachusetts, is probably climatically more northern.

Weak Potassium chloride (York Imperial Apple).—

	Storrs, Conn.	Auburn, Ala.
Leaf buds eased	February 1.	February 14.
Leaf buds burst	February 3.	February 15.

Strong Sodium bicarbonate (*Æsculus hippocastanum*).—

	University of Pennsylvania.	Penna. State College.	New Brunswick, N. J.
Leaf buds eased	February 1.	January 30.	February 4.
Leaf buds burst	February 7.	January 31.	February 7.
First leaf unfolded		February 11.	February 11.

Weak Sodium bicarbonate (Red Astrachan Apple).—

	Storrs, Conn.	Auburn, Ala.
Leaf buds eased	February 1.	......
Leaf buds burst		February 7.
First leaf unfolded	February 4.	February 21.

—— (Clapp Favorite Pear).—

	Storrs, Conn.	Lansing, Mich.
Leaf buds eased	January 31.	....
Leaf buds burst	February 3.	February 1.

—— (*Populus monilifera*).—

	Storrs, Conn.	Lexington, Ky.	Auburn, Ala.
Leaf buds eased		February 7.	
Leaf buds burst	February 1.	February 7.	February 14.
First leaf unfolded			February 14.

—— (*Æsculus hippocastanum*).—

	Lansing, Mich.	Lexington, Ky.
Leaf buds eased	February 4.	February 3.
Leaf buds burst	February 7.	February 7.
First leaf unfolded	February 11.	February 11.

In this case the buds developed coincidently from widely separated localities upon a European forest tree. Is this an evidence that *Æsculus hippocastanum* is not acclimated, or an evidence that as a more plastic species that it is more thoroughly so. Yet in the next experiment there is a difference.

Strong Potassium bisulphate (*Æsculus hippocastanum*).—

	Geneva, N. Y.	New Brunswick, N. J.
Leaf buds eased	January 30.	February 4.
Leaf buds burst	February 3.	February 5.

Weak Potassium bisulphate (Clapp Favorite Pear).—

	Lansing, Mich.	Storrs, Conn.
Leaf buds eased	January 30.	January 30.
Leaf buds burst	....	February 1.
First leaf unfolded	February 3.	February 4.

—— (Kieffer Pear).—

	Lafayette, Ind.	Lansing, Mich.
Leaf buds eased	February 3.	....
Leaf buds burst	....	January 29.
First leaf unfolded	February 5.	February 3.

—— (*Æsculus hippocastanum*).—

	Lansing, Mich.	Lexington, Ky.
Leaf buds eased	February 3.	February 4.
Leaf buds burst	February 7.	February 7.
First leaf unfolded	February 11.	February 11.

The same coincidence of dates will be noticed with this tree as noted above. The response is more rapid with the more northern tree than with the more southern, but the subsequent development runs parallel as to the dates at which the various manifestations of development occur.

Weak Hydrochloric Acid (Kieffer Pear).—

	Lansing, Mich.	Lafayette, Ind.
Leaf buds eased	January 29.	January 30.
Leaf buds burst	January 31.	January 31.

Strong Acetic Acid (*Æsculus hippocastanum*).—

	University of Pennsylvania.	New Brunswick, N. J.
Leaf buds eased	January 31.	February 5.
Leaf buds burst	February 7.	February 8.

Weak Acetic Acid (Red Astrachan Apple).—

	Storrs, Conn.	Auburn, Ala.
Leaf buds eased	....	February 5.
Leaf buds burst	February 3.	February 7.
First leaf unfolded	February 4.	February 14.

Weak Nitric Acid (Red Astrachan Apple).—

	Storrs, Conn.	Auburn, Ala.
Leaf buds eased	February 4.	February 7.
Leaf buds burst	February 5.	February 11.

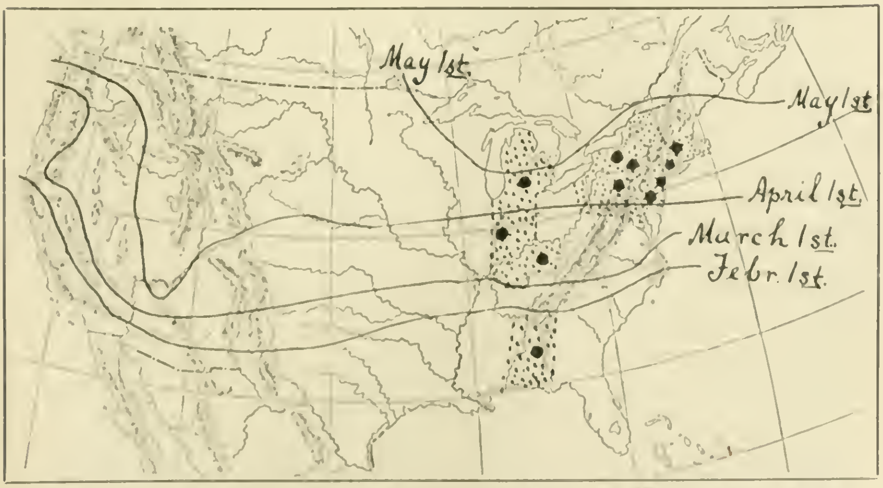
Weak Chromic Acid.—

	Lansing, Mich.	Auburn, Ala.[6]
Leaf buds eased	....	February 4.
Leaf buds burst	February 8.	February 11.
First leaf unfolded	February 11.	February 14.

The fact that there is such a difference between the time when the leaf and flower buds of the same variety and species of fruit and forest trees open is an index of the extent of their acclimatization. The native trees have, since their migration from the original forest centre, been acclimated to their new localities of growth, while the introduced fruit trees since their introduction to America have become similarly ameliorated to the American climate, so that they react in nature and in the experimental culture solutions exactly as do the native plants.

Bearing of Experimental Data on the Advent of Spring.

The climatic differences between the north and the south, representing the amount of acclimatization which each species has had to adopt, may be demonstrated by a study of the advent of spring. The temperature of 42.8° F. (6° C.) is that at which the protoplasmic contents of the ordinary plant find the limits of their activity. The advent of spring may be considered as taking place at the approach of an isotherm one degree higher, or 43.8° F. This isotherm, progressing steadily in



Map illustrating the advance of the isotherm of spring (43.8° F.), as well as the regions ( ) and stations (●) from which the experimental twigs were obtained.

[6] Started two days later.

its advance across the United States, is illustrated in the accompanying map which was constructed from the recorded mean temperatures for 15 years from 1870–1885.[7] This line may be regarded as the edge of spring. In the Gulf States there is no true advent of spring. On February 1 the isotherm in question crosses the United States from the vicinity of Cape Hatteras on the east to the north of El Paso, then turns northwestward and reaches the Pacific coast some distance north of San Francisco. The advance on the first of successive months is illustrated by the map.

Spring may be said to begin in our most northern locality, Lansing, Michigan, about May 1. Auburn, Alabama, lies below the isotherm of February 1. We therefore have a difference of three months in the awakenment of vegetation under the influence of the advent of spring conditions. Yet in our experimental cultures no such great discrepancy existed, because the heat of the greenhouse is more uniform (not so fluctuating), and yet, notwithstanding the fact that the interval between the successive events is shortened, nevertheless the same phenologic sequence is maintained as described above. The difference of three months in the advent of spring between the most northern and the most southern of our localities indicates the real amount of acclimatization of the same species and race growing in the different places from which the experimental material was obtained. That is, the growing season of trees and shrubs is very much abbreviated compared with the growing season in more southern situations. Three months difference is a very appreciable amount between the northern and southern States, and the fact that such fruit trees as the Maiden Blush apple and the Kieffer pear can be grown in Michigan and Alabama is noteworthy as an instance of acclimatization of the most pronounced type. In Alabama the growing season is about nine months long, from February 1 to November 1. In Michigan the growing season begins May 1 and is completed by the beginning of October, a length of about five and a half months. The fact that many of the fruit trees mentioned above did not take kindly to the American climate, and that they afterwards became adapted to its wide range of climatic conditions is proof of their acclimatization. Yet some doubt that acclimatization occurs. A writer in *Forest Leaves* (XI : 108) says that "Trees are fixed, almost inflexible, in their habits. For centuries, indeed as long as we have record, each species has kept in its beaten ways, insisting on the same average of temperature and refusing to

[7] Harrington, Mark W.: The Advent of Spring. *Harper's Magazine*, May, 1894.

grow where this could not be, seeking and occupying certain kinds of soil and demanding certain amounts of moisture and avoiding situations where these were wanting." In connection with the experiments which have preceded, some experimental data from other sources should be given in order to prove that organisms can be acclimated, that is can be inured or habituated to conditions at first injurious to them. A reference to the short bibliography of acclimatization at the end of this paper will enable the investigator to obtain the additional evidence of acclimatization which it is not possible to review. The experimental data for animals and plants is here given.

General Experimental Work on Acclimatization.

Among invertebrates Loew[8] has found in Owen's Lake, California, the alkaline waters of which contain among other things 2.5% of Na_2CO_3, numerous living infusoria, Copepoda, larvæ of Ephydra and molds. Again the vinegar eel, *Rhabditis aceti*, lives in a 4% solution of acetic acid, although this strength is usually fatal: *e. g.*, a 0.23% solution of acetic acid kills the tentacles of *Drosera*, according to Darwin. Beudant accustomed fresh-water animals to salt water. He used *Lymnea*, *Physa*, *Planorbis*, *Ancyclus*, *Paludina* and some other fresh-water mollusks. He began in April by putting these organisms into a 1% NaCl solution, and, continuing to add salt slowly, by September many of these withstood a 4% solution, a solution which kills animals suddenly subjected to it. He performed the reverse experiment upon marine mollusca, bringing them to live in fresh water by gradually diluting the medium. According to MacDougal,[9] Lopriori found that while the streaming movements of protoplasm were inhibited by exposure to an atmosphere of one part oxygen and four parts carbon dioxide, yet if the plant were first exposed to a mixture of 25 parts of oxygen and 75 of carbon dioxide for a time, it might then be brought successively into atmospheres containing 80, 85, 90, 95 and even 100 parts of the gas without immediate injury. Organisms can be acclimatized to extreme temperatures. Davenport (*loc. cit.*, 249) cites illustrations of both. Few active organisms can withstand a temperature of over 45° C., and for whole groups like Cœlenterata, marine mollusca, crustacea and fishes 40° is a point of death. There are plant and animal organisms that carry on their life processes in hot springs. Simple plants like *Chroococcus*, *Nostoc*, *Anabæna*, *Leptothrix*, *Oscillaria*, etc.,

[8] Davenport, C. B., *Experimental Morphology*, p. 28.
[9] *Textbook of Plant Physiology*, 57.

exist in springs where the temperature ranges from 45° to 93° C. Rotifers and Anguillulidæ were found in the Carlsbad Springs of Bohemia at a temperature of 44° to 54°; *Cypris balnearia* occurred in water 45° to 50.5° and *Stratiomys* larva at 69° in a hot spring in Colorado. But the experiments of Dallinger are remarkable illustrations of gradual acclimatization. He kept Flagellata in a warm oven for many months. Beginning with a temperature of 15.6° C. he employed the first four months in raising the temperature 5.5°; this, however, was not necessary, since the rise to 21° can be made rapidly, but for success in higher temperatures he found it best to proceed slowly from the beginning. When the temperatures had been raised to 23° the organisms began drying, but soon ceased, and after two months the temperature was raised half a degree more and eventually to 25.5°. Here the organisms began to succumb again, but finally after several years of treatment Dallinger succeeded in rearing the organisms in a temperature of 70° C. The same acclimatization to cold may be shown. Thus the swarm spores of a marine alga were liberated when the temperature of the water was between 1.5° and 1.8° C.

We can exemplify this kind of acclimatization in the higher plants. Our treatment of the twigs from various localities demonstrates that this kind of acclimatization was operative in the past with each tree species. Sweet peas raised in Calcutta from seed imported from England rarely blossom and never yield seed; plants from French seed flower better, but are still sterile; but those raised from Darjeeling seed (originally imported from England) both flower and seed profusely, according to Wallace.[10] Speaking of the introduction of the Sea Island cotton into the United States, Wight[11] says that (*Gossypium barbadense* and *G. vitifolium*) they were with much difficulty introduced into North America owing to the shortness of the summer season. The former (Sea Island), indeed, could not be established until a fortunate occurrence of a very mild winter permitted the roots to live through it and produce an early crop of fresh shoots in the spring. These bore and ripened, the seed of which was found sufficiently hardy to resist the cold of spring and matured a crop of excellent cotton in the course of the succeeding autumn. Indian corn develops local varieties with extreme readiness, but they seldom succeed when transferred even short distances, at least until time enough for acclimatization has elapsed. E. Davenport sent a standard white Illinois corn, ripening in about

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[10] *Encyclopedia Britannica*, article "Acclimatization."

[11] Watt, Sir George: *The Wild and Cultivated Cotton Plants of the World*, 1907, p. 272.

120 days and capable of maximum yields (75 bushels per acre), to be grown in Michigan, Wisconsin, Maine and Mississippi. In Maine it failed to ripen, but at all other points it ripened in about 100 days, producing small, inferior ears. That it should hurry through its period of growth at the north was not surprising, but that it should do so in the south is unaccountable.[12] The season of maize varies from six months in the elevated plains of Santa Fé in South America to four months in the middle United States and two and one-half months in the rainy lake district northwest of Lake Superior.[13] Peach trees from central Georgia blossom ten to twelve days later in Virginia and Maryland than do those of the same variety from New Jersey or New York. As peach trees are propagated by buds we may regard the Georgia and New Jersey trees, being of the same variety, as parts of the same individual. The foregoing citations indicate that acclimatization does occur, and that in the case of the experimental twigs the differences in the time of the bud development illustrates that acclimatization has taken place to the extent of a variation in habit as to their seasonal development, emphasized in the acclimatization of the cotton, corn and peach previously described.

The response of the buds in the chemical solutions was an immediate one, and at a season of the year when all of the twigs from widely separated stations (north and south) were in a dormant condition. The advantage of these experiments in demonstrating the above conclusions is marked over the growth of such trees in the forest, or in the orchard, for the reason that as to temperature all of the twigs were exposed equally to the same amount, and those placed in the pure water were under practically the same conditions, while the chemical solutions provided enough of different conditions under experimental control which would produce alterations in the time and method of response, if such could be produced by experimental means. The results have already been summarized.

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[12] Davenport, E.: *Principles of Breeding*, 1907, p. 222.

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AN ORTHOPTEROLOGICAL RECONNOISSANCE OF THE SOUTHWESTERN UNITED STATES. PART II: NEW MEXICO AND WESTERN TEXAS.

BY JAMES A. G. REHN and MORGAN HEBARD.

The first portion of the results of this examination of the southwestern United States, treating of Arizona material, has already been published in these PROCEEDINGS.[1]

Seven rather distinct regions were examined in the area covered by this paper, notes on the localities being given below. In addition a number of other localities are represented in the series by lots of from one to six species. A small lot of material from Fort Wingate, McKinley County, New Mexico, collected by Mr. John Woodgate and now the property of the Academy, has also been examined in this connection.

Mr. Otho Poling, of Quincy, Illinois, assisted in collecting some of the material secured at Deming, while all taken at Albuquerque and Aden was collected by the junior author.

The number of species examined and treated in this report is one hundred and fifteen, of which six prove to be new, while the specimens number one thousand, three hundred and ninety-five.

The types of all the new forms are in the Hebard Collection.

El Paso and Franklin Mountains, El Paso County, Texas. Altitudes, 3,700 to about 5,600 feet. July 9 to 11 and 17, 1907.

The vicinity of El Paso may be divided into several regions: first, the low bottom-land along the river, this section being threaded with acequias and a considerable portion is or has been under cultivation; second, a region of low sand dunes slightly northeast of the city, covered with a scattering growth of mesquite; third, a fairly extensive mesa bordering the Franklin Mountains, very broken and rugged on its eroded marginal slopes where is exposed a sort of caliche as the basis of the mesa, and quite level on the summit, all covered more or less completely with rather uniformly-sized greasewood (*Covillea tridentata*) bushes, mingled on the rugged base slopes with mesquite (*Prosopis velutina*) and occasionally tornillo or screw bean (*Prosopis odorata*); fourth, the Franklin Mountains, rising from the mesa to an elevation

[1] *Proc. Acad. Nat. Sci. Phila.*, 1908, pp. 365–402.

of from 5,000 to 7,000 feet. The latter were ascended to the summit of the South Peak, altitude about 5,600 feet, and found to be desert to that height. The slopes of this range are covered more or less uniformly on the lower section with greasewood, while the higher portions are sparsely covered with aloes and other desert species. They were very productive of Orthoptera, *Syrbula fuscovittata*, *Boötettix argentatus*, *Diapheromera covilleæ*, *Pseudosermyle tenuis*, *Mermiria texana*, *Arphia teporata* and others being taken.

On the mesa and at the foot of the same the greasewood yielded, among others, *Diapheromera covilleæ*, *Boötettix argentatus*, *Melanoplus bowditchi*, *M. herbaceus*, *Ateloplus macroscelus* and *Litaneutria skinneri*, while *Anconia cæruleipennis*, *Heliastus aridus*, *Schistocerca vaga*, *Trimerotropis texana*, *Psoloessa texana*, *Derotmema laticinctum* and *Phrynotettix robustus* were found on and about the mesa. In the sand-hill region the character of the Orthoptera was found to be much like that of the mesa, but in the clumps of mesquite *Melanoplus glaucipes*, *M. herbaceus*, *Æoloplus elegans*, and *Schistocerca shoshone* were found.

The low bottom-land is covered in many places with tangles of screw bean (*Prosopis odorata*), with tall rank weeds in others, and areas of hardened bare adobe are also to be found. In the tornillo tangles *Melanoplus glaucipes*, *Æoloplus elegans*, *Mermiria bivittata and Diapheromera mesillana* were found, while the areas of high weeds harbored *Æoloplus elegans*, *Melanoplus herbaceus*, *M. aridus*, *M. atlanis*, *Stagmomantis* sp., and *Diapheromera persimilis*. On the bare spots *Paropomala virgata*, *Derotmema laticinctum*, *Trimerotropis rubripes* and *Hippiscus corallipes* were found.

Alamogordo and Dry Canyon, Sacramento Mountains, Otero County, New Mexico. Altitude, 4,300 to 5,500 feet. July 12 and 13, 1907.

The conditions in the vicinity of Alamogordo have already been treated by Stone and Rehn[2] and Ruthven.[3] Our collecting was restricted to the edge of the mesquite area, on the eastern margin of which the town is situated, and the greasewood slopes leading to Dry Canyon. The mesquite section was unproductive, while in the greasewood belt *Boötettix argentatus*, *Ectatoderus borealis*, *Gryllus alogus* and *Psoloessa texana* were secured, but most of them not in such numbers as at El Paso. In the broken country at the first foothills and in the arroyos at the canyon mouth collecting was more productive, *Parabacillus coloradus*, *Dichopetala brevihastata* and *Yersinia solitaria*

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[2] *Proc. Acad. Nat. Sci. Phila.*, 1903, p. 16.

[3] *Bull. Amer. Mus. Nat. Hist.*, XXIII, pp. 492–499.

being taken and a greater variety of species noticed. Work was continued up the south arm of Dry Canyon to the broader valley-like portion of the canyon above the spring. Here piñon (*Pinus edulis* or *cembroides*) and juniper (*Juniperus pachyphlœa*) appeared, giving the canyon bottom a park-like appearance quite different from the sotol (*Dasylirion*) and ocotillo (*Fouquieria splendens*) covered slopes at the canyon's mouth. In this region, which is at about 5,500 feet elevation, one *Amblycorypha huasteca* was beaten from a small green tree, while on the barer slopes at the same elevation several interesting species, such as *Yersinia solitaria, Syrbula fuscovittata, Amphitornus ornatus* and *Melanoplus aridus*, were taken.

At night in Alamogordo several species of Orthoptera, such as *Derotmema laticinctum, Trimerotropis texana* and *Gryllus*, came to the street lamps, while Coleoptera and Lepidoptera were attracted in the greatest numbers. Certain species of beetles, as *Cicindela lemniscata* and *Tetracha carolina*, fairly swarmed, and the great moth *Marumba occidentalis* was by no means uncommon.

Cloudcroft, Sacramento Mountains, Otero County, New Mexico. Altitude 8,600 to 8,700 feet. July 14 to 16, 1907.

This charming spot, situated on the summit of the Sacramento range, does not appear to be on the mountain top except at certain points of lookout, where one looks down on the long slopes and deep canyons of the mountains which sink into the desert plain of the Otero basin or Hueco bolson as it is variously called. The Cloudcroft region is one of low hills with beautiful open vales between them. The hills and some of the level areas are covered with magnificent forests, chiefly of Douglas fir (*Pseudotsuga mucronata*), western yellow pine (*Pinus ponderosa*) and in some places aspen (*Populus tremuloides*). The vales, or "canyons" as they are termed by courtesy, are usually carpeted with numerous grasses and in many places are veritable flower beds. Many of the forest trees are of immense size, and the rich greens of the region are in striking contrast to the colors of the desert but ten miles away, though some thousands of feet below. In a grassy field, bounded on one side by a stand of deciduous saplings and on the other by huge firs, we found *Gomphocerus clavatus, Melanoplus calidus* and *M. atlanis* plentiful. One specimen of *Eritettix variabilis* was also taken in this location. Among the firs on the border of this field a single *Chlœaltis abdominalis* was heard stridulating among some low herbage near a stump and was captured. The very noisy *Circotettix undulatus* was plentiful in open spots in the forest, along the roads and on bare lumbered slopes. One *Melanoplus altitudinum* was found in damp grasses at the junction of two of the glades, and another specimen was taken on a steep hillside in open conifer forest. In the latter situation *Acrydium crassum* was also taken. Search in many pine and fir logs disclosed only a few *Ceuthophilus*, *valgus* and *uniformis* being taken.

The nights were very chilly and no katydids were heard. The effect of the cool evenings was apparent in the scarcity of *Melanoplus calidus* and *Gomphocerus clavatus* before ten in the mornings, both species occurring in numbers in the afternoon.

Aden, Donna Ana County, New Mexico. Altitude, 4,382 to 5,000 feet. July 21, 1907.

The plain about this station differs from the greater part of the southern New Mexican desert plains in that it is covered in most places by low grasses, giving it some slight resemblance to the Great Plains. Over this plain small mesquite bushes are scattered at greater distances than usual. Near the railroad track the grasses grow in great profusion, reaching in many places a height of nearly a foot. In this location Orthoptera were found in very great numbers, among the series taken being several plains species not found on the surrounding deserts.

About a quarter of a mile from the station a rounded hill rises directly from the prairie. This hill is very rocky and covered by a scattered growth of greasewood (*Covillea tridentata*), and in spite of its elevation of not more than 600 feet above the surrounding plain several mountain-loving species, such as *Eritettix variabilis* and *Arphia teporata*, were found on it. It is interesting to note that such forms of Orthoptera were to be found on this solitary little knob, in spite of its small size, low altitude and the fact that it is several miles distant from the nearest hills.

Deming, Luna County, New Mexico. Altitude about 4,350 feet. July 18–21, 1907.

About the town of Deming stretches a typical desert plain, covered with groves of medium-sized mesquite (*Prosopis velutina*) and large areas of rabbit-weed (*Isocoma heterophylla*), broken on the north by the bed of the Mimbres River. On both sides of this stream-bed are extensive flats of white sand closely dotted with tall yuccas. These flats average about half a mile to a mile in width and are hard to cross, owing to the loose and yielding sand. No low vegetation is present on these areas, and but two species of Orthoptera, *Trimerotropis texana* and *laticincta*, were taken in the section. On the north side of the sand and yucca belt, in extensive rabbit-weed tracts, collecting was very productive, *Hesperotettix viridis* being found in abundance and *Pseudosermyle straminea* and *truncata* were taken, the former in numbers, the latter sparingly. As Deming is a considerable distance from the greasewood slopes at the bases of the nearest mountains (Florida and Cook's ranges), those areas were too distant to be examined on foot.

The interesting roach *Homœogamia erratica* was found at night about lights in the town, while *Hormilia elegans* was attracted the same way.

Florida Mountains, Luna County, New Mexico. Altitude, 4,500 to 5,500 feet. July 19, 1907.

By driving fourteen miles across the mesquite plain from Deming and ascending the gradual greasewood slopes the Florida Mountains were reached. Various stops on the way revealed nothing of special interest in either the mesquite or greasewood areas. A canyon at the north end of the range, extending southwest under the towering bulk of Capitol Dome, was our objective point. A small spring which trickled a short distance over the rocks before disappearing proved very attractive to *Telmatettix aztecus,* which was present in numbers on the damp spots. The slopes of the canyon were rugged and steep, but we ascended the east face to about 5,500 feet elevation. On the semi-barren slope, with here and there a holly-like scrub oak and numerous scattered mountain bushes, the former often with a precarious hold between boulders, Orthoptera were not uncommon and in character were very interesting. Among the species found were *Yersinia solitaria, Mermiria texana, Melanoplus aridus, Mestobregma plattei* and *Trimerotropis cyaneipennis.* The steepness of the ascent and the short length of time at our disposal prevented us from reaching the summit of the mountains. The slopes at the foot of the mountains did not yield even moderately good collecting and but two or three common species were taken.

Silver City, Grant County, New Mexico. Altitude, 5,900 feet. July 20, 1907.

About one-half day was spent at Silver City, collecting on the rounded hills west of the town. Various short grasses scantily covered the tops and slopes of these hills, with here and there in the ravines and valleys clumps of juniper. Collecting was not very productive, the only species worthy of note being *Aulocara rufum* (the first New Mexican record), *Cordillacris apache, Stirapleura pusilla* and *Trimerotropis melanoptera.*

Albuquerque, Bernalillo County, New Mexico. Altitude about 4,900 feet. September 14, 1907.

Nearly all the collecting at Albuquerque was accomplished near the river in low grassy fields and areas of cultivated ground. In this location Orthoptera were found in great numbers, but collecting was made difficult by the swarms of mosquitoes which were everywhere very active and vicious. On areas of short grass were found *Encoptolophus texensis*, *Litaneutria skinneri*, *Paropomala calamus* and *virgata* and *Mermiria bivittata*, while in the higher and more succulent growths of heavy weeds, clover and grasses many *Melanoplus bivittatus*, *M. femur-rubrum*, *M. differentialis* and *Nemobius utahensis* were found. A single specimen of *Telmatettix aztecus* was captured by a pool beside the river and one other specimen was seen. In the arid foothill section but two specimens of *Trimerotropis fascicula* and one or two *T. vinculata* were found.

BLATTIDÆ.

BLATTELLA Caudell.

Blattella germanica (Linnæus).

A specimen of this cosmopolitan species was attracted to light at Deming, July 20.

TEMNOPTERYX Brunner.

Temnopteryx desertæ n. sp.

Type: ♀; Johnstone, Valverde Co., Texas. July 8, 1907. M. Hebard. [Hebard Collection.]

A very peculiar species with lateral, non-attingent tegmina. Its relationship is closer to *T. limbata* Saussure from eastern Mexico and *T. lobipennis* Saussure from Brazil than to any other species of the genus, differing from the former in the more elongate and non-attingent tegmina, which reach to the apical margin of the first abdominal segment, and in the shorter and thicker cerci; from the latter in the proportionately shorter tegmina and much smaller general size.

In general appearance the resemblance of the species to those of the genus *Loboptera* is very great, but the wings are present as distinct, articulate though functionless appendages, which is not the case with *Loboptera*.

Size small; form depressed, ovate. Head with the occipital outline arcuate and distinctly projecting beyond the pronotum; space between the eyes great, slightly more than that between the ocellar spots. Pronotum slightly broader than longer, moderately arcuate transversely, lateral and cephalic margins slightly thickened, cephalic margin arcuato-truncate, lateral margins moderately arcuate, caudo-lateral angles rounded rectangulate, caudal margin very slightly arcuate; caudal portion of the disk with a pair of shallowly impressed areas. Tegmina about equal to the pronotum in length, elongate trigonal, reaching to the margin of the first abdominal segment, the greatest width contained one and one-half times in the length; costal margin straight, arcuate at the base and at the apex, sutural margin arcuate, the apex very narrowly rounded; anal vein distinct, arcuate, reaching the sutural margin distad of the middle, costal field separated by a moderately impressed line; space between the tegmina about equal to the width of one of them. Wings falling slightly short of the tips of the tegmina. Mesonotum and metanotum with their margins truncate. Abdomen with its greatest width distinctly exceeding that of the pronotum; proximal dorsal segment with the margin arcuate, second with the margin slightly arcuate, third, fourth and fifth sub-truncate, sixth and seventh arcuate-emarginate, eighth arcuate-emarginate laterad and produced obtuse-angulate mesad; supra-anal plate trigonal, apex rectangulate, medio-longitudinal carina blunt; subgenital plate moderately arcuate in transverse section, margin arcuate, truncate mesad; cerci distinctly but not greatly exceeding the subgenital plate, heavy, depressed, fusiform, apex moderately sharp. Limbs so badly damaged that the spine formula cannot be satisfactorily determined.


Fig. 1.—*Temnopteryx desertæ* n. sp. Dorsal view of type. (× 3.)

General color of the head and pronotum ochraceous, becoming paler toward the lateral margin of the pronotum; color of the abdomen and thoracic segments except the cephalic half of the mesonotum which is ochraceous, chestnut, venter of the abdomen chestnut mesad becoming ochraceous laterad, subgenital plate tawny ochraceous, venter of the thorax and limbs pale buff. Eyes black; tegmina chestnut with the costal portion pale buff; cerci burnt sienna edged with blackish.

Measurements.

Length of body,	9.5 mm.
Length of pronotum,	3 "
Greatest width of pronotum	4.1 "
Length of tegmen,	3 "
Greatest width of abdomen,	5.2 "

The unique type was found upon overturning a small boulder on the bare desert.

HOMŒOGAMIA Burmeister.

Homœogamia erratica Rehn.

At Deming, July 18 to 20, a series of eleven males of this species was collected at night about electric lights in the town. All the specimens were taken on rough walls or screens upon which a light shone, excepting one specimen which was flying about a light, much in the manner of a Noctuid, but not so erratic. There is in the lot an appreciable amount of variation in size, and in a few specimens the disk of the pronotum is darker than in others. In all of the eleven individuals the interspace between the ocelli is greater than that between the eyes, although in one specimen the difference is very slight.

This is the first exact record of the species from New Mexico.

MANTIDÆ.

YERSINIA Saussure.

Yersinia solitaria Scudder.

On rocky slopes and ledges and on scattered boulders at altitudes of from 4,300 to 6,000 feet this species appears at home. Perfectly protected by its coloration which harmonizes with its environment, it is with considerable difficulty that individuals are located. When disturbed they spring very quickly to a new resting-place, often jumping as much as six inches, frequently repeating their spring several times until a place of safety is reached.

A series of twenty-six specimens was taken at the following localities: Dry Canyon, Sacramento Mountains, 4,900–5,500 feet, July 13, two males and two females; Aden, 4,386 feet, July 21, one male; Florida Mountains, 5,100–5,200 feet, July 19, eight males, five females; Silver City, 5,900 feet, July 20, four males, one female and two with the sex not determinable as the apex of the abdomen is missing in both. The majority of the individuals collected are immature, but several from Dry Canyon, a number from the Florida Mountains and one from Silver City are fully adult. Adult males from the Florida Mountains range from 19 to 22 mm. in length of body, while mature females from the same locality show extremes of 18 and 25 mm. In color numerous shades are present—clay color, ochraceous, orange-red, wood brown, seal brown and greenish-yellow, one specimen being parti-color, the head, pro- and mesothorax and limbs pale orange-red, the remainder of the body very pale ochraceous.

Two males and two females from Fort Wingate, New Mexico, taken

September 15–16, 1908, by John Woodgate, have also been examined.

The records given herewith are the first published ones of the species from southern New Mexico, while the known range extends from western Nebraska and southwestern Colorado south to central southern New Mexico and southeastern Arizona.

LITANEUTRIA Saussure.

Litaneutria skinneri Rehn.

At El Paso this interesting species was taken in three quite different situations: swept from dry grass in sandy ground along the Rio Grande, July 10 (one ♂); swept from greasewood on edge of mesa, 4,200 feet, July 11 (one ♀), and taken from the bare face of a precipitous rock at 5,000 feet elevation in the Franklin Mountains, July 9 (one ♀). One male and two females were taken on dry bunch grass at Albuquerque on September 14, while five immature specimens (two ♂, three ♀) taken at Aden, July 21, on grass prairie, and at Silver City, July 20, are provisionally referred to this species. The Albuquerque females and the Franklin Mountains individual are equal to the female type in size, while the other El Paso female is distinctly smaller and less robust. The Franklin Mountains specimen is blotched and barred with seal-brown on a pale mars-brown ground, a coloration eminently protective as our field notes mention the blending of this insect's coloring into the surroundings.

The range of this species now extends from the Grand Canyon region, Arizona, and Albuquerque, New Mexico, south to the Huachuca Mountains, Arizona, and the vicinity of El Paso, Texas.

STAGMOMANTIS Saussure.

Stagmomantis sp.

Immature specimens of a species of this genus were taken as follows: on irrigated land at El Paso, July 10 and 11; at the east base of the Franklin Mountains, July 9; Alamogordo, July 13; Aden, July 21, on rabbit weed; Deming, July 18; Silver City, July 20. Of the eleven specimens before us all are in the green phase except one which has the thorax dark brown. The Alamogordo specimen is a female nearly mature.

PHASMIDÆ.

PARABACILLUS Caudell.

Parabacillus coloradus (Scudder).

This peculiar walking stick was encountered at three localities, viz.: Dry Canyon, 5,000 feet elevation, July 13, two females; Cloudcroft, 8,600 feet elevation, July 15, one male; Aden, 4,400–4,500 feet elevation, July 21, five females. The Cloudcroft male is apparently mature, the remainder being in about the same stage of the immature condition.

At Aden and in Dry Canyon the species was taken by beating low vegetation, while at Cloudcroft it was captured in a clump of grass under pines and fir. Two females, taken at Fort Wingate, New Mexico, Nov. 4, 1907, and Sept. 9, 1908, by John Woodgate, have also been examined. The range of this form now extends from Nebraska and Colorado south to southern New Mexico and west to southern California.

PSEUDOSERMYLE Caudell.

Pseudosermyle straminea (Scudder).

This species was present, July 18, in great numbers on rabbit weed on the plain north of the town of Deming and around the dry bed of the Mimbres River. A series of twenty-one males, all adult, and four females in various stages of immaturity was taken on that date. A single male was taken from the same plant on the lower slopes of the Florida Mountains, July 19, while six of the same sex from Aden, July 21, and one other male from Dry Canyon, Sacramento Mountains, taken on July 13, are included in the collection. Practically all of the specimens were taken by beating, the insects exhibiting a striking reliance upon their protective form and coloration. When alarmed they held themselves motionless with legs at stiff angles and, upon experimenting with one of the individuals, this was found to be true when it was picked from the bush, and even when dropped upon the sand it retained its rigidity.

In size there is a considerable amount of variation, the extremes of the Deming series of males measuring 40.5 and 47 millimeters in the length of the body. The form of the male cerci remains essentially the same, some slight but unimportant variations being present. In coloration there appears to be two types, in the male at least, one olive-greenish, the other greenish-yellow, the whitish lateral lines being present more or less distinctly in all the adult males seen. The immature females are all yellowish-green, with very faint indications, in one or two individuals, of the lateral lines.

This species was previously known only from the vicinity of Mesilla Park, Donna Ana County, New Mexico. The range now covers sections of Otero, Donna Ana and Luna Counties.

Pseudosermyle truncata Caudell.

Associated with *P. straminea* on rabbit weed, three males and one female of this species were taken near Deming, July 18, while under similar surroundings at Aden a pair were taken on July 21.

The males are of very similar coloration, the olive green predominating in one or two more than in the others. The females, however, are quite dissimilar, one being pale yellowish-green, the other pale cupreous green like weathered copper.

The range of this species is now known to extend from Aden, Donna Ana County, New Mexico, to Los Angeles County, California, and from the Grand Canyon region to near the Mexican line.

Pseudosermyle tenuis n. sp.

Type: ♂; Franklin Mountains, altitude 4,500 feet, near El Paso, El Paso County, Texas. July 9, 1907. Hebard and Rehn. [Hebard Collection.]

This new form is a most interesting species, allied to *P. banksii* Caudell, from eastern and east-central Texas. Through the kindness of the describer of *banksii* I have been able to compare the new form with a typical specimen of his species, from which *tenuis* differs in the slightly more robust build with slightly shorter legs though the body is slightly longer, in the absence of a median carina from the caudal portion of the occiput, in the smoother proximal antennal joint, in the narrower pronotum which is distinctly constricted cephalad, in the less distinctly keeled meso- and metanotum, in the less compressed and more inflated apex of the abdomen, and in the slightly more incurved cerci.

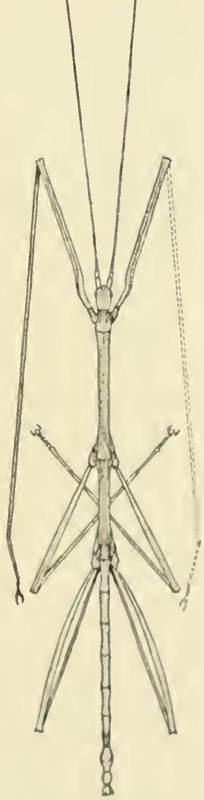

Fig. 2.—*Pseudosermyle tenuis* n. sp. Dorsal view of type. (Natural size.)

Size medium; form very elongate, extremely slender. Head slightly longer than the pronotum, decidedly longer than broad, slightly narrower at the caudal margin than immediately caudad of the eyes, a pair of short low sinuate carinæ present mesad and extending caudad as far as between the caudal margin of the eyes, these carinæ sharply constricted between the antennæ and again slightly constricted at a point between the cephalic margin of the eyes, a slight median carina present between the paired carinæ caudad;

occiput smooth; eyes slightly depressed, circular in outline, rather small, not prominent; antennæ slightly exceeding the head and thoracic segments in length, slender, the joints elongate, the proximal joint with a slight lamellate expansion on the proximo-internal portion. Pronotum narrow, the greatest width (supra-coxal) contained about one and one-half times in the length, the cephalic portion strongly constricted with the lateral margins bent ventrad and the section ∧-shaped; lateral margins very slightly converging caudad of the middle, the caudal margin truncate, a moderate median transverse and a broken longitudinal sulcus present. Mesonotum very slightly less than three times the length of the head and pronotum together, arcuate in section, very slightly expanding caudad, a very slight median carination present cephalad, the whole mesonotum elongate sub-cylindrical. Metanotum including the median segment four-fifths the length of the mesonotum, arcuate in section except caudad where it is flattened, slightly expanding caudad, a slight carination present on all but the median segment, which latter is less than a fifth the length of the metanotum *sensu strictiore*, with its greatest width (caudal) about equal to the length and the cephalic margin much narrower than the caudal. Abdomen slightly shorter than the thorax, the five proximal joints subequal in length and similar in character and width, each segment being about three times as long as wide and very slightly widened at the extremities; sixth joint about four-fifths the length of the fifth; seventh joint slightly longer than the sixth, narrow proximad, inflated dorsad, ventrad and laterad in the distal portion; eighth segment quite short, tapering caudad; ninth segment slightly longer than the eighth segment, moderately inflated but hardly expanded laterad, the distal margin ∧-shaped when seen from the caudal aspect; supra-anal plate visible as a point between the bases of the cerci; subgenital opercule tubular, moderately large, reaching to the distal margin of the eighth segment, the apical valve small with its margin with a slight projection; cerci about as long as the ninth segment, straight when seen from the side, moderately arcuate when seen from the dorsum, rather robust, trifid, the apical pair of processes less robust than the median one which is

Fig. 3.—*Pseudosermyle tenuis* n. sp. Dorsal outline of head and pronotum. (× 4.)

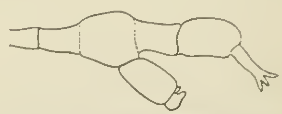

Fig. 4.—*Pseudosermyle tenuis* n. sp. Lateral view of apex of abdomen. (× 4.)

quite blunt at the apex. Limbs slender, the femora, particularly the caudal, very slightly bowed dorso-ventrad. Cephalic femora but slightly shorter than the head, pronotum and mesonotum together, proximal flexure rather sharp; cephalic tibiæ surpassing the head and thorax in length. Median femora when extended caudad reaching to the middle of the second abdominal segment; median tibiæ slightly longer than the femora. Caudal femora reaching to the apex of the sixth abdominal segment; caudal tibiæ slightly longer than the femora; caudal tarsi with the proximal joint about two-thirds the entire length of the same.

General color very pale greenish, becoming buff on the venter and limbs, the head and pronotum ochraceous-buff mesad, a white lateral line extending caudad from the antennæ, bordering the eye dorsad and becoming obsolete on the sides of the pronotum. Apex of the abdomen cream-buff, slightly washed with ochraceous-buff.

Measurements.

Length of body,	65	mm.
Length of pronotum,	2.7	"
Length of mesonotum,	17	"
Length of metanotum (including median segment),	13.3	"
Length of cephalic femur,	21	"
Length of median femur,	18	"
Length of caudal femur,	23	"

The unique type was taken on bunch grass on the east slope of the mountains. Upon being approached it violently shook the stems to which it was clinging, apparently to conceal itself or frighten away its enemies. Upon experimenting we found the insect would repeat this performance as often as approached.

DIAPHEROMERA Gray.

Diapheromera persimilis Caudell.

Two females, one mature, the other not quite mature, taken on irrigated land along the Rio Grande near El Paso, July 10, are referred to this species; the mature individual was swept from tornillo or screw bean, the other from thick weeds. After a careful study of the species of the genus, a tabulation of their more important character in the female sex, and of their measurements, we have reached the conclusion that this species described from the vicinity of Brownsville extends up the Rio Grande valley at least as far as El Paso. The cerci of the specimens in hand fully answer Caudell's description in being intermediate in length between those of *femorata* and *velici*, while the measurements as given below with those of the type female of *persimilis* show the similarity of proportions.

	Length of body.	Length of pronotum.	Length of mesonotum.	Length of metanotum (with median segment).	Length of cephalic femora.	Length of median femora.	Length of caudal femora.
	mm.	mm.	mm.	mm.	mm.	mm.	mm.
El Paso	86	3.3	18.1	15	20	15	18.3
El Paso	60	2.9	14.2	12.8	17	12	15.5
Brownsville, type (from Caudell)	78	......	17	13.5	18.5	14	17.5

The proportions of the El Paso specimens are seen to approximate very closely to those of the type female and we feel justified in considering them *persimilis*. Actual comparison with Brownsville females or the acquisition of El Paso males would, however, make the determination more positive. No very close relationship exists to the Mexican *D. calcarata* and comparison has been made with females of *femorata*, *veliei*[4] and *arizonensis*.

Diapheromera mesillana Scudder.

Ten females, including one mature specimen and others in three immature stages of growth, appear to represent this species, previously known only from the male sex. When compared with the species represented by the female sex in the collections before us they are clearly different, as the following comparison shows:

Head. Similar to *arizonensis* but more depressed.

Pronotum. Much as in *arizonensis*, distinctly shorter than in *veliei*.

Dorsal apical abdominal segments. Longer and narrower than in *femorata*, *persimilis*, and *arizonensis*, much as in *veliei*.

Cerci. Longer than in all but *persimilis* and *veliei*, tapering, acute,

[4] Brunner (*Insektenfam. Phasm.*, II, pp. 337, 338) has redescribed this species from Texas under the name *dolichocephala*. He entirely overlooked the name *veliei* as well as the species *arizonensis* Caudell, *carolina* Scudder, *mesillana* Scudder and *persimilis* Caudell.

grooved on the internal face, much shorter than *veliei*, much more acute and less subequal than in *persimilis*.

Subgenital opercule. Nearest to *veliei*, but blunter.

A key to the females of the five species before us would be as follows:

A.—Cerci hardly more than half the length of the eighth abdominal segment.
  B.—Subgenital opercule arcuate at the apex, . . *femorata*.
  BB.—Subgenital opercule arcuato-truncate at the apex with a distinct median projecting finger, . . . *arizonensis*.
AA.—Cerci decidedly more than half the length of the eighth abdominal segment.
  B.—Apical margin of the subgenital opercule not reaching to the apical margin of the eighth dorsal abdominal segment.
    C.—Head narrow, but little exceeding the cephalic width of the mesonotum. Cerci as long as the ninth dorsal abdominal segment, ... *veliei*.
    CC.—Head broad, half again as wide as the cephalic width of the mesonotum. Cerci no more than half the length of the ninth dorsal abdominal segment, *mesillana*.
  BB.—Apical margin of the subgenital opercule reaching to the apical margin of the eighth dorsal abdominal segment, *persimilis*.

Three of the specimens of *mesillana* measure as follows:

	Length of body.	Length of pronotum.	Length of mesonotum.	Length of metanotum.	Length of cephalic femora.	Length of median femora.	Length of caudal femora.
	mm.	mm.	mm.	mm.	mm.	mm.	mm.
El Paso (adult)...............	82.5	3.2	18	15.5	18.8	13.5	17
Deming (immature)..........	47.2	2.5	11	9.8	13.3	9.3	11
El Paso (immature)..........	40.5	2	9	7.8	9.6	7	8

Of the series referred to *mesillana*, a single one (adult) was taken at El Paso on July 17 on mesquite in the desert, an immature individual was collected at the same place on July 10 on the irrigated land along the Rio Grande, while seven in various stages of growth were taken at Deming on July 18 on the rabbit weed and mesquite flat, and a single immature specimen was taken on the lower slopes of the Florida Mountains, July 19.

A bleached female specimen from Pecos, Texas, in the collection of the Academy belongs to this species. It has been immersed in liquid preservative at some time and in consequence is somewhat shrivelled, but the character of the head and the apex of the abdomen show it to be *mesillana*.

The range of the species now extends from Reeves County, Texas, to Luna County, New Mexico.

CERATITES[5] n. subgenus.

Closely related to true *Diapheromera*, but differing in the presence of a pair of horns on the head in both sexes,[6] and in the peculiar recurved and inflated margin of the subgenital opercule in the male.

Type.—Diapheromera (*Ceratites*) *covilleæ* n. sp.

This subgenus includes four and probably five species: the type species, *tamaulipensis* Rehn from Tamaulipas, Mexico, and *beckeri* and *bidens* Kaup[7] from Mexico, while *saussurii* Kirby[8] from Dominica probably belongs in this group, although rather anomalous in the uninflated median femora.

Diapheromera (Ceratites) covilleæ n. sp.

Types: ♂ and ♀; Franklin Mountains, altitude 4,500 feet, near El Paso, El Paso County, Texas. July 9, 1907. On greasewood (*Covillea tridentata*). (Hebard and Rehn.) [Hebard Collection.]

Compared with *D. beckeri* and *bidens* Kaup, its nearest allies, the new species differs from the former in the head being longer than the pronotum, in the distinctly larger size and in the unarmed ventral margins of the cephalic limbs; from *bidens* it differs in the distinctly larger size, more distant horns and in the absence of granules from the head and thoracic segments. The cerci and eighth and ninth dorsal abdomi-

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[5] Κερατιτης, *one that has horns.*

[6] Horns are absent from the head of a male of a new species from Mexico (*tamaulipensis* Rehn), but the female of that species possesses such well-marked cephalic appendages that we feel justified in considering their absence in the male as purely accidental.

[7] *Berlin. Ent. Zeitschrift*, XV, pp. 27, 28, 1871.

[8] *Ann. Mag. Nat. Hist.*, (6). III, p. 501, 1889.

nal segments of the male type are absent or mutilated, the injury being due to the work of a fellow prisoner in the cyanide bottle.

Size moderately large; form moderately slender in the male, more robust in proportion in the female; surface smooth, polished in the male. Head slightly longer than the pronotum, broad, very slightly depressed in the male; occiput moderately inflated, somewhat globose; interocular region with a pair of short, erect, well separated conical horns, the horns placed nearer the eyes than they are to one another; eyes globose, quite prominent in the male when seen from the dorsum, somewhat smaller proportionately and less prominent in the female; antennæ reaching nearly to the apex of the abdomen in the male, reaching about to the third abdominal segment in the female. Pronotum longer than broad, the caudal portion slightly constricted; cephalic margin very slightly arcuato-emarginate, caudal margin subtruncate in the male, very broadly obtuse-angulate in the female; transverse depression broad and deep, making the pronotum subsellate when seen from the side, longitudinal median sulcus very slight. Mesonotum slightly more (♂) or slightly less (♀) than twice the length of the head and pronotum together, rather narrow, subequal distad and expanding in the caudal third in the male, regularly but not greatly expanding caudad throughout its whole length in the female. Metanotum and the median segment but slightly shorter than the mesonotum in the male, three-fourths the length of the same in the female, no broader than the mesonotum and similar in shape in the male, about equal to the widest portion of the mesonotum in the female; median segment slightly (♂) or strongly (♀) transverse, less than a fourth the length of the remainder of the

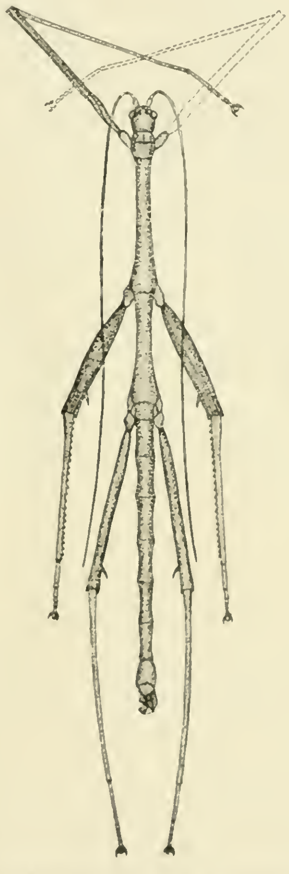

Fig. 5.—*Diapheromera* (*Ceratites*) *covilleæ* n. sp. Dorsal view of male type. (Natural size.)

which the species is found and feeds. As individuals near maturity this color pattern is lost, the dull coloration of the female type supplanting it. The two mesa adults have the hoary suffusion much stronger and more extensive than in the female type, the limbs and the greater portion of the body being much lighter than in the type. The cephalic horns are well indicated in all the immature specimens.

A series of seven females from Pecos, Reeves County, Texas, in the Academy collection are referred to this species, although rather smaller and slenderer, the latter difference probably being due to the fact that all have been immersed for some time in a liquid preservative and in consequence there has been considerable shrivelling. The essential characters, *i.e.*, width of head, horns and form of femoral spines and apex of abdomen, are the same as in the El Paso specimens.

ACRIDIDÆ.

TELMATETTIX Hancock.

Telmatettix aztecus (Saussure).

In a canyon in the Florida Mountains, at about 5,100 feet elevation, along a little rill of water which trickled a few dozen yards over a rock slope and thin top soil, this species was found quite plentiful on July 19. Specimens were noticed only on such spots as had been moistened by the water, a series of fourteen males and eleven females being taken in a short time. The insects were active and flew rapidly about when disturbed. There is a considerable range of color variation in the lot, many shades of browns and grays being represented, with several decidedly rufous individuals, and a number with complete or incomplete "saddle" of blackish brown caudad of the broadest portion of the pronotum. In one specimen the cephalic and median limbs and the ventral margin of the lateral lobes of the pronotum are ringed or spotted with brilliant red. All the series have the pronotum elongate.

PARATETTIX Bolivar.

Paratettix mexicanus (Saussure).

A male of this species was taken on irrigated land along the Rio Grande, at El Paso, July 10, and a female was captured on cultivated ground at Albuquerque, September 14.

ACRYDIUM Geoffroy.

Acrydium crassum (Morse).

A single male of this species was taken at Cloudcroft, July 15, being beaten from vegetation on the steep hillside of James Canyon at an elevation of about 8,800 feet. When compared with two male representatives of the species from near Manitou, Colorado, it is seen to differ only in the slightly more arcuate cephalic section of the median carina of the pronotum.

The only previous New Mexican record of the species was of its capture at Las Vegas, April 13.

Acrydium incurvatum (Hancock).

A pair of this species, taken at Fort Wingate, April 23 and May 8, 1908, by John Woodgate, have been examined.

The only definite record from New Mexico published previous to this date was from 6,500 feet elevation on the Rio Ruidoso, White Mountains, Lincoln County, July 30. The species has been recorded from Washington and Colorado.

MERMIRIA Stål.

Mermiria bivittata (Serville).

This widely distributed species is represented by a series of thirty-three specimens, taken at the following localities: Spofford, Kinney County, Texas, July 8 (one nymph); Johnstone, Valverde County, Texas, July 8 (one nymph); Seminole, Valverde County, Texas, July 8 (1 ♂); El Paso, July 10–11 (9 ♂, 2 ♀); Albuquerque, September 14 (12 ♂, 7 ♀). In size there is a very appreciable amount of variation, particularly in the male sex, while several types of coloration are easily recognized. The Albuquerque series is rather dull in color, with broad postocular bars which infringe on the dorsum of the pronotum in the male; the El Paso specimens represent two color types, one ochraceous with prominent postocular bars infringing on the dorsum of the pronotum and with a distinct or subobsolete median occipital stripe in the males, the other light greenish with the postocular bars narrower, limited to the lateral lobes and sharply defined, the occiput usually without a median line. The Seminole male belongs to the first type mentioned from El Paso. The pale subcostal streak is present on the tegmina of all the series, though varying somewhat in intensity and also in color, ranging from white to bright green. The form of the fastigium and of the rostrum when seen from the lateral aspect is subject to considerable variation, the latter particularly exhibiting a surprising range, from a type with the facial line regular from the fastigio-facial angle to the clypeal suture to one with a very evident though obtuse angle between the antennal bases. The Albuquerque series was taken on cultivated ground, while at El Paso the species was encountered among tornillo bushes in irrigated ground along the Rio Grande. The Seminole specimen was taken from grass growing on a sandy spot.

Mermiria texana Bruner.

This beautiful species is essentially one of the rough desert mountains and foothills, the altitude at which it occurs being between 4,000 and 5,500 feet. On the rugged slopes of the Franklin Mountains and their broken foothills three males and one immature female were captured on July 9, while on a rocky desert hill at Aden a pair were taken on July 21. An immature female from the lower slopes of the Florida Mountains, July 19, belongs to this species. A series of nine adult specimens of the species in the brown phase is now before us and surprisingly little difference in coloration is exhibited. Aside from the medio-longitudinal bar on the head and pronotum which is pale in one specimen, the only appreciable color variations are that the caudal tibiæ range from pale pinkish, through vermilion to solferino, and the antennæ are more obscure in some specimens than in others.

Individuals of the species are alert and quick to take wing, in fact this is one of the most difficult insects to capture among the Orthoptera of the Southwest.

PAROPOMALA Scudder.

In studying the series of *Paropomala* contained in the collection it was found necessary to critically examine the descriptions of all the species of the genus. Aside from the unique and little known *P. dissimilis* Bruner, the only species not easily located was *P. virgata* Scudder, very briefly described from Mesilla, New Mexico, between Gila Bend and Yuma, Arizona, Palm Springs, Cahon Pass, Lancaster and Kern City, California. In reply to a request for typical material of the species, Prof. Morse very kindly loaned us cotypes from all the typical localities, and on careful study it develops that at least two species are included in the series on which *virgata* was based. The Mesilla individuals belong to a short comparatively robust species found at several localities in the Rio Grande valley, while the southern Californian and Arizonan individuals belong to the species later called *pallida* by Bruner. One cotype from Kern City may be distinct from *pallida* of the Mohave, Colorado and Gila desert regions, having the fastigium very broad and the pronotum narrower than usual, but without additional material its separation does not seem warranted, inasmuch as forty-nine specimens of the species from Arizona, California and Nevada exhibit a great amount of individual variation.

As no single type or pair of types of *virgata* was originally designated, and the original diagnosis being too brief to give any assistance, the selection as typical *virgata* of either species known to exist in the type series is open to us, and in view of Mesilla, New Mexico, standing first in the list of localities the Rio Grande form is here selected as true *Paropomala virgata.*

To assist in the work of determination a key to the species in hand was constructed which is here reproduced to aid future workers. As stated above all the species have been examined except *P. dissimilis* Bruner.

A.—Tegmina not reaching tip of abdomen or even tip of caudal femora; subgenital plate of male elongate, half as long again as the last ventral segment.

B.—Antennæ of female as long as the caudal femora; eyes smaller, the interocular space in the male decidedly more than half the length from that region to the apex of the fastigium; caudal femora longer, ... *wyomingensis* (Thom.) [*cylindrica* Bruner].

BB.—Antennæ of female shorter than the caudal femora; eyes larger, the interocular space in the male less than half the length from that region to the apex of the fastigium; caudal femora shorter, ... *calamus* Scudd.

AA.—Tegmina surpassing the tips of the caudal femora, generally reaching the apex of the abdomen and in some cases surpassing it. Subgenital plate of male (at least in the species where known) not very long, hardly longer than the last ventral segment.

B.—Form rather slender or moderately robust (for the genus), slightly compressed; head moderately produced.

C.—Tegmina of male not exceeding the apex of the abdomen; occiput more or less appreciably inflated; caudal limbs rather slender; cerci styliform, comparatively slender.

D.—Size larger (body of male 18.5–24 mm., of female 27–36.5 mm.); antennæ more depressed proportionately; caudal margin of the disk of the pronotum arcuate; metazona more than two-thirds the length of the prozona, *pallida* Bruner.

DD.—Size smaller (body of male 16 mm.); antennæ less depressed proportionately; caudal margin of the disk of the pronotum very bluntly obtuse-angulate; metazona two-thirds the length of the prozona, . *perpallida* Rehn and Hebard.

CC.—Tegmina of male exceeding the apex of the abdomen; occiput not appreciably inflated; caudal limbs proportionately more robust; cerci styliform, moderately robust, ... *virgata* Scudder.

BB.—Form very slender, considerably compressed; head strongly produced. (Size rather small, ♂ 18–21 mm., ♀ 26–27.5 mm.), ... *acris* Rehn and Hebard.

A single imperfect specimen from Lathrop, California, seems to indicate the presence of a quite distinct species in the San Joaquin valley.

Paropomala calamus Scudder.

Rather unexpectedly this species was encountered at three places in or adjacent to the Rio Grande valley. On the bare desert slopes of the Franklin Mountains at El Paso a single immature specimen was taken on July 9 at an elevation of 4,500 feet; a series of six adult and five immature males and nine immature females was taken at Aden, July 21, while one adult male and two adult females were taken at Albuquerque on September 14 in dry grass. At Aden the species was taken chiefly in grass prairie land, where it was found clinging tightly to blades of grass, while at Albuquerque it was found in the river bottom-land. The immature specimens from Aden represent three stages of growth.

As no measurements have been published for this species the following may prove of service:

	♂		♀
	Albuquerque.	Aden.	Albuquerque.
Length of body, ...	22 mm.	25.5 mm.	30 mm.
Length of head, ...	3.4 "	4 "	4.7 "
Length of pronotum, . . .	3 "	3.4 "	4 "
Length of tegmen, ...	8 "	13.3 "	10 "
Length of caudal femur, . .	9 "	10.3 "	11.3 "

The specimens from Albuquerque are all in the green phase, while the Aden series and the Franklin Mountains specimen are in the pale brownish and hoary white phase. The adult males from Aden and nearly half the immature series have the hoary white suffusion very strongly marked, usually covering the head, pronotum, pleura and caudal femora.

The only previous record of this species is that of the types from Lancaster, California, in the Mohave desert.

Paropomala virgata Scudder.

This species appears to be one restricted to the eastern side of the continental divide, the only exact records being from the Rio Grande valley and the region adjacent to it. At El Paso a series of seven males and one female was taken July 10–11 on irrigated land along the Rio Grande and in dry grass in sand near the edge of the mesa.

A single male was taken in dry grass at Aden, July 21, while at Albuquerque, September 14, a series of thirteen females was taken in dry grass and on cultivated ground, chiefly on the latter. In size there is a slight amount of variation, but not enough to cause any difficulty in recognizing the species. An average pair measure as follows:

	♂ El Paso.	♀ Albuquerque.
Length of body,	17.3 mm.	24 mm.
Length of head,	3 "	4 "
Length of pronotum,	3 "	4 "
Length of tegmen,	13 "	17 "
Length of caudal femur,	9.5 "	12.7 "

In coloration the species appears to be quite uniform, although the Albuquerque series is darker than the individuals from the El Pasan region, all examined being in a buff and brown phase except one Albuquerque specimen which demonstrates the existence of a green phase.

The comparatively robust build of the species, particularly of the females, will readily serve to differentiate it from its allies.

The only positive records for the species aside from those given here are from the vicinity of Mesilla and Las Cruces, Donna Ana County, New Mexico.

Paropomala acris Rehn and Hebard.

This species, which was described from Railroad Pass, Cochise County, Arizona, was found to be fairly numerous at Aden, July 21, chiefly in grass prairie land, a series of eight adult and two immature males and two adult and three immature females being taken. A pair was also taken at El Paso: the male, July 11, clinging to a thorn of a mesquite near the edge of the mesa; the female, July 10, on prickly pear (*Opuntia* sp.) in the greasewood belt at the east base of the Franklin Mountains.

The El Paso male is of nearly the same size as the type, but all the Aden males are smaller. This difference in specimens from the two localities holds true in the female sex, the two Aden specimens of that sex being uniform in size and both smaller than the El Paso individual. The following measurements may be of interest.

	♂ El Paso.	♂ Aden.	♀ El Paso.	♀ Aden.
Length of body,	21 mm.	18.5 mm.	30.5 mm.	28 mm.
Length of head,	3.5 "	3.5 "	5 "	4.5 "
Length of pronotum,	3.2 "	2.8 "	5 "	4.7 "
Length of tegmen,	15 "	13 "	21.5 "	19.5 "
Length of caudal femur,	10.2 "	9 "	13.5 "	13.5 "

The majority of the Aden series is more grayish ochraceous than the type, the remainder being very similar to the Railroad Pass individual. The El Paso male is greenish yellow dorsad, while the female from the same locality is decidedly green with the tegmina roseate.

The only localities from which the species is known are those recorded here and the type locality—Railroad Pass, Arizona.

SYRBULA Stål.

Syrbula admirabilis (Uhler).

A single male taken July 8 at Johnstone, Valverde County, Texas, belongs to this species.

Syrbula fuscovittata Thomas.

A mature male and an immature female taken in Dry Canyon, Sacramento Mountains, July 13, and an adult female taken at 4,500 feet elevation in the Franklin Mountains, July 9, are referable to this species. Both adult specimens are in the brown phase of coloration. The male from Dry Canyon was taken at an elevation of about 5,000 feet, in the lower portion of the juniper and piñon zone.

BOÖTETTIX Bruner.

Boötettix argentatus Bruner.

This interesting grasshopper, which seems never to leave the branches of the greasewood (*Covillea tridentata*), was taken, July 9 to 11, at a number of points in the greasewood belt on the mesa northeast of El Paso and on the lower slopes of the Franklin Mountains. The series from the El Pasan region, numbering twenty-four males, fourteen females and eight nymphs, and two females and one nymph taken July 13 in the greasewood of the lower portion of Dry Canyon, Sacramento Mountains (elevation 4,800–4,900 feet), and the growth of the same shrub on the alluvial slope at the mouth of the same canyon, exhibits a very considerable amount of variation in size, the extremes of each sex being as follows:

	♂	♂	♀	♀
Length of body, .	17 mm.	21.2 mm.	20.5 mm.	25.5 mm.
Length of tegmen, .	14 "	19 "	16.8 "	20 "
Length of caudal femur, . . .	9.5 "	12 "	12 "	13.2 "

In color numerous little variations are noticeable, none, however, important enough to call for special note. In all the series the tegmina are more or less strongly maculate, although the markings are limited in the majority of the specimens to the vicinity of the anal area. The striking pearl markings on the pronotum, pleura and limbs are present in all the specimens, even in those in the immature condition, the brilliancy of these markings in the living insect being retained by a good proportion of the series.

The stridulation of *Boötettix* is a faint buzzing *szszszsz* terminated by a distinct whirr and repeated at intervals.

ERITETTIX Bruner.

Eritettix variabilis Bruner.

A single female of this species was taken at Cloudcroft, July 14, and eleven males were collected at Aden, July 21. At Cloudcroft it was taken in a mountain meadow, while at Aden the males were all collected among a scant covering of desert plants on the rocky hillside. As in the case of the other species of this genus, these individuals were found to be extremely active.

The males show a considerable amount of variation in size, but are rather uniform in coloration. However, none of the males have their color pattern as contrasted as the female, this being chiefly due to the uniform dorsal color of the males, the female having the pair of blackish dorsal lines quite distinct. The supplementary dorsal carinæ of the pronotum are rather well marked over the whole dorsum of the pronotum in some males, indicated only on the metazona in otherrs and entirely absent in a few, while the female possesses weakly developed ones.

This species has previously been recorded from Silver City, Grant County, and La Trementina, San Miguel County, New Mexico, and Douglas, Cochise County, Arizona.

OPEIA McNeill.

Opeia imperfecta Bruner.

During brief train stops made on July 8 at Dunlay, Medina County, and Spofford, Kinney County, Texas, this species was captured in a grassy spot under mesquite trees at the former locality and in dry grass at the latter. A single male was taken at Dunlay and four of each sex were collected at Spofford.

These specimens demonstrate the unreliability of the length of the tegmina and the form of the apex of the same as specific characters in this genus. The typical specimens examined by Bruner all possessed rather abbreviate tegmina, "about one-half (♀) or nearly three-fourths (♂) as long as the abdomen, their apices pointed or acuminate." In every character and every proportion the Dunlay and Spofford individuals fully agree with the original description, except that the males have the tegmina reaching or slightly exceeding the apex of the abdomen, while the females possess tegmina much over half as long as the abdomen, in all of that sex failing to reach the apices of the caudal femora by less than the length of the pronotum. The apices of the tegmina are more or less narrowly rounded in all the specimens. On examining a number of representatives of the Great Plains *O. obscura*, which it may be added has a considerable amount of variation in the tegminal length, it is noticed that individuals with rather short tegmina have the tips of the same pointed, while those with longer tegmina have the same portions rounded. This is true of almost all of a number of individuals of the species, and no doubt explains the presence of rounded apices to the tegmina in the long-winged Spofford and Dunlay individuals.

To the characters given by Bruner for separating *Opeia imperfecta* from *O. obscura* might be added the less inflated character of the head in *imperfecta* with the resultant straighter and less arcuate occiput.

This species was described from southwestern Texas and Jimulco and Comancho, Zacatecas, Mexico.

AMPHITORNUS McNeill.

Amphitornus ornatus McNeill.

On a desert hillside and on grassy prairie at Aden this species was found rather numerous on July 21, three individuals of each sex being taken. At an elevation of 5,300 feet in the piñon and juniper zone of Dry Canyon, Sacramento Mountains, a single male was taken, July 13, on bare ground among low bushes on the steep canyon wall. At both localities the species was found to be exceedingly wary and difficult to capture. The only previous New Mexican record of the species was of its capture at Little Mountain, east of Mesilla Park, Donna Ana County, on July 1.

CORDILLACRIS Rehn.

Cordillacris occipitalis (Thomas).

On the grassy rolling prairie at Aden this species was found fairly plentiful on July 21, a series of fifteen males and ten females being taken. A female of the species was also taken during a train stop at Faywood, Luna County, New Mexico, on July 20.

An appreciable amount of variation in size is noticeable in both sexes, but particularly in the male, while the general tone of the basic coloration varies from a predominating ochre type to one with gray-brown the main element, with, however, one specimen decidedly brick red in general tone.

The only previous record of this species in New Mexico is of its occurrence in Johnson's Basin, Socorro County, where it was taken, June 22, by Townsend. The record of its occurrence at Alamogordo, New Mexico, made by Rehn,[9] should be corrected, as a re-examination of the individual there recorded shows it to be the very closely allied *C. cinerea.*

Cordillacris cinerea (Bruner).

Two females, one taken at Aden, July 21, on grassy prairie, and the other from prickly pear (*Opuntia* sp.) growing on the greasewood covered mesa northeast of El Paso, July 10, are referred to this species. These specimens are very close to *C. occipitalis,* but seem to be separable from the specimens of the latter by the more protuberant eyes, the narrower fastigium and the more constricted interocular space. However, there is a great amount of variation along these lines in specimens of undoubted *occipitalis,* and an examination of the type material of the species may show no valid grounds for retaining *cinerea* as distinct from *occipitalis.* The color character given by Bruner[10] to separate the two species does not appear to be of value, as specimens of *occipitalis* have the caudal tibiæ various shades of testaceous as well as "in part red or reddish." This form has been recorded with some query as to the species from sandhills near Mesilla, New Mexico, June 27–30 and Sierra Blanca, Texas, June 26, while material from Alamogordo, New Mexico, April 9, belongs to this type.

Cordillacris apache n. sp.

Types: ♂ and ♀; Silver City, Grant County, New Mexico. July 20, 1907. (Hebard and Rehn.) [Hebard Collection.]

Related to *C. crenulata* (Bruner) and *C. pima* Rehn, differing from the former in the narrower ventral portion of the head, more retreating facial line, narrower interspace between the eyes, narrower tegmina and slightly more elongate caudal limbs; from *C. pima* it differs in the shorter caudal limbs, in the more constricted lateral carinæ of the pronotum and in the rectangulate angle of the fastigium in the female sex.

In determining the series representing this species it was found absolutely necessary to ascertain what true *C. crenulata* was, the original description of the latter species hardly being explicit enough to place the name on the northern form (Montana to Colorado) or the new one, the difficulty being further augmented by the fact that Bruner

[9] *Proc. Acad. Nat. Sci. Phila.,* 1902, p. 718.
[10] *Biol. Cent. Amer.,* Orth., II, p. 70.

originally placed Silver City among his localities for *crenulata*. The description of *crenulata* was dissected and tabulated in parallel columns of agreement with the two species in hand, but no definite conclusion could be reached, so in response to an inquiry Prof. Bruner wrote as follows: "The insect called *Cordillacris crenulata* was described chiefly from west Nebraska specimens, although I had at the time other specimens from New Mexico in my collection." In view of this statement it seems perfectly legitimate to consider the northern form, which we have before us from McCook and Sioux Counties, Nebraska, and Antonito, Rocky Ford, Colorado Springs and Fort Collins, Colorado, as the true *crenulata*.

Size medium; form rather similar to that of *C. crenulata*. Head with its dorsal length subequal to that of the pronotum, moderately but regularly ascending to the fastigium when seen from the side, the fastigium slightly descending; interocular region very slightly (♂) or not at all (♀) narrower than one of the eyes; fastigium with the apical angle rectangulate in both sexes, the disk very slightly depressed immediately caudad of the margin; fastigio-facial angle subrectangulate when seen from the side, face greatly (♂) or considerably (♀) retreating; ventral portion of the head moderately inflated, not at all (♂) or slightly (♀) broader than the

Fig. 10.—*Cordillacris apache* n. sp. Lateral view of female type. (× 3.)

width across the eyes; frontal costa very narrow and subequal dorsad, regularly and considerably expanding ventrad of the antennæ, sulcation deep dorsad, being very shallow and subobsolete ventrad. Eyes subovate (♂) or subtrigonal-ovate (♀) in outline, moderately prominent in both sexes when seen from the dorsum, the length subequal to (♀) or very slightly exceeding (♂) the infra-ocular sulcus; antennæ slightly (♂) or considerably (♀) exceeding the length of the head and pronotum together, slightly depressed, with a slight ensiform tendency in the female, apex rather blunt. Pronotum very slightly sellate; cephalic margin of the dorsum slightly emarginate truncate, caudal margin slightly arcuate (♂) or arcuato-truncate (♀); median carina low and weak, most apparent caudad, severed distinctly caudad of the middle; lateral carinæ regularly but not greatly converging caudad to the middle of the disk, where they are separated by about half the caudal width, thence more sharply divergent caudad; lateral lobes slightly longer than deep, ventral margin sinuate arcuato-truncate, ventro-cephalic angle rounded, ventro-caudal angle subrectangulate. Tegmina rather narrow, slightly (♀) or considerably (♂) exceeding the apex of the abdomen, but not quite reaching the extremities of the caudal femora, apex narrowly truncate. Interspace between the mesosternal lobes transverse; interspace between the metasternal lobes longitudinal (♂) or subquadrate (♀). Cephalic and median limbs quite slender, moderately long. Caudal femora in length slightly shorter than the tegmina, slender; caudal tibiæ about equal to the femora in length, armed with ten to twelve spines.

Fig. 11. — *Cordillacris apache* n. sp. Dorsal view of head and pronotum. (× 3.)

General color ochraceous marked with vandyke brown. Face and mouth parts buff, the frontal costa clay color and a distinct subocular blotch, which is divided by a carinal line of buff, vandyke brown. Genæ, portions of the pleura and the ventral portion of the lateral face of the caudal femora hoary white; ventral portion of the lateral lobes of the pronotum pale buff (♀) or buffy white (♂). Eyes ochraceous lined with narrow bars of vandyke brown; antennæ very pale bluish-green, narrowly tipped with buffy, whitish proximad in the female. Postocular bars and their continuations on the lateral lobes and pleura vandyke brown; a distinct broad median bar is present on the dorsum of the head. Dorsum of the pronotum with buff predominating, the median area somewhat infuscated, the usual trigonal caudal blotches vandyke brown. Tegmina with the crenulate maculations of dull whitish against vandyke brown, the crenulations more numerous in the male than in the female. Caudal femora with the dorsal portion of their lateral face vandyke brown, the dorsum with three indistinct vandyke brown bands, of which the proximal is suboblique; caudal tibiæ dull lavender distad and mesad, spine tipped with black.

Measurements.

	♂	♀
Length of body,	13 mm.	18 mm.
Length of pronotum,	2 "	2.8 "
Length of tegmen,	9.8 "	13 "
Length of caudal femur,	8.9 "	11.5 "

originally placed Silver City among his localities for *crenulata*. The description of *crenulata* was dissected and tabulated in parallel columns of agreement with the two species in hand, but no definite conclusion could be reached, so in response to an inquiry Prof. Bruner wrote as follows: "The insect called *Cordillacris crenulata* was described chiefly from west Nebraska specimens, although I had at the time other specimens from New Mexico in my collection." In view of this statement it seems perfectly legitimate to consider the northern form, which we have before us from McCook and Sioux Counties, Nebraska, and Antonito, Rocky Ford, Colorado Springs and Fort Collins, Colorado, as the true *crenulata*.

Size medium; form rather similar to that of *C. crenulata*. Head with its dorsal length subequal to that of the pronotum, moderately but regularly ascending to the fastigium when seen from the side, the fastigium slightly descending; interocular region very slightly (♂) or not at all (♀) narrower than one of the eyes; fastigium with the apical angle rectangulate in both sexes, the disk very slightly depressed immediately caudad of the margin; fastigio-facial angle subrectangulate when seen from the side, face greatly (♂) or considerably (♀) retreating; ventral portion of the head moderately inflated, not at all (♂) or slightly (♀) broader than the

Fig. 10.—*Cordillacris apache* n. sp. Lateral view of female type. (× 3.)

width across the eyes; frontal costa very narrow and subequal dorsad, regularly and considerably expanding ventrad of the antennæ, sulcation deep dorsad, being very shallow and subobsolete ventrad. Eyes subovate (♂) or subtrigonal-ovate (♀) in outline, moderately prominent in both sexes when seen from the dorsum, the length subequal to (♀) or very slightly exceeding (♂) the infra-ocular sulcus; antennæ slightly (♂) or considerably (♀) exceeding the length of the head and pronotum together, slightly depressed, with a slight ensiform tendency in the female, apex rather blunt. Pronotum very slightly sellate; cephalic margin of the dorsum slightly emarginate truncate, caudal margin slightly arcuate (♂) or arcuato-truncate (♀); median carina low and weak, most apparent caudad, severed distinctly caudad of the middle; lateral carinæ regularly but not greatly converging caudad to the middle of the disk, where they are separated by about half the caudal width, thence more sharply divergent caudad; lateral lobes slightly longer than deep, ventral margin sinuate arcuato-truncate, ventro-cephalic angle rounded, ventro-caudal angle subrectangulate. Tegmina rather narrow, slightly (♀) or considerably (♂) exceeding the apex of the abdomen, but not quite reaching the extremities of the caudal femora, apex narrowly truncate. Interspace between the mesosternal lobes transverse; interspace between the metasternal lobes longitudinal (♂) or subquadrate (♀). Cephalic and median limbs quite slender, moderately long. Caudal femora in length slightly shorter than the tegmina, slender; caudal tibiæ about equal to the femora in length, armed with ten to twelve spines.

Fig. 11. — *Cordillacris apache* n. sp. Dorsal view of head and pronotum. (× 3.)

General color ochraceous marked with vandyke brown. Face and mouth parts buff, the frontal costa clay color and a distinct subocular blotch, which is divided by a carinal line of buff, vandyke brown. Genæ, portions of the pleura and the ventral portion of the lateral face of the caudal femora hoary white; ventral portion of the lateral lobes of the pronotum pale buff (♀) or buffy white (♂). Eyes ochraceous lined with narrow bars of vandyke brown; antennæ very pale bluish-green, narrowly tipped with buffy, whitish proximad in the female. Postocular bars and their continuations on the lateral lobes and pleura vandyke brown; a distinct broad median bar is present on the dorsum of the head. Dorsum of the pronotum with buff predominating, the median area somewhat infuscated, the usual trigonal caudal blotches vandyke brown. Tegmina with the crenulate maculations of dull whitish against vandyke brown, the crenulations more numerous in the male than in the female. Caudal femora with the dorsal portion of their lateral face vandyke brown, the dorsum with three indistinct vandyke brown bands, of which the proximal is suboblique; caudal tibiæ dull lavender distad and mesad, spine tipped with black.

Measurements.

	♂	♀
Length of body,	13 mm.	18 mm.
Length of pronotum,	2 "	2.8 "
Length of tegmen,	9.8 "	13 "
Length of caudal femur,	8.9 "	11.5 "

In addition to the types a series of six adult males, six adult females and one female nymph have been examined. Of this representation four males, two females and the nymph are from Silver City, July 20; two males and two females from Aden, July 21; one female from the Florida Mountains, July 19, and one female from Spalding, Luna County, New Mexico, July 20.

In size the specimens are moderately uniform, one or more females being slightly larger than the type, while one male is somewhat smaller than the type of that sex. The coloration exhibits some little variation, but such differences as are seen are chiefly due to intensification or lightening of the general pattern and shades. The antennæ in some specimens are buffy proximad.

The habitat of this species at Aden was found to be a grassy rolling prairie, dotted with an extremely scanty and widely scattered growth of very low mesquite and a few sotols (*Dasylirion* sp.). The insects were found most plentiful where the grass was most abundant. At Silver City specimens were found in numbers among short grasses on the hillsides.

PHLIBOSTROMA Scudder.

Phlibostroma quadrimaculatum (Thomas).

An immature specimen of this species was taken at Silver City, July 20, in a small patch of short grass.

This is the first definite record of the species from southern New Mexico.

ORPHULELLA Giglio-Tos.

Orphulella picturata Scudder.

A single male of this species was taken at Dunlay, Medina County Texas, during a train stop on July 8. This specimen was found in the same surroundings as *Opeia testacea.*

Orphulella pelidna (Burmeister).

A male and two females of this species were taken on cultivated ground at Albuquerque, September 14. The male and one female are in the brown phase, the remaining female being of the green type. Comparison was made with individuals of the species from Nebraska.

The only previous New Mexican records are of captures of the species at Albuquerque and Mesilla.

DICHROMORPHA Morse.

Dichromorpha viridis (Scudder).

At San Antonio, Texas, July 8, a single female of this species was taken on a lot near the railroad station.

CHLOËALTIS Harris.

Chloëaltis abdominalis (Thomas).

On the edge of a field flanked by a forest of Douglas fir (*Pseudotsuga mucronata*) at Cloudcroft, one adult male and seven immature specimens of this species were taken on July 14. The adult specimen was located by his stridulation, although it was in the middle of the afternoon. The note of this insect was like that of individuals of the same species heard in Michigan.

When compared with a series of males of the species from Pequaming, Michigan, Yellowstone Park, and Manitou, Colorado, the Cloudcroft specimen is seen to be appreciably smaller, the measurements being as follows: Length of body, 15.7 mm.; length of pronotum, 3.3 mm.; length of tegmen, 8.8 mm.; length of caudal femur, 11.2 mm.

The previous records of this species in New Mexico are from Beulah, San Miguel County, and Truchas Peak, Rio Arriba–Mora Counties.

CHORTHIPPUS Fieber.

Chorthippus curtipennis (Harris).

One male and two females of this species were collected at Cloudcroft on July 14 and 15. These specimens were taken in damp grassy situations, the species being by no means common.

Beulah, San Miguel County, and Aqua Fria Park, Colfax County, are the previously known New Mexican localities for the species.

GOMPHOCERUS Thunberg.

Gomphocerus clavatus Thomas.

At Cloudcroft this species was found to be abundant in grassy mountain meadows, particularly along the edges of the forest. Here a series of fifteen males and sixteen females were taken on July 14 and 15. It was noticed that the species was very hard to find before ten o'clock in the morning, although quite abundant during the heat of the afternoon.

The series is quite uniform in size, but in color there is in a number of specimens a pronounced mixing and lining with shades of brown and ochre which is not seen in the other more uniformly colored individuals. This variable tendency is more apparent in the female sex. None of the individuals from Cloudcroft present areas or even traces of green in their coloration. A single female from Truchas Peak, New Mexico, taken August 2, 1902, by W. P. Cockerell, examined in this connection, has considerable green in its coloration. The previous exact New Mexican records for the species were from Cloudcroft and above timber-line, 13,000–14,000 feet, on Truchas Peak.

PSOLOESSA Scudder.

Psoloessa texana Scudder.

If further evidence is needed to support the opinion recently expressed by the authors (*Proc. Acad. Nat. Sci. Phila.*, 1908, pp. 381–383) regarding the impossibility of differentiating the four nominal species of the genus *Psoloessa,* the one hundred and forty-three specimens examined in this connection furnishes it, The data here given on the variability in this species should be considered supplementary to that presented in the paper mentioned above.

The typical *buddiana* type is represented by four specimens, typical *ferruginea* by nine, typical *maculipennis* by eleven and typical *texana* by eight, a total of twenty-three per cent. of the series, leaving an intermediate series of one hundred and eleven specimens or seventy-seven per cent., divided as follows;

A.—Sharing characters of *buddiana* and *ferruginea,* one individual.
B.—Sharing characters of *buddiana* and *maculipennis,* forty-seven individuals.
C.—Sharing characters of *ferruginea* and *maculipennis,* fifty-three individuals.
D.—Sharing characters of *maculipennis* and *texana,* four individuals.
E.—Sharing characters of *ferruginea* and *texana,* one individual.
F.—Sharing characters of *buddiana, ferruginea* and *maculipennis,* five individuals.

The distribution by localities of the specimens representing the types of the four "species" and the intermediate groups is as follows:

	El Paso.	Franklin Mts.	Alamogordo.	Dry Canyon.	Aden.	Deming.	Florida Mts.	Silver City.
Typical *buddiana*		*			*			*
Typical *ferruginea*					*	*		*
Typical *maculipennis*	*	*	*		*		*	*
Typical *texana*	*		*		*	*		*
A intermediate					*			
B "	*	*	*	*	*	*	*	*
C "	*	*	*	*	*	*		*
D "			*		*		*	*
E "					*			
F "	*	*						*

El Paso is represented by nine ♂, ten ♀, July 10 and 11; slopes of the Franklin Mountains by six ♂, seven ♀, July 9; Alamogordo by two ♂, four ♀, July 13; Dry Canyon, Sacramento Mountains, two ♂, three ♀, July 13; Deming, two ♂, four ♀, July 18; Florida Mountains, two ♂, two ♀, July 19; Aden, twenty-six ♂, thirty-eight ♀, July 21; Silver City, nineteen ♂, seven ♀, July 20. At El Paso, Alamogordo and at the foot of the Florida Mountains it was taken from the bare ground in greasewood (*Covillea*) areas, while in Dry Canyon, in the Franklin and Florida Mountains, and at Silver City it was taken from canyon and hill slopes usually covered with low vegetation. At Aden the species frequented a variety of habitats, being taken on a rocky hillside, in grass prairie land and from areas of dry grass in sand, being most abundant in the latter situation, while at Deming it was taken on the rabbit-weed and mesquite plain.

STIRAPLEURA[11] Scudder.

Stirapleura pusilla Scudder.

A series of thirty males and thirteen females are referred to this species, which seems to present quite a little variation in minor structural characters and size and to a considerable extent in color. Five males and four females were taken at Silver City, July 20, on rough slopes, the remainder of the series, twenty-five males and nine females, being from Aden, July 21, where the species was found in all the three types of surroundings examined, but was noted in greatest numbers in grass prairie. The Silver City specimens are smaller than the Aden individuals, although both series average larger than the original measurements. The proportions of an average pair from each locality are as follows:

	Silver City. ♂	Aden. ♂	Silver City. ♀	Aden. ♀
Length of body, .	12.8 mm.	15.5 mm.	19 mm.	21 mm.
Length of pronotum	2.9 "	3.1 "	3.4 "	4 "
Length of tegmen, .	14.1 "	14.8 "	17 "	18.7 "
Length of caudal femur, . . .	10 "	11.2 "	12.5 "	14 "

AGENEOTETTIX McNeill.

Ageneotettix deorum (Scudder).

At Aden, July 21, this species was found in grassy prairie land, on a rocky hillside and in a patch of dry grass along the railroad track, a series of thirteen males, one female and seven nymphs being taken.

[11] *Stirapleura mescalero* Rehn (*Proc. Acad. Nat. Sci. Phila.*, 1902, p. 719) is seen on re-examination of the type and comparison with material now in hand to be *Psoloessa texana* Scudder. The original reference to *Stirapleura* was caused by the degree of dorsal visibility of the lateral foveolæ, a character which appears to us to be almost worthless for separating the two genera, depending as it does on the angle from which the head is viewed.

At Silver City, July 20, a single male was taken, while one male and three females were secured at Albuquerque, September 14.

The Albuquerque individuals are quite dull colored, with, however, a longitudinal line present on the costal areas of the tegmina in three of the four specimens.

This species has previously been recorded from Mesilla Park and Chaves, New Mexico.

AULOCARA Scudder.

Aulocara rufum Scudder.

A single freshly moulted female of this species was taken at Silver City, July 20. It is rather dull in color, somewhat resembling specimens from Antonito and Nephista, Colorado, the head, pronotum, pleura and caudal femora being covered with numerous small blotches of olive green.

The only previous New Mexican record was La Cueva, Organ Mountains, September 3.

ARPHIA Stål.

Arphia luteola Scudder.

A single female taken at Spofford, Texas, July 8, belongs to this species. The disk of the wing is vermilion in color instead of yellowish, but there can be no doubt of the specific identity of the specimen.

Arphia arcta Scudder.

A male and three females of this species, taken at Fort Wingate, McKinley County, New Mexico, by John Woodgate, have been examined. The dates represented are April 25, May 11 and August 20, 1908. The specimens have been compared with Beulah, New Mexico, and Jerome, Arizona, material. Three of the four individuals possess red or reddish wings.

Arphia teporata Scudder.

On the desert slopes of the Franklin Mountains near El Paso, at elevations of from 4,200 to 4,800 feet, this species was found generally distributed and a series of three males and four females were taken on July 9. Two males were also taken on the edge of the mesa near El Paso, July 11, while a single male was taken at 5,300 feet in the Florida Mountains and one female at Aden, July 21.

In the Florida Mountains but two specimens were seen, both in dense oak scrub near bare rock slopes, while at Aden a few were seen on the hill visited at that locality, but the species was very wary and difficult to collect.

CHORTOPHAGA Saussure.

Chortophaga viridifasciata (De Geer).

A single female of this species was taken during a train stop at Converse, Bexar County, Texas, July 8.

ENCOPTOLOPHUS Scudder.

Encoptolophus coloradensis Bruner.

A pair of this interesting species was taken in dry grass along the railroad tracks at Spofford, Kinney County, Texas, July 8. The species was somewhat plentiful and very swift of flight.

This is the first record of the species from Texas.

Encoptolophus texensis Bruner.

In suitable locations, such as irrigated and grass prairie land, through southern Arizona and New Mexico and western Texas, this species will no doubt be found in fair numbers.

In Texas, two males were collected at Spofford, July 8, while a series of thirteen males and eight females were taken, July 10–11, at El Paso, all except one from irrigated land. At Albuquerque three males and eleven females were secured, September 14, on irrigated land, while a single female was attracted to light at Deming, July 20. A pair were taken in grass prairie land at Aden, July 21, while a single female was taken in the greasewood belt at Alamogordo, July 13.

The specimen from Ysleta, El Paso County, Texas, recorded as *E. costalis*,[12] proves on re-examination to be *E. texensis*, which was undescribed when this record was published. A female specimen taken at Roswell, New Mexico (August, 1902, at light, T. D. A. Cockerell), shows the presence of the species a considerable distance up the Pecos Valley.

In size there is a considerable amount of individual variation, a number of specimens of each sex being both larger and smaller than the measurements given by Bruner. The dimensions of several of these specimens may be of interest.

	Albuquerque. ♂	El Paso. ♂	Albuquerque. ♀	El Paso. ♀
Length of body, .	16.5 mm.	22 mm.	23 mm.	26.8 mm.
Length of pronotum,	3.3 "	4.8 "	4.2 "	5.6 "
Length of tegmen, .	16 "	20.2 "	20 "	25 "
Length of caudal femur, . . .	9.8 "	12.5 "	12 "	15. "

[12] Rehn, *Proc. Acad. Nat. Sci. Phila.*, 1902, p. 720.

Taking as units the two most extensive series here examined, the El Paso representation averages slightly larger than that from Albuquerque, but the variation within each is considerable.

All the specimens examined from Texas and New Mexico are in a brownish phase, no approach being noticed to the green phase. The Albuquerque and Deming specimens are quite grayish, the Alamogordo one reddish and the Spofford lot quite blackish, but the tegminal pattern is retained by all the individuals examined.

This species is now known from Carrizo Springs, Spofford, Ysleta and El Paso, Texas; Roswell, Alamogordo, Albuquerque, Mesilla, Aden and Deming, New Mexico; Tucson, Florence, Phœnix and San Bernardino Ranch, Arizona, and southern California.

In its actions this species is more active than *E. sordidus*, but much less so than *E. costalis*.

HIPPISCUS Saussure.

Hippiscus corallipes (Haldeman).

On the bare spots of an irrigated field along the Rio Grande below El Paso, two males and two females of this species were taken on July 11. At Aden, July 21, three of each sex were taken in all the situations found at that locality, but it was most commonly found in grass prairie land, where the species was very wary. All of the specimens have the internal faces of the caudal femora red or pinkish-red except the females from El Paso, one of which has the same areas deep blue, the other purplish.

Hippiscus cupidus Scudder.

Three males of this species have been examined from Fort Wingate, New Mexico, taken April 26, 1908, by John Woodgate. A comparison with males from Jerome, Arizona, reveals no differences worthy of mention.

The range of this species now extends from Jerome and Prescott, Arizona, to northwestern New Mexico. The record of *H. leprosus* from the Pinal Mountains, Arizona,[13] belongs to this species.

Hippiscus affrictus Scudder.

A single female of this species was taken at Fort Wingate, New Mexico, June 2, 1908, by John Wingate.

The range of the species is extended considerably to the southward by this record, which is the first of the species from New Mexico; Rangeley, on the lower White River, western Colorado, being the nearest locality from which it had previously been recorded.

[13] *Canad. Entom.*, XXXIII, p. 102.

DISSOSTEIRA Scudder.

Dissosteira carolina (Linnæus).

Two females of this species were taken on cultivated ground at Albuquerque, September 14.

SPHARAGEMON Scudder.

Spharagemon collare (Scudder).

A pair of this species taken at Albuquerque, September 14, on irrigated land are in the collection. They are closer to race *angustipennis* than to the other forms of the species.

In this location this species was extremely difficult to capture, partially on account of its powerful flight and its extreme wariness. This is the only locality in New Mexico from which the species has been recorded.

TOMONOTUS Saussure.

Tomonotus aztecus Saussure.

Apparently this species is generally distributed over that portion of western Texas between San Antonio and the Pecos River, specimens before us being from Lacoste, Medina County (1 ♂), Hondo, Medina County (1 ♀), D'Hanis, Medina County (2 ♂, 2 ♀), Sabinal, Uvalde County (1 ♂), Spofford, Kinney County (2 ♂), and Samuels, Valverde County (2 ♀), all taken during train stops on July 8.

The Samuels specimens are quite pale, while two of the D'Hanis series are quite uniform blackish-gray. The Sabinal, Spofford and Hondo individuals are as a rule quite dark, the Sabinal and Hondo representatives with the tegminal markings distinct, while the Lacoste specimen tends toward ferruginous.

The senior author's *Lactista boscanus*[14] from Ysleta, El Paso County, Texas, is referable to this species. As shown by Caudell[15] the specimens recorded by Scudder and Cockerell as *Lactista pellepidus* also belong to this form.

The range of this species in the United States is now known to extend from central Texas to south-central Arizona, north to the Organ Mountains of New Mexico.

MESTOBREGMA Scudder.

Mestobregma fuscifrons (Stål).

Five males and one female of this form were taken at Spofford, Texas, July 8; one male and two females also being taken at Dunlay, Medina County, Texas, the same date.

[14] *Proc. Acad. Nat. Sci. Phila.*, 1902, p. 721.
[15] *Proc. U. S. Nat. Mus.*, XXVIII, p. 469.

Mestobregma obliterata Bruner.

A single female from Albuquerque, September 14, is referred to this species.

Mestobregma plattei (Thomas).

Three males and one female of this species were taken at Silver City, July 20; two females also being included in the series from the lower slopes of the Florida Mountains, taken July 19. At Silver City it was captured on low rounded hills, while in the Florida range it was found sparingly on bare precipitous rocks, where it was noticed to be very vigorous and wary.

These specimens show some approach to the closely allied *M. rubripenne* from southern Arizona, but the general coloration is nearer *plattei*, while the slender caudal femora are not at all like the comparatively robust ones of *rubripenne*.

The range of this species is now known to extend from Wyoming south along the eastern side of the Rocky Mountains to Colorado, occurring also at Magdalena, New Mexico, and the localities given above.

DEROTMEMA Scudder.

Derotmema laticinctum Scudder.

This characteristic species of the desert regions of southern New Mexico and Arizona was captured at all the desert localities visited in southern New Mexico and at El Paso. In the vicinity of El Paso it was taken, July 10, 11 and 17, on irrigated land along the Rio Grande (1 ♂, 3 ♀), at the edge of the mesa, (1 ♂), in the greasewood belt (1 ♀), in bare desert east of city (2 ♂, 2 ♀), on desert hillside (2 ♂, 1 ♀), on sand with a sparse growth of dry grass (17 ♂, 8 ♀). At Alamogordo a single male was attracted to light, July 12; three males were collected in the rabbit-weed and mesquite plain around Deming, July 18; one male and two females secured at Silver City, July 20, and eight males and six females taken at Aden, July 21.

In the irrigated tract near El Paso the species was fairly common on the barer spots, usually in colonies, while at the foot of the mesa it was not common on pieces of bare ground. At Aden the species was found chiefly in grass prairie land, but in other situations as well, such as on cinders along the railroad track where it was inactive until the sun had warmed the ground, when the species became very active.

The El Paso specimens from sand area with dry grass are the largest of the species seen, a typical male and female measuring as follows:

	♂	♀
Length of body,	15.2 mm.	25.5 mm.
Length of pronotum,	3 "	4.8 "
Length of tegmen,	17.5 "	24.5 "
Length of caudal femur,	10.2 "	14.2 "

The Silver City male and the three individuals of that sex from Deming are quite small when compared with the El Paso series.

The series from sand areas at El Paso is uniformly more ashy gray than any other specimens of the species examined. The Aden series is quite dark when compared with the El Paso representation, while one female is strongly washed with rose red, particularly on the dorsum of the pronotum where the pink color is almost pure. The remarks previously made by the authors[16] regarding the variability of the coloration of the anal area of the tegmen and of the fuscous bar of the wings in this species also apply to the series examined in this connection.

This is the first record of the species from the State of Texas.

TRIMEROTROPIS Stål.

Trimerotropis texana (Bruner).

This interesting species was taken at all the purely Lower Sonoran localities visited in southern New Mexico and extreme western Texas. At El Paso it was found, July 10 and 11, rather sparingly in the broken country at the foot of the mesa northeast of the city, on the bare spots in the greasewood-covered mesa and in a dry stream bed in the irrigated section along the Rio Grande, six males and one female being taken in the several situations. A single female was secured in the street under an arc light the evening of July 12 at Alamogordo, while one male was captured among greasewood at 4,900 feet elevation in Dry Canyon, Sacramento Mountains, July 13. At Aden, July 21, in grass prairie land and in dry grass, five males and three females were secured, while a single male was taken at Lanark, Donna Ana County, New Mexico, during a train stop on July 18. Three males and two females were secured in the yucca-dotted sand waste along the Mimbres River, north of Deming, July 18. This species was always found sparingly and specimens were invariably collected singly. Although much slower of flight than *T. vinculata*, this species has a peculiar habit of delaying its flight until the net had passed over it, making it more difficult to capture. Protective coloration appears to be a considerable factor in the life of individuals of this species, its habitat being the barest spots to be found in the region in which it occurs.

There is considerable variation in size, even in specimens from the same environment, and the coloration exhibits a tendency toward predominating grayish-white tones in one direction and reddish-ochraceous in the other. The specimen from Lanark is ochraceous-buff in the general tone of all except the tegmina. The caudal angle

[16] *Proc. Acad. Nat. Sci. Phila.*, 1908, p. 388.

of the disk of the pronotum varies from acute to obtuse-angulate, though by far the greater majority of the specimens have it rectangulate.

Previously known only from El Paso, Texas; Mesilla, Mesilla Park and the region about Las Cruces, New Mexico, this species is now known to range north in the Otero basin to at least as far as Alamogordo and west at least to Deming.

Trimerotropis fascicula McNeill.

A pair of this species was taken at Albuquerque, September 14, while a single male was secured on the greasewood-covered mesa northeast of El Paso, July 10. The Albuquerque individuals were taken on dry ground near the river bottom. The tegminal bars are well defined in all three specimens.

Trimerotropis modesta Bruner.

A single freshly transformed female taken on the edge of the mesa near El Paso, July 11, is referred tentatively to this species. On account of its condition the wing membranes are quite delicate and the coloration very weak, but it appears to represent this species, although considerably larger than the original measurements and the specimens available for comparison.

Length of body,	30.5 mm.
Length of pronotum,	7 "
Length of tegmen,	34 "
Length of caudal femur,	17 "

Trimerotropis laticincta Saussure.

Of this rather striking species a single female was taken, July 11, at El Paso, and two males and one female at Deming, July 18. The El Paso individual was collected on the rough slopes at the foot of the mesa, while the Deming specimens were taken in the yucca-dotted sand waste along the dry bed of the Mimbres.

The wing-band in these specimens varies from a third to slightly more than a third the length of the wing. The ulnar spur is very short and sometimes hardly evident. The species is exceedingly vigorous and wary.

Trimerotropis rubripes Rehn.

This interesting species, previously known only from the unique type from Albuquerque, is now known to range southward along the Rio Grande Valley to El Paso and also eastward and westward over a good portion of the Eastern or Chihuahuan Desert tract. Near El Paso the species was found sparingly on bare patches among low weeds along the river bank in irrigated ground below the city. Here on July 10 and 11 four males and five females were taken. A single female was taken under a street arc light at Alamogordo, July 12, while one male was captured in grass prairie land at Aden, July 21.

This series is quite uniform in size. While but little color variation is noticeable, one female from El Paso is as reddish in general tone as the type, but all the other specimens are more grayish. There is some little variation in the intensity of the subobsolete tegminal bars, and the wing band also appears more blackish than the type.

Trimerotropis vinculata Scudder.

At every locality visited in New Mexico and around El Paso this species was present. From an elevation of less than 1,000 feet at Spofford, Texas, to 8,700 feet at Cloudcroft, every locality yielded this form in greater or less abundance. The series of 112 specimens is distributed as follows: Spofford, Texas, July 8, 1 ♀; near Pecos High Bridge, Valverde County, Texas, July 8, 1 ♂; El Paso, July 10–11, 24 ♂, 15 ♀; Franklin Mountains, July 9, 7 ♂, 5 ♀; Alamogordo, July 12–13, 3 ♂, 1 ♀; Cloudcroft, July 14, 15, 4 ♂, 3 ♀; Aden, July 21, 27 ♂, 8 ♀; Deming, July 18, 1 ♀; Florida Mountains, July 19, 1 ♂, 1 ♀; Silver City, July 20, 3 ♂, 1 ♀; Albuquerque, September 14, 4 ♂, 2 ♀.

In the vicinity of El Paso, where the greatest variety of conditions was encountered, the species was found on the greasewood-covered mesa, the rugged slopes of the Franklin Mountains, the broken area at the foot of the mesa and on bare spots in the irrigated region along the Rio Grande. At Deming the mesquite and rabbit-weed plain harbored this species, while in the Florida Mountains it occurred on the rugged lower slopes. At Cloudcroft it was found uncommon in meadow land and along the edge of the conifer forest, while at Alamogordo it was found in the greasewood area east of the town and around arc lights at night. Cultivated ground was frequented at Albuquerque and rugged hillsides at Silver City, while all situations yielded it at Aden.

The majority of the El Paso specimens are slightly more grayish than the others in the series examined, the contrast of the tegminal bars being more decided, although this latter feature is so variable as to be worth nothing more than passing notice.

Trimerotropis cyaneipennis Bruner.

On the very steep rocky slopes of the Florida Mountains this species occurred sparingly, two specimens, a male and female, being taken. It haunted the same jumble of boulders and precipitous exposures as *Mestobregma plattei* and was equally wary and vigorous. The male has the tegminal bars strongly marked, much as found in individuals of that sex from the Huachuca Mountains, while the female is paler, but is similar to a specimen of that sex from the latter locality. A single female of this species was also taken on Grand View Point at Cloudcroft, July 16, while an individual of the same sex from Fort Wingate, New Mexico, taken August 16 by John Woodgate, has also been examined. The disk of the wing is very pale greenish-blue in the Cloudcroft male, glaucous blue in the Florida Mountains male, campanula blue in the Florida Mountains female.

This species is now known to occur in suitable surroundings in New Mexico, in the Organ Mountains at about 5,700 feet, at 8,000 feet in the White Mountains, at 5,400 feet in the Florida Mountains; in Arizona at Flagstaff, in the Grand Canyon from 3,000 to 7,000, in Oak Creek Canyon, at Prescott and in the Huachuca range.

CIRCOTETTIX Scudder.

Circotettix undulatus (Thomas).

It is very hard to understand Bruner's statement[17] that "this locust is partial to bare, more or less alkaline ground, and for that reason is found throughout the more arid regions wherever suitable localities occur." Our experience with the species in Colorado, New Mexico and Arizona shows its range to be chiefly in the Transition, Canadian and Hudsonian zones, by no means in the "more arid" regions, frequenting often "slashings" or cut areas in the forest region still covered with the débris left by the lumberman. Here it delights in performing its interesting ærial dance, ascending as much as seventy feet in the air, and hovering there for some minutes, keeping up its continual clatter. Open hillsides in the park-like glade region of the higher ranges are much frequented by these insects, and when the sun has warmed them after the chill of the night they proceed with their regular clattering music.

At Cloudcroft, on July 14 and 15, this species was found numerous in several situations, the greatest number being taken on the hillside of James Canyon, where quite a colony was located and where their clatter was continuous. In all a series of ten males and eleven females was taken, comparatively little difference in size being exhibited by the sexes, although in color the males are more blackish than the females.

It is interesting to note that when a series of forty-nine specimens from Cloudcroft and Beulah, New Mexico, is compared with one of

[17] *Biol. Cent.-Amer.*, Orth., II, p. 183.

seventeen from the Grand Canyon region, the New Mexican series is seen to have the caudal angle of the disk of the pronotum more acute in both sexes.

HADROTETTIX Scudder.

Hadrotettix trifasciatus (Say).

A single male of this species was secured on a rugged hillside near Silver City, July 20. It is a very small specimen.

ANCONIA Scudder.

Anconia cæruleipennis Bruner.

This most interesting species, which was described from a single female from Hawthorne, Nevada, is represented by two males and seven females from the vicinity of El Paso. When compared with the brief original description of the species the specimens agree fully, and as a series show no differences worth noting, except a lightening or darkening of the cinereous base color.

One of the rather striking features of this species is the subinflated disk of the prozona and metazona, while the principal sulcus is deeply impressed and the median carina elevated or subtectate on the cephalic portion of the prozona. The ease with which this species in life loses its caudal limbs is remarkable.

Two females were taken on the mesa at the east base of the south peak of the Franklin Mountains, July 9; one male and two females were taken along the edge of the mesa, July 11; while one male and three females were secured in the irrigated section along the Rio Grande on the same date.

HELIASTUS Saussure.

Heliastus aridus (Bruner).

This characteristic desert species was taken at El Paso, Alamogordo, Silver City and Deming, in all of which localities it was found on rocky areas or bare spots between the greasewood or mesquite bushes. At El Paso, July 9–11, it was taken on the mesa, the broken edge of the mesa and on the slopes of the Franklin Mountains, a series of fifteen males and fourteen females being collected. Three males were secured in suitable surroundings in the mesquite and rabbit-weed plain at Deming, July 18; a pair at Alamogordo, July 13, in the greasewood belt, and an immature female at Silver City, July 20.

The Deming individuals have hoary white very prominent in their coloration, while several of the El Paso series have a strong bluish-gray tendency.

PHRYNOTETTIX Glover.

Phrynotettix verruculatus Uhler.

A single female which was taken on a bare spot of red earth in grass prairie land at Aden, July 21, belongs to this species. The coloration of the specimen resembles that of the surroundings in which it was taken. The specimen measures as follows: Length of body, 35 mm.; length of pronotum, 16; greatest dorsal width of pronotum, 11; exposed length of tegmen, 7; length of caudal femur, 16. One of the characters separating this species from *P. magnus* (Thomas) from southern Arizona is the more compressed and deeply sulcate inter-antennal portion of the frontal costa.

The records of this species are from the Pecos River in Texas or New Mexico; Las Cruces, La Cueva, Organ Mountains, Taos Valley and Aden, New Mexico, and Phœnix, Arizona.

Phrynotettix robustus (Bruner).

A single female of this species was collected on the summit of a boulder-covered hill at the foot of the mesa at El Paso, July 11. The specimen was squatted motionless on a large pebble like a toad.

This species is now known from localities in the Otero Basin (Alamogordo), Rio Grande Valley (El Paso, Las Cruces and Lake Valley) and Southwestern Arizona.

SCHISTOCERCA Stål.

Schistocerca alutacea (Harris).

A single female from Albuquerque, taken September 14 in the cultivated section along the Rio Grande, is referred to this species. It has the caudal tibiæ extremely dark and in this respect it approaches *S. obscura*, but on comparison with specimens of *S. alutacea, obscura* and *venusta* its most intimate relationship is seen to be with *alutacea*. The metazona is well supplied with fair-sized spots of yellowish, similar to those frequently noticed in *S. venusta* and more rarely in a weaker form in *S. alutacea*.

The previous New Mexican records of this species are from Las Cruces and the vicinity of Mesilla, its known distribution in the territory being in the bottom lands of a portion of the Rio Grande Valley.

Schistocerca shoshone (Thomas).

This powerful species was found at both El Paso and Albuquerque, two males and two females being taken at the former locality and four males and two females at the latter. At Albuquerque, September 14, the species was taken in the cultivated area along the river, while at El Paso one pair was taken from tall green weeds on irrigated land, July 11, and the other pair was captured, July 17, in the mesquite-dotted sand waste east of the town, in which latter situation the species was plentiful but very wary.

CAMPYLACANTHA Scudder.

Campylacantha lamprotata[18] n. sp.

Type: ♂; Hijito, Valverde County, Texas. July 8, 1907. (M. Hebard.) [Hebard Collection.]

Related to *C. vegana* Scudder and Cockerell[19] from Las Vegas, New Mexico, with a topotypic female of which it has been compared, but differing in the distinctly lanceolate tegmina, which are attingent and nearly twice as long as the dorsum of the pronotum, the more robust caudal femora, the substrangulate pronotum which has the caudal margin of the disk more decidedly angulate, the nearly straight ventral margin of the cerci and a number of features of the coloration.

Size medium; form moderately robust; surface of the pleura and metazona of the pronotum punctate, the greatest portion of the body covered with long whitish hairs. Head with the occiput arcuate, but hardly elevated dorsad of the level of the pronotum, the interocular

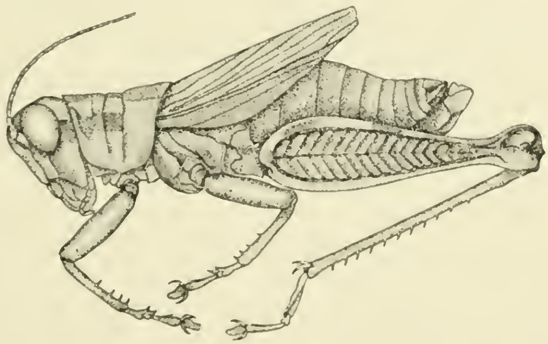

Fig. 12.—*Campylacantha lamprotata* n. sp. Lateral view of type. (× 3.)

region and the fastigium rather strongly declivent; space between the eyes very slightly narrower than the inter-antennal portion of the frontal costa; fastigium of moderate width, rather shallowly but distinctly excavated, the margins distinct; frontal costa slightly expanded between the antennæ otherwise subequal, biseriate punctate dorsad, distinctly sulcate ventrad of the ocellus; face appreciably retreating; eyes moderately prominent, ovate in outline, half again as long as the infraocular sulcus; antennæ distinctly longer than the head and pronotum together, very slightly thickened distad. Pronotum with the greatest (caudal) width of the dorsum contained slightly more than one and one-half times in the length; cephalic margin of the disk slightly arcuate, caudal margin obtuse-angulate with the angle well

[18] *Λαμπρότατα, most brilliant.*

[19] *Proc. Davenp. Acad. Sci.*, IX, p. 40.

rounded; prozona distinctly longer than the metazona, the former with a very weak median carina cephalad and the metazona with a very distinct but slightly elevated one; lateral lobes distinctly longer than deep, all the angles obtuse; transverse sulci of the whole pronotum well impressed. Tegmina hardly exceeding the head and pronotum in length, the greatest width slightly proximad of the middle, distal portion tapering, the apex narrowly oblique subtruncate; sutural margins overlapping. Wings equal to the tegmina in length. Prosternal spine strongly retrorse, conical, rather blunted; interspace between the mesosternal lobes decidedly longitudinal, the median width not a third the length of the same, the angles of the lobes well rounded; metasternal lobes attingent. Abdomen slightly compressed, carinate dorsad; furcula hardly indicated—mere broad areas with a hardly arcuate caudal margin; supra-anal plate slightly produced trigonal, apex very narrowly rounded, median sulcus indicated only on the proximal half, there deep and well impressed; cerci tapering in the proximal half, subequal distad and very slightly wider than half the basal width, the ventral margin hardly arcuate, the apex subacute and not exceeding the apex of the supra-anal plate; subgenital plate moderately produced and acute when seen from the side, the subapical tubercle distinct. Cephalic and median femora considerably bowed and inflated. Caudal femora robust, the greatest width contained three and one-half times in the length of the same, the tips considerably exceeding the apex of the abdomen; caudal tibiæ armed on the external margin with ten to eleven spines, on the internal with eleven.

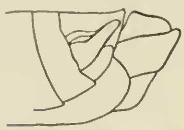

Fig. 13.—*Campylacantha lamprotata* n. sp. Lateral outline of apex of abdomen. (× 6.)

General color pale apple-green, becoming yellowish on the pleura, abdomen and venter, marked with bice-green. Face of the general color, the genæ slightly yellowish, while the occiput is pure lemon yellow, a distinct median occipital bar and much less distinct postocular bars bice green; eyes burnt umber; antennæ chinese orange, the two proximal joints greenish-yellow. Pronotum with the dorsum bice green, the lateral angles irregularly marked with dull lemon-yellow; the lateral lobes clouded with yellowish except for a clear bice green patch dorsad on the prozona. Tegmina bice green with yellowish-green veins. Apex of the abdomen decidedly yellowish. Cephalic and median

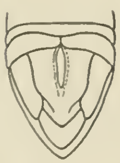

Fig. 14.—*Campylacantha lamprotata* n. sp. Dorsal outline of apex of abdomen. (× 6.)

femora pale chinese orange with a narrow distad area of bice green; cephalic and median tibiæ of the general color. Caudal femora of the general color, but rather more yellowish, having a number of bars of bice green, one imperfect proximal one hardly represented on the external face, one premedian, one postmedian and one apical (genicular), these being well indicated dorsad and less laterad, the ventral face uniform greenish-yellow, where the bars cross the lateral carinæ there is a tendency to glaucous, which is also found on the distal portion of the genicular region; caudal tibiæ glaucous blue with a poorly defined pale pregenicular annulus, spines very pale glaucous with black tips.

Measurements.

Length of body,	20	mm.
Length of pronotum,	4.8	"
Length of tegmen,	9	"
Length of caudal femur,	12	"

The type is the only specimen of this beautiful species seen by us, and was taken from a mesquite which had recently been drenched by heavy rain. No time was available for further search, as our stay was limited to a brief train stop.

HESPEROTETTIX Scudder.

Hesperotettix viridis (Thomas).

Of this beautiful species a series of seventy specimens is contained in the collection, of which fifty-three are males, twenty-two females and five immature individuals. The fondness of this species for the patches and larger areas of rabbit weed (*Isocoma heterophylla*) is very marked, and it usually occurs in abundance where that plant is present. Often in patches of this plant one would notice several specimens of this species sitting on the summit of a single clump.

At Deming it was very abundant on its food-plant on both sides of the dry bed of the Mimbres, a series of forty-five males, eighteen females and four nymphs being taken July 18. It also occurred in great numbers in suitable locations between the town and the Florida Mountains, while at 5,000 feet in a canyon in the Florida range it was very scarce, one male and two females being taken. At El Paso it was taken in the low country along the Rio Grande, four males and two females being secured on July 11. On the usual food-plant at Aden, July 21, one male and one female were taken, while one adult male and one nymph were collected at Silver City, July 20.

Of this large series thirty show no distinct blackish markings on or in the transverse sulci of the dorsum of the pronotum, although these are strongly pencilled in others. Of the Deming series of sixty-three adults twenty-three are without the blackish pencilling. The Deming series also contains one specimen in a brownish phase, while four others from the same locality approach it more or less closely. The red pregenicular annulus is present in every adult in the series, in by far the majority of the specimens very strongly indicated.

There is a considerable amount of individual variation in size, even in specimens from the same immediate locality, but even the largest specimens do not approach the robust, closely allied Mexican *H. meridionalis*. Several specimens from eastern Colorado (Lamar, Holly and Greeley), examined in connection with the New Mexican material, have the caudal femora very robust.

ÆOLOPLUS Scudder.

Æoloplus elegans Scudder.

This variable species, which at present is only known from localities in the Rio Grande Valley, was taken in numbers at El Paso, July 10, 11 and 17. It was found in greatest abundance in bottom land along the river, where it frequented the screw bean or tornillo (*Prosopis odorata*) and adjacent weedy areas, a series of sixteen males and nine females being taken. Along the edge of the mesa a single pair was taken, while the mesquite-covered sand desert east of the town furnished four males and one female.

In size there is a considerable amount of variation, so much so in fact that at first glance at a number of males of the species one would imagine they had two forms before them. This variation does not appear to be correlated with any particular environment or with the color phase of the individual. The extremes of the series measure as follows:

	♂	♂	♀	♀
Length of body .	13.2 mm.	20 mm.	19.2 mm.	19.8[20] mm.
Length of pronotum,	3.5 "	5 "	5 "	5.2 "
Length of tegmen, .	13 "	17.2 "	16.8 "	17.6 "
Length of caudal femur, . . .	9 "	12 "	11.8 "	13.2 "

As shown by the above measurements the greatest amount of variation is exhibited by the male, although that noticed in the female is quite perceptible.

The form of the male cerci is rather variable, in many specimens these

[20] Abdomen compressed.

appendages being slenderer and not as robust distad as figured by Scudder, although the general form remains essentially the same. There is also a slight variation in the shape of the tubercle of the subgenital plate.

In color, as pointed out by Scudder and Cockerell,[21] there is pronounced variation, although its description may be simplified by considering the green form one extreme and the full brownish and ochre form the other, leaving numerous specimens as intermediates between the two. The full green phase, having all the dark markings green and the lighter ones yellowish-green, is represented in our material by five males and one female, although closely approached by five other females. The full brown phase is represented by six males and one female, the remainder of the series being intermediate in coloration. The green phase was noticed chiefly among tall green weeds, while the brown phase was usually found in much fewer numbers upon the tornillo or screw bean. The tegmina are distinctly though not sharply maculate in eight specimens and unicolorous in six, the remainder having the anal vein marked more or less completely with a pale line. There is also a considerable amount of variation in the depth of the glaucous color of the caudal tibiæ.

The species has been recorded from Las Cruces and Mesilla Park, Donna Ana County, New Mexico.

MELANOPLUS Stål.

Melanoplus bowditchi Scudder.

This species is represented in the collection by three males and eight females, taken as follows: El Paso, July 10 and 17 (1 ♂, 2 ♀); Aden, July 21 (1 ♂, 4 ♀); Albuquerque, September 14 (1 ♀); Deming, July 18 (1 ♂, 1 ♀). At El Paso it was taken at the edge of the greasewood-covered mesa and from mesquite growing in the sandhill country east of the city. It frequented cultivated ground at Albuquerque, was taken in grass prairie land at Aden and frequented the mesquite and rabbit-weed plain at Deming.

In actions the species is extremely vigorous and alert, usually making long flights. But one of the specimens approaches anyway closely the type of coloration seen in individuals of the species from eastern Colorado and southwestern Nebraska, this individual being from mesquite at El Paso. The majority of the series are duller with umber browns the predominating colors, the postocular bar not strongly marked in two specimens and nearly obsolete in one. The bars on the dorsum

[21] *Proc. Davenp. Acad. Sci.*, IX, pp. 41–42.

of the caudal femora are more or less distinct in all but one individual which has them obsolete.

In size the specimens are decidedly larger than individuals from Colorado and Nebraska, as the following measurements show:

	Haigler, Neb. ♂	El Paso, Tex. ♂	Lamar, Col. ♀	Albuquerque, N. M. ♀
Length of body, .	21 mm.	22.5 mm.	28 mm.	30.2 mm.
Length of pronotum,	5 "	5.2 "	5.8 "	6.3 "
Length of tegmen, .	15.8 "	22.5 "	21 "	25.8 "
Length of caudal femur, . . .	11 "	14.2 "	13.5 "	16 "

The previous records of this species from New Mexico are from Belen, Valencia County, Sabinal, Socorro County, Las Cruces, Donna Ana County and Chaves, McKinley County.

Melanoplus herbaceus Bruner.

This variable species is represented by a series of forty-nine males and thirty-three females taken at El Paso, Albuquerque and Alamogordo. At El Paso it was found in a variety of habitats: on greasewood on the slopes of the Franklin Mountains (July 9, 1 ♂, 2 ♀), on greasewood on the mesa and at the edge of the same (July 10 and 11, 4 ♂, 1 ♀), on mesquite growing on the sandhills east of the city (July 17, 4 ♂, 2 ♀), and on irrigated land along the Rio Grande below the city (July 10 and 11, 38 ♂, 25 ♀). In the sandhill region the species was very wary and usually flew into the most inaccessible portions of the thickets of mesquite, while along the river it was plentiful but equally hard to capture. Two males and two females were secured in cultivated land at Albuquerque, September 14, while a single female was attracted to light at Alamogordo, July 12.

In size there is a considerable amount of individual variation, as the following measurements of extremes of the series from along the Rio Grande at El Paso will show:

	♂	♂	♀	♀
Length of body, .	20 mm.	23.6 mm.	26.2 mm.	29.2 mm.
Length of pronotum,	4.8 "	5.2 "	5.2 "	6.3 "
Length of tegmen, .	17.5 "	23 "	20.2 "	25.2 "
Length of caudal femur, . . .	11.2 "	13 "	13.2 "	15 "

The structure of the male cerci and of the furcula exhibits a considerable amount of variation in this species, about half of the males examined showing at least some slight approach to the form called *flavescens* by Scudder. A number of specimens are typical of *flavescens* as far as the cerci and furcula are concerned, but a careful study of this large series of eighty-one specimens shows that the slight genital characters and the color of the tips of the antennæ, of the pronotum and of the caudal tibiæ, given specific importance by Scudder to separate *M. herbaceus* and *flavescens*, are by no means specific and can be considered only individual, the extremes being connected by a number of intermediates.

In color we find two quite distinct extremes connected by intermediates, one extreme being uniform light green with the postocular bar subobsolete or entirely lacking, the other various shades of brown, touched with yellowish around the head and along the ventral border of the postocular bar which is quite distinct. Numerous intermediates show the postocular bar distinct with green the general color, others with yellowish and yellowish-brown the general color. The antennæ are usually not infuscate at the tips in the green phase, the majority of the other specimens having a more or less distinct apical infuscation. The caudal tibiæ are generally some shade of glaucous, varying considerably in depth, but a few specimens have a decided greenish tone to these parts.

The species has previously been recorded from El Paso, Texas, and Las Cruces, Mesilla Park and Albuquerque, New Mexico, while Scudder and Cockerell have assigned specimens from Mesilla and Mesilla Park to *M. flavescens*.

Melanoplus glaucipes (Scudder).

At El Paso this peculiar species was found in small numbers in thickets of screw bean or tornillo growing in the low river-land, where on July 10 one male and three females were taken. Two females were also secured on July 10 and 11 from mesquite, while one male and three females were taken, July 17, from mesquite thickets in the sand region east of the city. A single female was taken at Clin, Uvalde County, Texas, July 8, in a damp weedy location. The species is a vigorous one and at El Paso it was extremely difficult to capture, owing to its habit of seeking shelter by retiring to the thickest portion of the mesquite or tornillo bush on which it was found. In such surroundings a net was useless and work with the hands paid a penalty of thorn stabs sufficient to deter any but an enthusiast. It was impossible to flush specimens into the open, as the insects merely shifted their position to another portion of the bush.

There is a considerable amount of variation in the shade of the dorsum of the head, pronotum and anal area of the tegmina, face, genæ and ventral portion of the lateral lobe of the pronotum, and of the caudal femora; these portions being pale ochraceous in one specimen, very dull ochraceous in several others and warm red brown in another. The majority have these areas umber-brown. The red-brown specimen is from Clin and all the ochraceous individuals from the sandhill country.

The previous records of this species are from Dallas and Bonita, Texas; Mountain Park, Oklahoma; Mesilla Park, New Mexico, and Lerdo, Durango, Mexico.

Melanoplus atlanis (Riley).

Three males and two females of this widely spread species were taken in weedy spots in irrigated land along the Rio Grande below El Paso on July 10 and 11. A single male was taken on July 14 at Wootens, Otero County, New Mexico, at an elevation of about 7,000 feet, while a series of six females was taken in meadow-land at Cloudcroft, July 14–15.

As previously noticed by the authors[22] in regard to Arizona material of this species, the series before us show uniformly greater size than is true of specimens from the eastern United States, agreeing with material from Colorado and northern New Mexico, in addition to that previously recorded from Arizona.

Melanoplus aridus (Scudder).

This interesting species, which has a very considerable vertical range, is represented by five males and one female taken at El Paso (July 11, 1 ♂), in Dry Canyon, Sacramento Mountains (July 13, 1 ♂), Florida Mountains (July 19, 2 ♂, 1 ♀) and at Albuquerque (September 14, 1 ♂). A pair of this species from Fort Wingate, New Mexico, taken August 28 by John Woodgate, have also been examined.

At Albuquerque the species was taken on river bottom-land, at El Paso on weeds in field along river bank, while in Dry Canyon and in the Florida Mountains at elevations from 5,000 to 5,500 feet in the juniper and piñon zone, the species occurred among bush oaks (Florida Mountains) and on mesquite (Dry Canyon). In both of the latter situations adults of the species were very scarce, but a number of immature specimens, presumably of this species, were noticed.

The male from El Paso is larger and lighter in color than the other specimens of that sex, while the Albuquerque individual is very dark in color. The latter specimen resembles closely in general color tone

[22] *Proc. Acad. Nat. Sci. Phila.*, 1908, p. 396.

representatives of the species from northern Arizona. This is the first record of the species from Texas.

Melanoplus altitudinum (Scudder).[23]

Two females of this species were collected in James Canyon, Cloudcroft, July 14–15, one being from the overgrown slope of the canyon, the other from a weedy spot at the mouth of the canyon. The individual from the slope of the canyon is somewhat smaller than the other specimen.

The previous New Mexican records of the species are from northern New Mexico (Scudder), Taos Peak, 13,000 feet (Scudder), ridge between Sapello and upper Pecos River (Scudder, Cockerell) and Cloudcroft (Rehn).

Melanoplus femur-rubrum (De Geer).

A series of seven males and seven females of this widely distributed species were taken in cultivated ground at Albuquerque, September 14, a single male also being collected at El Paso, July 11, in bottomland along the Rio Grande.

Melanoplus calidus Scudder.

One of the most characteristic grasshoppers of the mountain meadows and of underbrush in certain portions of the forest-land around Cloudcroft is this striking species. Scudder originally described this insect from Gilman's Ranch, Eagle Creek, White Mountains, New Mexico, at an elevation of 7,000 feet; Scudder and Cockerell later recording it from the South Fork of Eagle Creek.

The species was found to be plentiful on July 14 and 15, although in the morning before ten o'clock it was very hard to find. The series taken consists of twenty-nine males and twenty females.

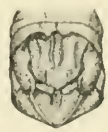

Fig. 15. — *Melanoplus calidus* Scudder. Dorsal view of apex of abdomen. (× 4.)

In size there is great uniformity in the male sex and but little variation in the female, and then chiefly in the length of the tegmina. Compared with Scudder's measurements the specimens are generally smaller, picked individuals giving measurements as follows:

[23] The great difficulty of separating some of the brachypterous species of *Melanoplus* from representatives of the genus *Podisma* and the close resemblance existing between *Melanoplus altitudinum* and *Podisma dodgei* was responsible for an erroneous determination made by the senior author (*Proc. Acad. Nat. Sci. Phila.*, 1904, p. 571). The specimens from Raton, New Mexico, and Prescott and Copper Basin, Arizona, there referred to *M. altitudinum*, are really *Podisma dodgei*, as a careful re-examination of all the available material in the two species shows. A series of Coloradan *P. dodgei* and Wyoming and New Mexican *M. altitudinum* have been used for comparison.

	Scudder's Meas.		Cloudcroft.			
	♂		♂		♂	
Length of body,	20	mm.	16.2	mm.	17.2	mm.
Length of pronotum,	—		4	"	4	"
Length of tegmen,	6	"	4.5	"	4.5	"
Length of caudal tegmen,	10	"	10.3	"	10.2	"
	♀		♀		♀	
Length of body,	21.75	mm.	18.2	mm.	25	mm.
Length of pronotum,	—		5	"	5	"
Length of tegmen,	6	"	4.7	"	5.2	"
Length of caudal tegmen,	10	"	12	"	12	"

The great length of the body in the last measured specimen is in part at least due to distension. The tegmina are quite uniform in the males, while in the females 6.3 mm. is the greatest length found. The caudal margin of the pronotum is subtruncate in a few individuals, and very slightly and broadly obtuse-angulate in the great majority. In color the general tone varies from gray-brown to umber-brown, but the pattern varies but little, while the pale yellowish stripe is more marked in some specimens than in others.

Fig. 16.—*Melanoplus calidus* Scudder. Lateral outline of apex of abdomen. (× 4.)

This species is apparently very close to *M. quadratus* Scudder from South Fork of Eagle Creek, 8,100 feet, White Mountains, New Mexico; at least the two descriptions are very similar and specimens are determined with considerable difficulty.

Melanoplus differentialis (Thomas).

This destructive species was found swarming on irrigated land along the Rio Grande below El Paso, July 11, two males being taken, while at Albuquerque it was found plentiful in high weeds on cultivated land on September 14, a pair being collected.

Melanoplus bivittatus (Say).

A series of five males and eight females was taken in the bottomland at Albuquerque on September 14. The caudal tibiæ are quite black proximad in a number of individuals and some shade of glaucous distad in all but three specimens, which are more or less strongly yellowish on that portion of the tibiæ. The dark line on the dorsal portion of the lateral face of the caudal femora is distinctly marked in all the individuals.

TETTIGONIDÆ.

DICHOPETALA Brunner.

Dichopetala brevihastata Scudder.

A single immature male taken on greasewood at an elevation of 4,800 feet at the mouth of Dry Canyon, Sacramento Mountains, appears to belong to this species, although the identification is attended with a little uncertainty owing to the immaturity of the specimen. Immature specimens apparently of this species were found to be fairly common when beating in the vicinity of the mouth of the canyon.

HORMILIA Stål.

Hormilia elegans Scudder.

Two females of this species were taken at Deming, July 20, both attracted to light. One specimen of the species was found in the lunch-room of the railroad station and brought to us by one of the waiters.

On comparing these specimens with the original measurements and with seven individuals from Florence, Arizona, it became apparent that specimens from the eastern side of the continental divide were larger than representatives from the western side. The following measurements may be of use when more extensive series are examined.

	Near Mesilla, N. M. (type; from Scudder).	Deming, N. M. VII. 20.07.	Deming, N. M. VII. 20.07.	Florence, Ariz. VII. 23.
		♀	♀	♀
Length of body (exclusive of ovipositor),	17 mm.	15 mm.	18 mm.	16.8 mm.
Length of tegmen,	28 "	29 "	31 "	—
Length of wing (approximate),	30 "	31 "	31.5 "	26 "
Length of caudal femur,	19 "	21 "	23.2 "	19 "

	Florence, Ariz.			
	IX. 20.	VII. 20.	VII. 13	VII. 22.
Length of body (exclusive of ovipositor),	18.2 mm.	19 mm.	15 mm.	15 mm.
Length of tegmen,	26.5 "	24 "	23 "	25 "
Length of wing (approximate),	29 "	25.5 "	25 "	25.5 "
Length of caudal femur,	20 "	19.5 "	17 "	17 "

	Florence, Ariz.	
	VI. 11.	VI. 8.
Length of body (exclusive of ovipositor),	15 mm.	17.8 mm.
Length of tegmen,	24 "	25 "
Length of wing (approximate),	25 "	27.5 "
Length of caudal femur,	19 "	21 "

One of the Deming females is a very pale buff, with the "herring-bone" tegminal pattern but faintly marked. The other individual is in the green phase with the pattern a pale green, and no indication of the blackish suffusion on the sutural areas frequently seen in the species.

The previous New Mexican records for the species were all from the vicinity of Las Cruces and Mesilla in the Mesilla Valley.

ARETHÆA Stål.

Arethæa constricta Brunner.

A single male of this species was taken at Fort Wingate, New Mexico, August 28, 1908, by John Woodgate.

The species has been recorded from Texas; near Organ Mountains, New Mexico; from an arroyo ten miles west of La Luz, Otero County, New Mexico; Tucson and Baboquivari Mountains, Arizona.

SCUDDERIA Stål.

Scudderia furcifera Scudder.

A single female of this species has been examined from Fort Wingate, New Mexico, taken August 23, 1908, by John Woodgate.

The only previous New Mexican records of this species were from the southern portion of the Territory, La Cueva, Organ Mountains, and Dripping Springs, Organ Mountains.

AMBLYCORYPHA Stål.

Amblycorypha huasteca (Saussure).

A single male of this species was beaten from a tall green bush growing in the bottom of Dry Canyon, Sacramento Mountains, at an elevation of 5,200 feet, in the piñon and juniper zone.

This specimen is of considerable interest, as when compared with a series of eight males and two females from Shovel Mount, Burnet County, Texas, the tegmina are found to be appreciably longer, although the body and caudal femora are of about the same size. The dimensions of the Dry Canyon specimen compared with an average Shovel Mount male and the original measurements of Saussure are as follows:

	Dry Canyon. ♂	Shovel Mount. ♂	Mexico (type; from Saussure). ♀
Length of body,	23.5 mm.	23 mm.	—
Length of pronotum,	7.5 "	7 "	—
Length of tegmen,	42 "	33.5 "	34 mm.
Greatest width of tegmen,	12 "	9.8 "	11 "
Length of caudal femur,	31 "	31.5 "	—

A sufficient series of the longer winged form may show the necessity of recognizing it as a geographic race.

This is the first record of the species from New Mexico and one of the few from west of Texas. The senior author has recorded it from southern Arizona, and Snow has credited it to Oak Creek Canyon, Coconino County, Arizona.

EREMOPEDES Cockerell.

Eremopedes albofasciata Scudder and Cockerell.

Four immature specimens, two of each sex, were taken at Aden, July 21, in grass prairie land; a single immature female from Deming, July 18, taken on rabbit weed, is also in the collection. The only previous record of the species was that of the type from Mesilla Park.

ATELOPLUS Scudder.

Ateloplus macroscelus[24] n. sp.

Type: ♀; El Paso, El Paso County, Texas. July 11, 1907. (Hebard and Rehn.) [Hebard Collection.]

Allied to *A. notatus* Scudder and *A. schwarzi* Caudell, but differing from both in the much more elongate caudal limbs and ovipositor and the different color pattern.

Size medium; form moderately elongate. Head quite short but rather broad and deep; fastigium of the vertex rounding to the facial fastigium which it touches, surface of the same not appreciably sulcate; eyes not prominent, subovate in outline; antennæ slightly more than twice the length of the body, proximal joint rather large, slightly produced on the internal face. Pronotum with its dorsal length slightly more than twice that of the exposed dorsum of the head, the dorsum of the pronotum regularly arcuate in transverse section rounding into the lateral lobes; cephalic margin of the dorsum subtruncate, caudal margin very broadly and shallowly but distinctly obtuse-angulate emarginate; when seen from the side the dorsal line of the pronotum is nearly straight, no sellate tendency being present; lateral lobes of the pronotum very considerably longer than deep, the ventral margin obtuse-angulate with the caudal portion of the angle slightly arcuate-emarginate. Tegmina present as the merest pads, hardly visible caudad of the pronotal margin. Prosternal processes the merest obtuse-angulate shoulders, in no sense spines. Abdomen with a very blunt dorsal carina; terminal dorsal abdominal segment with a considerable median impression which is folded ventrad; cerci short, conical, acute; ovipositor about three-fourths the length of the

[24] Μακροσκελής, *having long legs.*

caudal femora, moderately robust, somewhat arcuate proximad and distad, nearly straight in the middle, the proximal third more robust than the remainder, the apex acute; subgenital plate obtuse-angulate with a rather large and quite deep median V-shaped emargination, a pair of moderately distinct sub-parallel longitudinal carinæ present on the plate. Cephalic and median limbs of moderate length; cephalic femora equal to the pronotum in length, unarmed; cephalic tibiæ armed dorsad with three spines on the outer margin, with six on each of the ventral ones; median femora very slightly longer than the cephalic, unarmed; median tibiæ with the dorsal margins armed with two (cephalic) or four (caudal) spines, each of the ventrals with six spines. Caudal femora slightly longer than the body, moderately inflated in

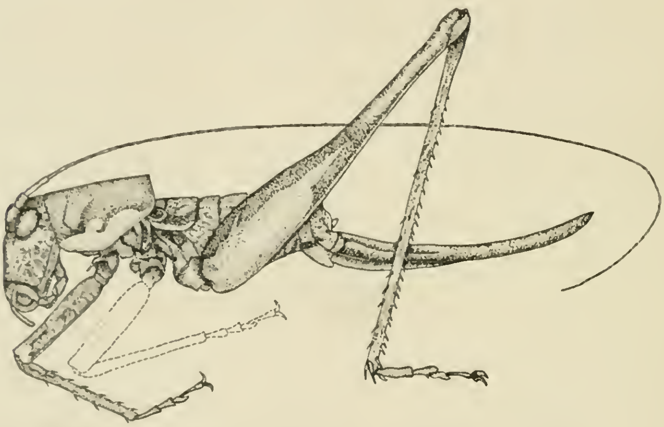

Fig. 17.—*Ateloplus macroscelus* n. sp. Lateral view of type. (× 2.)

the proximal half, slender distad, the greatest width contained nearly six times in the length, externo-ventral margin with a single spine, interno-ventral with five; caudal tibiæ about equal to the femora in length, all the margins spined, the dorsal ones with a number considerably exceeding that of the ventral series.

General colors cream white and blackish-brown, generally mingled and marbled, with but little pattern aside from several rather darker longitudinal areas on the abdomen and a median obsolete V-shaped figure on the pronotum. The ventral portion of the lateral lobes of the pronotum is pure cream-white divided sharply but irregularly from the darker dorsal section. On the face, the pleura and the sides of the proximal portion of the abdomen the lighter color predominates or is more conspicuous on account of the marbling being coarser.

Limbs marbled as is the case with the body, but a tendency toward broad annuli is noticed; caudal limbs with considerable blue-gray present in place of blackish-brown. Eyes wood-brown clouded with burnt umber; antennæ, except for the proximal joint, vandyke brown; ovipositor with the general pattern.

Measurements.

Length of body,	21	mm.
Length of pronotum,	6.8	"
Length of caudal femur,	25	"
Length of ovipositor,	18	"

The type and an immature paratypic female (July 10) were taken on greasewood on the mesa to the south and east of the Franklin Mountains.

STENOPELMATUS Burmeister.

Stenopelmatus oculatus Scudder.

A single female of this species from Fort Wingate, New Mexico, taken October 15, 1907, by John Woodgate, has been examined.

CEUTHOPHILUS Scudder.

Ceuthophilus uniformis Scudder.

Three females of this species were taken at Cloudcroft on July 14, under the bark of a stump of yellow pine (*Pinus ponderosa*). The only previous New Mexican records of the species are from Beulah, San Miguel County, and plains of northern New Mexico, eastern slope. Elsewhere the species is found in Colorado, western Nebraska and eastern Kansas.

Ceuthophilus valgus Scudder.

A single male of this very interesting species was taken from the interior of a decayed log of Douglas fir (*Pseudotsuga mucronata*). This individual is slightly larger than Scudder's original measurements and considerably larger than an individual from Beulah, New Mexico.

The species has been recorded from Santa Fé, Beulah and White Mountain region, New Mexico, and also from certain localities in Colorado.

Ceuthophilus paucispinosus Rehn

Two females of this species were taken in the Florida Mountains in November by Dr. H. A. Pilsbry. The specimens are of average size and do not differ from individuals from the Huachuca Mountains, Arizona. This is the first record of the species from New Mexico, the previous records being from the Huachuca Mountains and Oak Creek Canyon, Arizona, and without exact data from the southern portion of the same Territory.

UDEOPSYLLA Scudder.

Udeopsylla socorrensis (Rehn).

This species, which was described as a species of *Phrixocnemis*, should be placed in the genus *Udeopsylla*, probably with *U. franciscanus* and *viereckí* representing a new subgenus. The structure and armament of the caudal tibiæ are quite different from the type found in *U. robusta*, but with the small amount of material available it seems best to defer any division until an opportunity to examine a more extensive series presents itself. A single male of this species from Fort Wingate, collected May 12, 1908, by John Woodgate, has been examined. The only previous record for the species is that of the types from the Magdalena Mountains, New Mexico.

GRYLLIDÆ.

ECTATODERUS Guérin.

Ectatoderus borealis Scudder.

A single nearly mature female of this species was taken from a dead yucca on the greasewood slope between Alamogordo and Dry Canyon, July 13. Two adult females taken in the Florida Mountains in November by Dr. H. A. Pilsbry have also been examined, as well as a male from Claremont, California, taken by Prof. C. F. Baker.

The Alamogordo specimen has the lateral lobes of the pronotum quite blackish, but this is not the case with the Florida Mountain females, although present in the Claremont male. Its absence may be due to the fact that the specimens in which this coloration is absent were collected in alcohol.

The previous New Mexican records of this species were from La Cueva and Dripping Springs, Organ Mountains.

NEMOBIUS Scudder.

Nemobius neomexicanus Scudder.

Three specimens of this species, one adult male, one adult female and one immature individual, were taken at Alamogordo, July 16, in long grass under cottonwoods in the irrigated town park, where the species was abundant.

Both of the adults have the wings shorter than the tegmina, but otherwise they fully agree with an individual from Florence, Arizona.

The species has been recorded from Las Cruces and Mesilla, New

Mexico; Douglas, Cochise County, and Florence, Pinal County, Arizona; Los Angeles, California, and several localities in Lower California.

Nemobius utahensis Scudder.

A single female of this species, previously known only from Spring Lake and Salt Lake Valley, Utah, and Sedalia and Montevista, Colorado, was taken at Albuquerque, September 14, where the species was common in heavy weeds in the bottom-land. The capture of the species at Montevista, Colorado, is interesting when taken with the Albuquerque record, as the former locality is in the upper portion of the Rio Grande valley.

GRYLLUS Linnæus.

Gryllus personatus Uhler.

A single male of this species was taken at night from under a tin in the street at Alamogordo, July 12. A single female taken at San Marcial, Socorro County, New Mexico, July, 1907, by Otho Poling, has also been examined. Both specimens are macropterous. These are the first positive records of the species from New Mexico.

Gryllus armatus Scudder.

A series of five males and six females of this species was taken at Deming, July 19 and 20, where they were found attracted to electric lights. A single female was also taken, attracted to lights at Alamogordo, July 12. All the specimens are macropterous.

The principal measurements of the Deming specimens are as follows:

	♂	♂	♂	♂
Length of tegmen,	12.5 mm.	14 mm.	12.5 mm.	12.8 mm.
Length of caudal femur	10.5 "	12 "	10.5 "	10 "
Length of ovipositor	—	—	—	—

	♂	♀	♀	♀
Length of tegmen,	13 mm.	13.2 mm.	12.5 mm.	13 mm.
Length of caudal femur,	11 "	10.5 "	10.8 "	10 "
Length of ovipositor,	—	13 "	13.8 "	13 "

	♀	♀	♀
Length of tegmen,	13.5 mm.	13 mm.	13.5 mm.
Length of caudal femur,	10.5 "	10.5 "	10.2 "
Length of ovipositor,	14 "	12.8 "	12.2 "

These are the first records of the species from New Mexico.

Gryllus pennsylvanicus Burmeister

A single male of this species was taken from under a stone at night at Cloudcroft, July 15, while a female specimen was taken at light at Alamogordo, July 12.

The previous positive New Mexican records of the species were from Santa Fé, Las Vegas, Gallinas Canyon, Fort Buchanan and Mesilla Park, May to August.

Gryllus alogus Rehn.

A series of nine males and six females are contained in the collections examined in this connection. Of this series five males and three females were taken at Alamogordo, July 12 and 13, one male attracted to light, the remainder taken from a dead yucca; one pair was taken at El Paso, July 11, from a burrow, also inhabited by immature gryllids of other species, at the edge of the mesa; two males and one female from desert hillside and grass prairie at Aden, July 21; a single male from Deming, July 19, attracted to light, and a single female from Fort Wingate, May 12, collected by John Woodgate.

The Fort Wingate individual is quite small, no more than two-thirds the size of the other females, while the coloration of nearly all the specimens is uniformly darker than that of the type. The species appears to be closely related to the Californian *G. vocalis*.

The measurements of the specimens examined are as follows:

	Alamogordo.			
	♂	♂	♂	♂
Length of tegmen,	9.5 mm.	10 mm.	11 mm.	10 mm.
Length of caudal femur,	11.8 "	11 "	11.5 "	11 "
Length of ovipositor	—	—	—	—

	Alamogordo.			
	♂	♀	♀	♀
Length of tegmen,	9.8 mm.	7 mm.	8.2 mm.	8 mm.
Length of caudal femur,	11 "	11.5 "	12 "	12 "
Length of ovipositor,	—	12 "	13.5 "	—

	El Paso.	
	♂	♀
Length of tegmen,	11 mm.	9.2 mm.
Length of caudal femur,	11.5 "	13 "
Length of ovipositor,	—	14 "

	Aden.		
	♂	♂	♀
Length of tegmen,	9.5 mm.	9.5 mm.	9 mm.
Length of caudal femur,	11.5 "	11 "	12 "
Length of ovipositor,	—	—	13.5 "

	Deming.	Ft. Wingate.
	♂	♀
Length of tegmen,	11 mm.	4 mm.
Length of caudal femur,	11.8 "	8.7 "
Length of ovipositor,	—	10.2 "

The previous records are from Albuquerque, New Mexico, Huachuca Mountains and Phoenix, Arizona.

ŒCANTHUS Serville.

Œcanthus quadripunctatus Beutenmüller.

Three immature individuals swept from rabbit-weed at Deming, July 18, appear to be referable to this species.

This is the first record of the species from New Mexico.

Œcanthus fasciatus Fitch.

A pair of this species were taken from high weeds at 4,900 feet elevation in Dry Canyon, July 13. The limbs are brownish-yellow in both specimens, while the antennæ are blackish toward the bases.

The previous New Mexican records of the species are from Mescalero, Otero County, and Mesilla, Donna Ana County.

March 2.

Arthur Erwin Brown, Sc.D., Vice-President, in the Chair.

Thirty-one persons present.

The Publication Committee reported the reception of papers for publication under the following titles:

"Arachnida from Costa Rica." By Nathan Banks (February 19).

"Microscopical Image Formation." By F. J. Keeley (March 2).

Dr. John MacFarlane made a communication on irrito-contractility in plants. (No abstract.)

March 16.

Arthur Erwin Brown, Sc.D., Vice-President, in the Chair.

Twenty-five persons present.

The death of Prof. Percival de Loriol le Fort, a Correspondent, on December 23, 1908, was announced.

Dr. Henry Skinner made a communication on Antigeny or Sexual Diversity in Insects. (No abstract.)

Corrections: Dr. G. C. Crampton regrets that the following errors escaped him while reading the proofs of his paper entitled "A Contribution to the Comparative Morphology of the Thoracic Sclerites of Insects":

In Figures 6, 7 and 8, the region labelled S_1 should be designated S_2.

In the explanation of Figure 12, instead of "sternellum," read "scutellum."

Page 35, line 29, instead of "katepimeral complex," read "katepisternal complex."

Page 29, line 11, instead of *Corydalis*, read *Chrysopa*.

The insect figured in Plate I is not *Nemura*, but *Leuctra*.

William Welsh was elected a member.

The following was ordered to be printed:

MICROSCOPICAL IMAGE FORMATION.

BY F. J. KEELEY.

This subject is of importance to every user of a microscope, as a correct understanding of the optical laws which govern the formation of the image would assist in determining to what extent the true structure and size of the object under examination is correctly represented by the appearances presented to the eye. We are confronted with two radically different theories of microscopical vision, which may be termed the diffraction and dioptric theories, although the former requires the presence of both diffracted and dioptric beams, while the latter deals principally with the effect of diffraction, but only such as arises in the instrument itself and not from the object under examination. As the exponents of each seem to take partisan views and fail to give adequate consideration to the opposing theory, it appeared to be worth while to make a careful study of both in as far as possible an unprejudiced manner, supplemented by experiments, with the view of endeavoring to learn whether they are wholly irreconcilable.

From 1771, when Benjamin Martin applied a low power achromatic objective to a microscope and explained that its superiority was largely due to the increased aperture available, until Tolles, a century later, realized the possibility and practicability of producing objectives with apertures in excess of the equivalent of 180° in air, the principal efforts of the opticians and their collaborators, the microscopists, was in the direction of increased aperture and improved chromatic corrections, and no serious doubts appear to have been raised regarding the dioptric theory, in the form in which it had been worked out for the telescope; but when the practical limit of aperture with available materials had been reached by all the leading opticians, more attention was paid to theoretical questions, and it began to be apparent that there were certain phenomena connected with image formation in the microscope which could not be satisfactorily explained by accepted theories. Abbe investigated this problem with characteristic acumen and evolved the theory which has since borne his name, and although immediately attacked and later somewhat modified by himself, although in a radical direction, his theory has stood unrefuted up to the present time; but recently there has been a feeling aroused that, without further modification, it fails to fully account for all features of observed microscopical images.

The old dioptric theory has accordingly been re-expounded and amplified, and it is unnecessary to explain it in detail, as this has been most admirably and completely done in Wright's "Principles of Microscopy," published in 1906, which, while characterized by inaccuracies in connection with such matters as the measurement of focus and aperture, and indicating a lack of acquaintance with the diffraction theory, covers the ground from the dioptric point of view so thoroughly that I find but one point open to criticism, which is the employment of bright points and lines, equivalent to self-luminous objects, in explaining the formation of the diffraction patterns termed "antipoints." This is not a condition which is met in practical microscopy except with dark ground illumination, but every skilled microscopist knows that this form of illumination, although advantageous for many purposes, particularly for increasing the visibility of isolated points and lines, is never equal to direct light in developing true images of structure, the elements of which are not separated by distances exceeding their own diameters. The decreased resolution has recently been explained by Nelson, and, in addition to this, false appearances intermediate between true structural elements may be produced by the coincidence of diffracted rays, which would not be visible with direct light.

In the rare case of opaque particles in a transparent medium, such as is furnished by a rock section containing minute crystals of magnetite or pyrite, the phenomena observed at the margins of these crystals may be explained as just the reverse of those arising from a bright point image; but in the vast majority of all structures examined with the microscope there will be little difference in the illumination on opposite sides of a marginal line, possibly only a difference in color, and whether the margin be considered as imaged by slightly refracted rays or by slightly deflected diffracted rays, whether an image of the margin is produced at all or only an interference of "antipoints," it is unquestionable that in certain classes of objects at least, as my experiments have not covered the whole ground sufficiently to generalize, there is something visible corresponding to a limiting margin, which may be recognized and measured by a practiced eye, whether isolated when illuminated by a wide cone or flanked on both sides by diffraction bands with a narrow one. This fact had been impressed on me by previously made experiments, for when I first realized the effect that the size of the illuminated aperture should have on the apparent size of an object, the theoretical basis for this conclusion seemed so sound that I started a series of measurements to establish a table of corrections for "antipoint" for future use.

Failing to get any consistent results, or even any variations beyond the probable limits of instrumental error, in the course of micrometry of various objects at odd times, I finally made the following measurements with higher powers, adopting as most suitable objects two well-stained human blood corpuscles, mounted in balsam, and so marked that they could be found at any time, not only because they represented a class of objects frequently subjected to measurement, but also for the reason that they furnished an absorption image that should be particularly susceptible to dioptric law. Full data are as follows:

1. April 18: Stand, Zentmayer Centennial. Objective, Zeiss 3 mm. Apochromat, 1.40 N. A. Condenser, Powell & Lealand Apochromat, 1.40 N. A., no diaphragm, focussed for greatest aplanatic aperture, about 1.20 N. A. Stage Micrometer, Rogers "A" Division, third one-thousandth inch, Zentmayer Filar Micrometer. Diameter of corpuscle No. 1, .00032050 inch; diameter of corpuscle No. 2, .00031745 inch.

2. April 18: Everything exactly as above, except that a diaphragm was inserted in the condenser, reducing the cone of illumination to .20 N. A. Diameter of corpuscle No. 1, .00031860 inch; diameter of corpuscle No. 2, .00031747 inch. Variation from first measurements, corpuscle No. 1, —.00000190 inch; corpuscle No. 2, +.00000002 inch.

3. April 19: Stand, Zentmayer Centennial. Objective, Bausch & Lomb one-eighth inch, .85 N. A. Condenser, Beck Achromatic, 1.00 N. A., diaphragmed to .20 N. A. Stage Micrometer, Rogers "A" Division, third one-thousandth inch, Zentmayer Filar Micrometer. Diameter of corpuscle No. 1, .00031890 inch; diameter of corpuscle No. 2, .00031665. Variation from first measurements, corpuscle No. 1, —.0000016 inch; corpuscle No. 2, —.00000080 inch.

4. April 19: Stand, Watson Van Heurck. Objective, Beck one-eighth .90 N. A. Condenser, Bausch & Lomb Abbe Achromatic 1.00 N. A. diaphragmed to .50 N. A. Stage Micrometer, Fasoldt "A" Division, second one-thousandth, Bausch & Lomb Filar Micrometer. Measurement of corpuscle No. 1, .00031609 inch. Variation from first measurement, —.00000441.

5. April 28: Stand, Zentmayer Centennial. Objective, Bausch & Lomb one-twelfth inch, W. I., 1.00 N. A. Condenser, Beck Achroma-

tic, 1.00 N. A. diaphragmed to .50 N. A. Stage Micrometer, Rogers "B" Division, tenth two-thousandth inch, Zentmayer Filar Micrometer. Diameter of corpuscle No. 1, .00031770 inch. Variation from first measurement, —.00000280 inch.

These measurements were made with the utmost care, the mean of ten readings of the filar micrometer being taken in each case, and between the readings both the object and lines of filar micrometer moved and the focus changed, so that each reading required independent adjustment in all respects. The actual value of the micrometer divisions was not determined until after all the readings on the corpuscles were made, to avoid any possibility of unconscious mental bias. Fractions of an inch are employed because my best micrometers, those with the sharpest defined lines, are so ruled. It is easy to calculate the measurements to microns if desired, but this was useless in present case where the measurements had no value save for comparison.

It will be noted that the first two measurements, with illuminating cones of 1.20 and .20 N. A. respectively, agree far within the limits of probable instrumental error. In fact the small variation on corpuscle No. 2 is entirely a chance result, and I have experienced such close results in but one or two other cases out of many hundreds of measurements. The measurements on the second evening, under still different conditions, strongly confirmed the previous results. The last two measurements, each of but one corpuscle, were made principally to test the accuracy of the stage micrometers used, and the greater variation shown, which in the fourth measurement approaches what I would consider the probable limit of instrumental error under the conditions, might be ascribed to the use of different stage micrometers. I doubt if this is entirely true, as all my micrometers have been so thoroughly and repeatedly compared and studied, that any division or divisions of any one of a half dozen or more might be used with little chance of serious error, the true value of each, as recorded in my notebook, being of course used in making the comparison, as well as the same marked position on the division, as all stage micrometers vary materially not only in different divisions but in different parts of same division. The best have a horizontal line on which all comparisons should be made. It is more likely that the comparatively large variation in the fourth measurement is mostly due to the employment of the Bausch & Lomb instead of the Zentmayer Filar Micrometer. While the former is very accurately made, it has ruled lines instead of spider webs, and therefore does not admit of such accurate definition and placing of the lines, measurements being of course made between the interior edges of the lines, and the diameter of the latter allowed for in comparing with stage micrometer. In the fifth measurement, a slight error might occur from comparison with a different-sized division of stage micrometer, as owing to the variation in magnification over the field of ocular, even if errors of screw are immaterial, no filar micrometer is likely to give exactly double the reading on two equal divisions that it will on one of them. This difference, if only centre of field is employed, is too small to be serious, but in very accurate measurements it is always well to compare with divisions of stage micrometer as nearly as practicable corresponding to size of object measured.

From these data it will be evident that the unquestionable presence of "antipoint" phenomena need not be taken into consideration in connection with micrometry with white light, as a trained eye can select the same margins to measure under any ordinary conditions of illumination. This is not in the least contradictory to the theory, but demonstrates the possibility of overcoming a theoretical difficulty in actual practice. As anyone skilled at micrometry is likely to use a large cone whenever practicable, the only occasions when this question will be of importance will be when successive measurements must be made through covers of widely differing thickness. Owing to the impossibility of making any adjustment for this variation, it may be necessary to cut down the cone of illumination and depend on experience to select the margins to be measured.

In considering diffraction phenomena originating in the object, it will be well to first assume conditions under which the objective will be of greater aperture than the illuminating cone, and will therefore, when examined with ocular removed, exhibit a disk of light, the dioptric beam, surrounded by an unilluminated space. The insertion of an object in the focus of the objective will result in this dark space showing more or less light which may be both refracted and diffracted by the object. If the latter has a fine structure, periodically arranged, this light reaching the outer zone of the objective's aperture will be mostly of diffraction origin and will take the form of separated spectra. As is well known, the examination of such spectra will enable us to predicate in advance what will be the arrangement and distance of the structural elements visible, or if the objective is not of sufficient aperture to include at least the first order spectra, no image of the structure will be seen. Thus in arranging the illumination for the resolution of a difficult object—for instance, *Amphipleura pellucida* in dots, with a suitable objective—the easiest way is to pay little attention to the image seen through the ocular, but to remove the latter after focussing, and modify the illumination until two spectra at right angles, as well as the dioptric beam, are visible in the back of the objective. Then on inserting the ocular the resolution should be apparent at once, or by making any necessary spherical corrections by means of adjustment collar or tube length; but as long as both spectra are not seen, it is utterly useless to endeavor to effect resolution by altering the adjustment. If after satisfactory resolution be secured one of the spectra be obscured by an intruding point, only lines at right angles to the other spectrum will remain visible.

Another well-known experiment is available with any objective capable of resolving *Pleurosigma angulatum* with a very small central cone, in which case the six characteristic diffraction spectra, free from refracted rays, may be seen at margin of objective. A cover glass, on which have been marked with India ink six dots that will cover the diffraction spectra, may now be placed behind the objective, and no trace of resolution will be visible; but if the cover glass be rotated 30° so as to bring the dots between the spectra, the resolution will be as good as before. We here have a case where radically different results are obtained without changing the character of the screen behind the objective, and any argument that it acts as a diffraction grating is invalid, because if this were the case it should so act and produce similar results in one position as well as the other. It is now evident that there is some connection between these diffracted beams and image formation in the microscope, and the question becomes whether the formation of the image is dependent on their presence, or whether they are merely accompanying phenomena which happen to appear concomitantly with conditions which would permit of similar image formation in their absence.

That they are actually image forming rays can be readily proved in several ways, the easiest being to throw the objective out of adjustment sufficiently that the rays from its outer zone, which will be the diffracted rays, are brought to a different focus from those of the dioptric beam in the centre, and the two images can thus be examined successively by a slight change in focus. A more convincing method is that of Rheinberg, in which the rays from outer zone are refracted out of the optic axis and the two images can be examined or photographed simultaneously. Still a third method will shortly be referred to in connection with the case of an objective illuminated by a solid cone of light of its own aperture, which must now be considered.

This is a condition we rarely meet in practical microscopy except with low powers, as no wide-angled objectives have been made that are sufficiently well corrected to stand a full cone without breaking down, unless on objects such as deeply stained bacilli, where the image is formed principally by absorption and is practically a silhouette. There seems to be no reason why such images should not be regarded as dioptric, although there must be some diffracted rays from the margins which are undoubtedly utilized in the image.

When the back of the objective is entirely filled with light, the study of diffraction phenomena becomes difficult, as even with particularly suitable objects the diffraction beams are eclipsed by the brighter dioptric beam. As we open the iris of the condenser, however, it can be seen that the diffracted beams expand to the same extent as the dioptric beam, finally overlapping it and each other, until when the aperture of the objective is entirely filled with dioptric light it must unquestionably be similarly filled with diffracted rays. Unfortunately, there seems to be no way in which we can completely separate the beams derived from the two different sources, and the best expedient I could devise to obtain some idea of the conditions present consists in the use of a semicircular diaphragm in the condenser, so oriented that the left side of the back of objective is completely filled with light up to its margin, while the right side receives no direct rays whatever. Thus we have full cone conditions on one side, while the other will receive only refracted and diffracted rays, or if certain suitable objects are employed nothing but diffracted rays, whose behavior we can study separately.

For this purpose a binocular microscope should be employed with a specially short mounted objective, say a sixth of about .80 N. A., the back lens of which will come close to the Wenham prism. All the direct light from the fully illuminated left half of the objective will now pass up the right-hand tube of the microscope, while the diffracted beams from the right-hand half of objective will be reflected up the left tube. Assuming that *P. angulatum* is again the object, as it furnishes spectra singularly free from all indications of refracted light, and oriented longitudinally across the field in a right-and-left direction, on examining the back of objective, the previously dark space on the right will be found practically filled by three of the characteristic spectra of the object, and the other three will be present, although invisible, in the illuminated half, where they will occupy positions near the margin, as they can only be derived from central or nearly central dioptric rays. The diffracted beams in right half of objective, being derived from the dioptric beam which completely fills the left half, will extend from close to the centre of objective to beyond its margin, and correspond in all essential respects to those present in a fully illuminated objective, as such widely diffracted beams must be derived from dioptric rays which pass through that portion of the objective's aperture diametrically opposite to them. It is true these beams would be expanded if the full aperture was illuminated, but the expansion would be principally outside the margin of objective and, as far as present experiment is concerned, be immaterial. The following results demonstrate that three such spectra as we are considering will produce an image identical with that resulting from the whole six, and the conditions may be summed up as follows:

Through the right-hand tube of the binocular, the image will be produced by a full dioptric beam, supplemented by diffracted beams corresponding to those resulting from a small central illuminating cone, while through the left-hand tube it is derived from diffracted beams alone, corresponding to those present with a full cone of illumination. On examination, it will be found that both images are fairly well defined, but that the resolution of the fine structure is noticeably sharper and more distinct in the diffraction image through the left tube.

It will also be noted that the diffraction image is blue in color, and before going further it will be well to fully understand how the colors of such images are to be accounted for. The diffracted beams seen at back of objective correspond to any other diffraction spectra and include light of such wave lengths as enter into their formation. The images resulting from their recombination will accordingly have the same color as the light supplied to the microscope, as modified by absorption in passing through the object, provided complete spectra are included within the aperture of the objective; but should part of the spectra be cut off at its margin, the diffraction images will correspond to color sensation produced on the retina by light included in that portion of the spectrum admitted, and will accordingly depend on two factors: the distance between the elements of the object and the aperture of the objective. Under the conditions outlined in present experiment it has already been noted that the diffraction image of *P. angulatum* is blue, which is due to the red ends of its spectra being cut off at margin of the objective's aperture. If *Navicula Lewisiana* or a coarse *N. rhomboides* be substituted only the violet end of the spectra will be admitted and the unresolved image be similarly colored. On the other hand, *Pl. formosum*, whose spectra will be completely admitted, will appear just as white in the diffraction as in the directly illuminated image. Intermediate forms may appear green or even of a yellowish cast, but never red.

The agreement in color of the images seen through the left tube with what would be predicated from the examination of spectra admitted, is further evidence that they are due practically exclusively to diffracted rays, but still further experiment is required to demonstrate that they are free from refracted rays. The spectra here seen, and which have previously been considered, consist of an infinite number of overlapping images of the aperture in the substage diaphragm, each produced by light of a different wave length; hence only the extreme ends are practically pure colors, the middle portions of the spectra consisting of a jumble of colors sometimes producing the effect of white light; but if a narrow slit diaphragm be inserted in the condenser we can secure a spectrum that corresponds in sharpness to that from an ordinary spectroscope. This may be enlarged by the use of a low power objective in the draw tube, focussed on the back focal plane of the first objective as when using an Abbe apertometer. The microscope may now be used as a spectroscope, and by allowing the light supplied to it to pass through some coloring matter which has well-marked absorption bands, these will be visible in the spectra at back of objective. A solution of Eosin, which will be needed for a later experiment, will likewise answer here. It should be of such strength that when placed in a glass trough and examined with a spectroscope of low dispersion, it will show a black, well-defined band in the green adjoining the yellow, but allow the remainder of the spectrum to pass freely. On placing this trough in the path of the light used to illuminate the microscope, which should be an intense one, it will be noted that the absorption band in the spectrum derived from the diatom structure is perfectly black, furnishing a demonstration that it is practically free from refracted rays; for if it contained scattered refracted rays, as has been claimed, the absorption band would not appear black, but of same color as the light illuminating the object, which in this case is visually a bright red.

If we now examine the diffraction image produced under these conditions, taking the precaution to so adjust the slit diaphragm that the red end of diffraction spectrum is cut off by the margin of the objective's aperture, will find that it is just as blue with this visually red light as it was with white light, owing to the fact that Eosin transmits the blue rays freely; but the midrib of the diatom, and particularly any granular incrustation, such as may usually be found at places between the valve and cover-glass, will be tinted red, indicating that refracted rays or complete diffracted beams enter into their image formation.

Three important questions have now been settled: Firstly, that the diffracted beams from certain structures are free from refracted rays; secondly, that sharp distinct images may result from such diffracted beams exclusively; thirdly, that where such beams are sufficiently separated from the dioptric beam to permit of their being eclipsed by a suitable screen, no image of the elements producing them will be visible.

Returning to the conditions of the previous experiment, we will substitute for the diatom a well-stained blood slide, preferably pathological, containing large eosinophilous leucocytes. As this is mounted in balsam, the corpuscles would be scarcely visible were they not stained, hence the image must be produced principally by absorption and little refraction can be expected. There must be some diffraction at the margins, but the diffracted beams thus produced will be slightly deflected, and for all practical purposes indistinguishable in their effect from refracted rays. After examining the image through right tube, and noting that practically nothing can be seen save by contrast of color, even the granules of the leucocytes being "drowned out" by the wide cone of illumination, the eye should be rested for several minutes in a dark place, to recover its sensitiveness not merely to faint images, but, what is particularly important in this case, to color sensation, which will have been impaired by the brilliant red color of the stained blood. When this has been done, the image through left tube may be inspected, and as anticipated it will be found exceedingly faint. Mere sketchy outlines of the corpuscles will be seen, of a reddish tint, but what will most impress the observer will be that the granular texture of the leucocytes will be quite distinctly imaged and of a bluish-gray tint. It is hardly necessary to state that this indicates diffraction origin of the image if the diffracted beams are deflected sufficiently to be partly cut off at margin of objective, as the distancing of the granules would indicate should be the case. It has already been shown why the visually red Eosin stain presents no serious difficulties in the way of a contrasting diffraction image.

In these experiments the position of the semicircular diaphragm might be reversed so as to give the diffracted beam the advantage of the direct tube, but in a good Wenham binocular it makes little difference which tube is used. I may be particularly fortunate in this respect, but among my own binoculars this is the case, and in at least two of them the difference in definition between the two images is not greater than is commonly found between that of two objectives of identical construction from the same maker. Right here it may be well to mention two other fallacies regarding the Wenham binocular which seem likely to be perpetuated in microscopical literature, having even found a place in Spitta's recent valuable and generally accurate work on the microscope. One of these is, that the beam passing up the left tube produces a larger image (unless this is counteracted in the ocular) because it has to travel farther on account of the two reflections in the prism. As I many years ago explained, the path of the beam through the prism is but slightly over one and a half times the length of the path of direct beam alongside the prism. As this distance is in glass of at least 1.50 R. I. the ray emerges from the prism as if it had traveled only two-thirds as far in air, and the optical tube length is practically identical in both tubes, the difference not reaching a millimeter with an ordinary well proportioned prism. The other fallacy is that such binoculars are not suited for higher powers than about a half inch, while they really work well with objectives up to an eighth inch or higher, if the latter are mounted, as Wenham himself recommended, in short mounts, so as to avoid parallax between back lens and prism. If anyone doubts the immense advantage of stereoscopic effect with high powers, let him attempt with a monocular to demonstrate the anatomy, particularly the position of the unextruded proboscis, in a glycerine-mounted specimen of the motile condition of our too common pest, the San José scale, which I have never seen correctly figured, and then note the difference when a binocular is employed. The sculpturing on spores and capillitium of Myxomycetes, spores of ferns, etc., afford other good tests of its efficiency.

Returning to diffraction phenomena, I almost hesitate to refer to the two experiments by which Wright seems to think he has demolished the Abbe theory, as their fallacy is so self-evident that it must have been at once recognized by every microscopist having more than the most elementary acquaintance with the subject. The assumption, in the first experiment, that when the aperture of objective is fully illuminated there are no diffracted rays present, because they cannot be seen, is absurd, and needs no further consideration; but anyone desiring to know just what is the character of the diffracted beams resulting from any particular structure under the conditions specified, may secure the information by employing a pinhole diaphragm in a freely moving carrier connected with substage condenser. A circle should be drawn on a piece of paper to represent back of objective, and the diffracted beams visible plotted in with a red and blue pencil.

Diaphragm may then be moved slightly and the diffracted beams again recorded on same drawing. This can be repeated until the illumination from the pinhole has traversed every portion of the objective's aperture, or until the patience of the observer is exhausted, when, if the diaphragm be removed and the objective fully illuminated, it will be absolutely certain that all the diffracted beams represented on the composite sketch will still be present within the aperture of the objective. Twenty years ago Abbe published a paper dealing specially with fully illuminated apertures.

The other experiment described, which states that the image of an Abbe diffraction plate, illuminated through a narrow central aperture, and examined under a one-inch objective, becomes invisible when sunlight is used as the source of illumination, would be equally fallacious if true, as the glare of such light might prevent any image being seen, but its presence could be demonstrated by receiving it on a ground glass screen or by photographing it. But even the facts are here misstated. I did not doubt that the image might be obscured by the blinding effect of direct sunlight, and merely carried out the experiment to demonstrate that the image would appear on the screen of a camera, which from photomicrographic experience I knew would be the case; but I found not only that the lines were well defined on the ground glass of the camera, but also were equally distinct when examined directly through the microscope. Although Wright's description of the experiment had been followed in every detail, the conditions were likewise varied in every possible way that might lead to the results claimed. A shade prevented the sunlight from reaching any part of the microscope except the mirror, but in addition it was wrapped in several folds of a heavy focussing cloth, preventing the possible entrance of any light save the narrow central beam, which was modified in size first with the iris and then by a specially made pinhole diaphragm, much smaller than could be secured with the iris, or with the diaphragm accompanying the Abbe diffraction apparatus, recommended by Wright for the purpose. The disk of the sun was focussed sharply in the plane of the lines and also above and below; the condenser removed and sunlight merely restricted by the minute and larger diaphragms tried; eyepieces from two-inch to one-fifth inch employed; the fine one-inch objective at first used removed and replaced by the poorest one of this power in my collection, a cheap single system affair of low aperture; but it was useless to change the conditions, as under any of them the image remained just as sharp and distinct as it would have been with lamplight, and the only result of an hour's experimenting was a tired eye and the conviction that it was absolutely impossible for anyone with eyesight good enough to use the microscope at all to perform this experiment with the results claimed. Nevertheless, devoid as it is of the slightest basis in either fact or deduction, it is offered as one-half of all the evidence necessary to refute so well considered a theory as that of Abbe. As it should succeed under the dioptric theory, it indicates the inadequacy of that theory alone to account for microscopical image formation.

One more experiment, of the many made, may be worth mentioning. For this will be required an objective that will stand full cone illumination, and a Nobert test plate or other series of rulings will supply the object. No objective of more than very low power and aperture will fully fill the specifications, which would require resolution with a full cone, equal to that with oblique light, but an old Spencer one-half inch of 70°, which approaches perfection more closely than any other objective I have seen, was found to answer the purpose. If illuminated with a cone completely filling its aperture, it will be found that the seventh band of the Nobert plate is well resolved, and if the aperture of the illumination be cut down as far as the iris will close, so the dioptric beam seen at back of objective will not exceed one-twenty-fifth of the diameter of the back lens, the third band, which is just twice as coarsely ruled as the seventh, will still be easily and distinctly resolved. Now the aperture of the illuminating cone has been cut to one-twenty-fifth, and by a strict interpretation of the dioptric theory the resolution should be impaired to a similar extent, but it is found to be one-half as great as with the full aperture. This will be answered by the statement that the image is now formed by refracted rays, outside the dioptric beam. Very well, if that is the case, then one-half of the aperture of the objective is sufficient to resolve the third band, and it can therefore do no harm if we contract the aperture just a little, say 10 per cent., by means of an iris back of it. It will be found, however, that as soon as this is done the lines completely disappear. In fact, just as soon as two minute diffracted beams, visible at margin of objective, are partially eclipsed resolution is at an end.

This experiment, dealing with the "mystery of the dark space" which led Abbe to evolve a new theory, is introduced not to demonstrate that the unilluminated portion of an objective's aperture assists in image formation, which every microscopist must already know, but to call attention to the fact that it does so in a definite manner. Under the explanation given by the advocates of the dioptric theory alone, different results should be secured according to the character of the object. In the case of structure that could refract but little light the resolution would be cut down to 10 per cent. or less, owing to the large "antipoint," which would decrease in size and permit of greater resolution as the power of the object to refract rays increased, until in exceptional cases resolution practically equal to that with a full cone should be attainable. On the contrary it will always be found that, without regard to the character of the object, the resolution with central light will be just about one-half that with a full cone, or in other words, will correspond to the diffracted beams admitted by the objective.

In the absence of suitable rulings, the fact referred to may be demonstrated with diatoms or any other objects that may be at hand in sufficient variety, by noting the finest structure resolved under the two conditions of illumination, and then carefully counting the elements of the structure resolved in a given space. On a Moller 60 diatom test plate in styrax, the markings on all its forms having been accurately counted and recorded, it was found that the above objective with full cone, resolved *Grammatophora serpentina*, 48,000 per inch, and with central light reached its limit at the third *Navicula lyra*, 24,800 per inch, confirming the results from the rulings.

This objective, it may be mentioned, will resolve with oblique light, *Navicula Lewisiana*, with over 58,000 markings per inch, and thus go considerably beyond the usually accepted theoretical limits for its aperture. The recorded aperture of the objective, measured when purchased many years ago, was .57 N. A., and the markings of the diatom noted as varying from 57,000 per inch near the ends to 59,000 at centre of valve. After this resolution was found to be unmistakable, both measurements were repeated. The extreme rays entering the objective were determined by an Abbe apertometer placed on revolving stage with vernier and illuminated by edge of small lamp flame across the room. Two readings to tenth degrees at each "end reaction" agreed exactly, and the results, calculated by taking sine of the half angle multiplied by the refractive index of the apertometer, gave a numerical aperture of .588 which represents the outside limits.

A portion of the diatom valve, about half way between centre and end, which had been noted as being sharply resolved from raphe to margin, was then accurately counted under a high power, and the mean of a number of closely agreeing counts at slightly different points proved to be 58,800 per inch. The number in a full thousandth inch was counted to avoid the possibility of error in a smaller distance.

On glancing down the tube at back of objective when diatom was resolved, this result was at once accounted for, as only the blue and violet of the diffracted beam, with the merest tint of green, was admitted, and it therefore became apparent that for an objective as perfectly corrected as this one, we must use the column calculated for the "F" line, and not that for the "E" line, which is generally accepted as more nearly representing the effect of white light. It is hardly necessary to add that the resolution was effected with light from an ordinary microscope lamp, without color screen or other aid, as I never test an objective under any conditions, as to illumination or mounting medium, that will differ from those under which it will be used in routine work. It will be noted that the performance of this objective, when correctly interpreted, is strongly confirmatory of the Abbe theory.

Before proceeding to draw a conclusion from these heterogeneous and rambling notes, collated from records of work at odd times during past couple of years, I wish to reiterate the impartial attitude assumed in undertaking consideration of the subject. If there was any prejudice, it was in favor of at least a partial acceptance of the dioptric theory. When Wright's book was received and read, although recognizing many of its fallacies and rendered suspicious by its commendation of such old and discredited devices as the tandem microscope, better known here as "megamicroscope," and the insertion of a stop in the axis of the objective or Ramsden disk of the ocular to produce dark ground illumination, which equals the Abbe diffraction apparatus in its ability to conjure up "optical nightmares," I was nevertheless profoundly impressed, and after re-reading it several times and performing some of the experiments with which I had been previously unacquainted, concluded that the Abbe theory must undergo at least some modification; and if I no longer hold that view, it is principally as the result of experiments which were inaugurated with the idea of demonstrating exactly the reverse of the conclusions I was compelled to draw from them.

Much will of course depend on just what is understood to be included in Abbe's theory, on which various writers are by no means agreed. In his own papers Abbe appears to assume a thorough acquaintance with optical science on the part of his readers that few of us possess, hence he makes little reference to known facts and theories, but occasional passages show that he did not neglect to give them full consideration. In the start he unquestionably recognized the effect of absorption and refraction in producing the image, and his theory requires the presence of both dioptric and diffracted beams. Furthermore, he lays stress on the fact that diffraction in the aperture of the objective will result in every point being imaged by a "dispersive circle" (the "antipoint" of Gordon) of greater or less size according to circumstances, and recommends the examination of a brightly illuminated object through a pinhole one-two hundred and fiftieth of an inch in diameter in a card or piece of tinfoil, to secure an idea of what must be the appearance of the best image that could be produced through a microscope magnifying five thousand diameters, even if the construction was perfect.

If his later application of the diffraction theory to the images of coarser details, earlier termed "absorption images," could be interpreted as a denial that any refracted rays, outside the dioptric beam, entered into the image at all, then indeed some modification is necessary, as most objects unquestionably refract light outside the dioptric beam; and not only do the simplest laws of refraction require that these rays find a place in the image, but there is no other way of accounting for what becomes of them. It is more likely, however, that Abbe regarded this fact as self-evident. At any rate, the important work he undertook was not to refute the dioptric theory, but to supplement it by accounting for phenomena which it then, as now, failed to explain. He has done this in so eminently satisfactory a manner that it would appear that his theory, in all essential details, must be accepted, unless someone can bring indisputable experimental proof of the formation of a microscopical image that goes beyond its possibilities. Any experiment that merely demonstrates failure to fully realize the possibilities of the Abbe theory, on account of interference with image formation due to diffracted rays arising in the aperture of objective, or anywhere except in the object itself, is not pertinent, as this unavoidable limitation was evidently fully recognized in evolving the theory.

APRIL 6.

ARTHUR ERWIN BROWN, Sc.D., Vice-President, in the Chair.

Forty-six persons present.

The Publication Committee announced the reception of a paper entitled:

"Polychætous Annelids from Monterey Bay and San Diego, California." By J. Percy Moore (April 6).

The Recording Secretary read a short history of the Academy, prepared for publication in the *Founders' Week Memorial Volume*.

APRIL 20.

ARTHUR ERWIN BROWN, Sc.D., Vice-President, in the Chair.

Eighteen members present.

The death of Dr. Persifor Frazer, a member, April 7, 1909, was announced.

DR. H. A. PILSBRY made a communication on barnacles, with special reference to certain recently found commensal forms.

John Gribbel and Mrs. Elizabeth B. Gribbel were elected members.

The following were ordered to be printed:

ARACHNIDA FROM COSTA RICA.

BY NATHAN BANKS.

During the past few years the writer has received large series of spiders and daddy-longlegs from Costa Rica for identification. Most of these were collected and sent by Prof. J. Fid. Tristan, of San José. For a few years the late Dr. Paul Biolley sent me several lots, but soon turned the whole matter over to Prof. Tristan. Most of the specimens were collected at or near San José, but there are a considerable number from the Pacific slope of the country.

The majority of the species are of course already recorded by the *Biologia Centrali-America*, but about 70 species are new and about 20 more not treated in that work. A few species recorded from Costa Rica in the *Biologia* are not in the collections sent me. Many of the Costa Rican records in the *Biologia* are based on collections from Dr. Biolley and Prof. Tristan, although not expressly so stated in that work. The collection is similar to most tropical collections of spiders—a large number of Attidæ, Epeiridæ, and Clubionidæ, few Drassidæ and Thomisidæ. The number of Phalangida is truly remarkable.

The web-building species show a considerable number that also occur in our country, but of those not building webs there are very few that extend into our borders. About seven or eight are species commonly found in houses in the tropics of America.

Altogether there are 288 species, 65 of which are Epeiridæ, 48 Attidæ and 33 Phalangida. Records without any name are all from Prof. Tristan; elsewhere the collectors are given, "B. and T." signifying "Biolley and Tristan." Some species were collected by Mr. Picado; a few by Messrs Lankester and Maxon.

THERAPHOSIDÆ.

Eurypelma longipes Cambridge.

Biol. C. Am. Arachn. Aran., II, 21, 1897.

Machuca.

Eurypelma seemanni Cambridge.

Biol. C. Am. Arachn. Aran., II, 26, 1897.

Atenas, August (Picado), and Pozo Azal de Pirris (Pac.), 150 m., April (Biolley).

Eurypelma vagans Ausserer.

Verh. zool. bot. Ges. Wien, 1875, 197.

Uricuajo (Pac.), 200 m., January (B. and T.), and San Joaquin.

Tapinauchenius reduncus Karsch

Zeitschr. f. ges. Naturw., LIII, 387, 1880.

Turrijal, San José; Pacaca; Cangrial de Aserri; Rio Reventazon, near Santa Clara (Pac.), December (Biolley); Turrialba; and San José.

Sphærobothria hoffmanni Karsch.

Zeitschr. f. ges. Naturw., LII, p. 536, 1879.

Herran; and San José, in the houses and in trunks of old trees.

Schizopelma bicarinatum Cambridge.

Biol. C. Am. Arachn. Aran., II, 28, 1897.

Pacayas, N. de Cervantes (Atl.), March, 1,500 m. (Biolley).

Acanthopelma rufescens Cambridge.

Biol. C. Am. Arachn. Aran., II, 34, 1897.

Esparte (B.).

Ischnothele guianensis Walckenaer.

Hist. Nat. Apt., I, 23, 1837.

El Higuito, near San Mateo (Pac.), 230 m. (B. and T.); and Embouchure du Rio Jesus Maria (Pac.), January (B. and T.).

Hapalopus pentaloris Simon.

Ann. Soc. Ent. France, 1888, 216.

San José, under stones (B.); Aserri, February (B.); Atenas (Picado), and Salinas de Albina (Pac.), January (B. and T.).

Fufius atromentarius Simon

Ann. Soc. Ent. France, 1888, 213.

Machuca.

Pachylomerus rugosus Karsch.

Zeitschr. f. ges. Naturw., LIII, p. 388, 1880.

San José; and Santa Maria Dota, January, one with nest from the ground.

Metriopelma zebrata n. sp.

Carapace red-brown, clothed with golden or tawny hairs, most dense on the sides near margin. Legs, sternum, and venter black, black-haired, but the legs with some long tawny hairs. Abdomen black, with four nearly vertical golden bands on each side, reaching up to a middle golden area on dorsum; many long tawny hairs on the abdomen. Legs long and slender; with many spines on the hind pairs; tibiæ I and II of male without spurs, but with the two pairs of spines, as in the other species of the genus. Metatarsi I and II scopulate on apical half; tarsus IV with scopula divided by a row of hairs. Length 33 mm.

From Jesus Maria, Costa Rica (Biolley), and San Domingo de San Mateo (Maxon).

Metriopelma morosus n. sp.

Black; carapace reddish, venter black, coxæ and sternum dark red-brown. Clothed with fine red-brown hairs and long, erect bristles, hind legs with many spines, tarsus IV with scopula divided by a row of hairs; the long hairs on abdomen more tawny. Legs long and slender; tibiæ I and II each with two pairs of spines below, as in the other species of the genus, no spurs. Length 25 mm.

From Embouchure du Rio Jesus Maria, Platanal, Costa Rica, January (Biolley and Tristan). El Higuito, near San Mateo (Pac.), 250 m., January (B. and T.), and Uricuajo (Pac.), 200 m., January (B. and T.). Differs at once from the two known species by the shape of bulb of palpus.

FILISTATIDÆ.

Filistata hibernalis Hentz.

Spiders U. S., 23, 1875.

San José, in the houses; and Tiribi.

OÖNOPIDÆ.

Dysderina plena Cambridge.

Biol. C. Am. Arachn. Aran., I, 143, 1895.

La Palma.

SCYTODIDÆ.

Scytodes championi Cambridge.

Biol. C. Am. Arachn. Aran., II, 51, 1899.

From El Higuito, near San Mateo (Pac.), 200 m., January (B. and T.).

Scytodes fusca Walckenaer

Ins. Apt., I, 272, 1837.

Huacaste.

Scytodes intricata n. sp.

Cephalothorax yellowish, with black markings as indicated in the figure, very heavy behind; legs densely banded and spotted with black, the bands narrow, often oblique and sometimes connected to the spots; mandibles each with a black stripe curved outward near the tip. Abdomen densely streaked with black, a larger median black spot behind middle, and behind this the abdomen is pale with a few triangular black spots near the spinnerets, venter black on base extending back each side, median area pale; tips of coxæ black, sternum mostly black, a pale median stripe and some spots each side; vulva shows two plates each side similar to *S. longipes*, but farther apart, and not narrowed at base. Cephalothorax rather longer than in many species. Length 6.5 mm.

Specimens from Tegas de Cartágo (Tristan and Biolley), Tiribi (T.), San José (T.), Guayabo (Alfaro), Turricares (T.), Cartago (Picado), La Palma (T.), Surubres (B.), and Embouchure du Rio Jesus Maria (Pac.) (B. and T.).

DRASSIDÆ.

Echemus tropicalis n. sp.

Cephalothorax yellowish, A. M. E. on black spots; legs rather more brownish on basal joints; abdomen brown, venter paler brown; sternum and spinnerets yellowish. P. M. E. oval, about one diameter apart, closer to oval P. S. E., which nearly touch A. S. E.; A. M. E. one diameter apart, closer to the A. S. E. Sternum one and one-fourth times longer than broad, pointed behind. Legs rather long, a couple of small spines under tibiæ I and II, all femora with several spines above. Readily distinguished from *E. pedestris* by the P. M. E. well separated, and by the color of the legs, etc. Length 4.5 mm.

From Chiral Paraiso, Costa Rica (Tristan and Biolley).

CLUBIONIDÆ.

Trachelas morosus n. sp.

Cephalothorax, mandibles, and sternum red-brown; cephalothorax granulate, sternum nearly smooth, maxillæ without apical process, rounded at tip. Legs yellowish brown, leg I more red-brown, especially at base; abdomen dark brown, hairy, without scutum. By these characters it would be near the *T. spirifer* of the *Biologia*, but differs at once in the shape of the style to the palpal bulb, which here is short and stout; the tibial process is quite large and long. Length 7 mm.

One male from Aguas Caliente, Costa Rica (Picado).

Trachelas bispinosus Cambridge

Biol. C. Am. Arachn. Aran., II, 79, 1899.

La Palma; Tablazo; Santa Maria Dota; and Chiral Paraiso (B. and T.).

Trachelas similis Cambridge.

Biol. C. Am. Arachn. Aran., II, 80, 1899.

Tejar de Cartágo.

Corinna pictipes n. sp.

Cephalothorax dark red-brown, almost black, mandibles the same, sternum also; abdomen black, with a median triangular yellow spot, behind clothed with some yellowish hair; cephalothorax with some golden hair. Legs variegated; coxæ pale, trochanters with black spot in front and behind; femora black near base and near tip each side; patellæ dark near tip; tibiæ mostly brown, apical half of I and tip of IV pale, metatarsi and tarsi mostly pale brown. Cephalothorax nearly twice as long as wide, narrowed behind, above with a curved transverse furrow in front of the dorsal groove; the posterior eye-row is slightly procurved, the eyes almost equidistant; the mandibles large and slightly porrect; about six fine teeth on lower margin of fang groove; palpi long, very hairy and black, except the basal joint; the sternum is plainly longer than broad, and shows each side near coxæ I a distinct oval depression; abdomen elongate; legs slender, with few spines. Length 8 mm.

From Tejar de Cartágo, Costa Rica (Tristan).

Corinna modesta n. sp.

Carapace, sternum, and tips of legs red-brown, basal part of legs yellow-brown, mandibles nearly black; abdomen dark brown, paler beneath. Clypeus plainly higher than A. M. E.; six teeth on lower margin of the fang groove; sternum and legs not granulose; four pairs of spines under tibia I, no apicals, two under metatarsi, three pairs under tibia III; vulva with two circular cavities in a hard plate, this plate is punctate in front and on the sides. Length 10 mm.

From Santa María, Costa Rica (Tristan).

Corinna mucronata Cambridge.

Biol. C. Am. Arachn. Aran., II, 69, 1899.

San José; La Palma; Escazii; Tablazo (B.); and Cartágo (Picado).

Megalostrata formidabilis Cambridge.

Biol. C. Am. Arachn. Aran., I, 106, 1893.

Santa Maria Dota; Cartágo; and San José.

Clubiona tristani n. sp.

Carapace yellowish brown, darker in eye-region; mandibles red-brown; legs yellowish, metatarsi and tarsi darker. Abdomen black above, a pale median area to the middle, and a series of pale chevrons behind; venter pale. A. M. E. barely, if any, larger than the P. M. E., not one-half diameter apart and still nearer to the laterals; P. M. E. fully two diameters apart and about as far from the laterals; legs with long erect hairs, tibiæ I and II with 2–2–2 spines beneath, last apical, small; metatarsi with a pair at base; metatarsi and tarsi scopulate on legs I and II. Tibial spur of male palpus similar to that of *C. tricuspis*, but narrower and somewhat different at tip, as shown in the figure. Length 10 mm.

From Tablago, Costa Rica (Tristan).

Clubiona tigrina Cambridge.

Biol. C. Am. Arachn. Aran., I, 238, 1898.

San Joaquin Heredia Espinach; Santa Maria Dota; Tiribi; and Escazii.

Clubiona tumivulva n. sp.

Cephalothorax bright yellowish, more brownish in front, mandibles yellow-brown; legs and sternum pale yellowish, abdomen gray above, on posterior part with black marks, a median herring-bone mark and some spots on the upper sides, black. Legs I and II with a scopula below tarsi and metatarsi, and on the apical part of tibiæ. Vulva with a very broad median tongue, behind this the black area is greatly swollen out. Length 10 mm.

From Hatillo, Costa Rica (Picado). Differs from *C. tigrinus* by shape of vulva.

Chemmis frederici Simon.

Hist. Nat. Araign. (éd. 2), II, 215, 1898.

Santa Maria Dota; Tejar de Cartágo; San José; and Fortuna.

Chiracanthium ferum Cambridge.

Biol. C. Am. Arachn. Aran., I, 228, 1897.

Cartágo.

Pelayo insignis n. sp.

Cephalothorax yellowish, eye-region black, also the clypeus, extending back on each side a short distance; mandibles black; legs and palpi yellowish; abdomen yellowish, a black stripe on each anterior side, and a median black stripe, forked behind; behind it are two broad black chevrons, and then an apical spot, venter pale, with a broad median band from the lung-slits to the ventral furrow, extended slightly at each apical corner, and then a broad band from the furrow to the spinnerets, extended each side to the spinnerets. Posterior eye-row a trifle recurved, the P. M. E. farther from each other than from the equal P. S. E. Tibia I and II with 2–2–2 spines, last small, apical. Ventral furrow of abdomen much nearer to spinnerets than to base. Length 4.5 mm.

Volcan Poas, April, Costa Rica. The markings of abdomen are very characteristic.

Strotarchus minor n. sp.

Cephalothorax and legs yellow-brown, head darker; mandibles red-brown; abdomen above and below gray-brown; sternum yellow-brown; maxillæ and lip black, tip of palpus black. Legs long and slender, with few weak spines beneath, 2–2 under tibiæ I and II; vulva with large transverse concavity in front, behind is a chitinous ridge, and behind that is a curved dark line each side. Length 8 mm.

From Turrialba, Costa Rica (Tristan).

Aysha minuta Cambridge.

Biol. C. Am. Arachn. Aran., II, 99, 1900.

San José.

Aysha simplex Cambridge.

Biol. C. Am. Arachn. Aran., I, 227, 1897.

Anyphæna delicatula n. sp.

Cephalothorax yellowish, irregularly marked with blackish each side; eyes on black spots; abdomen pale, with many large grayish spots above nearly covering the dorsum; legs pale, slightly marked with black; sternum and venter pale. P. M. E. over one diameter apart, fully as far from the equal P. S. E.; A. M. E. plainly smaller than A. S. E. Tibiæ and metatarsi I and II with 2–2 spines beneath; abdomen rather short and broad, the ventral furrow at about middle of venter. Length 5 mm.

One female from Tablago, Costa Rica (Tristan).

Anyphæna plana Cambridge.

Biol. C. Am. Arachn. Aran., II, 97, 1900.

La Palma; and Poas Volcan.

Anyphæna simplex Cambridge.

Biol. C. Am. Arachn. Aran., I, 124, 1894.

San José.

Teudis elegans n. sp.

Cephalothorax brown, a median pale stripe from back of pars cephalica to tip, and a lateral pale stripe, much broken up in front; mandibles red-brown; legs yellowish, densely marked with small black spots, almost forming a band near the base of tibia, extreme bases of tibiæ (especially III and IV) are very pale. Abdomen brown, with four triangular median black spots from the middle to tip, the basal one is divided; venter pale; sternum dark, with pale median area. Posterior eye-row procurved, eyes equal; P. M. E. less than diameter apart, fully diameter from the laterals; A. M. E. very small; legs slender, tibiæ I and II with 2–2 spines beneath, no apical pair visible; metatarsi I and II with one pair of spines beneath; ventral furrow at middle of the venter. Length 5 mm.

From Tablago, Costa Rica (Tristan).

Teudis gentilis Cambridge.

Biol. C. Am. Arachn. Aran., I, 199, 1896.

San José.

Teudis bicolor n. sp.

Cephalothorax pale yellowish, legs and palpi pale, mandibles pale as also the sternum; abdomen olive-brown, above and below without markings. Eyes rather close together, posteriors equidistant; A. M. E. close together, and as near to larger A. S. E. The metatarsi I and II scopulate, and with one pair of long basal spines, and two laterals; all spines very long; legs long and slender; abdomen rather elongate. Length 10 mm.

From Aguas Caliente, Costa Rica (Picado).

Sillus putus Cambridge.

Biol. C. Am. Arachn. Aran., I, 200, 1896.

Tablazo.

Sillus longispina Cambridge.

Biol. C. Am. Arachn. Aran., II, 104, 1900.

From El Higuito, near San Mateo (Pac.), 200 m., January (B. and T.).

Eutichurus frontalis n. sp.

Cephalothorax pale yellow; mandibles black, paler on base; legs pale yellowish, tips of tarsi black; maxillæ black; sternum yellow; abdomen yellowish gray above and below. Cephalothorax rather broad and high in front, no dorsal groove; eye-rows broad; A. M. E. slightly larger than the S. E., posterior eyes subequal, the P. M. E. as far apart as from the P. S. E.; legs slender; mandibles high, not porrect; one spine under tibia I, a pair under base of metatarsus I; last joint of upper spinnerets long, but not as long as in *E. ferox*; vulva shows a large elliptical cavity. Length 8 mm.

From Aguas Caliente, January, Costa Rica (Picado).

HERSILIIDÆ

Tama mexicana Cambridge.

Biol. C. Am. Arachn. Aran., I, 107, 1893.

La Verbena; Surubres (B.); and San José, on the branches of trees.

AGALENIDÆ.

Agalena costata Cambridge.

Biol. C. Am. Arachn. Aran., II, 337, 1902.

Tejar de Cartágo (B. and T.); and Santa Maria Dota.

Agalena penetralis Cambridge.

Biol. C. Am. Arachn. Aran., II, 337, 1902.

Turrialba; Poas Volcano; Tiribi; Tablazo, September; Tejar de Cartágo (B. and T.); La Verbena; and San José (Picado).

Tegenaria sp.

Immature specimens from Tablazo and Fortuna.

Metafecenia albolineata Cambridge.

Biol. C. Am. Arachn. Aran., II, 356, 1902.

Tiribi.

DICTYNIDÆ.

Dictyna parietalis Cambridge.

Biol. C. Am. Arachn. Aran., I, 171, 1896.

San José, 5th July (Picado); and Tejar de Cartágo.

ULOBORIDÆ.

Uloborus geniculatus Olivier.

Encycl. Méthod., IV, 214, 1789.

La Verbena.

Uloborus spernax Cambridge.

Biol. C. Am. Arachn. Aran., I, 265, 1902.

Orosi, 6th July (Picado).

Uloborus plumipes Lucas.

Explor. Algér. Anim. Art., I, 252, 1849.

Orosi, 9th July (Picado).

Uloborus signatus Cambridge.

Biol. C. Am. Arachn. Aran., I, 264, 1898.

La Verbena.

PHOLCIDÆ.

Physocyclus dugesi Simon.

Ann. Soc. Ent. France, 1893, 320.

Santa Maria Dota; Tejar de Cartágo; Paraiso; and San José, a house spider.

Modisimus inornatus Cambridge.

Biol. C. Am. Arachn. Aran., I, 149, 1895.

La Palma.

THERIDIIDÆ.

Theridium fordum Keyserling.

Spinn. Amer. Therid., I, 23, 1884.

Santa Maria Dota; Tejar de Cartágo, July; Tiribi; La Verbena; Anonos, September; Fortuna; Escazii; Turrialba; La Bolca (Picado); Punta Arenas (Biolley); San Joaquin Heredia Espinach; San José, March; and Uricuajo (Pac.) (B. and T.).

Theridium oblivium Cambridge.

Biol. C. Am. Arachn. Aran., I, 207, 1896.

Tejar de Cartágo (B. and T.); La Palma; and La Verbena.

Theridium tæniatum Keyserling.

Spinn. Amer. Therid., I, 12, 1884.

Turrialba, Tablazo; and Escazii.

Theridium mixtum Cambridge.

Biol. C. Am. Arachn. Aran., I, 206, 1896.

Turrialba; Orosi, 2d July (Picado); and San Joaquin Heredia Espinach.

Theridium compressum Cambridge.

Biol. C. Am. Arachn. Aran., II, 383, 1902.

Orosi, 19th July (Picado).

Theridium florens Cambridge.

Biol. C. Am. Arachn. Aran., I, 205, 1896.

Tejar de Cartágo (B. and T.); Fortuna, with cocoon; Cartágo, July, with nest; and San José (Picado).

Theridium rufipes Lucas.

Explor. Algérie, Zool., III, 263, 1849.

Santa Maria Dota; and San José (B.).

Theridium fordulum n. sp.

Cephalothorax pale yellowish, a median black stripe over clypeus through eye-area, and back where it tapers to a point; sides with a broad black stripe. Abdomen dark brown, mottled with brown and black and many silvery white marks, these silvery marks faintly outline a median folium on the anterior part of the dorsum, from its ends a bright silvery line extends down on each side, behind on the middle is an interrupted silvery line to tip. Venter with a black mark, narrowed behind, sternum black, with a median pale streak. Legs pale, heavily marked with black, the joints with broad black bands at tip, and the rest of femur, tibia and metatarsus more or less dotted with black; the hind femora are mostly black beneath, mandibles pale, each with an inner dark line. Abdomen high and rounded. Metatarsus I about as long as tibia plus patella I. Length 2.5 mm.

Chiral Paraiso, Costa Rica (Tristan and Biolley).

Theridium biolleyi n. sp.

Cephalothorax pale, with a broad median black stripe from eyes to base, widened and then narrowed before middle, and with a lateral extension each side, margin narrowly black; legs pale, with rings and marks, mostly at middle and tip of joints, except tarsi. Dorsum dark gray and white, with black patches mostly to outline a pale median stripe; sternum dark, pale on each anterior side; venter pale, with some small white spots, and a pair of larger submedian black spots. Legs long, very bristly, tibia I a trifle shorter than the metatarsus I; abdomen moderately high, rather long. General structure as in *T. tepidariorum*; vulva shows two small openings as figured. Length 4 mm.

From Tablazo, Costa Rica (Biolley).

Theridium rostratum Cambridge.

Biol. C. Am. Arachn. Aran., I, 204, 1896.

Tejar de Cartágo (B. and T.).

Theridium thorelli Cambridge.

Biol. C. Am. Arachn. Aran., I, 132, 1894.

Ahaya (Picado); and Volcano Poas.

Theridium picadoi n. sp.

Cephalothorax brown, a broad dark-brown stripe on each lower side. Abdomen generally pale, with a large black spot on each anterior side, a smaller one behind it; on the dorsum behind the middle is a large black spot, emarginate in front. Sternum yellow-brown, with a median black streak, venter with a median black stripe, and the posterior of the side-marks reaches down on the venter. Legs dull yellowish, femora suffused black, with a paler spot above the tibia and metatarsus with a dark ring at tip; mandibles yellowish, each with two dark lines in front. Femora of legs rather heavy; metatarsus I hardly as long as tibia plus patella I; abdomen not especially high, rounded above. Length 3 mm.

From Orosi, Costa Rica, 18th July (Picado).

Anelosimus studiosus Hentz.

Journ. Bost. Soc. Nat. Hist., VI, 274, 1850.

Tejar de Cartágo (B. and T.); Aguas Calientes (Picado); Chiral (B. and T.); Anonos; Tablazo; and Escazii.

Dipœna micratula n. sp.

Cephalothorax pale yellowish, rather darker on the sides, eyes surrounded by black, palpi pale yellowish; legs yellowish on femora, rest greenish; abdomen greenish gray, a black spot above the spinnerets and a black median stripe on venter; sternum yellowish. Cephalothorax high; eyes rather large, A. M. E. larger than others; clypeus concave; abdomen short and broad, and high; legs slender, but short, finely hairy, palpi as figured. Length 1 mm.

Orosi, Costa Rica, 5th July (Picado).

Dipœna proba Cambridge.

Biol. C. Am. Arachn. Aran., I, 294, 1899.

Fortuna (B. and T.); and Chiral Paraiso (B. and T.).

Teutana grossa Koch.

Die Arachn., IV, 112, 1838.

Cartágo (Picado); and Turrialba, August.

Steatoda americana Cambridge.

Biol. C. Am. Arachn. Aran., II, 377, 1902.

Anonos, September.

Lithyphantes hermosa n. sp.

Cephalothorax and legs reddish, femora more purplish; abdomen purplish, with two oblique white bands each side, and a pale area behind near tip; venter purplish, with a white crescent-like mark in front of the spinnerets; sternum reddish. Legs short; abdomen broadest and rather highest behind. Vulva showing two circular orifices, fully their diameter apart. Length 3.2 mm.

Punta Arenas, Costa Rica (Biolley).

Argyrodes americanus Taczanowski.

Hor. Soc. Ent. Ross., X, 62, 1873.

Tejar de Cartágo (B. and T.); La Verbena, March; Anonos, September; and Orosi, 2d July (Picado).

Argyrodes maculosus Cambridge.

Biol. C. Am. Arachn. Aran., I, 258, 1898.

Santa Maria Dota.

Neriene maculosa n. sp.

Cephalothorax orange, eyes on black spots, legs pale yellow, coxæ and mandibles orange, sternum also orange; abdomen brown, a faint paler median area, which, behind the middle, is more definite and margined by two black streaks to tip of abdomen, rest of the dorsum spotted with white, most of the spots on the upper sides; venter dark, with a few white spots, and each side a little beyond ends of lung-slits is a larger white spot. Vulva as figured for *N. convexa* and *emarginata*; a pair of cavities separated by a median septum, which behind shows a short tongue. Abdomen of female rather broad, pointed behind, much like a *Europis*. Length 3 mm.

From Cartágo, Costa Rica, 1st July (Picado). A male that may belong to the species is from Orosi, 2d July.

Neriene gamma Cambridge.

Biol. C. Am. Arachn. Aran., II, 419, 1902.

San José.

Neriene bisignata n. sp.

Cephalothorax and mandibles yellowish-brown; legs paler, posterior sides of cephalothorax rather darker, eyes on black spots, sternum, venter and palpal organ black; dorsum of abdomen mostly white, a median black stripe and some lateral and apical marks as figured. Legs very slender, especially the tarsi; palpus with a slender, curved, basal hook, an apical pointed process and a more slender style, pointing toward the process. A female has the abdomen marked the same, but the cephalothorax is dark brown. Length 3 mm.

From Aguas Caliente, January (Tristan), and San José, in *Bromelia* (Picado), Costa Rica.

Neriene postica n. sp.

Cephalothorax pale yellowish in the middle, dark on sides; sternum black; abdomen greenish gray, with some cretaceous white spots, and dark marks as figured, the tip conical and jet black; venter black, a white spot each side at base of the spinnerets; legs greenish yellow. Cephalothorax narrow, head high; posterior middle eyes very large, situate on tubercles, one and one-half diameter apart, about one diameter from the laterals. Length 2.5 mm.

From Orosi, 5th June, Costa Rica (Picado).

Frontinella communis Hentz.

Journ. Bost. Soc. Nat. Hist., VI, 28, 1847.

La Palma.

MIMETIDÆ.

Mimetus rapax Cambridge.

Biol. C. Am. Arachn. Aran., I, 296, 1899.

Turrialba; and Escazii.

EPEIRIDÆ.

Tetragnatha alba Cambridge.

Biol. C. Am. Arachn. Aran., II, 432, 1902.

San José (B. and T.); La Bolca (Picado); and Aguas Calientes (Picado).

Tetragnatha antillana Simon.

Proc. Zool. Soc. Lond., 1897, 868.

San José; La Verbena; San Joaquin; and Tejar de Cartágo.

Tetragnatha guatemalensis Cambridge.

Biol. C. Am. Arachn. Aran., I, 8, 1889.

San José; and Santa Maria Dota.

Tetragnatha mexicana Keyserling.

Verh. zool. bot. Ges. Wien, 1865, 854.

La Verbena.

Tetragnatha confraterna n. sp.

Cephalothorax pale, with indication of a broad stripe over head, divided by a pale median line. Abdomen dark, rather swollen at base, and at tip above is slightly projecting; legs of male very pale, of female darker. Anterior side-eyes plainly smaller and well separated from the posterior side-eyes; anterior median eyes larger than all others. Mandibles porrect, elongate; in female nearly as long as the cephalothorax, the outer corner below with a strong tooth; the male mandibles are about as long as the cephalothorax, slightly divergent, toothed as in the figure; the tibia and patella of palpus of equal length. Length 10–12 mm.

From Machuca (Biolley), Escazii (Tristan), Tiribi (Tristan), and Esparte (Biolley); all Costa Rica.

Tetragnatha tenuissima Cambridge.

Biol. C. Am. Arachn. Aran., I, 9, 1889.

Tejar de Cartágo; and Orosi (Picado).

Tetragnatha tropica Cambridge

Biol. C. Am. Arachn. Aran., I, 11, 1889.

Guanacaste (Lankester).

Tetragnatha tristani n. sp.

Cephalothorax pale yellowish, abdomen rather silvery above; venter and sternum blackish; legs pale, greenish yellow, tips of tibiæ and metatarsi darker; S. E. touching, the lower one much the smaller; abdomen not very slender; mandibles not very long, nor much porrect, a tooth above before tip, not very long, and three subequal teeth on inner margin. It runs to *T. digitata* in the *Biologia*, having the tibia of palpus extremely short, but differs in the mandibles. Length 4 mm.

San José (Tristan).

Agriognatha bella Cambridge

Biol. C. Am. Arachn. Aran., I, 213, 1896.

Machuca (B.).

Dolichognatha tuberculata Keyserling

Spinn. Amer. Epeirid., 265, 1893.

Turrialba.

Azilia guatemalensis Cambridge.

Biol. C. Am. Arachn. Aran., I, 12, 1889.

Embouchure du Rio Jesus Maria (Pac.), January (B. and T.).

Nephila clavipes Linné.

Syst. Nat. (XII), 1034, 1767.

Rio Reventazon, Plaines de Santa Clara, December (B.); and Embouchure du Rio Jesus Maria (Pac.), January (B. and T.).

Metargyra debilis Cambridge.

Biol. C. Am. Arachn. Aran., I, 5, 1889.

La Palma.

Leucauge moerens Cambridge.

Biol. C. Am. Arachn. Aran., I, 185, 1896.

Turrialba.

Leucauge fragilis Cambridge.

Biol. C. Am. Arachn. Aran., I, 6, 1889.

Embouchure du Rio Jesus Maria (Pac.), January (B. and T.).

Leucauge hortorum Hentz.

Journ. Bost. Soc. Nat. Hist., V, 477, 1847.

Santa Maria Dota; Tejar de Cartágo (B. and T.); La Verbena; and Cartágo, 8th July (Picado).

Leucauge acuminata Cambridge.

Biol. C. Am. Arachn. Aran., I, 5, 1889.

Turrialba (Picado).

Pseudometa bella n. sp.

Cephalothorax yellowish, with a median black streak from eyes to near base, its anterior part geminate by a pale line. Legs pale yellowish, tips of tibiæ darker; sternum black; abdomen whitish on sides, in middle above is a broad blackish stripe, including a pair of pale spots; venter black in the middle, white on sides, and a white dot each side near the spinnerets. Length 3 mm.

From Santa Maria, Costa Rica (Tristan).

Pseudometa alboguttata Cambridge.

Biol. C. Am. Arachn. Aran., I, 2, 1889.

Tablazo.

Pseudometa decolorata Cambridge.

Biol. C. Am. Arachn. Aran., I, 3, 1889.

Orosi, in *Bromelia karatos*, 2d July (Picado).

Argiope argentata Fabricius.

Ent. Syst., II, 414, 1793.

Salinas de Albina (Pac.), January (B. and T.); El Higuito, near San Mateo (Pac.), 250 m., January (B. and T.); Uricuajo (Pac.). January (B. and T.); Chiral Paraiso (B. and T.); San José (B.); and Punta Arenas (B.).

Argiope personata Cambridge.

Biol. C. Am. Arachn. Aran., I, 110, 1892.

Chiral (B. and T.); and San Jesus.

Cyclosa walckenaeri Cambridge.

Biol. C. Am. Arachn. Aran., I, 47, 1889.

Chiral Paraiso (B. and T.); and El Higuito, near San Mateo (Pac.), 250 m., January (B. and T.).

Cyclosa conica Pallas.

Spicil. Zool., I, 48, 1772.

San José.

Cyclosa caroli Hentz.

Journ. Bost. Soc. Nat. Hist., VI, 24, 1850.

Tejar de Cartágo; San Joaquin Heredia Espinach; and Orosi, 6th July (Picado).

Cyclosa index Cambridge.

Biol. C. Am. Arachn. Aran., I, 51, 1889.

Aguas Calientes, July (Picado); La Fortuna; Cartágo; Santa Maria Dota; and Chiral Paraiso (B. and T.).

Mangora trilineata Cambridge.

Biol. C. Am. Arachn. Aran., I, 14, 1889.

Orosi, 2d July (Picado).

Mangora spinula Cambridge.

Biol. C. Am. Arachn. Aran., II, 480, 1903.

Orosi, 9th July (Picado).

Mangora picta Cambridge.

Biol. C. Am. Arachn. Aran., I, 14, 1889.

Orosi (Picado).

Eriophora purpurascens Cambridge.

Biol. C. Am. Arachn. Aran., I, 33, 1889.

San José (B.); and Surubres, near San Mateo (Pac.), 250 m., February (B.).

Eriophora edax Blackwall.

Ann. Mag. Nat. Hist. (3), XI, 30, 1863.

San José, Punta Arenas (B.); Surubres (B.); and Hatillo, 9th June (Picado).

Eriophora minax Cambridge.

Biol. C. Amer. Arachn. Aran., I, 112, 1893.

San José; Anonos, September; Atenas, August (Picado); Embouchure du Rio Jesus Maria (Pac.), January (B. and T.); and Surubres, near San Mateo (Pac.), 250 m., February (B. and T.).

Eriophora bivariolata Cambridge.

Biol. C. Am. Arachn. Aran., I, 27, 1889.

San José; and La Verbena.

Eriophora nephiloides Cambridge.

Biol. C. Am. Arachn. Aran., I, 32, 1889.

San José, 9th October (Picado); and Tiribi.

Epeira pallidula Keyserling.

Sitzungsb. Nat. Ges. Isis, Dresden, 1863, 124.

Turrialba.

Epeira anguinifera Cambridge.

Biol. C. Am. Arachn. Aran., II, 514, 1904.

Turrialba.

Epeira fuscovittata Keyserling.

Sitzungsb. Nat. Ges. Isis, Dresden, 1863, 129.

La Verbena; El Higuito, near San Mateo (Pac.), January, 250 m. (B. and T.); Surubres, February.

Epeira scutigera Cambridge.

Biol. C. Am. Arachn. Aran., I, 243, 1898.

San José; Aguas Calientes (Picado).

Epeira vulgaris Hentz.

Journ. Bost. Soc. Nat. Hist., V, 469, 1847.

San José, very common house spider; Escazii; Uricuajo (Pac.), 200 m., January (B. and T.).

Epeira solersioides Cambridge.

Biol. C. Am. Arachn. Aran., I, 25, 1889.

El Higuito, near San Mateo (Pac.), 250 m., January (B. and T.).

Epeira minima Cambridge.

Biol. C. Am. Arachn. Aran., II, 471, 1904.

Escazii.

Epeira domiciliorum Hentz.

Journ. Bost. Soc. Nat. Hist., V, 469, 1847.

San José.

Epeira detrimentosa Cambridge.

Biol. C. Amer. Arachn. Aran., I, 26, 1889.

San José (B.); El Higuito, near San Mateo (Pac.), 250 m., January (B. and T.).

Epeira globosa Keyserling.

Verh. zool. bot. Ges. Wien, 1865, 820.

El Higuito, near San Mateo (Pac.), 250 m., January (B. and T.).

Epeira incerta Cambridge.

Biol. C. Am. Arachn. Aran., I, 23, 1889.

San José, abundant house spider; Fortuna (T. and B.); Cartágo, 8th July (Picado); Tiribi; La Verbena; Surubres (B.); Aguas Calientes (Picado); Anonos, September; Machuca (B.); San Joaquin Heredia Espinach.

Epeira gravabilis Cambridge.

Biol. C. Am. Arachn. Aran., I, 33, 1889.

Volcan Poas, March.

Epeira microsoma n. sp.

Male; cephalothorax yellowish, eyes on black spots; legs yellowish, femora and tibiæ darkened on apical half; abdomen yellowish brown, with an indistinct, broad, dark brown median area, containing a pair of small yellow spots; sternum pale. Abdomen twice as long as broad; legs not thickened, and without groups of spines. The male palpus shows a curved black piece at apex, and on the inner side a plate with two prominent black teeth. A female (probably of this species) has the legs and body more unicolorous, sternum darker; abdomen nearly round. The smallest *Epeira* known to me. Length ♂ 2 mm., ♀ 2.2 mm.

From La Palma, on bushes, Costa Rica (Tristan).

Epeira anastera Walckenaer.

Ins. Apt., II, 33, 1842.

La Verbena, in nest of a mud-dauber wasp.

Epeira smithi Cambridge.

Biol. C. Am. Arachn. Aran., I, 280, 1898.

Santa Maria Dota.

Epeira bifida Cambridge.

Biol. C. Am. Arachn. Aran., II, 507, 1904.

La Verbena, in nest of mud-dauber wasp; Rio Jesus Maria (Pac.), January (B. and T.), in nest of a Hymenopteron.

Metepeira labyrinthea Hentz.

Journ. Bost. Soc. Nat. Hist., V, 471, 1847.

San José; and Anonos, September.

Metazygia gregalis Cambridge.

Biol. C. Am. Arachn. Aran., I, 22, 1889.

San José, very abundant (B.); La Verbena; Tiribi.

Larinia directa Hentz.

Journ. Bost. Soc. Nat. Hist., V, 478, 1847.

Machuca (B.); Surubres, near San Mateo (Pac.), 250 m., January (B. and T.); and El Higuito, near San Mateo (Pac.), (B. and T.).

Mahadiva 11-variolata Cambridge.

Biol. C. Am. Arachn. Aran., I, 53, 1889.

Aguas Calientes, July (Picado).

Acrosoma gracilis Walckenaer.

Tabl. des Aran., 65, 1805.

Uricuajo (Pac.), 200 m., January (B. and T.).

Acrosoma obtusispina Keyserling.

Sitzungsb. Nat. Ges. Isis, Dresden, 1863, 76.

Tiribi; Machuca (B.); Rio Jesus Maria (Pac.), January (B. and T.); El Higuito, near San Mateo (Pac.), 250 m., January (B. and T.).

Acrosoma inæqualis Cambridge.

Biol. C. Am. Arachn Aran., II, 535, 1904.

La Verbena, near San José.

Acrosoma triserrata Cambridge.

Biol. C. Am. Arachn. Aran., II, 534, 1904.

Tablazo.

Acrosoma patruelis Koch.

Die Arachn., VI, 130, 1839.

Turrialba; Orosi, 2d July (Picado).

Acrosoma fidelis n. sp.

Cephalothorax yellowish, legs more reddish; abdomen clear yellow above, darker on sides and behind, tips of spines black. Abdomen about twice as long as broad, not very much broader behind, where it is furcate, each corner terminating in two small equal spines, one above the other; on each side of dorsum are two spines, one small beyond middle, the other one larger before middle, none in front. Length 6 mm.

From Tablazo, September, Costa Rica (Tristan). Differs from nearly all the species which have two spines at each posterior corner in lacking spines at anterior corners. *A. bisicata* Walck., which seems allied, has ten spines.

Acrosoma 12-spinosa Cambridge.

Biol. C. Am. Arachn. Aran., I, 63, 1890.

Machuca (B.); Pitahaya, August (Picado); Embouchure du Rio Jesus Maria (Pac.), January (B. and T.)

Acrosoma sexspinosa Hahn.

Die Arachn., II, 18, 1834.

Surubres (B.); Embouchure du Rio Jesus Maria (Pac.); January (B. and T.).

Acrosoma mammillata Butler.

Proc. Zool. Soc. Lond., 1873, 427.

Esparta (Pac.), 50 m., January (B.).

Gasteracantha kochi Butler.

Trans. Ent. Soc. Lond., 1873, 169

Punta Arenas (B.); San José, abundant on coffee plantations; Guadelupe, July (Picado); San Joaquin Heredia Espinach; Hatillo, 8th June (Picado); Embouchure du Rio Jesus Maria (Pac.), January (B. and T.).

Tricantha tricornis Simon.

Hist. Nat. Araign. (I ed.), 293, 1864.

Tablazo.

SPARASSIDÆ.

Strophius hirsutus Cambridge.

Biol. C. Am. Arachn. Aran., I, 87, 1891.

Turrialba.

Heteropoda venatoria Linné.

Syst. Nat. (XII), 1035, 1767.

Punta Arenas (B.); Surubres, near San Mateo (Pac.), January (B. and T.).

Selenops mexicanus Keyserling.

Spinn. Amer. Laterg., 223, 1880.

San José, in houses; Escazii; Pacaca; San Joaquin Heredia Espinach; Uricuajo (Pac.), 200 m., January (B. and T.); El Higuito, near San Mateo (Pac.), January (B. and T.); Canorejal de Asseri (Pac.), 800 m., April (B.).

Selenops bifurcatus n. sp.

Cephalothorax yellow; eyes on black spots; abdomen brown; legs yellow, banded with black; sternum and venter pale. Length ♂, 10 mm. Known by the forked apophysis of the tibia of male palpus. A female is about of the same size; the vulva is very similar to that of *S. mexicanus*, but narrower.

Uricuajo (Pac.), 200 m., January (B. and T.).

Sparassus obscurus Keyserling.

Spinn. Amer. Laterg., I, 255, 1880.

Surubres, near San Mateo (Pac.), 250 m., February (B. and T.).

Sparassus audax n. sp.

Male, pale yellowish; abdomen with some black marks above more or less in lines; tips of tarsi and of palpi darker; venter sometimes showing a median black area. Female, more yellowish brown; abdomen more spotted, a faint, basal, median line; venter with a broad, black middle area; mandibles blackish, with two black lines; tarsi and metatarsi infuscate. Anterior eye-row straight, M. E. large; legs very long. Differs from *S. simoni* by lack of black at tips of femora and tibiæ, and from all males by shape of the palpus. Length ♀ 15 mm., ♂ 12 mm.

Punta Arenas (B.); Santa Maria Dota (T.); San José (T.), Chiral Paraiso (B. and T.); Orosi (Picado); El Higuito, near San Mateo (Pac.) (B. and T.), and Surubres, near San Mateo (Pac.), 250 m. (B. and T.), February.

Sparassus crassus n. sp.

Wholly pale yellowish; mandibles and venter pale; legs very long and slender. Easily known by the extremely heavy tibial apophysis, as shown in the figure. Length ♂, 10 mm.

San Joaquin Heredia Espinach, February (T.)

Epicadus granulatus n. sp.

Eyes arranged as in this genus; carapace with a raised point at the dorsal groove. Abdomen high; dorsum hard, and with many small granules and tubercles of irregular size, also small ones on the cephalothorax. Legs I and II equal; no median apical spine to metatarsi; tibiæ I and II with 2–2 spines, metatarsi I and II with 2–2–2 spines; legs roughened and granulate. Length 18 mm.; abdomen high 13 m.

Surubres (Biolley), Costa Rica.

THOMISIDÆ.

Xysticus advectus Cambridge.

Biol. C. Am. Arachn. Aran., I, 71, 1890.

Cartágo (Picado).

Synema affinitatum Cambridge.
Biol. C. Am. Arachn. Aran., I, 82, 1891.

Tablazo; La Palma.

Synema maculosum Cambridge.
Biol. C. Am. Arachn. Aran., I, 81, 1891.

La Palma, on the shrubs.

Bassania æmula Cambridge.
Biol. C. Am. Arachn. Aran., I, 249, 1898.

Turrialba.

Runcinia magna Keyserling.
Spinn. Amer. Laterg., 125, 1880

Uricuajo (Pac.), 200 m., January (B. and T.).

Misumena asperata Hentz.
Journ. Bost. Soc. Nat. Hist., V, 447, 1847.

Cartágo (Picado).

Apollophanes punctipes Cambridge.
Biol. C. Am. Arachn. Aran., I, 79, 1891.

Los Anonos, September; Tiribi; San José (Picado).

PISAURIDÆ.

Enna velox Cambridge.
Biol. C. Am. Arachn. Aran., I, 232, 1897.

Pacaca.

Thaumasia nigrinus Cambridge.
Biol. C. Am. Arachn. Aran., II, 310, 1901.

Herbesan, San José, February (B.); La Verbena; San José.

Lycoctenus bogotensis Keyserling.
Verh. zool. bot. Ges. Wien, 1877, 681.

Esparta (B.); Surubres, near San Mateo (Pac.), 250 m., February B.), under stones on bank of river.

Cupiennius sallei Keyserling.
Verh. zool. bot. Ges. Wien, 1877, 685.

Pacaca; Surubres, near San Mateo (Pac.); 250 m., February (B.).

Cupiennius minimus n. sp.

Cephalothorax brown on central region, paler on the sides, abdomen with large broad folium above, sometimes (in two specimens) truncated behind by a broad pale spot. Venter pale, no median stripe; legs mottled with blackish above, no speckles beneath. Abdomen is much broader than in *C. foliatus*; vulva as figured. It is the smallest species, only 12 to 14 mm. long in female.

Sta. Maria Dota, Costa Rica.

Cupiennius foliatus Cambridge.

Biol. C. Am. Arachn. Aran., II, 307, 1901.

Turrialba; La Palma.

Cupiennius getazi Simon.

Bull. Soc. Zool. France, 1891, 110

San José; Turrialba, May.

Cupiennius griseus Cambridge.

Biol. C. Am. Arachn. Aran., II, 307, 1901.

Tablazo; Sta. Maria Dota.

Trechalea convexa Cambridge.

Biol. Cent. Am. Arachn. Aran., I, 233, 1898.

Sta. Maria Dota; Turricares, February; Tiribi; Pacaca; Uricuajo (Pac.); Rio Jesus Maria (Pac.) (B. and T.); El Higuito, near San Mateo (Pac.), January (B. and T.); Surubres, near San Mateo (Pac.), February (B.), under stones.

CTENIDÆ.

Ctenus sinuatipes Cambridge.

Ann. Mag. Nat. Hist. (6), XIX, 84, 1897.

Aguas Calientes (Picado); La Palma; San José, in houses; San Joaquin Heredia Espinach; La Carpintera, 1,500 m., October (Alfaro); Estacion de Turrialba (Maxon); El Higuito, near San Mateo (Pac.), January, 250 m. (B. and T.).

Ctenus spiralis Cambridge.

Biol. C. Am. Arachn. Aran., II, 112, 1900.

Surubres, near San Mateo (Pac.), 250 m., February (B. and T.).

Ctenus incolans Cambridge.

Biol. C. Am. Arachn. Aran., II, 111, 1900.

Huacas (Pac.).

Ctenus supinus Cambridge.

Biol. C. Am. Arachn. Aran., II, 110, 1900.

La Verbena.

Ctenus convexus Cambridge.

Biol. C. Am. Arachn. Aran., II, 114, 1900.

Pacaca; Sta. Maria Dota.

Ctenus peregrinus Cambridge.

Biol. C. Am. Arachn. Aran., II, 110, 1900.

San José, on the walls of houses; Turrialba; Pacaca; Tejar de Cartágo.

Acanthoctenus spinipes Cambridge.

Verh. zool. bot. Ges. Wien, 1876, 695.

Tiribi; San José (B. and T.); Salvinas de Attina (Pac.), January (B. and T.).

LYCOSIDÆ.

Sosippus agalenoides n. sp.

Cephalothorax brown; a very narrow, median pale line, sides narrowly pale, mandibles jet black on front, a narrow line of yellow hair each side, palpi black at tip; legs pale yellowish, tarsi and metatarsi blackish, sternum and coxæ pale yellowish. Abdomen pale grayish yellow above, with a brown median stripe from base to tip, not outlined by pale, but with a few pale spots on anterior sides, and behind this it is dentated; venter wholly pale. Length 22 mm.

From Punta Arenas, Costa Rica (Biolley). Differs from *S. mexicanus* in larger size, different abdominal markings, rather broader cephalothorax, and in the shape of the vulva.

Sosippus mexicanus Simon.

Ann. Soc. Ent. France, 1888, 206.

El Higuito, near San Mateo (Pac.), January (B. and T.).

Arotosa trifida Cambridge.

Biol. C. Am. Arachn. Aran., II, 330, 1902.

Embouchure du Rio Jesus Maria, January (B. and T.).

Arctosa minuta Cambridge.

Biol. C. Am. Arachn. Aran., II, 331, 1902.

Tiribi; San José; Embouchure du Rio Jesus Maria (Pac.), January (B. and T.).

Lycosa insignis Cambridge.

Biol. C. Am. Arachn. Aran., I, 272, 1898.

Punta Arenas (B.); San Joaquin Heredia Espinach, in the pastures.

Lycosa longitarsis Cambridge.

Biol. C. Am. Arachn. Aran., II, 327, 1902.

Guanacaste (Lankester); Atenas (Picado); San José; San Joaquin Heredia Espinach.

Lycosa brevitarsis Cambridge.

Biol. C. Am. Arachn. Aran., II, 327, 1902.

San José; Sta. Maria Dota.

Lycosa signiventris n. sp.

Cephalothorax brown, head black; a pale narrow median stripe rom head to base, side margins narrowly pale, a short curved pale stripe each side under dorsal eye reaching forward; mandibles with tawny yellow hairs, except black along inner side, showing a broad median black stripe, each side tawny; legs pale brown to middle, rest darker, femora with a black mark below at tip, a narrow one at base of tibiæ and middle of tibiæ and beyond nearly black; tibiæ III and IV pale beneath, with a black mark at base and at tip; coxæ and sternum pale, the former infuscated. Abdomen pale above, with a larger, black, basal spear-mark, followed by many small dots and many lateral dots and marks; base of venter to furrow pale, beyond covered with a large, deep-black mark, having each side of the middle a clear pale elongate spot. Length 27 mm.

From San Joaquin (Tristan). The common name is "Pica caballo."

Lycosa subfusca Cambridge.

Biol. C. Am. Arachn. Aran., II, 325, 1902.

Huacas (Pac.).

Lycosa morosina n. sp.

Cephalothorax with a broad bright yellowish-brown stripe on middle, black in the eye-region, brown on sides, with indications of some pale spots near margin; palpi yellowish, basal joint brown; legs dark brown on femora, yellowish beyond; mandibles yellowish brown, with some yellowish hairs. Sternum black, coxæ blackish; abdomen dark brown, a black mark over base followed by a broad pale yellowish mark, not extending far each side; venter black on sides, pale in the middle with a median black stripe from vulva to spinnerets. Legs long and slender, especially leg IV, anterior eye-row procurved, much narrower than second row, three pairs of spines under tibiæ and metatarsi I and II. Vulva with two cavities in front, and a basal plate behind. Near to *L. dilatata* of the "Biologia," but the vulva is very different. Length 8 mm.

One from Turrialba, August, Costa Rica (Picado).

Lycosa brunnea Cambridge.

Biol. C. Am. Arachn. Aran., II, 325, 1902.

Embouchure du Rio Jesus Maria (Pac.), January (B. and T.).

Lycosa tristani n. sp.

Cephalothorax brown, a broad pale median stripe, slightly broadened a little behind the eye-region, then tapering to tip; abdomen brown on middle, with a broad median spot of yellowish hair, with a median dark spear-mark in front and some spots behind, venter with rather golden yellow hair, and a basal dusky streak, sides darker; sternum pale, but with a broad dark streak through the middle; legs yellowish, marked with brown, golden hair around eyes, and some in front of the brown mandibles. Anterior eye-row procurved, and shorter than the second row; legs slender, especially the hind tarsi. Male has the sternum and coxæ black; legs mostly black, tarsi, metatarsi, and apical half of the tibia pale; venter as in the female; the tibia of the palpus is enlarged. Length 8 mm.

From Turrialba, Costa Rica (Tristan).

Lycosa biolleyi n. sp.

Cephalothorax brown, with three pale stripes, the lateral rather narrow, the median broad and not constricted, narrowed between dorsal eyes, and here it contains a median black line; mandible red-brown; legs yellowish, faintly maculate with brown and blackish, quite distinct on the hind femora. Abdomen black above, paler beneath. Cephalothorax rather long; anterior eye-row a little narrower than the second row; legs long and slender, metatarsi IV about as long as the cephalothorax; tibiæ I and II with 2–2–2 spines. Vulva very characteristic. Length 10 mm.

From Tablazo, Costa Rica (Biolley).

Pardosa falcifera Cambridge.

Biol. C. Am. Arachn. Aran., II, 318, 1901.

Tejar de Cartágo; San Isidro; Sta. Maria Dota; Turrialba, August (Picado); La Palma, very common in the grass.

Pardosa uncatula Cambridge.

Biol. C. Am. Arachn. Aran., II, 319, 1902

Tablazo.

Pardosa prolifica Cambridge.

Biol. C. Am. Arachn. Aran., II, 317, 1902.

La Bolca, January (Picado); Cartágo (B.); San José; Tablazo.

OXYOPIDÆ.

Peucetia viridans Hentz.

Journ. Bost. Soc. Nat. Hist., V, 195, 1845.

San José; Punta Arenas (B.); Jesus Maria (B.); Uricuajo (Pac.), 200 m., January (B. and T.); El Higuito, near San Mateo (Pac.), 250 m., January (B. and T.).

Oxyopeidon putum Cambridge.

Biol. C. Am. Arachn. Aran., I, 140, 1894.

Anonos, September.

ATTIDÆ.

Phidippus chrysis Walckenaer.

Ins. Apt., I. 454, 1837.

Pitahaya, August (Picado).

Phidippus marmoratus Cambridge.

Biol. C. Am. Arachn. Aran., II, 276, 1901.

La Verbena; Tiribi; San José, nests on leaves of trees; Embouchure du Rio Jesus Maria (Pac.), January (B. and T.).

Phidippus funebris Banks.

Proc. Calif. Acad. Sci. (3), I, 280, 1898.

San José (B.); Tablazo, September; Tiribi.

Phidippus disjunctus Banks.

Proc. Calif. Acad. Sci. (3), I, 281, 1898.

La Bolca, June (Picado).

Phidippus incontesta n. sp.

Cephalothorax and mandibles dark red-brown; abdomen brown, with metallic scales, several black spots each side. Leg I blackish, except on metatarsus and tarsus which are pale yellow; other legs yellowish-brown, darker at tips of joints; leg I with fringe of black hair beneath. Sternum red-brown; venter paler reddish-brown; mandibles brown; rather porrect, with a large straight tooth near inner base. Second row of eyes half-way to dorsal eyes. Length 6 mm.

From Tablazo, Costa Rica (Tristan).

Phidippus luteus Peckham.

Occas. Papers Nat. Hist. Soc. Wisc., III, 40, 1896.

San José, a young specimen.

Dendryphantes quadrinotatus Cambridge.

Biol. C. Am. Arachn. Aran., II, 271, 1901.

Aguas Calientes (Picado).

Dendryphantes digitatus Cambridge.

Biol. C. Am. Arachn. Aran., II, 269, 1901.

Chiral Paraiso.

Dendryphantes globosus Cambridge.

Biol. C. Am. Arachn. Aran., II, 265, 1901.

La Palma.

Dendryphantes bispinosus Cambridge.

Biol. C. Am. Arachn. Aran., II, 266, 1901.

Sta. Maria Dota; Chiral Paraiso.

Dendryphantes lanceolatus Cambridge.

Biol. C. Am. Arachn. Aran., II, 266, 1901.

La Verbena, March.

Dendryphantes octonotatus Cambridge.

Biol. C. Am. Arachn. Aran., II, 263, 1901.

Fortuna (B. and T.); Aguas Calientes (Picado); Hatillo (Picado); Turrialba.

Dendryphantes comptus n. sp.

Cephalothorax red-brown, a broad white stripe on each side, margin red-brown; abdomen red-brown in middle, the sides of which are indented three times behind, upper sides white, lower sides with brown stripe; venter red-brown in middle, sides pale; sternum red-brown. Leg I brown, pale on tarsus and base of metatarsus; other legs yellow, femora with a brown streak each side, and brown bands at tips of patella, tibia, and metatarsus. Length 3 mm.

From Aguas Calientes, Costa Rica (Picado).

Dendryphantes pallens Cambridge.

Biol. C. Am. Arachn. Aran., II, 272, 1901.

La Palma.

Sidusa spiralis Cambridge.

Biol. C. Am. Arachn. Aran., II, 217, 1901.

La Verbena, March; Tablazo.

Sidusa tarsalis n. sp.

Cephalothorax dark red-brown, abdomen blackish, with an oblique white streak on each anterior side, and behind is a broad oblique white mark each side, not meeting in middle; venter blackish; sternum dark red-brown; legs with the femora and tarsi dark red-brown, the other joints pale reddish, especially pale on legs I and II; in legs III and IV the tibia and base and tip of metatarsi dark; palpi pale reddish-yellow except the dark brown basal joint; mandibles red-brown. Length 8.5 mm.

Salinas de Albina (Pac.), January (Biolley and Tristan).

Sidusa sulphurea Cambridge.

Biol. C. Am. Arachn. Aran., II, 218, 1901.

Orosi, 2d July (Picado).

Sidusa conspecta Peckham.

Occas. Papers Nat. Hist. Soc. Wisc., III, 12, 1896.

Tiribi.

Sidusa femoralis n. sp.

Head black; behind are two large oval yellow spots, leaving a median black stripe. Abdomen with a broad median black stripe from base to tip, tapering behind and there indented from the sides; the sides pale grayish, with some black streaks; venter pale, mottled with black; sternum red-brown. Leg I mostly red-brown, tarsus yellowish; leg II more mottled, the patella yellowish above; legs III and IV with mostly dark femora, rest pale, tips of tibia and metatarsus black. Length 3.5 mm.

From Poas Volcano, April (Tristan).

Sidusa nigropicta Cambridge.

Biol. C. Am. Arachn. Aran., II, 212, 1901.

Aguas Calientes (Picado).

Sidusa parvula Peckham.

Occas. Papers Nat. Hist. Soc. Wisc., III, 44, 1896.

Aguas Calientes (Picado).

Sidusa albicincta Cambridge.

Biol. C. Am. Arachn. Aran., II, 215, 1901.

Turrialba.

Sidusa opima Peckham.

Proc. Nat. Hist. Soc. Wisc., 1895, 71.

Orosi (Picado); Chiral Paraiso.

Sidusa fulvoguttata Cambridge.

Biol. C. Am. Arachn. Aran., II, 214, 1901.

San José; Tiribi.

Sidusa marmorea Cambridge.

Biol. C. Am. Arachn. Aran., II, 211, 1901.

La Verbena.

Cyrene interrupta Cambridge.

Biol. C. Am. Arachn. Aran., II, 239, 1901.

Tejar de Cartágo; Anonos; Orosi (Picado).

Cyrene dolosa n. sp.

Cephalothorax red-brown, eyes on large black spots, a pale median stripe, and the side margins pale; the red-brown stripes are nearly black under the base of the abdomen. Abdomen pale, four black spots each side, the middle area very pale, some small blackish streaks on the sides; venter pale, spinnerets black, and the black continued as a stripe on venter to near the middle where it ends in a sharp point; sternum pale; legs pale, more reddish on tibiæ and patellæ; mandibles reddish. The spines on legs are as in *C. flava*, but none above on tibia III and IV; the vulva is nearer to *C. pratensis*. Length 8 mm.

From Punta Arenas (Biolley) and Uricuajo (Pac.), January, 200 m. (Biolley and Tristan).

Cyrene delecta Peckham.

Occas. Pap. Nat. Hist. Soc. Wisc., III, 68, 1896.

San Mateo (Pac.).

Cyrene magnifica n. sp.

Cephalothorax black, a broad marginal white stripe each side, and a white spot in the middle; abdomen black, a curved basal white band, and behind on each side are two large white spots; and in the middle line are three white spots, the last over the spinnerets is the largest. Venter with four narrow pale lines in the middle area, and a white spot each side near base; sternum and legs black, with black hair, the latter with some white hairs beneath, which form white bands on the middle of the tibiæ and metatarsi III and IV; palpi pale yellowish, with white hair. Length 15 mm.

From San Mateo, Costa Rica (Biolley). It is the largest species of the genus known to me.

Cyrene fusca Cambridge.

Biol. C. Am. Arachn. Aran., II, 238, 1901.

San José.

Cyrene formosa n. sp.

Black, clothed with deep black hairs, a white median stripe extending out each side in front to the dorsal eyes, a narrow white band above anterior eye-row, and the clypeus broadly white, a marginal white stripe. Abdomen black, with black hair, a median white stripe, crossed in front by a white band, and a broad basal white band, which extends back each side, the posterior sides white; the sides white with many elongate black dashes; venter black in the middle; sternum pale brown; legs red-brown or black, with black hair, the tarsi and metatarsi are pale, hind femora below, and the basal half of tibia pale. No fringes on legs; patella and tibia of male palpus with white hair above. Length 9–10 mm.

From Turrialba, Costa Rica (Tristan).

Cyrene pratensis Peckham.

Proc. Nat. Hist. Soc. Wisc., 1885, 70.

San José.

Cyrene bicuspidata Cambridge.

Biol. C. Am. Arachn. Aran., II, 238, 1901.

Pacaca.

Thiodina retarius Hentz.

Journ. Bost. Soc. Nat. Hist., VI, 288, 1850.

Huacas.

Marpissa melanognatha Lucas.

Hist. Nat. Canaries, Arachn., 29, 1839.

Punta Arenas (B.); San José (B.), (Picado).

Marpissa magna Peckham.

Occas. Pap. Nat. Hist. Soc. Wisc., II, 87, 1894.

Guanacaste (Lankester).

Marpissa minor Cambridge.

Biol. C. Am. Arachn. Aran., II, 250, 1901.

Turrialba.

Phanias marginalis n. sp.

Cephalothorax dark red-brown, a transverse patch of white hair just behind dorsal eyes, the margins of cephalothorax broadly snow-white. Dorsum of abdomen pale brown, a darker brown basal spear-mark, and some dark chevrons behind, also an indistinct lateral dark streak; sternum red-brown, venter pale brown. Legs pale brown, femur I dark, other joints darkened at tips; patellæ of palpus snow-white. Length 6 mm.

San José, Costa Rica (Tristan).

Plexippus paykulli Aud. et Sav.

Descript. Egypte (éd. 2), XXII, 172, 1827.

Huacas; La Verbena, March; Surubres (Pac.) (B.); Congrejal de Asseri (Pac.), 800 m., April (B.).

Metacyrba tæniola Hentz.

Journ. Bost. Soc. Nat. Hist., V, 353, 1895.

Turrialba.

Messua desidiosa Peckham.

Occas. Pap. Nat. Hist. Soc. Wisc., III, 93, 1896.

San Joaquin Heredia Espinach.

Nagaina incunda Peckham.

Occas. Pap. Nat. Hist. Soc. Wisc., III, 54, 1896.

Orosi, 20th July (Picado).

Ashtabula nigricans Cambridge.

Biol. C. Am. Arachn. Aran., II, 257, 1901.

Anonos, September; La Bolca (Picado).

Zygoballus tibialis Cambridge.

Biol. C. Am. Arachn. Aran., II, 292, 1901.

San José.

Martella lineatipes Cambridge.

Biol. C. Am. Arachn. Aran., II, 175, 1900.

La Verbena.

Sarinda pretiosa n. sp.

Cephalothorax and abdomen black, mandibles and palpi red-brown; cephalothorax with two pale yellowish transverse marks above, just behind cephalic part; abdomen with two transverse white marks rather before middle, and on lower sides is another; venter with a pale band behind the vulva; coxæ and legs pale, I and II striped with black, tarsi I black, femora III and IV black, patellæ wholly pale, tibiæ and metatarsi striped with dark. Tibia I and II with 2–2–2 spines, metatarsi with 2–2 spines. Length 3.5 mm.

From Turrialba, Costa Rica (Tristan).

Lyssomanes spinifer Cambridge.

Biol. C. Am. Arachn. Aran., II, 184, 1900.

Surubres (Pac.) (B.); Aguas Calientes (Picado); San José, July (Picado).

Lyssomanes convexa n. sp.

Pale yellowish green throughout, eyes on black spots, no other marks. Tibia I with but outer lateral spine, which is toward the tip. Vulva near *L. elegans*, but the apertures much closer together, and the basal part longer. Length 8 mm.

One female from Navarro, Costa Rica (Maxon).

PHALANGIDA.

Cynorta albipunctata Cambridge.

Biol. C. Am. Arachn. Aran., II, 556, 1904.

San José, under stones (B.); Tejar de Cartágo, under trunks of trees (B. and T.); La Verbena; La Bolea, July (Picado); Tablazo; San Isidro; La Palma.

Cynorta biguttata Cambridge

Biol. C. Am. Arachn. Aran., II 557, 1904.

Sta. Maria Dota; Tiribi; Cartágo (B. and T.); Fortuna Cervantes; San José, under stones in dark places.

Cynorta marginalis n. sp.

Dorsum a beautiful, uniform, deep, dark brown, shining, narrowly margined each side by a reticulate greenish-yellow stripe; no V-mark, hind margin of the shield and of the three other segments narrowly greenish yellow. Legs yellowish, more or less reticulate with brown, the tip of femur, and tibia, and whole of patella dark brown; mandibles pale, venter black. Dorsum smooth, a pair of minute tubercles in front, and behind a pair of rather large tubercles, but with rounded tips. Legs long and slender. Runs to *C. conigera* in the *Biologia*, but tarsus IV has 11 joints; differs however much in other ways. Length, body 6 mm., femur II 12 mm.

Several specimens from Turrialba, Costa Rica (Tristan).

Cynorta longipes Cambridge.

Biol. C. Am. Arachn. Aran., II, 557, 1904.

San Isidro; Tablazo, September.

Cynorta lata n. sp.

Very dark red-brown, a yellow Y-mark enlarged at each anterior end, a transverse line behind, mandibles and legs not very pale, tarsi paler. Dorsum minutely granulate, posterior tubercles low and blunt, posterior segments each with row of granules; body very broad, over coxæ IV nearly as broad as long; basal joint of mandibles spinulose above; legs very rough, but the granules are blunt and none enlarged; trochanter III has a little process behind, a larger one on trochanter IV, a short, stout spine above at tip of coxa IV; tarsus I with 6 joints, II with 11, III with 7, and IV with 8 joints. Venter dark brown; coxæ granulate, coxæ IV only toward tip. Length 8 mm., femur IV 6 mm., femur II 7 mm.

Santa Domingo, San Mateo, Costa Rica, August (Tristan).

Cynorta conigera Cambridge.

Biol. C. Am. Arachn. Aran., II, 559, 1904.

El Higuito, near San Mateo (Pac.), January (B. and T.).

Cynorta pictipes n. sp.

Black, a narrow yellow V-mark, some lines at sides, and following this a faint scallop behind and passing behind the posterior tubercles; many small yellow dots scattered over the abdomen; mandibles, palpi, and venter black; legs yellow, femora on apical half black, patellæ wholly black, tibiæ on apical half and most of the metatarsi black, several black spots on trochanters. Dorsum smooth; posterior tubercles thick and heavy, acute, but not very high; coxa IV at tip with one small tubercle; legs very short; tarsus I with 6 joints, II with 9, III with 7, IV with 8 joints. Length, body 5.5 mm.; femur II 5 mm.

From Turrialba, Costa Rica (Tristan).

Cynorta longispina Cambridge.

Biol. C. Am. Arachn. Aran., II, 558, 1904.

Uricuajo (Pac.), 200 m., January (B. and T.).

Cynorta posticata n. sp.

Dorsum rich deep brown, a narrow white line each side, not reaching either end of body, each end of line turned up or down a short distance; sometimes the line is broken over coxæ III. Three posterior segments mostly white, the last with a large white triangle each side at base; legs and mandibles pale yellowish, heavily reticulate with black. Venter red-brown, granulate. Dorsum smooth, posterior tubercles rather large; legs long, tarsus I with 6 joints, II with 17, III with 9, and IV with 10 joints. Hind legs of male with femur and tibia slightly curved, the metatarsi sinuate, and at base above with a series of over 20 teeth. Length 6 to 7 mm.

From Turrialba, Costa Rica (Tristan); nine specimens, all agreeing in the peculiar coloration.

Cynorta bipunctata Cambridge.

Biol. C. Am. Arachn. Aran., II, 556, 1904.

Fortuna; La Palma; Turrialba.

Cynorta pedalis n. sp.

Very dark red-brown; a yellow Y-mark as usual, the anterior ends of which terminate in large spots, each with several dark dots, a yellow oblong behind at region of tubercles, and a line from it to each side yellow. Legs yellowish; the trochanters very bright yellow, the femora more or less distinctly banded with dark at base, before middle, beyond middle, and at tip; the tibiæ with indistinct bands at base, middle, and tip; the metatarsi with four bands as on the femora; hind tarsi pale yellow, others darker. The dorsum is mostly smooth, the tubercles practically absent; legs spinulose; femur IV more strongly so, but hardly with teeth, no large tooth at tip of coxa IV. Tarsus I with 6 joints (three enlarged), II with 11, III with 7, and IV with 8 joints. Hind femur about as long as body. Length 6 mm.

From San Isidro, Costa Rica (Tristan).

Cynorta tristani n. sp.

Dark red-brown, marked with yellowish; a Y-mark as usual, the sides and posterior margin narrowly yellow, many small dots above, some forming two transverse rows. Legs pale, densely marked with black. Dorsum smooth, two large posterior tubercles, and on posterior segments a few small granules; legs slightly roughened. Venter mostly smooth, coxæ I, II, and III, slightly granulate, and a row of teeth on their posterior borders. Legs not very long; tarsus I with 6 joints, II with 14, III with 8, and IV with 9 joints. Length 5 mm.

El Higuito, Jesus San Mateo (Pac.) (Biolley and Tristan). The posterior tubercles are much shorter than in *C. longispina*, to which it is otherwise much related.

Vonones lateralis n. sp.

Dorsum with a large brown spot in middle of sides, in front and behind reticulate greenish-yellow, many yellow spots here and there, and also scattered yellow granules, the posterior tubercles large, hardly acute and bearing small spinules, basal joint of mandibles spinulose above. Legs yellow, more or less marked with fine black lines. Posterior segments brown, with yellow dots, four larger dots on the last segment. Venter rufous, granulate, a prominent quadrangular yellow spot on each hind coxa near the tip. The coxæ above end in three small teeth, the trochanters on inner side with two teeth at tip; hind femora with a series of teeth above and below near tip as in *Erginus*, no teeth longer than the width of the joint. Length 6.5 mm.

Several from Turrialba, Costa Rica (Tristan).

CYNORTINA n. gen.

Gonyleptidæ, subfam. Stygninæ. Spiracles distinct, hind coxæ free at apex, much broader than a ventral segment; eye-tubercle broad, with two short blunt projections between eyes; legs short, tarsi I with 3 joints, II with 7, III with 6, IV with 6 joints; palpi not very long, joints cylindrical, and each with a few spiniform bristles.

Cynortina tarsalis n. sp.

Very dark brown, the tips of the coxæ, trochanters, femora, and tibiæ pale, also tips of femora and tibiæ of palpus pale. Dorsum smooth, a few low granules in transverse rows on the dorsal shield, lateral margin of shield with a submarginal row of stronger granules, a few small ones on hind margin and on each of the posterior segments; legs without granules, except under all femora, and patella and tibia IV; all legs with fine short hairs, coxa IV below has a small tooth lying close to venter, hardly discernible. The palpus has four spines on outside of femur (two near base), and one on inner side near tip; patella one on inner side; tibia two on outer side, three on inner side; tarsus with two on each side; claw fully one-half as long as tarsus. Length 4 mm.

La Palma, Costa Rica (Tristan).

Meterginus signatus n. sp.

Dorsum dark red-brown, a large yellowish patch each side over coxæ II and III, and another behind, reticulate, over coxæ IV, the two each side are indistinctly connected, no yellow V-mark, nor borders to segments. Venter red-brown; legs yellow, reticulate with blackish. Dorsum smooth; posterior tubercles small, rounded, wide apart; basal joint of mandibles granulate above, second joint in the male is greatly enlarged, swollen above and in front, in the female normal, femur of palpus with a row of ten teeth below, much smaller in the female; legs long, rough; hind pair longer, no teeth on femur IV of male, coxæ IV ends in one tooth above, hind femur nearly two-thirds as long as body. Tarsus I with 7 joints, first four enlarged, II with 15, III with 10, IV with 11 joints. Length, ♂ 8 mm., ♀ 6.5 mm., femur IV, ♂, 15 mm.

From Turrialba, Costa Rica (Tristan).

Meterginus inermis n. sp.

Red-brown, mandibles paler, trochanters rather bright yellowish, rest of legs brownish, two large connected spots each side of the cephalothorax, the Y-mark indistinct, and a faint transverse line behind. Dorsum smooth, no tubercles; eye-tubercle very broad, smooth; legs spinulose, hind femora with several rows of blunt teeth, largest below, with many scattered rather larger granules; a series of granules under femur of palpus; second joint of mandibles large, but not much swollen above; legs rather long, hind pairs plainly larger than others; femur IV nearly as long as body, tarsus I with 7 joints (4 enlarged), II with 14, III with 8, and IV with 8 joints. Length of body 6 mm., of femur IV, 5 mm.

From Tablazo, Costa Rica, September (Tristan).

Erginus subserialis Cambridge.

Biol. C. Am. Arachn. Aran., II, 564, 1904.

Uricuajo (Pac.), 250 m. (B. and T.), and El Higuito, near San Mateo (Pac.), January (B. and T.).

Erginus parvulus n. sp.

Dark red-brown, a few yellow dots each side, and a line across behind the tubercles; legs pale yellowish. Dorsum mostly smooth, a few granules; eye-tubercle spinulose each side; basal joint of mandibles very much spinulose above, the second joint is greatly swollen above. Posterior tubercles large, acute, and less than their length apart; posterior segments granulate along the edge. Legs spinulose; coxæ III with a little cusp behind, IV with a very large spine at tip, trochanter IV with a small one on inner side at tip; femur IV about as long as body, much roughened, on inner side near the middle is a series of six teeth, none as long as width of joint, and on outer side near tip is a series of five teeth, none as long as width of joint; patella and tibia IV also much roughened. Tarsus I with 6 joints (3 enlarged), III with 7, IV with 7 joints. Length 4 mm.

From San Isidro, Costa Rica (Tristan).

Erginus sinuosus Cambridge

Biol. C. Am. Arachn. Aran., II, 563, 1905.

Tablazo, September.

Hernandria spinosa n. sp.

Pale reddish-brown, legs and palpi paler; eye-tubercle with two small spines above. Dorsal shield with two pairs of small tubercles, and a larger apical pair; the second of the posterior segments with a larger, yellow, median spine; longer than those on dorsal shield, small spines on the edges of these segments; dorsal shield with two deep transverse grooves. Legs moderately slender, with rows of short spine-like granules, the patellæ slightly enlarged; coxæ I, II and IV granulate on upper sides, coxa IV with a large spine at tip above; tarsi III and IV very broad and flattened, and at tip an apical process over the claws; tarsus I with 5 joints, II with 11, III with 6, IV with 6 joints. Palpi with spines, tibiæ with two long and one short (apical) on outer side, two long and two short on inner side, tarsus with two long and two short each side, claw as long as tarsus. Length 5 mm., femur IV 4 mm.

From Santa Maria Dota, January (Tristan), Costa Rica.

Palpinus lævis Cambridge.

Biol. C. Am. Arachn. Aran., II, 577, 1905.

La Palma.

Metapachylus rugosus n. sp.

Red-brown on body and legs, palpi, mandibles and trochanters pale yellow, in the male the legs are more yellowish. Body very much roughened, a large spine on eye-tubercle curving forward, a small one at each anterior corner of the cephalothorax; dorsal shield with lateral row of granules, and about 8 transverse rows of spine-like granules on abdomen, and the last segment with two rows of granules, each granule is tipped by a hair; ventral segments also with rows of granules, hardly as large as those above; legs also roughened, except on the metatarsi and tarsi, many granules on coxæ, trochanters and femora are tipped by bristles; tarsus I with 3 joints, II with 7, III with 5, IV with 6 joints. Femur of palpus with three spines beneath (two basal), tibia and tarsus with two each side. In male the legs are very much longer, especially the hind pair, of which the femur, tibia, and metatarsus are each longer than the body, and metatarsus IV has above four granules of which one is apical. Length 4.5 mm., tibia IV 6 mm.

From San Isidro, San José, Santa Maria Dota (Tristan), Uricuajo (Pac.), 200 meters (Biolley and Tristan), Atenas, 2d June (Picado), and La Bolca (Picado); all Costa Rica.

Mitopus australis n. sp.

Pale brown, mottled with black, middle of eye-tubercles white. Dorsum densely minutely granulate, two little elevations on the anterior margin, each with three or four little teeth; eye-tubercles spinulose, three first abdominal segments each with a submedian pair of sharp spines, next two with four spines, last with two; each segment with a few minute spinules, and on anterior border of abdomen a curved series of minute spinules; legs with rows of very prominent spinules, and at tips of femora and patellæ are several larger spinules; coxæ minutely spinulose, each spinule bearing a black hair. Femur, patella, and tibia all thick and heavy, metatarsi and tarsi very slender, femur I longer than width of body, II as long as body. Length 4.5 mm.

From San José, Costa Rica (Tristan).

Phalangium ornatipes n. sp.

Body brown, paler below, dorsum darkest in front, a paler median stripe which expands to sides at middle of length; palpi pale, brown on base of femur, patella, and base of tibia; trochanters of legs pale yellowish, also extreme bases of femora, rest of femora brown, patella brown, with a pale streak above, tibia brown on base, paler beyond, metatarsi and tarsi pale. Eye-tubercle smooth; a cluster of small spines each side on front margin; palpi very short. Dorsum with eight transverse rows of six spine-like tubercles, the median pair of each row much larger than others, coxæ slightly granulate, a small white spine at anterior tip of each coxa, except I where it is on the posterior tip. Legs rather short. Length 7 mm.

From La Fortuna Cervantes (Tristan), Costa Rica.

Liobunum biolleyi n. sp.

Anterior part of cephalothorax brown, tubercle and middle part black; abdomen black; coxæ and venter pale brown, trochanters and rest of legs black, tips pale, a prominent yellow spot at tip of hind coxa; two golden yellow spots each side near apex of abdomen above, and sometimes a yellowish spot each side in front of these; palpi brown on base, tarsus pale yellowish, mandibles pale. The cephalothorax is pitted, and a narrow pitted band on base of the abdomen, then a large area, densely pitted, occupying most of dorsum, and the posterior segments each with a pitted band; coxæ and sternum granulate, venter less strongly so; eye-tubercle with a few minute spicules above in front; legs very long and slender. Length 6 mm.

From Congrejal de Aserri (Pac.), 800 meters, April (Biolley).

Liobunum coriaceum Cambridge.

Biol. C. Am. Arachn. Aran., II, 582, 1905.

Turrialba.

Liobunum tristani n. sp.

Dark brown, anterior part of the cephalothorax paler, a yellowish mark on each side of the abdomen behind, one or two dots on the posterior dorsal segments; palpi and mandibles wholly pale yellow; coxæ and trochanters black, the suture white, and a white (or yellow) spot at apex of hind coxa; rest of legs brown, patellæ rather darker; sternum and venter dark brown or black, each side at base of the abdomen is more yellowish. The cephalothorax is pitted, a pitted band on basal part of abdomen, then a large square pitted area occupying most of dorsum, and the posterior segments each with pitted band; coxæ and sternum densely granulate; venter with a row of granules on each segment; legs only finely granulate, of moderate length, eye-tubercle with a few spicules in front above. In the male the body is broader and flat, of a rather uniform brown, densely pitted; eye-tubercle with more prominent spicules; palpi rather long, tarsi slightly curved. Length, ♀ 6 mm., ♂ 5 mm.

From Fortuna Cervantes (Biolley and Tristan), San José, and La Verbena, near San José, "on the stones near the river, thrive in dark places" (Tristan); all Costa Rica.

Liobunum annulipes n. sp.

Marmorate with brown and yellowish; eye-tubercle pale; a narrow brown line reaches to front margin, some pale median spots behind; coxæ mostly brown, an irregular pale patch near base of each; sternum pale at base, dark on tip, venter pale, densely mottled with brown. Palpi pale, except a brown band at base of tarsus. Legs pale, with many brown bands, many of these brown bands contain a white mark; trochanters mostly brown. Dorsum pitted as usual, eye-tubercle smooth, coxæ granulate, venter slightly granulate; legs quite long, especially the second pair. Length 7 mm.

From Tablazo, Costa Rica, "on the ferns" (Tristan).

Liobunum foveolatum Cambridge.

Biol. C. Am. Arachn. Aran., II, 583, 1905.

Tablazo.

Liobunum frontale n. sp.

Dark brown, coxæ and trochanters same color; legs paler at base, darker beyond, then pale toward tips; in front of eye-tubercle is a white spot extending to front margin; palpi brown, tarsus pale;

mandibles pale; sternum yellowish. Dorsum pitted as usual, coxæ granulate, but sparsely so on hind pairs; sternum and venter with few granules; eye-tubercle smooth; legs very long, finely granulate; palpi slender, tarsus very long and slightly curved. Length 4 mm.

From Embouchure du Rio Jesus Maria (Pac.), January, Costa Rica (Biolley and Tristan).

Liobunum laterale n. sp.

Pale brown, coxæ and trochanters a little darker, rest of legs paler, at tip of coxa IV is an indistinct pale spot; a black streak each side near middle of dorsum; venter pale yellowish on the extreme upper ends of the basal three segments; palpi and mandibles pale. The dorsum is densely pitted, with a narrow pitted band on base of abdomen, and on posterior segments; the coxæ are densely granulate, the sternum and bands on ventral segments less strongly so; the eye-tubercle with very minute spicules above; the patellæ of the palpi have a very distinct process from the inner tip; legs not very long. The male is similar to the female, with longer legs, the abdomen flat and short, with the two dark streaks; palpi with the process to patellæ, the tarsus slender and curved. Length, ♀ 5 mm., ♂ 4 mm.

From Chiral Paraiso, July (Biolley and Tristan), Fortuna Cervantes, and Huacas (Pac.) (Tristan); all Costa Rica.

Liobunum intermedium n. sp.

Dark brown above, pale brown beneath, coxæ and trochanters pale brown, legs pale at base, darker near middle, and pale toward tips; palpi mostly pale; mandibles pale yellowish; a golden yellow spot at tip of coxa IV, no golden spots behind (as in *L. biolleyi*). Dorsum pitted as usual; eye-tubercle minutely spinulate; coxæ granulate, sternum and venter less so; legs of female rather short, of male much longer; patella of palpus with an inner projection at tip in both sexes. Length, ♀ 5 mm., ♂ 4 mm.

From Fortuna Cervantes (Tristan and Biolley), Pacaca, and Turricares, February (Tristan); all Costa Rica.

Liobunum coxalis n. sp.

Body reddish, coxæ and trochanters deep black, legs pale, but base near trochanters is black, eye-tubercle black, palpi and mandibles pale yellowish.

Dorsum (♂) short and broad, densely pitted; eye-tubercle smooth; coxa granulate, venter and sternum slightly so, sternum very broad; palpi of moderate length, the patellæ with a minute tooth at inner tip; legs not very long. Length 2.5 mm.

From Tejar de Cartágo, Costa Rica (Tristan).

SOLPUGIDA.

Ammotrecha stolli Pocock

Ann. Mag. Nat. Hist. (6), XVI, 97, 1895.

San José. 2d May (Picado).

Explanation of Plates V and VI.

Plate V—Fig. 1.—*Sidusa femoralis.*
Fig. 2.—*Phidippus incontesta.*
Fig. 3.—*Selenops bifurcatus.*
Fig. 4.—*Lycosa tristani.*
Fig. 5.—*Clubiona tristani.*
Fig. 6.—*Sidusa femoralis.*
Fig. 7.—*Cyrene formosa.*
Fig. 8.—*Metriopelma zebrata.*
Fig. 9.—*Phanias marginalis.*
Fig. 10.—*Sparassus crassus.*
Fig. 11.—*Cyrene dolosa.*
Fig. 12.—*Sparassus audax.*
Fig. 14.—*Dendryphantes comptus.*
Fig. 15.—*Trachelas morosa.*
Fig. 16.—*Metriopelma morosa.*
Fig. 17.—*Sidusa tarsalis.*
Fig. 18.—*Strotarchus minor.*
Fig. 19.—*Clubiona tumivulva.*
Fig. 20.—*Lycosa signiventris.*

Plate VI—Fig. 21.—*Sarinda pretiosa.*
Fig. 22.—*Neriene bisignata.*
Fig. 23.—*Neriene postica.*
Fig. 24.—*Scytodes intricata.*
Fig. 25.—*Epicadus granulatus.*
Fig. 26.—*Theridium biolleyi.*
Fig. 27.—*Cupiennius minimus.*
Fig. 28.—*Pelayo insignis.*
Fig. 29.—*Dipœna micratula.*
Fig. 30.—*Pseudometa bella.*
Fig. 31.—*Neriene postica.*
Fig. 32.—*Corinna modesta.*
Fig. 33.—*Sosippus agalenoides.*
Fig. 34.—*Tetragnatha confraterna.*
Fig. 35.—*Lycosa biolleyi.*
Fig. 36.—*Echemus tropicalis.*
Fig. 37.—*Teudis bicolor.*
Fig. 38.—*Cyrene magnifica.*
Fig. 39.—*Epeira microsoma.*
Fig. 40.—*Anyphæna delicatula.*
Fig. 41.—*Lyssomanes convexus.*
Fig. 42.—*Lycosa tristani.*
Fig. 43.—*Lycosa morosina.*
Fig. 44.—*Lithyphantes hermosa.*
Fig. 45.—*Epeira microsoma.*
Fig. 46.—*Tetragnatha tristani.*
Fig. 47.—*Corinna pictipes.*
Fig. 48.—*Teudis elegans.*
Fig. 49.—*Eutichurus frontalis.*
Fig. 50.—*Neriene postica.*

POLYCHÆTOUS ANNELIDS FROM MONTEREY BAY AND SAN DIEGO, CALIFORNIA.

BY J. PERCY MOORE, PH.D.

In this paper are recorded the results of a study of the California Polychæta belonging to the Museum of Leland Stanford Junior University, which were submitted to me at various times by Profs. Harold Heath and W. K. Fisher of that institution. Descriptions of a few new species from San Diego have been published already in these *Proceedings* for 1904, pp. 484–503. The localities at which the collections were made are limited to two, namely: the vicinity of Monterey Bay, at about the middle of the California coast, where Mr. M. H. Spaulding collected in 1903 and 1904, chiefly at Pacific Grove, and San Diego, chiefly on a sand-bar in the bay, near the southern boundary of California, where Prof. E. C. Starks collected during 1902 and 1903. At both places the collecting was nearly limited to the littoral zone between tide limits, though a few dredgings were also made. A few specimens collected at Pacific Grove by Prof. Heath and presented to this Academy some years ago are also mentioned. In all cases where nothing different is stated it will be understood that the specimens were taken between tides and by one of the two gentlemen who made the bulk of the collections. Also, unless otherwise stated, the types of new species are in the Museum of Stanford University. A set of cotypes and duplicates has been added to the collection of the Academy of Natural Sciences of Philadelphia.

The total number of species mentioned is 64, of which 21 are considered to have been previously undescribed. While this must represent a small part only of the Polychæte fauna of that region the records are important because they are in nearly all cases material extensions of the known ranges of the species. Scarcely anything has hitherto been published concerning the Polychæta of the coast of the southern half of California or of the Pacific coast of Mexico and a rich field for faunal investigation remains. When these collections were placed in my hands for study it was hoped that Prof. H. P. Johnson's projected paper on the Polychæta of California would be available for their determination, but this much-desired publication has been unavoidably delayed.

SYLLIDÆ.

Syllis elongata Johnson.

Pionosyllis elongata (Johnson), Proc. Bos. Soc. Nat. Hist., XXIX, pp. 403–405; Pl. 6, figs. 67–70; Pl. 7, fig. 71.

Dredged at Delmonte wharf, vicinity of Monterey Bay, July 12, 1904.

A fine specimen 40 mm. long, with 193 segments, the last 28 or 29 of which are much distended with sperm and elongated to three times the length of the preceding 29 segments. The notocirri are more tapered and acute than represented in Johnson's figure. This species is very slender and in general aspect closely resembles *Syllis gracilis* Grube. At least the dorsalmost seta of many of the middle segments has the appendage coalesced with the stem to form bifurcate setæ as in that species. Probably it should be placed in Verrill's subgenus *Synsyllis*. It certainly departs widely from the type of *Pionosyllis* in the form of its setæ and its strongly moniliform tentacles and cirri. The posterior region is so much enlarged that it seems probable that it separates at maturity.

Trypanosyllis intermedia sp. nov. (Plate VII, figs. 1 and 2).

An imperfectly known species resembling *T. gemmipara* Johnson in general aspect, but readily distinguished from that species by the much longer appendages of its setæ.

Length of the anterior 80 segments of an incomplete specimen, 18 mm.; maximum width between tips of parapodia, 2 mm.

Prostomium quadrate, silghtly wider than long, with a median dorsal furrow. Eyes small, red, dorso-lateral; the anterior slightly farther apart and less than one-eighth the width of the prostomium; the posterior pair about one-twelfth the width of the prostomium and separated from the anterior by an equal distance. Palpi about as long as prostomium, projecting forward and widely divergent. Tentacles all missing.

Anterior end of body broad and strongly depressed, becoming gradually less so posteriorly. Segments all extremely short and crowded, especially anteriorly, where they are slightly biannulate. Pygidium unknown.

Parapodia uniramous, short, stout and slightly notched distally. Neurocirri short, cylindrical, rounded distally, and arising from middle of ventral face of neuropodia, the end of which they scarcely reach. Notocirri arising from prominent cirrophores immediately above the base of the neuropodia; styles very readily detached and only a few remaining so that their relative length is unknown, those remaining rather stout, swollen beyond base and thence tapered to the blunt end, the longer ones about equal to total width of worm and with about 20 short articles, the shorter two-thirds as long with about 15 articles.

Acicula three, tapered, with the ends blunt, slightly flattened and just perceptibly enlarged. Setæ few (about 9–11), all subacicular, colorless, with rather strongly curved stems acutely beveled at the end, smooth, with a slight shoulder for attachment of the appendage (Plate VII, figs. 1 and 2); length of appendages varying from one and one-third times (on posterior parapodia) to more than twice (on anterior parapodia) the distal thickness of the stems, their distal ends hooked and conspicuously bifid, the teeth being much more widely separated on posterior setæ, on which also the marginal fringe is much less developed.

The single incomplete specimen was taken at "point above Third Beach," vicinity of Monterey Bay, July 12, 1904.

PHYLLODOCIDÆ.

Phyllodoce medipapillata sp. nov. (Plate VII, figs. 3 and 4).

The two examples upon which this species is based differ greatly in appearance and degree of contraction, one being robust, the other very slender. Length of type 100 mm., maximum width of body 1.8 mm., total width including parapodia 3.5 mm.; number of segments 201. Length of cotype 170 mm., width of body 3.5, total width including parapodia 8 mm.; number of segments 240.

Prostomium rather thick, depressed, broad, slightly cordate behind; about as wide as long, the greatest breadth at the eyes about one-third of the length from the posterior end, the sides very strongly convex at this point; anterior border broadly rounded, projecting slightly beyond tentacles. Eyes circular, their diameter about one-eighth to one-tenth width of prostomium, at the widest part of which they are situated, separated by about one-half its width. The tentacles, which arise from a shallow annular depression, short conical, diverging equally in both directions, about as long as one-third width of prostomium. Nuchal organs everted as prominent knobs between sides of prostomium and peristomium just below eyes. A minute nuchal tubercle, about one-third diameter of nuchal organs, occupies the posterior emargination of the prostomium.

Peristomium and somite II coalesced, achætous, nearly concealed above by the prostomial lobes, between which the nuchal tubercle projects; below forming a smooth, somewhat swollen lip. Except in the character of its parapodia III is similar to succeeding segments. Tentacular cirri all short, with distinct cirrophores and rather stout styles tapering to delicate tips. On the type they reach to the following segments: that of I to VII, dorsal of II and III both to IX, ventral of II to VI or VII. On the cotype, which has the anterior segments much contracted, each reaches about three segments farther caudad.

The body of the type is slender, slightly depressed, flattened ventrally, widest in anterior fourth, and tapers regularly caudad; the length of the segments varies from one-fifth the width anteriorly to two-thirds width posteriorly. As noted above the cotype is much contracted and consequently much stouter. Pygidium unknown.

Parapodia (Plate VII, fig. 3) uniramous, prominent, strictly lateral, posteriorly equaling width of somites. That of I a tentacular cirrus (neurocirrus) only; of II dorsal and ventral tentacular cirri (notocirrus and neurocirrus); III the first setigerous. Typical parapodia consist of somewhat flattened neuropodia supported by a single, stout, tapered aciculum and divided at the distal end into a low, entire post-setal lip and a slightly more prominent presetal lip divided by a notch into supra-acicular and subacicular lobes, to the dorsal border of the latter of which the slightly curved end of the aciculum is adherent.

Foliaceous notocirri begin on IV and foliaceous neurocirri on III; both are prominent and the former strongly imbricated on the dorsum of the parapodia. Notocirrophores prominent, erect, well separated from the neuropodia, more than half as long as the latter and equally broad. Styles not strongly asymmetrical, with basal auricles only slightly developed, those of anterior segments nearly regularly ovoidal, with bluntly rounded ends and about two-thirds as wide as long. Farther back they increase in size and become more slender (twice as long as wide) and more acutely tipped, without any trace of the truncate end seen in so many species, though the tips of some are slightly recurved. On middle somites they approach nearer to the ovate-lanceolate form usual in *Eulalia* rather than the form usually characterizing *Phyllodoce*. In the posterior third they again become shorter and broader—much like poplar leaves—with rather abruptly acuminate tips. Rather firmly attached, of thin, membranous texture and with a striated border of colored glands. Neurocirri attached by low, broad cirrophores to the bases of the neuropodia. Styles all very large and foliaceous and projecting one-third or more of their length beyond the neuropodia. On the first few segments they are very broad and subelliptical, but soon become more acute and asymmetrical and gradually much more elongated and slender.

Setæ (Plate VII, fig. 4) all colorless, in fan-shaped supra- and subacicular fascicles of (in the type) from eight (on IV) to twenty-six (on XXV), decreasing to eleven or twelve at *CL*, the cotype bearing about one-third as many more. Stems slightly curved and slightly enlarged distally to form an oblique socket, each side of which bears a small brush of hairs, none of which is enlarged. Appendages very long, slender, tapering, slightly curved, with a border of minute serrations; their length is from more than one-half to nearly the depth of the neuropodia and they vary little in the different regions.

Proboscis of type fully extended, clavate, 7 mm. long, 1.8 mm. in distal and 1.2 mm. in basal diameter. Orifice surrounded by nineteen rather prominent, compressed ovoid papillæ. Greater part of surface smooth, with six very obscure longitudinal ridges becoming gradually more roughened toward the base. Papillæ confined to basal one-sixth or less, arranged in six longitudinal rows on each side separated by dorsal and ventral intervals, of which the former is the greater and about equals the width of the papillated areas. The papillæ are slightly flattened and the posterior face is brown. Each row contains from nine or ten (ventral) to twelve (dorsal), the increased number resulting from a few papillæ placed irregularly at the anterior end of the more dorsal rows. In addition to the paired series, about four or five very small papillæ form an irregular dorso-median row. Except for the greater contraction the proboscis of the cotype is exactly similar.

Color of type confined to a brownish tinge on the dorsum and notocirri; cotype uniform purplish-brown.

Type locality, vicinity of Monterey Bay, M. H. Spaulding. The cotype was taken at San Diego by E. C. Stark.

Phyllodoce (Carobia) castanea Marenzeller.

Carobia castanea v. Marenzeller, Denkschr. K. Acad. Wissensch., Wien, XLI (1879), Math-naturw. Cl., 2d Abth., pp. 127, 128, Tab. III, fig. 2.

A much contracted specimen which agrees very closely with v. Marenzeller's description was dredged by Mr. Spaulding on July 12, 1903, at Delmonte wharf, near Monterey Bay. Length 21 mm.; segments 160.

Prostomium regularly subovate, about as broad as long, truncate posteriorly with a very slight median emargination; no anterior constriction or furrow. Eyes very large, dorso-lateral, about one-fourth diameter of prostomium and about an equal distance apart. Tentacles lateral and ventro-lateral, near anterior end of prostomium, directed almost laterad and very little forward, acutely subulate, thickened toward base, the dorsal pair as long as prostomium, the ventral two-thirds as long.

Tentacular cirri very much crowded, slightly flattened, very short, the longest (dorsal of II) about four times length of prostomium and reaching VII, the shortest (ventral of II) about twice prostomium, the remaining two subequal and about two and one-half times prostomium. Peristomium and II coalesced and scarcely visible from above. There may be a minute nuchal tubercle, but this is uncertain. Pygidium a minute ring bearing a pair of short, subulate cirri.

Notocirrophores low and broad, styles rather thick and easily detached, in this specimen carried nearly erect over the parapodia; broadly foliaceous, nearly uniform in size and shape throughout, triangular ovate, about three-fifths as wide as long with rounded apex and oblique but not auriculate base, the markings arranged bipinnately from a central axis.

Neurocirri foliaceous, subquadrate elliptical, all free surfaces evenly rounded, very broadly attached to venter of neuropodium and carried posterior to the latter, scarcely reaching beyond end of neuropodium.

Aciculum single, stout, tapered, straight. Setæ in spreading, vertical series, colorless, transparent, rather stout, with curved stems rather abruptly enlarged distally, the margins of the socket bearing a single series of rather long hairs. Appendages short, their length not exceeding one-third depth of parapodia, very delicate, broad at base but rapidly tapering to a tenuous tip; marginal serrations scarcely visible. Six supra- and ten subacicular setæ on middle parapodia.

Color pale reddish-brown, brightest on notocirri and anterior dorsum of body. Female with immature eggs.

POLYNOIDÆ.

Halosydna pulchra (Johnson).

Polynoë pulchra Johnson, Proc. Cal. Acad. Sci. (3), Zoology, I (1897), pp. 177–179, Pl. VII, figs. 34, 43*a*; Pl. VIII, figs. 50–50*b*.

Three specimens occur in the collection, two certainly from the Monterey Bay region, the other unlabeled but probably from the same place. Of the first two one was commensal on the holothurian *Stichopus*, the other on *Cryptochiton*. The latter is a fine specimen with milk-white elytra marked with a small, round, clear-cut black spot over the area of attachment.

Halosydna brevisetosa Kinberg.

Halosydna brevisetosa Kinberg, Ofver. K. Vetensk. Akad. Forh., XII (1855), p. 385.

Two small specimens were taken at San Diego, others in the vicinity of Monterey Bay, at "big tide pool, Lighthouse Point," on June 28, 1904, and at "point above Third Beach," on July 12, 1904.

All of the specimens are dark colored, with heavily mottled elytra.

Halosydna reticulata (Johnson).

Polynoë reticulata Johnson, Proc. Cal. Acad. Sci. (3), Zoology, I, pp. 170. 171; Pl. VII, figs. 32–41*a*, Pl. VII, figs. 47–47*b*.

Eleven specimens from San Diego occur in the collection and only two from Monterey Bay, where they were dredged on July 9, 1904.

These specimens exhibit considerable variation. Some are almost pigmentless and of a nearly uniform pale yellow, gray or brown; others are thickly mottled with deep brown on the elytra and barred on both dorsal and ventral surfaces of the body. Usually a brown spot or ring is present on the elytra over the point of attachment. The elytra differ greatly in the degree to which the surface is roughened with conical projections and in the number of marginal cilia. The latter appear to be gradually lost with increased age and size. They are plentiful on the elytra of small specimens and on newly regenerated elytra, fewer on those of medium size and frequently totally absent from larger specimens, as is the case with the two from Monterey Bay. As a result of loss and regeneration the elytra of some specimens are of very unequal size. The labels give no information concerning commensalism.

Lepidonotus cæloris Moore.

Lepidonotus cæloris Moore, Proc. Acad. Nat. Sci. Phila., 1903, pp. 412–414, Pl. XXIII, fig. 12.

A solitary specimen of small size was dredged at Delmonte wharf, Monterey Bay, on July 12, 1904.

Lepidasthenia gigas (Johnson).

Polynoë gigas Johnson, Proc. Cal. Acad. Sci. (3), Zoology, I, pp. 172–175; Pl. VII, figs. 33, 42*b*; Pl. VIII, figs. 48, 49.

Three examples from San Diego. One has the parapodia much entangled with Terebellid tentacles and probably came from the tube of the *Amphitrite* with which Johnson states that it lives commensally. Notopodial setæ are more usually present in the anterior parapodia, and the first parapodium bears a single seta of a form intermediate between the typical notopodial and neuropodial types.

One specimen 89 mm. long and having 83 somites has the elytra arranged in symmetrical pairs, except on somite LXV, which bears the right one only, the left side bearing a notocirrus; there are 39 pairs on the segments numbered 2, 4, 5, 7, 9, 11, 13, 17, 19, 21, 25, 27, 28, 30, 31, 33, 35, 37, 39, 41, 43, 45, 47, 48, 52, 54, 55, 56, 58, 60, 61, 62, 66, 67, 68, 69, 70, 71, 72.

SIGALEONIDÆ.

Sthenelais fusca Johnson.

Sthenelais fusca Johnson, Proc. Cal. Acad. Sci. (3), Zoology, I, pp. 185–186; Pl. IX, figs. 60–61*b*, Pl. X, figs. 64, 64*g*.

Two examples from San Diego and one from Chinatown Point, August 12, 1904.

One specimen is 110 mm. long with 172 pairs of elytra; the other is about the same size, but the number of elytra was not counted. The first mentioned has a caudal regenerating region of about a dozen segments, so that it is probable that the species reached a considerably larger size than the original description indicated. The first pair of elytra is pale and without markings, the others are of a darker brown, thickly and finely mottled with a reticular pattern of black. The pygidium, which was not described by Johnson, bears a pair of subanal cirri about as long as the last six or seven segments and of slender, tapered form. The distal papillæ of both rami of the parapodia are frequently more numerous than indicated in Johnson's figure.

Peisidice aspera Johnson.

Peisidice aspera Johnson, Proc. Cal. Acad. Sci. (3), (Zool.), Vol. I, pp. 184, 185; Pl. IX, figs. 56–59; Pl. X, figs. 63*a–d*.

A single specimen with twenty-one pairs of elytra, dredged at Delmonte wharf, vicinity of Monterey Bay, on July 12, 1904, represents this species in the collection.

AMPHINOMIDÆ.

Eurythoë californica Johnson.

Eurythoë californica Johnson, Proc. Calif. Acad. Sci. (3), Zoology, I, pp. 184, 185; Pl. IX, figs. 56–59, Pl. X, figs. 63–63*d*.

This species is represented in the collection by about a dozen specimens from San Diego and a single one from Monterey Bay, collected on July 12, 1904, from the "point above Third Beach."

Johnson gives no account of the proboscis, and as one of the specimens has it protruded the following brief description is added. It is about 3 mm. long and 1.8 mm. in diameter, subcylindrical, but slightly compressed and slightly wider distally than at the base. It terminates in a firm elliptical disk, with a vertical slit open ventrally and a central depression in which the mouth lies; surrounding this disk is a low annular fold. The cuticle is everywhere smooth, without papillæ, jaws or teeth of any kind.

HESIONIDÆ.

Podarke pugettensis Johnson.

Podarke pugettensis Johnson, Proc. Bos. Soc. Nat. Hist., XXIX (1901), pp. 397, 398; Pl. 3, figs. 23–25.

About fifty specimens collected at San Diego are stated to have been "parasitic on starfish."

The occurrence of this species on a starfish (*Luidia*) in the vicinity of Port Townsend has been already reported in these *Proceedings* for 1908 and it seems probable that this habit is general. The reference by Harrington and Griffin in their paper on Puget Sound Invertebrates to "the curious *Ophiodromus*, an annelid that lives between the arms of the starfish [*Asterias*] and is colored so as to resemble the surface of the latter," probably relates to this species.

The appendages of some of the dorsalmost setæ of the subacicular fascicle and the ventralmost of the supra-acicular fascicle are much longer and more slender than the others.

NEPHTHYDIDÆ.

Nephthys cæca (Fabricius) Oersted.

Nereis cæca, Fabricius, Fauna Groenlandica, 1780, p. 304.

This species is represented by six large specimens from the vicinity of Monterey Bay and by about twenty from San Diego, where it appears to be common and was taken from the littoral zone and down to a depth of fifty feet.

The San Diego examples are of small to medium size and colorless or slightly marked with brown figures and bands on the prostomium and a few anterior segments. The setæ of some specimens are long, of others short and one of the latter is filled with nearly mature ova.

Those from Monterey Bay are much larger, measuring about 180 mm. in length and one counted having 152 segments. Three of them are very smooth and colorless, except that there is a brown or black "spread-eagle" figure on the prostomium and crossbars on a few anterior segments. The others have the body of a deep purplish brown both dorsally and ventrally, the parapodia colorless.

The free margins of the prostomium are thin and produced. The serrated setæ form long flowing tufts, dusky at the base, as long as the parapodia or nearly equal to the body width. The annulated setæ are short and small, except on anterior parapodia. Several specimens have the single caudal cirrus intact.

The extended proboscis is rather slender clavate with ten bifid orifical papillæ above and ten below and twenty-two longitudinal rows of conical papillæ of usually five each, the unpaired dorsal and ventral papillæ being no larger than the others.

No characters distinguishing these specimens from examples of the species from the Atlantic Ocean are obvious.

NEREIDÆ.

Nereis procera Ehlers.

Nereis procera Ehlers, Die Borstenwürmer, 1868, pp. 557–559; Taf. XXIII, fig. 2.

Ten specimens were taken in the vicinity of Monterey Bay, two bearing each of the following labels: Point about Third Beach; Big tide pool, Lighthouse Point, June 20, 1905, and June 28, 1904; dredged July 9, 1904, and dredged Delmonte wharf, July 12, 1904. Of the three from San Diego one is 3 mm. in diameter and filled with large eggs. The parapodia and other parts exhibit no epitokous modification.

Nereis (Alitta) vexillosa Grube.

Nereis vexillosa Grube, in Middendorff, Reise in Siberiens, etc., II, 1851, p. 4; Taf. II, figs. 1, 5, 6.

Taken at San Diego only; 14 small atokes and one small female epitoke. The largest of the atokes is 50 mm. long, and all of them have the notocirral laminæ much less developed than on larger specimens. One exserted proboscis has paragnaths arranged as follows: I, three in a longitudinal series; II, tapering arcuate groups of three rows of small cones; III, transverse band in three rows; IV, wider curved band, broader behind; V, absent; VI, four large cones in lozenge-shaped figure; VII and VIII, broad transverse band encircling ventral and lateral portion of basal ring, a tract of very small paragnaths in front of ventral part.

The epitoke is filled with large eggs. The parapodia agree with Johnson's figure, but the setæ are arranged somewhat differently. Those of the dorsal rami are all of the "fish-bone" type, the stout compound setæ belonging to the dorsal supra-acicular fascicle of the neuropodium. The paragnaths exhibit several peculiarities; their number is generally reduced, those of VI are coalesced into a single large one on each side; V is present as a single cone.

Nereis (Alitta) virens plenidentata subsp. nov.

Under this name I am recording provisionally a species of *Alitta* that appears to be quite common on the sand-bars in San Diego Bay. The northern Pacific species, which is found from Ochotsk Sea and Alaska south nearly to San Francisco, seems to differ from Atlantic examples of *A. virens* in several respects, and particularly in having more numerous paragnaths and a greater number of segments. Probably it must be considered to be at least a subspecies under the name of *brandti* Malmgren.

These specimens from southern California exhibit more extreme divergence in the same direction. Like both of the forms mentioned the paragnaths are reduced in number with age and increased size, but compared with specimens of the same size they are very much more numerous. For example a specimen 150 mm. long and 8 mm. wide between the tips of the parapodia and having 218 segments[1] has the hard, black, strictly conical paragnaths arranged as follows: I, 3 in tandem; II, small groups of 7–9 in two oblique rows; III, broad dense, transverse band of small cones chiefly arranged in longitudinal or somewhat oblique lines of six or seven each, with numerous shorter lines and small groups uniting them anteriorly; IV, dense, somewhat arched, dumbbell-shaped groups of small cones, from three to five across and tending to coalesce at their posterior ends with the lateral borders of III; V, a diffuse subcircular area spreading laterally to the level of VI and with a median row of four large paragnaths reaching anteriorly beyond the others; VI, a compact group of four or five large cones forming a lozenge-shaped figure; VI and VII coalesced and forming a broad zone encircling the basal ring of the proboscis below the level of VI and nearly joining V above, the numerous cones (from six to ten in the width of the band) increasing in size and becoming more distant anteriorly and dorsally.

The tentacles are also longer and most of the specimens are noteworthy for the deep brown pigment deposited in the lamellar notocirrophores.

The relations of this form to *N. virens* and *brandti* will be discussed fully at another time, when I hope to have for comparison specimens from other parts of the California coast.

N. foliata Baird evidently applies to the northern form; *N. chilensis* Ehlers (= *Thoosa Gayi* Kinberg) is not at present recognizable, and there appears to be no name for this southern form.

Nereis (Platynereis) agassizi Ehlers.

Nereis agassizi Ehlers, Die Borstenwurmer, 1868, pp. 542–546; Taf. XXIII, fig. 1.

A few small specimens were taken at San Diego and two at Monterey Bay, one of the latter dredged and one between tides at the "point above Third Beach."

[1] A specimen of *N. virens* from New Jersey of the same size has 130 segments.

The San Diego specimens are noteworthy for the very conspicuous notopodial spots and in one case for the equally conspicuous spots on the pygidium. The example dredged at Monterey is filled with small eggs and has the eyes enlarged, but is not otherwise modified.

EUNICIDÆ.

Eunice (Eriphyle) paloloides sp. nov. (Plate VII, figs. 5–7).

The type of this species is a nearly complete worm closely related to the celebrated "palolo" (*Eunice viridis*) which it resembles in form. It consists of a thicker anterior non-sexual region of about 200 segments and a slender posterior sexual region of more than 550 segments. Owing to the softening of a portion of the worm the exact point of transition cannot be determined and accurate measurements cannot be given. The size and proportions, however, closely approximate those of *E. viridis*.

Prostomium (somewhat distorted by protrusion of the jaws) about twice as wide as long, broadening anteriorly where it is divided into two short, wide, broadly rounded lobes by a shallow emargination which continues caudad as a dorso-median furrow; a transverse furrow passes across the posterior ventral part of each of these frontal lobes. Five tentacles arranged in a nearly straight transverse line, the middle one being slightly behind the others and in contact with the nuchal fold. Middle one slightly the longest (1½ times length of prostomium), the lateral shortest and separated from the second pair by a wider space than separates the latter from the median. All regularly tapered and transversely wrinkled, but not beaded or articulated. Eyes conspicuous, with large lenses, situated between the outer and inner paired tentacles close to base of latter. On one side a rather conspicuous pigment spot lies just anterior and external to the lateral tentacle.

Peristomium a slightly swollen naked ring considerably longer than the prostomium and forming a distinct nuchal fold dorsally, but little swollen laterally. Somite II is a short, simple, apodous ring bearing, close to the anterior border, and on a level with the lateral tentacles, a pair of short conical nuchal cirri slightly longer than the segment.

Segments of anterior region very short, flattened and concave below, at first strongly arched above but gradually becoming flatter and more depressed. Owing to the poor preservation of the segments following *CC* it is not possible to determine at just what point the epitokous sexual region separates, but a marked softening of the tissues and the enlarged size of the neural eye-spots (phototactic organs) on subsequent segments indicates that it probably occurs at *CCX*, though eye-spots of smaller size appear abruptly at *CLII*.

The epitokous region is very slender, subterete or slightly depressed, with a well-defined neural groove and distinct furrows separating segments generally about three times as wide as long. Surrounding each segment in the parapodial zone is a raised glandular band, sometimes single but oftener formed of two lines. Posteriorly the body tapers and is composed of numerous very small segments—evidently a rapidly proliferating region. The ventral eye-spots form a neural series of usually two spots to each segment: one on the glandular girdle, the other at the intersegmental furrow, sometimes one, sometimes the other being larger and frequently one or both subdivided.

Pygidium tubular and somewhat elongated, obliquely truncated with the small anus facing dorsad; posterior to anus two pairs of conical caudal cirri, of which the dorsal pair is about as long as the diameter of the pygidium and nearly three times the ventral.

Parapodia uniramal. Typical parapodia of the anterior region consist of a short, broad, truncate neuropodium, bearing a low post-setal fold behind the compound setæ and a small presetal lobe in front of the simple setæ. The simple notocirrus springs without a cirrophore from above the neuropodium and is a bent, slightly tapered blunt process reaching a short distance beyond the distal end of the foot. Neurocirrus consists of a low glandular elliptical cirrophore adnate to the side of the segment ventral to the parapodium and bearing a small, blunt, cylindroid or conical style. Farther back all parts and particularly the cirri are gradually reduced in size. The first parapodium (on III) has the setigerous lobe rudimentary, bearing only two or three setæ, and consists chiefly of a simple notocirrus and neurocirrus nearly in contact, the former shorter and stouter, the latter about twice as long, more slender, obscurely articulated and more or less bent into a bow. Several succeeding parapodia are transitional to the typical form, springing from a gradually rising level, the neuropodium gradually increasing in size and the cirri becoming smaller. In the epitokous region the entire foot is much smaller, the neuropodium a conical process whose outlines pass into the dorsal and ventral curvatures of the segments, the notocirrus a minute conical process above the foot and at the base of the gill, and a similarly formed neurocirrus arising from a thick glandular ventral area or cirrophore.

Gills appear as a pair of minute papillæ on the medial side of the base of the notocirri of *CVII* and increase in length gradually until they become slender tapering filaments having a length of one-half to one-third the body width, the longest ones in the neighborhood of somite *CC* reaching easily beyond the middle line; in the posterior region they continue nearly to the pygidium and as far as the last one hundred segments reach to the median line.

Acicula anteriorly are three or four, stout, tapered, chiefly very dark brown, the dark tips exposed, blunt, somewhat oblique but not knobbed. Posteriorly there are but two and finally one, and except that they become more slender there is no change in form.

Setæ are of two forms: simple supra-acicular and compound sub-acicular. No pectinate setæ are visible in any of the preparations. Simple setæ have long, slender shafts, dark colored toward the base, but pale distally; they project prominently, the ends being slightly doubly curved and gently tapered to very slender acute tips with a faint marginal fringe but no distinct limbus. Somite III bears only three or four simple setæ, the number increasing to about twenty on X. Behind *C* the number again diminishes, but the setæ become first longer, then very few and of small size on the caudal segments. Compound setæ (Pl. VII, fig. 5) are enlarged toward the distal ends of the shaft which bears a few small marginal teeth, the appendage broad, bidentate and slightly hooked distally and provided with a fringed guard, its length one and one-half times width of enlarged end of shaft and remarkably uniform on all parapodia. They are absent from III and numerous by X, on which they form rows extending anterior to and below the acicula. Farther back they undergo changes similar to those affecting the simple setæ.

Mandibles (Pl. VII, fig. 6) large, very hard, the horny carriers yellowish with dark lines, very thick and firm, with an angular ridge running the entire length. Jaw plates very large, white, calcareous, of stony hardness, each plate bent nearly into a semicircle at the free margin which is faintly denticulated, the dorso-lateral angle freely projecting. Maxillæ (Pl. VII, fig. 7) deep brown, hard. Carriers of forceps jaws broad with lateral emarginations and the two halves closely united except at the caudal end; forceps with broad bases marked by three longitudinal ridges, no masticatory teeth and short, strongly hooked ends. Second pair (II) massive with four stout teeth on the left and three and a rudimentary fourth on the right side. Three accessory jaws (III, IV, V) each with a single tooth on the left side arranged in a semicircle and two, one with two teeth, the other with a single tooth, on the right side.

Color of anterior end deep, iridescent purple, posterior reproductive region of male pale brown, of female greenish drab with white rings. Ventral phototactic organs brown.

Collected by Prof. E. C. Starks at San Diego, Cal. Besides the nearly complete type there is a fragment of the reproductive region of a male and one of a female, both fully mature and probably nearly ready to separate and swarm.

The occurrence of a *Eunice* with the habits of a "palolo" worm on the California coast is of much interest, and it is to be hoped that some zoologist on the ground will determine its life-history and especially the habits of swarming and if possible the conditions affecting it. While the species is closely related to *Eunice viridis* and *E. siciliensis* it is readily enough distinguished from both.

Eunice biannulata Moore.

Eunice biannulata Moore, Proc. Acad. Nat. Sci. Phila., 1904, pp. 487–490; Pl. XXXVII, figs. 10–18; Plate XXXVIII, fig. 42.

San Diego, type and cotype only.

Marphysa stylobranchiata sp. nov. (Plate VII, figs. 8–12).

Form moderately stout. Length about 100 mm. the longest 110 mm. long and 4.5 mm. in maximum width at about XXX. Number of segments 142–160.

Prostomium about one-half as wide as long, divided anteriorly into two broadly rounded prominent entire lobes which exhibit no ventral furrow or swelling. Tentacles five, smooth, short, thick, sausage-shaped, arranged in a slightly curved row near the posterior end of the prostomium; middle one longest, nearly equal to length of prostomium, the outer pair shortest, about two-thirds length of middle tentacle. Eyes small, behind interval between outer and middle tentacles, or absent.

Peristomium about three times as long as first setigerous segment, perfectly naked, divided into two rings probably representing segments, the posterior slightly more than one-half anterior, from which it is separated by a continuous faint groove. Laterally the anterior ring projects somewhat forward and is united with the sides of the prostomium, thus concealing a small internal or mandibular lobe. Remaining segments well defined by deep furrows, all short, strictly uniannular, generally one-sixth to one-eighth as long as wide. To about somite VIII the body is quite terete, but soon becomes wider than deep, the ratio in the middle region being about as five to three. Posteriorly the body tapers, first gently, then rapidly, to the pygidium, which is short, annular, radially furrowed or rosetted and bears a pair of rather stout, tapering ventral cirri as long as the last five or six segments and below these a second pair of minute cirri.

Parapodia strictly uniramous, lateral, the first five or six more ventral than the others. Neuropodium short, stout, bearing a fleshy post-acicular lobe on anterior parapodia which disappears on middle and posterior ones. Anterior to this is a row of conspicuous black acicula and a rather complex group of setæ. Notocirrus of first parapodium (III) rather stout, conical, tapering, simple, free from but immediately above foot and about twice as long as the latter; thence becoming gradually smaller caudad and in branchial region reduced to a mere tubercle, but increasing in length again posteriorly. Neurocirrus coalesced with base of neuropodium, consisting of a stout, swollen cirrophore and a short, thick, cylindroid, imperfectly differentiated style; farther back the cirrophore merges more into the body outline and the style becomes more slender but is otherwise unaltered.

Gills simple, tapering filaments throughout. The first appears as a minute papilla on the notocirrus of XVI to XX, but they are usually not developed into efficient gills for several segments. At XXI or XXII they are usually as long as the notocirrus; in the middle region they reach the middle line and posteriorly gradually diminish in size and finally disappear about twenty segments anterior to the pygidium.

Acicula three to five anteriorly, simple, tapered, black, with pale tips little or not at all exposed. They become gradually longer, constantly three in number, conspicuous with prominently projecting bluntly-pointed tips which are always pale with black cores. Somewhere between XX and XXX and on following segments an especially large one diverges from the others and protrudes from the surface between the neurocirrus and the compound setæ.

Setæ all nearly or quite colorless, of three forms: two forms of simple setæ in supra-post-acicular fascicles and compound setæ in sub-pre-acicular fascicles. Compound setæ (Pl. VII, fig. 10) numerous, especially anteriorly where they occur in several rows anterior as well as ventral to the acicula; farther back they become fewer and are confined to the ventral group. The stems are gently curved and very little thickened distally; the appendages very uniformly of a length about four times the distal diameter of the stem with obscurely hooked bidentate tips and a finely fringed border separating at the tip into the usual guard. The fascicles of simple setæ consist chiefly of curved, capillary, slightly limbate or at least flattened setæ (Pl. VII, fig. 8) considerably longer than the compound setæ. Concealed among the bases of the latter on the acicular side of the fascicle is a group of very delicate gouge-shaped, pectinate setæ (Pl. VII, fig. 9), very few anteriorly, more numerous farther back and apparently all of one form.

Jaws of somewhat soft and flexible brown chitinoid material, the teeth somewhat whitened and hardened by a calcareous deposit. Mandibles (Pl. VII, fig. 11) consisting of long, slender, strongly divergent carriers, firmly united anteriorly and bearing white, hard, calcareous, subovate distal plates with smooth and entire margins. Forceps jaws (Pl. VII, fig. 12) massive, with an undivided, shield-shaped base about three-fifths as wide as long, truncate distally, pointed behind; the forceps stout with strongly ridged but toothless bases and hooked tips flattened and angulated along the concavity. Second pair of maxillæ (II) also massive, the left one with three, the right with four stout teeth. Maxillæ (III) consist of a pair of crescentic plates bearing ridges with five teeth on the left, six on the right side; IV bears three or four stout teeth on the left side and a low edentulous ridge on the right side; V is represented on the left side only and is similar to the right IV.

Color in life unknown, but probably pale reddish like other species of the gens.

Known only from the vicinity of Monterey Bay; "big tide pool, June 20, 1905," E. C. Starks.

Marphysa californica sp. nov. (Plates VII and VIII, figs. 13–20).

This species is based upon the anterior ends of two specimens, one (type) very large, measuring 11 mm. wide and 80 mm. long for 92 segments, the other, consisting of 140 segments, 45 mm. long and 3 mm. wide. Both are much contracted.

Prostomium retracted beneath nuchal collar as far as base of tentacles, the exposed portion nearly as wide as long and consisting chiefly of the pair of broadly ovate frontal lobes divided by a median furrow that reaches nearly to the median tentacle, but with no trace of a ventral transverse furrow. Tentacles five, arising along a transverse curved line, median and outer pair subequal, the inner pair slightly longer and about equal to one and one-half times the width of the prostomium. They are longer and more slender than those of *M. stylobranchiata* and taper regularly to the end, being marked by irregular, more or less conspicuous transverse wrinkles for the entire length. Eyes one pair, inconspicuous and small, behind and external to the base of the inner paired tentacles.

Peristomium large, terete, swollen and furrowed laterally where it is more than three times as long as somite II, which is simple and apodous and about as long as the succeeding podous segments. No nuchal cirri. Remaining segments foot-bearing, the first five or six terete and narrow, after which they become wider and more depressed but not longer, those of the anterior branchial region being ten to twelve times as wide as long, decidedly depressed and equally convex dorsally and ventrally. The smaller specimen is widest at about the posterior end of the anterior fourth and tapers thence caudad. Caudal end and pygidium unknown.

Parapodia begin on II at a low level and gradually rise to about XV, where they occupy about a middle level. First four small, the others of normal proportions and differing in no essential from those of *M. stylobranchiata*, although the postsetal lobe is relatively broader (that of IV is abnormally bifid).

Gills when fully developed pectinate, consisting of a short basal stem bearing from four to six slender, tapering, cross-wrinkled, crowded filaments not exceeding a length of one-fifth of the body width and none of which reaches the median line. On the type they begin at XXXIII on the left side with two filaments and at XXXIV on the right side with two filaments; three filaments occur on each side of XXXVI; for the next fifteen segments four is the usual number of filaments; between LV and LXV five is more frequent and thence to LXXXV or LXXXVI the maximum number of five or six or rarely even seven occurs; behind this to the end of the piece all gills are quinquefid. On the smaller specimen the gills begin farther forward and are much simpler. From XX or XXI to XXV they are simple, to XLIV and LI bifid, thence to about XC mostly trifid, then again bifid to CXXIV, and after that to the end of the piece they consist of a single filament.

Neuropodial acicula are simple, straight, tapered, blunt-pointed spikes, black or nearly black to the tips. On anterior parapodia there are four to six, with the tips little or not at all exposed and arranged in an oblique series between the two tufts of setæ. Farther back on middle segments there are only three much stouter acicula, the nearly black tips of which are conspicuously exposed. The cotype has only two of the spinelike acicula on middle parapodia and in addition a pale, more slender, bifid and hooded ventral crochet (Pl. VII, fig. 16), which is missing in all of the preparations made from the type.

Setæ generally more prolonged than those of *M. stylobranchiata*. Post-supra-acicular tuft very dense on anterior segments, consisting of numerous curved, tapering alimbate setæ (Pl. VII, fig. 13), the dorsal ones longer, more slender and colorless, the ventral shorter, stouter and yellow. On these segments the pectinate setæ are few and difficult to see and bear numerous fine teeth (Pl. VII, fig. 14*a*).

Farther back the slender setæ become fewer and the pectinate setæ of two forms, the one like those on anterior segments, the other (fig. 14*b*) with few coarse teeth. Compound setæ have the distal end of the stems somewhat coarsely toothed and the appendages very long, slender and tapered, with scarcely visible marginal denticulation (Pl. VII, fig. 15); more dorsal appendages are fully twice as long as the most ventral and all appendages become longer caudad.

Jaws deep brown, moderately hard but generally less massive than those of *M. stylobranchiata*. Mandibles (Pl. VII, figs. 17, 18) of two sides only slightly united, the carriers moderately divergent, long, regularly tapered and rather rough; calcified end-plates small, irregularly elliptical and coarsely toothed on the margin. Forceps jaws (Pl. VIII, figs. 19, 20) with carriers of incompletely united halves, quite as wide as long, broad and truncated at both ends and with a deep lateral notch about the middle of each side. The forceps have broad, strongly ridged hinge bases and edentulous masticatory plates, the distal part being comparatively slender and not strongly hooked. The second pair of maxillæ (II) are large and nearly symmetrical, each bearing four or five large, stout, hooked teeth. The next plate (III) is curved and much larger on the right, on which it bears seven or eight blunt conical teeth, than on the left side which bears six. In addition the right side bears a single small jaw, consisting of two thin plates meeting in a thickened ridge (IV). On the left side is a similar but smaller lateral jaw (V) and an internal curved plate bearing about six marginal teeth (IV).

Color anteriorly dull reddish purple marked with numerous small white spots, the cuticle with a greenish iridescence. Posteriorly the color is grayish with a pink tinge.

Type locality San Diego; E. C. Starks, collector.

ONUPHIDÆ.

Diopatra californica Moore.

Diopatra californica Moore, Proc. Acad. Nat. Sci. Phila., 1904, pp. 484–487, Pl. XXXVII, figs. 1–9.

San Diego, six specimens, including the type and cotype, taken in the tidal zone. Some of the gills are less elongated than in the type, and on one the spiral arrangement continues to about XXXIV. When perfect the tentacles taper to slender tips, the median reaching to XX, the inner pair to XVIII and the outer pair to XII. On one counted the last gill is on LVI.

LUMBRINERIDÆ.

Lumbrineris zonata Johnson.

Lumbriconereis zonata Johnson, Proc. Bos. Soc. Nat. Hist., XXIX (1901), pp. 408, 409; Pl. 9, figs. 93–100.

San Diego, several. Monterey Bay, numerous specimens taken at the following named points: "big tide pool," June 20, 1905; "point above Third Beach," July 12, 1904, and July 6, 1905; "Moss Beach," July 7, 1905; and "picnic tables, 17-mile drive," June 29, 1904.

This species is generally more slender than the next, the largest example reaching a diameter of only 3 mm. The cuticle frequently exhibits a beautiful greenish luster. Many of the specimens are brown or purplish-brown with darker spots on the prostomium, peristomium and on the sides of the setigerous segments; others are conspicuously annulated with dark brown bands and others nearly uniform in color. Those carefully studied have the setæ arranged in some of the anterior parapodia (V–XV) as follows: 3 or 4 large bilimbate dorsal setæ, 3 or 4 short hooded crochets in the middle and 3 small sigmoid bilimbate setæ below. The large maxillæ commonly bear four or five teeth. The caudal end tapers rapidly to a minute tubular pygidium bearing a pair of closely approximated, very short, thick, blunt cirri.

Lumbrineris erecta Moore

Lumbriconereis erecta Moore, Proc. Acad. Nat. Sci. Phila., 1904, pp. 490–492; Pl. XXXVII, figs. 19–22, Pl. XXXVIII, figs. 23–25.

Unlike the last this species appears to be most abundant at San Diego, where about forty specimens were taken in the littoral zone. At Monterey Bay several were taken at "big tide pool," June 20, 1905, and "Third Beach Point," July 6, 1905.

The largest measure nearly 7 mm. in diameter. The prostomium may be broad and obtuse or pointed. The posterior parapodia bear very long erect lobes which are the distinguishing feature of this species. The large maxillæ bear four teeth. Stalked infusoria are frequently attached in the furrows between the parapodia.

Drilonereis nuda sp. nov. (Plate VIII, figs. 21–23).

Excessively elongated and filamentous and of nearly uniform diameter. The three complete specimens in the collection are respectively 327, 445 (type) and 630 mm. long, with 480, 652 and 935 segments, the maximum width being 1.3 mm. and the depth 1 mm.

Prostomium strongly depressed, about one-third as deep as broad and nearly as broad as long in the type, but more extended in one cotype, broadly rounded in front, slight median grooves extending for most of the length of both dorsal and ventral faces. No eyes or nuchal organs visible.

Peristomium a simple ring, strictly terete and about one-half as long as and slightly wider than the prostomium; its free ventral border forming a furrowed lip bounding the large mouth.

Somite II also achætous, slightly smaller and more strongly convex laterally, in the latter respect resembling the setigerous segments. Body terete or with the venter slightly flattened, a little wider than deep and with a more or less evident longitudinal parapodial furrow along the sides. It is slightly enlarged in the middle and tapers gently both ways, the posterior end being more slender. Setigerous segments simple or when contracted faintly triannulate; anterior segments one-third as long as wide, middle and posterior often as long as wide. Pygidium a simple ring with vertical slit-like anus and no trace of cirri.

Parapodia (Pl. VIII, fig. 21) strictly lateral, minute, the posterior ones slightly larger but never exceeding one-third the length of their somites; all similar, consisting of a small rounded setigerous tubercle and a small postsetal lobe slightly flattened and bent dorsad.

Setæ few, varying from nine to eleven anteriorly and six or seven posteriorly; all pale yellow and of one form (Pl. VIII, fig. 22), somewhat geniculate, with the narrowly limbate end exhibiting a gentle sigmoid curve. In the bundles they tend to separate into a dorsal and a ventral group, the former including the somewhat larger number, or into three groups, the dorsalmost of which is formed of one, two or three setæ having somewhat more prolonged tips than the others. Anterior parapodia are supported by one or two stout acicula completely concealed within the body walls. At about XXV to XXX the aciculum (or acicula) reaches the surface and projects as a stout spine (or 2) ventral to the fascicle of setæ (fig. 21), a condition that continues to the caudal end. When two acicula are present one is usually stouter and is accompanied by a minute delicate seta, probably the tip of an undeveloped ordinary seta.

Jaws when at rest and retracted in somites VIII to X. Although the pharynx is lined throughout by a thick cuticle there is no trace of mandibles in the two specimens dissected. Maxillæ (Pl. VIII, fig. 23) black, dense and very hard; the forceps jaws (I) broad at base, stout, very strongly hooked at the end and lacking basal masticatory teeth; their paired filamentous carriers twice as long as the entire series of jaws and distinct nearly to the anterior end, where they unite into a small vertical plate bearing on its ventral margin an irregular horizontal plate with ragged tendons for muscular attachment. Second pair of maxillæ (II) thick, triangular, curved plates bearing a thin internal accessory plate or wing, and about five marginal teeth on the left and seven on the right side, the most anterior in each case being strongly hooked and much the largest. The anterior pairs (III and IV) are small plates with one very acute, erect, claw-like tooth, III, having on the left side one and on the right side two additional small internal cusps. On the left side there is also a minute V bearing two small hooked teeth.

Color brown, each somite sometimes with two dark rings which may be concentrated in deep spots above the parapodia. Cuticle with a brilliant green iridescence.

The specimens were taken at a big tide pool near Monterey Bay, the type on July 6, 1905, and the cotypes on June 20, 1905.

STAURONEREIDÆ.

Stauronereis moniloceras sp. nov. (Plate VIII, figs. 24–29).

Form moderately slender, stoutest in pharyngeal region, thence tapering regularly caudad; anterior end broadly rounded, strongly arched above, flat below becoming rather more depressed posteriorly but the dorsum remaining rather strongly arched. Maximum length recorded 69 mm., width in pharyngeal region 3 mm.; number of segments up to 110.

Prostomium subgloboid, not annulated, broadly shield-shaped in outline, slightly longer than broad, slightly contracted toward the posterior border which bears a small, median, rounded lobe united with the median peristomial lobe. Ventrally a pair of conspicuous palpal ridges separated by a deep cleft pass from the prostomium into the mouth and terminate in pointed processes within the buccal chamber. Dorsal tentacles arise from sides of prostomium just behind the middle, are about one and one-half times as long as prostomium, slightly curved and divided into about seven (6–8) short joints. Very conspicuous palps arise from beneath the tentacles from enlarged bases continuous with the palpal ridges and curve boldly back round the sides of the mouth; they are about one and one-half times as long as the tentacles, rather strongly flattened proximally and undivided except for a few transverse furrows along the concave side. Eyes two pairs, black, conspicuous, rounded, the posterior dorsal and close to the posterior border, the anterior dorso-lateral and just anterior to base of tentacles.

Peristomium enlarged and swollen, three times as wide as prostomium, nearly twice as wide as long and about as long as three succeeding segments, uniannular, strongly convex and elevated above and divided anteriorly into three lobes: a median united with the median prostomial lobe and a prominent lateral pair which embraces the sides of the prostomium as far forward as the tentacles. Nuchal organs between these lobes and the prostomium, deep, quadrate, with furrows passing from the angles. Mouth large with deeply furrowed lips, cutting the peristomium nearly to its caudal border.

Somite II a simple apodous ring one-third as long as the prostomium. Succeeding segments podous, but otherwise similar to II. Anteriorly they are one-eighth to one-sixth as long as wide, but become one-fourth to one-third as wide in the middle and posterior region. All perfectly simple with rounded, bulging sides and separated by deep furrows; a projection below each parapodium, combined with the flattened venter, produces an almost sole-like surface.

Pygidium an oblique ring with anus directed obliquely dorsad and surrounded by a low welt. Caudal cirri two pairs, behind anus; the more dorsal cylindrical, longer, about equaling diameter of pygidium and formed of four or five articulations; the more ventral about one-half as long, clavate and formed of two articulations.

Parapodia arise from a slight depression close to the ventral level of the segments and project prominently directly laterad to a distance of more than one-half width of body. They are uniramal, consisting of a prominent neuropodium, compressed and somewhat expanded distally where it is divided into a broad rounded postsetal lobe, a shorter presetal lobe subdivided into two small secondary lobes and a small subsetal lobe. In different regions the form of these lobes varies somewhat and especially they become more pointed posteriorly. Neurocirri arise from basal half of venter of neuropodium, and as a simple conical or subcylindrical process reach nearly as far as its end. Notocirri arise in contact with dorsal base of neuropodium and consist of a long cylindrical cirrophore ciliated on its ventral side, probably representing the notopodium, as it contains a slender aciculum or rarely two acicula, and reaching beyond the end of the neuropodium except on anterior segments; at its end it bears a conical style about one-third its length. The first parapodium (on III) differs from all of the others in its very small size, greater simplicity (being entire distally), in its short, rounded neurocirrus and especially in the total absence of a notocirrus.

Neuropodial aciculum always single, moderately stout, tapered, straight, with a simple blunt point. Notopodial acicula, one, or rarely two, very slender, almost fibre-like, tapered and reaching nearly to tip of cirrophore. All acicula pale yellow.

Setæ perfectly colorless and vitreous, of two kinds: simple supra-acicular and compound subacicular. The former (Pl. VIII, fig. 25) number 15–20 on anterior parapodia, and become gradually fewer and stouter posteriorly until they are reduced to a single rather stout one. They are gently curved, slightly tapered and faintly fringed along the convex side, and terminate rather abruptly in a small blunt hook which is embraced between a pair of guards difficult to observe on the more slender setæ, but sufficiently obvious on most of the stouter ones. Compound setæ form an oblique spreading tuft of twenty to thirty on anterior and about one-half as many or even fewer on posterior segments. The stems (fig. 24) are gently curved, slightly enlarged and obliquely truncate distally, and just perceptibly denticulated on the convexity. Appendages subtriangular, their length two or three times the distal width of the shaft, tapered to the prominently hooked tip, below which is a conspicuous accessory tooth, the whole protected on one side by a very delicate, minutely denticulated guard.

The jaws of only one specimen were dissected. The smallest ones are deep brown, the others black and opaque. Mandibles (fig. 26) are heavy, with forcep-shaped bases and massive end-plates, the convex margins and ends of which bear a series of blunt teeth and are much broken with use; a thin chitinoid streamer containing two or three black nodules is appended to the lateral side of the tip and the two plates are lightly jointed medially. Maxillæ form two long bands extending through about eight segments and borne on the dorsal face of a thick muscular pad. They are slightly united behind and each consists of three series of denticles of about thirty-five or forty each, besides a posterior tract where the separate denticles of each series have coalesced. All free denticles have more or less deeply cleft V-shaped bases, and those at the anterior end of each series are most complex, hooked and slender. The inner series consists of small denticles (figs. 29*a* and *b*), the anterior members of which have a pair of long, subequal, acute teeth often flanked by smaller ones; passing caudad the lateral teeth disappear and then one of the large teeth, leaving a series of one-toothed plates that soon unite into a serrated band. Jaws of the outer and middle series are much larger; the outer ones (fig. 27) with strongly curved stems and several acute teeth arranged asymmetrically near the end; several of the most anterior are very slender, strongly falcate and nearly simple, but they soon become more complex and then more massive, with the lateral teeth shorter and less distinct; finally they coalesce into a flexible band. Those of the middle series (fig. 28) are generally similar to the outer, but tend toward greater symmetry and undergo similar changes caudally, where they tend to unite with the jaws of the outer series as well as with one another. Sometimes the outer series is partly deficient.

The type is a female filled with large eggs and of a generally pale color tinged with rich rusty yellow anteriorly.

It was taken at Monterey Bay on June 20, 1905, by Mr. E. C. Starks. Additional specimens were collected at the point above Third Beach, vicinity of Monterey Bay, on July 12, 1904.

This species resembles *Anisoceras vittata* Grube and Oersted somewhat closely, and more complete information regarding the latter, which was taken at Punta Arenas, Costa Rica, may establish their identity. It is, however, much larger than Oersted's specimens and differs from Grube's description in several other respects.

GLYCERIDÆ.

Glycera nana Johnson.

Glycera nana Johnson, Proc. Bos. Soc. Nat. Hist., XXIX (1901), p. 411, Pl. 10, figs. 103, 103*a*.

Seven specimens, one of large size, were taken at San Diego.

Glycera rugosa Johnson.

Glycera rugosa Johnson, Proc. Bos. Soc. Nat. Hist., XXIX (1901), pp. 409–411; Pl. 10, figs. 101, 102.

San Diego, six specimens. Some of these have the branched gills extended on nearly every parapodium; on one they reach far beyond the parapodial lobes; others have all or nearly all retracted.

Hemipodia borealis Johnson.

Hemipodia borealis Johnson, Proc. Bos. Soc. Nat. Hist., XXIX (1901), pp. 411, 412; Pl. 10, figs. 104, 104*a*.

San Diego, four specimens; Monterey Bay, one at point above Third Beach, July 12, 1904.

An example 60 mm. long and 2.5 mm. in maximum width (exclusive of the parapodia) in the anterior fourth tapers regularly to the caudal end, and has 141 strongly biannulate segments which become relatively longer caudad where the larger podous annulus may be again divided.

The "head" consists of a wider basal two-fifths or more, consisting of at least two segments bearing minute setigerous parapodia, the peristomium and a portion of the prostomium. It includes the mouth, which is bounded laterally by a pair of large, low pads. The anterior part is a short, somewhat depressed, rapidly tapered cone obscurely divided into about eight rings and bearing at the apex two pairs of small but distinct, slender, divergent tentacles.

The parapodia agree with Johnson's figures; anteriorly they are small, but gradually increase in length until the posterior ones become quite prominent and slender.

ARICIIDÆ.

Aricia johnsoni sp. nov. (Plate VIII, figs. 30–33).

The solitary specimen upon which the following description is based lacks perhaps about 100 caudal segments, the remaining 182 segments measuring 72 mm., and in the widest part of the anterior region is 3 mm. wide and 1.8 mm. deep.

Prostomium small, acutely conical, about twice as long as the basal width, bearing at the apex a minute cirriform palpode, the base slightly swollen and on the dorsal surface exhibiting an obscure transverse row of minute specks, probably eye-spots.

Peristomium a truncated cone nearly as long as the peristomium and two to two and one-half times as broad; on its venter is a quadrate, cushion-like area, behind which the minute mouth lies between it and somite II.

Anterior region of body strongly depressed, elliptical in section and scarcely two-thirds as deep as wide, increasing in width rapidly to X, then more gradually to the widest point at XVIII or XIX, following which is a rather marked constriction extending over about ten segments (those bearing the pectinated ventral folds). The entire posterior region is very strongly convex below, flattened above, and bears the parapodial lobes, setæ and gills in a dense brush-like arrangement. Intersegmental furrows well marked; segments of anterior region one-third to one-fifth as long as broad, obscurely biannulate owing to a slight welt and groove encircling them opposite the parapodia; segments following region of ventral pectinations simple and much shorter. Pygidium unknown.

The ventral half of the welts alluded to above is better developed than the dorsal half and bears the pectinated folds which are incipient, as two or three small slender papillæ, on each side of the neural line of XXI and XXII. On XXIII they reach from the neuropodium to the middle line, consisting of five or six closely contiguous smaller papillæ at the dorsal end and two or three larger detached papillæ at the ventral end. On succeeding somites the number of papillæ increases to fifteen or sixteen on each side, all but the two or three ventralmost being in a close transverse series beginning immediately beneath the neuropodia. On XXIX the papillæ become fewer and less crowded and the next three segments bear only two or three detached papillæ on each side immediately beneath the neuropodia, the median area being bare.

Parapodia of the anterior region are lateral and consist of low sloping neuropodial platforms, bearing palisades of four to six rows of setæ backed by a low postsetal fold. In the neighborhood of XV, where they are largest, they are about twice as deep as long, but anteriorly the depth diminishes until it scarcely exceeds the length, while behind XV they gradually decrease in both length and depth and in the pectinated region shift dorsad to assume the form characteristic of the posterior region at about XXII. Notopodia of anterior region inconspicuous spreading tufts of sessile setæ immediately dorsad of the neuropodia. When fully changed, beginning at XXIV, the parapodia of the posterior region are strictly dorsal, borne with the gills on a transverse fold. Each ramus consists of an elevated setigerous tubercle bearing a small erect tuft of slender capillary setæ and, in the case of the neuropodium, a postsetal lobe divided into a minute conical ventral part connected by a membrane to the side of the segment, and a larger somewhat foliaceous dorsal part, while the postsetal lobe of the notopodium is slightly foliaceous, sublanceolate and abruptly bent at the base where it embraces the setæ tuft. The only change caudad is an increasing prominence for a time of the parapodia and a progressive increase in length and slenderness of the notopodial postsetal lobes.

Gills begin on XX as a pair of minute papillæ situated on the dorsum and well separated from the notopodia. They increase in length gradually and are fully developed only on segments following the pectinated region, where they increase correspondingly to the growth of the parapodia, but alway rise above the notopodial lobes as erect, slightly flattened, lanceolate and ciliated processes close to the median line and united with the opposite member of the pair by a low membrane.

No color remaining. Proboscis unknown.

Notopodial setæ of anterior region in spreading tufts, rather short, tapered, flexible, capillary, with conspicuous subannular cameration and along one side a small oblique opening into each chamber (Pl. VIII, fig. 32). In the posterior region they are straighter, much longer, more slender and erect, and associated with the capillary setæ in the ventral part of middle and posterior bundles are a few very delicate bifurcate setæ of peculiar form (fig. 33). They have the slender stem with half-round collar flanges which appear in profile as marginal serrations; the end of each prong is expanded and slightly bilobed and provided along the inner side with long oblique hairs. Anterior neuropodials form dense palisades of four to six series of chiefly short, blunt, somewhat clavate, yellow spines, bent near the end and marked with transverse serrulæ at the convexity and with the tips enclosed in a sheath (fig. 30). Those of the most caudal series of each palisade are more slender and bear a slender, tapered, smooth tip; and at the ventral border of each is a small tuft of setæ like the notopodials but smaller. Neuropodial fascicles of the posterior region are small, compact, erect and consist of a few very slender, straight setæ (fig. 31) with minute appressed teeth along one side. Setæ all colorless.

This species was taken at Moss Beach, near Monterey, Cal., on July 7, 1905. It is probably the species mentioned as occurring commonly on the California coast by Dr. H. P. Johnson, our leading authority on the Polychæta of that region, to whom it is a pleasure to dedicate it. The type is a female filled with large eggs.

Naineris robusta sp. nov. (Plate VIII, figs. 34–37).

Form generally similar to *N. longa* but decidedly stouter, tapered both ways from the middle, the anterior end more depressed and broadly rounded into the prostomium, the posterior region subterete, strongly convex below, flattened above. The largest specimen is 170 mm. long and has a maximum diameter in the middle of the body of 4 mm.; from 26 to 30 segments constitute the anterior region and as many as 360 the posterior region.

Prostomium broad, flat, somewhat shovel-shaped, broadly rounded and with a thin margin anteriorly; posteriorly somewhat narrower and retracted within the peristomium; ventrally it is continued by a somewhat swollen rugous area to the mouth and is united to the anterior peristomial ring. No eyes; deep lateral recesses at the properistomial furrow represent the nuchal organs.

Peristomium a somewhat indistinct naked ring about equaling II, simple above, below split into two rings between the rugous folds of which the mouth lies.

Segments of anterior region about eight times as wide as long, convex below, slightly concave above and about half as deep as wide. Passing into the posterior region the segments become shorter (about 12 times as wide as long), much deeper, very convex below and nearly flat above. No sharp boundary exists between the two regions, but estimated by the segment upon which conspicuous neuropodial setæ cease twenty-eight may be counted in the anterior region.

Pygidium a short tube with large terminal anus surrounded by a membrane bearing a circle of minute papillæ and a small but distinct pair of ventral cirri knobbed at the ends.

Parapodia begin on II. When fully developed at about X the neuropodia consist of low fleshy projections at the extreme dorsal level of the sides; they bear a scarcely evident presetal lobe and a more prominent thick postsetal lobe which rises above into a free process especially evident on the more restricted neuropodia of anterior and posterior segments. Setæ are of a deep brown color and form a conspicuous palisade of five or sometimes six vertical series arranged in an elliptical area three times as deep (dorso-ventrally) as long (antero-posteriorly) on middle segments, but less deep anteriorly and posteriorly. In the posterior region neuropodia become reduced to small pointed processes situated ventro-laterad of the notopodia, with which they are united by an integumental fold; they bear a tuft of inconspicuous setæ. Notopodia of anterior region dorsal, separated from the neuropodia by a short interval and consisting of a short setigerous tubercle and a small but prominent postsetal lobe thickened along the lateral border and rising mesially into a pointed process; they bear small spreading tufts of setæ of various lengths, the longest directed mesially. Except that they become more elevated, the postsetal lobes erect and sublanceolate in form and the setæ reduced to small vertical fascicles, the notopodia are little changed in the posterior region.

Branchiæ appear at from VII to X as slender and inconspicuous processes as long as the segment and arising from the dorsum just mediad of the notopodia. No marked change is undergone until, passing into the posterior region at about XXIX, they abruptly become much longer, flattened and lanceolate, densely ciliated on both borders and united to the notopodia by a membranous fold. They completely fill the dorsal field between the notopodia and generally extend mediad until they touch and bend sharply dorsad. They continue to the posterior end.

No clear distinction between acicula and setæ exists, but some of the latter reach deeply into the body walls and serve for muscular attachment. On typical anterior neuropodia the stout, brown setæ form a conspicuous palisade of five (or rarely six) vertical rows which bend backward and successively overlap. Those of the posterior series (Pl. VIII, fig. 34) are stouter than the others, with short, blunt roughened tips; the others (fig. 35) are abruptly contracted immediately beyond the surface of the body and taper into long, acute tips finely denticulated along one margin. There is also a small ventral group, arranged in a few obliquely longitudinal rows, of slender capillary setæ denticulated and camerated like the notopodials. Anteriorly these capillary setæ increase in number, the tips of the stouter setæ lengthen and the rows become shorter, although remaining five. Posteriorly the length of the rows again decreases and at about XXX their number is abruptly reduced from five to three and the stout setæ quickly disappear, leaving only the ventral capillary setæ. These are colorless and exactly like the notopodials of the same region, except that they are somewhat shorter and the fascicles more spreading. They undergo little change throughout the posterior region, but on middle and posterior segments six or eight small blunt spines appear among their bases and probably represent the projecting ends of acicula. Except that the tufts are larger and more spreading in the anterior and more erect in the posterior region the capillary notopodial setæ do not differ. They are colorless, slender with much attenuated tips, slightly curved and the distal half asymmetrically camerated and finely denticulated along the convexity (fig. 36). A very small number of bifurcate setæ (fig. 37) are associated with the capillary setæ in the ventral part of the bundle, but they are difficult to see and appear to be absent from the anterior and many segments of the posterior region.

The protruded proboscis has the form of a rosette with ruffled margins, the deepest folds dividing it into four lobes, each of which is again subdivided into two, three or four much folded lobules.

Color pale brown with neural and infrapodal series of spots, or more extensively pigmented with dark brown.

The type and two other examples, the former being an egg-bearing female, were taken between tides at San Diego, and a single specimen at Monterey Bay on June 20, 1905.

Naineris longa sp. nov. (Plate VIII, figs. 38–42).

Form moderately slender; the anterior region slightly wider and obscurely separated from the posterior by a slight constriction, rather strongly depressed, flattened above; posterior region gently tapered caudad, strongly convex below, flat above. Length up to 140 mm., of which the anterior region is 16 mm.; width and depth at caudal end of anterior region respectively 3 mm. and 2.5 mm. Number of segments of full-grown worms 290 to 310, of which 22 to 26 belong to the anterior region.

Prostomium broad, flat, about twice as wide as long; anterior border gently convex and slightly upturned; ventral surface extended somewhat backwards to the mouth as a slightly rugous area; a few spots of pigment but no distinct eyes on the dorsum. On each side at the junction of prostomium and peristomium is a deep nuchal pit.

Peristomium a distinct achætous ring, longer than either prostomium or somite II, simple and entire dorsally, but ventrally divided nearly or quite to its posterior border by the large subtriangular mouth, a small median process of II projecting slightly into the incision.

Two regions of the body not sharply defined, distinguished chiefly by differences in character of the notopodia and degree of development of the gills. Segments of anterior region depressed, convex below and flat above, distinct and sharply defined by well-marked but not especially deep furrows, uniannular marked by a slight transverse ridge ventrally and by a pair of faint impressed paramedian longitudinal lines dorsally. Segments of posterior region short, at first much crowded but farther back much less so, similar to those of anterior region, but lacking the dorsal impressed lines and much more strongly convex below. Caudal end depressed and broadly rounded, ending in a short tubular pygidium with large anus directed slightly upward and surrounded by a circle of papillæ and a pair of minute ventral cirri.

Parapodia biramous, beginning on II and situated at a high level. Neuropodia of anterior segments small, rather fleshy, elliptical sloping prominences about as deep dorso-ventrally as long antero-posteriorly, and produced into small rounded postsetal lobes which on more posterior segments tend to be prolonged dorsad. They are largest on the middle segments of the region and the three rows of stout setæ that they bear are here stoutest. Notopodia separated from neuropodia by a deep groove and consisting of small tubercles bearing a slender tuft of capillary setæ, behind and below which is a subconical, erect postsetal lobe most prominent on anterior somites, and when best developed bearing a convex wing on the ventral side of its base. On posterior segments of this region the neuropodia become smaller and shifted dorsad and the rami crowded. On the posterior region both rami are borne on the dorsum and so closely approximated that they seem almost to have a common somewhat elevated base. Both rami are foliaceous, the neuropodium small and somewhat mammilliform bearing its setæ in a fan-shaped fascicle; the notopodium consisting of an erect, sub-lanceolate postsetal lobe and bearing a small compact tuft of setæ.

Gills begin on from X to XII as slender, erect, conical processes on the dorsum immediately above the notopodia. They undergo little change to the last two or three segments of the anterior region, where they rather abruptly become longer and thicker. On anterior segments of the second region they extend transversely across the dorsum from the notopodia and meet medially, but though continuing to the posterior end they become gradually smaller. Each includes a single vascular loop, and is heavily ciliated along the medial margin.

Notopodial capillary setæ (Pl. VIII, fig. 40) appear to be similar throughout—soft, slender, tapered, regularly and closely provided with obscure, incomplete sheaths, corresponding to slight internal cameration. The fascicles are slightly more spreading anteriorly, more compact and erect posteriorly. At the base of the notopodials on the ventral side of the tuft are three or four small and delicate bifurcate setæ (fig. 42) with serrated stems and slender tapered prongs bearing a series of long oblique hairs. Neuropodials of the posterior region are mostly similar to the notopodials, but the sculptured region is shorter, and in addition there is a ventral series of about six small smooth blunt spines (fig. 41). Anterior neuropodials are arranged in three nearly vertical series, the first extending most ventral. All are stout, but those of the anterior two rows (fig. 39) bear slender terminal portions similar in structure to the notopodial setæ but much more abruptly tapered; those of the posterior series are stout, curved, smooth, clavate spines (fig. 38). Ventral to the palisade is a crescentic series of smaller capillary setæ. All of these setæ are stoutest in the middle and posterior parapodia of the anterior region, but on the last few transition segments rapidly become more slender and the series short and restricted from the ventral end. Or it may be said that the three series of stout spinous setæ gradually disappear, finally leaving only the ventral group of slender setæ with a few small spines.

Proboscis partially protruded on several specimens. It appears to consist of four principal divisions, each again bilobate and bearing from four to ten slender elongated processes with a continuous hem-like raised border, leaving a longitudinal groove on each. The lobes are often irregular and unequal and some specimens appear to have the proboscis divided into from five to eight fimbriated lobes.

Color in alcohol dull creamy yellow, more or less marked with brown pigment which is most constant as three series of ventral spots, a subneural and paired infra-podal. Others have the gills or parapodia pigmented and others the dorsum marked with suffused spots or well-defined annulations, while extreme forms may be deep chocolate brown.

This species appears to be quite plentiful between tides in the vicinity of Monterey Bay and was taken at Third Beach Point (which is the type locality) on July 6, and at "big tide pool" on June 20. A single example also occurs in the Starks collection from San Diego, also taken between tides.

CIRRATULIDÆ.

Cirratulus spirabranchus Moore.

Cirratulus spirabranchus Moore, Proc. Acad. Nat. Sci. Phila., 1904, pp. 492, 493; Pl. XXXVIII, figs. 26 and 27.

Cirratulus luxuriosus Moore.

Cirratulus luxuriosus Moore, Id., pp. 493, 494; Pl. XXXVIII, figs. 28–31.

Both of these species are quite plentiful between tides on the beach at San Diego.

Tharyx multifilis sp. nov. (Plate IX, fig. 43).

The type (a male) is 58 mm. long and has a maximum diameter at the end of the anterior third of 2.1 mm. The segments number 240. A female is slightly smaller and more slender.

Prostomium (fig. 43) a short slightly depressed cone with a rather deep ventral longitudinal groove and just anterior to it a transverse one. No eyes visible, though there is a slight discoloration near the posterior border. A pair of swellings behind and above mouth are the nuchal organs, but there is no trace of appendages.

Peristomium—probably representing three coalesced segments—a large, swollen, apodous region about twice as wide and long as the prostomium and marked with one or two partial furrows. Mouth large, with smooth lips.

Remaining segments setigerous, the anterior region about six millimeters long, consisting of about sixty excessively short segments, twelve to twenty times as wide as long, depressed and somewhat widened. Behind this the body is nearly terete, slightly flattened below and composed of longer, feebly separated segments about six to eight times as long as wide. Segments all perfectly simple and uniannular. The body increases in diameter through the anterior third and then tapers gradually to the caudal end, terminated by a minute pygidium with its central anus surrounded by a welt-like rim. A narrow neural groove extends for the entire length and forks at the peristomium to embrace the mouth.

Parapodia consisting of minute setigerous notopodial and neuropodial tubercles, the latter situated close to the ventral surface at the foot of the strongly arched dorsum. Immediately above the first arises the pair of large clavate tentacular cirri, which have a diameter nearly equal to the length of the prostomium and a length of nearly one-third the body, grooved and crenulated for the entire length, narrow at the base and becoming gradually thicker toward the distal end. One specimen bears a pair of minute branchiæ on this segment; on the other they begin on the following segments. The branchiæ are very delicate extensile vascular filaments, which in all cases arise in actual contact with the dorsal side of the notopodium. In perfect specimens they probably occur on every segment except about twenty at the caudal end, but in both of the two here described they are small or absent on many of the middle ones. In the anterior depressed region they are more firmly attached and longer than elsewhere, occur regularly on every segment and form a crowded tangled mass.

Setæ perfectly simple, colorless, smooth, slender capillaries, forming small, spreading, fan-shaped notopodial and neuropodial tufts; except that the notopodials are longer than the neuropodials and the anterior longer than the posterior they are all exactly alike, the longest equaling one-half the body diameter.

Color of male pale brownish, of female deep slate color.

Since the type of the genus *Heterocirrus* has been shown to be an epitokous phase of *Dodecaceria*, the next available name for such forms as *Heterocirris multibranchis* and the present species is *Tharyx* Webster and Benedict.

Dodecaceria paoifica (Fewkes) (Plate IX, fig. 44).

Sabella Pacifica Fewkes, Bull. Essex Inst., XXI (1889), pp. 132, 133; Pl. VII, figs. 1, 2.

More than a score of well-preserved examples of this species permit of the preparation of a description more complete than the original.

Usual length 30 to 40 mm., but sometimes extended to nearly twice that length; maximum diameter about 1 mm.; number of segments from 90 to 110.

Body generally terete, usually slightly enlarged in the middle and tapered a little each way, but often depressed and distinctly widened at the posterior end; irregular enlargements and constrictions often present at one or two other points. When depressed the venter is flat, the dorsum convex.

Prostomium and peristomium completely coalesced, together forming a subconical head about one and one-half times as long as wide, entirely without definite appendages, but with a pair of small dorsal spots which probably represent the nuchal organs. The anterior half, representing the prostomium, is a somewhat scoop-like, broadly rounded lip deeply excavated below and overhanging the mouth, from the sides of which project a pair of small lobes probably representing palpi; these lobes and the ventral surface of the lip are pale, in sharp contrast to the nearly black surface of the remainder of the head. The posterior or peristomial half is a simple naked ring.

Several of the immediately succeeding metastomial segments are very short, but those following become gradually longer until they are one-fourth or one-third as long as wide, but caudally they again become very short and crowded and end in a simple pygidium with rather large central anus.

The first metastomial segment (II) bears a dorsal pair of simple terete branchial filaments or notocirri which in extension are smooth and three or four times as long as the head and in contraction transversely wrinkled and much shorter; ventral to these is a pair of usually shorter and thicker neurocirri or prehensile tentacles which are grooved along the ventral face and transversely wrinkled. The latter vary much in length in different specimens, being in some less than the diameter of the body, in others more than three times the diameter. Notocirral branchiæ also occur on from seven to ten next succeeding segments (III to IX or XII). Of these the first three are commonly larger than that on II, and because of the dorsal position of the latter and the extreme shortness of the segments lie at successively lower levels in a nearly vertical series; the fifth and succeeding pairs arise immediately dorsal to the notopodial setæ and on the same level as the fourth pair. Specimens from the vicinity of Monterey Bay have the fifth and rarely the sixth pair nearly as long as the more anterior, but on those from San Diego they are always much shorter like the remaining more caudal pairs, the last of which are usually mere rudiments.

Parapodia very small, lateral notopodial and ventro-lateral neuropodial tubercles separated by a small interval. Small tufts of notopodial and neuropodial setæ begin on II. On from eight to eleven segments they are all slender, finely serrate setæ, most numerous and longest in the notopodia, in which they may be as long as their segment or longer. At from IX to XII two stout yellow spines, bifid and hooked at the end, appear in the neuropodium and a few segments caudad similar ones in the notopodium. They may be accompanied by and alternate with two or three minute capillary setæ, but by about XX and all through the middle region spines alone are present, from two to four occurring in each fascicle and the neuropodial (Pl. IX, fig. 44) being decidedly stouter with the terminal prong slightly hooked, flattened and excavated. Notopodials straighter, less hooked and more flattened distally. In the posterior fourth the spines of both fascicles become less stout, straighter and associated with capillary setæ which gradually increase in length and finally displace the spines altogether.

In the preserved state these worms are perfectly opaque and of a deep sooty black or sometimes a bluish black, especially deep and uniform in the San Diego examples, but some of them become more or less brown in the middle or anterior regions. Ventral face of prostomium, groove of prehensile neurocirri and bases of branchial notocirri pale.

About fifteen examples were taken at Third Beach Point, vicinity of Monterey Bay, on July 6, 1905, and about thirty at San Diego. Most of these are mature and contain nearly ripe ova or sperm balls.

TEREBELLIDÆ.

Terebella californica Moore.

Terebella (*Schmardanella*) *californica* Moore, Proc. Acad. Nat. Sci. Phila., 1904, pp. 496–498; Pl. XXXVIII, figs. 36, 37.

This species is quite plentiful at San Diego, living in burrows in the beach at low water. Including the lot upon which the original description was based, about thirty specimens occur in the collection. Several are packed full of eggs and some of them are much longer than the type, reaching 130 mm. The number of setigerous segments varies from 25 to 28.

Amphitrite robusta Johnson.

Amphitrite robusta Johnson, Proc. Bos. Soc. Nat. Hist., XXIX (1901), pp. 425, 426; Pl. 16, figs. 164–168.

A single example taken at San Diego is a female stuffed with eggs. It is about 105 mm. long, the first eleven thoracic segments being 11 mm. long and equal to the greatest width of the thorax.

Lanice heterobranchia Johnson.

Lanice heterobranchia Johnson, Proc. Bos. Soc. Nat. Hist. XXIX (1901), pp. 427; Pl. 17, figs. 172–174.

San Diego. A single small macerated *Lanice* probably represents this species, with the description of which it is in accord, except that the terminal twigs of the branchiæ are fewer.

Pista elongata sp. nov. (Plate IX, figs. 45–47).

Form rather slender and elongated, clavate, the somewhat thickened thorax followed by a constriction in the anterior abdominal region; posteriorly gently tapered to the pygidium. Length 160–192 mm., of which the thorax is 25–28 mm.; diameter of thorax 5 mm. Number of segments 176–240, 20 belonging to the thorax.

Prostomium a prominent, stiff, broad and simply arched upper lip, behind which is the broad, tumid crescentic tentacular ridge, bearing the very numerous tentacles in about eight transverse rows.

Peristomium very short and obscure dorsally; ventrally prolonged into a prominent scoop-like fold bearing a tumid lower lip and produced laterally into a pair of rather prominent, broadly rounded wings. Next three segments short, somewhat depressed, and branchiferous. A pair of prominent, rounded, lateral wings arise at a level somewhat more dorsal than those on the peristomium and conceal the greater part of the sides of II. Remaining thoracic somites are much longer and subterete, 3 or 4 annulate, with prominent, glandular parapodial areas and the dorsal and ventral fields much transversely wrinkled. Ventral gland plates on II to XIII inclusive, but all rather inconspicuous and the first especially small. Abdominal segments very numerous, flattened and muscular below, arched and thin-walled above. Pygidium annular with a brownish thickened rim bearing a circle of about sixteen small, equal papillæ surrounding the large anus.

Gills three pairs, on II, III and IV; except in one case all present and well developed, symmetrical, usually decreasing in size from before caudad, those of the middle pair arising at a slightly lower level than the others. Owing to their great contractility they differ much in form and appearance, but are strictly aborescent and more or less open according to the degree of contraction. When fully extended the stem is a smooth, tapering column having a length equaling or exceeding the thoracic diameter and bearing at the summit four or five main branches, each of which again divides about six times and terminates in slender tapered filaments. The plan of division is dichotomous but irregularities are numerous, and although the trunk cannot be traced through the crown, one branch of a pair is usually larger than the other and frequently a single long tapering filament occurs opposite the point of origin of a branch of any order. When contracted the branches appear short and cylindrical, with the filaments in crowded terminal tufts. The latter are readily detached and regenerated.

Setigerous tubercles begin on IV and continue for seventeen segments or to XX. They are large, prominent, well separated from the tori, somewhat flattened and bear broad fascicles of setæ. The first pair (on IV) are smaller, and small papilliform cirri occur behind the setigerous tubercles of VI to X inclusive. Uncinigerous tori well marked and regular, retractile ridges separated from the setigerous tubercles by an interval exceeding the diameter of the latter.

The first six (V–X) with uncini in one row and having a length of about twice the segment bearing them, the others with uncini in two interlocking series and at first abruptly much longer, but the caudal three or four again shorter and shifting on to the venter behind the ventral plates. Abdominal tori small but prominent, latero-ventral lappets bearing a single series of uncini sunken below a raised border and terminating dorsally in a short cirrus-like projection.

Setæ pale yellow, numerous, arranged in two ranks in broad fascicles, those of one rank shorter, but all rather long, tapered, acute, bilimbate with rather broad but not extensive margins and entire, unfringed tips.

Uncini deep yellow on thorax, paler on abdomen. On first six thoracic and all abdominal tori in a single series pointing forward, on XI to XX in double interlocking series. About 40 on V to VII, 50 on VIII–X, 80–85 on XI to XV and 50–60 on XVI to XX. Anterior abdominal tori bear about 70 uncini. On somites V, VI and VII they are large, with long tapered handle-like bases (Pl. IX, fig. 45) and a prominent anterior projection for muscular attachment; the beak is long and nearly straight, the crest composed of a single transverse series of large teeth and the guard large. These characters are most pronounced on V and gradually decline on VI and VII. On VIII to X the uncini are transitional to the typical form (Pl. IX, fig. 46), which on the posterior thoracic somites has the manubrium much reduced and chiefly replaced by a thin, translucent, ligamentous expansion, the base short and triangular, the beak strongly hooked, short and stout and the crest more elevated and composed of about three transverse series of teeth of diminishing size. Abdominal uncini (Pl. IX, fig. 47) still smaller with reduced convex bodies, acute, strongly hooked beak, high crest composed of numerous teeth and long filamentous anterior and posterior ligaments.

Color in alcohol uniform dark brown.

This species is founded on four specimens taken between tides at San Diego by E. C. Starks. It differs from the Alaskan species provisionally referred to *P. fasciata* in the much greater length and more numerous abdominal segments, in the smaller lateral wings, the absence of a post-branchial fold and especially in the form of the branchiæ. It is closely related to the Japanese species *P. maculata* Marenzeller which has a similarly elongated body, three pairs of similarly branched gills and uncini of similar form. The principal distinctions are that the latter has larger and more numerous ventral plates and no distinct second pair of lateral wings.

Pista (Scionopsis) alata sp. nov. (Plate IX, figs. 48–51).

Form moderately stout, widest and somewhat depressed anteriorly, tapered regularly to caudal end. Length of type 63 mm., maximum width at X 9 mm. Number of segments 94, in addition to a few scarcely differentiated ones at the caudal end.

Prostomium rather small but prominent, thickened, arched, its sides continued ventrad to nearly enclose the mouth, below which they end in a pair of short, thick lobes each bounded laterally by a slight indentation. Tentaculiferous ridge low and thick, bearing numerous tentacles arranged in a single transverse row in the medial and in two transverse rows in the lateral part. Tentacles numerous, rather short and thick, very slightly attached by a contracted base and deeply grooved or folded for most of their length. Many of the dorsalmost ones are short and imperfectly developed.

Peristomium and two or three immediately following segments short, contracted and terete. Peristomium produced into a prominent ventral fold with a deep median emargination, on each side of which it spreads laterally as a great flaring wing reaching dorsally to the level of the setigerous tubercles. Somites II and III are distinct dorsally and ventrally but confounded laterally. The anterior margin of the former is produced on the ventral surface as a slight fold. Beginning at the sides of the ventral plate of III is a pair of conspicuous wings which extend obliquely up the sides of III and the anterior margin of IV and which are united across the dorsum of the latter by a transverse fold bearing a prominent median forward projection.

Posterior to the branchial region the thoracic segments develop prominent glandular thickenings along the parapodial field, as a result of which they are wider than deep. Behind X the thoracic region tapers into the abdomen, the transition into which is somewhat abrupt. Annulation of the somites is obscure, only the posterior thoracic and anterior abdominal showing faint indications of subdivisions. There are fourteen well-marked ventral plates, the first on III, the last on XVI, behind which more obscure wrinkled and subdivided areas continue to the end of the thorax. The first five are short, about four or five times as wide as long. The others are very smooth, apparently very vascular and probably deep red in life, the relative width gradually increasing from equality to the length to double it, the greatest width in all cases being anterior, so that the entire series appears serrated laterally. By the sides of each is a pair of rough glandular areas which posterior to XVI become united with the glandular ventral areas, giving them an irregular polygonal outline and roughened surface. Slight traces of similar structures continue on to a few anterior abdominal segments. Middle and posterior abdominal segments are marked about the middle in the parapodial zone by a distinct, elevated, glandular ring, the remainder of the body wall being relatively thin and translucent. Pygidium slightly expanded and bent dorsad, the large anus surrounded by a raised border.

Branchiæ two pairs, on somites II and III, when contracted partially protected by the lateral wings and dorsal fold. As in *Scionopsis palmata* Verrill they are very unequally, asymmetrically and irregularly developed. Both specimens have all four present. On the type the right anterior is much the largest and situated exactly in the median line, the left anterior is very small; those of the posterior pair are symmetrical in position and close to the median line, and intermediate in size between those of the anterior pair, that of the left side being slightly larger. The cotype has the anterior left largest, then the posterior right, the posterior left and the anterior right quite small. The well-developed branchiæ consist of a rather tall, column-like trunk which at once divides into several (3 to 5) main limbs which diverge and spread more or less horizontally. Each main limb consists of a tapering, strongly zigzag axis which may be traced to the tip and gives rise at each bend to similar lateral branches which also spread horizontally and divide into branches of the third order. Most of the latter bear two to six slender filaments which occasionally bifurcate or divide even farther and are usually (but not always) confined to one side of the branch. Thus is produced a very beautiful and characteristic plume-like structure more or less complexly branched according to the size of the gill and having nearly the form of a branch of certain species of the plant *Selaginella*. The main divisions of the large gill of the type specimen spread symmetrically and are so large that the second pair of gills is completely concealed beneath their posterior limbs, although these are much shorter than the anterior limbs.

Setigerous tubercles occur on somites IV to XX inclusive, separated from the uncinigerous tori by a slight interval and nearly in line with them. They are nearly cylindrical but somewhat compressed anteroposteriorly. Thoracic uncinigerous tori begin on V and are raised on thickened glandular areas. The first two are longer than the others which are of nearly uniform length. Nephridial papillæ exist above those of VII to XVI at least. Abdominal tori are small but prominent and decrease in vertical extent caudad. All are distinctly bilobate, having the angles, especially the dorsal angle, produced, bent forward and free from uncini.

Setæ in prominent flattened fascicles, arranged in two series of about fourteen to sixteen each, those of the anterior row about one-half as long as those of the other. Rather stout (Pl. IX, fig. 48), pale yellow, slightly curved and tapered to an acute tip, bilimbate with well-marked, lanceolate, entire but striated blades rather wider on the convex side. Uncini in single series pointing forward on somites V to X and on all abdominal somites, in double interlocking series on somites XI to XX, 105 on V, 98 more crowded on VII, and about 65 in each row on XII. On abdominal tori their number decreases from before caudad, there being 32 on XXI, 25 on XXXV, etc. Uncini of somites V to VII (Pl. IX, fig. 49) have the base prolonged into a slender manubrium with a thin membranous border and a prominent anterior angle, the beak is long and slender and the low crest formed of a few large teeth; guard slightly developed. On somites VIII to X the manubrium becomes gradually reduced and the remaining thoracic tori bear uncini of the form shown in fig. 50, which have the base short, without a manubrium, convex below, with slender ligament, well developed guard, stout beak, and high crest of several transverse rows of teeth. Abdominal uncini (fig. 51) are small, with short base convex below and provided with slender anterior and posterior ligaments, no guard and beak and crest nearly as in posterior thoracic uncini.

The color has faded, but in life is probably chiefly translucent green or olive green, with scattered flakes of white and deep red blood spots behind the ventral plates and below the setigerous tubercles.

Type locality, San Diego; E. C. Starks, collector. Two specimens, the type a female filled with large eggs.

Thelepus crispus Johnson.

Thelepus crispus Johnson, Proc. Bos. Soc. Nat. Hist., XXIX, p. 428; Pl. 17, figs. 175–178*b*.

Common at both San Diego and Monterey; at the former between tides and at the latter above and below low water. At Monterey Bay specimens were taken at "big tide pool," June 28, 1904, point above Third Beach, July 12, 1904, and dredged at Delmonte wharf, same date.

Young and half-grown examples possess numerous eyes, but full-grown ones are nearly or quite eyeless. All specimens examined by me have the deep end of the uncini narrower than in Johnson's figure and the knob terminal with no projection beyond it. The uncini differ constantly from those of *T. hamatus* in the prominence of the large crest teeth, while the row of smaller apical teeth is very little developed or absent. Those of *T. hamatus*, on the contrary, have the crest teeth less prominent but more numerous and subdivided. The tubes resemble those of *T. cincinnatus*; sometimes they are covered with shell sand.

Polycirrus sp. ? (Plate IX, fig. 54).

A much macerated *Polycirrus*, dredged at Delmonte wharf, Monterey Bay, on July 12, 1904, has uncini very closely resembling those of *P. aurantiacus* (Grube) Malmgren, but is too imperfect for description.

Polycirrus californicus sp. nov. (Plate IX, figs. 52, 53).

The type is 28 mm. long, about 1.5 mm. in maximum diameter and has 65 segments, 28 of which are setigerous.

Prostomium large, projecting far forward as a long, narrow, highly arched lobe shaped much like the inverted bowl of a spoon, about twice as long as wide and equaling the first four segments. No eyes. Tentacles very numerous, forming a densely tangled mass which conceals much of the anterior end of the body, of two kinds, one very slender and delicate, slightly enlarged distally and arising from a pair of lateral areas, the other stouter with thin marginal expansions and arising from a transverse band near the anterior border of the tentaculiferous area.

Peristomium a short, simple ring bounding the mouth; other segments varying in size with the degree of distention of the cœlom, the anterior ones faintly biannulate and the intersegmental furrows usually rather obscure; dorsum smooth and strongly arched, a longitudinal furrow immediately above the setigerous tubercles. Venter with a deep neural groove bounded by prominent lateral muscular ridges supporting the parapodia.

First ventral plate entire, equilaterally triangular, the apex forward, extending the entire length of the peristomium and somite II, followed by eight short, oblong, ventral plates, each divided into equal quadrate halves by the deep neural groove, the first five reaching the full length of somites III to VII, the remaining three on segments VII to X being reduced in size.

The last ten or twelve segments taper very rapidly to a minute simple pygidium. Cœlom packed full of small eggs.

Setigerous tubercles begin on II and continue to XXIX (inclusive). They are small, project dorsad and laterad and bear small fan-shaped fascicles of delicate colorless setæ arranged in pairs of a small simply capillary setæ and a longer limbate one. After about XX the fascicles become much smaller and inconspicuous. Tori begin on XIV, at least no trace of uncini can be detected anterior to this segment.

At first they are long, narrow ridges reaching nearly to the middle line and bearing a single series of about sixty uncini. Posterior to the setigerous region the tori are shorter and thicker and bear only about forty uncini.

Uncini are small and delicate, the base with prominent posterior angle, the rostrum slender and acute and about half as long as the base, crest with two large profile teeth. Anterior uncini (Pl. IX, fig. 52) have the base less produced and blunter in front than those from posterior tori (Pl. IX, fig. 53).

The uncini closely resemble those of *P. nervosus* v. Marenzeller, but the latter has thirty-two setigerous segments and differs in the character of the tentacles, the ventral plates and other features.

Besides the type there is one additional incomplete specimen, both having been taken at San Diego.

AMPHICTENIDÆ.

Pectinaria brevicoma Johnson.

Pectinaria brevicoma Johnson, Proc. Bos. Soc. Nat. Hist., XXIX (1901), pp. 423, 424; Pl. 15, figs. 151–156.

A single specimen taken at Delmonte wharf, in the vicinity of Monterey Bay, on July 12, 1904, agrees with Johnson's description. The tube is constructed of coarse sand grains.

CAPITELLIDÆ.

Notomastus tenuis sp. nov. (Plate IX, fig. 55).

A slender elongated worm, the single example of which is macerated in the middle but well preserved at the ends. The two pieces probably represent a nearly or quite complete worm which is 118 mm. long and .8 mm. in diameter. Thoracic segments number 12 and abdominal 191. The thorax of 12 segments is clavate, the anterior half thickened, the posterior gradually narrowed, the abdomen abruptly expanded to equal the maximum width of the thorax, then tapering gently to the pygidium.

Prostomium conical, pointed, with a few specks of pigment scattered along the sides; when retracted somewhat inflated and completely closing the mouth.

Peristomium simple, achætous. Thorax clavate, terete, smooth and scarcely iridescent, the intersegmental furrows faint; widest segment about two-fifths as long as wide, narrowest two-thirds as wide as long, most of them equally and obscurely biannulate, the inter-annular furrow with a backward bend or inset into the succeeding one at the position of the lateral organs. Neuropodia and notopodia represented by small linear depressed tufts of capillary setæ, the notopodial setæ fewer and less crowded.

Anterior and posterior abdominal segments are relatively short (one-half to two-thirds as long as wide) and separated by deep intersegmental furrows; in the middle macerated region the segments are stretched to about twice their diameter. Except at the posterior end, where the segments are somewhat angulated, the body is terete. Pygidium (possibly regenerated) a simple, short, subconical ring.

No gills, genital pores, or lateral sense organs are visible.

Abdominal tori are short and scarcely visible. The anterior notopodia bear about ten and the posterior about six crochets, while anterior neuropodia have 16–18 and posterior neuropodia about 10 crochets.

Crochets (Pl. IX, fig. 55) very small and all alike, with a distinct shoulder and a swelling neck bearing a very small head enclosed in a large hood.

San Diego, Cal.; type only known.

Eunotomastus gordiodes sp. nov. (Plate IX, fig. 56).

Evidently an elongated and slender species, but none of the specimens is nearly complete. The longest pieces are 60 mm. long and 1 mm. diameter.

Prostomium a minute blunt palpode bearing a pair of nuchal organs.

Peristomium a truncate, subconical, smooth segment slightly longer than somite II and somewhat constricted about the middle. A pair of small spots probably represent openings of the lateral organs.

The thorax consists of seventeen setigerous segments in addition to the peristomium, terete, of nearly uniform diameter, slightly contracted toward the posterior end, very smooth and with faint and often obsolete intersegmental furrows. All of these segments bear small notopodial and neuropodial tufts of setæ, the former separated by a distance slightly greater than the latter. A very faint depressed spot on each side of the segment somewhat nearer to the notopodia than the neuropodia seems to be the orifice of the lateral organ; and almost equally obscure pores at the same level and in most of the posterior intersegmental furrows may be genital orifices.

Anterior abdominal segments scarcely differ from the thoracic, being similar in shape and proportions but less polished and iridescent, farther back they become longer but remain smooth and ill-defined. The largest number of abdominal segments on any one piece is ninety-five. Abdominal neuropodia form distinct ventro-lateral tori, somewhat elevated and glandular, connected ventrally only by a glandular line and bearing a series of crochets extending over about one-sixth of the body circumference. Notopodia similar but smaller, the first bearing capillary setæ, the others crochets. Number of neuropodial crochets on XIX 12–14, on XXV 32, notopodials on XXV 16.

Posterior abdominal segments bear rather conspicuous tufted dorsal gills, each consisting of eight or ten short filaments arising close together from the posterior margin of the segment in line with the notopodia. The most anterior of these gills are small and somewhat pectinate, farther back they increase in size until the filaments have a length of one-third to one-half the diameter of the segments.

All setæ are of the usual limbate, capillary form with very slender tips. The crochets (Pl. IX, fig. 56) have a distinct shoulder, a neck that gradually increases in diameter to a rather large head with stout beak and high crest enclosed in a short but much inflated hood.

Each of the specimens is enveloped in a thin membranous tube covered by a single layer of loosely attached sand grains.

Taken only at San Diego at low water by E. C. Starks; four specimens.

As both this species and the type of *Eunotomastus* are known from incomplete specimens it is by no means certain that *E. gordiodes* is correctly referred to this genus.

Dasybranchus giganteus (Moore) (Plate IX, fig. 57).

Notomastus giganteus Moore, Proc. Acad. Nat. Sci. Phila., 1906, pp. 227, 228; Pl. X, figs. 24, 25.

Specimens in this collection much better preserved than the type enable me to correct and amplify the original description and to correct the generic reference. The stout form and large size are of course not at all noteworthy in the genus to which the worm is now referred.

Prostomium much retracted so that the tip alone is visible. Protruded proboscis subglobular, bulbous, with a rosette-like end presenting eight sulcated radiating lobes and proximad to this a closely granulated basal ring.

All six specimens have twelve thoracic segments. Peristomium about as long as succeeding segments, achætous and biannulate. Remaining thoracic segments setigerous, strongly biannulated and areolated on the surface. Notopodial and neuropodial fascicles both simple linear tufts borne on the posterior ring just behind a tenon-like inset of the anterior ring. Except on the first two or three setigerous segments the neuropodial fascicles are nearly twice as wide as the notopodial and separated by a ventral interval of nearly one-half the body diameter, the inter-ramal interval being slightly more than the inter-notopodial interval on anterior segments and nearly twice as great on XII.

Abdominal segments about half as long as thoracic, usually irregularly biannulate, thickly glandular anteriorly but (except at the tori) becoming thin-walled posteriorly. Neuropodial tori extensive low ridges, reaching on anterior segments from above the middle level nearly to the neural line, but posteriorly scarcely half as long. They become more elevated dorsally and end abruptly in a prominence, above which is the small but distinct rounded ovoid lateral organ. The very small notopodial tori are dorsal and connected across the dorsum by a low transverse fold. Posteriorly they become very obscure.

Branchiæ are retractile and usually obscure anteriorly; on middle and posterior abdominal segments they become conspicuous bushy tufts composed of numerous (about 20–30) filaments arising from the posterior end of the notopodial tori, or posteriorly, where the tori become obsolete, replacing them.

Abdominal lateral organs are distinct only posteriorly where the tori become widely separated, appearing halfway between them as small rounded elevations, above and below which a few small papillæ are scattered. Thoracic lateral organs and genital pores were not observed.

The original drawings of crochets of this species were made from imperfect specimens and a corrected representation is shown in fig. 57, Plate IX.

Six specimens of this species, one of which is 6 mm. in diameter, occur in the Starks collection and were taken at San Diego between tides.

Dasybranchus glabrus sp. nov. (Plate IX. fig. 58).

Body moderately stout, terete, and thickest anteriorly where it is shaped much like a small earthworm; posteriorly more slender and gently tapered, subquadrate, flattened below. The type and only specimen is 45 mm. long with a maximum diameter of 2.4 mm. Thoracic segments 14, abdominal 157.

Prostomium partially retracted within the collar-like anterior border of the peristomium, the exposed part bluntly rounded anteriorly with a slight ventral longitudinal furrow.

Peristomium a long, deeply biannulate segment (perhaps two segments) as long as any two of those following; the first ring is marked by several shallow furrows. Entire thorax with firm, smooth, thickly glandular walls, with very few markings; the segments all uniannulate and separated by deep intersegmental furrows. Thoracic notopodia and neuropodia bear short, equal, retractile linear tufts of setæ, the neuropodia being about twice as far apart as the notopodia and the distance between the latter about equaling the interramal space. Lateral sense organs quite evident, slit-like pores near the caudal border of the segments and nearer to the notopodia than the neuropodia.

Abdominal segments very short and much crowded, especially toward the anterior end; posteriorly they are obscurely biannulate and less crowded. Anterior abdominal segments are terete and have thick glandular walls much like the thoracic segments; farther back the walls become thinner and non-glandular and except in the region of the tori the surface is granular, and, chiefly owing to the separation of the tori dorsally and ventrally, the section becomes subquadrate. Anterior abdominal segments have no distinct tori, but bear a continuous line of sessile crochets which appear to completely encircle the segment at the middle. After about the twelfth abdominal segment a slight lateral or interramal break appears and gradually widens until the notopodia and neuropodia become well separated and distinct tori. The neuropodia of each pair remain, however, continuous across the neural surface, but except on a few anterior segments the notopodia are discontinuous and posteriorly become separated quite widely. Lateral sense organs are obscure on anterior abdominal segments, but on middle and posterior segments become distinct though small rounded eminences. Pygidium probably injured as it is divided into several very irregular lobes.

Gills appear only in the posterior half of the body, usually as two, or sometimes three, short, hollow, sausage-shaped filaments issuing from a pore immediately dorsal to the neuropodium.

Thoracic setæ are exclusively of the usual tapering capillary form with narrowly bilimbate ends. Abdominal segments bear exclusively very numerous crochets of one form in both notopodia and neuropodia (Pl. IX, fig. 58). They are slender without a distinct shoulder, but with a subterminal enlargement that tapers to a small head with hooked beak and three small teeth in the vertex of the crest, the end enclosed in a somewhat inflated hood.

The type was taken at San Diego Bay in December, 1902.

This species differs from typical members of the genus in having two more than the usual number of thoracic segments.

MALDANIDÆ.

Maldane disparidentata Moore.

Maldane disparidentata Moore, Proc. Acad. Nat. Sci. Phila., 1904, pp. 494–496; Pl. XXXVIII, figs. 28–31.

This species occurs in the collections from San Diego only, but appears to be quite common there.

One bottle contains, along with a specimen of this annelid, a small amphipod determined by Prof. S. J. Holmes as *Melita* sp. which the label states lives commensally in its tube. From *M. biceps*, to which it is most nearly related, this species is readily distinguished by having more numerous and blunter teeth on the anterior division of the cephalic limbus, the last preanal segment uniannulate instead of biannulate, and the emargination on the ventral division of the caudal funnel entire instead of emarginated and slightly lobate. The fringed setæ are of the bispiral type.

Clymenella rubrocincta Johnson.

Clymenella rubrocincta Johnson, Proc. Bos. Soc. Nat. Hist., XXIX (1901), pp. 418, 419; Pl. 13, figs. 128–133.

The anterior half of one was taken between tides at San Diego.

AMMOCHARIDÆ.

Ammochares occidentalis Johnson.

Ammochares occidentalis Johnson, Proc. Bos. Soc. Nat. Hist., XXIX (1901), pp. 420–421; Pl. 14, figs. 140–142.

A single example from San Diego. It is a beautifully preserved specimen 30 mm. long, with 22 setigerous segments. A fragment of a tube is formed entirely of particles of shells.

Sclerocheilus pacificus sp. nov. (Plate IX, fig. 59).

Form as in *Scalibregma*, clavate, the posterior two-thirds slender and of nearly uniform diameter but tapering slightly caudad; the anterior one-third abruptly swollen to three times the posterior diameter. Length 25–35 mm., maximum diameter 2.5–3.6 mm. Segments 60–72.

Prostomium depressed T-shaped, the basal part about as broad as long and nearly half as wide as the peristomium, into which it is deeply retracted. Antero-lateral limbs blunt projections each about half as long as the width of the body of the prostomium. On each side of the posterior dorsal region is a broad, black oblique streak which appears to be constituted of two parallel rows of small pigment specks. At their anterior ends they are separated by one-half the width of the body of the prostomium, but diverge as they pass backward beneath the peristomial fold apparently into the nuchal organs.

Peristomium a short, simple, unsculptured ring incomplete ventrally where it reaches the sides of the mouth. Somite II also a simple ring, but bearing lateral parapodia and bounding the mouth behind. Succeeding somites increase in diameter and become rapidly inflated; III, IV and V are biannulate, with the larger setigerous annulus posterior, the smaller annulus apparently arising in the intersegmental furrow; VI and succeeding somites of the anterior region have the setigerous annulus divided equally by a furrow that appears just behind the setæ. Each of the three rings thus formed is divided by short deep furrows into a ring of tessellæ or subquadrate areas which are much more conspicuous on the dorsum than on the venter. In the posterior region the interannular furrows become very faint or completely disappear, leaving well-marked simple segments, generally about one-fourth or one-fifth as long as wide and only very obscurely areolated.

Pygidium a simple, slightly oblique ring which bears no cirri on either the type or cotype. Body walls very thin and readily ruptured. Proboscis partly everted as a smooth broadly trilobed disk.

Parapodia merely obscure lateral swellings involving the entire length of the somites in the anterior enlarged region and bearing the two well-separated linear tufts of setæ opposite to the middle annulus. Apparently there are no cirri, unless the minute knobs related to the setæ fascicles prove to be such. Gills are totally absent.

Setæ colorless with a faint bluish luster, chiefly capillary, of various lengths, curved and slightly flattened distally. Anteriorly they are most conspicuous, forming fan-shaped tufts with linear bases, the neuropodial more spreading, the notopodial longer and curved dorsad; the longest setæ about as long as the segment. Posteriorly the setæ are fewer and less slender. Short inconspicuous furcate setæ (fig. 59) are paired with the capillary setæ on all except a few anterior segments on which they cannot be seen. There are no stout setæ on II.

The type, a mature male, and a smaller cotype were taken at Third Beach Point, vicinity of Monterey Bay, by Mr. Spaulding on July 6, 1905.

This species as described differs widely from the type of the genus, especially in the absence of stout setæ on II and the absence of neurocirri, though it is possible that the latter, like the caudal cirri, may be easily detached. On the other hand the absence of gills and the presence of eye-spots are characters which approximate it to the type, *S. minutus* Grube. This species would also seem to indicate that the creation of *Asclerocheilus* as a separate genus is unnecessary.

CHLORHÆMIDÆ.

Brada sp.? juv.

Two small specimens dredged at a depth of forty feet at San Diego are considered to be the young of a species of *Brada* or possibly of a *Trophonia* in which the anterior setæ have not yet elongated. They are about one-half inch long, clavate, with well-marked, simple segments, a few of which have been lost, thickly and uniformly covered with papillæ both dorsally and ventrally, those in the neighborhood of the parapodia scarcely longer than the others. All setæ are short, only the notopodials of II being noticeably longer than the others. On other segments both notopodial and neuropodial tufts consist of a very few small, slender, tapered, flexible setæ composed of numerous joints which are always considerably longer than the diameter of the seta. Neuropodials are no stouter than notopodials. The setæ differ from any species of *Brada* or *Trophonia* examined by me, but the differences are such as might be expected in juveniles.

Trophonia papillata Johnson.

Trophonia papillata Johnson, Proc. Bos. Soc. Nat. Hist., XXIX (1901), p. 416; Pl. 12, figs. 122, 123.

Two specimens dredged at Delmonte wharf, Monterey Bay, July 12, 1904.

The larger one has the head protruded. The mouth is a transverse crescentic slit bounded below by a flat, slightly bilobed lip and above by the slightly arched and thickened prostomium which bears the two thick palps, grooved below, and above them eight tentacles in a transverse series; the latter are about one-fourth as thick as the palps and slightly exceed them in length. The small specimen is only 16 mm. long with 36 segments, badly abraded and nearly smooth except the anterior four segments which are encased in a coating of agglutinated sand grains. This may possibly be a distinct species.

Trophonia capulata sp. nov. (Plate IX, figs. 60, 61).

This very distinct species is represented by the type only, which measures, exclusive of the cephalic setæ, 108 mm. long, the cephalic setæ being 9 mm. and the maximum diameter at the end of the first fourth 5.5 mm. Number of segments 136, the first achætous. Form elongated clavate, somewhat depressed at anterior end, subterete at middle, becoming gradually subquadrate posteriorly. Anterior half moderately stout, the posterior slender and gently tapered. Cœlom containing many large free eggs.

Prostomium and peristomium completely retracted within first setigerous somite, leaving a small opening directed somewhat ventrad and surrounded by prominent papillæ, often arranged in groups, and encrusted with fine sand grains, a particularly prominent group of about four forming a small tuft supported on a narrow pedicle in the mid-dorsal line between the first pair of notopodial setæ fascicles.

Anterior end broadly rounded, the first few segments decidedly depressed but increasing in depth rapidly until by about VI they have become terete. These segments are short, crowded and somewhat telescoped, so that each one somewhat overlaps the next anterior, especially dorsally where this feature is emphasized by the greater prominence of the cutaneous papillæ. Remaining segments very regular, simple and smooth, with clean-cut though shallow furrows and from one-sixth to one-third as long as wide, becoming proportionately longer as the diameter decreases posteriorly. Pygidium a simple ring entirely lacking cirri.

Integument thick and tough and more or less coated with a hard, adhesive layer of fine sand, beyond which the tips of only the larger papillæ project. On the venter and posteriorly the surface is nearly smooth and the incrustation thin, but on the anterior dorsal region it becomes rough and much thicker, forming, with the papillæ, projecting anterior margins to the segments and ensheathing even the larger papillæ nearly to their ends. The larger cutaneous papillæ are arranged as follows: On the dorsal field is a transverse row of six or eight projecting forward from the cephalic margin of each anterior segment. In the ventral field on each side of the neural line and generally near the middle of the segment is a single clavate papilla, replaced on more anterior segments by a group of two or three; from one to three more occur ventrad of the neuropodium. Surrounding the latter is an irregular ring of papillæ composed usually of one or two dorsal and ventral, two to four anterior and usually three posterior, the middle one of the last group being much larger than the others and elevated prominently on a conical base. A similar ring surrounds the notopodium, the postsetal group here also consisting of one or two of moderate size, and one very large one, often equaling the segment in length anteriorly and elevated on a base which may bear the smaller papillæ as well. Passing from before caudad all of these papillæ gradually diminish in length, but their arrangement is constant.

Except on the first two or three segments, on which they are more crowded, the parapodia consist of widely separated notopodial and neuropodial nearly or quite sessile tufts of setæ. The former are fan-shaped fascicles of five to eight (the larger numbers on middle segments) flexible capillary setæ. Those of the first four (II to V) are elongated and directed forward, becoming in both respects less so from before backward; on II and III they are remarkably slender and silky and project far in front of the head to a distance of more than twice the diameter of the body; those of V scarcely equal the body diameter. On middle segments the fascicles spread more widely over the dorsum and scarcely exceed the length of their segments. Posteriorly they appear relatively but not actually longer. Neuropodial setæ are slightly coarser and fewer than the corresponding notopodials; those of the first three fascicles have filamentous tips and project forward like the notopodials, but are only about half as long; on other segments they curve dorsad up the sides of the body.

Setæ are all pale brown, soft and iridescent. As long as they project forward notopodials and neuropodials are similar, excessively slender, with straight acute tips and numerous cross fractures or nodes, which at the base of fully-grown setæ occur five or six in a distance equal to the diameter, becoming gradually fewer until they are six or eight times as far apart. As they lose the filamentous tips the notopodial setæ have the region of crowded joints toward the base much restricted (Pl. IX, fig. 61).

Neuropodial setæ in becoming shorter and stouter also acquire fewer and much longer joints, the terminal one becoming especially long and, beginning with V, with a distinctly hooked tip, which a few segments farther back becomes much larger and provided with an accessory process (fig. 60), thus having the form of a halter-snap like the setæ seen in certain species of *Sthenelais*.

Color deep buff-gray and nearly uniform.

Type locality, San Diego Bay, Cal., between tide limits.

Flabelligera commensalis sp. nov. (Plate IX, figs. 62, 63).

Form moderately slender, thickest in the cephalic fourth, thence tapering to caudal end but usually exhibiting irregular contractions or swellings; more or less distinctly prismatic and somewhat compressed; body-walls thin and delicate and more or less ruptured so that the viscera protrude. Type and largest complete specimen 50 mm. long and at the widest part (XX) 2.4 mm. wide and 3.2 mm. deep; this thickness, however, is probably in part due to an abnormal swelling. Number of somites 90; a second complete specimen 48 mm. long has 70 segments.

Prostomium with its appendages capable of complete retraction within the collar and only incompletely exposed in these specimens. So far as observed it consists of a pair of thin membranous dorsal lobes, each bearing a dense tuft of thirty or forty slender tentacular filaments, the ends of which reach in extension scarcely beyond the ends of the collar setæ. The palpi, arising immediately beneath the tentacles and above the mouth, are more than twice as long and four or five times as thick as the tentacles, blunt, slightly tapered and finger-like, not at all spatulate or flabelliform, the venter with a deep longitudinal groove, the margins of which are merely slightly crenulate and not lobed. Mouth a transverse slit or a more rounded opening with lobed margins normally hidden at the bottom of the collar.

The collar region, reaching back as far as the first ordinary somite, probably represents the peristomium alone or perhaps both I and II. It consists of a short achætous posterior ring and a cylindrical or funnelform, thin membranous collar with small dorso-median, ventro-median and lateral incisions in its border, the whole being about as long as the three somites next following. It bears the broad fan-shaped conjoined fascicles of notopodial and neuropodial setæ forming a close continuous series, which, like a palisade of stakes, build up the collar to double its own height. When the cephalic appendages are extended they are embraced by the peristomial collar and seta cage and when retracted are concealed within them, the setæ of the two sides drawing toward the middle line. The collar, which clearly represents a pair of parapodia, is thickly studded with cutaneous papillæ, those at the base of the setæ being very numerous, much elongated and slender, with filamentous stalks bearing terminal knobs and often reaching the tips of the setæ.

Succeeding segments are much shorter, their length never exceeding one-third the width, and quite simple, with the intersegmental papillæ quite high between the parapodia but elsewhere very slightly developed. Anteriorly for a short distance the body is subterete or subquadrate, but for most of its length, owing to the position of the parapodia, is subtriangular in section, the somewhat truncated apex being ventral, the nearly flat base dorsal and the usually somewhat convex sides lateral. In places where the body is much distended this convexity or bulging may be sufficient to give to it a cross-section approaching the circular. As noted above the body-wall is thin, easily ruptured, and semi-translucent. Most of the surface is smooth and bears few and small papillæ, but on the dorsum and about the parapodia they become larger and more numerous, those on and near the notopodia being largest of all and, like the collar papillæ, bearing very large terminal knobs, and when extended reaching to the tips of the setæ and giving to the notopodia the aspect of erect tufts or tassels. The neuropodial papillæ on the other hand are much shorter and, like those scattered over the dorsum, bear small terminal knobs.

Parapodia are remarkable chiefly for the position of the neuropodia. The rami are rather large, widely separated and rather conspicuous papillæ. Notopodia situated at the extreme dorsal and widest part of their segments, except on the first few at the basal angles of the triangle. Owing to the slender papillæ which they bear they have the form of graceful plumes or tassels bearing a few small capillary setæ. Neuropodia are rather larger, stouter and shorter subconical tubercles, resembling the false feet of certain caterpillars, and bearing much smaller and less conspicuous papillæ and a single stout hooked seta. Except on the first eight or ten segments which are more or less subterete and where they are widely separated, the bases of the two neuropodia are nearly in contact at the neural apex of the compressed triangular body.

Notopodial and collar setæ (Pl. IX, fig. 62) are all of the capillary, soft, flexible, cross-fractured type, the former differing only in their much greater length. In addition to a few, scarcely apparent, rudimentary setæ of the same type each neuropodium bears one (or rarely two) large and stout hook (fig. 63), deep brown and opaque at the end, but becoming paler toward the base and having an imperfect joint below the hooked end. These hooks are directed toward the middle line and are operated in pairs by powerful muscles, forming most effective organs of adhesion.

Dorsal surface and notopodia more or less deep (sometimes purplish) brown, which color usually completely covers the collar and may extend somewhat down the sides of the body which, like the venter and neuropodia, is pale yellow, usually sharply contrasted with the brown of the dorsum which appears to be due to the sensory papillæ.

The alimentary canal exhibits the gizzard-like stomach and looped intestine characteristic of annelids of this family. Unlike most species of the genus there is no mucous investment, at least on these specimens.

The four known specimens were taken at Picnic Tables, near Monterey, Cal., on August 14, 1904, from among the spines of *Strongylocentrotus purpuratus*. The latter is undoubtedly a normal habitat, for which the structure of the worm admirably adapts it. The color, lateral compression of the body, position of the neuropodia and the stout neuropodial hooks would be especially useful in this situation.

SABELLIDÆ.

Sabella elegans Bush.

Sabella elegans Bush, Tubicolous Annelids from the Pacific Ocean, Harriman Alaska Expedition Reports, 1905, pp. 194, 195 (figures).

Vicinity of Monterey Bay only; four specimens "big tide pool," June 20, 1905; one small example dredged Delmonte wharf, July 12, 1904.

These specimens appear to belong to the above-named species, although Miss Bush's species of *Sabella* are not clearly differentiated in the brief descriptions. The spots on the branchiæ are usually five, fairly regular in arrangement, but varying much in intensity and the degree to which they extend on to the gill filaments. The number of rachises varies from 18 to 22 on each side. The segments of one counted number 70, 8 of which are setigerous thoracic.

Distylia rugosa Moore.

Distylia rugosa Moore, Proc. Acad. Nat. Sci. Phila., 1904, pp. 499-501; Pl. XXXVIII, figs. 38-41.

Besides the type and cotype from which this species was originally described several additional specimens, all taken between tides at San Diego, occur in the collection.

The specimens are of various sizes, the largest measuring in its contracted state 105 mm. long, of which the gills are 30 mm., and 11 mm. wide. In the different specimens the branchial rachises vary in number from 24 in one 40 mm. long to 68 on each side of the large specimen. In no case are any of the rachises forked. The branchial bases make about 1½ turns. The eyes referred to in the original description are mere specks and dashes of pigment arranged in two series which may coalesce into more or less broken lines or be totally absent.

Sometimes the branchiæ are of a nearly uniform wine brown with regular but obscure transverse pale bands; in other cases they may be light or dark brown, irregularly mottled with pale. The gill bases are uniform deep brown. At the dorsal end of each abdominal torus is a very deep and conspicuous brown spot, from which a narrow brown line runs along the torus for its entire length, ending in a small spot at the ventral end. The ventral plates are very deep purplish brown, the body elsewhere pale brown.

The largest specimen has the collar region so relaxed that the mouth parts are well displayed. The tentacles are narrowly lanceolate with a small divergent basal lobe and reach barely to the distal border of the branchial base.

Pseudopotamilla brevibranchiata Moore.

Pseudopotamilla brevibranchiata Moore, Proc. Acad. Nat. Sci. Phila., 1905, pp. 559-562; Pl. XXXVII, figs. 8-14.

Two specimens taken at "big tide pool," Monterey Bay, present several interesting divergences from the types.

The branchial barbs are somewhat longer—four or five times the diameter of the rachises and diminished but slightly toward the distal end—and the dorsal branchial lappet is very prominent. Both specimens are filled with nearly mature eggs. One has nine setigerous segments, the other only six and the thorax shorter than the gills. The first has the eye-spots scattered through a wide zone and occasionally more than one on a rachis; the other has a single nearly black eye-spot proximad of the middle on most of the middle rachises. Both have the gills otherwise colorless.

The tubes form a cluster of three and are nearly colorless, stiff and hard and covered with an incrustation of fine sand. Two other empty tubes dredged near the same locality probably also belong to this species.

SERPULIDÆ.

Protula superba sp. nov. (Plate IX, figs. 64, 65).

The least contracted specimen of this magnificent serpulid has the body 88 mm. long and the contracted gill-crowns 37 mm. long; length of thorax measured along venter of mantle 37 mm.; width of thorax at anterior end 16 mm., at posterior end 12 mm.; depth at latter point 7 mm.; width of abdomen at middle 10 mm.; depth at same point 9 mm.; length of branchial base 9 mm.; length of one of the longest rachises 23 mm. Number of thoracic segments 8 (7 setigerous), of abdominal segments 115–120. Another specimen is even larger but more contracted.

The contracted branchial crowns form a pair of great compact brushes or plumes, the base and axis of which is a high spiral permanently wound into seven or eight close turns, stout and of firm texture throughout and triangular in section. They are readily detached, leaving a triangular scar on each side of the mouth. Leaving a short pedicel of attachment the branchiferous spiral begins on the dorsal side and bears in the one cotype on which they were counted no less than 320 radioles in a closely crowded series on each side. The basal ones are the longest and they diminish in length regularly to the apex at a rate that indicates that their tips reach a uniform level in full extension. A rather thick interbranchial membrane is connected with the outer faces of the basal ends of the rachises and unites them for about one-fifth of their length. The rachises are compressed triangular with the base directed outward and the apex toward the center; narrow membranous borders are appended to the basal angles and reach from the interbranchial membrane nearly to their tips. A double rank of numerous pinnæ or filaments arises along the inner or apical face of the rachises and continues nearly to their tips; the longest of these scarcely exceed the greater diameter of the rachises and they diminish in length distally.

Tentacles lanceolate, foliaceous, about as long as the diameter of the branchial bases, to the ventral side of which they are attached. Just within them, enclosing the mouth and about one-third as high as the interbranchial membrane, are the oral membranes, which like the tentacles are detached with the branchial crowns. Mouth transverse, its corners bounded above by a low rounded elevation, from between which a tongue-shaped process projects over the mouth. Ventral to it is a soft irregular lip, and below this again a much larger firm triangular lip.

Thorax depressed, broader anteriorly than posteriorly and regularly tapered caudally. Segments eight, all but the peristomium setigerous; intersegmental furrows obsolete. Thoracic mantle thin and greatly developed, embracing all of the setæ tufts and extending beyond them to a width fully equal to that of the thorax. Though folded and somewhat tufted between the fascicles of setæ the margin of the membrane appears to be entire and not scalloped. Its cephalic border is divided into a pair of dorsal setal lobes, enclosing the collar seta tufts, and a ventral pair of branchial lobes. The median notch separating the latter is wide and shallow, the lateral notches, on the contrary, being deep and narrow. The posterior fold or apron is thicker, has an extensive glandular area and projects only slightly as a broad median ventral lobe. There is a broad but shallow and rather ill-defined dorsal thoracic groove and an annular groove, somewhat distinct on the dorsum, separating the thorax and abdomen.

Abdomen rather soft, broadly rounded laterally, slightly depressed, tapered gently to the pygidium and divided into dorsal, lateral or parapodial, and ventral or neural fields, the latter being marked by a broad, open fecal groove. Abdominal segments numerous, very short, much crowded, and distinctly indicated by the extensive tori only. Integument of dorsal and ventral surfaces more or less swollen and wrinkled, probably in part due to the preserving fluid. A calcareous incrustation occupies a nearly circular area on the dorsum of the caudal end, which is bluntly rounded and terminated by a very short pygidium containing a large, vertical, slit-like anus guarded by somewhat tumid lips.

Thoracic setæ form seven compact flattened tufts, somewhat spreading distally, of very numerous setæ; they project obliquely dorsad and the collar tuft somewhat cephalad, the others caudad. The collar fascicle is subdivided into two, the others into three ranks closely united above but separating somewhat ventrally, the anterior rank being composed of smaller setæ and separated from the others by a small membranous fold. All thoracic setæ (Pl. IX, fig. 65) are similar, pale yellow, narrowly bilimbate, the more dorsal ones somewhat longer and those of the posterior rank slightly curved. Abdominal fascicles are much smaller, with seldom more than twelve shorter but otherwise similar setæ. At the caudal end a certain number of segments bear much longer, very slender capillary setæ without limbæ.

Thoracic tori are very difficult to discern, the long, somewhat irregular series of very numerous uncini being nearly embedded in thick glandular areas below the setæ tufts. The narrow, vertical abdominal tori occupy the sides of the segments rather toward the venter. They are crowded fleshy folds slightly free and projecting at both ends, longer in the middle of the abdomen, becoming shorter toward both ends, and finally obsolete caudally. Uncini (Pl. IX, fig. 65) very numerous, not less than 350 on VIII, small, with the toothed margin very long, conspicuously elevated above and prolonged into a slender, blunt and slightly bifid or notched process below and bearing twenty to twenty-five long, slender, acute teeth, of which four or five smaller ones are on the inferior prolongation. No difference between thoracic and abdominal tori was perceived. At the ventral end of each abdominal torus is a small group of simple spines which persist through the caudal region after the uncini have ceased.

All of the four specimens examined are quite colorless and totally ack pigment. The preserved worms bear a striking resemblance in form to the conventionalized classic torch with the vigorous and somewhat divided flame represented by the gill plumes, which when living and extended must form a magnificent crown.

Tube white, thick, massive, the walls often 5–6 mm. thick and the outer diameter up to 19 mm. The inner layers are hard and stony, the lining somewhat polished, the outer layers becoming chalky and the outer surface roughened by numerous growth lines. The older parts make several irregular open coils beneath and around stones, the newer portions extending freely horizontally into the water, in one case to a distance of 145 mm. Orifice perfectly terete, smooth, polished and thin.

The type (No. 79, Coll. Acad. Nat. Sci.), together with the tube and two other worms, were collected for the Academy at Pacific Grove, near Monterey Bay, at a depth of 40 fathoms, by Prof. Harold Heath. A single example appears in the Stanford University collection, and was taken by a Chinese fisherman on a red-cod line in the vicinity of Monterey Bay on February 20, 1902.

Several species of *Protula* have been described from the Pacific, and it is possible that *P. atypha* Bush or some of the other smaller species may be the young of this, but they have far fewer branchial rachises. Indeed this species departs from typical members of the genus in the large number of rachises and complexity of the gill-bearers or bases.

Serpula columbiana Johnson.

Serpula columbiana Johnson, Proc. Bos. Soc. Nat. Hist., XXIX, pp. 432, 433; Pl. 19, figs. 199-204.

"Lighthouse Point," vicinity of Monterey Bay, in a big tide pool, June 28, 1904. Three medium-sized specimens with portions of tubes.

The operculum is more slender and has a more finely serrated margin than the one figured by Johnson. One counted had 140 serrations and ribs and 38 pairs of branchial rachises.

HERMELLIDÆ.

Sabellaria californica Fewkes (Plate IX, figs. 66*a* and *b*).

Sabellaria Californica Fewkes, Bull. Essex Inst., XX (1889), pp. 130-132; Pl. VII, figs. 3 and 4.

Only two specimens from San Diego are contained in the collection. In the vicinity of Monterey Bay the species appears to be more abundant, specimens being present from "Lighthouse Point," June 28, 1904; "big tide pool," June 20, 1905, and Delmonte wharf, dredged July 12, 1904.

The degree of pigmentation differs greatly, some being pale, others deep brown, the latter type strongly prevailing.

This species is readily distinguished from the next by the character of the opercular spines, which, with the exception of those of the concealed inner series, are opaque, dark brown or black. The exposed parts of the outer series are erect, of the inner and middle series recumbent, whereas in *S. cementarium* the yellow spines of all three series are more or less erect, those of the middle series being very prominently so. The exposed parts of both the inner and middle series of this species are placed at right angles to the slender stem or tendon. The long, pick-like spines of the middle series (fig. 66*a*) are very hard and the pointed, slightly hooked tips frequently interdigitate and cross in the middle, completely concealing the inner whorl. The latter (fig. 66*b*) are much more delicate, flattened, yellow, somewhat chaff-like structures, the divided and densely fringed tips of which often embrace the ends of the middle series of spines.

The tubes of this species Fewkes describes as forming great masses of agglutinated sand grains and shell fragments in the caverns of wave-worn cliffs. Those of *S. cementarium*, so far as known, occur singly or in small groups attached to shells and stones. Which one of these species, if either, was described by Baird under the name of *S. saxicava* it is impossible to determine from the brief description. So far as it goes the description fails to fit either, and it seems probable that a third species is represented on this coast.

Sabellaria cementarium Moore.

Sabellaria cementarium Moore, Proc. Acad. Nat. Sci. Phila., 1906, pp. 248–253; Pl. XII, figs. 45–51.

Two specimens among *S. californica* from "big tide pool," Monterey Bay, June 20, 1905.

Explanation of Plates VII, VIII, IX.

Plate VII.—*Trypanosyllis intermedia*—figs. 1 and 2.
Fig. 1.—End of seta from somite X, × 360.
Fig. 2.—Same from somite L, × 360.
Phyllodoce medipapillata—figs. 3 and 4.
Fig. 3.—Parapodium from somite X, × 24.
Fig. 4.—Seta from somite XXV, × 360.
Eunice paloloides—figs. 5–7.
Fig. 5.—Compound seta from somite C, × 440.
Fig. 6.—Ventral view of mandibles, × 9.
Fig. 7.—Dorsal view of maxillæ, × 9.
Marphysa stylobranchiata—figs. 8–12.
Fig. 8.—Simple acute seta from somite XXV, × 250.
Fig. 9.—Simple pectiniform seta from same, × 440.
Fig. 10.—Compound seta from same, × 440.
Fig. 11.—Mandibles from ventral side, × 24
Fig. 12.—Maxillæ from dorsum, × 24.
Marphysa californica—figs. 13–20.
Fig. 13.—Simple seta from dorsal portion of upper tuft of XXV, × 250.
Fig. 14*a* and *b*.—Two forms of simple pectiniform setæ from somite XC, × 440.
Fig. 15.—Compound seta with appendage of moderate length from somite XXV, × 360.
Fig. 16.—Hooded crochet from somite C, × 360.
Fig. 17.—Ventral view of mandibles, × 9.
Fig. 18.—Dorsal view of right mandible, × 9.

Plate VIII.—*Marphysa californica.*
Fig. 19.—Dorsal view of maxillæ of left side in normal relation, × 9.
Fig. 20.—Dorsal view of right maxillæ partly separated, × 9.
Drilonereis nuda—figs. 21–23.
Fig. 21.—Parapodium C, anterior face, × 83.
Fig. 22.—Seta from middle of same, × 360.
Fig. 23.—Dorsal view of jaws, × 24.
Stauronereis moniloceras—figs. 24–29.
Fig. 24.—Compound seta from parapodium XXV, × 440.
Fig. 25.—Tip of a coarser simple seta from XXV, × 600.

Fig. 26.—Ventral view of mandibles, × 24.
Fig 27.—Anterior (*a*) and posterior (*b*) maxillæ of outer series, × 83.
Fig. 28.—Anterior maxilla of middle series, × 83.
Fig. 29.—Anterior (*a*) and middle (*b*) maxillæ of inner series, × 83.

Aricia johnsoni—figs. 30–33.
Fig. 30.—Tip of stout neuropodial seta from somite X, × 600.
Fig. 31.—Portion of slender neuropodial seta from somite L, × 600.
Fig. 32.—Optical section of a portion of a notopodial seta from somite L, × 600.
Fig. 33.—End of a furcate notopodial seta from somite C, × 600.

Naineris robusta—figs. 34–37.
Fig. 34.—Stout neuropodial seta from somite XXV, × 250.
Fig. 35.—Slender neuropodial from same, × 250.
Fig. 36.—Face (*a*) and profile (*b*) views of a portion of a capillary notopodial seta from somite C, × 600.
Fig. 37.—Two furcate notopodial setæ from somite C, × 360.

Naineris longa—figs. 38–42.
Fig. 38.—Stout neuropodial seta from posterior series of somite XX, × 250.
Fig. 39.—Slender neuropodial seta from anterior series of somite XX, × 250.
Fig. 40.—Notopodial seta from somite XX, × 83.
Fig. 41.—Neuropodial spine from posterior series of a middle somite, × 250.
Fig. 42.—Furcate notopodial seta from middle region, × 360.

Plate IX.—Fig. 43.—*Tharyx multifilis*—Anterior end of cotype, × 9.
Fig. 44.—*Dodecaceria pacifica*—Neuropodial spine from somite LXXV, × 250.

Pista elongata—figs. 45–47.
Figs. 45–47.—Uncini from somites V, XIV and XXV respectively, × 250.

Pista alata—figs. 48–51.
Fig. 48.—Limbate seta from somite XV, × 250.
Figs. 49–51.—Uncini from somite V, XV and XXX respectively, × 250.

Polycirrus californicus—figs. 52, 53.
Fig. 52.—Uncinus from XX, × 440.
Fig. 53 —Uncinus from XXXV, × 440.
Fig. 54.—*Polycirrus* sp.—Anterior uncinus, × 440.
Fig. 55.—*Notomastus tenuis*—Anterior abdominal crochet, × 440.
Fig. 56.—*Eunotomastus gordiodes*—Neuropodial crochet from somite XXV, × 360.
Fig. 57.—*Dasybranchus giganteus*—Corrected figure of crochet, × 360.
Fig. 58.—*Dasybranchus glabrus*—Neuropodial crochet from somite XXV, × 360.
Fig. 59.—*Sclerocheilus pacificus*—Quarter view of a posterior furcate seta, × 440.

Trophonia capulata—figs. 60, 61.
Fig. 60.—End of neuropodial seta from somite XXV, × 250.
Fig. 61.—Notopodial seta of same, × 56.

Flabelligera commensalis—figs. 62, 63.
Fig. 62.—Collar seta, × 56; *a*, portion of same, × 250; *b*, distal end of a sensory papilla from collar, × 56.
Fig. 63.—Neuropodial hook from somite XXV, × 83.

Protula superba—figs. 64, 65.
Fig. 64.—Shorter limbate seta from somite VIII, × 56.
Fig. 65.—Uncinus from somite XXV, × 360.

Sabellaria californica—figs. 66*a* and *b*.
Fig. 66*a*.—Palea of middle series of operculum, × 33.
Fig. 66*b*.—Same of inner series, × 33.

May 4.

Arthur Erwin Brown, Sc.D., Vice-President, in the Chair.

Sixty-five persons present.

The Publication Committee reported the reception of a paper entitled "The Vegetation of the Salt Marshes and of the Salt and Fresh-water Ponds of Northern Coastal New Jersey," by John W. Harshberger, Ph.D. (April 24).

The deaths of Charles Hartshorne, October 30, 1908, and of Dr. Joseph Thomas, January 28, 1909, members, were announced.

Mr. Stewardson Brown made a communication on a botanical trip to the headwaters of the Saskatchewan and Athabasca Rivers, British Columbia. (No abstract.)

May 18.

Arthur Erwin Brown, Sc.D., Vice-President, in the Chair.

Forty-one persons present.

The presentation of a paper entitled "The Occurrence of Bufo columbiensis East of the Rocky Mountains," by Robert T. Young (May 5), was reported by the Publication Committee.

The death of Dr. C. N. Peirce, a member of the Council, May 15, was announced.

Prof. Gilbert Van Ingen made a communication on the so-called Clinton Iron Ore of Bloomsburg, Penna. (No abstract.)

Mr. Edgar T. Wherry spoke of the silicified woods of the New Red. (No abstracts.)

Scolithus linearis Burrows with Orifice Complete.—Mr. Benjamin Smith Lyman remarked that *Scolithus linearis*, so abundant at many places in the Pennsylvania Cambrian quartzite, was long supposed to be a fucoid plant; and even so late as thirty years ago was in a well-known valuable text-book called a plant, though at least fifteen years earlier it had been correctly given as a worm-burrow in Dana's *Manual*, where it was said to be common in the Potsdam sandstone. Walcott later found it to be Cambrian; and said, in 1890, he had never seen it in the classical Potsdam.

Specimens were met with during a field excursion of the Mineralogical and Geological Section on October 17, 1908, which fully demonstrated with remarkable clearness that the *Scolithus linearis* is a worm-burrow in the sand of a sea-beach. In one of Mr. Bean's Cambrian quartzite quarries, called by him the Davis quarry, at the eastern end of the North Valley Hill and at three-quarters of a mile southwest of Valley Forge, many burrows of *Scolithus linearis* were found; and on one small slab, with burrows, numerous little circular ridges were instantly recognized by Mr. F. J. Keeley as the crater-shaped orifices of *Scolithus* holes precisely like those of sand-burrowing worms to be seen on our present sea-beaches at Atlantic City and elsewhere (Plate X).

The highly interesting and useful, perhaps hitherto unique slab, $5\frac{1}{4} \times 6\frac{1}{2}$ inches, was presented to the Academy by the finder, Mr. Alan G. Smith. It is well, however, to bear in mind, that further quarrying may, of course, disclose other equally perfect specimens that originated on the same ancient sea-beach.

A somewhat similar burrow with a rather complete orifice was found by the late Ellis Clark "in the Siluro-Cambrian limestone of Lehigh County, about a quarter of a mile north of Helfrich's Spring:" and is described by Prof. Frederick Prime in Report D2, p. 79, of the State Geological Survey, 1878. The fossil was submitted to Dr. Otto Torell, Director of the Geological Survey of Sweden, and at once recognized by him as belonging to his genus *Monocraterion*, and given the specific name of *lesleyi*. The genus is closely allied to *Scolithus*, but the straight tube "gradually expands at the top into a funnel-shaped cavity, corresponding to a like protuberance in the animal." The smaller part of the tube is larger than our *Scolithus*; and in one specimen is three-eighths of an inch in diameter, with the funnel expanding, within a length of half an inch, to an inch or more in diameter.

The following were ordered to be published:

THE OCCURRENCE OF BUFO COLUMBIENSIS EAST OF THE ROCKY MOUNTAINS.

BY ROBERT T. YOUNG.

High mountain chains, especially those whose crests extend above timber line, are more or less efficient barriers to the spread of animals. This is more particularly so in the case of species which do not migrate easily from place to place.

The capture of *Bufo columbiensis* on the eastern slope of the Continental Divide in Colorado is, therefore, of some interest.

In August, 1902, I obtained a specimen of this toad on the eastern slopes of the Arapahoe Peaks, about 28 km. west of Boulder, Colo., at an altitude of about 3,100 m., and it has since been reported to me by Prof. Beardsley, of the Colorado State Normal School, from the eastern slope of the mountains west of Greeley.

Cope[1] gives this species as a characteristic of the Pacific district of the Western sub-region of the Medicolumbian region, included in the Transition of Merriam.[2] My records, however, show it to occur in the Hudsonian zone, far above the upper limit of the Transition, where it has doubtless migrated from its original habitat.

There are several passes in northern Colorado over the Continental Divide which cross the mountains below timber line, affording possible paths of migration for toads from the western to the eastern slope.

Further observations on the distribution of this species on both slopes of the mountains, taken from year to year, would doubtless be of interest as affording some data for a determination of the conditions and rate of migration of toads.

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[1] The Geographical Distribution of Batrachia and Reptilia in North America, *Am. Nat.*, XXX, 886–902 and 1003–1026.

[2] Laws of Temperature Control of the Geographic Distribution of Terrestrial Animals and Plants, *Nat. Geog. Mag.*, VI, 229–238.

ON THE SPINNERETS, CRIBELLUM, COLULUS, TRACHEÆ AND LUNG BOOKS OF ARANEADS.

BY THOMAS H. MONTGOMERY, JR.

This paper presents observations on the ontogeny of the organs mentioned in the title, together with notes on the anatomy of the cribellum and colulus and with certain considerations on the broader morphological relations of these various organs.

The embryos of the spiders examined were killed in Carnoy's fluid (absolute alcohol, chloroform and glacial acetic acid in equal parts, with corrosive sublimate to saturation), an excellent fixative that makes it possible to cut with ease good series of paraffine sections; it has the disadvantage of frequently producing an extra ovat of yolk in the earlier stages. After fixation and hardening the egg membranes are readily removed with needles. In order to secure good surface views of the abdomen after the stage of reversion it is best to cut off the cephalothorax, and with a knife to remove a considerable portion of the abdomen itself so as to allow the stain (preferably Delafield's hæmatoxyline) to penetrate evenly. The adult spinning organs with the cribellum or colulus are best examined in balsam after dehydration and clearing, and after the dorsal half of the abdomen has been cut away. Of *Theridium tepidariorum* and *Loxosceles rufescens* I secured accurately timed stages by breeding females in captivity. The material of *Theridium* was collected by me at Woods Hole, Massachusetts, and that of *Loxosceles*, *Evagrus* and *Filistata hibernalis* at Austin, Texas. I am obliged to Mr. Nathan Banks for the determination of these species.

1. Colulus, Cribellum and Spinnerets.

The first question to be taken up is the matter of the morphological relations of the colulus and cribellum to the spinnerets.

According to the classification of Simon (1892) two main groups of the Araneæ are distinguished: the Araneæ theraphosæ and the Araneæ veræ. The former include the families Liphistiidæ, Aviculariidæ and Atypidæ; of these the first are unique among all spiders in the possession of four pairs of true spinnerets (mammillæ), while most

Aviculariidæ possess only two pairs,[1] and the Atypidæ (the genus *Brachybothrium* excepted) possess three pairs. Almost all the Araneæ veræ have three pairs of spinnerets.[2] These discrepancies in number make it somewhat difficult to homologize the pairs of different groups, a difficulty briefly mentioned by Stevenson (1908).

The three pairs of spinnerets found in most of the Araneæ veræ are named in antero-posterior order: the anterior (inferior), the median, and the posterior (superior). Between the spinnerets of the anterior pair may be placed either a cribellum or a colulus, both of which are absent in the Theraphosæ. The cribellum was discovered by Blackwall (1839), and has been most thoroughly described by Bertkau (1882) as a small transverse plate, sometimes halved by a median carina, this plate provided with the very numerous minute pores which are the openings of multicellular spinning glands, and the spinning plate enclosed in a chitinous frame. In species possessing it the fourth pair of metatarsi are each provided with a row of recurved hairs, called the calamistrum and also dicovered by Blackwall; the latter is used as a comb to draw out the silk issuing from the cribellum—an operation that can be clearly seen in the larger species of *Filistata*, though it is performed with great rapidity. In mature males the cribellum is more or less rudimentary, for which Bertkau offers the valid explanation that adult males do not spin snares. Blackwall and Bertkau correctly interpreted the cribellum as a modified and fused pair of spinnerets, while Thorell (1870), who called it the "infra-mamillary organ," argued against such a comparison, though without cogent reasons.

The colulus or hypopygium (Menge, 1843) is a conical projection or small tubercle occupying approximately the place of the cribellum in some of the families of the Araneæ veræ which do not possess the cribellum. It has no spinning glands and there is no calamistrum associated with it. Menge compared it with a rudimentary cribellum, but Bertkau argued that the colulus is a simple integumentary fold representing the region between tracheal stigma and cribellum.

To decide with which of the three pairs of spinnerets of most Araneæ the two pairs of most Aviculariidæ correspond, I have examined some

[1] The exceptions are the genera *Hexathele* and *Scotinœcus* with a third (most anterior) pair of very small spinnerets; and *Anisapis* and *Diplothele* with only one pair.

[2] According to Simon, *l.c.*, less than three pairs are exhibited by the following: the Hadrotarsidæ, Palpimanidæ (except *Huttonia*), the Zodariid genera *Lutica*, *Hermipus*, *Mallinus*, and the Archæid *Mecysmauchenius*—these named genera having only one pair.

early stages of the Aviculariid *Evagrus*—this being to my knowledge the first account of the embryology of any Theraphosid. The earliest stage possessing extremities found is shown in fig. 28, Plate XIV, a lateral view. Next to the head lobe is found the cheliceron (*Chel.*), then the pedipalp (*Ped.*), then the four pairs of thoracal legs (*L.* 1–*L.* 4). The abdomen is remarkable in possessing only two segments (1, 2), whereas in other spiders at a corresponding stage the abdomen would be richly segmented, and in having a huge caudal lobe (*C. L.*) projecting forward. The next stage available is that of fig. 29, a ventral view of the abdomen: the two pairs of lung books (*Pul.*) have formed, the nerve ganglia (*N. C.*) are clearly marked, and there are indications of three pairs of spinnerets. Of the latter the anterior (*A. Sp.*) are only faintly marked thickenings, and evidently belong to the fourth abdominal segment; the median spinnerets (*M. Sp.*) are rounded projections just median to and in the same plane with the largest posterior spinnerets (*P. Sp.*), therefore outgrowths of the fifth segment. Three successive later stages, shown in figs. 30–32 respectively, show that the anterior spinnerets have disappeared and that it is those of the fifth segment, the median and the posterior, that persist into the adult. Thus the fourth segment, as shown clearly in figs. 30 and 31, produces no respiratory organs, but originates a pair of rudimentary spinnerets that subsequently disappear.

The two pairs of spinnerets of *Evagrus*, and of probably also other Aviculariids with that number, correspond to the median and posterior spinnerets of those araneads with three pairs; but the development shows that *Evagrus* retains in the embryo a slight trace of the anterior pair. This homology has been already suggested by Simon, on the basis of the relative position of the parts in the adult.

In the next place we may consider the colulus, an organ that has received only the scantiest attention. It may be best studied in Sicariids where it attains its greatest size, and the following account applies to the genus *Loxosceles*.

In an adult individual the form and position of the colulus is shown on ventral view in fig. 26, Pl. XIII. It is an unpaired conical projection (*Col.*) between the anterior spinnerets (*A. Sp.*), its base confluent with their bases and at some distance behind the tracheal stigma (*T. St.*). The transverse line in the figure which crosses it from left to right represents the border of a skin-fold just dorsal to it and to the spinnerets, and this fold is deeply indented in the median line. Its free apex is directed ventro-caudad; its surface bears simple hairs like those on the ventral surface of the abdomen, and the small circles indicate the insertion points of these hairs. A median section of it is represented in fig. 25, where the apex is at the left and the dorsal border uppermost. It is covered by a cuticula (*Cut.*), which is less thick than that of the adjacent body surface, beneath which is a hypodermis (*Hyp.*) considerably thicker than that of the rest of the abdomen. The interior of the organ is a blood-space (*Bl. Car.*), shown by stippling, containing neither glands nor muscles, though muscles insert near its base. The colulus is equally developed in both sexes. Thus it is a simple integumentary extension with a large axial blood cavity. An organ of its volume must surely fulfill some important function. Its thickened hypodermis might suggest sensory nature. But I think it may be more likely a supplementary respiratory organ, for which the combination of relatively thin cuticula and vascular space would speak, and furthermore the tracheæ are relatively poorly developed in this species.

In *Peucetia* (Oxyopid) and *Lathrodectus* (Theridiid) it is about twice as long as broad, shorter and relatively broader in Dysderids and Argiopids. But in the Agalenids I have found the most interesting relations: in *Tegenaria derhamii* it is a plate about twice as broad as long, in *Hahnia bimaculata* a transverse plate eight times as broad as its antero-posterior length, while in *Agelena nævia* there are a pair of small plates completely separated in the mid-line by a little more than their diameter and inserted well anterior to the roots of the anterior spinnerets. The last case is interesting, for it exhibits the colulus in a distinctly paired condition, the first case of such a relation yet known.

We have next to consider the ontogeny of colulus and spinnerets. Salensky (1871) first proved that the appendages of the fourth and fifth abdominal appendages become the spinnerets. He found the fourth appendages originate the anterior spinnerets, the fifth the posterior, and that the median spinnerets "do not develop from the abdominal feet, but appear between them" (I cite from Jaworowski, for I cannot read the original Russian). This origin of the anterior and posterior spinnerets has been confirmed by Locy (1886), Morin (1887), Kishinouye (1890) and Korschelt (1892), while Barrois (1878), Balfour (1880) and Schimkewitsch (1887) erroneously held that the embryonic appendages disappear and that spinnerets are new formations. The most detailed and satisfactory account is that of Jaworowski (1895) of *Trochosa*. He found that after reversion each appendage of the fourth and fifth abdominal segments is bilobed, consisting of an outer sacculus (exopodite) and inner sacculus (endopodite); on the fourth segment the exopodites become the anterior spinnerets and the endopodites form a "rudimentary cribellum" (more strictly, colulus) that later disappears; on the fifth segment the exopodites become the posterior spinnerets, and the endopodites the median spinnerets. Wallstabe (1908) also found, in *Agelena*, that the median spinnerets arise by splitting off from the posterior pair.

I am able on embryos of *Loxosceles* to essentially confirm the account of Jaworowski and to trace the colulus to its adult condition. Fig. 17, Pl. XIII, represents that stage before reversion, when the maximum number of abdominal appendages is present, and there are seen to be six pairs of them, on segments 2 to 7 inclusive. The two most posterior pairs are the smallest and are temporary, for in the next stage, figs. 18, 19, of the beginning reversion they have disappeared and only the four anterior pairs persist.[3] Later, fig. 20, the third and fourth pairs of these appendages become the largest. The process of reversion brings them close together in the mid-line, and an interesting and decisive condition is exhibited in the stage of fig. 21. The fourth pair of appendages (*P. Sp.*) are approximated, and on the median side of each is an elongated thickening of the hypodermis, the first indication of the median spinnerets (*M. Sp.*). Between the third pair of appendages (*A. Sp.*) there is an undivided, so unpaired, thickening, the primordium of the colulus (*Col.*). My observations differ mainly from those of Jaworowski in finding the colulus to be unpaired at the start, and in finding that the colulus and the median spinnerets behind it do not arise as saccular endopodites of the embryonic appendages, but as thickenings immediately mesial to the appendages. This is a rather important difference, for Jaworowski's description would indicate a cleft condition of these appendages, such as is found in Crustacea, while I do not find such a condition. In *Loxosceles* the colulus and the median spinnerets would seem not to be parts of the appendages, but immediately contiguous to them. Figs. 22–24 show successive later stages, with lengthening of the three pairs of spinnerets and of the unpaired colulus, as well as the gradual extension forward of the largest pair of spinning glands.

The colulus, accordingly, arises as a hypodermal thickening between the anterior spinnerets, and the median spinnerets from a pair of thick-

[3] In the stage of figs. 18 and 19 there are eleven well-marked abdominal segments exclusive of the caudal lobe. The largest number yet described for araneads is twelve, which with the seven of the cephalothorax makes a total of nineteen. The three most posterior of them together with the caudal lobe constitute a projecting postabdomen, such as has been described for *Pholcus* by Claparède (1862) and Schimkewitsch (1887); this may be compared with that of *Evagrus*, fig. 28, Pl. IV.

enings between the posterior spinnerets. The only difference in *Loxosceles* is that the colulus has an unpaired origin; but this difference does not hold in all cases, for in *Trochosa* (Jaworowski) the colulus has a paired origin, and we have seen that in *Agelena* the colulus is a paired structure in the adult. Evidently colulus and median spinnerets are homodynamous.

I have examined the cribellum in *Filistata*, *Hyptiotes*, *Uloborus* and *Dictyna*. In the adult female of *Filistata* there is found a transversely oval plate between the anterior spinnerets and somewhat anterior to them. This plate (fig. 34, Plate XIV) shows a pair of spinning plates (*Cr. Pl.*), provided with numerous fine pores, and these spinning plates are set in the much larger chitinous frame; on the anterior portion of this frame are inserted hairs (their insertion points indicated by the small circles), which hairs are plumose like these of the venter and differ from them only in their much smaller size. These relations are essentially such as Bertkau and others have described. But an important relation seems to have been heretofore entirely overlooked. The paired spinning plates, the cribellum proper, are only the uncovered free surfaces of a pair of appendages, the remaining portion of which is sunk below the chitinous frame. Thus when one examines on a cleared balsam mount the cribellum from the ventral surface, one sees at a higher focus of the microscope only the frame and the spinning plates; but on deeper focus one finds a column of delicate parallel spinning tubules, too fine to be represented on the scale of our drawing, extending from each spinning plate to the anterior edge of the frame. The lateral boundaries of these columns or appendages are shown in fig. 34 by the lines extending forward (upward) from the spinning plates (*Cr. Pl.*) to the upper border of the frame.

Further, each spinning plate shows a slight line of division at its middle, from which point of indentation a line extends some distance forward; this subdivision is probably due to the presence of a muscle (as it is certainly in some other species), though I could not clearly recognize a muscle. In other words, the spinning plates are merely the free, uncovered apices of a pair of spinnerets, the greater region of which lie covered by the cuticular frame. Or the relation might be represented in another way: the cribellum of *Filistata* is a pair of spinnerets mesially approximated, their glands opening distally (on the spinning plates), and across and around these spinnerets has developed a cuticular frame.

This interesting relation in *Filistata* is further explained by a study of the embryo shown in fig. 33, Pl. XIV; no one has previously described any developmental stage of the cribellum, for what Jaworowski described as a "rudimentary cribellum" in *Trochosa* was really a colulus. Fig. 33 represents a ventral view of the abdomen shortly after reversion, and the abdominal segments are well pronounced. The tracheal stigma (*T. St.*) is at the boundary of the third and fourth segments. On the fourth segment are found the anterior spinnerets (*A. Sp.*), and between them a pair of large thickenings (*Cr.*), the paired primordium of the cribellum. On the fifth segment are seen the posterior spinnerets (*P. Sp.*), and between them the median spinnerets as a pair of thickenings (*M. Sp.*). The resemblance of the cribellum to the median spinnerets at this stage is very close, each consisting of a pair of elongate ectoblastic thickenings near the mid-line; and the cribellum is even larger than the median spinnerets. There can be no doubt in this case of the homodynamy of cribellum and median spinnerets.

Fig. 36 shows a ventral view of the cribellum of a mature female of *Hyptiotes cavatus*, and fig. 35 a similar view of that of *Dictyna volupis*. In both of these there is a distinct pair of muscles (*M.*) passing from the spinning plate (*Cr. Pl.*) to the anterior edge of the cuticular frame. In these species the spinning plate is not paired, nor yet is the deeper portion composed of the ductules paired, in which points these species appear much less primitive than *Filistata*. I find the cribellum of *Uloborus plumipes* to be very similar to that of *Hyptiotes*. In *Hyptiotes* the tracheal stigma (*T. St.*) is immediately contiguous to the frame of the cribellum, while in *Dictyna* (fig. 35) they are separated.

Thus we come to the conclusion that the spinnerets, colulus and cribellum all develop from the fourth and fifth abdominal segments; the anterior spinnerets and colulus or cribellum from the fourth, the median and posterior spinnerets from the fifth, as concluded by Jaworowski. The colulus and cribellum arise as elongate thickenings mesial from the appendages of these segments, the appendages becoming the anterior and posterior spinnerets. Colulus and cribellum, as we have seen, are in their development homodynamous with the median spinnerets of the segment behind them. Accordingly, colulus and cribellum arising in a similar position in corresponding segments must be considered essentially homologous organs, conformably with the view of Blackwall, whom Dahl (1901, 1904) has followed. The case of *Filistata* renders it a strong probability that the colulus and cribellum correspond with the antero-median spinnerets of *Liphistius*. The cribellum is a less degenerate structure than the colulus, because it still possesses spinning glands, is larger, and is more frequently paired.

These homologies might be shown tabularly as follows:

	Spinnerets.			
Liphistiidæ.	Antero-lateral.	Antero-median.	Postero-lateral.	Postero-median.
Aviculariidæ.			Posterior.	Median.
Araneæ veræ.	Anterior.	Colulus or cribellum.	Posterior.	Median.

2. Development of the Tracheæ.

Locy (1886), the first to mention the development of these structures, simply states that "upon the ventral surface appear the infoldings, from which are formed the tracheæ." Schimkewitsch (1887) is mistaken in saying that Balfour (1880) demonstrated the origin of tracheæ and lungs, for Balfour did not mention these organs. Schimkewitsch briefly mentions a stage in *Lycosa* before hatching where the tracheæ are already branched. Kishinouye (1890) writes: "In the basal part of the second abdominal appendage, on the interior side, another ectodermic invagination is produced. It assumes the shape of a deeply invaginated tube and remains in this condition till after the time of hatching. The appendage itself is not invaginated and becomes from this time gradually shorter." Purcell (1895) states that the "entapophyses connected with the second (tracheal) pair of appendages become each drawn out into a long tube, to or near the blind, inner end of which the middle pair of endosternites is attached in the adult. These long tubes are represented by the two large trunks which form the tracheæ in the Attidæ, and by the medial pair of the four trunks which compose the tracheæ in most other Spiders (Agelenidæ, Drassidæ, Epeiridæ, Lycosidæ, etc.)."[4]

The preceding references to the tracheæ are all brief and not illustrated by figures. Simmons (1894) goes into the subject somewhat more fully; he finds the tracheæ arising before reversion behind the appendage of the third abdominal segment as a tubular, ectoblastic ingrowth, and the tube so produced to have an irregular folding of its

[4] My friend Dr. Purcell's brief but important preliminary paper deals mostly with the homologies of the tracheæ and entopoyhyses, on which subject he has now an extensive paper in press. I have not considered these relations. In *Loxosceles* I find just latero-posterior to each appendage of the four anterior abdominal pairs a thickening which appears darker than the surroundings on stained surface views, these being marked x in figs. 20–24 of Pl. XIII. I have not determined whether these are apophyses or simple muscle insertions.

wall, resembling to some extent the primary folds of the pulmonary invagination. After the stage of reversion he figures it as a simple tube without branching. The most recent paper is that of Janeck (1909); he did not see the earliest stages, but describes and figures a stage shortly after hatching with the beginning of the branching, and an advanced stage after reversion.

Accordingly, no one has figured the earliest stages of the tracheæ, and our knowledge of their development is very fragmentary.

In *Loxosceles* the conditions are as follows, as observed in surface views only. In the stages of figs. 17–19, Plate XIII, the appendages of the third abdominal segment (3) are simple rounded protuberances like those of the adjacent segments. Later, fig. 20, the appendage of the third segment becomes flatter and less distinct, and its elevated portion has taken on somewhat the shape of a quarter moon. At the stage of fig. 21, completed reversion, no elevated appendages are found in that segment, but at its posterior edge a transverse groove circularly enlarged at each lateral corner (*T. St.*). This condition persists through the stages of figs. 22 and 23, but at that of fig. 24 a pair of lateral tracheal branches, recognizable by being filled with air, and marked *Tr.*, are growing forward from the groove. The transverse groove is evidently the stigma leading into the vestibulum; and this stigma, developing at the posterior edge of the third segment, evidently arises behind the appendages of the segment. In the adult a larger median and four pairs of smaller lateral tracheæ extend forward from the vestibulum (fig. 27).

A better knowledge can be obtained from the study of sections which I have made of *Theridium*. At the time of reversion (fig. 16, Pl. XII) the abdominal appendages show much the same relation as in *Loxosceles*, though a narrow elevated ectoblastic ridge joins the second and third abdominal appendages (*2. Ap.*, *3. Ap.*). Sections of this stage (figs. 1, 2, Pl. XI) show the still heightened appendage (*3. Ap.*) of the third segment behind the pulmonary invagination and a distinct cœlomic sac (*Cœl.*) appertaining to it. But in subsequent stages (figs. 5, 7, 9) the appendage of the third segment disappears, the whole becoming flush with the remainder of the surface of that segment and without any process of invagination. It is not until after this appendage has disappeared entirely that the tracheal invagination takes place, and evidently as in *Loxosceles* behind the region where that appendage was. The first appearance of the tracheæ is seen in fig. 12, Pl. XII; the pulmonary stigma (*P. St.*) is at the posterior edge of the second segment, the tracheal (*T. St.*) not near this, as was the appendage of its segment, but close to the spinnerets (*Sp.*) at the posterior edge of the third segment. The stigma (*T. St.*) is a slight transverse groove, the trachea (*Tr.*) itself is a conical plug of ectoblast cells pushing into the archicœlic space between hypodermis and mesoblast (*Mes.*). Successive later stages of the ectoblastic impaired ingrowth (*T. St.*) are shown in median section in figs. 13–15; in these stages it already shows the division into an outer vestibulum, transversely widened, from the middle of which extends forward a single tracheal trunk, all with a thin chitinous lining. Fig. 15 is the stage of hatching, aged fifteen days, and shows just behind the stigma the still solid primordium of the colulus (*Col.*).

Thus the appendages of the third abdominal segment disappear entirely by merging with the circumjacent hypodermis and without forming any invagination. Quite independent of them and at the posterior margin of the third abdominal segment arises subsequently an unpaired ectoblastic inpushing, the vestibulum, from the middle part of which grows forward a little before the time of hatching a single tracheal trunk. I have not found any indications of folding of the tracheal wall like the pulmonary folding, such as Simmons described, and I would judge that the fold supposed by Simmons to be the trachea, represented in his fig. 8, is not a tracheal invagination at all, but merely the space dorso-posterior to the caudal lobe.

Reference may be made, in passing, to the relative position of the segments in the adult abdomen. The pulmonary stigma marks the posterior border of the second segment, the tracheal stigma (or, in Dipneumonids, that of the second pair of lungs) the posterior border of the third segment, while the anterior and posterior spinnerets mark the posterior regions of the fourth and fifth segments respectively. In *Loxosceles* the third segment comes to occupy a large portion of the venter, as shown in figs. 22–24, Pl. XIII. In *Filistata* (fig. 33, Pl. XIV) and *Evagrus* (figs. 30–32) the third segment is relatively much smaller After the stage of reversion the first abdominal segment cannot be distinguished externally from the second, and I am inclined to think it enters mostly into the composition of the pedicel.

3. Development of the Lung-books.

A considerable amount of work has been done upon the development of these organs since Salensky (1871) showed that they are derived from the appendages of the second abdominal segment.

Bertkau (1872) found that new lamellæ are added during the growth of the spider, each new one as an invagination from the region of the lateral corner of the stigma.

Locy (1886) figured and described two rather late stages, in the earlier of which "the lungs appear as oblong plates of cells, the large oval nuclei of which are arranged in parallel rows"; ultimately there result bicellular interlamellar pillars. Schimkewitsch (1887) described briefly a single rather late stage before hatching, the single figure of which given by him by no means proves that "the lungs of the embryo of *Lycosa saccata* consist of true tracheæ disposed in bundles." Morin (1887) found the lungs to be formed from thickenings at the bases of the appendages of the second abdominal segment, these thickenings becoming the opercula. What Bruce (1887) has described as a pulmonary operculum and lung cavity seems to be nothing more, and Kishinouye has previously made the criticism, judging from his figs. LXXIX and LXXIX,[1] than the caudal lobe at the stage of reversion and the space between it and the body wall; his account has accordingly no value. Kishinouye (1890) found "in the basal part of the first abdominal appendage of each side, there arises an ectodermic invagination whose opening faces away from the median line. . . . Of the wall of the invaginated pocket, that which faces the distal end of the appendage is much thicker than the opposite wall, filling the interior of the appendage. The cells composing it become after awhile arranged in parallel rows. Each two of these parallel rows adhering together produce the lamellæ of the lung-book. The external epithelium of the appendage which covers these lamellæ becomes the operculum of the lung-book after it is depressed in height." Simmons (1894) has given the fullest account up to his time, and the one most fully illustrated by figures. He described fully the method of invagination of the first abdominal appendage, found on its inner (mesial) surface a series of folds during this process of invagination, which folds he believed become the pulmonary lamellæ. There is, however, a great hiatus between the stages of his figs. 6 and 7, and the early embryonic folds do not lie in the same position as the adult lamellæ. Purcell (1895) found that "the earliest lung-leaves appear on the exposed posterior sides of the appendages before the latter have commenced to sink below the surface into the body, and completely outside of the basal sack," and, like Simmons, he concludes these become the adult lamellæ, but without tracing completely their later history. Wallstabe (1908) says he can corroborate Simmon's results, but does not enter into details.

Jaworowski (1894) presented a full account, well illustrated, but did not describe any stage earlier than one considerably later than reversion. He began with a stage where beneath the first abdominal appendage there is a saccular invagination, from which proceeds dorsally a tube dividing into several branches; "it is, however, clear that the so-called lungs of the spider in the embryonal condition are repeatedly branched tracheæ." These tracheal tubes ultimately disappear, and the definitive pulmonary lamellæ arise from parallel outgrowths of the vestibule (Vorraum).

Finally, the latest memoir, that of Janeck (1909) on *Lycosa*, is the most extensive, and he had not only an excellent series of stages, but he also made use of wax reconstructions. He describes thoroughly the infolding of the first abdominal appendage, finds that it develops a series of pronounced folds on its inner (mesial) surface, thus far essentially corroborating the observations of Simmons and Purcell, but, contrary to these writers, he finds these embryonic folds disappear. "Especially important is the demonstration that the folds of text figure 16, which many authors refer directly to the lung-leaves, have no relation at all to the lung . . . and the fold formation of these stages show themselves to be not even forerunners of the lung-leaves." The pulmonary lamellæ arise as secondary folds from a compact lung mass.

It will be seen that there are considerable differences of opinion, out of which it is hard to reach the true state of affairs. My observations are in entire disagreement with the conclusions of Schimkewitsch and Jaworowski, that the lungs arise as tubular tracheæ, and I believe that Jaworoski misinterpreted embryonic dorso-ventral muscles. Then neither of these authors described the earliest stages. With Purcell, I find folds appearing upon the posterior surface of the pulmonary appendages before it invaginates; but, in opposition to him and Simmons, and in agreement with Janeck, I find these folds are only temporary, and that the definitive lamellæ arise from a disassociated solid cell mass. Locy, Morin and Kishinouye were correct, so far as their observations went.

In *Theridium*, about the stage of reversion, the pulmonary stigma (*P. St.*, fig. 1, Pl. XI) is present as an ectoblastic invagination just behind the appendage of the second abdominal segment, and on the posterior face of this appendage are present three folds (*Lam. 1*). These embryonic folds may be called the primary lamellæ. In a later stage, shown in fig. 2 (a surface view of this stage is represented in fig. 16, Pl. XII), the pulmonary stigma (*P. St.*) has become deeper, and the primary lamellæ (*Lam. 1*) more pronounced. Later, fig. 3, the pulmonary sac or chamber has become a narrow space by the further insinking of the pulmonary appendage. Two primary lamellæ can be still distinguished (*Lam. 1*) but they have become relatively smaller; fig, 4 is a section of the same appendage but to one side of the stigma, where there is a closed tube beneath the outer ectoblast formed by overgrowth in the manner described by Janeck. Fig. 5 represents a stage still later; the whole pulmonary appendage has become flattened down to the surface of the abdomen, the primary lamellæ (*Lam. 1*) are not more than two in number and only slightly pronounced, while the anterior end of the pulmonary ingrowth is growing larger in the cephalad direction. In fig. 6, cut to one side of the stigma (so comparable with fig. 4 of an earlier stage), the anterior region of the solid ingrowth is divided into two parts, the beginning of the first two true or secondary lamellæ (*Lam. 2*). The slightly later stage of fig. 7 is particularly instructive. The abdomen now makes a short angle with the cephalothorax, so that the layer of ectoblast (*Ect.*) most to the left in the figure is the lining of the cephalothorax. The pulmonary stigma (*P. St.*) occupies the same relative position as in fig. 5, but the pulmonary sac or cavity (*P. Car.*), which is lined on all sides by ectoblast, has become more voluminous and anterior extensions of it lead into three secondary lamellæ (*Lam. 2*). There is no longer any trace of the primary lamellæ. These had become gradually shorter in the successive stages, shown in figs. 2, 3, and 5, being only faintly marked in the last. There is no trace of them in the stage of fig. 7; were they present they should show just above the stigma (*P. St.*) on the mesial (right) side of the ectoblastic operculum. The primary lamellæ have not become the secondary lamellæ (*Lam. 2*), for the latter are directed cephalad and arise, as we have seen, from the solid anterior portion of the pulmonary primordium. These results are in essential agreement with those of Janeck, though in the form studied by him, *Lycosa*, the primary lamellæ are larger and more numerous, and by the fusion of their free ends with the mesial wall of the lung cavity give rise to a series of small cavities lined by ectoblast which ultimately close up. The primary lamellæ do not become the lamellæ of the adult, and, as Janeck has indicated, would seem to have no more morphological importance than the slight integumentary folds found on the mesial side of the proximal portion of the cephalothoracal appendages.

The history of the secondary or definitive lamellæ is as follows. Arising from the solid anterior region of the lung tissue, as shown in figs. 6 and 7, these lamellæ become larger and more cylindrical with narrower lamina (*Lam. 2*, fig. 8). Successive ones are formed from the solid mesial wall of the lung ingrowth, and in their growth they press into an archicœlic cavity (*Bl. Car.*) between the ectoblast (*Ect.*) and mesoblast (*Mes.*). In fig. 9, Pl. XII, three of these secondary lamellæ

(*Lam. 2*) are shown; each contains a narrow canal communicating posteriorly with the main pulmonary cavity (*P. Cav.*) and their wall is lined by a very flattened epithelium; where the nuclei are placed there is a heightening of the cytoplasm around them, and the figure shows clearly the biserial arrangement of the nuclei, at certain intervals bicellular pillars occurring between adjacent lamellæ. The archicœlic space around these lamellæ has become a vascular cavity (*Bl. Cav.*), shown by stippling. A cross-section of the lung region of this stage is shown in fig. 10; in the vascular cavity (*Bl. Cav.*) lie the lamellæ (*Lam. 2*) which are seen to be flattened tubes. The last stage I have been interested to examine is that of fig. 11, one of about nine days (hatching usually takes place in the fifteenth day). Five lamellæ are developed, but owing to obliquity of the section none are seen in their full length.[5] Mesial to them (to the right in the figure) there is an ectoblastic layer (*Ect.*), from which further lamellæ will be formed. The relation of the bicellular pillars to the lamellæ and to the blood cavity (*Bl. Cav.*) is perfectly clear.

Thus each lung-book arises in the region of the appendage of the second abdominal segment. Immediately behind this appendage develops an ectoblastic invagination, the stigma and pulmonary chamber, and into this the appendage invaginates. There are temporary lamellæ on the posterior surface of this appendage, and these come to lie within the pulmonary chamber, but they disappear entirely and from a thickened cell mass of the anterior region of the invagination the secondary or definitive lamellæ develop. The appendage thereby forms both operculum and secondary lamellæ.

4. Genetic Relations of the Tracheæ and Lung-books of Araneads.

In the Araneæ theraphosæ there are two pairs of lung-books and no tracheæ, and this is also the case in the Hypochilidæ among the Araneæ veræ. Nothing is known of the development of these organs in these forms, except my observation that in *Evagrus* the lung-books are derivations of the second and third abdominal segments. All other Araneæ veræ with two exceptions have one pair of lung-books

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[5] It will be noted that all the drawings on Plate XI are made to the same scale, yet in some cases, as on comparison of fig. 3 with figs. 2 and 5, the parts and nuclei of one embryo may be much smaller than in another embryo of approximately the same age. This is because there are great individual differences in the size of eggs, so of the size of the cells that compose them. The number of cells appears to be constant for a particular stage, but the size of the cells depends upon the size of the embryo.

and an unpaired or paired (Dysderidæ) tracheal stigma; the exceptions are the Caponiidæ with four tracheal stigmata, but no lung-books, and the Pholcidæ with one pair of lung-books, but with no tracheæ or only very rudimentary ones (Lamy, 1902).

There has been much discussion as to the genetic relations of these two organs. They have been so fully and ably compared by Lamy that it is not necessary to more than summarize his account. Since the time of Leuckart (1849) all writers on the subject seem to conclude an essential homodynamy of lung-books and tracheæ, save Berteaux (1889), who, however, reached quite an erroneous idea of the structure of the pulmonary lamellæ. But three different opinions have arisen, namely, whether the lungs are modified tracheæ, the tracheæ modified lungs, or both derived from a common ancestral organ. That the lungs are modified tracheæ is held by Leuckart (1849), Leydig (1855), Bertkau (1872), Schimkewitsch (1884, 1887), Croneberg (1888), Schneider (1892), Sinclair (1892), v. Kennel (1892), Jaworowski (1894), Lamy (1902), and Janeck (1909). That the tracheæ are derived from lung-books is maintained by Lankester (1881), MacLeod (1884), Kingsley (1893), Simmons (1895), Laurie (1894), Wagner (1895) and Kishinouye (1890)—this group of naturalists being mainly influenced by the Limulus-ancestry theory. Finally, Weissenborn (1886) and Bernard (1893) hold that lung-books and tracheæ are divergent derivatives of a common ancestral organ, in the one case from tracheæ of the type of *Peripatus*, in the other from acicular glands of Annelids.

In their adult condition lungs and tracheæ are both branched cavities lined by cuticulated hypodermis. In the lung-books the branches are flattened lamellæ placed parallel, in the tracheæ the branches are usually cylindrical ramifying tubes. But sometimes the main tracheal trunk has no branches, and sometimes the branches are arranged in parallel bundles, all of which details have been described by Lamy; further, I have noticed in *Loxosceles* that the large median tracheal trunk is excessively compressed, quite as much as a pulmonary lamella. Further, tracheæ and lung-books may replace each other in both the second and third abdominal segments. Therefore there are no radical anatomical differences between the two.

Ontogenetically both arise as ectoblastic invaginations, and there is a vestibulum in each case. But there are four differences in the development: (1) In the case of the lung-books the abdominal appendage invaginates and the wall of the part so invaginated bounds the main pulmonary chamber, while the external surface of the appendage becomes the operculum. In the case of the trachea the abdominal appendage does not invaginate, but disappears by merging with the surrounding ectoblast, the trachea arises after it has disappeared, the tracheal vestibulum is not formed from this appendage, and there is no operculum. (2) The pulmonary stigma arises immediately behind its appendage, but the tracheal stigma develops more or less behind the original position of the appendage of its segment. (3) The pulmonary lamellæ arise from a thickened solid cell mass, which is not the case with the tracheal branches. (4) The tracheæ appear somewhat later in the ontogeny.

Thus while the anatomical differences are not great the ontogenetic are considerable. The most important difference is that the lung-books develop from appendages. On the basis of this particular difference we must conclude that there is no complete homodynamy between the two sets of organs, but an incomplete resemblance. The trachea exhibits a simpler method of formation, but this in itself need speak no more for primitiveness than for degeneracy. The present evidence does not clearly indicate which is the more primitive.

5. Limulus and the Arachnids.

To one question, however, we may take a more decided stand—that, namely, of the reference of aranead lung-books to the branchiæ of *Limulus*. Since Straus-Durckheim (1829) first insisted that *Limulus* is much more closely related to Arachnids than to Crustaceans, this view has grown steadily in support, especially in the hands of E. Van Beneden (1871), A. Milne-Edwards (1873), Barrois (1878), Lankester (1881), Patten (1890) and Kingsley (1893). And there can be little question that *Limulus* and the Arachnids are related, from the correspondence in segmentation, arrangement and number of appendages, endosternal and entapophysial structures, central nervous and vascular systems and other organs, all of which have been carefully compared by Lankester and Kingsley. The principal difference between the two has been considered the respiratory organs, and Lankester sought to obviate this by reasoning that the lung-books of Arachnids arose by the invagination of lamelligerous branchial appendages, and that the tracheæ are in their turn modifications of lung-books. This view seemed to be confirmed by the accounts of the development of arachnidan lung-books as given for spiders by Kishinouye, Purcell and Simmons, and for the scorpion by Brauer (1895).[6]

[6] Brauer's study did not determine the first origin of the pulmonary lamellæ, for there is a gap between the stages shown in his text figs. 15*b* and *c*.

Simmons insisted on the following points: (1) that primary folds appear very early on the posterior surface of the invaginating pulmonary appendage of the spider, resembling very closely in position the gill-leaf development of *Limulus* as described by Kingsley; and (2) that such folds become the pulmonary lamellæ of the adult spider. But Janeck and I demonstrate that these primary lamellæ of the spider are only temporary, with probably no more significance than the folds on the mesial surfaces of the cephalothoracal appendages, and they certainly do not become the definitive lamellæ of the lung-book. The truth is that the secondary pulmonary plates of the spider do not arise from folds on the outer surface of an appendage, but in a different position from a solid cell mass after the appendage has invaginated.

Therefore there is nothing in the ontogeny of the lung-books of spiders similar to the development of the gills of the Xiphosura, beyond that they are both connected with abdominal appendages; consequently no embryological ground for deriving the lung-books from gills.

Further, objections of a theoretical nature may also be made against the derivation of the lung-books from gills. First, the direct change of a water-breathing organ into an air-breathing one would be almost without parallel; at least I cannot recall any instance of this kind in animals. Second, granted that *Limulus* is genetically related with arachnids, a view to which I subscribe, what reason have we for assuming that *Limulus* is the more primitive form? The only good anatomical argument for this view is that *Limulus* retains through life six pairs of abdominal appendages, and also a pair of nephridia. The general reason for the primitiveness of *Limulus* is its marine habitude, with the assumption that the ancestors of most groups must have originated in the seas. The latter assumption lacks all solid basis, and has been opposed by Simroth (1891) and myself (1906). But the true arachnids are essentially terrestrial, quite as much as the insects are, and though a few have taken to aquatic existence, such as the Hydrachnids and *Argyroneta*, all of them breathe atmospheric air. Further, true araneads occurred in the Carboniferous, in times as early as the first fossil traces of Limuloids, while terrestrial scorpions existed in the Silurian. These facts would indicate that the true arachnids originated on the land. It would, accordingly, seem to me that if *Limulus* be related to the arachnid stock, and this seems well established, that the former represents a line of descent that has taken secondarily to aquatic life; and for this view would speak also its existence in shoal waters, and its behavior in laying its eggs close to the land. The position I have taken is in direct opposition to the general one as voiced by Korschelt and Heider, "that the Arachnida have developed from the Paleostraca by adaptation to land life."

6. The Taxonomic Rank of the Theraphosæ.

By quite general consent arachnologists consider the Araneæ theraphosæ to be more primitive than the Araneæ veræ. I do not know whether this conclusion has at any time been critically discussed, and in the present place I shall touch on it only briefly and tentatively, for I feel my knowledge of the families of spiders is too deficient for me to attempt to make any positive decision.

The Theraphosæ differ from the Araneæ veræ in having the chelicera directed forward instead of downward, in possessing no tracheæ, and in having no maxillary plates on the pedipalp (except in certain Atypidæ).

We cannot say whether the character of the position of the chelicera is more primitive in the first case than the other. The lack of maxillary plates might or might not be due to degeneration, and we have seen that there is no good basis for deciding whether lung-books are more primitive than tracheæ.

Thus these anatomical differences in themselves furnish no good answer to our question. The Liphistiids in their general structure appear decidedly primitive, with their four pairs of functional spinnerets and their segmented abdominal terga; yet Simon (1908) in his recent description of the male of *Liphistius birmanicus* has shown that the palpal bulbus is much more complex than in other Theraphosids.

Excluding the Liphistiidæ, the other families of the Theraphosæ, namely, the Aviculariidæ and the Atypidæ, would seem to be degenerate in one respect, that of the spinnerets. For they possess neither colulus nor cribellum, and almost all the Aviculariids lack also the anterior spinnerets. The great length and appendage-like appearance of the posterior spinnerets in the Aviculariids might not be a primitive character, but be due to compensatory growth on account of the loss of the anterior spinnerets. The general small size and compact grouping of the eyes might well be the result of the usual tubicolous mode of life. Further, there are certain Araneæ veræ (such as *Filistata*) which show the male copulatory bulbus less complex than in the Theraphosæ.

In the loss of the spinnerets of the fourth abdominal segment, in the small size of the eyes, and in the occasional great volume of the body the Aviculariidæ at least would seem to be considerably modified. They might well be considered a modified branch which has to great extent replaced spinning by burrowing. Few of them construct true snares, and then only simple ones. Thus they might stand in somewhat the same relation to the Araneæ veræ, as the Ratitæ do to the Carinatæ among birds.

While this hypothesis of the systematic rank of the Aviculariidæ may appear reasonable, we can hardly at the present time decide the rank of the Liphistiidæ and Atypidæ, or indeed decide whether the Theraphosæ represent a homogeneous group.

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Explanation of Plates XI, XII, XIII, XIV.

All the figures have been made by the author with the aid of the camera lucida, and in each the anterior region is directed upwards. In the lettering of the plates the following abbreviations have been employed:

1–11, abdominal segments 1 to 11.
1 G.–11 G., ganglia of the preceding.
2 Ap.–5 Ap., appendages of abdominal segments 2–5.
An., anus.
A. Sp., anterior spinneret.
Bl. Car., blood cavity.
Chel., cheliceron.
C. L., caudal lobe.
Cœl., cœlom.

Col., colulus.
Cr., cribellum.
Cr. Pl., spinning plate of cribellum.
Ect., ectoblast.
H., heart.
L. 1–L. 4, ambulatory limbs 1–4.
L. 1 G.–L. 4 G., ganglia of the preceding.
Lam. 1, primary lamella of lung-book.
Lam. 2, secondary lamella of lung-book.
M., muscle.
Mes., mesoblast.
M. Sp., median spinneret.
N. C., nerve cord.
P. Cav., ectoblastic cavity of lung-book.
Ped., pedicel of abdomen.
P. Sp., posterior spinneret.
P. St., pulmonary stigma.
Pul., lung-book.
R. B., rectal bladder (stercoral pocket).
Ros., rostrum.
Sp., spinneret.
Sp. Gl., spinning gland.
Tr., trachea.
T. St., tracheal stigma and vestibulum.
x., ectoblastic thickening of undetermined significance.

Plate XI.—Theridium tepidariorum.—Oblique longitudinal sections through the lung-book region, all drawn to the same scale.
Fig. 1.—About 98 hours.
Fig. 2.—About 127 hours.
Figs. 3, 4.—121 hours; fig. 3 through the stigma, and fig. 4 somewhat lateral to it, of the same lung-book.
Fig. 5.—Of another embryo of 121 hours.
Fig. 6.—Of another embryo of 121 hours, to one side of the stigma.
Fig. 7.—145 hours.
Fig. 8.—145 hours.

Plate XII.—Theridium tepidariorum.—All the figures except 16 drawn to the same scale.
Fig. 9. Longitudinal section of lung-book, about 150 hours.
Fig. 10.—Oblique cross-section of lung-book of an embryo of the same age.
Fig. 11.—Longitudinal section of a lung-book, the lamella not shown in their full length, about 218 hours.
Fig. 12.—Longitudinal section through pulmonary and tracheal stigma, 145 hours.
Fig. 13.—Median section of tracheal stigma, 168 hours.
Fig. 14.—Median section of trachea, about 218 hours.
Fig. 15.—Median section of trachea, 15 days.
Fig. 16.—Oblique dorso-lateral surface view of embryo of about 127 hours.

Plate XIII.—Loxosceles.—Figs. 17–24 are surface views of whole-stained embryos drawn to the same scale, in figs. 17–19 the extra-embryonic area being stippled.
Fig. 17.—Postero-ventral, 190 hours (8 days).
Fig. 18.—Postero-ventral, 170 hours (7 days).
Fig. 19.—Postero-lateral, 170 hours (7 days).
Fig. 20.—Lateral, 218 hours (9 days).
Fig. 21.—Ventral.
Fig. 22.—Abdomen, ventral, 265 hours (11 days).
Fig. 23.—Abdomen, ventral, 14 days.
Fig. 24. Abdomen, ventral, 20 days, the hypodermal hairs not drawn
Fig. 25.—Median longitudinal section of the colulus of an adult, its free apex at the left and its dorsal surface above.
Fig. 26.—Ventral view of colulus and spinnerets of an adult female, from an unstained balsam mount.
Fig. 27.—Adult vestibulum and roots of main tracheal branches, caustic potash preparation.

Plate XIV.—Evagrus, Filistata, Dictyna, Hyptiotes.—Figs. 28–32 are drawn to the same scale.
Fig. 28.—*Evagrus*, lateral view of embryo before reversion.

Fig. 29.—*Evagrus*, ventral view of abdomen shortly after reversion; the dotted line in the upper portion of the figure indicates where the cephalothorax had been broken off and a part of the abdomen removed.

Figs. 30–32.—*Evagrus*, ventral views of abdomina of successive later stages, fig. 32 of an embryo of 19 days (just hatching).

Fig. 33.—*Filistata*, ventral view of abdomen of embryo shortly after reversion.

Fig. 34.—*Filistata*, ventral view of cribellum of adult female, balsam mount.

Fig. 35.—*Dictyna volupis*, ventral view of cribellum and tracheal vestibulum of adult female, balsam mount.

Fig. 36.—*Hyptiotes cavatus*, ventral view of cribellum of adult female, balsam mount.

THE POLYCHÆTOUS ANNELIDS DREDGED BY THE U. S. S. "ALBATROSS" OFF THE COAST OF SOUTHERN CALIFORNIA IN 1904. I. SYLLIDÆ, SPHÆRODORIDÆ, HESIONIDÆ AND PHYLLODOCIDÆ.

BY J. PERCY MOORE.

Until in 1904 the U. S. Bureau of Fisheries, the University of California, and Stanford University joined forces in initiating an investigation of the marine biology of California upon a comprehensive scale, most of the faunal work done on the invertebrates of that region had been limited to the littoral zone, and much of it had been of a local or desultory character.

Early in that year the Fisheries steamer "Albatross" was detailed to investigate the deeper waters off the coast of the southern half of the State. From March 1 to April 15 collections and physical observations were made at 139 dredging stations in the region south of Point Conception, chiefly in the vicinity of San Diego and among the Santa Catalina and Santa Barbara Islands. Between May 10 and June 15, 128 dredging stations were established in Monterey Bay, making 267 in all. The full data relating to these stations have been compiled and published as Fisheries Document No. 604, Washington, 1906.

Among the material gathered is a rich but rather indifferently preserved collection of Polychæta which was submitted to the writer for study, especially through the interest of Prof. Charles H. Gilbert, of Stanford University. Coming from the deeper waters, this collection admirably supplements the shore collections from the vicinity of San Diego and Monterey Bay contained in the Stanford University Museum and already reported upon in these PROCEEDINGS. It had been expected that the bulk of the collections would be made up of known shore forms, but the large number of undescribed species encountered in the families already studied has dispelled that anticipation. Types of new species are to be deposited in the National Museum, and sets of cotypes and duplicates, as far as possible, also in the coöperating Universities and this Academy.

SYLLIDÆ.

Syllis alternata Moore.

This species is the most common syllid in the collection and occurs at depths of from 33 fathoms to 1,400 fathoms and chiefly among the Santa Catalina and Santa Barbara Islands. The largest and best preserved specimens are 40–44 mm. long and have 125 to 137 segments, but some are only 12–20 mm. long. In some the eyes, and particularly the posterior pair, are enlarged until those on each side nearly meet. There are indications that this condition may be correlated with bathymetrical distribution, the approximation being most marked in the examples from the greatest depth and least in those from more shallow waters.

When contracted the notocirri exhibit a distinct thickening above the base, when extended they taper nearly uniformly from the base, but in all cases the alternation in length is obvious. Some examples have the anterior twenty or so segments each marked by a dusky band, not narrow and sharply defined as in *S. armillaris*, but broad and ill defined. The accessory tooth of the seta appendages is frequently much worn or nearly obsolete, causing the tips to appear simple. In no case do the appendages exhibit any tendency to unite with the stems, as in *Pionosyllis elongata* Johnson and other species of the *Synsyllis* group.

The chitinous lining of the pharynx terminates in a thickened, somewhat crenulated border, behind which is a circle of soft papillæ and dorsally a large, blunt, conical tooth. In the retracted state the tooth lies in somite III, the gizzard in XI–XXVII, the œsophageal loop in XVIII and the cæca in XVII and XVIII.

S. californica Kinberg may be this species, but no certainty can be reached from the brief diagnosis. The *Eusyllis tubifex* Gosse reported by Treadwell from near Monterey Bay is very probably this species. *S. violaceo-flava* Grube is another related species from the Philippines.

Stations 4,326, off Point La Jolla, near San Diego, March 8, 280 fathoms, green mud; 4,400, between San Diego and San Clemente Island, April 8, 500 fathoms, green mud; 4,420, off San Nicolas Island, April 12, 33 fathoms, fine gray sand; 4,427, off Santa Cruz Island, April 14, 447 fathoms, black mud and stones; 4,430, off Santa Cruz Island, April 14, 197 fathoms, black sand and pebbles; 4,574, off Cape Colnett, Lower California, October 8, 1,400 fathoms.

Syllis (Ehlersia) heterochæta sp. nov. Pl. XV, figs. 1–4.

Described from the type only, a small complete specimen 9 mm. long, with a width, in the region of the gizzard, of body of .4 mm. and between tips of parapodia of .7 mm. Segments 80.

Prostomium (Pl. XV, fig. 1) pentagonal, with very unequal sides, the posterior longest and nearly straight, the lateral shortest and convex, the anterior meeting in a rounded apex; about twice as wide as long. Eyes three pairs, forming a triangular group on each side; the middle pair with distinct lenses and much the largest, but not more than one-ninth the width of the prostomium and situated about their diameter from its lateral border; the posterior also with lenses, directed dorso-caudad, about one-fourth the diameter of the middle pair and situated medio-caudad of them; the anterior[1] mere specks of pigment without lenses situated in line with the posterior pair and equally distant from the middle pair. Behind the posterior pair is a large black blotch on each side. Palps prominent, projecting straight forward, separate to the base, about one and one-half times as long as the prostomium, broad at the base where they equal one-half the width of the prostomium, thence diverging slightly and tapering to the rather slender, bluntly rounded tips. Median tentacle arising posterior to middle of prostomium between middle pair of eyes, lateral tentacles close to base of palps laterad of anterior eyes; both slender, little tapered, subequal, reaching about one-fifth of their length beyond palps, strongly moniliform except at base, with twenty to twenty-two joints.

Peristomium (Pl. XV, fig. 1) a short but distinct ring bearing two pairs of tentacular cirri similar to cephalic tentacles but with distinct ceratophores, similar to the cephalic tentacles; the dorsal equal to the latter and with twenty or twenty-one joints, the ventral two-thirds as long with fourteen or fifteen joints. Segments all distinct, short, uniannulate, slightly depressed, increasing in width to near the middle. Pygidium a broadly expanded, furrowed ring whose cirri have been lost.

Parapodia (Pl. XV, fig. 2) of a length generally about one-third the width of their segments. Neuropodia thick, little compressed and little tapered, divided distally into a low postsetal lip which curves over and encloses the ends of the acicula, and a slightly longer presetal lip, the supraacicular portion of which is a small, blunt, projecting lobe forming the dorso-distal angle of the neuropodium. Posteriorly this lobe is much reduced and the postsetal lip becomes longer and more pointed. Neurocirri nearly free from base of neuropodia; their cirrophores small and indistinct; styles slender, tapered, blunt, longer than neuropodium and with a swelling on the dorsal side above the base. Posteriorly they become more slender. Notocirri strongly moniliform and very distinctly jointed (though the joints become cylindrical rather than spheroidal or ellipsoidal) even to the caudal

[1] Omitted from the figure.

end; cirrophores short but generally distinct. Those on II and V are the longest, about one and one-half times the dorsal tentacular cirrus and exceeding the greatest width of the body; they have twenty-four to twenty-seven joints; III and IV are slightly longer than the dorsal of I and have nineteen to twenty-two segments. The remaining notocirri are more or less regularly alternately longer and shorter even to the caudal end, the longer in general equalling about three-fourths the width of their segments and the shorter about three-fifths their width. Those in the middle of the body have about sixteen or seventeen (fig. 2) and eleven to thirteen (fig. 2*a*) joints respectively.

Acicula (Pl. XV, fig. 2) of anterior parapodia in a row of six or seven, the ends of which appear in a groove at the dorso-distal angle of the neuropodia. They are pale yellow, rather stout, tapered and end in blunt points, slightly knobbed and variously slightly bent or even hooked; middle neuropodia have three or four and posterior only two.

Setæ in rough, irregular subacicular fascicles of about seven rows of three or four each. They are colorless with rather long, curved shafts slightly enlarged at the distal end (Pl. XV, fig. 3) to form simple, oblique articulations roughened by a few minute points. Appendages of all except the setæ of the dorsal row comparatively short (fig. 3), two to four times the length of the oblique end of shaft, scarcely curved and not hooked at the tip, which is a simple point below which is sometimes an obscure accessory tooth; margin strongly toothed. Setæ of dorsal series and sometimes one or two of the next row more slender (Pl. XV, fig. 4) with very long, slender, straight appendages usually about four times the longest of the lower rows, with blunt ends (fig. 4*b*) and finer marginal denticulation (fig. 4*a*). Such setæ continue to the caudal end and are similar on all segments. Many of the posterior parapodia also bear a single stout, nearly straight, spine-like simple seta, as long as the shafts of the others, in the dorsal part of the bundle; it is probably to be regarded as a prolonged aciculum.

Proboscis (Pl. XV, fig. 1) protruded about one-third of its length beyond palps, broad cylindroid, diameter exceeding prostomium, cuticle thick, smooth and entire at orifice; dorsal tooth stout and blunt, probably from wear; behind this is a circular fold bearing eight (or nine?) distant, soft, rounded papillæ. Gizzard reaches from IX to XXI and has thirty-seven rings. Colorless in alcohol.

The only specimen was taken at Station 4,423, off San Nicolas Island, April 13, 339 fathoms, gray sand, black pebbles, shells.

Syllis (*Ehlersia*) *anops* Ehlers, from the Straits of Magellan, is a much more elongated species with the anterior and posterior dorsal setæ appendages differing in form. *S. singulisetis* Grube, from the Philippines, also belongs to the subgenus *Ehlersia*, but has only four eyes.

Pionosyllis typica sp. nov. Pl. XV, figs. 5–7.

Form moderately slender, widest in the region of the gizzard, from which it tapers regularly to the caudal end. The well-extended and complete type has 96 segments and is 31 mm. long and 1.2 mm. in diameter at XXV.

Prostomium small, somewhat sunken into peristomium, about one and two-thirds times as wide as long, the greatest width posterior, the sides and front broadly and regularly rounded. Eyes two pairs, dark brown, small, anterior pair close to lateral border and about midway of length of prostomium; posterior pair little more than one-half diameter of anterior and slightly behind and within them. A pair of faint ridges run from the posterior eyes to the posterior border of the prostomium, nearly completing with the eyes a V-shaped figure.

Palps completely separated to base, bent somewhat ventrad, broadly triangular with rounded angles, about as long as prostomium and basal width about two-thirds length. Median tentacle arising between posterior eyes, about one and one-fourth times as long as prostomium and palps, slender and slightly tapered, divided into about twenty-four articles, distinct distally but obscure toward the base, not strongly moniliform. Lateral tentacles similar, arising from a slight depression just anterior to anterior eyes, nearly three-fourths as long as median and reaching nearly as far, divided into nineteen or twenty joints. Mouth rather large with prominent crenulated lips.

Peristomium short and partly crowded beneath prostomium, but visible for entire width of dorsum. Tentacular cirri similar to tentacles, the dorsal slightly exceeding median tentacle in length, with about twenty-six joints; the ventral somewhat shorter, with twenty joints. Body segments nearly terete, remarkably regular but separated by shallow, inconspicuous furrows; except for a few short anterior ones they are half as long as wide or more. From the maximum width at the end of the first fourth they taper regularly to the pygidium, which is a small ring and bears one of a pair of cirri as long as the last nine segments and resembling the posterior neurocirri in being scarcely articulated.

Parapodia (Pl. XV, fig. 5) situated at ventral level of body, well separated throughout, slender, rather conspicuous in ventral view but largely concealed from the dorsum. The neuropodia are slightly compressed and taper slightly to the bluntly rounded and rather abruptly contracted end, which is divided into two small lips separated by a deep cleft, from which the setæ arise and into which the tips of the acicula enter. Neurocirri arise obliquely from basal half of neuropodium, cylindrical or slightly tapered to blunt tips reaching well beyond end of neuropodium, especially on anterior segments. Notocirri arise from rather prominent but indistinct cirrophores immediately above base of neuropodia and all at same level. Styles all approximately of one length, about two-thirds width of body, the anterior and alternate ones scarcely longer than the others, but the alternate ones carried erect. Anterior notocirri are somewhat articulated, similarly to the tentacles, but this character becomes more obscure toward the base and on more caudal cirri; most of them are rather stout, rather quickly tapered and more or less transversely wrinkled, rather than jointed. Near the caudal end they become much reduced in size.

Acicula number from five or six anteriorly to two or three posteriorly; pale yellow, tapered, the ends blunt and very slightly knobbed (Pl XV, fig. 6).

Setæ generally about twelve or fifteen, in oblique, spreading, fan-shaped tufts; colorless, the stems long, slender, curved, the ends (Pl. XV, fig. 7) slightly enlarged, oblique, with four or five just perceptible teeth on the convexity of the front face and a slight shoulder behind. Appendages moderately long, varying from three times diameter of distal end of stem in ventral to five times its diameter in dorsal setæ, except at the posterior end, where all are shorter. They (fig. 7) are of peculiar form with very oblique base, beyond which the width remains nearly uniform; distally abruptly truncated and ending in a stout oblique spur, above which is a delicate curved tooth often nearly worn away; a very fine marginal fringe ending in a more prominent tuft of hairs.

This species stands closer to the type species than any of the three already described from the Pacific coast of North America. Johnson's species, *P. elongata*, appears to be more properly referred to *Synsyllis* Verrill. Much confusion in the usage of the genus exists among authors.

Station 4,430, off Santa Cruz Island, April 14, 197 fathoms, black sand and pebbles. Two specimens.

Pionosyllis gigantea Moore.

About forty anterior segments of a specimen of this large species from an unknown locality. As noted above it is doubtful if this species really belongs to *Pionosyllis*.

Trypanosyllis intermedia Moore.

Owing to the deficiencies of the type the original description of this species is incomplete and may be added to here.

A complete specimen with 230 much contracted segments is 60 mm. long, with a maximum body width of 3.2 mm. at XXX. Prostomium subquadrate, slightly wider than long; with a deep postero-median dorsal incision and furrow. Palps completely separated to base, slightly longer than prostomium, somewhat divided into basal and terminal portions; the former somewhat swollen and the latter slender and abruptly bent ventrad. Median tentacle five or six times length of prostomium and composed of fifty-six very short joints; lateral tentacles about one-half as long, with thirty-five to thirty-eight joints. Eyes on each side nearly or quite coalesced. Tentacular cirri arising beneath prostomium, the dorsal nearly equal to median tentacle, with fifty joints; the ventral slightly shorter than lateral tentacle, with about thirty-five joints. Notocirrus of II the longest, about one-third more than the median tentacle, with sixty-four to seventy joints; that of III scarcely shorter and of IV two-thirds as long as II. Following this the notocirrophores of odd-numbered segments are at a slightly higher level and bear slender styles as long as the width of their segments and with as many as sixty or seventy very short joints; those of even-numbered segments have styles about two-thirds as long. Pygidium a tapered ring bearing a pair of slender cirri as long as its diameter and with twenty-five to thirty joints.

A pharynx dissected had the circle of teeth in somite VIII; there are eighteen to twenty slender compressed soft papillae and apparently as many teeth, but the latter are so much broken that this cannot be determined with certainty. Gizzard in XVIII to XXIX with thirty-five distinct and seven or eight indistinct rings.

The anterior thirty-five or forty segments are reddish-brown above with pale intersegmental lines.

One specimen each from stations 4,417, off Santa Barbara Island, April 12, 29 fathoms, fine yellow sand, rock and coralline; and 4,420, off San Nicolas Island, April 12, 291 fathoms, gray mud and rock.

Odontosyllis phosphorea sp. nov. Pl. XV, figs. 8–10.

Epitokous, sexually mature examples, unfortunately much distorted and broken. The type and largest specimen lacks some of the caudal segments and measures 23 mm. long, 2.5 mm. in maximum width between tips of parapodia and 1.5 mm. in width of body only. The anterior region of twenty-three segments is 4.6 mm. long, the middle of fifty-one segments provided with swimming notopodial setae is 17 mm., and only four segments of the posterior region remain, making seventy-eight segments in all. A smaller, more extended and posteriorly complete cotype is 18 mm. long, the anterior region being 5 mm. and the posterior 5.5 mm. Segments 23 + 26 + 31 = 80.

Form rather short and stout, widest at the middle, the ventral surface flat, the dorsal more or less arched, most so in the anterior region, which is nearly as high as wide; the middle and posterior regions depressed.

Prostomium small, short, bent downward, subprismatic with rounded angles, about two-thirds as long as wide and deeper than long, the front abruptly vertical, somewhat excavated for the tentacles. Eyes two pairs, moderately large with large lenses, brown, occupying sides of prostomium, the anterior pair directed chiefly forward, the posterior upward. Though themselves distinct they are enveloped in an irregular curved, broad band of black pigment which occupies most of the lateral and posterior dorsal part of the prostomium. The three tentacles arise close together, the median more dorsal, from a depression in the middle of the frontal face, small, slender, unjointed, subequal, somewhat exceeding length of prostomium. Palpi directed ventrad, thick, fleshy separated knobs.

Peristomium achætous, largely concealed by prostomium, only a very short dorsal ring and larger lateral prominences showing. Two pairs of tentacular cirri, unjointed but transversely wrinkled, the ventral about as long as width of prostomium, the dorsal about one and one-half times as long. The nuchal fold arises from the dorsum of II and is a prominent, semicircular, deeply pigmented, free, membranous flap, with a basal width equal to one-half the segment and covering the posterior part of the prostomium as far as the anterior eyes. Somite II and remaining setigerous segments are uniannular and well marked by irregular furrows, differing in the several regions as indicated above. Pygidium a small, low, dome-shaped ring having a pair of short, thick fusiform cirri.

Parapodia, owing partly to the contraction of the specimens, very little prominent, those of the anterior and posterior regions uniramous (Pl. XV, fig. 8), of the middle region biramous (fig. 9). Neuropodia short, stout, with blunt ends, terminating in two short, thick, rounded lips, of which the postsetal is usually slightly the longer; both terminating dorsally at the acicula, which lie slightly below the dorsal border of the neuropodia. In the middle region the neuropodia (Pl. XV, fig. 9) are somewhat longer than in the anterior region, but otherwise similar. The notopodia are low, flattened protuberances pushed out anterior to the seta tuft into a pointed, conical acicular process. In the posterior region the parapodia are neuropodial only and are gradually reduced in size. Neurocirri arise from beneath the base and rather on the posterior face of the neuropodia, and have somewhat swollen bases and a small, slightly distinct distal piece reaching about as far as the end of the neuropodium. They are similar on all parapodia. Notocirri arising from low swellings (but not distinct cirrophores) on the dorsum well above the parapodia. Styles rather long, slender and unjointed, but more or less wrinkled. The first (on II) is longer than the others, about twice the dorsal peristomial cirrus and about one and one-third the width of the segment; that of III is less than two-fifths, of IV about three-fifths and of V about seven-eighths of that of II; remaining notocirri are alternately longer and shorter, those in the middle region being respectively about equal to three-fifths and one-third the width of their segments.

Neuropodial acicula generally two in anterior, three in middle region, moderately stout, straight, tapered, the ends slightly knobbed. Notopodial aciculum single, slender, gently tapered and curved, the distal end slightly knobbed and often bent at the end. Neuropodial setæ entirely subacicular, in dense fascicles of several ranks, rather numerous, usually ten or eleven ranks of three or four each. They are colorless, rather stout, with curved stems becoming thicker distally and ending obliquely in a blunt, slightly roughened point (Pl. XV, fig. 10). Appendages short broad blades varying in length only from once to twice the width of the distal end of the stem, the longest occurring in anterior parapodia and the ventral part of the bundles, terminating in a prominent hook, well below which is a stout spur. In the posterior region a solitary slender, curved simple seta also occurs in each fascicle, but has not been detected elsewhere.

A dissected proboscis exhibits the characteristic thick bow and fold of the chitinous rim, but the number and character of the teeth is not evident. The gizzard of the same specimen has sixty-seven annulations.

Color pale yellow with a conspicuous spot on the prostomium, the nuchal fold and narrow intersegmental transverse lines black; in the middle and posterior regions every fourth one of the latter is much wider and denser, and at these deeply pigmented furrows the frequent fractures of the body-walls always occur; appendages colorless; eyes brown.

The label reads: "Phosphorescent annelids caught at surface, Avalon Bay, Catalina Island, evening, April 11, 1904, Albatross." Professor William S. Ritter writes that a phosphorescent annelid swarms at the surface of San Diego Bay. Doubtless this is the species here described. It is a frequent characteristic of species of this genus to be luminiferous

Syllid gen. et sp.?

A small syllid, probably a true *Syllis* or *Eusyllis*, from an unknown station, cannot be identified, and its characters are put on record for the use of a future describer.

Length 11 mm., segments 72.

Prostomium nearly twice as wide as long, rounded laterally, slightly convex anteriorly and nearly straight posteriorly. Eyes very imperfect (probably abnormal), represented by a minute speck of pigment close to the base of the palp on one side, and a larger but still very small eye with a lens on the other side. No trace of tentacles remains, but it seems very improbable that they should be normally absent in a syllid of this type. Palps projecting forward and curved downward pistally, free, broad, subelliptical, flattened, their length nearly equal to width of prostomium, and their combined width exceeding that of prostomium.

Peristomium very short above, swelling to a broad lip at the sides and below. An incomplete, strongly moniliform, dorsal tentacular cirrus with seventeen joints remaining exists on one side, but the others are lost.

Body strongly arched anteriorly, but more flattened behind. First twelve segments very short and separated by deep furrows, the others becoming longer until in the middle region they are one-fourth as long as wide. Pygidium a very short ring with a slight median lobe, bearing a pair of very long, slender, moniliform cirri as long as the last twelve segments and consisting of more than forty joints; in addition there is a very minute unjointed median cirrus.

Parapodia small, the neuropodia cylindroid, little compressed, truncate, the distal end divided into nearly equal, short, thick, rounded presetal and postsetal lips. Neurocirri rather slender, tapered, unjointed, blunt, reaching slightly beyond end of neurocirri. Notocirri arising from prominent swellings and small cirrophores well above neuropodia; very long, flexible, very strongly moniliform, alternately longer (on odd-numbered segments) and shorter (even-numbered segments). At the anterior end mostly lost; on middle segments the short ones exceed the width of their segments and have thirty-five or forty joints, the long ones are twice the width of their segments and have fifty to fifty-five joints. Even near the caudal end they are not much shorter, the longest having forty or more joints and the short ones twenty-five or thirty.

Acicula three or four in a row ending at the dorso-lateral angle, pale yellow, tapered to blunt, slightly knobbed tips. Setæ few, seldom exceeding ten or twelve and oftener fewer, colorless, transparent, with rather stout, curved stems, terminating in enlarged, oblique ends which appear to be quite smooth. Appendages usually about twice as long as the oblique end of stem, with straight, simple points and strongly developed marginal fringe. Parapodia of the last thirty segments at least bear a single simple spine which projects prominently from the dorsal part of the bundle. It has about twice the thickness of the compound setæ, is very slightly curved and ends in a blunt point. The most posterior project very prominently to quite the length of the compound setæ; further forward they are less conspicuous, and anterior to XL none can be detected.

Proboscis retracted and on account of the opacity and pigmentation of the anterior end difficult to see. It appears, however, to have a smooth margin. Gizzard in XV to XXII, with thirty-four rings.

Color anteriorly pale brown owing to numerous granules in the integument, passing through yellow into a nearly colorless posterior end.

Autolytus sp.?

A single example of a stock regenerating behind and incomplete from the loss of many of the appendages. Length 16 mm., width between tips of parapodia 1.4 mm.; segments 85 with a narrow regenerating bud of 13 segments.

Prostomium broadly ellipsoid, anterior and posterior borders nearly straight, sides prominently convex; with the palps as seen from above the outline nearly circular. Eyes two pairs with lenses, the anterior nearly black, diameter about one-fifth width of prostomium, located midway of the length of prostomium at its lateral borders, looking outward and a little downward and forward; posterior brown, about one-half diameter of anterior, with which they are in contact on the dorso-postero-median side. Palps completely coalesced to tips, but having a depressed median line and barely perceptible distal emargination. Median tentacle lost, but one lateral tentacle present, arising just above base of palp nearly in line with anterior eye, coarse, little tapered, its length six or seven times prostomium and palps, but much twisted and probably incomplete.

Peristomium bearing large cirrophores, but only the ventral style of one side remaining, this being one-half the length of the lateral tentacle. Anterior segments imperfectly separated, the furrows shallow; width increasing for about twenty segments to the gizzard region and then nearly uniform to the end. A wedge-shaped median elevation with apex at the peristomium extends over the first six or seven segments, and is bounded by the divergent epaulettes which extend caudad from the peristomium and have pigmented borders. The regenerating region is quite small, barely a mm. in length and about one-fourth that in width, and ends in an unsegmented blunt pygidium without cirri.

Parapodia, as usual in the genus, short, thick, ventral in position, lacking free neurocirri which become coalesced with the neuropodia to form opaque ventral swellings; neuropodia terminating in short, thick, presetal and postsetal lips. Notocirri with large cirrophores, often as large as the neuropodia; styles unjointed, coarse and similar to the tentacle, very easily detached and many missing. That of II very long, about twice the lateral tentacle and reaching to about XX; that of III about one-half as long; the others much shorter, the longest about one-half III or about width of body.

Acicula four (on one parapodium studied), tapered to blunt points. Setæ forming rather dense tufts, colorless, the shafts rather stout, strongly curved, distally enlarged and near the articulation denticulated on both faces. Appendages little longer than oblique end of shaft, triangular with bidentate ends, the anterior tooth larger and somewhat hooked.

No teeth visible at end of retracted proboscis, œsophagus scarcely looped; gizzard in XX–XXVIII, apparently about thirty-three rings. No color.

The single specimen comes from an unknown station.

SPHÆRODORIDÆ.

Although at least five generic names have been applied to the few known species of this very small family, it seems that the forms possessing compound setæ still lack proper generic designation. Indeed, if the synonymies published by European authors be correct, all of these names are based upon a single type species. As each was originally proposed for a single species, there is no difficulty about fixing the types. Three names were proposed in 1843: *Ephesia* Rathke for *E. gracilis* Rathke (n. sp.). *Sphærodorum* Oersted for *S. flavum* Oersted (n. sp.) and *Bebryce* Johnston for *P. peripatus* Johnston (n. sp.). *Ephesia* was previously used by Hübner in 1816 for a genus of Lepidoptera, and *Bebryce* is preoccupied by *Bebryce* Philippi, 1842. Nothing in the descriptions of the types serves to differentiate them; they all certainly have simple setæ and lack spherical organs other than those directly related to the parapodia. Two years later Johnston, discovering the earlier use of *Bebryce*, substituted *Pollicita*, but admits the probable identity of his type species with *Sphærodorum flavum* Oersted. Perrier in 1897 proposed *Hypephesia* for species with simple setæ, naming *H. gracilis* as the type.

Levinsen employs *Ephesia* to include both typical species with simple setæ like *E. gracilis* Rathke and forms with compound setæ like *E. peripatus* Claparède (non Johnston), while *Sphærodorum* is retained for those species which bear several series of spherical appendages with granular contents and which have the setæ compound, like *S. claparedii* Greeff. St. Joseph, on the other hand, prefers to separate the genera on the basis of setæ characters, ranging under *Ephesia* species with simple setæ and under *Sphærodorum* those with the setæ compound. Finally Perrier recognizes the three generic types apparent in the family, retains Levinsen's application of *Sphærodorum* but divides his *Ephesia*, unfortunately applying that name to the *E. peripatus* group and giving a new name (*Hypephesia*) to the typical *E. gracilis* with simple setæ.

It is evident, therefore, that *Sphærodorum* is the proper name for the papillated forms with simple setæ only, and, so far as I am aware, no distinct tenable generic names are in existence for the two types with compound setæ.

The present collection includes a species of each of the three types known in the family, but all are provisionally placed in the genus *Sphærodorum*, a proceeding that may be justified because the known number of species is so small that no confusion will result from placing all in a single genus, because increased knowledge of the species of the family may make known forms possessing intermediate characters, and because the relationships of the Sphærodoridæ have been so variously conceived that it is possible that other generic names have been overlooked.

Sphærodorum papillifer sp. nov. Pl. XV, figs. 11, 12.

Moderately slender, tapering both ways, the greatest width nearer the anterior end, subterete, but somewhat depressed and flattened below. Length of type 30 mm.; maximum diameter at end of anterior two-fifths 1 mm.; segments 102. Other specimens one or two millimeters shorter.

Anterior end blunt, the prostomium and peristomium retracted and difficult to distinguish, the former a very short, simple, slightly domed lobe studded with papillæ and without definite appendages, though three papillæ longer than the others may represent the tentacles and a pair of mammilliform papillæ the palps. Peristomium a simple, not clearly differentiated ring surrounding the mouth and bearing a pair of small globoid cirri. On the dorsum is a <-shaped group of conspicuous black eye-spots which extend on to somite II. Typically there seem to be two pairs, but frequently there is an additional pair of spots or a median spot anteriorly.

Segments short and uniannular or slightly and irregularly annulated, mobile and irregularly contracted in the different regions; posteriorly becoming very small and tapering into a minute pygidium which bear a pair of spherical cirri with small apical papillæ and in addition a minute median cirrus or papilla. Surface, particularly toward the ends of the body, bearing numerous small, pointed or somewhat clavate retractile papillæ which are evidently of a sensory nature and become larger in the neighborhood of the parapodia.

Parapodia (Pl. XV, fig. 11) rather inconspicuous, lateral, probably uniramous. They consist of a slender, conical setigerous neuropodium roughened with small, conical, sensory papillæ becoming longer towards its distal end, which terminates in an especially prominent one or postsetal lobe. A much stouter process arising from the postero-ventral region of the neuropodium, having nearly the structure of the sensory papillæ, is undoubtedly the neurocirrus. Quite distinct from and well dorsad of the neuropodium is a spherical prominence (notopodium?) bearing on the middle of the distal face a small clavate cirrus. The spherical body is largest and most conspicuous on middle segments, but the distal cirrus is larger, both relatively and absolutely, at the ends. These organs are enveloped in a thick cuticle and the interior is filled with a snarl of slender, elongated bodies and opaque brownish granules, giving to the entire organ its characteristic opacity. A short distance farther dorsad is a clavate papillæ similar to that borne by the spherical body but more slender and elongated, especially on middle segments.

Neuropodial aciculum single—a rather stout, yellowish, tapered spine ending in a simple, blunt, somewhat projecting point. Setæ few, about four to six, projecting unequal distances in an irregular fascicle in each neuropodium (fig. 11). All are simple, colorless, rather stout, the shafts straight or nearly so, the ends expanded into a blade-like extremity with a knife-like edge rising into a slightly curved point and passing at the base into a slightly differentiated lateral spur. They exhibit little variety in shape or proportions (Pl. XV, fig. 12).

Proboscis unknown. Color nearly uniform pale yellow, faded, the eye-spots deep brown.

Six specimens from station 4,400, off San Diego, April 8, 500 fathoms green mud.

One is a female filled with large eggs distinctly visible to the naked eye; the others, including the type, appear to be males.

Sphærodorum brevicapitis sp. nov. Pl. XV, figs. 13, 14.

Although considerably larger this species closely resembles *S. papillifer* in general appearance. The type and only specimen, much contracted and distorted, is 39 mm. long, with a maximum diameter without parapodia of 1.6 mm., and has 96 segments.

Owing to the partial protrusion of the proboscis as a soft bulbous structure the prostomium is crowded dorsad. It appears as a very slight, scarcely distinguishable lobe, bearing scattered papillæ, of which five, though still small, are larger than the others; three of these are very close together near the anterior margin of the lip; the others are separated by a considerable interval on each side.

Peristomium likewise indistinct—a short achætous ring bearing a minute mammilliform papilla on each side. A pair of rather large, widely separated pigment spots, the remains of a pair of eyes, lies partly on this segment but chiefly on III. Owing to the condition of the specimen little can be determined about the normal appearance of the segments. The cutaneous papillæ, however, are less numerous and smaller than in *S. papillifer*. They are scattered fairly uniformly over the surface, becoming more numerous on the parapodia. Pygidium a minute ring bearing a pair of low, broad, mammilliform papillæ, besides at least two small, simple papillæ.

Parapodia (Pl. XV, fig. 13) in general similar to those of *S. papillifer*, but the parts more widely separated and the neuropodia more slender and cylindrical with a conical apex, rather than simply conical, and ending in a small postacicular lobe. Neurocirri small, subconical processes arising from the posterior ventral side of the neuropodia just at the base of the terminal cone. Spherical organ prominent, with a thinner cuticle than in *S. papillifer*, and the papilla borne on the ventral side of the base instead of on the outer surface. Dorsal papilla (notocirrus) well above spherical organ, small, claviform, with a widened base.

Aciculum single, rather more slender than that of *S. papillifer*, but similar in form, colorless, the blunt-pointed tip projecting freely. Setæ in irregular fascicles of usually eight or nine, rather prominent, all compound or semi-compound, becoming widened and flattened distally and then tapering into a hooked tip or appendage which is articulated to the stem by an oblique joint, the absence of which would leave these setæ very similar to those of *S. papillifer* (Pl. XV, fig. 14).

Proboscis—see above. Color slightly yellowish; opaque from presence of sperm-balls with which cœlom is packed.

Type only, from station 4,395, off Santa Catalina Islands, March 31, 2,045 fathoms, blue-gray mud.

Sphærodorum sphærulifer sp. nov.

Fragment of caudal end of a species related to *S. claparedii* Greeff, but with the large spherical bodies more numerous. It is dark brown and very opaque. Each segment bears on the dorsum two or three pairs of large, and alternating with them smaller, spheroidal bodies, all partially united at their bases into a somewhat irregular transverse ridge. The smaller numbers are at the posterior end, and they increase regularly as far as the piece extends to the middle segments. Several similar but smaller bodies occur on the venter. Neuropodia generally similar to those of *S. brevicapitis*, but the very extensile neurocirri and postacicular lobes are much larger, a papilla appears to be absent from the notopodial organ and the first (a smaller one) of the transverse series of dorsal appendages may be the notocirrus of each segment. Setæ compound, similar to those of *S. brevicapitis*, but with the joint more distinct and the appendage somewhat longer.

The single specimen, included among some invertebrates presented to the Academy by Professor Harold Heath, was taken from a deep-sea fish-line in Monterey Bay on July 16, 1902.

HESIONIDÆ.

Podarke pugettensis Johnson.

About a dozen specimens with up to fifty-eight segments and except for the eyes devoid of pigment. One is regenerating the caudal end. Many have the proboscis, which has not been described, protruded. It measures about 1.5 mm. long and half as wide, the basal two-thirds swollen, bulbous and smooth, the distal portion subcylindrical or truncated conical and more or less compressed; terminal orifice a vertical slit surrounded by eight or ten faintly marked small papillæ.

The first mention of this species in literature is under the name of *Ophiodromus* by Harrington and Griffin as a parasite on *Asterias* in Puget Sound.

San Diego Bay, Beacon No. 3 Shoal, March 1, 1904.

PHYLLODOCIDÆ.

Phyllodoce mucosa Oersted.

This species, already recorded from the North Pacific, appears to be common off southern California. Most of the specimens are well preserved and agree closely with typical examples of the species taken in the North Atlantic at Labrador and Greenland, as well as with the figures of Malmgren and other European authors. The only apparent difference is that the Pacific examples may have one or two more papillæ in some of the rows on the proboscis, most of them having 11 or 12 in the upper and lower and 13 or 14 or rarely 15 in the middle rows. None shows any trace of a median dorsal series, but the other papillæ are prominent and generally have a conspicuous brown spot on the posterior face. The form of the prostomium is very changeable and may be pyramidal, ovate or deeply cordate, but is always more or less emarginate posteriorly. The nuchal papilla is minute and inconspicuous. Several specimens are regenerating lost caudal ends and one is filled with eggs.

Seven specimens from station 4,399, off San Diego, April 7, 245 fathoms, fine gray sand and rock; and one from each of the following: 4,445, Monterey Bay, May 11, 66 fathoms, green mud; 4,476, same, May 16, 39 fathoms, soft green mud; 4,482, same, May 17, 43 fathoms, soft green mud; 4,485, same, 108 fathoms, soft green mud and sand; 4,519, same, May 26, 35 fathoms, hard gray sand; 4,548, same, June 7, 46 fathoms, coarse sand, shells and rock.

Phyllodoce medipapillata Moore.

The median dorsal series of proboscidial papillæ is always well developed and quite as conspicuous as the others. Besides this character this species is distinguished from the related *P. mucosa* by having the setæ appendages much shorter and the notocirri ovate-lanceolate instead of truncated as in that species. The large specimen is just 100 mm. long with 201 segments.

A single example was collected at each of the following stations: 4,420, off San Nicolas Island, April 12, 33 fathoms, fine gray sand; 4,460, Monterey Bay, May 12, 55 fathoms, green mud, gravel; 4,558, Monterey Bay, June 9, 40 fathoms, rock.

Phyllodoce ferruginea sp. nov. Pl. XV, figs. 15–18.

Two complete specimens of nearly equal size. The type measures 46 mm. long, .7 mm. in maximum width of body and 1.2 mm. between tips of parapodia; 148 segments. Very slender, nearly linear, widest about end of anterior third, somewhat depressed.

Prostomium (Pl. XV, fig. 15) regularly elliptical, about five-sixths as wide as long, slightly depressed, slightly truncated at both ends and with a very slight posterior median emargination, strongly convex above. Eyes one pair, brown, very large with prominent lenses.

their diameter nearly one-third width of prostomium, situated just posterior to middle of length close to posterior borders of prostomium and looking dorso-laterad. Frontal tentacles arising by restricted bases, widely separated on antero-lateral borders of prostomium, long, slender and subulate, tapered regularly from above base to slender tip; the dorsal one and one-half times or more the length of prostomium, the ventral about as long as prostomium. Study of additional material may modify the last statement, as some of the tentacles of both specimens have evidently suffered injury and one (type) has two, the cotype one, in regeneration as small knob-like buds. The cells of the prostomium form a small rosette-like radiation anterior to the eyes, but there is no indication of a median tentacle.

Peristomium completely crowded beneath prostomium, projecting as lateral lobes merely, from the upper part of which arise the two pairs of tentacular cirri. No nuchal papilla. Posterior lip prominent. Somites II and III very short but distinct, except that ventrally the former coalesces with the prostomium to form the lower lip. Tentacular cirri (fig. 15) all unusually long and slender, regularly tapered, with well-developed cirrophores. The peristomial arises at about the level of the foliaceous notocirri and reaches to about XII; the dorsal of II is at a higher level and reaches XVII; ventral of II at a very low level and equals peristomial; that of III at nearly the level of succeeding notocirri and reaches XIV. Three or four small setæ arise from a small tubercle between the cirri of II and a fully developed neuropodium occurs on III. Anterior segments all very short and distinctly biannulate; farther back they become nearly half as long as wide. Pygidium a rather long ring, but cirri wanting.

Parapodia (Pl. XV, fig. 16) unusually small, projecting very little from side of body, the neuropodium flattened, with postsetal lip obsolete and presetal lip large and broadly rounded distally with a very slight notch, from which the point of the aciculum projects (fig. 17). Neurocirrus very strongly foliaceous, broadly subovate, several times larger than neuropodium on all somites, completely concealing them from behind and bending dorsad until on most somites it meets the notocirrus; arrangement of veins radial. Notocirrophores prominent, somewhat flattened domes, two or three times as large at the neuropodia on middle segments. Strongly foliaceous, thin, imbricated but covering only a small part of the sides of the body, of moderate size but very large in comparison with the neuropodia, broadly cordate with apex bluntly rounded (usually broader at the end than the one figured) and base deeply excavated, with deep yellow-brown veins forming a dense bipinnate figure; rather easily detached.

Aciculum single, nearly colorless, straight, tapered to a point like a sharpened pencil which projects slightly beyond the acicular notch (fig. 17). Setæ rather numerous, in broad, fan-shaped fascicles only obscurely divided into supra- and subacicular groups; 8 + 11 on somite X, 9 + 12 on XXV and L, 7 + 9 on C of type. They are colorless with moderately long stems scarcely reaching beyond the border of the neurocirri of middle segments, slender and gently curved, rather conspicuously inflated at the ends (Pl. XV, fig. 18) to form a socket bounded by lateral ranks of slender teeth connected anteriorly by a row of much smaller teeth. Appendages rather long, equalling or generally exceeding depth of neuropodia, very delicate with striations and marginal denticulations not visible under the magnification shown.

Color generally rusty, the body pale with little color, the cephalic appendages and neurocirri deeper and the notocirri very brilliant yellowish brown which contrasts strongly with the paler body and gives the worm its conspicuous coloring. Proboscis unknown.

Station 4,550, Monterey Bay, June 7, 50 fathoms, green mud, rock.

In form of the prostomium and other features this species approaches *P. citrina* Malmgren.

Phyllodoce (Carobia) castanea Marenzeller.

A small example 26 mm. long with 106 segments. Like the specimen previously reported from Monterey Bay this one has notocirri somewhat more elongated than those of Marenzeller's Japanese types. The color is paler and more yellowish than in the specimen above mentioned, though, like it, this is a female with eggs. There is no trace of a nuchal papilla and the flattening of the tentacular cirri is very obvious.

Phyllodoce polyphylla Ehlers, from South Georgia, is probably closely related to this species, though Ehler's figure exhibits no setigerous lobe on II, which is very obvious in this specimen. The minute dorsal tentacles shown by the type of *P. polyphylla* are probably merely the result of these being in process of regeneration after having been lost, as I have seen precisely similar conditions in several species.

Station 4,496, Monterey Bay, May 19, 10 fathoms, fine gray sand and rock.

Anaitis polynoides sp. nov. Pl. XVI, figs. 19-21.

Owing to the closely imbricated manner in which the large notocirri overlap the slender body this species bears a superficial resemblance to an elongated *Polynoe* or even more to a *Sthenelais*. The single specimen is complete, but the posterior one-fourth of the body has evidently been recently regenerated—being abruptly unpigmented and of smaller size.

Form slender, depressed, the segments scarcely exceeding one-third of total width between margins of notocirri or tips of parapodia. From the maximum width at the end of the anterior fourth the extreme outline tapers slightly forward and regularly and continuously caudad. Length 44 mm.; maximum width of segments 1.6 mm.; total width 3.8 mm. Segments 88.

Prostomium very short, broad and depressed, decidedly bent downward. In the figure (Pl. XVI, fig. 19) the prostomium is represented as pressed upward somewhat, but in the position in which it naturally rests the anterior outline is regularly semicircular and the length (exclusive of the posterior prolongation) about one-half the width. From the slightly convex posterior margin a median prolongation fits into a deep depression in the peristomium and bears a knob-like nuchal cirrus having a diameter about equal to the eyes. Eyes one pair, conspicuous, circular, brown, about one-ninth or one-eighth the width of the prostomium and widely separated by an interval of about five times their diameter, close to the posterior margin of the prostomium. Frontal tentacles very short, subconical with small terminal appendages, very widely separated and somewhat reflexed on sides of prostomium; the dorsal about as long as one-third width of prostomium and separated by about twice their length; the ventral somewhat longer, nearer together and reflexed so that they are concealed in dorsal views.

Peristomium somewhat tumid laterally, but excavated dorso-medially for the nuchal projection and papilla, almost indistinguishably coalesced with II which is similarly tumid laterally but lacks a median depression.

Tentacular cirri four pairs, rather short, thick, blunt, and stiff. The first (or peristomial) pair scarcely longer than width of prostomium and not reaching beyond IV; dorsal of II with a much larger ceratophore and reaching VII; ventral of II equal to peristomial and that of III (notocirrus) similar to dorsal of II and reaching VIII.

Podous segments well defined, very regular, the anterior very short, but soon becoming one-third as long as wide, slightly convex above, flat below, with a shallow neural groove. Posteriorly the segments taper to a very minute pygidium bearing a pair of relatively stout, cylindroid anal cirri, the combined width of which equals that of the pygidium and the length the last five or six segments.

Parapodia (Pl. XVI, fig. 20) begin on III, strictly lateral, prominent, their length exceeding one-half width of body, toward the ends becoming smaller but otherwise unmodified. Strictly uniramal, the neuropodia compressed, with obsolete postsetal lip and prominent, foliaceous presetal lip divided by an acicular notch into a larger, broadly-rounded, supra-acicular lobe and a somewhat shorter subacicular lobe obliquely tapered to a blunt point.

Notocirrophores large, those of all except most anterior segments flattened and auriculate (fig. 20). Notocirrostyles beginning with IV, thin and membranous; typically broadly lunate-reniform, the external border squarish, very regularly, closely and broadly imbricated, covering and concealing the parapodia and posteriorly the entire dorsum, but leaving the middle of the segments exposed anteriorly. Toward the anterior end the styles approach a circular form and become gradually smaller until practically the entire dorsum is left uncovered. The notocirrus of III is the last tentacular cirrus, while the neurocirrus of the same segment differs in no respect from those following. Neurocirrophores prominent swellings at base of ventral side of neuropodia. Neurostyles (fig. 20) oblong elliptical, with the broad distal end subtruncate, foliaceous, about equalling the neuropodia in size and reaching to or, on anterior parapodia, beyond their ends.

Aciculum single, stout, pale yellow, gently curved, with simple bluntly pointed tip. Setæ (Pl. XVI, fig. 21) colorless, numerous (about 30, equally divided between supra- and subacicular groups on middle segments), in a broad, fan-shaped fascicle. Shafts slender, slightly curved, slightly enlarged at the end; the very asymmetrical socket prolonged on one side into a great spine with a few small teeth on its base; the other side bearing a shoulder for articulation of the appendage which is supported by a thin, scale-like process slightly fimbriated at the end. Appendages long, about equal to the depth of the neuropodia, slender and delicate with the margin very finely but distinctly denticulated. The form of the articulation resembles the *Eteone* type.

Color generally, including prostomium and four anterior segments, under parts, parapodia, lateral parts of notocirri and posterior fourth of body, pale yellowish or yellowish ashy; exposed part of dorsum rich purplish-red with a fine blue-green iridescence. Inner thirds of notocirri rich brown, together forming a pair of broad stripes extending continuously for the anterior three-fourths and becoming darker anteriorly. Tentacular cirri except colorless tips, largely of a somewhat darker brown. Eyes dark brown.

Proboscis unknown. The type is a female containing half-grown ova which largely fill the cœlom and enter the cavities of the parapodia and notocirrophores.

Station 4,548, Monterey Bay, June 7, 46 fathoms, coarse sand, shells and rock.

Eumida tubiformis sp. nov. Pl. XVI, figs. 22, 23.

All of the specimens are contracted and in this state are depressed and stout, with the segments much crowded, particularly at the anterior end. The type, a female with 137 segments, is 67 mm. long, with a maximum body width of 3.1 mm. and a width between tips of parapodia of 4.5 mm. A male with 104 segments is 37 mm. long, and a small portion of the anterior end of a very large example measures 7 mm. between the tips of the setæ.

Prostomium in the several specimens varying in degree of contraction and proportions, in the type and most of the others being nearly twice as wide as long, subelliptical, slightly concave posteriorly and with a tentaculiferous prominence in front, the prominent lateral ocular lobes resting upon the peristomium. One specimen has the prostomium subtriangular and only about one-fourth wider than long. In life it would probably be broadly cordate. Eyes one pair, very large, about one-fourth, or somewhat less, the width of the prostomium, with large lenses looking upward. Immediately behind and below them are the small nuchal sense organs.

Frontal tentacles arising close together on front of prostomium separated by a distance of about one-fourth width of prostomium, all subulate with basal half thickened and beyond that abruptly tapered to very slender tips, subequal or the ventral pair somewhat longer, slightly exceeding one-half width of prostomium. Median tentacle arising from a slight depression between lenses of eyes, not abruptly thickened at base, more slender and slightly longer than frontal tentacles.

Peristomium much shortened, crowded beneath prostomium, not visible as a distinct segment from above; somites II and III also much shortened and crowded. Tentacular cirri with well-developed cirrophores and large stout subulate styles shaped like the median tentacle but very much larger. Dorsal and ventral of II widely separated, the ventral being at nearly the level of the notocirri of succeeding somites. The single pairs of I and III lie opposite the interval between those of II, the peristomial being at the higher level. That of I reaches VI, ventral of II reaches VIII and dorsals of II and III reach IX.

Body of very uniform diameter, being perhaps widest at about XL, thence tapered very gradually and regularly caudad. Owing to the manner in which the notocirri are imbricated an aspect of rather strong depression results, but the body is really very little depressed. Segments arched above, flattened below with a slight neural ridge, distinctly biannulate dorsally with small intersegmental rings. Pygidium a very small, slightly thickened and rugous ring.

Normal setigerous parapodia (Pl. XVI, fig. 22) begin on III, but a small tubercle bearing a few setæ lies between the cirri of II. They arise at the ventral level of the segments and are prominent, being from more than one-third to one-half the width of their segments. Neuropodium somewhat compressed, supported by a single aciculum, the postsetal lobe nearly obsolete, presetal well developed, divided by an acicular notch into a supra- and a subacicular lobe, both rounded on anterior but bluntly pointed on posterior parapodia.

Neurocirri broadly foliaceous, ovate with bluntly pointed tip and oblique base attached to a low cirrophore, reaching to or beyond end of neuropodium which they exceed in width and overlap and conceal from behind. They are relatively much larger on anterior somites where they equal one-half the notocirri, diminishing to one-fourth the notocirri posteriorly. Notocirrophores low and broad. Notocirrostyles (Pl. XVI, fig. 22) of moderate size, broadly foliaceous and imbricated over bases of parapodia, leaving most of the dorsum of body exposed. They are broadly cordate with blunt apex and nearly symmetrical base, the anterior ones broader, often wider than long and blunter, the posterior tending to more acute, cuneate, longer, less cordate forms, with the length as much as one and one-third times the width.

Aciculum single, yellow, stout, tapered, straight or slightly curved and ending in a simple blunt point at the acicular notch. Setæ in a single vertical series spreading fanwise and only very slightly separated at the acicular notch into supra- and subacicular groups. On the type they are distributed as follows: somite X, 13 supra- and 21 subacicular; XXV, 14 and 25; L, 11 and 24; LXXV, 11 and 17; and C, 8 and 14.

They are nearly colorless, with slender slightly curved stems scarcely enlarged at the ends (Pl. XVI, fig. 23) to form an imperfect asymmetrical socket, the best developed side of which is broadly rounded and provided with a uniform series of slender teeth. Appendages of moderate length, very uniformly about one-half depth of neuropodium, rather broad at base but tapering to a slender tip with scarcely discernible marginal denticulation.

Color uniform dark brown, yellowish brown or pale yellow with a few irregularly scattered dusky or black blotches, one of which may be on the prostomium.

Proboscis of type 8.5 mm. long, 2.4 mm. in diameter at orifice; of largest specimen 16 mm. long, 3 mm. in diameter at base and 4 mm. at orifice. It is somewhat trumpet-shaped, gradually widening to the somewhat flaring distal end which is surrounded by a circle of 18 to 20 low, rounded, soft papillæ more or less incised at the base and in some cases cleft in two. When protruded the proboscis has a slight spiral twist and is marked by three narrow, raised longitudinal lines on each side, the dorsal and ventral intervals between those of the two sides being one-third more than the lateral intervals between those of the same side. The general surface is marked with fine irregular wrinkles and usually, but not always, with minute granulations which are slightly more conspicuous along the raised lines.

Stations 4,430, off Santa Cruz Island, April 14, 197 fathoms, black sand and pebbles, six specimens, two of which (including the type, a female filled with large ova) are mature; 4,423, off San Nicolas Island, April 13, 339 fathoms, gray sand, black pebbles, shells, one young specimen, in which the longest (second dorsal) tentacular cirri each bears a symmetrical swelling on its anterior face near the middle.

Eulalia nigrimaculata sp. nov. Pl. XVI, figs. 24–26.

Two complete specimens considerably contracted have the following measurements: Type 33 mm. long; maximum width near middle body only 1.5 mm., extreme width between tips of parapodia 3 mm.; number of segments 89; female with eggs. Cotype 36 mm. long with 90 segments.

Prostomium subglobose, slightly depressed, nearly circular in outline as seen from above; profile strongly convex, sloping downward anteriorly; sharply differentiated from peristomium. Eyes one pair, brown, with well-developed lenses, large, nearly one-fourth width of prostomium, midway of the length and close to the lateral margins of which they are situated. On the type the right eye is enormously and abnormally enlarged and occupies the most of that side, to the displacement of the dorsal right tentacle. Frontal tentacles widely separated, the dorsal just outside of line of lateral border of eyes, the ventral slightly nearer together; length of dorsal equal to prostomial width, with swollen fusiform basal half and abruptly contracted filamentous distal half; ventral similar but with much shorter terminal filament. Median tentacle (present in type only) arising between eyes, slightly longer than frontal tentacles, with less swollen base and regularly tapered.

Peristomium and II coalesced, forming a short distinct ring above, crowded forward beneath the prostomium, at the sides of which the peristomium appears. Mouth large, bounded by a nearly smooth posterior lip. Tentacular cirri much crowded, the peristomial and that of III (notocirrus) arising almost between the dorsal and ventral cirri of II, the former at the higher level. All have short but distinct ceratophores and prominent, regularly acuminate styles with slender tips. They are slightly flattened in the type, much more strongly flattened, apparently as a result of accidental pressure, in the cotype. The longest (dorsal of II) reaches to XII, those of I and III reach to IX and the ventral of II to VI. A conspicuous tuft of neuropodial setæ occurs between the two cirri of II.

Setigerous segments sharply defined by deep furrows; very short anteriorly but increasing until in the middle region they are at least one-third as long as wide. Slightly depressed and little more convex above than below. Behind the middle they gradually diminish in size to the pygidium, which is a very short and small ring, the cirri of which have been lost.

Parapodia rather short, scarcely exceeding one-third width of their segments but with conspicuous spreading tufts of setæ which begin on II. Neuropodia (Pl. XVI, fig. 24) strongly compressed, subovate; postsetal lip rudimentary; presetal lip well developed, foliaceous, symmetrical, terminating in a blunt point but altogether lacking a notch, though there is a slight posterior groove in which the end of the aciculum rests (fig. 25). Neurocirri (fig. 24) rather thick, very large, especially anteriorly where they have an area of about four times the neuropodium, but diminishing to twice the neuropodium posteriorly. They are narrowly palette-shaped, the excavated portion attached to low cirrophores on the ventral base of the neuropodia, the broad end outward and bent dorsad behind and extending far beyond the neuropodia, which they completely conceal from behind and serve the purpose of postsetal lobes. They are crowded with deep-brown or on the margins often nearly black glands. Notocirrophores (fig. 24) large and prominent, erect, more or less dome-like with a restricted area for attachment of the styles. Styles thin and membranous, easily detached, somewhat imbricated and concealing the parapodia; anteriorly ovate with rounded ends, on middle segments broadly ovate-cuneate with pointed ends and posteriorly becoming elongated; the base oblique and asymmetrical with a shallow sinus for attachment. Internal structure finely reticular with slightly developed veins and glands.

Aciculum single, colorless, tapered, ending in a rather acute point. Setæ forming a very broad undivided, fan-shaped fascicle, very numerous for the genus (30 on X, 48 on XXV, 40 on L and 36 on LXXV), projecting about one-fourth of their length beyond the neurocirri. Stems colorless, of moderate length, nearly straight, little enlarged at the distal end (Pl. XVI, fig. 26) where they terminate in a small shoulder and a socket bounded on each side by a fringe of long delicate teeth. Appendages very delicate, about as long as depth of neuropodium with barely discernible marginal teeth.

Proboscis (only partially protruded) cylindrical, 5.5 mm. long and .6 mm. in diameter, surface thickly covered with small, blunt, flattened, slightly retrorse papillæ, separated by considerably more than their length.

Color gray-blue or bluish-plumbeous with a metallic blue iridescence and brownish suffusions and marked with a few conspicuous gradrate black spots, especially on the ventral surface, either widely scattered singly or aggregated in groups. Notocirri uniform orange yellow. Neurocirri yellowish with dark brown or blackish margin.

Station 4,454, Monterey Bay, May 12, 71 fathoms, green mud and sand.

Eulalia levicornuta sp. nov. Pl. XVI, figs. 27–30.

Only one small specimen measuring 43 mm. long is complete, with 221 segments. The type is much larger, being 70 mm. long for 172 segments and lacking perhaps the caudal one-third and 100 segments; its maximum width of body at C–CXX is 1.2 mm., between tips of parapodia 1.8 mm. Another very much macerated and incomplete specimen referred here somewhat doubtfully has 240 segments and is 94 mm. long, and less than 1 mm. wide, having therefore nearly the proportions of a slender lumbriconereid.

Form very slender and elongated, nearly linear, but tapering gently both ways from about the end of the anterior third.

Prostomium (Pl. XVI, fig. 27) about as wide as long, moderately depressed, semiovate with truncate ends or subtriangular with rounded basal angles and truncated apex, usually sharply differentiated from the peristomium, but in one specimen almost continuous with it dorsally. Eyes one pair, small, about one-seventh of posterior width of prostomium, close to its postero-lateral angles, separated by three to three and one-half times their diameter, dark brown, with small lenses. Frontal tentacles situated on the sides of a distinctly separated anterior segment of the prostomium, subconical, their length about one-half prostomium. Median tentacle a minute, slender, conical papilla situated on line between anterior border of eyes and having a length of from one to one and one-half times their diameter.

Peristomium a complete ring entirely posterior to the prostomium and usually free from it all round, scarcely wider than prostomium, dorsally elevated into a convex platform-like area which in one case overlaps the prostomium and partly covers the eyes. Mouth small with nearly smooth posterior lip. Somites II and III similarly well differentiated with similarly elevated dorsum. Tentacular cirri arising from large cirrophores, the styles rather stout, tapered and short; the peristomial pair about as long as prostomium and reaching to III; ventral of II equal to peristomial and above its base a tubercle bearing a small tuft of setæ; dorsal of II about twice as long and reaching VI or VII. Somite III bears a fully developed setigerous parapodium and its tentacular notocirrus is equal to that of II.

Anterior somites are uniannulate and very distinct, becoming less well differentiated farther back as small interpodal annuli appear. The raised dorsal field gradually merges with the general convexity of the back. The venter is flat. They very gradually increase in size to or beyond C, and taper thence caudad.

Pygidium a dome-shaped ring about twice as long as the last setigerous segment, bearing a pair of somewhat flattened, subcylindrical cirri resembling the posterior notocirri but rather larger than they, together with a minute median cirrus (described from one specimen, station 4,431).

Parapodia (Pl. XVI, figs. 28, 29) small, little prominent and scarcely exceeding one-fourth the width of their segments, but becoming relatively longer and more prominent posteriorly. Setigerous neuropodia begin on II; they are slender, only slightly compressed, and little tapered to a bluntly rounded presetal lip divided by a slight acicular notch into two equally rounded lobes, of which the subacicular is usually somewhat longer; postsetal lip scarcely developed.

Neurocirrophores broad and low, the styles (Pl. XVII, figs. 28, 29) subelliptical, little excavated for attachment, thick, more or less foliaceous, broadest and relatively largest on anterior parapodia, where they considerably exceed the neuropodia and extend somewhat beyond them. Posteriorly they are relatively smaller and narrower, but often so much longer that fully one-fourth of their length projects beyond the neuropodia, but they always tend to diverge from the latter and not to bend dorsad behind them. Notocirrophores (Pl. XVI, figs. 28, 29) of anterior somites rather small, of middle somites low but nearly as wide as the length of the neuropodia. Styles generally foliaceous but comparatively small, carried nearly erect, little imbricated and covering but a small part of the sides of the parapodia. On anterior somites (fig. 28) they are regularly ovate with broadly rounded distal end and scarcely excavated base; on middle segments larger, more broadly ovate, with bluntly pointed tips and nearly straight symmetrical bases; while posteriorly they become again smaller and tend toward a cuneate form. They all exhibit strongly marked internal striations arranged in a partly bipinnate, partly radiate pattern. On some specimens the styles are contracted and much thicker, the anterior ones being nearly cylindrical, and all are opaque and of a more or less deep brown color. Greatly extended specimens have the notocirri all erect and widely separated.

Aciculum single, rather slender, of the form usual in the genus, with the bluntly pointed tip projecting slightly from the notch. Setæ (Pl. XVI, fig. 30) arranged in the usual fan-shaped vertical fascicles of one series, of a rather small number, as follows in the type: on X 7 supra- and 5 subacicular, on XXV 5 + 11, on L 9 + 11, on LXXV 11 + 12, on C 7 + 14 and on CLXX 14 in all. They have remarkably long, slender shafts with slightly enlarged symmetrically cleft ends forming the socket, each side of which is prolonged obliquely into a prominent elongated tooth flanked on each side by a fringe of delicate spinules. Appendages (fig. 30) rather short, usually one-third to one-half depth of neuropodium, but on one specimen (station 4,431) rather longer, broad at base and tapered and gently curved to a delicate tip, the marginal denticulations and oblique striations fine but distinct.

Proboscis of a cotype protruded 2.5 mm., .4 mm. in diameter at distal end, terete, gradually increasing in diameter distally, the entire surface covered so thickly that they touch each other with crowded, granulated, slightly flattened, rounded papillæ, at least three irregular circles of which at the distal end are of much larger size.

Color of type (female filled with eggs) faded to a uniform pale greenish drab or light olive. Another specimen is nearly uniform brown and still another pale yellow with a thin brown line of granules across each segment and the head, tentacular cirri and parapodial cirri deep brown with aggregations of similar granules.

One specimen from each of the following stations: 4,418, off Santa Barbara Island, April 12, 238 fathoms, gray sand; 4,420, off San Nicolas Island, April 12, 291 fathoms, gray mud, rocks; 4,430 (type), off Santa Cruz Island, April 14, 197 fathoms, black sand and pebbles; 4,433, off Santa Rosa Island, April 15, 265 fathoms, gray mud.

This species belongs to the *bilineata-gracilis* group and, with the exception of the Hawaiian species *E. navaica* Kinberg, appears to be the first of that group to be described from the Pacific. As is the case with *E. gracilis* Verrill, specimens in different states of contraction differ considerably in appearance.

Eulalia (Sige) bifoliata sp. nov. Pl. XVI, figs. 31-34.

Described from a single imperfect anterior end consisting of the head and 57 segments, having a length of 18 mm. and a maximum diameter between tips of parapodia of nearly 2 mm. Contracted and rather stout, strongly arched above, flat below and little tapered in the length of the piece.

Prostomium (Pl. XVI, fig. 31) about three-fourths as long as wide, somewhat depressed, subpyramidal with a straight, inclined profile, greatest width in posterior half, posterior border nearly straight, entire, bounded by a deep furrow separating the peristomium. No anterior furrow behind tentacles. Eyes circular with prominent lenses, brown, large, about one-fourth width of prostomium and situated at its greatest width, about one-half their diameter anterior to posterior border and close to lateral border. Frontal tentacles situated rather close together at the truncated apex of prostomium, separated by little more than one and one-half times their diameter, somewhat macerated and imperfect, but their length approximately one-half prostomium or slightly less. Median tentacle situated between anterior border of eyes at centre of prostomium, much smaller than frontal tentacle, but macerated so that the exact size is not certain. Immediately behind each eye is a faint brown spot.

Peristomium scarcely visible above, forming a swollen lower lip and small lobes beneath eyes. Remaining segments short, uniannulate. Tentacular cirri with distinct cirrophores, all styles lost except the ventral of II on one side, which is rather short and stout, conical, about one and one-half times length of prostomium and reaching to V. A small tuft of setæ on II.

Parapodia (Pl. XVI, figs. 32, 33) small and little prominent, their length about one-fourth width of somites on anterior and one-half on posterior (middle) somites, but strongly compressed and d ep. Postsetal lip obsolete; presetal greatly developed and foliaceous, divided by a deep acicular notch into a much smaller subacicular lobe, rounded at the end, and a larger supra-acicular lobe prolonged into an acuminate but blunt tip frequently much longer and more slender than those figured. Neurocirrophores (figs. 32, 33) rounded swellings at base of neuropodia; styles strongly foliaceous, thin, quadrant-shaped, with the dorsal angle prolonged similarly to the supra-acicular lobe, but usually extended far beyond the latter. Though of large size they do not exceed the neuropodia of middle segments, the subsetal lobes of which they completely cover from behind, reaching slightly dorsad of the acicular notch, their nearly straight dorsal border being parallel to the axis of the supra-acicular lobe and serving as a postsetal support to the setæ. Notocirrophores (fig. 33) low and flat, moderate in size, immediately above notopodium. Three or four only of the notostyles remain. They are strongly foliaceous but rather small, scarcely or not longer than the neurostyles and about one and one-half times as wide as they, broad ovate or suborbicular with nearly straight, truncate, scarcely excavated base, opaque brown with granules chiefly arranged in radial lines.

Aciculum single, pale yellowish, with colorless base, straight, regularly tapered to a simple point, which enters but does not project beyond the acicular notch. Setæ (Pl. XVI, fig. 34) numerous (18 supra- and 27 subacicular on XXV), forming a broad, spreading, fan-shaped fascicle, the shafts colorless, long, with about one-third of their length projecting beyond the margin of the neurocirrus, slightly curved, little enlarged at the end, where they terminate in a prominent shoulder and a pair of high, tapered processes finely denticulated at the ends which bound the socket. The only perfect appendage seen has a length of about three-fifths the depth of the neuropodium and is slender and finely denticulated.

Proboscis (dissected) tubular with smooth non-papillated lining; orifice surrounded by a circle of apparently eighteen soft papillæ.

This species has the smooth proboscis, prolonged neuropodia and neuropodial cirri and form of setæ characteristic of the subgenus *Sige*, features which appear in the descriptions of no known *Eulalia* from the North Pacific or the west coast of South America.

Type from station 4,522, Monterey Bay, May 26, 149 fathoms, gray sand and shells.

Explanation of Plates XV and XVI.

Plate XV.—*Syllis heterochæta*—figs. 1–4.

Fig. 1.—Anterior end, × 56.

Fig. 2.—Parapodium XXV with one long and one short seta in place; *a*, short notocirrus from XXVI, × 56.

Fig. 3.—End of short seta from XXV, × 600.

Fig. 4.—Same of long seta, × 250; *a* and *b*, articulation and tip of appendage of same, × 600.

Pionosyllis typica—figs. 5–7.

Fig. 5.—Parapodium with dorsalmost and ventralmost setæ represented, × 24.

Fig. 6.—Tips of two acicula, × 400.

Fig. 7.—End of a seta from XXV, × 600.

Odontosyllis phosphorea—figs. 8–10.

Fig. 8.—Parapodium X without setæ, 56.

Fig. 9.—Parapodium L with bases of notopodial setæ only, × 56.

Fig. 10.—Distal end of middle seta from L, × 600.

Sphærodorum papillifer—figs. 11, 12.
Fig. 11.—Parapodium X with setæ, × 98.
Fig. 12.—Seta from X, × 440.
Sphærodorum brevicapitis—figs. 13, 14.
Fig. 13.—Parapodium X (the parts may be abnormally separated owing to distention of body walls) without setæ, × 56
Fig. 14.—Average seta from somite X, × 440.
Phyllodoce ferruginea—figs. 15–18.
Fig. 15.—Anterior end, × 56.
Fig. 16.—Parapodium XXV with dorsalmost and ventralmost seta shown, × 56.
Fig. 17.—End of neuropodium showing tip of aciculum, × 500.
Fig. 18.—Profile and front view of region of articulation of seta from XXV, × 440.

Plate XVI.—*Anaitis polynoides*—figs. 19–21.
Fig. 19.—Anterior end, from the dorsum, × 24
Fig. 20.—Parapodium of XXV, anterior view, dorsalmost and ventralmost setæ shown, × 24.
Fig. 21.—Profile and rear views of articular region of two setæ from somite X, × 360.
Eumidia tubiformis—figs. 22, 23.
Fig. 22.—Anterior aspect of parapodium L, showing dorsalmost and ventralmost setæ in place, × 24.
Fig. 23.—A seta from somite XXV, × 360.
Eulalia nigrimaculata—figs. 24–26.
Fig. 24.—Anterior aspect of parapodium L, with dorsalmost and ventralmost setæ in place, × 24.
Fig. 25.—Outline of neuropodium showing tip of aciculum, × 56.
Fig. 26.—Two views of articular region of seta from X, × 440.
Eulalia levicornuta—figs. 27–30.
Fig. 27.—Anterior end, × 24.
Fig. 28.—Anterior aspect of parapodium XXV, × 56.
Fig. 29.—Same of parapodium LXXV, with dorsalmost and ventralmost setæ in place, × 24.
Fig. 30.—A seta from XXV; *a*, front view of articulation of same, × 440.
Eulalia bifoliata—figs. 31–34.
Fig. 31.—Head from dorsum, × 24.
Fig. 32.—Posterior view of parapodium XXXIII, without notostyle or setæ, × 56.
Fig. 33.—Anterior view of parapodium XXXIX, without setæ, × 56.
Fig. 34.—Profile and rear views of articulation of seta from XXXIII, × 440

NOTES ON THE BIRDS OF SAN DOMINGO, WITH A LIST OF THE SPECIES, INCLUDING A NEW HAWK.

BY A. E. VERRILL AND A. HYATT VERRILL.

During the winter and spring of 1906 and 1907, the junior author visited San Domingo on a collecting trip, mainly for the mammals, birds and reptiles, and especially for specimens of *Solenodon paradoxus*, of which an account by him has been published in the *Annals and Magazine of Natural History* and elsewhere.[1] He had already obtained a large and interesting collection when an attack of typhoid fever unfortunately put an end to his work.

The avifauna of San Domingo is remarkable for the number of species peculiar to the island, many of which are confined to special, isolated localities. Many species are met with only at certain seasons, while others, usually very rare, are abundant in places where their food plants occur, during the season when these plants are in fruit.

The birds comprised in the accompanying list were obtained by the junior author[2] in the Dominican Republic (Santo Domingo), between December 21, 1906, and April 13, 1907.

The list includes numerous species not hitherto recorded as taken in San Domingo, two of which were undescribed forms. Many species of migratory North American birds were obtained there for the first time, so that the list gives valuable data as to the winter habitat of many northern birds. A few species previously recorded from the island were not observed, while several, such as the flamingo, spoonbill and certain herons, were seen, but were not secured on account of their shyness and the nearly inaccessible places which they frequent.

The difficulties to be overcome in collecting in San Domingo are very great; birds are comparatively scarce and many species are exceedingly shy from constant hunting by the natives. It is quite probable, therefore, that a number of species yet remain to be discovered in the more remote and inaccessible swamps and mountains.

Although practically the entire republic was covered by this trip,

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[1] *Ann. and Mag. Nat. Hist.*, vol. XX, p. 68, pl. IV; *Amer. Journ. Science*, vol. XXIV, pp. 55–57 (cut), 1907; *Bull. Am. Mus. Nat. Hist. New York* (J. A. Allen), vol. XXIV, art. XXIII, pp. 505–517, figs. plates XXVIII to XXXIII, 1908.

[2] The notes on habits, etc., are taken from his field notes, made at the time.

localities were designated by districts as follows: Sanchez; Samaná; San Lorenzo; El Valle; La Vega; Miranda. Each of these districts included the surrounding country for a radius of from twenty to thirty miles. Sanchez, situated at the head of Samaná Bay, proved the most profitable collecting ground, for it affords a great variety of country and vegetation. The town is built close to the shore of the bay on a steep hillside. Directly back of the town a range of mountains, which rises to a height of 3,500 feet, is covered with a dense tropical forest, with the exception of the lower slopes, which are cleared and partially under cultivation. West and south of the town are extensive mangrove swamps, extending inland for twenty-five to thirty miles and stretching across the bay to the mouth of the Barracota River. Samana is also situated on the northern shore of Samaná Bay, about 16 miles east of Sanchez, and is surrounded by rolling hills, forest-clad mountains, and broad and fertile valleys. The fauna was much like that of the Sanchez district, but birds were by no means so abundant. A few miles east of Samaná, and half way across the bay, is a large, wooded Key, known as the Cayo Levantado, and here several rare species, as well as several migrants hitherto unrecorded from San Domingo, were obtained.

San Lorenzo is an abandoned banana estate on the southern shore of Samaná Bay, almost directly opposite Samaná, and ten miles distant. It is situated on a small bay of its own (San Lorenzo Bay), into which the Caña Honda River empties, and this bay and river are fringed with extensive and deep mangrove swamps. The hills and mountains back of San Lorenzo are of limestone formation, and are remarkable for their isolated, conical forms and numerous caves. Between the hills are wide, partly swampy valleys, some of which are covered with dense forests, while others are open and grassy. This proved an excellent collecting ground, and many species occurred here which were not seen elsewhere. El Valle is a small interior village, some twenty-five miles inland from San Lorenzo. It is built on a wide and beautiful prairie. These prairies or savannas are often swampy and are covered with a luxuriant growth of coarse high grass, with numerous clumps of trees and dense underbrush scattered over them. In many places deep ravines, or arroyos, intersect the savannas, and these are invariably filled with dense forest growth. The forests in this vicinity are almost impenetrable on account of the sharp saw-grass, which cuts the skin like a knife and even penetrates strong clothing and leather leggings. It is quite different from the saw-grass of the southern United States, inasmuch as it climbs over the trees, often completely covering them to a height of twenty to thirty feet. The El Valle district proved rich in species, and here were obtained a number of unrecorded forms, as well as the two undescribed species.

La Vega is a good-sized town, about seventy-five miles from Sanchez, and is the inland terminal of a railway from the latter town. It is built in the midst of the splendid Vega Real (Royal Valley), an immense inland plain, surrounded by pine-covered mountains and with numerous wooded ravines and river beds. Several rare species were taken here, while in the pine forests of the mountains such species as the trogan and white-winged dove were found. Miranda is a small village nearly forty miles inland from La Vega, and situated in the heart of the wild and unsettled mountains of the island. The birds were very scarce in this locality, but several species not observed elsewhere were obtained here.

The climate of San Domingo is healthy and the usual tropical fevers and malaria are almost unknown. Typhoid fever, however, is at times prevalent in the interior. Although the annual rainfall is great on many portions of the island, especially at Sanchez and Samaná, yet it was no greater than in the majority of the Antilles, and during the months of February, March, and April the island suffered from a prolonged drought. The temperature is variable, ranging from 85° during the day to 48° at night. This extreme variation at sea level is due largely to the easterly and northerly winds which prevail during the night, while during the daytime they blow mainly from the west and south. In this connection the following table may be of interest:

San Lorenzo, December 29 to January 13:
Average temperature—Day (9 A.M.), 84°; night, 60°.
Average number of rainy days, $\frac{1}{7}$.
Average of barometric readings, 30.10; 30.25.

El Valle, January 13 to January 19:
Average temperature—Day (9 A.M.), 82°; night, 53°.
Average of rainy days, $\frac{1}{2}$.
Average of barometric readings, 30.15; 30.25.

Sanchez, January 20 to January 28:
Average of temperature—Day (9 A.M.), 83°; night, 59°.
Average of rainy days, $\frac{1}{3}$.
Average barometric readings, 30.20; 30.25.

Sanchez, February 26 to March 11:
Average temperature—Day (9 A.M.), 85°; night, 55°.
Average of rainy days, $\frac{1}{2}$.
Average of barometric readings, 30.20; 30.25.

Samaná, January 29 to February 25:
Average temperature—Day (9 A.M.), 88°; night, 63°.
Average of rainy days, $\frac{1}{20}$.
Average of barometric readings, 30.20; 30.25.

La Vega, March 11 to March 18:
Average temperature—Day (9 A.M.), 88°; night, 68°.
Average of rainy days, $\frac{1}{2}$.
Average of barometric readings, 30.15; 30.20.

List of Birds obtained and Notes on their Habits.

1. **Colymbus dominicus**, San Domingo Grebe.

Yabon River, San Lorenzo; Yaqui River, Miranda; rare.

2. **Podilimbus podiceps**, Pied-billed Grebe.

Camu River, La Vega; rare.

3. **Sterna maxima**, Royal Tern, "Gavióta."

Abundant in all the harbors.

4. **Pelecanus fuscus**, Brown Pelican.

The most abundant seabird all around the coasts.

5. **Fregata aquila**, Frigate-bird.

Common in the mangrove swamps of San Lorenzo.

6. **Querquedula discors**, Blue-winged Teal.

Common in the swamps and rivers.

7. **Aythia marila**, Scaup Duck.

One flock found in San Lorenzo Bay.

8. **Nomonyx dominicus**, Masked Duck.

Colorado River, Sanchez; rare.

9. **Dendrocygna arborea**, Tree Duck, "Yaguása."

Common in all swamps. This bird is frequently found feeding on the fruit of the royal palm, far from any water.

10. **Guara alba**, White Ibis, "Cóco."

Abundant in all swamps and much hunted by the natives for food. They are excellent eating.

11. **Plegadis autumnalis**, Glossy Ibis.

One specimen taken at Colorado River.

12. **Ardea cærulea cærulescens**, West Indian Little Blue Heron, "Garza."

Very abundant in all swamps, along the rivers and in damp meadows and savannas. At Samaná this species frequents the shores and water front of the town, where they act as scavengers and are exceedingly tame and unsuspicious.

13. **Butoroides virescens maculata**, West Indian Green Heron, "Cangrito," "Martin-Pescador."

Very abundant and tame. Found wherever there was a pond, brook or even a roadside mud puddle.

14. **Aramus giganteus**, Limpkin, "Carrara."

Common in savannas throughout the country, but seldom seen, although frequently heard.

15. **Ionornis martinica**, Purple Gallinule.

Not rare at San Lorenzo and in the vicinity of Sanchez.

16. **Gallinula galeata**, Florida Gallinule.

Common in the mangrove swamps and damp savannas.

17. **Fulica americana**. American Coot.

Not rare in the swamps and rivers.

18. **Actitis macularia**, Spotted Sandpiper.

Exceedingly common everywhere.

19. **Ereunetes pusillus**, Least Sandpiper.

Rare; one specimen taken at Sanchez.

20. **Gallinago delicata**, Wilson's Snipe.

Abundant at San Lorenzo and at El Valle, where in the broad wet savannas I found the best snipe shooting I have ever seen. The natives had never seen the bird except in flight, as they are unable to shoot them on the wing.

21. **Ægialitis vocifera**, Killdeer.

Common at El Valle; Sanchez; Samaná and La Vega.

22. **Ægialitis semipalmata**, Semipalmated Plover.

Common at Samaná.

23. **Ægialitis wilsoni**, Wilson's Plover.

Common at Samaná.

24. **Arenaria interpres**, Turnstone.

Common on the small sandy cays in Samaná Bay.

25. **Œdicnemus dominicensis**, "Boukaru."

Formerly common on all the interior savannas, but now rare. This strange bird is often kept domesticated for the purpose of ridding the native huts of roaches and other vermin. The eggs are dark chocolate-brown, marbled with blackish. It breeds readily in captivity. The natives have a peculiar method of capturing this bird alive at night. They stand naked in the long grass of the prairies frequented by the birds and wave fire-flies about their heads with one hand. The birds approach to capture the flies and are readily captured with the free hand.

26. **Nycticorax violaceus**, Yellow-crowned Night Heron, "Rey Congo."

Very common in the swamps and along the larger rivers.

27. **Numida meleagris**, Guinea Fowl.

Introduced and now common in the interior of the country. Affords excellent shooting.

28. **Columba leucocephala**, White-headed Pigeon, "Paloma."

The commonest of the pigeons throughout the country. These fine birds are extensively hunted and sell for from 10 cents to 25 cents per pair. At certain seasons—May to September—these pigeons appear in huge flocks. At other times they are shy and suspicious, and are seen only singly or in pairs. They feed extensively on the fruit of the mangroves.

29. **Columba corensis**, Squamated Pigeon, "Paloma Torcáz."

Fairly common in the mangrove swamps and dense forests of the interior.

30. **Columba inornata**, West Indian Pigeon.

Rarer than the preceding species and found in the same localities.

31. **Zenaidura macroura**, Mourning Dove.

Rare; a single specimen was obtained near La Vega.

32. **Zenaida zenaida**, Zenaida Dove, "Tórtola."

Abundant along the river banks of the interior where they feed on the seeds of a yellow-flowered, poppy-like plant.

33. **Melopelia leucoptera**, White-winged Dove, "Rollón."

Rare; confined to the pine forests of the mountains of the interior.

34. **Geotrygon martinica**, Key West Quail-dove, "Perdiz."

Only one specimen, obtained on Cayo Levantádo, in Samaná Bay.

35. **Geotrygon montana**, Ruddy Quail-dove, "Perdiz Colorado."

Abundant in damp, dark, open woodland throughout the republic. Particularly fond of the impenetrable saw-grass thickets, into which it runs at the first sign of danger. Large numbers are trapped by the natives for food. They were sold in the markets of El Valle for three cents a pair.

36. **Accipiter fringilloides**, "San Nicolo," "Harpon."

Rare; found in all parts of the island, but obtained only at Miranda.

37. **Rupornis ridgwayi**, Ridgway's Buzzard, "Guaraguäjo."

Rare; taken only at Miranda, but seen flying over in other localities.

38. **Buteo tropicalis**, sp. nov., Tropical Buzzard.

This fine new hawk, of which two specimens were obtained, is confined to the southern side of Samaná Bay. They are a sluggish, heavily flying bird and will sit motionless for hours on the dead trees of cleared land waiting for rats and lizards. Their note resembles that of *Buteo latissimus*. The nest is built on dead trees, preferably Ceibas, at a great height from the ground.

Description.—Male, type, San Lorenzo, January 12, 1907. Above, sooty-brownish with a rich, metallic, purplish gloss. Scapulars and tertials, as well as upper wing-coverts, narrowly edged and tipped with ashy-gray. Neck and shoulders streaked, and each feather edged, with rich ferruginous. Upper tail-coverts rusty-white, barred with sienna-brown. Tail rusty-ferruginous, the feathers white at base and tips, and with a subterminal bar of dusky-black, broadest on the outer feathers. About seven to nine distinct, dusky bands on upper surface of tail. Under surface of tail pale, rusty-white without bars. Forehead, lores, orbital region and a patch on crown, pure white; the last partially concealed by dusky tips to the feathers. A distinct "mustache" and a narrow superciliary stripe of black. Primaries and secondaries rich brown, broadly tipped with and crossed by five bars of black. Outer webs of first five primaries, and about one-half of the inner webs of same, dusky with purplish reflections.

Below white, tinged with buffy on chest, crissum and thighs; the chin and throat narrowly streaked with dusky. Chest thickly streaked with ferruginous, thickest on sides and almost confluent, forming there a more or less distinct ferruginous patch. Feathers of belly broadly tipped with dusky, with a "dumbbell-shaped" spot near the base of each feather, forming a distinct, dusky zone across the abdomen. Flanks dusky brown, each feather spotted with white. Thighs barred with ferruginous. Lower tail coverts buff. Under wing coverts buffy-white streaked with sienna-brown, and with a large triangular dark-brown patch near carpal joint. Eyes, pale yellow; feet and legs, yellow; cere, pale green; bill, bluish.

Immature birds much resemble the adults, but lack the rich purple gloss of upper parts, and the tail is brownish-gray, crossed by about ten distinct, dusky bands.

Length, 19 to 21 inches. Wing, 14 to 14.50. Tail, 7.50 to 8.

39. **Falco dominicensis**, Dominican Sparrow-hawk.

Not uncommon in the interior and on the northern coast.

40. **Falco sparverius**, Cuban Sparrow-hawk.

Rare. Taken only at Miranda.

41. **Falco columbarius**, Pigeon Hawk.

Not common. Obtained at Miranda.

42. **Pandion haliaëtus**, Osprey.

Abundant around the mangrove swamps, but very shy.

43. **Strix glaucops**, San Domingo Barn-owl. "Lechúsa."

Common, but seldom seen during the day.

44. **Speotyto dominicensis**, San Domingo Burrowing-owl, "Tucú."

Common on the dry prairies between La Vega and Santiago, as well as in the vicinity of Azua on the southwestern coast.

45. **Conurus chloropterus**, Parroquet. "Periquíto."

Rare and confined to certain localities, as El Valle and Matánzas. They feed on the fruit of the royal palm and are hunted by the natives for food.

46. **Amazona sallæi**, Salle's Parrot. "Cotórro."

Common throughout the island, but particularly abundant during the months of January and February when the seeds of the "Guama" trees are ripe. Large numbers are killed for food and many are taken from the nests and tamed. They are very gentle in captivity and are splendid talkers.

47. **Crotophaga ani**, Ani, "Júdio."

Abundant everywhere. The native name—"Judio" or Jew—refers to the heavy, roman-nosed beak.

48. **Coccyzus minor**, Mangrove Cuckoo, "Montéro."

Abundant in some localities and entirely absent in others near by. This bird was particularly common at San Lorenzo and El Valle, but was never seen at Sanchez, sixteen miles distant, although it was quite common at La Vega and throughout the interior.

49. **Coccyzus maynardi**, Maynard's Cuckoo.

Rare. One specimen obtained at San Lorenzo.

50. **Saurothera dominicensis**, San Domingo Cuckoo, "Bobo."

Abundant in all portions of the republic. They are very tame and stupid, as implied by the native name of "Bobo," meaning a fool. This bird is eaten by the natives as a cure for stomach troubles.

51. **Hyetornis fieldii**.

Met with only between Miranda and La Vega.

52. **Temnotrogan roseigaster**, San Domingo Trogan, "Papa gayo."

Common in the pine forests about La Vega and Miranda, but very shy and difficult to obtain. They perch motionless in the pine trees, and their colors blend perfectly with that of the pine needles and reddish bark.

53. **Ceryle alcyon**, Belted Kingfisher.

Common near water everywhere. Breeds.

54 **Todus subulatus**, Tody, "Barrancalí."

Abundant at all localities visited. Very tame and unsuspicious. On one occasion one of these birds actually alighted on my gun-barrel, as I stood motionless near a small stream. The note of this bird is a frog-like croak. The nest is built in holes in the banks of streams; eggs pure white.

55. **Todus angustirostris**, Narrow-billed Tody, "Barrancalí chico."

The habits and note of this species are similar to the preceding, but it is not so common and is very local in its distribution. I found it more common than *subulatus* at San Lorenzo and El Valle, but did not meet with it at all at Sanchez, and saw but one or two individuals at Samaná. In the interior it was about as abundant as *subulatus*.

56. **Picumnus lawrencei**, Lawrence's Pigmy Woodpecker.

This odd little bird is rather rare, although possibly its apparent scarcity is due to its quiet and retiring habits and dull coloring which render it inconspicuous. It was not known to any natives I met, and was obtained only at Sanchez and Samaná.

57. **Melanerpes striatus**, Woodpecker, "Carpintéro"

This is the most abundant and destructive bird on the island. It is seen everywhere and there is hardly a palm tree in the republic that is not riddled with its holes. It feeds on fruits, oranges, and cacao-pods and frequently ruins the crop.

Fortunately its increase is kept down by a fatal provision of nature in the shape of a parasitic worm which infests the throat and head. This worm matures at the season when the young woodpeckers are able to leave the nest, and after that time it is practically impossible to find an adult *Melanerpes* alive. The ground beneath the nests is often strewn with dead and dying adult birds, their throats and crops so distended with the disgusting parasites as to render them incapable of flight.

58. **Chordeiles minor**, Cuban Nighthawk.

Common on the open savannas of the interior.

59. **Antrostomus carolinensis**, Chuck-Wills-Widow, "Quiere Bebér."

Not rare in the more open portions of wooded hillsides and on open savannas. Sanchez; La Vega; El Valle.

60. **Cypseloides niger**, Black Swift, "Golondrina negro."

Common in the interior and at Samaná.

61. **Cypselus phœnicobius**, Swift.

Common along the Camu River at La Vega.

62. **Chætura zonaris**, Collared Swift.

This large swift is common at La Vega and in the interior, but usually flies at such an elevation that it is very difficult to shoot.

63. **Lampornis dominicus**, "Zumbadór."

This humming-bird is common throughout the island.

64. **Mellisuga minima**, "Zumbadorito."

This tiny atom of bird life is very common at all points visited. It is remarkable for its loud and penetrating song, which it gives forth hour after hour, as it perches on some slender twig or on the topmost leaf of some palm tree.

65. **Sporadinus elegans.**

I found this handsome humming-bird at all points visited, but most abundant at El Valle. It loves dark woods and swamps and dashes suddenly into sight, only to flash off almost before the gun can be raised to shoulder.

66. **Tyrannus dominicensis**, Gray Kingbird, "Pe Tigre."

Very common everywhere.

67. **Pitangus gabbii**, Gabb's Petarchy.

Rare; found only at Miranda.

68. **Myiarchus dominicensis**, Dominican Crested Flycatcher, "Manuelito."

Common in most localities.

69. **Blacicus hispaniolensis**, Hispaniola Flycatcher.

Common in most places.

70. **Lawrencia nanus.**

Extremely rare; found at Miranda only.

71. **Elaina cherriei.**

One specimen taken at Miranda.

72. **Corvus leucognaphalus**, Crow, "Cuervo."

Abundant in the mangrove swamps, but so frequently hunted for food that they are shy and suspicious. At San Lorenzo immense flocks of this crow flew back and forth from their roosts in the mountains to their feeding grounds in the swamps, at morning and evening, but always at a great elevation.

Their note resembles the words "Quiero casa carrajo," and the natives firmly believe that they can understand and converse in Spanish. Their calls certainly more nearly resemble human speech than anything else.

73. **Corvus solitarius**, Solitary Crow, "Cáo."

Rarer than the preceding and confined to the interior. The habits and notes are much the same as of the last.

74. **Icterus dominicensis**, San Domingo Oriole, "Sigua calándre."

This bird, which is a charming songster, is common at all points visited. It is found in small flocks, the young males, females and males keeping in separate flocks.

75. **Quiscalus niger**, Black Grackle, "Chinchiling."

Abundant at all points visited, although mainly found in the vicinity of houses and settlements. It is a noisy creature, continually uttering its loud, liquid cry of "Chiniling-ling-eeee."

76. **Quiscalus** sp?.

Among the *Quiscali* obtained were a number which to me appear distinct from *niger*, as they are much larger and heavier, with relatively stouter bill and feet. The note is quite distinct from that of *niger*, and the natives state that they are different. Dr. Hartert, of Tring, thinks, however, that the difference is merely sexual.

77. **Loximitris dominicensis**, Dominican Grosbeak.

I found this pretty species abundant in certain localities near La Vega. They were always found in large flocks in open pasture land, and in habits, flight and notes much resembled the American Goldfinch. They fed on wild guava fruit. They are shy, restless birds and are usually found in flocks of a dozen to twenty individuals. Sometimes they will remain until the intruder approaches within a few yards, while at other times they take flight long before one can approach within gunshot. They are fond of perching on dead or partly dead bushes and trees in open prairie or pasture land, near rivers or on the edges of thickets, and invariably fly into the latter or across the former when disturbed.

78. **Loxigilla violacea**, Violet Loxigilla, "Prieto" (male), "Chichigua" (female).

Abundant in all parts of the island.

79. **Tiaris bicolor**, Grassquit, "Juana Marúca."

Common in most places. In a few localities entirely replaced by *T. lepida*, as examples at El Valle and in some spots near La Vega.

80. **Tiaris lepida**, Yellow-faced Grassquit.

Abundant at La Vega, El Valle and other localities, but entirely absent from the vicinity of Sanchez and Samaná.

81. **Ammodramus savannarum intricatus.**

This new species, described by Dr. Ernst Hartert from specimens obtained by me at El Valle, is very common on the broad grassy savannas of that region. They are difficult to shoot as they flit up from the dense grass, to disappear in it again almost instantly. The note is short, weak and insect-like, and greatly resembles that of our own Grasshopper Sparrow.

82. **Euphonia musica**, Musical Euphonia.

All the specimens of this rare species which I obtained were killed from a single tree near Sanchez. It was never seen or heard elsewhere. The first specimen was taken on February 26. It was feeding on a parasitic vine with greenish-white berries, resembling mistletoe. A few moments later several additional birds arrived and commenced feeding, although none had ever been seen there before, and the tree was one from which I secured birds daily. For several days thereafter the Euphonias could always be found on this tree, although none were ever seen elsewhere. They are quiet, slow moving birds and crawl about in the deliberate, parrot-like manner of others of the genus. The song is very clear, liquid and musical, closely resembling that of the White-throated Sparrow.

83. **Spindalis multicolor**, Painted Tanager.

This rare and beautiful bird is a good example of the class of birds common at one season and very rare at others. Not a single bird of this species was seen previous to January 22, 1907, on which date I obtained a single female at Sanchez. No others were seen until February 26, and then, in a single week, over sixty specimens were secured within a radius of one hundred yards. After the last date no others could be found.

All these specimens were feeding on the reddish-purple berries of a parasitic plant. They are very curious birds in their habits, and quite different from any other species with which I am familiar. They arrive and depart from their feeding grounds so suddenly and silently that one must watch constantly in order to see them. While feeding they are also silent and stand almost motionless in one spot until all the berries within reach are consumed, when they dart suddenly to another spot and repeat the operation. The males are fond of perching in dense thickets or among clumps of thickly growing air-plants, singing their feeble, insect-like song. They are very shy and at the least movement or noise cease their notes and remain motionless, and if discovered at once dash into the thickest growth, where it is impossible to follow them.

84. **Phœnicophilus dominicanus**.

Rare; only found at Miranda.

85. **Phœnicophilus palmarum**, "Cuarto ojos."

This beautiful tanager was abundant everywhere. Its habits resemble those of a vireo more than those of a tanager.

86. **Calyptophilus frugivorus.**

Rare at most places visited. La Vega and Miranda only.

87. **Progne dominicensis,** San Domingo Martin.

Common near the coasts.

88. **Petrochelidon fulva,** Cuban Cliff-swallow, "Golondrína."

Common at most localities visited.

89. **Hirundo sclateri,** Sclater's Swallow, "Golondrína vérde."

This most beautiful species was met with only at La Vega, where it was abundant along the Camu River.

90. **Dulus dominicus,** "Sigua palméra."

This odd bird is excessively abundant throughout the island. It is gregarious and breeds in colonies in huge nests, which are usually placed in the royal palms. They are noisy, restless creatures, and the cries from a nest of these birds during the breeding season can be heard for half a mile. I was unable to determine whether each female had a compartment in the huge nests, or if they deposited their eggs and sat upon them at random. I am inclined to think the latter is the case, however, as the eggs are scattered through the nest, with no apparent attempt at order, and I do not believe that even the parent birds could identify the young, that scramble back and forth throughout the nest.

The old nests are torn down bodily by the birds and often huge piles of old nesting materials are scattered on the ground beneath the palms where they breed. When they wish to destroy a nest, several hundred birds will seize hold of the structure and by pulling and tugging will succeed in tearing it from its support. They are curious, inquisitive creatures and always gather about and protest vigorously at the report of a gun.

91. **Vireo calidris,** West Indian Vireo, "Qúien fúe"; "Juan Chívi."

Common everywhere. The two local names refer to the note. The first, meaning "Who Goes There," is very appropriate, as the bird always becomes restless at one's approach, and repeats the short, pertinent query over and over, at times being answered by another vireo in notes that resemble the words "Juan Chivi."

92. **Cœreba bananivora,** Banana Creeper, "Sígua."

Common in most places.

93. **Mniotilta varia,** Black and White Warbler.

Abundant migrant.

94. **Parula americana,** Parula Warbler.

Very common during migrations.

95. **Dendroica tigrina,** Cape May Warbler.

Abundant. Among the large series of specimens of this species which I obtained, there appear to be two forms; one, the common North American bird; the other, more richly colored, with distinctly chestnut breast, deep-yellow wing-bars, and rich—almost orange—yellow breast and belly. As young birds in nestling plumage, as well as females containing eggs ready for the nest, were obtained, I consider it possible to separate the resident bird from the northern form as a local variety or subspecies.

96. **Dendroica cœrulescens,** Black-throated Blue Warbler.

An abundant migrant.

97. **Dendroica coronata,** Myrtle Warbler.

Very common during migrations.

98. **D. maculosa,** Magnolia Warbler.

A rare migrant, one specimen taken at Samaná.

99. **D. dominica,** Yellow-throated Warbler.

A common species.

100. **D. vigorsii,** Pine Warbler.

Common in pine forests of the interior where it breeds.

101. **D. palmarum,** Palm Warbler.

An abundant migrant.

102. **D. discolor,** Prairie Warbler.

A common migrant.

103. **Seiurus aurocapillus,** Oven Bird.

An abundant species during the migrations.

104. **S. motacilla,** Large-billed Water-thrush.

Common during migrations, but confined to the vicinity of salt water.

105. **S. noveboracensis,** Small-billed Water-thrush.

Common, but seen only near fresh water.

106. **Geothlypis trichas,** Maryland Yellowthroat.

Common.

107. **Microlegia palustris.**

Said to be common in various parts of the country, but only met with once, at El Valle.

108. **Setophaga ruticilla,** American Redstart.

Abundant during migrations.

109. **Mimus dominicus.** San Domingo Mockingbird. "Rúisenor."

An abundant and charming songster.

110. **Mimocichla ardesiaca,** "Calándre," "Cañélo," "Flotéro."

A common but shy inhabitant of woods and thickets, this bird is more frequently heard than seen. Its note is a charming, flute-like whistle.

111. **Turdus aliciæ,** Alice's Thrush.

A rare migrant. One specimen taken near Sanchez.

112. **Myiadestes montanus,** "Jilgúero."

Not uncommon, but, like the other members of the genus, shy and retiring. The mournful, flute-like song of this bird is often heard in the mountainous districts. It is very difficult to see or shoot the birds. Sanchez and Miranda.

A NEW SPECIES OF SCALPELLUM FROM BRITISH COLUMBIA.

BY HENRY A. PILSBRY.

Scalpellum (Arcoscalpellum) columbianum n. sp. Figs. 1, 2.

The capitulum is much compressed, more than twice as long as wide, white under a very thin smooth pale yellowish cuticle; occludent border straight, carinal border evenly arched; greatest width about median. There is no sculpture aside from indistinct growth-lines.

The scutum has parallel occludent and internal margins, and is rather narrow, with apical umbo.

The tergum is long, triangular, its occludent margin short, arched, apex slightly recurved; the scutal and carinal margins are very long and nearly straight.

The carina is very long, with well-developed parietes of nearly equal width; dorsal face very narrow throughout, and deeply guttered, the high bordering ribs about as wide as the intervening groove or gutter. It is more curved near the apex, which is situated high, about at the upper sixth of the carinal side of the tergum. At its base the carina intrudes between the umbones of the carinal latera.

The upper latus is roughly trapezoidal, the scutal and carinal borders parallel, upper border oblique, basal border convex.

The rostrum is minute, oblong, slightly contracted in the middle.

The rostral latus is rather low, triangular, the upper and lower margins converging toward the rostral apex.

The inframedian latus is narrowly subtriangular, spreading above, narrowed towards the base. The umbo is near or at the lower third.

The carinal latus is subtriangular, the umbo projecting at the base of the carina, far below the bases of the other plates. The carinal border is straight above, becoming concave near the base.

The peduncle is short, covered with scales, of which there are about 16 rows of about 10 scales each. They are not regularly arranged.

Length of capitulum 8.5, width 3.4, diameter 1.3 mm.; length of carina 7.25 mm.; length of peduncle 3 mm. (fig. 1).

Length of capitulum 7.7, width 3.3 mm.; length of carina 6.8 mm., of peduncle 4 mm. (fig. 2).

Lowe Inlet, British Columbia. Type (fig. 1) No. 38,697 U. S. Nat.

Mus. Cotype No. 1,843 A. N. S. P. (fig. 2). A third specimen, from Burrard Inlet, is in the collection of Rev. George W. Taylor, Biological Station, Wellington, B. C., who collected the specimens.

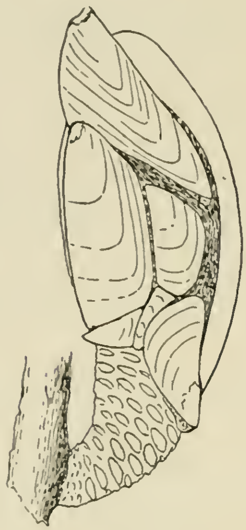

Fig. 1.

Fig. 2.

This species is known by three specimens of about equal size, which were preserved dry; hence no examination of the internal organs has been attempted. It is related to *Scalpellum soror* Pils.[1] from deep water (634 fathoms), near the Galápagos Islands, but differs from that species by the more lengthened capitulum, the larger and somewhat differently shaped upper inframedian and carinal latera, the more compressed carina and shorter peduncle. The carina of *S. columbianum* reaches farther up on the tergum than is usual in *Scalpellum*.

S. sanctipetrense Pils.[2] is a broader species than *S. columbianum*, with a narrower inframedian latus, having the umbo at its upper third. It was taken at San Pedro, California, in 50 to 75 fathoms. *S. gravelianum* Pils., another Californian species, is larger than *S. columbianum*, the inframedian latus smaller with apical umbo.

[1] Bulletin 60, U. S. National Museum, p. 42.

[2] *L.c.*, p. 39.

NOTE ON THE MORPHOLOGY OF FULGUR.

BY BURNETT SMITH.

On the whole the marine gastropods are singularly free from individual abnormalities or deformations, and this rule holds good for the two large conchs (*Fulgur carica* Gmelin and *F. canaliculatum* Say) which are washed upon our Atlantic Coast in such large numbers during the winter storms. As far as the writer knows there is no record of an abnormal individual of *F. carica*. *F. canaliculatum*, on the other hand, has furnished a small number of deformed specimens which have found their way into museums. Some of these have been described and figured.

Deformations of the Shell in F. canaliculatum.—In the museum of the Academy of Natural Sciences of Philadelphia there are two abnormal shells of this species. In the first of these the branchial siphon has grown in such a way that its direction is almost at right angles to the axis of coiling of the spire. From an examination of the exterior of the shell it is impossible to state with certainty the causes of this condition. Whether it is the result of accident or of some truly pathologic condition cannot be determined.[1] The second specimen, collected at Longport, New Jersey, was figured and described by the present writer.[2] In this case the deformation can be traced to a break in the shell which occurred at a relatively early stage in the ontogeny. The result of this has been a complete change in the whorl form and sculpture, the tubercles and shoulder keel disappear and we have a smooth, rounded whorl very similar to that of *F. pyrum* Dilw. In this connection it is interesting to note that paleontological data points to the descent of *F. pyrum* either from *F. canaliculatum* or from some very closely allied form, and furthermore that this descent was marked by the almost complete disappear-

[1] "A Remarkable Monstrosity of Fulgur canaliculatum," C. W. Johnson and H. A. Pilsbry, *The Nautilus*, July, 1895, p. 25, fig. 1.

[2] Proc. Acad. Nat. Sci. Phila., June, 1902, p. 507, and April, 1905, p. 358, Pl. XXXI, fig. 10.

ance (through acceleration) of the shoulder keel and the assumption of a smooth, rounded whorl outline. In other words we have here a striking parallel of an evolutional process which has taken place slowly during geological time and resulted in the change of one species into another, with a change which has been caused by accident in the growth of an individual.

In this Longport specimen the animal when washed ashore fortunately possessed the soft parts intact. A carefull examination of these disclosed no unusual condition other than the fact that the mantle was rounded instead of angulated. The mantle edge was in no way peculiar and the penis, which in the normal male underlies the shoulder angle, was fully developed and exactly similar to that found in other individuals. In fact no peculiarity of the soft parts could be detected which would account for the causes of the change in shell growth.

Abnormality in the Soft Parts of F. canaliculatum.—In the specimen just described the absence of a shoulder angle in the mantle and in the shell does not seem to be connected in any way with the underlying reproductive organ. Fig. 1 shows the character of the normal, backward folded penis which lies immediately below the shoulder angle. Inasmuch, then, as we have noted an individual with abnormal shell but with normal reproductive organs, it is of interest to call attention to another specimen collected by the writer which has an entirely normal shell but whose reproductive organs are imperfect (fig. 2). In this case the penis is small, not being more than one-fifth the usual length. If this condition had been the result of an injury to the penis we might expect to find traces of its original condition at least around its base. This, however, is not shown for the base is small, having about one-half the normal width. We are therefore justified, it is believed, in regarding this as an instance of arrested development in a particular organ. No other abnormalities in the soft parts were observed and, as stated before, the shell is in every regard similar to that of the normal individual.

Fig. 1—*Fulgur canaliculatum* Say. Diagram showing the normal male reproductive organ.

Fig. 2—*Fulgur canaliculatum* Say. Diagram showing undeveloped male reproductive organ.

The Penis of F. carica.—Some interesting points in the comparative morphology of *F. canaliculatum* and *F. carica* are furnished by a study of the male reproductive organ. In the former species the penis is turned backward and folded (fig. 1). It likewise retains the same width at the distal end as at the proximal, while in addition the terminal process is relatively large. In *F. carica*, on the other hand, the organ tapers gradually from the proximal to the distal end and the terminal process is very small (fig. 3). The penis though turned backward is not folded at the turn as in *F. canaliculatum*.

Fig. 3—*Fulgur carica* Gmelin. Diagram showing the normal male reproductive organ.

Influence of the Soft Parts on Shell Form and Sculpture.—No one, of course, denies that all the features of the gastropod shell, its form, size and ornamentation, are the result of changes in the lime-secreting soft parts. A shoulder keel, for instance, is caused by a permanent angle, while a spine represents the effect of a temporary elevation of the mantle. What is it though which produces this temporary bulging of the mantle edge? What is the physiological meaning of the spine? This is a question which has never yet been satisfactorily answered in spite of many ingenious suggestions. One view, often expressed, holds that the spines represent an activity of the mantle edge which is manifested at recurrent reproductive periods. This may indeed be true, but it is yet to be proved.

To apply the discussion to the forms considered in this paper we may ask: Have the spines in *Fulgur carica* any connection with either copulation or oviposition? Though this question could probably be solved at one of our marine laboratories, its solution has apparently never been attempted. In the absence, then, of definite information on the subject, it is believed that it is pertinent to outline here certain objections which might be raised against the above theory.

(1) If the spines are caused by oviposition there is a difficulty in explaining their equal development in both the male and the female.

(2) If the spines are caused by the act of copulation there is likewise a difficulty in explaining their exact similarity in the two sexes.

To extend our inquiry to *Fulgur canaliculatum*, it is first to be noted that this species has no true spines. In this form the spines have disappeared, their former presence being shown by the small tubercles which have been crowded back by acceleration into the early whorls.

It is difficult therefore to believe that spine production in *Fulgur* is the result of reproductive activity when we regard these two Atlantic Coast species, with equally well developed reproductive organs and with presumably similar habits of oviposition, the one spineless and the other spined. By an examination of the penis in the two species we can select no character in one which should produce a spine, or in the other case state why the protrusion of the penis should not produce a spine.

Considering now the shoulder keel, which seems to be the evolutional successor of the row of spines, we know by actual observation that the non-development of the penis in *F. canaliculatum* does not necessarily affect the keel, while, on the other hand, an injured keelless individual may possess the organ in its normal condition.

From these facts we can be reasonably confident that the shoulder keel has no connection with reproductive activity. When it comes to the spines, however, we can but say that there are no characters in the penis of *F. canaliculatum* which we can definitely correlate with the spineless condition of the shell, and in *F. carica* we can assign to the different form of the organ no cause for the development of spines.

THE VEGETATION OF THE SALT MARSHES AND OF THE SALT AND FRESH WATER PONDS OF NORTHERN COASTAL NEW JERSEY.

BY JOHN W. HARSHBERGER.

In a number of papers[1] of greater or less length, I have discussed the character of the vegetation of the New Jersey coast. The observations recorded in these various brochures cover territorially the immediate coast from Bay Head in the north to Cape May in the south, and were based on field work and on the study of collections made for the several large herbaria in Philadelphia. During a residence at Belmar, New Jersey, from August 12 to September 15, 1908, and July 7 to September 8, 1909, an opportunity was afforded of making collections, and of completing a survey of the vegetation of the New Jersey coast, begun in 1893, by a study of the coast from Manasquan Inlet north to Sandy Hook and along Sandy Hook Bay several miles westward from Highland Beach.

On several railroad trips from Belmar to New York City, I was able, by a familiarity with the coastal flora for over a period of fifteen years, to extend my observations, while on the moving trains, as far north as the Hudson River, notably at Red Bank on the Navesink River, at Matawan on Matawan Creek, along Newark Bay—in fact, such observations were made wherever undisturbed salt marshes were crossed by the Central Railroad of New Jersey and the Pennsylvania Railroad between Belmar and Jersey City. So that, although the description given in this paper is confined to the coast between Manasquan Inlet and Sandy Hook Bay, where collections and a field study were made, yet it can be said that, from the car-window observations,[2] essentially

[1] Harshberger, John W.: Plants for the Seashore, *Garden and Forest*, V: 45; An Ecological Study of the New Jersey Strand Flora, *Proceedings of the Academy of Natural Sciences of Philadelphia*, 1900: 623–671; Additional Observations on the Strand Flora of New Jersey, do., 1902: 642–669; Forest Growth at Wildwood, New Jersey, *Forest Leaves*, IX: 40, June, 1903; The Mutation of *Hibiscus moscheutos*, *Proceedings of the Academy of Natural Sciences of Philadelphia*, 1903: 326; The Formation and Structure of the Mycodomatia of *Myrica cerifera*, do., 1903: 352–362; The Comparative Leaf Structure of the Strand Plants of New Jersey, *Proceedings of the American Philosophical Society*, XLVIII: 72–89, with 4 plates.

[2] This has been the favorite method of Dr. Roland M. Harper in his study of the coastal flora of the Southern States. It is fairly satisfactory as extending the range of certain types of vegetation, but is unscientific unless checked by actual collections and study of a section of the plant formations investigated, as put into practice above.

the same type of salt marsh vegetation exists as far north as New York City.

Early in the field work it became apparent that my entire time and attention could be devoted to the salt marsh and pond vegetation of the region covered by this phytogeographic survey, for a study of the flora of the sea beaches and sand dunes, which are not extensive on the northern New Jersey coast, revealed the fact that the same association of shore and dune plants existed north of Manasquan Inlet as south of it as far as Cape May. The vegetation of the salt marshes, salt ponds and fresh water ponds of the northern New Jersey coast present so many features of interest that it was fortunate that my undivided attention could be given to its study, so that the dune flora will be mentioned in what follows only when necessary in elucidating the composition of juxtaposed plant formations.

Physiography of the Region.

No mention is made of the ponds which are characteristic of the northern shore of New Jersey in the works that have been published on the physiography of New Jersey. Several of them at Ocean Grove and Asbury Park have been surrounded by embankments, and are used for pleasure craft and for winter and summer carnivals. Beginning at Manasquan Inlet in the south and traveling northward, one encounters the following bodies of water, which will be designated as open or closed to the ocean, and therefore fresh or salt:[3]

Manasquan Inlet (open and salt).

Newberry Lake = Stockton Lake (open and salt, connected with Manasquan River).

Wreck Pond (open and salt in 1908; closed during the summer of 1909 and fresh until August 13, 1909, when it was opened to let in the salt water).

Spring Lake (closed and fresh).

Como Lake (closed and fresh).

Silver Lake (closed and fresh; pleasure lake).

Shark River Inlet (open, with strong tidal movement to and from the sea; closed on July 23, 1909, by the formation of a sand bar during a southeast storm; opened again August 12, 1909).

Sylvan Lake = Duck Pond (closed and fresh, but connected with sea at very high tides).

[3] The following maps, published under the auspices of the Geological Survey of New Jersey, will be found useful: Atlas Sheet No. 9, Monmouth Shore, 1902; Navesink Sheet, 1901; Long Branch Sheet, 1901; Shark River Sheet, 1903.

Fletcher Lake (closed and fresh; pleasure lake).

Wesley Lake (closed and fresh; pleasure lake).

Sunset Lake (closed and fresh; pleasure lake).

Deal Lake (open by a closed sluice gate filled with sand and totally fresh).

Whale Pond = Takanassee Lake (open by a made channel, but entirely fresh).

Shrewsbury River (opening northward into Sandy Hook Bay and navigable to large excursion steamers).

All of these ponds, whether fresh or salt, have had essentially the same physiographic history. They have all started as the outlets of larger or smaller streams, which flowed sluggishly seaward from a more elevated but still almost level interior. Upon reaching the immediate sea coast, these streams had to contend with the sand of the traveling beaches, which form an almost unbroken line for a thousand miles from Montauk Point, on the eastern end of Long Island, to Jupiter Inlet, in Florida. These sandy beaches never maintain the same relative position, but are moved about by the ocean currents and more fickle winds. Since the beaches have been inhabited by summer and winter residents attempts have been made to stop the movement of the sand by the construction of jetties, stone walls and revetments, with some degree of success, but in the past the action of nature's forces were untrammeled. The continuity of such beaches is broken only by the action of a river. The Hudson River, flowing out of New York Bay, breaks the beach between the Navesink Highlands and Long Island. There has been a big contest for supremacy between the beach and the river. Coney Island has crept out like a crooked finger from the east, and Sandy Hook has traveled up several miles from the south. But the great river has kept open its channel to the sea, notwithstanding the fact that Fire Island Inlet has drifted to the west at the average rate of three miles in sixty years, or nearly 260 feet per annum. The encroachment of these bars threatens the channels which lead into the Narrows and New York Bay, so that until recently the largest steamers had to wait outside for the tides, while the least deviation from the channel insured their grounding. All of the rivers south of Sandy Hook have had a similar contest with the sand beaches. The Shrewsbury and Navesink rivers have had such a struggle to keep open their outlet to the sea.[4] The sandy beach, however, succeeded in

[4] Consult the facsimile made from a survey map by Ratzer in 1769 and published in England in 1777, where these rivers are represented as open to the sea. Also the papers by Prof. Lewis M. Haupt (*Annual Report State Geologist of New Jersey*, 1905: 27–95; 1907: 72–81), where by photographs and diagrams the changes of the New Jersey coast line are well illustrated.

closing the mouths of both rivers, which united together into a common stream, cutting its way past the Navesink Highlands and emptying into Sandy Hook Bay. Even to-day the low sand beach is so narrow that often the sea breaks entirely over it, and this is particularly true of the portion immediately in front of the Navesink Highlands, for here it is barely wide enough to accommodate double railroad tracks and a carriage road, protected as they are from the full force of the ocean storms and high tides by a sea wall of stone and piling. This narrow strip of sand, about six miles long, connects Sandy Hook with the mainland. All of the smaller streams have been obliged to meet the same sand encroachment; but many of them, unable to keep their outlets open, have been converted into salt ponds, and if shut off from the sea for any length of time they have been gradually transformed into fresh water ponds. Only two of the larger rivers have been equal to the task of cutting through the barrier beach, viz., Shark River and Manasquan River. The outlet of Shark River several years ago had been almost closed, except a narrow channel which one could step across at low tide; but in the summer of 1908 the river had a new lease of life, its inlet opened wider than ever, so that naphtha launches drawing several feet of water entered from the open ocean. During the summer of 1909, however, the sand barrier had traveled so far north that a southeast storm on July 23, 1909, completely closed the inlet.[5]

We can arrange the inlets and ponds in a regular sequence, with reference to the stage which they have reached in their developmental history (see note 16), beginning as ocean inlets and ending in closed fresh water ponds. In an earlier paragraph I have arranged all the known bodies of water in geographic order. Their physiographic sequence is somewhat as follows:

1. *Salt Water*[6] (Active Tidal Flow).

Manasquan River; Shark River (open until July 23, 1909, when it closed, to be opened by digging away the bar on August 13, 1909); Navesink and Shrewsbury Rivers; Wreck Pond (open and salt in 1908, closed by a sand bar and fresh during 1909 until August 13, when the inlet was opened to the sea).

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[5] The only open inlet from Barnegat Inlet to Sandy Hook during the summer of 1909 after July 23, when Shark River Inlet closed, was at Manasquan. Later, on August 13, 1909, Wreck Pond Inlet was opened, and on August 12 that of Shark River.

[6] In all cases the character of the water was determined by a hydrometer that, read 0–50 degrees Beaumè. When the scale read 0 degrees the water was considered undoubtedly fresh.

2. *Fresh Water.*
   (A) With Natural Surroundings—Wreck Pond (salt in 1908; fresh in 1909); Como Lake (sluiceway to sea); Sylvan Lake = Duck Pond (sluiceway to sea).
   (B) With Artificial Surroundings (pleasure lakes)—Spring Lake; Silver Lake.
   (C) With Protected Shores (pleasure lakes)—Fletcher Lake; Wesley Lake (sluiceway to sea); Sunset Lake; Deal Lake (sluiceway to sea, opened fifteen years ago); Whale Pond = Takanassee Lake (sluiceway to the sea).

The vegetation will be considered in the sequence which follows the physiographic history of the bodies of water mentioned above. Wherever the tidal action is sufficient to keep the basins of the rivers in the first category filled with salt water, we have the level areas along their banks and the sand and muck islands formed by the action of the currents covered with a typic salt marsh vegetation.

Salt Marsh Formation.

The salt marsh areas in New Jersey with which we are concerned occur around the shores of Newark Bay, and extend for some distance along the Hackensack and Passaic rivers. There is no salt marsh on the banks of the Hudson River, and none at present in New Jersey on New York Bay. Salt marshes extend along Arthur Kill and inland along the shores of the rivers that empty into it. Raritan Bay has its marshes where there are indentations and where small streams empty into it, and for several miles along both banks of the Raritan River there are extensive flats. The shores of the Navesink River, except a few islands near its mouth, are destitute of salt marshes; but the Shrewsbury River has low, swampy shores, covering some space between the highland and the shore. Then comes a stretch of sea coast extending from North Long Branch to Bay Head, along which the mainland is washed by the ocean waves; the beach is abrupt, the sand is coarse and there is no marsh, except on the banks of Stockton Lake, Shark River, Wreck Pond and Manasquan River. South of Bay Head the salt marshes back of the sand islands are very extensive, as described in previous papers.

Three kinds of salt marshes may be distinguished in New Jersey. The first, and smallest in area, is that which is covered at every mean high tide. The second in area is rarely covered at ordinary tides, but so little above mean high water that even the slightest rise, due to wind storm or moon changes, results in a partial covering with water. The third type of marsh is that above mean high tide and more or less completely covered with vegetation. All three kinds of marsh may be covered at the time of the Spring and Fall tides, and they are intersected by ditches, thorofares, and deeper boat channels, which give a characteristic appearance to the monotonous landscape.

The following analysis of a machine-cut sod, 10 x 10 x 27 inches, weighing 121 pounds, was made by Dr. Jacob G. Lipman, of the New Jersey Agricultural College, from material taken August 13, 1907, on a Raritan marsh opposite Sayreville:

Original Weight,	121	pounds.
Dry Weight,	23.39	"
Moisture,	80.67	per cent.
Dry Matter,	19.33	"

	Upper Portion.	Lower Portion.
Nitrogen,	0.65 per cent.	0.63 per cent.
Organic Matter,	34.23 "	21.30 "
Ash,	65.75 "	78.70 "

The spongy, fibrous character of the upper portion of the sod, extending from twelve to eighteen inches and composed of roots and other vegetable matter, is gradually modified in its lower portion. The distinct root structure tends to disappear, and with the darker color the entire mass becomes more compact and resembles muck rather than peat. The proportionate amount of carbon and ash are both increased, while the proportion of organic matter is diminished.[7]

The development of the salt marsh vegetation was studied in a number of places. When the mud flats rise above the surface at any stage of tide plants begin to invade them. Such a bar, uncovered in the Shrewsbury River five or six years ago, according to a fisherman who lived in the neighborhood, is now covered by a dense growth of *Spartina stricta maritima*, a grass which has large root-stocks that extend deep into the mud. At the end of each year the tops of this wiry grass die, and new shoots come up the next Spring; mud and other materials are held at the base of the stems until the surface is gradually built up, when the first type of salt marsh passes into the second. Gradually other plants come in that have a root system adapted to growth under the conditions provided by mud covered and uncovered alternately by tidal flow, until the zonal arrangement of plants which

[7] Smith, John B.: The New Jersey Salt Marsh and its Improvement, *Bulletin 207, New Jersey Agricultural Experiment Station, 1907*. In one marsh the writer found the marsh soil above a gravel bed measured 82 cm. (= 32½ inches), and in a subsequent paper he will describe the appearance and constitution of each soil stratum.

characterizes the long established marshes arises. This stage of development seems to mark the culmination of the salt marsh vegetation. If the marsh rises above the level where the typic salt marsh plants can grow, a different kind of drainage of the marsh is established and the salt marsh plants are replaced by others. The decay of the remains of the salt marsh plants produces holes here and there over the surface of the marsh, which, in the parlance of the sea coast farmer, becomes "rotten."

The composition of the salt marsh vegetation of the northern New Jersey coast can be illustrated best by a study of several typic kinds of marshes as they occur from Sandy Hook Bay south to Manasquan Inlet. The description and the sketches which accompany them will illustrate the similarities, as well as the differences, induced by a difference in the edaphic factors of the several localities.[8]

The salt marshes at Water Witch Park, a resort on the north slopes of the Navesink Highlands, along Sandy Hook Bay, along the channel edge of Plum Island, along the east front of the Highlands, a marsh island in the Navesink River, at Navesink Beach and at Normandie consist of *Spartina stricta maritima* (sp. gr. 1.017–1.0185) where a muddy bottom is found, but it disappears where sand and gravel form the river bottom. Associated with this salt grass in front of the Navesink Highlands are found *Spartina polystachya*, together with *Atriplex hastata* and *Tissa marina*. At Navesink Beach is a low mud island formed five or six years ago, but now completely covered with *Spartina stricta maritima*. The second inner strip consists of the low salt grass *Spartina patens*, together with patches of *Salicornia herbacea*, as at Water Witch Park, *Scirpus pungens* at Navesink Highlands, with a few specimens of *Solidago sempervirens* and *Salicornia herbacea*. On the marsh island in the Navesink River, *Spartina patens* is associated with *Distichlis spicata*, covering nearly half an acre of the island, between which and the outer fringe of salt grass occur in mixed growth (sp. gr. 1.0180) *Limonium carolinianum*, *Spartina patens*, *Plantago maritima*,

[8] The edaphic conditions were determined during the summer of 1909 by means of a specific gravity hydrometer with a scale reading from 0.995 to 1.065, good to four decimal places by a secondary subdivision of the scale. An attached thermometer allowed readings to be made from −15° to +45° Centigrade. By means of this hydrometer the character of the submerging water, or water from holes dug in the marsh soil, which influenced the roots or bases of each marsh species, was determined. The results are given in specific gravities. Absolutely pure water (distilled) reads 1.0000 on the scale, and sea water taken from the surf at Belmar at 21.1° C. reads 1.0215, so that the figures from the different marsh habitats approach closely the first figure if the water is fresh or the second figure if more or less saline. The specific gravities, as far as possible, are given in parentheses, leaving the detailed results for a subsequent paper.

Salicornia mucronata, *S. herbacea*, *Aster subulatus*, *Tissa marina*, *Suæda linearis* and *Chenopodium rubrum*. At Navesink Beach *Salsola kali* has invaded this strip of *Spartina patens*, and at Normandie *Atriplex hastata* and *Suæda linearis* (= *Dondia americana*) form almost pure associations, while at this place, between the low dunes and the last mentioned marsh strip, are found associations of *Lathyrus maritimus*, mixed with *Solidago sempervirens* and *Œnothera biennis*.

The third inner strip of salt marsh at Water Witch Park is composed of an association of *Scirpus pungens*, *Gerardia maritima*, *Pluchea camphorata* and *Cyperus erythrorhizos*, while the fourth strip of vegetation is characterized by tall-growing herbs and shrubs, viz., *Scirpus pungens*, *Panicum virgatum*, *Polygonum sagittatum*, *Hibiscus moscheutos*, *Eupatorium perfoliatum*, *Solidago sempervirens* and *Baccharis halimifolia*, some which suggest proximity of fresh water conditions.

The salt marsh along the upper portion of Wreck Pond shows a modification of the outer fringing strip of *Spartina stricta maritima*. Along the north shore of the Pond edaphic conditions control the distribution of plants, for the fringing growth of *Spartina stricta maritima* (sp. gr. 1.014) is not continuous, but is more or less interrupted by tongues of *Spartina patens*, while in two places *Scirpus pungens* in two isolated associations is the character plant which touches the channel currents. Back of the tall salt grass is found an almost continuous strip of *Spartina patens*, in some places mixed with *Scirpus pungens* and *Panicum virgatum*. From the distribution of the plants and the direction of the shore lines, it would seem that the ocean currents are deflected against the north shore, where the salt marsh conditions are more typically found, while the fresh water of the river flows seaward along the south shore. This, however, is not the determining factor in the replacement of *Spartina stricta maritima* along the south shore by *Spartina patens*, for the north shore has a muddy bottom and the south shore a gravelly one.

Plum Island Salt Marsh (Fig. 1).

Plum Island is found lying between the southern end of Sandy Hook and the Highlands of Navesink.

It is irregular in shape and consists of low sandhills surrounded by salt marsh, as indicated in Fig. 1, which also indicates the areas of marsh covered by this survey (I, II, III). Considering the composition of the salt marsh at the locality marked I on the sketch map of Plum Island, we find the outer strip (sp. gr. 1.016) (Fig. 2) composed of a pure growth of *Spartina stricta maritima* (X), which is succeeded by a pure growth (sp. gr. 1.0155) of *Baccharis halimifolia* (θ), which wedges in between the outer strip and the third strip of *Spartina patens* (V), which in most places usually succeeds the outer one of the taller salt grass. Along the inner edge of the clumps of *Baccharis halimi-*

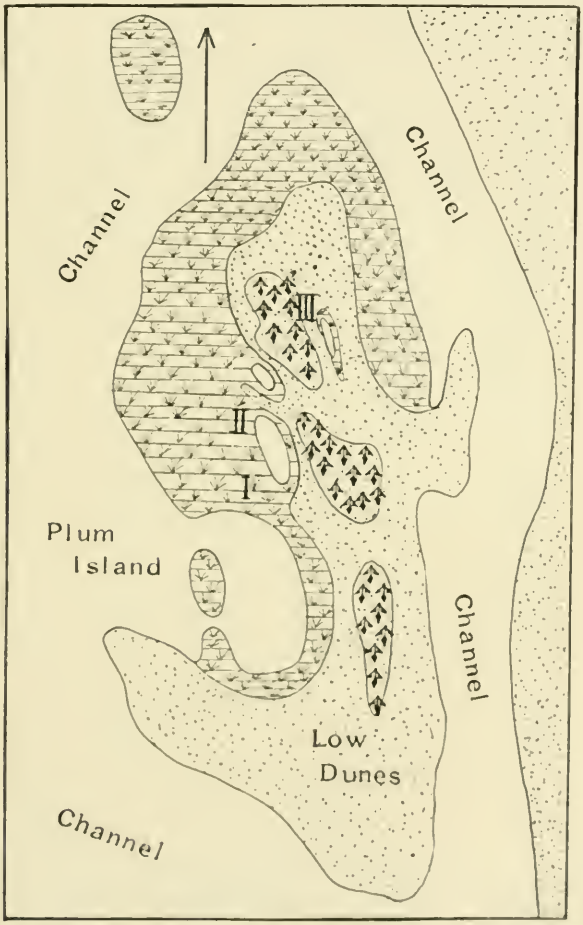


Fig. 1.—Plum Island in Sandy Hook Bay. Dotted areas represent sandy; ↑, thickets and trees; ⚶, salt marsh; numerals indicate areas treated of in this paper.

folia (θ) occur pure associations of *Suæda linearis* (S) and *Salicornia herbacea* (⊨), as indicated in the sketch.

Sand Dune Formation.—Low sandy stretches back of the marsh are covered with typic dune plants, including the marram grass, *Ammo-*

phila arenaria (A), *Cakile edentula* (= *C. americana*), *Myrica carolinensis*, and an extensive clump of *Prunus maritima* (P), with an occasional cedar, *Juniperus virginiana* (JV). In places *Myrica carolinensis* and *Hudsonia tomentosa* cover extensive tracts in pure association, together with *Lechea maritima*.

Thicket Formation (↑ ↑).—The thickets on the more elevated sandy parts of this island consist of *Juniperus virginiana* (JV), *Prunus maritima* (P), *Myrica carolinensis*, *Baccharis halimifolia*,

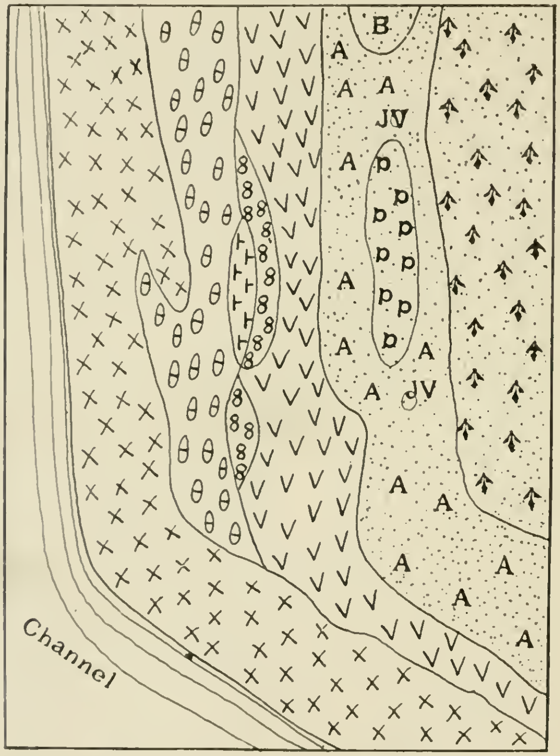


Fig. 2.—Portion of Plum Island Salt Marsh marked I in Fig. 1. X, *Spartina stricta maritima;* θ, *Baccharis halimifolia;* ⊢, *Salicornia herbacea;* 8, *Suæda linearis;* V, *Spartina juncea;* dotted area = sand; A, *Ammophila arenaria;* ↑, thicket and forest growth.

together with the poison ivy, *Rhus radicans*, while the prickly pear cactus, *Opuntia vulgaris*, is abundant in the sandy stretches between the trees.

Plum Island is characterized by a number of salt lagoons. The vegetation surrounding these lagoons was studied at two places (II and III), as indicated in the sketch. The open water (sp. gr. 1.016) of the first lagoon (II) is completely surrounded by a circumarea (sp. gr. 1.016) of *Spartina stricta maritima* (X), in the midst of which arises an association of *Spartina polystachya* ($). This circumarea is in turn surrounded by a continuous one (sp. gr. 1.018) of *Baccharis halimifolia* (θ), in front of which in two small associations (sp. gr. 1.020) occur *Spartina patens* (V), together with *Salicornia herbacea*

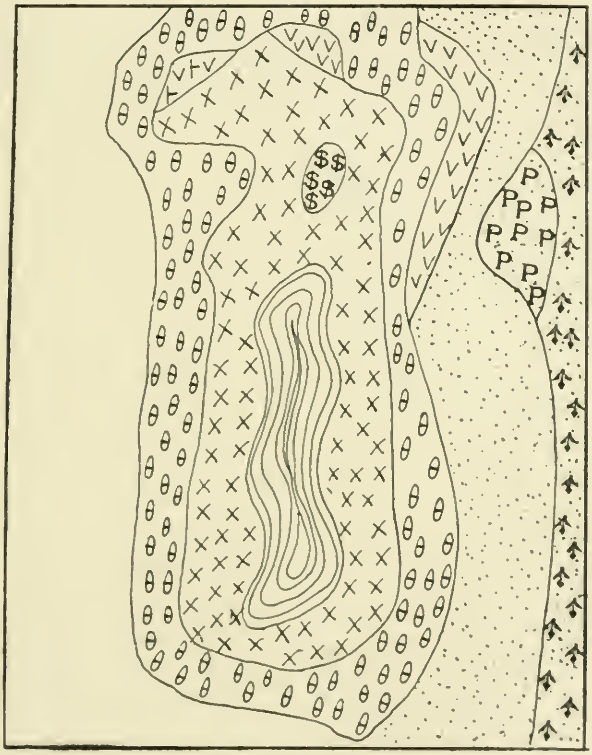


Fig. 3. Survey of Salt Marsh on Plum Island, Sandy Hook Bay, marked II on the Sketch Map of the island. X, *Spartina stricta maritima;* $, *Spartina polystachya;* θ, *Baccharis halimifolia;* dotted area = sand; V, *Spartina patens;* ⊢, *Salicornia herbacea;* P, *Prunus maritima;* A, *Ammophila arenaria;* ↑, thicket of trees.

(⊢). In one corner of the marsh (sp. gr. 1.0185), just back of the *Baccharis halimifolia* (θ), is found an extensive association of *Spartina patens* (V), which touches the sandy slopes covered with *Ammophila arenaria* (A) and *Solidago sempervirens*. This dune strip merges into the thicket formation previously described, where *Prunus maritima* (P) occupies the outer edge of tree growth (see Fig. 3).

The second lagoon studied is a much smaller one, and is located on the map (Fig. 1) at the place marked III. As with the other lagoon, it is completely surrounded by a circumarea of *Spartina stricta maritima* (X), and it is fringed on one side by a broad strip of *Spartina patens* (V). Touching the tall salt grass on the other side (sp. gr. 1.003) are found *Salicornia herbacea* (⊢) and *Limonium carolinianum* (Δ), *Atriplex hastata* and *Suæda linearis,* while here and there occur clumps

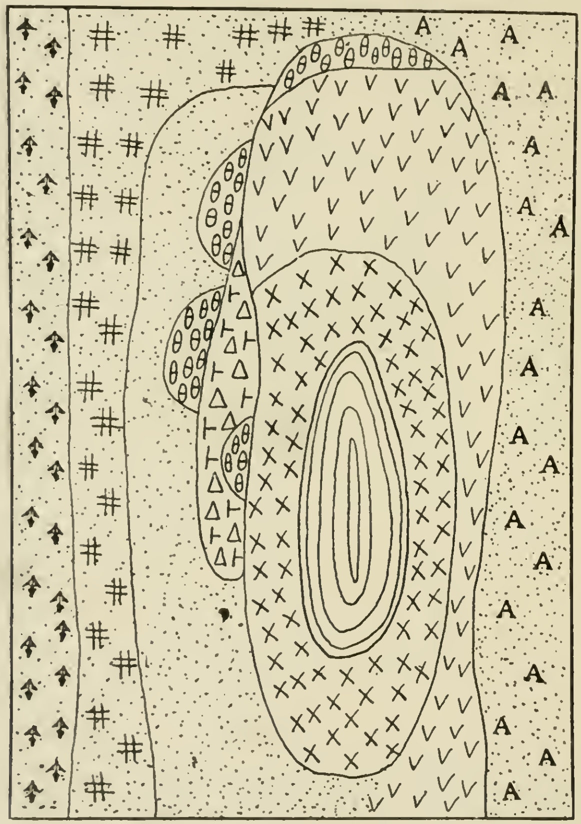


Fig 4.—Survey of Salt Marsh on Plum Island, Sandy Hook Bay, marked III in Fig. 1. X, *Spartina stricta maritima;* V, *Spartina patens;* ⊢, *Salicornia herbacea;* Δ, *Limonium carolinianum;* θ, *Baccharis halimifolia;* ✱, *Solidago sempervirens;* A, *Ammophila arenaria;* ↑, tree thicket.

of *Baccharis halimifolia* (θ), at least four such having been seen in the immediate neighborhood of this lagoon. This lagoon basin is surrounded by low sandy slopes, barren on one side, but covered with

Ammophila arenaria (A) and *Solidago sempervirens* on the other, while a thicket where *Rhus radicans* is prominent occurs on the higher sand slopes (Fig. 4). The water of this lagoon, although it is near the center of the island, remains salt, because at high tides it is replenished by the entrance of sea water, which enters through a valley-like depression running diagonally across the island.

Salt Marshes along Shark River.

Shark River (Fig. 5) rises inland about seven miles from the coast. The inner line of its watershed is marked approximately by the New Jersey Southern Railroad, running between Farmingdale and Pine Brook near Eatontown. It runs seaward in two main branches, forking from each other close to Shark River Bay. The southern branch rises in elevated country (100–164 feet contour) near Shark River Station on the New Jersey Southern Railroad. The northern branch rises near Centerville, and flows approximately southeast to join the other branch before they enter Shark River Bay, which is fresh at its head, but gradually becomes more salt near its narrow outlet to the sea, more or less surrounded by salt marshes or salt marsh islands (Fig. 5). The bay is about two miles long from east to west. The outlet is marked by the line of the New York & Long Branch Railroad, which crosses by a trestle bridge. Below the trestle the river channel is scoured by the rapidly moving inflowing and outflowing tides, and its banks are lined with salt marshes now to be described. The close proximity of these marshes to Belmar enabled me to visit them frequently on foot and in a boat, and to construct a map which represents the distribution of the salt marsh plants (Fig. 5).

The salt marsh vegetation of the south shore of the river, between the ocean and the trolley bridge, will be described in detail first. The river channel (sp. gr. 1.0212) is fringed by *Spartina stricta maritima* (X) where the muddy shore is submerged at high tide (sp. gr. 1.0140). This grass also fringes the marsh island, which was originally formed by tidal action. Near the ocean front *Spartina patens* (V) forms a strip which is barely touched by salt water at high tide, while in different association and on the same level is found *Scirpus pungens* (Z) associated with *Limonium carolinianum* (△). These plants are backed by low dunes covered with *Triodia cuprea*, *Ammophila arenaria*, *Strophostyles helvola*, *Lathyrus maritimus*, *Euphorbia polygonifolia*, *Cakile edentula*, *Cassia nictitans*, *Ampelopsis quinquefolia*, *Solidago sempervirens*, *Trifolium repens*, *T. hybridum* and *Xanthium echinatum*. In the bend of the river between B Street and D Street, Belmar, the salt marsh forms a V-shaped cusp; the sides and apex of this projecting marsh are fringed with *Spartina stricta maritima* (X). Enclosed by this grass, as shown in Fig. 5, are found pure associations as follows: 1, *Spartina patens* (V), *Salicornia herbacea* (⊢) and *Limonium caro-*

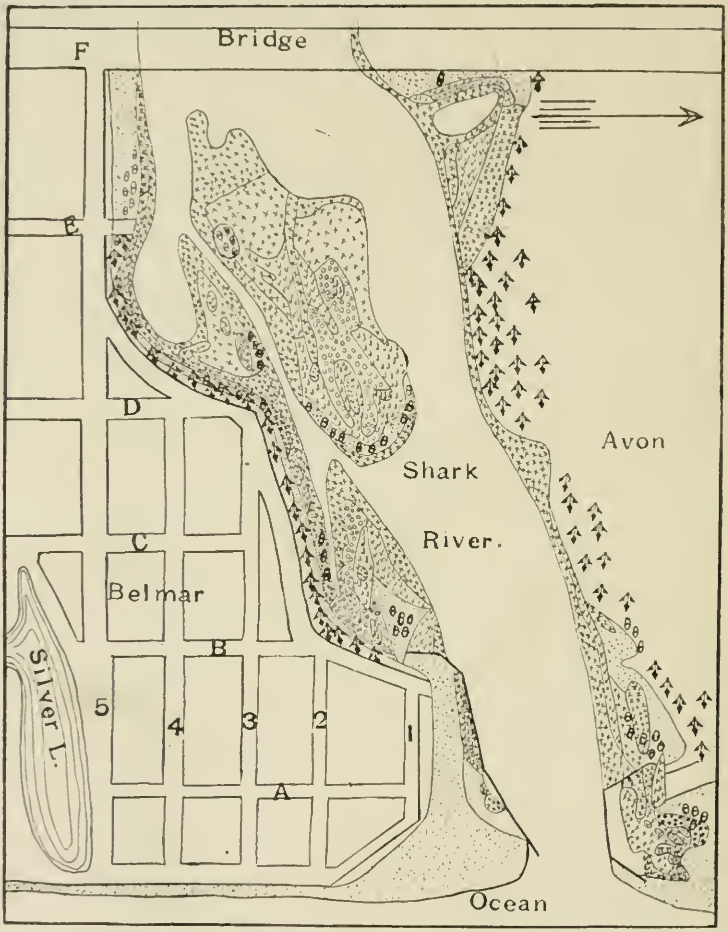


Fig. 5.—Salt Marshes along Shark River. X, *Spartina stricta maritima;* V, *Spartina patens;* Z, *Scirpus pungens;* O, *Distichlis spicata;* θ, *Baccharis halimifolia;* J, *Juncus Gerardi;* ·, *Phragmites communis;* ⊢, *Salicornia herbacea;* II, *Gerardia purpurea;* dotted areas = sand with typic dune plants; ↑, tree thickets.

linianum in the low ground partially submerged at high tide; 2, *Distichlis spicata* (O), *Salicornia herbacea* (⊢), and *Limonium carolinianum* in similar soil situations as the first associations and extending around the head of a slough at this point of the shore; 3, *Juncus Gerardi* (J), one patch of which surrounded a low dune covered with *Panicum virgatum*. A high dune spit projecting into the marsh was covered by *Panicum virgatum*, *Xanthium echinatum*, *Œnothera biennis* and *Ammophila arenaria*.

The straight portion of the main shore, between this V-shaped marsh on the one hand and the marsh island on the other, is occupied by a narrow salt marsh, the vegetation of which consists of a frontal strip of *Scirpus pungens* (Z), out of which grow *Baccharis halimifolia* (θ) and *Hibiscus moscheutos*. This strip is continued by two pure associations of *Spartina patens* (V) (sp. gr. 1.0069) and *Scirpus pungens* (Z) respectively. A second shoreward marsh strip is occupied by fresh water marsh plants, such as *Impatiens fulva* (= *I. biflora*), *Sambucus canadensis* and *Polygonum sagittatum*, while the drier portions of this strip are characterized by *Panicum virgatum*. The second short offset between D and E Streets, Belmar, is noted for a projecting tongue of low marshland completely surrounded by a growth of *Spartina stricta maritima* (X) in full flower (August), while surrounded by the taller salt marsh grass is a lower flowerless growth of *Spartina stricta maritima* (X), with two associations of *Distichlis spicata* (O) and one of *Spartina patens* (V). Immediately back of this marsh tongue are found several strips of vegetation. In front is an irregular association of *Spartina patens* (X) in soil merely wetted by the rising tide, but seldom entirely submerged. Inside of this is a narrow association of *Scirpus pungens* (Z), succeeded in the drier shore soil by *Baccharis halimifolia* (θ) and *Hibiscus moscheutos* (sp. gr. 1.0000), while in places in this strip occur fresh-water swamp plants, such as *Cicuta maculata*, *Peltandra virginica*, *Scirpus robustus* and *Impatiens fulva* (= *I. biflora*). Situated between the outer strip of *Spartina stricta maritima* (X) and the inner fresh water marsh strip occur longitudinally disposed three alternating associations, viz.: two societies of *Scirpus pungens* (Z), between which is found an association of *Spartina patens* (V) and *Scirpus robustus*.

The gradual slopes of the shore above the marshland is covered with *Panicum virgatum*, *Rhus radicans*, *Xanthium echinatum*, *Baccharis halimifolia* (θ), over which clambers *Sicyos angulatus*.

Vegetation of the Marsh Island.

The marsh island in Shark River with a slough at its western end is completely surrounded by *Spartina stricta maritima* (X), except in two places where the shore is a little more elevated. At one place

Baccharis halimifolia (θ) and *Panicum virgatum* in dry sandy soil above tide action forms the border growth, while on the opposite side of the island in wetter soil is found the edge of an extensive association of *Juncus Gerardi* (J), which here touches the river channel. An extensive growth of *Spartina stricta maritima* (X) covers the western end of the island surrounding the slough marked on the map (Fig. 5). As this growth of salt grass is found in soil only covered at high tide in its development here, it is in marked contrast to its growth in the shore mud, which is never practically uncovered by tidal flow. Elsewhere in the center of the island occur associations of 1, *Distichlis spicata* (O) with *Limonium carolinianum* (△); 2, *Juncus Gerardi* (J); 3, *Spartina patens* (V), with and without *Iva imbricata*, while a small dune is covered with *Panicum virgatum* and *Solidago sempervirens*.

Vegetation of the North (Avon) Shore of Shark River.

Beginning at the beach front, where it covers a wide area of shore mud, and extending in a narrow strip to the trolley bridge, where it again widens, *Spartina stricta maritima* occurs as a border growth. Just back of the ocean dunes, this association surrounds several smaller ones of *Spartina patens* (V) alone, *Distichlis spicata* (O) alone, *Scirpus pungens* (Z) alone and *Phragmites communis* (·), which grows at the inner edge of the marshland proper, as do *Salicornia herbacea* (⊢) and *Limonium carolinianum*, while in a smaller growth of *Spartina stricta maritima* (X) back of the border strip grow *Scirpus robustus* and *Baccharis halimifolia* (θ). Lying between this strip and the sandy shore, where *Panicum virgatum* is the character plant, is an extensive association of *Scirpus pungens* (Z). As the shore bluff comes within a few feet of the water's edge for a considerable distance along the north shore of the river, the marshland narrows until only the fringing growth of *Spartina stricta maritima* occupies the shore line, with a narrow strip just back of it of *Spartina patens* (V), which as elsewhere grows in the soil rarely exposed to the full tidal action. In a triangular corner formed by the bluff as one side of the triangle, the trolley road and the river as the other two sides, the marsh widens with a lagoon in its center. The shore growth of *Spartina stricta maritima* (X) is continuous with the growth of the grass which surrounds the water of the lagoon (sp. gr. 1.0180). Forming conspicuous elements of the vegetation of this triangle, and here as elsewhere to be distinguished by the color of the plants, are several associations of marsh species. One of the largest associations in contact with the bluff is composed of *Scirpus pungens* (Z), surrounding *Iva imbricata* and *Hibiscus moscheutos* (sp. gr. 1.0000), while *Pluchea camphorata* mixes its growth with the sedge, as does *Juncus Gerardi* (J), which surrounds a low sand dune covered with *Panicum virgatum*. In three isolated areas is found an association of *Spartina patens* (V), while back of *Spartina stricta maritima* (X) on the roadside of the lagoon occurs an association of *Juncus Gerardi* (J), at one end of which *Limonium carolinianum* enters the association. At the head of the lagoon, at the inner edge of the marsh soil, *Cyperus erythrorhizos* and *Polygonum ramosissimum*, which indicate beginning fresh water conditions, have established themselves. Outside of the influence of the salt water, where the inner edge of the salt marsh (sp. gr. 1.0000) owes its wetness to rains and fresh water springs, just in front of the river bluff occur plants of fresh water swamps, such as the shrubs *Alnus serrulata*, *Pyrus arbutifolia*, *Clethra alnifolia* and the herbs *Vernonia noveboracensis*, *Eupatorium purpureum*, *Polygonum sagittatum*, *Osmunda cinnamomea*, *Sagittaria variabilis*, *Cicuta maculata* and *Lobelia cardinalis*.

Transition to Fresh Water Ponds.

Upper Wreck Pond.—We have seen that the appearance of *Spartina patens* indicates that the soil is only periodically flooded with salt water. Above the carriage road, where the forest approaches the water's edge, *Spartina stricta maritima* gradually thins out, and its place as a border plant is taken by *Scirpus pungens* (sp. gr. 1.000), *Scirpus lacustris* and *Spartina polystachya*. But the persistence of this grass here, where the fresh water conditions are becoming pronounced, is perhaps explainable by the fact that the periodic entrance of salt water prevents the replacement of this grass entirely by typic fresh water vegetation, which is unable to survive a short exposure to salt water; while *Spartina stricta maritima* not only withstands salt water, but actually thrives in it, and also adapts itself to growth in water which varies its salinity within wide limits, becoming almost fresh when the inland rains are especially heavy or when the inlets of the streams are closed by sand bars during severe storms, as during the summer of 1909. During this summer the outlet of Wreck Pond was closed to the sea until, as indicated by the hydrometer, the water became entirely fresh, and yet *Spartina stricta maritima* and *Spartina patens* persisted in their usual habitats flowering as usual, even when partially submerged by the overflow of fresh water during heavy summer rains.[9] However, before we reach the place where this change

[9] This matter, as indicated by the sp. gr. hydrometer, will appear in a later paper, but it should be emphasized here that salt water plants stand submergence in fresh water much better than fresh water plants in salt water.

occurs, the following marsh strips may be recognized, beginning with the outer one, which consists of *Spartina stricta maritima* (sp. gr. 1.003). Then comes a strip of *Spartina patens* and a middle one of *Panicum virgatum*, filled in between with *Spartina patens* and *S. polystachya*. In the shoreward strip at the edge of the woods, where the salt marsh vegetation merges with the fresh water vegetation (sp. gr. 1.000), occur clumps of *Cicuta maculata, Iris versicolor, Hibiscus moscheutos, Polygonum sagittatum, P. pennsylvanicum, P. arifolium, Eryngium virginianum, Ptilimnium capillaceum, Hydrocotyle umbellata, Lobelia cardinalis, Convolvulus sepium* and *Impatiens fulva* (visited by humming birds). The third strip may be considered to be the tension one, where there is a gradual blending of the salt water and fresh water vegetation. As one ascends the stream the salt marsh plants dwindle, until not a trace of them is left and the marsh becomes entirely a fresh water marsh, covered with plants which lower down merely fringed the inner margin of the salt marsh.

Sylvan Lake is the receptacle for the fresh water of a small stream which rises in two forks in Mt. Prospect Cemetery, west of Ocean Grove (80 feet contour). These two branches unite in a small pond at Ocean Grove Heights, and the main stream flows seaward a distance of a mile, until it enters Sylvan Lake (Duck Pond of the survey map), which is about three-quarters of a mile long. As Sylvan Lake is shut off from the ocean by a low sand bar, with a timbered sluiceway still connecting it with the sea during high tides, it is sometimes supplied with salt water, which enters the pond by means of the usually dry sluiceway, which has been left as a means of keeping the water level of the lake within certain limits. We can divide the vegetation of the lake basin into two main divisions: (1) The vegetation uninfluenced or rarely influenced by salt water, and growing in the western part of the pond where the water is kept fresh by the stream which enters at this end, and (2) the vegetation influenced more or less directly by the sea water, when it enters by the sluice during exceptionally high tides, which may rise high enough to enter the pond only three or four times each year, and in the winter time, when the vegetation in the pond, and surrounding it, being in its winter state, would be very little injured by an overflow of salt water. Consequently the water of most of the pond, especially near the landward end, is fresh, while near the seaward end it is usually fresh, but brackish only after the sea water has entered the pond during some high side, enabling a few salt marsh species to persist, although generally subjected to fresh water conditions (see note 9).

One, therefore, notices the entire absence of such typic salt plants as *Spartina stricta maritima*, *Distichlis spicata*, *Salicornia herbacea*, *S. mucronata*, *Limonium carolinianum* and *Suæda linearis*, while the remnant of this true salt marsh vegetation left at the margin of the pond, owing to the occasional entrance of salt water, consists of such plants as *Spartina patens* and *Juncus Gerardi*.

Vegetation in Proximity to the Ocean.

The low ground margining Sylvan Lake at its seaward end is occupied by *Scirpus pungens* at the water's edge, while back of it occur *Spartina patens*, *Hibiscus moscheutos* and *Juncus Gerardi*, together with *Elodes virginica* and *Juncus canadensis*. The tall reed grass *Phragmites communis* forms a pure association at this level, as does also *Cladium mariscoides* mixed with *Solidago sempervirens*. The cattail, *Typha angustifolia*, is found in small cove-like indentations of the shore, while *Nymphæa odorata* with *Panicum crus-galli* occur in small sloughs found here and there along the outer shore line. The low sand levels above the marsh are covered with *Myrica carolinensis*, in association with *Panicum virgatum*, *Baccharis halimifolia*, *Strophostyles helvola*, *Baptisia tinctoria*, *Vaccinium atrococcum*, *Ilex glabra* and *Prunus maritima*, extending back to the edge of the woods behind what was formerly, before grading operations altered the original conditions, the dune complex of my earlier papers. The following plants, *Vaccinium atrococcum*, *Ilex glabra* and *Baptisia tinctoria*, which enter the dune formation, may be considered to be elements which have invaded the formation from an inland pine barren source of supply.

Vegetation Controlled by Fresh Water.

Early in my study of the flora of Sylvan Lake my attention was directed to the north shore, because the south shore of the lake had been altered too much by the encroachment of the building line of Avon-by-the-Sea. Only a few patches of the original vegetation was left, and so much altered as not worth a detailed study. Three strips of vegetation can be recognized along the northern shore of the lake, and in the description of them which follows the plants will be mentioned in the order in which they were collected in walking from the western end to the eastern end. This plan is pursued because it was found impossible to recognize associations of the species, because they were so mixed together, especially in the second strip, as not to be separable into distinct groups.

The lake is almost choked with a green alga, *Cladophora flavescens*, which has invaded the water lily associations and threatens to exterminate them. Not only that, but the lake for boating purposes has been ruined by the floating masses of *Cladophora* which at times of low water form mats of algal felt, and unless copper sulphate is used to destroy this plant the lake will be converted gradually into a fresh water marsh.

The water's edge is margined generally by *Panicum crus-galli* and *Scirpus pungens*, with which in close association were found, but in varying abundance, *Panicum virgatum*, *Scirpus pungens*, *Typha angustifolia* and *Nymphæa odorata*, which formed in most places the outward edge of this strip, growing in the shallow water in several places and extending its growth out over the surface of the lake.

The only plant of the second strip which may be said to grow in pure association is *Cladium mariscoides*, which forms back of *Panicum crus-galli* of the first strip a growth in some places 100 feet long, extending back to drier soil. Associated with this sedge grow *Polygala cruciata* and *Sabbatia angularis*. The second strip, however, is characterized by the presence of *Gerardia purpurea*, *Rhexia virginica*, *Drosera linearis*, *D. filiformis*, *Fuirena squarrosa hispida*, *Panicum virgatum*, *Polygonum sagittatum*, *Hibiscus moscheutos* and *Lobelia spicata*. In a few wet places sphagnum occurs, and here grow *Vaccinium macrocarpon* and *Drosera filiformis*.

Fresh Water Pond Formations.

When the sand bar formed across the end of an inlet has become permanent, the lake formed back of it gradually becomes converted into a basin holding nothing but fresh water (instance Wreck Pond in 1909, with salt marsh species), and the vegetation becomes eventually that found in fresh water ponds and along their margin. Three such fresh water lakes were studied carefully on the northern New Jersey coast, viz.: Como Lake, a small uncharted pond back of Como Lake and formerly part of it, and Silver Lake. Incidentally in this survey Bradley Lake and Wesley Lake at Ocean Grove and Sunset Lake in Asbury Park were visited, but it was found that the banks of these lakes were sodded with cultivated grasses and planted with shrubs for ornamental purposes, so that these lakes, although formed in a similar manner to the ones studied, are omitted from further consideration.

Silver Lake.—Silver Lake is situated in the borough of Belmar and is entirely surrounded by summer cottages (Fig. 5). It is less than half a mile long, and its banks have been sodded, the undergrowth has been removed and the tree vegetation, notably *Pinus rigida*, has been left, giving a park-like aspect to the surroundings. The authorities periodically clear the lake of all vegetation, in order to provide for the water carnivals which are held some time during the summer months. But yet the vegetation grows almost as rapidly as it is removed, and constant vigilance must be exercised to prevent the filling of the shallow lake basin. The most persistent of these plants is *Potamogeton perfoliatus*, which forms extensive associations here and there in the quieter portions of the lake. Another persistent plant is *Elodea* (*Philotria*) *canadensis*, which grows so fast as to choke portions of the lake. Upon this aquatic plant grow epiphytically, according to a study of microscopic material collected in the summer of 1908, a blue-green alga, *Mastigonema sejunctum*, which lives in tufts or soft mosses on the leaves of *Elodea*, as also a diatom, *Gomphonema constrictum*. The filaments of *Mastigonema* are rather rigid, straight and spuriously branched, and their apex is delicately hair-like, while heterocysts are found at the base of each of the branches. The diatom, *Gomphonema constrictum*, has wedge-shaped frustules in the girdle-view, and in the specimens studied they were attached by their inferior smaller extremities to a system of hyaline threads that form bound together a stalk, which attaches them to the *Elodea* leaf. The fresh water plankton of this lake was found to consist in September, 1908, of *Spirogyra crassa* (which lives over the winter), *Anabæna flos-aquæ* var. *circinalis* and *Scenedesmus obliquus*. The water silk, *Spirogyra crassa*, formed floating masses near the shore (found by me also in April, 1909), while *Anabæna flos-aquæ* var. *circinalis* about the end of August was in such abundance as to suggest "the flowering of the mere." Its beaded filaments formed most beautiful coils or spirals.

Como Lake.—Como Lake will be treated in a few years like those at Asbury Park and Ocean Grove, as the building of summer houses is fast approaching it, so that these observations will preserve to botanic posterity the only statement as to the original flora which surrounded it. Following the south shore first, we can recognize four strips of plants, viz.: (1) the water strip; (2) the wet ground strip; (3) the dry ground strip; (4) the forest strip. The first two strips are practically the same, because the vegetation of the wet soil encroaches upon the water surface. The west shore is somewhat gravelly and sandy, and here I found, beginning at the western end of the pond and walking eastward, the following characteristic plants: *Agrostis hyemalis* (= *A. scabra*), *Polygonum sagittatum*, *P. acre*, *Cyperus erythrorhizos* (abundant). *Panicum crus-galli* (occasional). *Scirpus pungens*. Then at the eastern end. I noted in the water strip *Juncus canadensis*, *J. debilis*, *Cyperus dentatus* var. *ctenostachys*, *C. erythrorhizos*, *Scirpus pungens*, *Polygonum* sp., *Panicum crus-galli*. On a small rounded bar in the lake near the ocean grew in the summer of 1908 *Panicum crus-galli*, *Polygonum acre*, *Cyperus erythrorhizos*, *C. Nuttallii*. Where a small spring enters the lake, I found *Nasturtium officinale*, *Polygonum acre* and *Spirogyra* sp.

The third strip on the south side of the lake consists of plants which occupy low sandy slopes. Such are *Myrica carolinensis*, *Solidago sempervirens*, *Panicum virgatum*, *Strophostyles helvola*, *Rhus copallina*, *Baptisia tinctoria*, *Cyperus dentatus* (proliferated sedge), according to my notes.

The seaward end of the north shore has been graded. Beginning at the edge of the improvements(?) and walking westward along the shore, the following strips of vegetation were recognized and studied: (1) the marsh strip at the edge of the water; (2) the dry sandy strip; (3) the forest strip. The marsh strip, proceeding westward, is characterized by *Scirpus pungens*, *Polygonum acre*, *Cyperus erythrorhizos*, *Polygonum sagittatum*, *Gerardia purpurea*, *Ptilimnium capillaceum*, *Panicum crus-galli* (nearly always at the water's edge). A small stream which enters between the pine woods showed in its expanded portion the white water lily, *Nymphæa odorata*, and at the edge *Panicum crus-galli*, *Polygonum sagittatum* and *P. acre*. Passing a sharp bend of the shore the marsh vegetation increases in density with the association of *Scirpus pungens*, *Gerardia purpurea*, *Polygonum acre*, *P. sagittatum*, *Ptilimnium capillaceum*, *Hypericum canadensis*, *Bidens frondosa*, *Hibiscus moscheutos*, *Scirpus cyperinus*, *Panicum crus-galli*. The bur reed, *Sparganium euycarpum*, forms a small association at the western end of the lake, while in front of the trolley embankment, in water six inches deep, was found an association of *Panicum crus-galli*, *Cyperus erythrorhizos* and *Glyceria obtusa*. Here the marsh expands into a triangular area, where I collected *Polygonum sagittatum*, *P. acre*, *Cladium mariscoides*, *Scirpus pungens* (abundant), *Eryngium virginianum*, *Solidago tenuifolia*, *Panicum virgatum*, *Gerardia purpurea*, *Ptilimnium capillaceum*, *Iris versicolor*, while in another portion of the marsh, alternating with the dry ground, grew *Alnus serrulata*, *Aspidium thelypteris*, *Cladium mariscoides*, *Aster subulatus* and *Hibiscus moscheutos*.

The second strip, or that of the treeless dry ground, is characterized by its extensive clumps of *Panicum virgatum*, with which grows *Polygala cruciata*.

Separated from Como Lake by a carriage road, and situated in the angle which this road forms with the main or trolley road, is a small triangular pond of fresh water, completely covered with a small-flowered variety of the white water lily, *Nymphæa odorata*, with the margin of the pond fringed with a circumarea of *Panicum crus-galli*. Como Lake proper has relatively no growth of water lilies, except as previously noted in a small embayment of the shore, where a small stream enters from the pine woods, and yet in the pond, cut off from the main lake by the construction of the carriage road, it is the dominant and exclusive plant.

Fresh Water Swamp Formation.

Como Swamp.—West of the trolley road is a swamp (Fig. 6) which occupies the area covered formerly by a western extension of Lake Como, but cut off from it by the construction of the wagon road. As this swamp is fed by a small stream about three-eighths of a mile long, there is a partially open channel running through the middle of it, and a small fresh water lagoon has been formed at one side by a choking of the former lake basin with vegetation. This extremely wet swamp illustrates the last stage in the conversion of a salt water pond with its salt marsh vegetation, first into a brackish pond with the suppression of most salt water plants (Sylvan Lake stage) and then into a fresh water lake with its characteristic vegetation (Como Lake stage), and finally the invasion of the shallow lake with vegetation peculiar to fresh water swamps (Como Swamp stage, Fig. 6).

The channel (ditch) is blocked in its lower portion by sedges and grasses, in the midst of which we find an association of *Potamogeton* sp. (♦), *Polygonum acre* (˙) and *Scirpus pungens* (+) surrounding a smaller association of *Sparganium eurycarpum* (= Fig. 6). On the north side of the ditch we find an association of *Leersia oryzoides* (±), *Panicum crus-galli* (|) and a few scattered clumps of *Typha angustifolia* (∓). A triangular-shaped association comprises *Nymphæa* (*Castalia*) *odorata* (⊙), *Scirpus pungens* (+), *Panicum crus-galli* (|), with a few scattered specimens of *Scirpus lacustris* (⊕), and the arrangement of the plants suggests that the water lilies represent the original facies which has been invaded by other specis. The cranberry, *Vaccinium macrocarpon* (M), forms a pure association at the edge of the marsh, while nearby *Juncus canadensis* (¨), *Polygonum acre* (·), *P. sagittatum* (↑), *Nymphæa odorata* (⊙) are in association (see Fig. 6). Along the north edge of Como Swamp two other associations are found, one consisting of the admixture of *Scirpus pungens* (+), *Poly-*

gonum acre (•), *P. sagittatum* (↑), *Xyris caroliniana* (✻), *Eryngium virginianum* (E), *Sabbatia angularis* (A), while the other association comprises *Scirpus pungens* (+), *Rhynchospora glomerata* (†), *Polygonum acre* (•), *Ptilimnium capillaceum* (φ), *Juncus canadensis* (♂). The swamp on the south side of the ditch is more extensive, surrounding a central lagoon with water lilies (⊙). Here also are found pure associations of *Typha angustifolia* (♀), *Rhynchospora glomerata* (†),

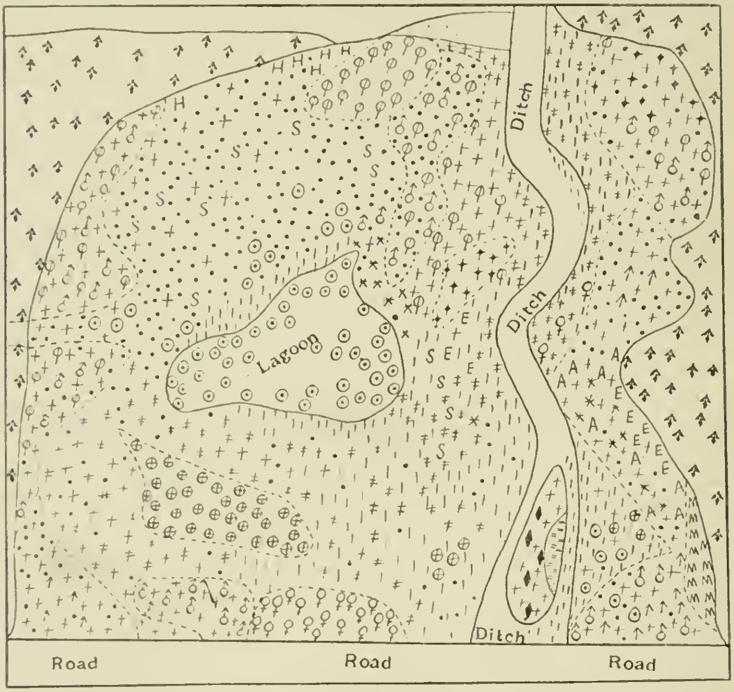


Fig. 6.—Survey of Como Fresh Water Swamp. ↑, thicket; ⊙, *Nymphæa odorata;* ♀, *Typha angustifolia;* ♦, *Potamogeton* sp.; |, *Panicum crus-galli;* =, *Sparganium eurycarpum;* ±, *Leersia oryzoides;* ↑, *Polygonum sagittatum;* +, *Scirpus pungens;* ⊕, *Scirpus lacustris;* E, *Eryngium virginianum;* ✻, *Xyris caroliniana;* S, *Solidago tenuifolia;* M, *Vaccinium macrocarpon;* ♂, *Juncus canadensis;* †, *Rhynchospora glomerata;* A, *Sabbatia angularis;* •, *Polygonum acre;* φ, *Ptilimnium capillaceum.*

Scirpus lacustris (⊕), *Ptilimnium capillaceum* (φ) and several mixed associations of species, as illustrated in Fig. 6. The largest association is west of the lagoon; here occur *Polygonum acre* (•) associated with *Solidago tenuifolia* (S) and *Nymphæa odorata* (⊙). Another association is composed predominantly of *Juncus canadensis* (♂), another of *Scirpus pungens* (+), while *Panicum crus-galli* (|) and *Leersia oryzoides* (±) fill the interspaces between some of the aforementioned groups of species. *Hibiscus moscheutos* occurs sparingly along the edge of the swamp. *Bidens chrysanthemoides* appears abundantly in the Fall of the year.

Relation of Salt Marsh to Salt Water.

Sodium chloride in solution is known to have strong plasmolytic properties, removing water from living cells, when these are subjected to its action, and hence causing the protoplasm to contract away from the cell walls. Ordinary plants are soon killed when exposed to the action of salt or salt water, and yet we have a group of plants, the so-called halophytes, which possess great powers of resisting the action of sodium chloride in solutions as strong as sea water. The sea beach plants are excluded from consideration, because Kearney[10] has shown that the salt content of the shore sand is a negligible quantity, and that some cultivated soils contain a larger percentage of common salt than the beach sand, so that of the strand plants the salt marsh species are the only ones which belong to the halophytic class of plants. Schimper[11] has called attention to the fact that any considerable amount of salt in the cell sap is detrimental to the plant, and that this fact explains the probable cause of the characteristic halophytic modifications, which have to do with reducing the transpiration current, which accounts for the abundant absorption of water with various salts of the soil in solution. Warming, however, replied that the reduction of transpiration would cause the increase of the salts in the cell sap, and he suggested a theory, which is now the current one, viz., that the protective contrivances, such as hairs, sunken stomata, succulency, etc., against strong transpiration are necessary in halophytic plants, because absorption of water from a salt solution is slow and difficult.

In the absence of experimental data which will enable us to arrange the salt marsh plants of New Jersey into a series with reference to their greater or less power of resistance to salt water,[12] the following general

[10] Kearney, T. H.: Are Plants of Sea Beaches and Dunes True Halophytes? *The Botanical Gazette*, XXXVII: 424–436, June, 1904.

[11] Schimper, A. F. W.: Ueber Schutzmittel des Laubes gegen Transpiration, besonders in der Flora Java's. Sitzb. Acad. Berlin, 1890: 1045; Die indo-malayische Strandflora. Botan. Mittheil. aus den Tropen, 1^3 : 1–204.

[12] This was written in 1908. During the summer of 1909 the writer by means of a hydrometer (see previous note) made a detailed study of the various salt marsh plant habitats.

observations may be made. Evidently, as it is exposed along the channels which it fringes to the full effect of salt water (sp. gr. 1.0185), the salt grass *Spartina stricta maritima* is the best adapted of all the species studied to the halophytic conditions under which such plants grow. Second in order of resistance to the detrimental influence of saline solutions should be mentioned *Spartina patens, Salicornia herbacea, S. mucronata, Limonium carolinianum* (sp. gr. 1.018),[13] *Baccharis halimifolia, Distichlis spicata* and *Juncus Gerardi*. While to a third group of still less resistant halophytic plants, I would include *Typha angustifolia, Scirpus robustus, Gerardia purpurea, Solidago sempervirens* and *Atriplex hastata*. Such plants as *Hibiscus moscheutos, Cicuta maculata, Peltandra virginica, Panicum crus-galli* and *Sparganium eurycarpum*, mentioned in the foregoing account, are plants indicative of fresh water marsh conditions, and are not to be included among the true halophytes.

Without experimental data, which I will later supply in a detailed manner, with reference to the halophytism of all of the above-mentioned plants, the observations of Ganong[14] and Graves[15] have an important bearing upon our study of the distribution of the vegetation of the salt marshes of northern New Jersey. Ganong has found that the root hairs of *Salicornia herbacea* can endure a 100 per cent. sea water without plasmolysis; those of *Suæda maritima* 80 per cent.; those of *Plantago maritima* 70 per cent.; while those of *Atriplex patulum* withstood 50 per cent. sea water. Graves found that the root hairs of *Ruppia maritima* could stand a 105 per cent. sea water with occasionally very slight plasmolysis, while with 110 per cent. sea water it was rather slow, but finally distinct. He also used solutions of 2.5, 3 and 5 per cent. sodium chloride with the following results. In the 2.5 per cent. solution, the leaves of *Ruppia maritima* did not plasmolyze; in the 3 per cent. solution they plasmolyzed in 4–5 minutes; in 5 per cent. solution in about 1 minute. Ordinary ocean water contains about 3.5 per cent. of salts, and it would seem, therefore, on *à priori* grounds, that the water of New Haven harbor does not contain as much salts as the 3 per cent. quantity of sodium chloride in the above experiment. It shows, however, that the adaptation of halophytic plants is within a narrow limit of salinity, and if the salinity

[13] According to my hydrometer investigations, to be published later in detail, the sp. gr. of sea water is 1.0215 at 21.1° C.

[14] Ganong, W. F.: The Vegetation of the Bay of Fundy Salt and Diked Marshes, *Botanical Gazette*, XXXVI: 161–186, 280–302, 349–367, 429–455.

[15] Graves, Arthur H. The Morphology of *Ruppia maritima*, *Transactions of the Connecticut Academy of Arts and Sciences*, XIV: 59–170, December, 1908.

of the water varies within wider limits such plants are checked in their growth or completely exterminated. This was emphasized in our discussion of the salt marsh vegetation found in Upper Wreck Pond, and it accounts for the limitation of fresh water species when the water in which they grow reaches a certain degree of salinity.

The study of the salt marshes, salt ponds and fresh water lakes of northern coastal New Jersey has developed many features of phytogeographic importance. The origin of the lakes and ponds, it has been proved, is due to the advance of sand dunes across the outlet of various streams that have their rise some distance inland. Most of the larger streams, that have kept open their outlets to the sea, are lined for some distance from the ocean by salt marsh vegetation, which shows a number of characteristic plants in pure association. As the sand bar encroached upon the outlets of the streams the water became somewhat brackish, and the conditions favorable to the salt marsh species became more precarious, one species at a time disappearing with the decrease of water saltiness. Finally, near the heads of several of the bays, and also in several of the smaller ponds, the water becomes more and more fresh, and we find a replacement of salt marsh plants by those accustomed to grow in or near fresh water streams. Similarly salt ponds have by a slow process of change been converted into fresh water lakes, and the vegetation has changed accordingly with the altered physiographic conditions. Instead of the vegetation of the New Jersey coast remaining of a fixed type, we can trace, by a comparison of the several plant formations in various conditions of development, the stages through which the vegetation has passed in reaching its present aspect, and the age of these different associations of plants can be determined by comparing the marsh areas given on the present survey maps with those indicated on the older survey maps of the inlets made at various times in the past by engineers for harbor improvement.[16] The development has been a progressive one, and all in a certain direction from an original salt marsh vegetation to a fresh water and dry land flora. If at any time in this orderly sequence the sea should break through the barrier of sand, or remove it by the ordinary physiographic processes which are constantly active in the region, then there is a reversal of the orderly progression of one type

[16] See for this purpose the illustrated paper by Prof. Lewis M. Haupt, on "Changes along the New Jersey Coast," *Annual Report State Geologist of New Jersey*, 1905: 27–95; 1907: 72–81, and for methods of using similar survey maps see Otto E. Jennings, "A Botanical Survey of Presque Isle, Pa.," *Annals of the Carnegie Museum*, V: 294–305 *et seq.*

of plant formation to another and the original salt marsh conditions are restored. This reversal may be sudden, if the sand barrier is destroyed in a single storm, or it may be gradual, if by a shifting of the ocean currents the sand is removed slowly away from the outlet of the stream or lake, as has happened within the past two years at the mouth of Shark River, which was a few years ago almost closed from the sea, and closed completely by a southeast storm on July 23, 1909.

In the sudden reversal by a heavy storm, all of the fresh water plant formations would be destroyed and the shore line would be made barren for a number of years, until by the usual methods of plant dispersal and invasion the salt marsh plants again take possession of the river banks, or line the shores of the bays and estuaries that may have been formed. If by the second method the reversal has taken place, then by the water becoming gradually brackish and finally salt, the fresh water plants will slowly lose their hold as the soil which they have occupied is invaded by the typic salt marsh plants.

Man, however, has worked greater changes in the original vegetation of northern coastal New Jersey than all of the agencies previously outlined have produced. He has cut down the forests, spanned the rivers with bridges so as to disturb their natural flow, built railroads and wagon roads, constructed jetties and stone revetments, filled in ponds and ditches, spread kerosene over marshes to kill mosquitoes, and altered the drainage areas until in some places no trace of the original vegetation is left.

ON THE TRUE STATUS OF THE GENUS CACOPOIDES.

BY THOMAS BARBOUR.

In August, 1907, a considerable collection of reptiles and amphibians was purchased from Mr. Alan Owston, of Yokohama, Japan. Most of the specimens were from the island of Formosa, from Hainan and from various localities in the Riu Kiu archipelago. A few specimens, however, were from the Chinese mainland, some from Sian, capital of the province of Shensi, while others were from Antung in Manchuria. Among the specimens from this last locality was a peculiar "digger toad" upon which I founded the genus *Cacopoides*. Dr. Stejneger, about the time of the description, rather doubted the probability of the specimen having come from Manchuria. I am assured, however, that the locality is correct by Mr. Owston, and from the specimens which were received with the toad there seems every reason to believe that it is authentic. Two typical Northern species of frogs, to wit, *Rana nigromaculata* and *Rana amurensis*, as well as a specimen of *Amyda schlegelii*, came in the same jar with *Cacopoides*. In October, 1908, the writer happened to be in London for a few days, en route to Brazil. The opportunity was taken to discuss the new genus with Dr. Boulenger at the British Museum. He had not at that time received a copy of the paper in which *Cacopoides* was described. From my verbal description it seemed very probable that the new genus was identical with Boulenger's *Kaloula verrucosa*. This species resembles the other closely in outward appearance and in coloration, and moreover had been reported recently by Wolterstorff from the neighborhood of Tsingtau in Shantung.

The finding of an amphibian of the family Engystomatidae as far north as the province of Shantung immediately makes it evident that there was no particular reason to doubt the accuracy of the locality of *Cacopoides borealis*, which I must confess I did at first.

Now, thanks to the kindness of Dr. Boulenger, I have two specimens of *Kaloula verrucosa* from authentic topotype material taken at Yunnan-fu, as well as a third specimen obtained by purchase and collected there also by Mr. John Graham, the discoverer of the species. So that it becomes possible to present a comparison of this species with the one from Manchuria.

Unfortunately, the case was somewhat complicated by a short note which I mailed from Europe and published in the *Proceedings of the Biological Society of Washington* (Vol. XXII, April 17, 1909, p. 89) This note read as follows:

"A correction is to be made in the case of *Cacopoides borealis* Barbour, described as the type of a new genus and species in a paper on 'Some New Reptiles and Amphibians' (*Bull. Mus. Comp. Zool.*, Vol. 50, No. 12, p. 321, April, 1908). It appears that this must now be considered identical with *Callula verrucosa* Boulenger, though considerably variant from the type of that species and vastly removed from it in range. Boulenger's specimen came from Yunnan, while that on which the supposed new species was based was collected at Antung, Manchuria."

Drawings have been prepared to show not only the difference in outward appearance between the two species but the shapes of the terminal phalanges, the sacral diapophyses, the sterna, and the interiors of the mouth cavities. In some cases drawings illustrate the form of the same structures in the allied genus *Cacopus*. A comparison of these figures will serve to show graphically and more satisfactorily the differences than would a lengthy verbal description.

For the sake of record the original description is appended herewith from the *Bulletin of the Museum of Comparative Zoology* (Vol. LI, No. 12, April, 1908, p. 321):

Cacopoides gen. nov.

An engystomatid related to *Cacopus*. The precoracoids are wanting, the coracoids meet each other on the median line, without an intercalated cartilage; the large metasternal cartilage, instead of being connected to the coracoids by an isthmus, much more narrow than the metasternum itself, is closely adpressed to the coracoidal symphysis. This may be made more clear by the appended drawings. Choanæ small, with valve-like flaps; dermal ridges behind the choanæ converging posteriorly and each with an enlarged papilla near the median line; another long ridge in front of the œsophagus which is sharply curved anteriorly near the median line. Tympanum hidden. Fingers free, toes webbed at base, tips not dilated. Sacral diapophyses rather strongly dilated.

Cacopoides borealis sp. nov.

Habit very stout. Head small; snout rounded; no canthus rostralis; snout about as long as orbital diameter; interorbital space more than twice the diameter of the upper eyelid. Fingers moderate, first shorter than second; toes moderate, webbed at base; no subarticular tubercles; two metatarsal tubercles, the inner strong and shovel-like, the outer weak. Hind limb short. Skin smooth, the dorsal surface with scattered minute pits. Color dark brown-olive above; beneath dusky, marbled with brown. A subgular vocal sac is present.

A re-examination of the type has not rendered it necessary to make any very radical change in the diagnosis as it was originally published. A careful examination shows, however, that there is a very small bit of intercalated cartilage at the symphysis of the coracoids.

There remains, however, a considerable number of differences from *Kaloula*, which seem well worth pointing out. In the first place, the presence of valves in the choanæ serves to distinguish the interior of the mouth at once from that in *Kaloula* and suggests a possible relationship with *Cacopus*. In this genus, however, though valves are present in the internal nares, nevertheless the great size of the openings and the characteristic reduction of the palatal projections to two small bony points serve to distinguish this Indian genus at once from ours. The diagrams of the three sterna show that in shape the sternum of *Cacopoides* is more or less intermediate in form between those of the other two genera. As regards the shape of the terminal phalanges it will be seen that here again the form is intermediate between those of *K. verrucosa* and *Cacopus globulosus*. For the sake of comparison, drawings have been made to show the phalanges in *Kaloula pulchra* and *K. baleata*. These call attention to the extreme variation which may take place in the shape of these bones within a single genus. In the first specimen which Boulenger received, and in many of the subsequent specimens, the verrucose condition of the skin of the dorsum led to his giving the name he did to the Yunnan species. In the type of *Cacopoides*, however, the skin presents a finely pitted appearance, in sharp distinction to the common condition in the species previously mentioned. The reduction of size of the hind limb, the relatively large size of the mouth opening, the difference in coloring which is readily seen from a glance at the drawings, as well as the shape and size of the sacrum and urostyle, serve at once to show the complete distinction of the new genus. The type of *Cacopoides borealis* in actual size is somewhat larger than the largest of the three specimens of *Kaloula verrucosa*. Yet the urostyle is shorter and the sacrum narrower and rather more dilated than in the other species.

The discovery of this toad in Manchuria is as remarkable as unexpected when we think of the distribution of the Engystomatidæ in eastern Asia. The probability that, owing to the habits of these creatures they may exist in a locality comparatively well explored zoologically without their presence being suspected until they are found by the merest accident, renders it quite impossible to draw any conclusions regarding the exact relationships and dispersal of these forms.

For the sake of comparison, descriptions of the genera *Cacopus* and *Kaloula* are added hereto, as well as Boulenger's original description of *Kaloula verrucosa* :—

Cacopus Gthr.

Pupil erect. Tongue oval, entire and free behind. Choanæ very large, with a dermal movable flap, which can close the nostril; two small bony prominences close together, between and on a level with the hinder edge of the choanæ; a small papilla on the hind margin of each choana; a narrow denticulated dermal ridge across the sphenoidal region; another, very broad, in the front of the œsophagus. Tympanum hidden or very indistinct. Fingers free; toes webbed at the base, the tips not dilated. Outer metatarsals united. Precoracoids none; sternum a large cartilaginous plate. Diapophyses of sacral vertebra rather strongly dilated. Terminal phalanges simple.

India. (Boulenger, *Cat. Batr. Sal.*, 1882, p. 174.)

Kaloula Gray.

Pupil erect. Tongue oblong, entire and free behind. Vomerine teeth none. Palatine bone forming an acute, sometimes toothed ridge across the palate. Two cutaneous, more or less distinctly denticulated ridges across the palate, in front of the oesophagus. Tympanum hidden. Fingers free, toes more or less webbed (exceptionally free), the tips more or less dilated. Outer metatarsals united. No precoracoids; no omosternum; sternum cartilaginous. Diapophyses of sacral vertebra moderately dilated. Terminal phalanges triangular or T-shaped.

East Indies. (Boulenger, *l. c.*, p. 167.)

Kaloula verrucosa Blgr.

Snout rounded, not prominent, as long as the eye; interorbital space as broad as the upper eyelid. Fingers slender, with slightly swollen tips, first a little shorter than second; toes moderate, nearly half-webbed, the tips blunt, not swollen, fifth considerably shorter than third; subarticular tubercles well developed; metatarsal tubercles two, oval, compressed, the inner very large. The tibiotarsal articulation reaches the shoulder or between the shoulder and the eye Upper parts with large smooth warts; a fold from the eye to the shoulder. Dark grayish brown above, uniform or with six longitudinal rows of small darker spots; lower parts uniform dirty white.

Kaloula, spelt thus, dates from Gray's *Zoological Miscellany*, 1831 p. 38. *Callula*, a more recent emendation, has no standing in nomenclature.

Explanation of Plates XVII and XVIII.

Plate XVII.—Fig. 1.—Mouth of *Kaloula verrucosa*. × 2.
Fig. 2.—Mouth of *Cacopoides borealis*. × 2.
Fig. 3.—Mouth of *Cacopus globulosus*. × 2.
Fig. 4.—*Kaloula verrucosa* (Blgr.). Natural size.
Fig. 5.—Type of *Cacopoides borealis* Barbour. Natural size.

Plate XVIII.—Fig. 1.—Sternum of *Cacopus* after Boulenger.
Fig. 2.—Sternum of *Cacopoides*. × 2.
Fig. 3.—Sternum of *Kaloula verrucosa*. 2.
Fig. 4.—Sacrum and urostyle of *Cacopoides*. × 2.
Fig. 5.—Sacrum and urostyle of *Kaloula verrucosa*. × 2.
Fig. 6.—Terminal phalanx, *Kaloula baleata*.
Fig. 7.—Terminal phalanx, *Kaloula pulchra*.
Fig. 8.—Terminal phalanx, *Kaloula verrucosa*.
Fig. 9.—Terminal phalanx, *Cacopoides borealis*.
Fig. 10.—Terminal phalanx, *Cacopus globulosus*.

A NEW SPECIES OF FISH OF THE GENUS ATOPICHTHYS, WITH NOTES ON NEW JERSEY FISHES.

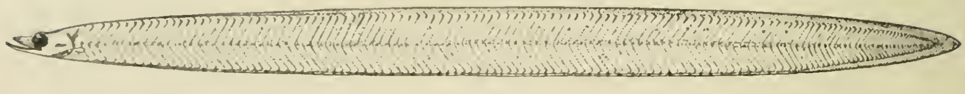
BY HENRY W. FOWLER.

Atopichthys phillipsi sp. nov.

Head about 14; depth about 14; snout about 3½ in head, measured from tip of upper jaw; eye 3½; maxillary 2; interorbital 5; head depth at occiput 2; muscular segments about 88 + 35?

Body oblong, greatly compressed, and tapering from about last third its length toward each end, greatest depth including area of trunk posterior to middle of entire body length. Tail tapering down rather suddenly.

Head widest part of body, compressed, upper profile generally concave and lower rather convex. Snout compressed, narrowly triangular, both in profile and as viewed from above. Eye large, rounded. Mouth large, oblique. Mandible shallow, attenuated, and protruding well be-



yond snout tip. Teeth narrow, long, pointed, apparently uniserial and all directed anteriorly in jaws. Tongue not evident. Nostrils small, well separated, similar, anterior near snout end and posterior close before eye. Interorbital slightly convex.

Gill-opening inferior, below and before pectoral base.

Body naked, smooth.

Vertical fins low, continuous around caudal, latter small, short and little developed. Pectoral small, short, low. Vent far back, near last sixth in entire length.

Color in alcohol whitish, becoming transparent when removed and a little dry, though again turning whitish when submerged. Along middle of each side a minute dark dot or chromatophore on most myocommas. Along lower edge of body also a dark chromatophore at most of myocommas. Occasionally minute chromatophores scattered inconspicuously along side of body, here and there. A number of rather enlarged blackish chromatophores in branchiostegal region. Iris blackish, veneered with silvery and slightly tinged pinkish.

Length $3\frac{5}{16}$ inches (85 mm.).

Type, No. 36,638, A. N. S. P. Corson's Inlet, Cape May County, New Jersey. April 11, 1909. Dr. R. J. Phillips.

This interesting fish was picked up on the ocean beach after a storm, with a number of other small fishes, such as *Raja crinacea*, *Syngnathus fuscus*, *Hippocampus hudsonius*, *Centropristis striatus*, *Prionotus evolans strigatus*, *Gobiosoma bosci*, *Opsanus tau* and *Lophius piscatorius*. Dr. Phillips noted the color of the *Atopichthys* as ivory-white when first found and measuring $3\frac{3}{4}$ inches in length, so that it has shrunk considerably after being placed in alcohol. It is most closely related to *Leptocephalus amphioxus* Eigenmann and Kennedy, but differs at once in having the area of its greatest depth extending well behind the middle of the length of the body, and therefore with an extremely elongated ovoid contour. It agrees, however, in the chromatophores and posterior vent, though there are no branchiostegal chromatophores indicated for *L. amphioxus*. Further it differs from the latter in fewer trunk myomeres, protruding mandible, widely separated nostrils, and more numerous ventral chromatophores. Possibly it may be the young of some genus like *Uropterygius*?

(Named for Dr. Richard J. Phillips, of Philadelphia, who collected the type.)

Notes on some New Jersey Fishes.—Dr. R. J. Phillips secured a number of interesting fishes at Corson's Inlet during the past season, among them a fine example of *Hemitripterus americanus* on April 25th, on May 10th a fine adult example of *Pomolobus mediocris* with a small blue *Petromyzon marinus* attached, and on March 21st six small *Fundulus luciæ*. On May 20th he secured, besides an interesting young *P. mediocris*, *Anchovia mitchilli*, *Lucania parva*, *Syngnathus fuscus*, young *Poronotus triacanthus* and *Phycis regius* in the bait-net. A few specimens of *Menticirrhus americanus* were taken there during the past summer, as well as at Somers' Point, and early in November of 1908 several of *Squalus acanthias* and a large *Raja lævis* were taken at Corson's. Mr. W. J. Fox secured a fine *Zoarces anguillaris* taken March 14, 1909, and noted three *Pollachius virens* on April 4th at Sea Isle City. An *Alopias vulpes*, $15\frac{1}{2}$ feet long, was taken at Cape May Point on June 18th, according to Mr. H. W. Hand. During the past month the latter also noted *Carcharias littoralis*, *Cynais canis* and *Sphyrna zygæna* about Cape May, and found *Gambusia gracilis* apparently more abundant in Teal's Branch than when first discovered in 1907. On July 14th I received a *Raja eglanteria* and four *Dasyatis* *centroura* from off Green Creek in Delaware Bay. Mr. Fox is informed that two large *Tarpon atlanticus* were reported from the pounds at Sea Isle City about 1901 or 1902. Mr. I. N. DeHaven reported *Tarpon atlanticus* taken at Chadwick in 1907, and *Trichuirus lepturus* later. Perhaps the most interesting fish captured in New Jersey waters this season was a fine large example of *Rhinoptera bonasus* taken on September 11th in the bay at Ocean City, and secured for the Academy by Mr. David McCadden. No definite New Jersey record has ever been given since LeSueur described it from Egg Harbor in 1817 in the Journal of the Academy. Dr. Phillips has kindly furnished me with a drawing and detailed description of a young *Garrupa nigrita* taken at Corson's Inlet on September 2d, which is the first record for this fish in New Jersey waters.

AN ORTHOPTEROLOGICAL RECONNOISSANCE OF THE SOUTHWESTERN UNITED STATES. PART III: CALIFORNIA AND NEVADA.

BY JAMES A. G. REHN AND MORGAN HEBARD.

The first and second portions of the results of this examination of the southwestern United States, treating of Arizona, New Mexico and western Texas material, have already been published in these PROCEEDINGS.[1] The present is the final one of the series, bringing to a close the study of the collections made in 1907.

The material treated in this paper was almost wholly collected by the junior author, although several small but interesting lots taken by Dr. Joseph Grinnell and Mr. Fordyce Grinnell, Jr., have added materially to the interest of the work. The collections made by these gentlemen were very kindly given by them to the Academy. Mr. Otho Poling, of Quincy, Illinois, whose assistance was acknowledged in the previous papers, aided in securing a good portion of the material taken in the Los Angeles region (Alamitos Bay, Miramar, Pasadena, Echo Mountain and Mt. Lowe), while collections made by him in late August near Los Angeles, at Altadena and on Mt. Lowe contain much of interest.

The number of species examined and treated in this report is one hundred and ten, of which six species and two subspecies prove to be new, while the specimens number one thousand eight hundred and seventy.

LOCALITIES.

Indio, Riverside County, California. Altitude, 26 feet below sea-level; July 29, 1907. Orthoptera were found plentiful near the town on the sun-baked plain, upon which grew a high dense growth of plants, and also in small irrigated spots near the railroad station. The intense heat made collecting rather difficult.

Alamitos Bay, Los Angeles County, California. July 31. Near the ocean beach on the loose sand, upon which typical beach vegetation was growing, some few species of Orthoptera were found. In a few very small damp spots in this situation several specimens of the genus *Conocephalus* were taken.

[1] *Proc. Acad. Nat. Sci. Phila.*, 1908, pp. 365–402; 1909, pp. 111–175.

Miramar, Los Angeles County, California. July 31. In this locality a field of dry trampled grass near the shore proved the most productive location. On the whole collecting near the shore was not nearly as good as it was farther inland near the hills.

Pasadena, Los Angeles County, California. Altitude, 824 feet; August 1. A good lot of material was secured in the Arroyo Seco, where in the heavy brush and cactus and also beside the stream a number of interesting species were encountered. Nearby in cultivated ground collecting was also productive. On the nearer slopes of the San Rafael Hills quite a different and nearly as interesting a series of Orthoptera was taken. These hills were covered with low dry grasses, with frequent dense tangles of low bushes between them. This vegetation and the steepness of the slopes made collecting much more difficult than in the Arroyo Seco.

Between Altadena and Rubio a very few specimens were taken on August 8, among low bushes.

Echo Mountain, San Gabriel Range, Los Angeles County, California. Altitude, 2,700–3,500 feet; August 8. On the steep slopes covered with dense but low bushes a few interesting specimens were taken in a short time.

Mt. Lowe, San Gabriel Range, Los Angeles County, California. Altitude, 5,200–5,600 feet; August 8. Between Alpine and the summit the steep mountain side is clothed with heavy shrubs and low oaks, while the ravines in places are filled with tall trees. On the mountain side collecting was most productive and interesting, but in the ravines only a few Melanopli were found.

Between Echo and Alpine, altitude 4,000–4,800 feet, the mountain slopes proved splendid collecting places, especially where there was an occasional small pocket or basin. In one of these nearly level areas *Napaia gracilis, Dracotettix californicus* and other very interesting species were found. The mountain sides are in the majority of places clothed with manzanita and other low bushes.

Santa Catalina Island, Los Angeles County, California. August 3–7. On Catalina Island the slopes of the hills about Avalon, which are covered with low bushes and weeds and an occasional thick clump of stunted oaks, proved quite unproductive. On the golf course, farther up in the Avalon Valley, certain common species were abundant, and toward dusk several species of Locustids and crickets were heard in some cultivated bushes about the club house and about the town. Of these specimens of *Œcanthus* and *Scudderia* alone were captured.

A trip to the highest point on the island involved considerable effort with little result.

Collecting at Catalina was much like that among the low hills along the coast and not nearly as good as among the San Gabriel foothills.

Cottonwood, San Bernardino County, California. Altitude, 2,274 feet; September 9. On the desert clothed with greasewood and other plants of the Mohavan region collecting was very productive, especially at dusk when a number of interesting things were taken. The desert is here more or less rolling and the spot is ideal for collecting in a dry region. Nearby along the border of the Mohave River, in tall weeds and grassy ground which had been inundated but was at the time parched, a number of interesting species were found. On the train at night species of *Homœogamia* and *Stagmomantis* were taken, two of which are new. On the whole, this was the most interesting desert situation in which collecting was done during this trip.

Kelso, San Bernardino County, California. Altitude, 2,118 feet; August 12. In this the most extremely arid desert area encountered, covered only with a scattered growth of greasewood and a very few low desert plants, quite a few specimens were taken. North from the station, among the volcanic foothills of the North Range of the Providence Mountains, a very few specimens were captured, but these were the most interesting captures made at this point. *Pœcilotettix sanguineus* was seen but not taken. Kelso is situated seven miles from the huge shifting sand hills called the Devil's Playground, and near it is a dry soda lake. A visit to that area would doubtless have proved interesting, but time was not available.

Cima, San Bernardino County, California. Altitude, 4,192 feet; August 12. Cima is situated on a high plateau covered with tall tree yuccas. The low vegetation was scant and consisted of a very few greasewood bushes and other species of desert shrubs. In some nearby low hills covered with essentially the same vegetation long search failed to disclose any species of special interest. In a growth of tumble-weed beside the railroad all the specimens of *Agenotettix australis* and *Cordillacris apache* were taken.

Lyons, San Bernardino County, California. Altitude, 2,850 feet; August 11. In an area of loose sand with scattered tufts of dry grass *Heliastus minimus* alone was found. The desert here was covered with fragments of volcanic rock, among which greasewood and a very few other desert plants grew and the entire country had a decidedly baked appearance. In this area a number of very valuable captures were made, although it was insufferably hot, much more so than at Yuma.

Bird Spring Mountains, McCullough Range, Lincoln County, Nevada. Altitude, 2,900–3,000 feet; August 11. On the slopes up to the foothills of these mountains the character of country and vegetation was much the same as about Lyons, California, nearby, except that the volcanic fragments were here much more abundant. *Tytthotyle maculata* was found here also, and the single specimen of *Drymadusa arizonensis* taken on this trip was found just where the slopes reached the plain.

Las Vegas, Lincoln County, Nevada. Altitude, 2,050 feet; August 9, 10. Most of the material from this locality was taken in the only green place for many miles around, along the small stream which springs out of the desert to the north of Las Vegas. A good series was also captured on the surrounding desert, which differed from the usual desert of the Southwest in that there was no greasewood and hardly any mesquite to be found. In some spots this desert was excessively parched and barren. Las Vegas, offering both desert and damp land collecting, was more productive than the majority of places in this character of country.

El Toro, Orange County, California. August 20. Collecting was found to be unproductive in the rolling grain fields about the village, which were very dusty and warm at this season.

Tia Juana, San Diego County, California. August 16. The low hills, covered with scant vegetation, and a swampy section near the Mexican boundary line were examined.

Coronado Beach, San Diego County, California. August 14, 15 and 16. Salt marsh, strand and weed field situations were examined at this locality and at South Coronado Beach.

Raymond, Madera County, California. Altitude, 940 feet; September 3. In a hillside stubble field near the village Orthoptera was found in quantities. The Decticid *Clinopleura minuta* was particularly abundant. The town is not as far out in the valley as Merced, and collecting between this place and Miami would without doubt have proved extremely productive had more time been available.

Merced, Merced County, California. Altitude, 173 feet; August 30. All of the Orthoptera captured at Merced were taken in a very dry stubble field near the railroad station.

Summit House, Madera County, California. Altitude, 2,200 feet; September 3. In this vicinity specimens of interest were taken on a hillside covered with a scattering growth of oaks. The undergrowth here consisted of a thick mat of short dry yellow grasses interspersed with very low tar weed.

Miami, Mariposa County, California. Altitude, 4,200 feet; September 3. A few specimens were taken on a hillside in a conifer forest.

Ahwahnee, Madera County, California. Altitude, 3,700 feet; September 3. In a large patch of tar weed and other high plants collecting was found to be extremely productive, and several species were found which had not been met with in the higher parts of the Sierras. Had more time been available there is but little doubt that a very interesting series could have been taken. This was by far the best locality for collecting between Wawona and Raymond.

From the Yosemite Valley to the Mariposa *Sequoia* grove the roads are bordered by great open conifer forests, in which *Trimerotropis fallax* and *Trimerotropis cærulcipes* were found almost invariably plentiful. In this region collecting was done at Wawona, altitude 4,000 feet, September 1; at Mariposa Grove, altitude 7,000 feet, September 2; at Grouse Creek, altitude 6,000 feet, September 1, and at Eight Mile Camp, altitude 5,000 feet, September 1. All of these localities were much the same for collecting.

Sentinel, Yosemite Valley, Yosemite National Park, California. Altitude, 4,000 feet; August 31–September 1. In the heavy grass near the hotel Melanopli were found in small numbers, while on the opposite side of the Merced River many more were taken in a similar location. In the pine woods of the valley bottom several species of *Trimerotropis* were taken, and in one clearing dotted with low bushes, in the direction of the Yosemite Falls, a series of *Trimerotropis koebelei* was taken. At a higher elevation among the conifers growing on the walls of the valley *Aglaothorax sierranus* was found, as well as the ever present *Trimerotropis fallax* and *Trimerotropis cæruleipes*, and on the steep upper ledges of bare rock near the upper part of the valley wall *Circotettix shastanus* was discovered.

El Portal, Mariposa County, California. Altitude, about 3,200 feet; August 30. This is the terminus of the railroad in the gorge of the Merced, near the entrance of the Yosemite National Park. At this point the rather steep sides of the gorge are clothed with a heavy forest of oaks and other deciduous trees mingled with some few conifers. Few but interesting specimens were taken in the undergrowth, particularly *Melanoplus ablutus* and *Cyrtophyllicus chlorum.* A longer stay would have proved very productive.

Mill Valley, Marin County, California. Altitude, 300 feet; August 23. A few specimens of the genus *Conocephalus* were taken among weeds growing in the street ditches. Just outside of the town on the grassy slopes, which ascend farther back to Mt. Tamalpais, several very interesting species of *Melanoplus* were found among numerous more common Orthoptera. The region was dry and dusty and much like the other low dry grass-covered hills of the coast.

Mt. Tamalpais, Marin County, California. Altitude, 1,500–2,500 feet; August 23. On the summit but little Orthoptera was to be found among the manzanita and other low shrubbery. A fog continually driving across the mountain top during my stay no doubt prevented a larger number being taken. Near the upper level of the timber a colony of *Neduba* was found in a grassy ravine with a scattered growth of pines, oaks and other trees. From this point downward, collecting among the grasses and herbs beside the railroad track was rather productive, but the mountain ridges covered with manzanita bushes and low herbs revealed Orthoptera in numbers, among which were some very interesting species. The slopes were usually steep, and collecting seemed both more convenient and more productive on the ridges and occasional small level spots. Just below the central portion of this manzanita-covered zone proved the most productive altitude.

The material collected by Dr. Joseph Grinnell was all taken during a biological survey of the San Bernardino Mountains,[2] the greater proportion of the specimens being taken on the South Fork of the Santa Ana River. The specimens given by Mr. Fordyce Grinnell, Jr., were secured at several localities in the San Jacinto Mountains, and their eastern spur the Santa Rosa Mountains, on Mt. Wilson, San Gabriel Mountains and at Pasadena. The material from the San Bernardino, San Jacinto and Santa Rosa ranges was of exceptional interest, as little or nothing was known of them orthopterologically. The latter is also true of the material taken by Hebard in the Bird Spring Mountains, at Cima, in the North Range of the Providence Mountains and at Las Vegas, Nevada.

FORFICULIDÆ.

Anisolabis annulipes (H. Lucas).

Three males of this species were taken at Coronado Beach, August 15, from under marigolds in a garden.

Caudell has recorded this species from California.

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[2] The Biota of the San Bernardino Mountains, by Joseph Grinnell, *Univ. of Cal. Publ., Zool.*, V, No. 1.

BLATTIDÆ.

Ischnoptera consobrina Saussure.

A single male of this species, collected at Pasadena by Fordyce Grinnell, Jr., has been examined.

The only previous record of the species from the Pacific States is that of its occurrence at Claremont, Los Angeles County, California, by Baker,[3] the material having been determined by the senior author.

Homœogamia erratica Rehn.

A single male of this species was taken September 9 at Cottonwood on board a train, to which it had been attracted by the lights. The specimen is paler than a number of Arizona individuals, having practically no markings except an arcuate reddish line meso-caudad on the pronotum.

This is the first record of the species from California.

Homœogamia subdiaphana mohavensis n. subsp.

Four males of an extremely pale form of *H. subdiaphana*, Scudder, previously known only from several localities in New Mexico, were taken at Cottonwood, September 9, under similar conditions to the individual of *H. erratica* recorded above.

These specimens are very pale cream-buff in base color, the tegminal veins pencilled with burnt umber, those of the anal area, which are strongly lined in the typical form, being hardly more defined than those of the proximal portion of the discoidal area. The pronotum is clouded caudad with ochraceous, particularly on the paired lateral and single caudal areas which are dragon's blood red to bay in the typical form.

Two forms of pronotum are noticed in the series of *H. subdiaphana* and *H. s. mohavensis*, one with the cephalic margin distinctly obtuse angulate, the other with the same portion broadly arcuate.

Measurements.

Length of body,	10.5 mm.
Length of pronotum,	3 "
Greatest width of pronotum,	4.2 "
Length of tegmen,	11 "

MANTIDÆ.

Litaneutria minor (Scudder).

A single female from Cottonwood, September 9, taken on greasewood, was actively climbing and jumping about. In size and pale

[3] *Invertebrata Pacifica*, I, p. 72.

general coloration it is similar to two specimens from Florence, Arizona. The subbasal fuscous spot on the tegmina is moderately distinct, but not large.

Litaneutria skinneri Rehn.

A single male of this species, collected at an elevation of 5,500 feet on the Santa Ana River, San Bernardino Mountains, California, by Dr. Joseph Grinnell, has been examined. It is inseparable from typical material from the Huachuca Mountains, Arizona.

This is the first record of the species from California.

Stagmomantis californica n. sp.

Types: ♂ and ♀; Cottonwood, Mohave Desert, San Bernardino County, California. Attracted to light. September 9, 1907. [Hebard Collection.]

Allied to *S. fraterna*, *montana* and *venusta* Saussure and Zehntner and *gracilipes* Rehn. From *fraterna* it differs in the slenderer pronotum, particularly the shaft, more prominent eyes, differently colored wings in both sexes and longer pronotum and cephalic femora and shorter tegmina in the male; from *montana* in the much smaller size, proportionately longer and slenderer pronotum and much broader head and differently colored wings; from *venusta* in the more truncate and less arcuate occiput, the less pyriform eyes when viewed from the side, the absence of black markings from the internal face of the cephalic femora in the male, in the stigma being distinctly colored as in the female; from *gracilipes* in the shorter pronotum with the supra-coxal region more dilated and in the shorter limbs, the cephalic femora being much broader and heavier.

The species is in no way related to *S. heterogamia* Saussure and Zehntner, and differs from *S. carolina* in the different proportions of the head and pronotum, the coriaceous costal field of the tegmina of the male and in the stigma not being distinctively colored in the same sex; from *S. limbata* it differs in the smaller size, proportionately broader head, more prominent eyes, slighter pronotum (particularly in the female) and the shorter and narrower tegmina of the female.

Form moderately slender; size medium. Head quite broad, the depth contained one and one-half (♀) to one and two-thirds (♂) times in the width; occipital outline nearly straight, not arcuate; facial scutellum with the greatest depth (median) contained slightly more than twice in the width, dorsal margin obtuse-angulate, very slightly fissate at the angle in the male, the lateral portions of the angle slightly arcuate-emarginate ventrad of the insertion of the antennæ; ocelli placed in a triangle, two dorsad, one ventrad, the dorsal ones well separated, those of the female quite small compared with the large jewel-like ocelli of the male; eyes large, quite prominent, very broad elliptical in shape when seen from the side, not elevated dorsad of the occipital line; antennæ setaceous in both sexes, slenderer and shorter in the female than in the male. Pronotum slightly longer than twice the width of the head, the supra-coxal width contained four (♂) or three and a half (♀) times in the length of the pronotum; shaft considerably compressed mesad, the whole shaft carinate, the expansion and collar pyriform, broadly (♀) or narrowly (♂) so, margins of the male unarmed, rather strongly denticulate cephalad in the female, the teeth becoming weaker caudad until absent from the caudal portion. Tegmina of the male very slightly exceeding the apex of the abdomen, hyaline with the rather narrow costal field opaque and sub-coriaceous; tegmina of the female about equal to the pronotum in length and reaching about to the middle of the abdomen; costal margin considerably arcuate proximad; the costal field slightly more than a fourth the width of the whole tegmen; apex rounded; stigma distinct, longitudinal. Wings hardly exceeding the tips of the tegmina. Supra-anal plate of the male transverse, the apical margin regularly but not very greatly arcuate; subgenital plate of the male moderately produced, the apical margin very narrowly and angularly emarginate; cerci slightly exceeding the apex of the subgenital plate, tapering, the joints elongate sub-moniliform; supra-anal plate of the female strongly transverse, the margin rotundato-angulate; subgenital plate compressed, rostrate caudad; cerci about three-fourths

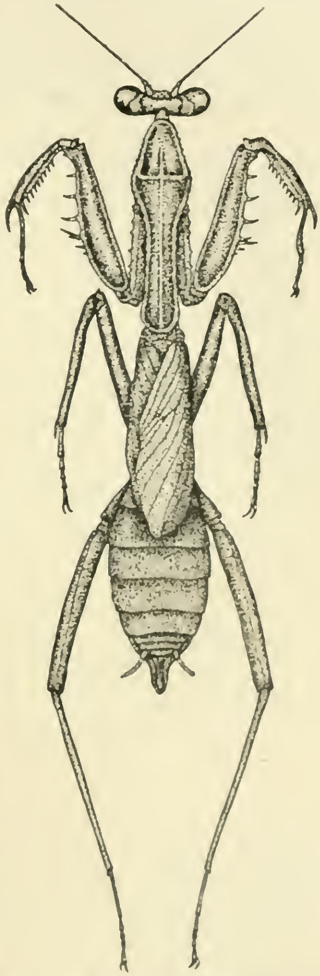

Fig. 1. *Stagmomantis californica* n. sp. Dorsal view of female type. (× 2½.)

the length of the subgenital plate, moderately tapering, rather blunt. Cephalic coxæ distinctly (♂) or very slightly (♀) shorter than the shaft of the pronotum, the cephalic margin of the same armed with six or more spines of rather uniform size, with a few much smaller spines scattered between them; cephalic femora nearly (♂) or quite (♀) equal to the shaft of the pronotum in length, rather heavy in the female, armed on the external margin with five spines one of which is small and genicular in position, internal margin with fourteen to fifteen spines of several sizes, alternating more or less regularly in length, discoidal spines four in number; cephalic tibiæ about half the length of the femora, armed on the external margin with eight spines which leave a considerable unarmed proximal diastema, internal margin armed with twelve spines; cephalic tarsi reaching to the base of the femora. Median femora somewhat shorter than the shaft of the pronotum; tibiæ subequal. Caudal femora nearly equal to the pronotum in length; tibiæ subequal.

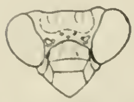

Fig. 2.—*Stagmomantis californica* n. sp. Cephalic view of head of female type. (× 4.)

General color of the male cream-buff, with the pronotum very faintly brownish; costal field of the tegmina chalky-white; eyes mars brown; facial scutellum drab; ocelli clear orange-red; proximal dorsal abdominal segments broadly edged with seal-brown. General color of the female oil green, becoming reddish-brown on the shaft of the pronotum; stigma of the tegmina buff, brownish caudad; proximal abdominal segments as in the male; eyes walnut brown; facial scutellum, labrum and mouth parts pale tawny; cephalic femora edged on the spined margins with yellowish.

Measurements.

	♂	♀
Length of body,	45.5 mm.	46.5 mm.
Length of pronotum,	13.5 "	16.5 "
Greatest width of supra-coxal expansion,	3 "	4.5 "
Length of tegmen,	32 "	17 "
Length of caudal femur,	9.5 "	12.5 "

An additional paratypic male has been examined, as well as a male from Kelso (VIII, 12; attracted to light), a female from North Range, Providence Mountains (VIII, 12), and one from Pasadena (F. Grinnell, Jr.; Coll. A. N. S. Phila.). There is a slight amount of variation in size and considerable in color. The extra Cottonwood male is similar to the type, but the Kelso individual of that sex is red-brown with the limbs annulate with buffy and the costal half of the tegmina sprinkled with small ashy blotches. The Providence Mountains female is similar to the type but paler, inclining toward emerald green, with the brownish on the pronotum reduced.[4] The Pasadena individual is in a brownish phase corresponding to that of the Kelso male, the limbs being more (particularly the cephalic) or less annulate with buffy, the tegmina entirely sprinkled with small creamy-white maculations and the stigma marked.

At Cottonwood all the specimens were attracted to the lights of the train, the individual taken at Kelso having been captured in a similar manner, while in the North Range of the Providence Mountains the species was taken on green desert weeds.

PHASMIDÆ.

Parabacillus coloradus (Scudder).

A broken specimen of this species, taken at Pasadena, California, by Fordyce Grinnell, Jr., has been examined. The right cephalic limb is aborted, the whole regenerated leg being but little longer than the head. The only previous exact Californian record of the species is of its occurrence at Elsinore, Riverside County.

ACRIDIDÆ.

Acrydium granulatum Kirby.

A single adult male and three nymphs of this northern species were taken in tall grass in meadow land at Sentinel, Yosemite National Park, August 31. When compared with material from Michigan the adult specimen is found to be inseparable. This is the first record of the species from California.

Paratettix toltecus (Saussure)

A series of seven males and nine females of this species were taken at Las Vegas, August 10, in a grassy well-watered strip along a stream. A single female was also taken at Cottonwood, September 9, on dry grassy ground along the course of the Mohave River. These specimens are quite uniform in size, the males of course smaller than the females, while the color varies from a blackish-brown base color to one of deep dull maroon-red; the paired blackish triangles placed caudad of the greatest width of the pronotum are present more or less distinctly on all but one of the specimens. This one, a male, has a broad medio-longitudinal bar of dull ochraceous present from the fastigium to the apex of the pronotum, this margined laterad at the greatest width with blackish-brown.

[4] This color is probably due to discoloration in drying.

This is the first record of the species from Nevada and the second with exact data from California, Riley having recorded it from Panamint Valley, Inyo County.

Morsea californica Scudder.

This very interesting Eumastacid was found on manzanita bushes (*Arctostaphylos tomentosa*), at elevations of from 5,200 feet to 5,600 feet on Mt. Lowe, August 8, where a series of two presumably adult males, three females and six immature specimens was taken. A single female was also taken at an elevation of 3,200 feet on Echo Mountain, while a male from 5,000 feet on Mt. Wilson, taken September 15, by Fordyce Grinnell, Jr., is also before us.

From the original measurement given by Scudder, "length of the body and of the hind femora . . . . 9 mm.," it would appear that the types are immature, as a pair from Mt. Lowe, which we judge to be adults, measure as follows:

	♂	♀
Length of body,	12 mm.	16.5 mm.
Length of pronotum,	2.2 "	2.7 "
Length of caudal femur,	10 "	11 "

There is little variation in size in the adult specimens, the Echo Mountain female, however, being slightly smaller than the others of that sex.

In color the adults show little variation, the general tone of the female being dull blackish brown dusted with grayish with the limbs irregularly annulate with very dull grayish, except the caudal tibiæ which are mottled; the general color of the males is usually more warm brown on the dorsum, with a narrow median dark-brown line on the pronotum and much broader, poorly defined postocular bars of the same color, the limbs annulate as in the females, and in two of the specimens the whole surface is much dusted with hoary. The postocular bars of the male are sometimes continued on the sides of the abdomen, and in the Echo Mountain female indications of these bars are also present. A pale edging to the ventral margin of the lateral lobes of the pronotum is present more or less distinctly and of varying width in a number of the adults. The immature specimens are much more uniformly red-brown than the adults, although one, a female, has the coloration of adults of that sex.

No traces of tegmina or wings are apparent.

These insects were usually to be found perched on the upper portions of the manzanita bushes. They were found to be very active with saltatorial powers much developed, added to which their small size would have made them very difficult to capture, had they not almost invariably alighted in an exposed position. As they were constantly alert, the only successful way to capture them was by a quick sweep of the net. The types of the species came from the Cahon Pass and Mt. Wilson.

Morsea californica tamalpaisensis n. subsp.

Types: ♂ and ♀; Mt. Tamalpais, Marin County, California. August 23, 1907. [Hebard Collection.]

A series of thirteen adult males, two females and four nymphs of a small form of *M. californica* were taken on the slopes of Mt. Tamalpais, at elevations of from 1,500 to 2,100 feet, on August 23.

This geographic race differs from the typical form from the Sierra Madre of southern California in the angle of the vertex being slightly more protuberant and more decidedly acute-angulate when seen from the side, in the antennæ being somewhat more expanded distad, in the male cerci being slightly more robust and shorter, in the caudal margin of the pronotum being more decidedly angulate-emarginate and in the general size being smaller.

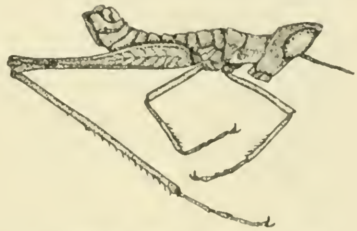

Fig. 3.—*Morsea californica tamalpaisensis* n. subsp. Lateral view of male type. (× 3.)

Measurements.

	♂	♀
Length of body,	10 mm.	14 mm.
Length of pronotum,	2 "	2.2 "
Length of caudal femur,	8.2 "	9 "

The coloration is much as in the typical form, the nymphs being ochraceous-red, one adult female also being decidedly ochraceous.

Figs. 4–7.—Lateral views of heads of male (4) and female (5) of *M. californica tamalpaisensis* and of male (6) and female (7) of *M. californica*. (× 3½.)

These reddish individuals were captured on manzanita (*Arctostaphylos* sp.), with the bark of which they are uniformly colored.

The habits of this subspecies were essentially the same as those of the typical form. The insects were always more abundant on the bushes along the summits of the ridges.

Paropomala pallida Bruner

This species, which appears to be rather generally distributed over the Mohave, Colorado and Gila Deserts in suitable environments, was taken at Cottonwood, Cima, in the foothills of the Bird Spring Mountains, California and Nevada, at Lyons, Nevada, and Las Vegas, Nevada. At Cottonwood, September 9, seven males and one female were taken from dry vegetation along the wash of the Mohave River, where the species was very plentiful. At Cima, August 12, a single female was captured, while in the Bird Spring Mountains and at Lyons, August 11, the species was found in patches of dry high grass growing in deep sand, two males and four females being taken at the former locality and two females at the latter. Grassy spots in the desert were the haunts of the insect at Las Vegas, where eleven males and five females were taken on August 10.

In size the males are rather uniform, but the females exhibit a considerable amount of geographic and some slight individual variation. Specimens from the localities represented measure as follows:

	Length of body. mm.	Length of pronotum. mm.	Length of tegmen. mm.	Length of caudal femur. mm.
		♂		
Cottonwood, Cal.,	18.5	3	13	9.2
Bird Spring Mts., Cal.,	19.2	3.2	15.2	9.6
Las Vegas, Nev.,	20.5	3.7	14.9	9.8
		♀		
Cottonwood, Cal.,	28.8	4.9	20.5	13.5
Cima, Cal.,	27	4	19	12
Bird Spring Mts., Nev.,	36.5	6	26.5	15.3
Lyons, Nev.,	30.5	4.8	21.5	13
Las Vegas, Nev.,	34	5.5	22	14.5

The series from the Bird Spring Mountains and Las Vegas exhibit a considerable amount of individual variation in size in the female sex, the specimens measured being nearer the maximum size in each lot.

In color, after allowance is made for green and brownish phases, variation appears to be limited to a lightening of the general shades in some specimens and a general intensification in others. The Cottonwood and Lyons females are in the greenish phase, but the color is decidedly yellowish with a suppression of the lateral bars, which latter is absolute in all the Bird Spring Mountains females and several from Las Vegas. Three of the Bird Spring Mountains females are uniform gall stone yellow, the other one uniform light green with the tegmina yellowish and antennæ brownish. One of the Las Vegas females is similar to the latter, and another from the same locality closely approaches it. Two of the Las Vegas females are light brownish much suffused on the head, pronotum and caudal limbs with hoary white, the lateral bars very weak in two specimens. The single Cima female is most peculiarly colored, being umber brownish with the lateral bars marked, but the whole surface except the abdomen is more or less clouded and washed with rather weak hoary white. The males are quite uniform in color compared with the females, all being in the green phase, the lateral bars prominent except in one specimen. The color of the antennæ is subject to a considerable amount of variation, and often irrespective of phase, being brownish, yellow or orange.

The species has previously been recorded from Indio, California, and erroneously as *P. virgata* from Yuma, Arizona; between Yuma and Gila Bend, Arizona, Palm Springs, Cahon Pass and Lancaster, California.

Bootettix punctatus (Scudder).

As recently shown by Caudell,[5] Scudder's *Gymnes punctatus* is really a species of *Boötettix*, related to, but quite distinct from, the type species *B. argentatus*, which latter appears to be peculiar to the Chihuahuan desert region east of the continental divide. The species of the Western desert tract is invariably found on greasewood (*Covillea tridentata*), as is also the case with *B. argentatus*.

When specimens of *B. punctatus* are compared with representatives of *B. argentatus* they show differences as follows:

♂		♀	
B. argentatus.	*B. punctatus.*	*B. argentatus.*	*B. punctatus.*
Fastigium comparatively broad, not strongly acute-angulate, hardly carinate.	Fastigium narrow, sublanceolate, distinctly carinate.	Fastigium broad, subrectangulate to very slightly acute, hardly carinate.	Fastigium somewhat produced, decidedly acute-angulate, distinctly carinate.
Face moderately retreating.	Face very considerably retreating.	Face moderately retreating.	Face very considerably retreating
Eye not more than half again as long as the infraocular sulcus.	Eye twice as long as the infraocular sulcus.	Eye but little longer than the infraocular sulcus.	Eye more than half as long again as the infraocular sulcus.
Blackish-brown maculations on lateral lobes of pronotum and pleura marked.	Blackish-brown maculations on lateral lobes of pronotum and pleura very weak.	As in the male.	As in the male.
Tegmina with more numerous maculations.	Tegmina with few or no maculations.	As in the male.	As in the male.
Caudal femora with the dark bars usually quite prominent.	Caudal femora with the dark bars weaker or even subobsolete.	As in the male.	As in the male.
Size larger.	Size smaller.	Size larger.	Size smaller

[5] *Proc. U. S. Nat. Mus.*, XXXIV, p. 73.

Measurements.

	♂		♀	
	B. argentatus. El Paso, Tex.	*B. punctatus.* Cottonwood, Cal.	*B. argentatus.* El Paso, Tex.	*B. punctatus.* Cottonwood, Cal.
	mm.	mm.	mm.	mm.
Length of body,	20	23	17	22
Length of pronotum,	3.9	4.2	3.2	3.8
Length of tegmen,	18.5	18.5	15.8	15
Length of caudal tegmen,	11.2	12	9.2	10.2

The series before us is from the following localities: Cottonwood, September 9, 12 ♂, 10 ♀, 1 immature specimen; North Range, Providence Mountains, August 12, 1 ♂, 2 ♀, 2 immature specimens; Cima, August 12, 1 ♀; Kelso, August 12, 1 ♀, 1 immature specimen; foothills Bird Spring Mountains, California and Nevada, August 11, 3 ♂.

On re-examining all the available material of the genus we find that specimens from Yuma, Sentinel and Sahuaro Plain near Tucson Mountains, Arizona, recorded by us[6] as *B. argentatus*, are really *B. punctatus;* but it also appears probable that the two species may intergrade in the vicinity of the divide and the more elevated central tract, as the specimen from Sahuaro Plain and other material from Florence, Arizona, show a tendency toward *B. argentatus* in the form of the fastigium, although distinctly *punctatus* in the sum total of characters. The Yuma specimens are typical *punctatus*, the tegmina being even more immaculate than is the case with the Californian specimens.

It is quite probable that the specimens of this genus previously recorded from Bill Williams Fork, Indio and Palm Springs as *B. argentatus* belong to *B. punctatus*. This species produced practically the same stridulation as *B. argentatus* and in habits was also similar.

Amphitornus ornatus McNeill.

This species is represented by a series of two males and one female from Pasadena, taken August 1; five males and three females from Mt. Lowe, taken at elevations of from 4,000 to 4,800 feet, August 8; and one pair from El Toro, Orange County, taken August 20.

When compared with specimens from Aden, New Mexico, the Californian individuals are inseparable. The pair from El Toro are more reddish than the others, the pattern also being duller and less con-

[6] *Proc. Acad. Nat. Sci. Phila.*, 1908, p. 376.

trasted, while the Mt. Lowe individuals have the bars and maculations standing out in strong contrast. The femoral bars are limited to the vicinity of the dorso-lateral carina in the El Toro specimens, more extensive ventrad in the Pasadena individuals and covering the greater portion of the lateral face of the femora in the Mt. Lowe representatives.

At Pasadena the species was taken on the lower slopes of the San Rafael Hills, among shrubs and dry grasses. On Mt. Lowe the insect was found to be very shy, of swift but not long flight, and when pursued closely the individuals would hide in the grasses, very effectually concealing themselves. At El Toro the species was found common in high grain growing along irrigating ditches.

The species has previously been recorded from the following localities in California: Los Angeles, Point Loma, Lancaster, Cahon Pass and Gazelle.

Opeia testacea Scudder.

Eight males, two females and two immature individuals from Las Vegas, taken August 10, are referred to this species. Here the species occurred in a growth of desert plants and grasses on the plain surrounding the town.

The broad postocular bar is more or less strongly present on the head and dorsal half of the lateral lobes of the pronotum in the majority of the specimens, those without indications of the bar having the sides of the head and the whole of the pronotal lobes entirely infuscated.

The species has been recorded from the following Californian localities: Lancaster, Kern City, Tulare, Lathrop and Dominguez.

Cordillacris grinnelli n. sp.

Type: ♀; South Fork of the Santa Ana River, elevation 6,200 feet, San Bernardino Mountains, California, July 6, 1906. Collected by Joseph Grinnell. [Acad. Nat. Sci. Phila.]

Related to *C. occipitalis*, *cinerea* and *affinis*, but differing from all in the shorter tegmina which leave a considerable portion of the abdomen exposed. The coloration is nearer to that of *affinis*, as represented by Idaho specimens, but the longitudinal line on the lateral face of the caudal femora is more continuous than in that species.

Size medium (for the genus); form moderately slender. Head but little expanding ventrad, with the dorsal length about subequal to that of the dorsum of the pronotum, the occiput very slightly arcuate and the fastigium horizontal when seen from the side; fastigium slightly acute-angulate with the apex rotundato-truncate, the disk of the fastigium with the impressed line of essentially the same form as the margin of the fastigium, the apex of the impressed line being nearer to a line drawn between the cephalic margins of the eyes than to the apex of the fastigium; angle of the fastigium when seen from the side rectangulate, the facial line vertical to between the antennæ where the face becomes considerably retreating; lateral foveolæ elongate-lanceolate, the ventral margin not strongly marked; frontal costa regularly but very slightly expanding caudad, considerably sulcate ventrad of the ocellus, slightly so dorsad; eyes trigonal-ovoid, in length about equal to the infraocular sulcus, when seen from the dorsum not very prominent; antennæ about four-fifths the length of the caudal femora, slightly ensiform proximad. Pronotum with the disk slightly less than one and one-half times as long as the greatest caudal width of the same; cephalic margin subtruncate, caudal margin very slightly arcuato-angulate; median carina not prominent but distinct; lateral carinæ but little constricted mesad, moderately divergent caudad, the width between the same cephalad being two-thirds of that caudad; principal transverse sulcus placed distinctly caudad of the middle. Tegmina less than three times as long as the disk of the pronotum, failing to cover the abdomen by nearly the pronotal length, the tegmina considerably narrowed distad, the apices narrowly rounded. Interspace between the mesosternal lobes decidedly shallow and transverse, the width being equal to that of one of the lobes; interspace between the metasternal lobes small, subquadrate. Caudal femora reaching to but not surpassing the apex of the abdomen, slender, but more robust than usual in the genus, the greatest width contained about four times in the length, pattern of the paginæ well impressed, internal genicular lobes slightly acute, external obtuse-angulate; caudal tibiæ slightly arcuate proximad, spines numbering from eleven to thirteen.

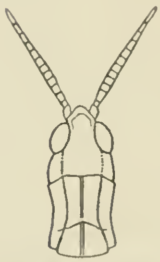

Fig. 8.—*Cordillacris grinnelli* n. sp. Dorsal outline of the head and pronotum of type. (× 3.)

General color ochraceous-buff, becoming ochraceous on the abdomen, hoary-white on the sides of the head, dark clay color on the dorsum of the head and pronotum and french gray distad on the tegmina. The usual broad postocular bar is mars brown, the longitudinal line on the external face of the caudal tibiæ is vandyke brown and unbroken. The lateral carinæ of the pronotum are ochraceous-buff, marked mesad with very dark brown on the metazona, with the same laterad all their length. Occiput darker mesad, eyes raw umber; antennæ clay color; face sprinkled with blackish brown. Tegmina with a few scattered quadrate brownish patches, more or less distinct and chiefly proximad. Caudal femora strongly pinkish brown dorsad with slight indications of three transverse bars; caudal tibiæ dull brownish with a faint purplish tinge, the spines with their apical halves blackish.

Measurements.

Length of body,	19.5 mm.
Length of pronotum,	3.6 "
Length of tegmen,	10 "
Length of caudal femur,	11.3 "

In addition to the type we have examined a single paratypic adult and two paratypic immature females. The adult differs from the type only in a slightly greater intensity of coloration.

We take great pleasure in dedicating this interesting species to Dr. Joseph Grinnell, to whose kindly interest we are indebted for this and a number of other Californian Orthoptera.

Cordillacris apache Rehn and Hebard.

This species, previously known only from four localities in southwestern New Mexico, is represented by two males and one female from Cima, taken August 12. These specimens were taken in tumbleweed along the railroad track, individuals being very scarce.

One of the males is slightly more ochraceous than the others, while the female is rather grayish. The specimens are rather smaller than the average when compared with the original series from New Mexico.

Orphulella compta Scudder.

This species is represented in the collections before us by eight males and eight females taken at Las Vegas, Nevada, August 10, and fifteen males and five females from Indio, taken July 29.

All the Indio specimens are in the green phase, although somewhat modified in several, while five-eighths of the Las Vegas series is in the same phase, the remaining specimens being either umber brown and buff in general tones or pinkish ochraceous marked with blackish brown on the sides of the head and pronotum.

At Las Vegas the species was found well distributed in grass beside a stream.

The species is now known from Yuma, Bill Williams Fork and San

Bernardino Ranch, Arizona; Palm Springs and Indio, California, and Las Vegas, Nevada.

Orphulella affinis Scudder.

At Alamitos Bay, July 31, this species was found common among the scant grasses of the beach dunes, while at South Coronado Beach, August 16, it was secured among low salt marsh plants. Nine males, five females and one immature specimen were taken at the former locality and two adults of each sex and four immature individuals at the latter.

A moderate amount of variation in size in both sexes is presented by the Alamitos Bay series. All the specimens are in the brown phase except three males from Alamitos Bay and one immature specimen from South Coronado Beach.

The species is now known from San Diego, South Coronado and Coronado Beach, Alamitos Bay, Kern City and "Colorado Desert," California.

Napaia gracilis McNeill.

This interesting species was found at an elevation of 4,000 to 4,800 feet on Mt. Lowe, August 8, where it lives among grasses, leaping and crawling about actively. The wings are not used for flight, serving the sole purpose of stridulating organs in the male sex. The stridulation is quite like that of *Chorthippus curtipennis*, but much louder.

A series of six males and seven females was taken, and but little variation in size and color is to be noticed. The insect appeared to be extremely local and was found in but one location between two small mountain slopes.

The species is known from Mt. Wilson, 2,400 feet, and Mt. Lowe, 4,000 to 4,800 feet, the San Gabriel Mountains near Claremont, at Claremont and Los Angeles, California.

Psoloessa texana Scudder.

A series of forty-seven Californian specimens of this very variable species have been examined. This series is distributed as follows: Tia Juana, August 16, one male; Coronado Beach, August 15–16, five males, two females; Alamitos Bay, July 31, one female; Miramar, July 31, five males, two females and three immature specimens; Altadena, August 8, nine males, ten females; Pasadena, August 1, three males, one female; Echo Mountain, San Gabriel Range, August 8, 2,700 to 3,500 feet, one male.

Two of the males and three of the females belong to the form *budd-*

iana, while two males and two females belong to the true *texana* type. The remainder of the series represent the numerous intermediate phases between the two extremes, except one male from Pasadena which has the dorsum dull maroon, the lateral lobes almost entirely pale greenish yellow and no broad postocular bar or broken remnants of the same present, the pale lateral carinæ being merely edged with dark laterad.

Specimens from the beach localities, Pasadena and Echo Mountain, are paler in color than the others.

At Tia Juana the species occurred on rocky hillsides, while at Coronado Beach it swarmed on dry grasses. At Alamitos Bay it was taken on dunes, and at Miramar found very active but not common back of the low beach dunes.

Ageneotettix australis Bruner.[7]

On August 12, at Cima, California, this species was quite common in tumbleweed along the railroad track, a series of twenty-six males and seven females being taken. When compared with specimens from southern Arizona, *i.e.*, Huachuca and Tucson Mountains, the Cima series is uniformly smaller, the difference being less appreciable, however, in the male than in the female.

The coloration of the series is rather subdued, although the bars on the dorsal surfaces of the caudal femora and the lateral carinæ of the pronotum are marked in all the specimens. The caudal tibiæ vary somewhat in the exact shade of color, but all possess a distinct ochraceous proximal annulus.

There is considerable individual variation in the length of the tegmina and wings, some having them slightly but distinctly exceeding the tips of the caudal femora, others have them distinctly but not greatly shorter than the tips of the femora, the average being very slightly shorter than the femoral tips.

This is the first record of the species from California.

Ageneotettix sierranus n. sp.

Types: ♂ and ♀; Summit House, Madera County, California. Altitude, 3,200 feet. September 3, 1907. Collected by M. Hebard. [Hebard Collection.]

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[7] A single short-winged female of this genus from Cuyamaca, San Diego County, California (October 1, 1900; G. W. Dunn), in the Academy Collection, has been examined and is referred provisionally to *A. occidentalis*, although the status of this form is in the authors' opinion very doubtful. It is quite possible that the long-winged forms are more or less completely dimorphic.

Allied to *A. australis* Bruner, but differing in the glaucous caudal tibiæ, the less inflated and more tapering caudal femora, the more sharply defined and more decidedly sulcate frontal costa in both sexes, this being narrower dorsad in the new form, and in the facial outline being truncate between the antennæ, this being more decided in the male than in the female.

Size rather small; form moderately slender. Head with the dorsal length equal to (♂) or slightly less than (♀) the dorsum of the pronotum; occiput considerably ascending to the interocular region, slightly arcuate in the male, hardly so in the female, the interocular region elevated considerably dorsad of the dorsum of the pronotum; fastigium distinctly but not greatly arcuate declivent, the fastigio-frontal angle rounded obtuse, fastigium slightly acute-angulate in both sexes when viewed from the dorsum, distinctly but shallowly excavate; lateral foveolæ well impressed, elongate, subtrigonal, the apex blunt,

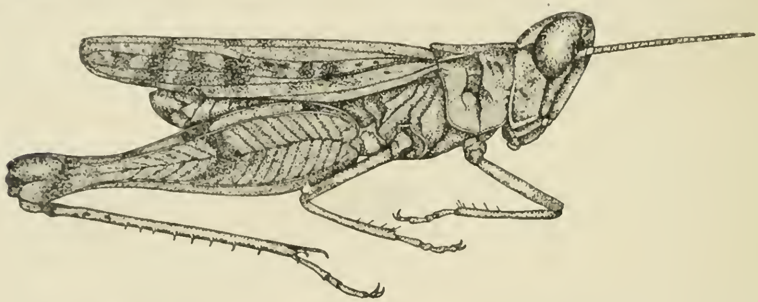

Fig. 9.—*Ageneotettix sierranus* n. sp. Lateral view of male type. (× 5.)

cephalad, the caudal width but little exceeding half the length; facial line considerably retreating ventrad and distinctly subtruncate and vertical from the fastigio-facial angle to a point directly cephalad of the insertion of the antennæ; frontal costa with the margins regularly diverging caudad with a hardly appreciable constriction in the vicinity of the ocellus, distinctly sulcate dorsad and mesad and shallowly so ventrad; eyes moderately prominent in the male, hardly so in the female, elliptical reniform in outline, in length about twice (♂) or half again (♀) as long as the infraocular sulcus; antennæ equal to (♀) or slightly exceeding (♂) the head and pronotum in length, slightly depressed, the apices acuminate. Pronotum with the greatest dorsal width about four-fifths the length, the dorsal line of the same slightly depressed mesad when seen from the side; cephalic margin angulato-truncate, caudal margin broadly obtuse-angulate, the immediate angle well rounded in the female; median carina distinct throughout its length, not high; lateral carinæ low, the width between them at the cephalic margin nearly twice that at the first transverse sulcus and but little more than half that at the caudal margin; lateral lobes very slightly deeper than wide, ventro-cephalic angle obtuse, ventro-caudal angle well rounded. Tegmina reaching to the middle of the genicular arches of the caudal femora, tips rather narrowly rounded. Prosternum moderately inflated, a distinct, transverse, oblong swelling present; interspace between the mesosternal lobes distinctly transverse, as wide as one of the lobes; metasternal lobes subcontiguous. Caudal femora very slightly shorter than the length of the tegmina, considerably inflated proximad, the pregenicular portion quite slender (for the genus), pattern of the paginæ distinct and regular but not very deeply impressed; caudal tibiæ with eight spines on the lateral margins, nine on the internal margins.

Fig. 10.—*Ageneotettix sierranus* n. sp. Dorsal view of head and pronotum. (× 5.)

General color buff, pale on the venter and abdomen, the dorsum tending toward ochraceous and clay color. The usual markings found in species of the genus, *i.e.*, on the dorsum of the caudal femora, on the disk of the metazona and bordering the lateral carinæ laterad and the narrow postocular line, are distinctly marked in seal brown, the tegmina with a number of small quadrate patches of the same and with the pleura much touched with the same color. Lateral carinæ decidedly contrasted, the ventral portion of the metazona of the lateral lobes usually being pale when contrasted with the remainder of the lobe. Face more or less sprinkled with fine spots of bistre, except a pair of areas ventrad of the eyes which are pale. Eyes broccoli brown, suffused more (ventrad) or less (dorsad) heavily with seal brown. Antennæ cream-buff, washed with very dull mauve distad, the extreme tips very pale. Caudal tibiæ pale buff or buff yellow, more or less completely washed with very pale and dull mauve and speckled with dark patches proximad, a seal brown genicular annulus present, the spines blackish to their bases. Tarsi buffy, more or less distinctly and strikingly marked with blackish.

Measurements.	♂	♀
Length of body,	12 mm.	15.5 mm.
Length of pronotum,	2 "	2.8 "
Length of tegmen,	9.5 "	10.8 "
Length of caudal femur,	8.6 "	10.3 "

Two paratypic males and one paratypic female, as well as three males from Raymond, Madera County, California, taken September 3, 1907, have been examined by the authors. There appears to be little variation in size and nothing noteworthy in structure, except that the lateral foveolæ are broader in some specimens than in the types and in some more rectangular than elongate-trigonal. In color there is considerable variation, a tendency toward linear streaking of the dorsum of head, pronotum and tegmina being noticed in one Summit House male, while two of the Raymond males are rather rufescent and the remaining one is predominatingly buffy yellow, with the pattern strikingly contrasted, the occipital bars and maculations of the anal area of the tegmina absent with those parts pure buffy-yellow. In some specimens the caudal tibiæ are inclined more or less strongly toward glaucous.

At Summit House the species was scarce and extremely active, being found in short, dry grass and tarweed under a scattering growth of oak. At Raymond it was taken in stubble and was not common. The contrastingly colored tarsi are very conspicuous in life.

Ligurotettix coquilletti McNeill.

A series of forty-nine specimens from localities in the Mohave and Las Vegas Deserts are referred to this species, to which *L. kunzei* Caudell from southern Arizona is closely related, differing only in the average larger size and slenderer caudal femora. The series is distributed as follows: Cottonwood, September 9, 2 ♂, 1 ♀; Kelso, August 12, 4 ♂, 2 ♀; Cima, August 12, 3 ♂, 3 ♀; North Range, Providence Mountains, August 12, 1 ♀; foothills Bird Spring Mountains, California and Nevada, August 11, 12 ♂, 9 ♀, 1 immature individual; Las Vegas, Nevada, August 10, 9 ♂, 2 ♀.

In size there appears to be considerable geographic variation, Cima individuals being quite small, while the largest female of the Bird Spring Mountains series and of the two of that sex from Kelso are almost as large as individuals of *L. kunzei*. Individual variation is also quite marked in the Bird Spring Mountains series and the two Kelso females are rather different in size, one of the four males from the latter locality also appreciably exceeding the others from that region in size. Average specimens from the various localities measure as follows:

	Length of body.	Length of pronotum.	Length of tegmen.	Length of caudal femur.
			♂	
	mm.	mm.	mm.	mm.
Cottonwood, Cal.,	14.5	3	14.5	8.7
Kelso, Cal.,	13.8	2.9	14.1	8.3
Kelso, Cal.,	15.5	3.2	16	9.1
Cima, Cal.,	13.3	2.9	12.5	7.3
Cima, Cal.,	14	2.9	13.5	8
Bird Spg. Mts., Cal.-Nev.,	13.3	2.5	12.6	8
Bird Spg. Mts., Cal.-Nev.,	15.3	3	13.9	8.3
Las Vegas, Nev.,	14	2.9	14	8
			♀	
Cottonwood, Cal.,	19	3.5	17.1	9.6
Kelso, Cal.,	21	3.9	18	10.5
Kelso, Cal.,	23.3	3.8	19.2	11.3
Cima, Cal.,	17 7	3.3	15	8.9
Cima, Cal.,	17.5	3.3	16.7	9.1
North Range, Prov. Mts., Cal.,	19.5	3.7	17.8	10
Bird Spg. Mts., Cal.-Nev.,	19.8	4	16.8	10.2
Bird Spg. Mts., Cal.-Nev.,	21.2	4.3	20	11
Las Vegas, Nev.,	18.5	3.8	18.5	9.9

The large Kelso and Bird Spring Mountains females are very similar in size to individuals of the Arizonan *kunzei*, as will be seen by comparing the measurements given above with those of *kunzei* recently published by the authors,[8] but on comparing the proportions of the caudal femur the relationship of the larger Californian specimens is seen to be with *coquilletti*. It appears quite probable that *kunzei* is merely a geographic race of *coquilletti*.

The color form with blackish brown on the prozona of the lateral lobes of the pronotum, genæ and pleura already described by the authors from Yuma material is strongly represented in the California *coquilletti*, two males and two females from Cima and five males and four females from the Bird Spring Mountains being in this phase. The Las Vegas and Kelso series are uniformly paler and less contrastingly colored, the Las Vegas one very much paler and grayer, than the other lots; the Cottonwood individuals are dusty blackish-gray with the ochraceous tones reduced to a minimum. The dorsal femoral bars are quite strongly marked in the individuals with the blackish-brown markings on the pronotum, while the dorsal aspect is also more buffy in these specimens.

At Cottonwood the species was found common on greasewood (*Covillea tridentata*), and plentiful at Kelso and in the Bird Spring

[8] *Proc. Acad. Nat. Sci. Phila.*, 1908, p. 384.

Mountains on the same plant. At Cima it was found on small thorny bushes, and at Las Vegas one small colony was located in a low thicket of spiny desert bushes.

The species was originally described from Los Angeles County, California, and has since been recorded from Needles, California, and Yuma, Arizona, by Bruner, and Yuma, Arizona, and Palm Springs and Lancaster, California, by Scudder. Specimens from Yuma examined by the present authors are clearly *kunzei*, and it appears probable that the records from Yuma and possibly from Needles and Palm Springs may be the same. True *coquilletti* appears to be a Mohavan and Nevadan form.

Arphia ramona Rehn.

From the evidence of a series of eighteen specimens of this species before us it is apparent that it enjoys a considerable vertical range and also that it is considerably modified by the same. This series is from the following localities: Pasadena, July 6, 1899 ((Fordyce Grinnell, Jr.), two males; Mt. Lowe, August 8, 4,700 feet, one female, 5,300 to 5,600 feet, one male; Kenworthy, San Jacinto Mountains, 4,500 to 5,000 feet, June 3–8 (Fordyce Grinnell, Jr.), one male, three females; Strawberry Valley, San Jacinto Mountains, 6,000 feet, July 18 (F. Grinnell, Jr.), one male; Santa Ana River, San Bernardino Mountains, 5,500 to 6,200 feet, July 1–14 (Joseph Grinnell), three males, one female; Fish Creek, San Bernardino Mountains, 6,500 to 7,200 feet, June 17 to July 10 (Joseph Grinnell), one male, three females; Mt. Pinos, Kern County, June 6, 1904 (F. Grinnell, Jr.), one female.

When compared with the types from San Diego and a paratypic series of two males and three females, the specimens from points under 6,000 feet elevation are seen to be very similar to the types, the tegmina and wings alone being slightly longer in several of the mountain specimens. The individuals from greater elevations than 6,000 feet show a perceptible reduction in size, which is very apparent when the specimens are arranged serially according to altitude. There also appears to be a slight flattening of the median carina of the pronotum in individuals from the higher regions.

The female specimen from Fish Creek, 7,200 feet elevation, measures as follows: Length of body, 31 mm.; pronotum, 6.2; tegmen, 26; caudal femur, 15.3.

There is a considerable amount of individual variation in the general color, this being blackish or brownish, strongly speckled or nearly uniform, the pale stripe on the anal field of the tegmina also being equally variable in its width, presence or absence.

At 5,300 to 5,600 feet on Mt. Lowe the species was found on a steep rock slide and at 4,700 feet it occurred on a steep slope.

This species has been previously recorded from but two localities—San Diego and Los Angeles, California.

Chimarocephala incisa Caudell.

A single specimen of this species, taken at an elevation of 5,500 feet on the Santa Ana River, San Bernardino Mountains, June 14, by Dr. Joseph Grinnell, has been examined. This individual is quite blackish, with the femoral and pronotal maculations strongly contrasted when compared with individuals from San Diego and Claremont, California.

We have followed Caudell[9] in using this name for the species usually known as *C. pacifica* Thomas.

Encoptolophus californicus Bruner.

A female specimen of this species was taken among sand dunes at Alamitos Bay, July 31, while one male individual was captured along the Mohave River at Cottonwood, September 9. The Cottonwood specimen is smaller than the measurements given by Bruner for the male sex, the length of body being 15 mm., that of the pronotum 3.3, of the tegmen 13 and of the caudal femur 10, although in almost all other respects the specimen is typical. The lateral carinæ of the pronotum are somewhat undulate on the prozona in the male, although nearly straight in the female. Both specimens are in a brownish phase similar to the male type.

The only previous record of the species is that of the type—Los Angeles, California.

Encoptolophus robustus n. sp.

Type: ♀; Los Angeles River near Los Angeles, California. August 24, 1907. (Otho Poling.) [Hebard Collection.]

Closely related to *E. texensis* and *subgracilis*, differing in the more robust build, more prominent and elevated pronotal carinæ, the lateral ones being less divergent caudad than in *texensis*, in the more excavate fastigium and the more inflated caudal femora.

This species is not at all close to *E. pallidus* Bruner, with cotypes of which it has been compared.

Size medium; form robust though slightly compressed. Head with the dorsum considerably arcuate when seen from the side, though not elevated dorsad of the median pronotal carina, interspace between the eyes rather broad though less than the short diameter of the eye; fastigium as much arcuate declivent as the occiput rises to the interspace between the eyes, subpyriform, slightly longer than wide, rather deeply excavate, a distinct median carina present on the

[9] *Proc. Ent. Soc. Wash.*, VII, p. 121.

caudal portion and becoming subobsolete on the occiput; angle of the fastigium and face rounded obtuse; lateral foveolæ trigonal, rather large, moderately excavate; frontal costa as a whole rather broad, moderately and regularly expanding from the distinct fastigio-facial division to the ocellus, below which it is slightly constricted then moderately expanded to the clypeal suture, sulcate throughout except close to the clypeal suture; eyes reniform-elliptical, slightly prominent, somewhat exceeding the infraocular sulcus in length; antennæ distinctly less than the head and pronotum in length. Pronotum with the median carina moderately elevated, rather uniform in height, although the section on the metazona is a trifle lower than that on the

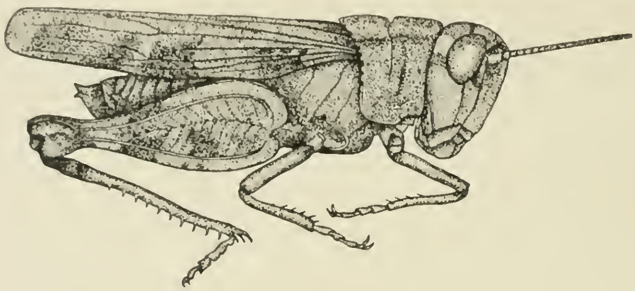

Fig. 11.—*Encoptolophus robustus* n. sp. Lateral view of type. (× 3.)

prozona, the incision being well marked and rather broad; lateral carinæ marked, regularly divergent caudad, the space separating them caudad half again as much as that cephalad, the carinæ being sinuate for a short distance on the caudal portion of the prozona; cephalic angle of the disk broad obtuse, caudal angle of the disk slightly obtuse with the angle narrowly rounded; lateral lobes deeper than long, slightly narrowing ventrad, the ventral margin considerably sinuate cephalad. Tegmina very slightly surpassing the tips of the caudal femora; intercalary vein with the proximal half nearer to the ulnar vein, the distal half equidistant between the ulnar and median veins. Interspace between the mesosternal lobes strongly transverse; interspace between the metasternal lobes quadrate. Caudal femora considerably inflated, the greatest width being about one-third the length; pattern of the pagina well impressed and regular, the expansion of the ventral carinæ slight; caudal tibiæ with nine to ten spines on the external margins.

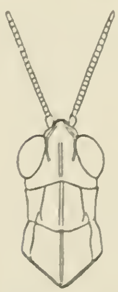

Fig. 12.—*Encoptolophus robustus* n. sp. Dorsal view of head and pronotum. (× 3.)

General color wood brown with the tegminal bars and general mottling bistre. Head with the occiput and face thickly mottled and finely dotted, the postocular region with a poorly defined postocular bar present only on the face, this bordered dorsad with a patch of almost clear wood brown; eyes tawny olive clouded ventrad with bistre; antennæ walnut-brown with obscure broad dark annuli; face with two obsolete and poorly defined transverse blackish bars on the frontal costa ventrad of the antennæ. Pronotum almost uniformly mottled with the general colors, a slight blackish patch present in the middle of each lateral lobe. Tegmina with three dark transverse bars, the two distal ones oblique and the third from the base fading distad, the apical portion with numerous very small dots, the bars not reaching the anal field which has a number of small irregular maculations. Wings bluish-hyaline proximad, the apex with the slightest possible infumation, the stigma brownish. Caudal femora with three dark bands, one median, one pre-apical, one genicular, these bands more distinct and blackish on the dorsum, genicular arches and lower portion of the paginæ, which latter the median one crosses obliquely, the pre-apical one being marked on the ventral surface, though all are present on the ventral sulcus and internal face; caudal tibiæ pale glaucous-blue with a wood-brown proximal annulus which is touched with darker brown, spines blackish for the greater portion of the length.

Measurements.

Length of body,	19 mm.
Length of pronotum,	4.5 "
Length of tegmen,	15.8 "
Length of caudal femur,	11.3 "

In addition to the type two specimens of this species, one male and one female, in the U. S. National Museum collection, from Los Angeles (Coquillett), have been examined. These individuals agree with the type in all essential characters, the female, however, being somewhat larger. The measurements of these specimens are as follows:

	♂	♀
Length of body,	16.3 mm.	21.5 mm.
Length of pronotum,	3.6 "	5 "
Length of tegmen,	14.5 "	18 "
Length of caudal femur,	10.8 "	13.5 "

In color the Los Angeles pair are slightly paler, with the tegminal and femoral bars less plainly indicated in the female, while the glaucous-blue of the caudal tibiæ is paler than in the type. The wing of the male is distinctly very pale yellowish-hyaline proximad.

Camnula pellucida (Scudder).

On Santa Catalina Island this species was found to be extremely local, but plentiful in a small area of short grass, where one male and eight females were taken on August 7. At Mill Valley, August 23, the species was found uncommon on dry grassy hillsides, two females being taken, while a single male was captured at Merced, August 30, in very dry, yellow, oat-like grass.

The Santa Catalina Island and Merced individuals are more yellowish in color than the Mill Valley specimens.

Hippiscus pardalinus (Saussure).

Six specimens, two males and four females, from the San Bernardino Mountains, taken by Dr. Joseph Grinnell, belong to this widely distributed species. One male and two females are from Fish Creek, at an elevation of 6,500 feet, June 18–20; the remaining individuals being from the South Fork of the Santa Ana River, at an elevation of 6,200 to 6,700 feet, July 1–24.

The disk of the wing is orange vermilion in all the specimens instead of yellow as usually described, but in general characters and proportions no other differences are noted. Several of the females have a considerable amount of hoary-white suffusion.

The only previous exact Californian records were from San Diego and Rock Spring, southern California.

Hippiscus neglectus (Thomas).

Four males and four females of this species from the South Fork of the Santa Ana River, San Bernardino Mountains, taken at an elevation of 6,200 feet, on July 6 and August 26, by Dr. Joseph Grinnell, and a pair from Mt. Pinos, the female with a supplementary "Potrero" label, taken June, 1904 (♀ June 7), by F. Grinnell, Jr., have been examined. A considerable amount of variation is present in the series, but nothing other than one would expect in this very variable species. The tegminal stripe is very broadly marked in one male specimen.

This is the first record of this species from southern California, the only previous records from the State being from the Sierran region.

Leprus interior Bruner.

A single male of this species from the foothills of the Bird Spring Mountains, McCollough Range, Nevada, August 11, has been examined. It is very similar in character to a series from the Salt Lake Valley, Utah, and was collected on a bare volcanic mountain side. The specimen is slightly smaller than the original measurements of the male sex given by Bruner. This is the first record of the species from Nevada, and in fact from any locality but the Salt Lake Valley.

Leprus glaucipennis Scudder.[10]

A series of eleven males and eight females of this species are included in the collection, taken at the following localities: Tia Juana, August 16, two ♂, one nymph; El Toro, August 20, one ♂, one ♀; Santa Catalina Island, August 3 and 7, six ♂, one ♀; Pasadena, August 1, two ♂, three ♀, one additional ♀ taken June 10, 1898, by F. Grinnell, Jr., and Echo Mountain, San Gabriel Range, elevation 3,100 feet, August 8, two ♀.

At Tia Juana it was found on rocky hillsides, while at El Toro it occurred in rolling grain fields. On Santa Catalina Island it was uncommon in dry places, among rocks and scant grasses in a canyon bed, the sides of the mesa of the San Rafael Hills being frequented at Pasadena where it was very scarce. On Echo Mountain the species was numerous at 3,100 feet elevation.

There is some variation in general size and in the length of the wing in this species, the general coloration also exhibiting a tendency to red-brown suffusions, particularly on the head and pronotum, while the disk of the wing shows less greenish and more bluish in some specimens than in others. The latter is particularly true of one Pasadena female specimen.

This species has been recorded from Point Loma, La Jolla, Los Angeles, Rubio Wash, Altadena, Santa Catalina and Santa Rosa Islands, California, and Hermosillo, Sonora and Durango and San Luis Potosi, Mexico. Two females from San Diego have been examined by the authors.

Dissosteira spurcata Saussure.

A series of fifteen males and nine females was taken in a field of stubble at Raymond, September 3, and a single female was secured in a field of very dry, yellow, oat-like grass at Merced, August 30.

This species exhibits a great amount of variation in size and color, the measurements of the extremes of each sex being as follows:

[10] The specimens from the Huachuca Mountains, Arizona, recorded by the senior author (*Proc. Acad. Nat. Sci. Phila.*, 1907, p. 37) as *L. glaucipennis*, when examined with the present series are seen to be *L. cyaneus*.

	♂	♂	♀	♀
	mm.	mm.	mm.	mm.
Length of body,	27	33	32	39
Length of tegmen,	29	33.5	29	35.5

The measured specimens are all from Raymond.

Three of the Raymond males and two of the females are extremely pale in color, almost uniform straw-yellow in general tone, the pronotal, tegminal and femoral maculations being of the very faintest character. The wings of these pale individuals are either clear yellowish-hyaline without any maculations or with very faint indications of the fuscous cloud of the normal type. This yellowish phase is approached by two of the Raymond females, the remainder, however, of both sexes being of the normal type.

The habits of this species have been described by the authors in a previous paper.[11]

This species has been reported from the San Joaquin-Sacramento Valley between Merced and Redding.

Dissosteira venusta (Stål).

This species has been examined from a number of localities extending from Miramar and San Diego to Mill Valley, California. The series is distributed as follows: Miramar, July 31, ten ♂, 7 ♀; Pasadena, August 1, five ♂, ten ♀; Rubio Canyon, San Gabriel Mountains, August 8, three ♂; Santa Catalina Island, August 3, four ♂, seven ♀; Raymond, September 3, three ♂; Ahwahnee, September 3, one ♀; Miami, September 3, one ♀; Summit House, September 3, three ♂, one ♀; Sentinel, August 31, one ♂.

Specimens from the vicinity of Pasadena and Miramar are as a rule larger than those from the other localities, resembling in this respect specimens from San Diego. Santa Catalina Island individuals are smaller than representatives from the adjacent mainland, while the specimens in the Mill Valley series are appreciably smaller than the southern Californian mainland material. Specimens from the west slope of the Sierras are very similar in size to Mill Valley individuals. The following measurements may be of interest:

	♂			
	Mill Valley.	Raymond.	Summit House.	Rubio Canyon.
	mm.	mm.	mm.	mm.
Length of body,	18	20	18	18.6
Length of tegmen,	19.2	20.5	19.5	18.9
Length of caudal femur,	11	12	11.2	10.5

[11] *Proc. Acad. Nat. Sci. Phila.*, 1906, p. 378.

♂	Pasadena.	Miramar.	Santa Catalina Island.	San Diego.
	mm.	mm.	mm.	mm.
Length of body,	19	22.2	17.5	20
Length of tegmen,	19.5	21.5	17.6	20
Length of caudal femur,	11.5	13	10.5	11.5

♀	Mill Valley.	Summit House.	Ahwahnee.	Miami.
	mm.	mm.	mm.	mm.
Length of body,	24.8	25.5	26	24.5
Length of tegmen,	22	23.5	23.8	25 5
Length of caudal femur,	14	12.8	13.5	14

♀	Pasadena.	Miramar.	Santa Catalina Island.	San Diego.
	mm.	mm.	mm.	mm.
Length of body,	27.2	28	24 5	29.8
Length of tegmen,	26.5	28	26	29
Length of caudal femur,	16.2	16.2	14	17.2

There is an appreciable amount of individual variation in each lot, but apparently average specimens have been selected for measuring.

The caudal angle of the disk of the pronotum varies somewhat in the degree of angulation, one extreme being subrectangulate, the other distinctly obtuse, the apex more or less rounded. The median carina of the pronotum is rather variable in elevation and inflation, and in a single female from Ahwahnee, which has the pronotal crest quite low, the prozonal portion is uniform and not arcuate.

The general base color varies from dull blackish-brown to ochraceous-buff, the maculations more or less prominent in all but a few individuals which have them quite weak. The color variations, as far as can be determined, are not correlated geographically, dark and pale individuals being present from localities represented by a series of any size. There is also some variation in the intensity, fenestration and shape of the fuscous band of the wing and also a little in the width of the same.

This species is usually common where found and is very active and elusive, flying short distances and alighting precipitately. It occurred on dry grass hillsides at Mill Valley and in tarweed, stubble and meadow land on the west slope of the Sierras. At Miramar it was found back from the shore, along the border of a field of dry grass near high weeds, while in Santa Catalina Island it frequented dry places among rocks and grasses.

The range of this species in California is entirely west of the Sierras and Sierra Madre and San Jacinto ranges, as far as known not occurring in the true desert regions. Coquillett has recorded it from the San Joaquin-Sacramento Valley from Redding to Merced and from Los Angeles, while Baker has credited it to Claremont and Rehn to San Diego. Stål described it from San Francisco. We have followed Bruner[12] in placing this species in the genus *Dissosteira*, to which it appears to be more closely related than to *Spharagemon*.

Lactista gibbosus Saussure.

This species is represented by a considerable series distributed as follows: Tia Juana, August 16, one ♀; Los Angeles River, Los Angeles, August 24, two ♂, three ♀; Pasadena, August 1, twelve ♂, seventeen ♀; near Rubio Canyon, August 8, four ♂, two ♀; Echo Mountain, 2,700 to 3,500 feet, August 8, two ♂.

There is considerable individual variation in size, this, however, being more noticeable in the male than in the female, while in color the only noticeable variation is a tendency toward a blackish coloration in some individuals and washing with ochraceous in others.

At Pasadena the species was found to be common on the slopes of the San Rafael Hills, while it was equally numerous on Echo Mountain. At Tia Juana it occurred on a rocky hillside overgrown with bushes which were dry and parched.

The species has been recorded from Los Angeles, San Diego and Claremont, southern California.

Mestobregma rubripenne (Bruner).

A single male and three females of this species were taken at Cima, August 12, in low bushes near the railroad, and a single female was secured in the foothills of the Bird Spring Mountains, California, August 11, in sand. At Cima the species was extremely local.

The Californian specimens are all very slightly smaller than representatives from the Huachuca Mountains, Arizona, and also appreciably paler, but no other characters of importance show differences worthy of mention. The pattern, form of the caudal femora, height of the median carina of the pronotum and width of the wing-bar are the same as in the Arizona material. The disk of the wing is yellow or yellowish in all but one specimen.

[12] *Biol. Cent. Amer., Orth.*, II, p. 163.

The previous records of the species are all from southeastern and southern Arizona.

Trepidulus rosaceus (Scudder).

At Las Vegas, Nevada, August 10, this species was found numerous in bare desert places, both the typical phase with the wing roseate proximad and one with the same portion hyaline with an extremely faint whitish suffusion being taken. The series numbers twenty-five males and seven females, each phase represented by sixteen individuals. Fourteen males and two females have the wings roseate and eleven males and five females have the same members hyaline.

There is little variation in size, although the tegmina and wings vary somewhat in length. The degree of production of the ventro-caudal angle of the lateral lobes of the pronotum varies considerably and in a number of specimens the angle is well rounded. The character of this angle cannot be correlated with the color of the wings. The general color is more ashy in some individuals than in others, sometimes touched with dull reddish and again with the maculations more decided than in others. The Nevada specimens as a rule are paler than representatives from southeastern Arizona, but they are well matched in individuals from the lower Arizona deserts at Yuma and Florence.

Derotmema delicatulum Scudder.

The published records and the material at hand indicate that this species is well distributed over the lower portions of the Mohave desert and a considerable area of the Gila desert. A series of fifty-four Californian and Nevadan specimens is now before us, the following localities being represented: Cottonwood, September 9, two males, two females; Goffs, San Bernardino County, California, September 10, one female; Kelso, August 12, five males, seven females; North Range of Providence Mountains, August 12, six males, four females; foothills Bird Spring Mountains, California, August 11, two males, six females; foothills Bird Spring Mountains, Nevada, August 11, ten males, eight females; Arden, Lincoln County, Nevada, August 9, one female. When compared with two pairs from Sentinel, Maricopa County, Arizona, the eyes of all the Californian and Nevadan individuals are seen to be slightly less prominent than in the Sentinel specimens, but in all the essential characters they fully agree. The geographic and individual differences in size are very slight, but the caudal margin of the disk of the pronotum varies from broadly obtuse-angulate to subarcuate. The Kelso and Goffs individuals are paler than the others, in this respect resembling the Sentinel specimens.

although the latter have the pattern more decided than the former. The Bird Spring Mountains series has as a rule a pale ferruginous appearance, although a few are somewhat ashy, while the North Range and Goffs specimens are decidedly ashy, the former, however, with the pattern well contrasted, in the males as strongly as in the Sentinel individuals. The Kelso series is whitish or pale buffy yellow in general tone, while the Cottonwood specimens more nearly resemble the Bird Spring Mountains series than any of the others. The Arden specimen is much like Kelso individuals, but the head and portions of the pronotum and cephalic and median limbs are suffused with dull vermilion.

As far as examined the bar on the wing appears to be uniform in size, while the disk is very slightly more yellowish than in the Sentinel specimens.

At Kelso, in the Bird Spring Mountains, and in the North Range of the Providence Mountains the species was found on the ground and also on small desert weeds, frequently in arroyos.

The previous Californian records of the species are from Mohave and Lancaster.

Derotmema laticinctum Scudder,

It was with considerable surprise that this species was recognized in the series of Orthoptera taken at Cima, California, on August 12. This locality is represented by a series of sixteen males and four females which fully agrees with eastern Arizona and New Mexico material. At Cima the species was plentiful.

This is the first record of the species from California.

Derotmema saussureanum Scudder.

This southern Californian species is represented by a series of thirty specimens taken as follows: Pasadena, August 1, eleven males, thirteen females; near Rubio Canyon, altitude 1,400 to 1,600 feet, August 8, two females; Los Angeles River, Los Angeles, August 24, one male; Beaumont, Riverside County, July 30, one male; Devore, San Bernardino County, September 9, one male; summit Cahon Pass, September 9, one female.

There is considerable variation in the base color in the series, the Pasadena representation exhibiting numerous modifications, ashy, buffy, dull reddish-brown and sometimes overcast with a hoary suffusion.

At Pasadena the insect was found common on dry spots in and near the Arroyo Seco.

The species has previously been recorded from San Bernardino, Colton, Claremont, Los Angeles, Rubio Wash, Anaheim, San Diego, Coronado and Cahon Pass.

Conozoa behrensi Saussure.

A series of fifty-nine specimens is now before us, distributed as follows: Altadena, August 25 (Poling), nine males, sixteen females; Pasadena, August 1, fifteen males, five females; Alamitos Bay, July 31, five males, five females; Tia Juana, August 16, one male, two females; Cottonwood, September 9, one male; Tracy, Alameda County, August 30, one female. There is considerable individual variation in size in both sexes, the extremes of the series of females from Alamitos Bay, for example, measuring as follows:

Length of body,	26 mm.	30 mm.
Length of pronotum,	5.1 "	7 "
Length of tegmen,	25.2 "	30 "
Length of caudal femur,	14.8 "	17.8 "

In color numerous shades of umber, gray-brown, dull ferruginous and occasionally pale ochre occur as the principal value, the maculations being very pale in some individuals and strongly marked in others. The coloration of this insect appears to be profoundly modified by its environment, an individual from the sandy Arroyo Seco at Pasadena being in the pale ochre phase. The tegminal maculations are as a rule quite distinct, though varying considerably in length, the width, however, showing but little variation, while the positions of the bars appear to be fixed.

The fuscous band of the wing varies considerably in width and intensity, while the depth of the yellow color of the disk is distinctly variable. The caudal tibiæ are purplish pink in some specimens and vermilion in others, the latter in by far the greater majority of the specimens. The very pale Arroyo Seco specimen has the caudal tibiæ rather dark flesh color, yellowish toward the base, no blackish genicular patch present. The latter is strongly marked in the majority of the specimens.

At Tia Juana the species was found in a dry river bottom, some of the Pasadena individuals being from a similar situation, while at Alamitos Bay it frequented scant vegetation on the beach dunes. Its occurrence at Cottonwood in typical Mohavan surroundings is rather surprising as the species is only known elsewhere from the San Joaquin Valley and the slopes and valleys facing the Pacific.

This species has been definitely recorded from San Diego, Claremont and Guadelupe, California.

Conozoa sulcifrons (Scudder).

At Las Vegas, Nevada, a series of ten males and ten females of this species was taken on August 10, while a single male was collected at Indio on July 29.

When compared with a considerable series from Yuma, Arizona, no differences are noticeable.

The previous Californian records of the species were from near the Mohave River (type locality) and Indio. No Nevada records have previously been published.

Trimerotropis cristata McNeill.

Two males and two females of this very pale colored species were taken, August 10, at Las Vegas, Nevada, in typical desert surroundings.

The specimens are quite uniform in coloration and size.

The previous records of the species are from San Julio, Lower California, and Salt Lake Valley, Utah.

Trimerotropis albolineata (Bruner).

Three females of this species were taken in the Arroyo Seco at Pasadena, August 1, while a single male was secured at Beaumont, Riverside County, California, on July 30. Two females taken at Pasadena, June 21 and July 1, by Fordyce Grinnell, Jr., have also been examined.

Some individuals are much more ferruginous than others, and the pattern of the lateral lobes of the pronotum is fainter in one of the Pasadena specimens than in the other individuals examined.

This species is now known from Los Angeles, Pasadena, Ontario, San Bernardino County, Beaumont, Riverside County, and San Diego, California, and southern Arizona.

Trimerotropis cæruleipes Scudder.

An interesting series of seventy-eight specimens of this species is now before us, all but ten of which were taken by the authors. The localities represented are as follows: Mt. Tamalpais, 2,100 to 2,500 feet elevation, August 23, five males and one female; Sentinel, Yosemite National Park, August 31, two males; Yosemite Valley, 4,000 to 5,400 feet, September 1, six males, six females; Grouse Creek, Yosemite National Park, September 1, two males, one female; Eight-Mile Camp, Yosemite National Park, September 1, four males, three females; Mariposa Grove, September 2, four males, four females; Miami, September 3, three males, three females; Mt. Lowe, 5,200 feet to summit, August 8, two males, three females; Echo Mountain, August 8, four males; Mt. Wilson, 5,000 feet, September 15, one male; Pasadena, August 1, one male, June 23, one male and three females, collected by F. Grinnell, Jr.; Santa Catalina Island, August 3 and 7, three males, one female; Strawberry Valley, 5,000 feet, San Jacinto Mountains, July 7–9, F. Grinnell, Jr., one male, two females. A single male from Ormsby County, Nevada (Baker), and another of the same sex from Cuyamaca Mountains, San Diego County, California, October 1, 1900 (G. W. Dunn), have also been examined.

In a recent paper[13] Mr. Caudell has shown that *Trimerotropis tessellata* is not a valid species, and the material before us contains not only additional evidence on this point, but also enough to relegate *T. calignosa* to the synonymy as well, while even the recognition of the two "forms" as varieties appears undesirable, the intermediates being so numerous and graduated.

Almost one-half of the specimens in hand are spread, so the character of the fuscous band of the wing, the opacity of the disk and the amount of infuscation of the apex can be readily observed in a number of individuals.

The dark form, called *calignosa* by McNeill, with blackish coloration, the disk of the wing transparent faintly colored with greenish, and the faintly fuliginous apex with the extreme tip slightly infuscated, is represented by individuals from Mt. Tamalpais, Miami, Mariposa Grove, Mt. Lowe, Mt. Wilson and Pasadena. One female from Miami, another from Grouse Creek and a male from Yosemite Valley have the metazona of the pronotum ferruginous, strongly contrasted with the blackish general coloration.

The remaining specimens present a great complex of color tones, the dark shades being umber and vandyke brown, while the light bars are hoary, buffy and pale ferruginous. The wing band varies from very weak to well marked, while the apex is hyaline or more or less strongly fuliginous, sometimes with the greater portion of its surface infuscate. When the wing band is well defined the apex is usually hyaline, but this is not invariable. The shade of yellow of the disk of the wing varies considerably, a few specimens, aside from the *calignosa* type individuals, having it very weak.

This species was found particularly common throughout the conifer forests of the Yosemite region, in company with the slightly less plentiful and less widely distributed *Trimerotropis fallax*. Both of these

[13] *Proc. U. S. Nat. Mus.*, XXXIV, p. 75.

species were found in numbers on the bare needle-strewn ground under the conifers, especially in sunny spots. It was easier to capture *T. cæruleipes*, but owing to their numbers series of both species were taken without difficulty. The previous Californian records of the species are from Sissons, Marble Valley, El Dorado County, Los Angeles and Cuyamaca.

Trimerotropis bifasciata Bruner.

A pair of this species were taken in dry brush and grass between Rubio Canyon and Altadena, at an elevation of about 1,500 feet, August 8.

This species was scarce, but two specimens only being seen. The previous records are from Los Angeles and Tehama County, California, and Spokane, Washington.

Trimerotropis koebelei (Bruner).

This species was found to be common at Sentinel, Yosemite National Park, August 31 and September 1, a series of eighteen males and three females being taken, as well as a single female at another point in the Yosemite Valley on the last mentioned date.

Wherever collecting was done about Sentinel this species was found and taken without difficulty.

The series exhibits a moderate amount of variation in size, and the lateral lobes of the pronotum have the ventro-caudal margin either with a distinct obtuse angulation or well rounded, the great majority having this region very slightly angulate. The coloration varies somewhat in depth and slightly so in pattern, although the last is chiefly due to intensification or weakening. In but one specimen has the anal area of the tegmina any marked maculations, and then but a number of scattered spots. The black bands between the eyes, one above the antennæ, the other below the same, are often almost as distinct as in *T. cincta*. The dorsal one, however, is frequently absent, but the ventral one is present more or less distinctly in all but one male specimen, which latter with one of the females is remarkable in having the pronotum and head ochraceous-yellow. The broad white bars on the sides of the face are distinct in all but the two individuals mentioned above, although weak in a very dull colored female. The black markings on the lateral lobes of the pronotum are present in practically all the specimens, while the tegminal bars are distinct in all the specimens, although rather weak in several, the width of the bars varying considerably. The three femoral bars—median, preapical and apical—are marked in the majority of the specimens. The wing band is uniform in the spread specimens, but not strongly indicated or greatly contrasted.

The previous records of the species are from Placer County, Dunsmuir, Siskiyou County, and San Francisco, California.

Trimerotropis thalassica Bruner.

This interesting and peculiar species, concerning which practically nothing has been published, is represented by a series of forty-nine specimens from several different regions. Two males were taken, August 23, on Mt. Tamalpais, one at 1,500, the other at 2,100 feet elevation. On Mt. Lowe, August 8 and 24 and September 1, this species was taken at elevations ranging from 4,300 to 5,600 feet, a series of twenty males and twelve females being secured. Two males were taken August 8, in Rubio Canyon, between 2,200 and 3,000 feet, while three of each sex were secured on Santa Catalina Island, August 3. Two males and a female taken at 5,000 feet on Mt. Wilson, September 15, 1908, and four females from Arroyo Seco Canyon, San Gabriel Range, 3,000 feet elevation, October 8, taken by Fordyce Grinnell, Jr., have also been examined.

The favorite habitat of this species was found to be practically the same as that of *Morsea californica*. The insect was found plentiful, especially on Mt. Lowe among the manzanita bushes on the higher slopes. Owing to their lack of wariness and usual short flight specimens were easily taken. They were noted to alight almost invariably upon the manzanita bushes.

The Mt. Tamalpais specimens are quite small when compared with the Mt. Lowe individuals; the Mt. Wilson, Arroyo Seco Canyon and Rubio Canyon representatives also being appreciably smaller than the Mt. Lowe series, but the difference is not as great as in the Mt. Tamalpais specimens. The Santa Catalina Island specimens are also smaller than the average Mt. Lowe individual. Average individuals from the localities represented measure as follows:

♂

	Length of body.	Length of tegmen.	Length of caudal femur.
	mm.	mm.	mm.
Mt. Tamalpais,	16.5	17.5	9
Mt. Lowe (summit),	20.8	22	11.3
" (4,000 to 4,800 feet),	20.6	22.5	11.8
Mt. Wilson (5,000 feet),	21.8	22	11.2
Arroyo Seco Canyon (3,000 feet),	21	22	11
Rubio Canyon (2,200 to 3,000 feet),	19.5	21	10.8
Santa Catalina Island,	17.2	18	10

		♀	
	mm.	mm.	mm.
Mt. Tamalpais, ...	....	....	....
Mt. Lowe (summit), ...	27.5	28	14
" (4,000 to 4,800 feet), .	28	28.2	15.5
Mt. Wilson (5,000 feet), ...	27	27.5	14.8
Arroyo Seco Canyon (3,000 feet), .	....	....	....
Rubio Canyon (2,200 to 3,000 feet),	....	....	....
Santa Catalina Island, ...	26	26	14.5

The Mt. Lowe series also exhibits considerable individual variation in size in the specimens taken on the summit, the extremes of the males measuring as follows: Length of body, 17–22 mm.; length of tegmen, 20–25 mm.; length of caudal femur, 10.3–13 mm. In none of the other lots of specimens does individual variation play such a decided part, although the Arroyo Seco Canyon and Santa Catalina representatives show it in a lesser degree.

The basic color pattern has already been described by Bruner, but the tegminal bars show almost endless variations in width, intensity and solidarity, while the base color varies from pale ochraceous-buff shades to dull blue-gray, frequently pale pinkish-red. The fuscous band of the wing is also of variable intensity, being distinct and continuous, although not sharply defined, or nearly lacking, indicated only by a cloud at the stigma and another one just beyond the middle of the wing. The Santa Catalina series has the tegminal bars broader and more contrasted than in any of the other specimens.

The principal features of the species which strike one at first glance are the deep head, the usually pale and often black-dotted caudal margin of the pronotal disk, the peculiar granular character of the coloration and the coloration of the caudal femora.

The only previous record of this species is the original of Bruner, who described it from Los Angeles, California. Los Angeles County was probably intended.

Trimerotropis latifasciata Scudder.

A single female of this species was taken at Las Vegas, August 10. While somewhat larger than Scudder's measurements, this individual agrees very well with his description.

This species has been recorded from Wallula, Washington, Salt Lake Valley and Lake Point, Utah, and from Nebraska, although specimens from the last mentioned State may be *T. laticincta* Saussure, if the two forms are considered separable.

Trimerotropis californica Bruner.

This interesting species is represented by a series of twenty-eight specimens from the following localities: Pasadena, July 14, 1898, F. Grinnell, Jr., two males; Pasadena, August 1, 1907, nine males, seven females; Los Angeles River, August 24, one male, one female; near Rubio Canyon, San Gabriel Mountains, 1,000 to 1,600 feet, August 8, four males, two females; Altadena, August 8, one male; summit Cahon Pass, September 9, one male. There is a moderate amount of variation in size and also a great deal in coloration, although the latter is chiefly in the depth of the pattern. Some individuals have the tegminal bars poorly contrasted, but in all they are fairly well defined, though made up of annuli in some individuals. There is some individual variation in the width of the tegminal bars and in the number and position of the quadrate annuli in the apical portion. One of the Pasadena females is entirely suffused with ferruginous, others are partially so, while some are quite dull and others hoary-white. The Cahon Pass specimen is a typical individual, in a grayish type of coloration seen in a pair from Claremont. The wing-band varies to an appreciable extent in width and also somewhat in position.

The species was nowhere really plentiful and was found to be local in distribution, restricted usually to dry places, particularly in the Arroyo Seco at Pasadena. Although moderately vigorous it was more difficult to find than to capture.

This species has been recorded from San Luis Valley, Claremont, Los Angeles and Ontario, California.

Trimerotropis strenua McNeill.

This Great Basin and interior desert form is represented by four males from the Mohave desert and the region to the north, two taken at Cima, August 12, on a plateau of tree yucca, one at Cottonwood, September 9, and the other in the foothills of the Bird Spring Mountains, Lincoln County, Nevada, August 11.

The Cima specimens are inseparable from Salt Lake City individuals, but a tendency toward *californica* is noted in the Cottonwood specimen. The latter has the wing-band narrower than in typical individuals, but the general facies is more distinctly that of *strenua* than that of *californica*, although the former is probably nothing more than a geographic race of the latter.

In action the species was more vigorous than *T. californica* and is apparently a very much scarcer form. The specimens captured at Cima were taken on the tree yucca plateau among brush.

This species is now known from Salt Lake City and Valley and Beaver Creek Hills, Utah, Tucson and San Bernardino Ranch, Arizona, and Cima and Cottonwood, California.

Trimerotropis inconspicua Bruner.

Among the tree yuccas at Cima seven males and two females of this species were taken on August 12. At first glance two species appear to be represented in the series, one typically having the tegminal bars more sharply defined and usually broad, the wing-band rather broad and hardly interrupted and the ventral sulcus of the caudal femora blackish with two yellowish interruptions; the other type having the general coloration paler and more uniformly buffy and hoary-white, the tegminal bars narrower and frequently divided into the component annuli, the wing-band narrow, reduced in length and broadly interrupted, and the ventral sulcus of the caudal femora yellowish white with a single blackish interruption. When compared with all the specimens in the series these apparently separate types are found to have absolutely no structural characters to separate them, and one specimen having the tegminal bars as in the first has the wing-band nearer to that of the second described, while several other specimens apparently belonging to the second type have a decided blackish cloud at the base of the femoral sulcus.

This species has previously been recorded from the Grand River region of western Colorado and Bright Angel, Grand Canyon, Arizona.

Trimerotropis vinculata Scudder.

This widely distributed species is represented by a considerable series of specimens distributed as follows: Mill Valley, August 23, one male; Merced, August 30, one female; Tracy, Alameda County, August 30, one female; Echo Mountain, August 8, two males; Rubio Canyon, August 8, four males; Altadena, August 25, one female; Pasadena, July 18, one male and two females, F. Grinnell, Jr.; Pasadena, August 1, four males, seven females; Alamitos Bay, August 31, one female; Miramar, August 31, eight males, five females; Santa Catalina Island, August 3, twenty-five males, six females; South Fork, Santa Ana River, 6,200 feet, San Bernardino Mountains, July 2, J. Grinnell, one male; Fish Creek, 8,500 feet, San Bernardino Mountains, June 27, J. Grinnell, one male; Indio, August 29, four males; Cottonwood, September 9, one male; Cima, August 12, two males, four females; North Range, Providence Mountains, August 12, one male, one female; foothills Bird Spring Mountains, Nevada, August 11, one female; Arden, Lincoln County, Nevada, August 9, one male; Las Vegas, Nevada, August 10, four males.

This series includes individuals representing a number of color variations, both in pattern and tone, and also exhibiting great diversity in size. The measurements of certain specimens are here given:

	Length of body.	Length of tegmen.
♂		
Santa Catalina Island,	21 mm.	22 mm.
Miramar,	21 "	23.3 "
Pasadena,	24.2 "	26.7 "
♀		
Santa Catalina Island,	28.5 "	29.5 "
Miramar,	30.5 "	32.5 "
Pasadena,	30 "	35 "

The Santa Catalina series is as a whole distinctly smaller than any of the other comparable lots, considerable individual variation being noted, the measured specimens, however, being average ones. The specimens from the coast of the adjacent mainland, *i.e.*, Miramar and Alamitos Bay, are but little larger than the Catalina individuals, although there is also a considerable amount of individual difference, while the majority of the Pasadena representatives are considerably larger than any others in the series before us.

As a rule the Catalina, Miramar and Pasadena individuals are duller than specimens from the San Bernardino Mountains, Cima, Indio, Providence and Bird Spring Mountains and Las Vegas. The single Arden specimen has the cephalic portion of the body and limbs well sprinkled and partially washed with pinkish-red.

Trimerotropis vinculata form **similis** Scudder.

This form has rightly been reduced in rank to a variation of *vinculata* by Caudell,[14] and from material before us it appears to have an extensive range.

Two males were taken on Santa Catalina Island, August 3, and a single female at Miramar, July 31. Specimens have also been examined from San Diego and Claremont, California, Albuquerque, New Mexico (Oslar), and El Paso, Texas (Viereck and Rehn).

Trimerotropis fallax Saussure.

We have before us a series of thirty-two individuals of this peculiar species. The following localities are represented: Yosemite Valley, 4,000 to 5,400 feet, September 1, four males, four females; Sentinel, Yosemite National Park, September 1, one male; Eight-Mile Camp, Yosemite National Park, September 1, three females; Grouse Creek,

[14] *Proc. U. S. Nat. Mus.*, XXXIV, p. 76.

Yosemite National Park, September 1, five males, four females; Mariposa Grove, September 2, two males, two females; Miami, September 3, one female; Ahwahnee, September 3, one male; South Fork, Santa Ana River, San Bernardino Mountains, 6,200 to 6,700 feet, June 28–July 24, 1906, J. Grinnell, three males, two females.

We have mentioned the habitat and abundance of this species in the notes on *Trimerotropis cœruleipes*. In actions this insect much resembled species of *Circotettix* and appears to be very close to that genus. It makes a distinct clatter when in flight.

Yosemite Valley specimens are uniformly more reddish than individuals from the other localities, although closely approached in some Mariposa Grove specimens. A number of individuals have the pronotum reddish or dull ochraceous. The coloration of the tegmina is rather uniform considering the size of the series, the annular dark fuscous spots being regularly distributed, a tendency to form transverse bars being noted in but two specimens, these from the San Bernardino Mountains. There is some variation in the depth of the yellow on the disk of the wing, but the majority of the specimens are quite uniform in this respect, sulphur yellow being the color found in the greater number. The fuscous wing-band frequently has numerous pale cellular spots distributed over it, the veins being darker than the cells, but a number of individuals have the band nearly solid, and in all it is well defined and decidedly indicated. The apical portion of the wing is nearly uniform infumate in the series from the Yosemite and adjacent regions, while it is much paler and semi-hyaline in several San Bernardino Mountains specimens, although one individual from the latter region is similar to the Yosemite majority. In some specimens the pale cellular areas are also indicated in the apical region. This species has been recorded from "California" and Placer County, California.

Trimerotropis cæruleipennis Bruner.

This interesting species was common on Santa Catalina Island, where a series of forty-seven males and thirty-two females was taken on August 3 and 7. Generally speaking it frequented the steeper slopes of the island. These insects were not as active as some individuals of the species taken a few years ago at Salt Lake City. Two males were also taken in the greasewood section at Cottonwood, September 9, where they were the only individuals of the species seen.

When compared with two females from Salt Lake City, the Santa Catalina Island specimens are seen to be decidedly smaller, while the Cottonwood individuals are, allowing for the difference in sex, nearer the Salt Lake representatives in size. Average individuals measure as follows:

	Length of body.	Length of pronotum.	Length of tegmen.	Length of caudal femur.
			♂	
	mm.	mm.	mm.	mm.
Santa Catalina Island, Cal.,	17.8	4.1	19.5	10.5
Cottonwood, Cal., ...	24	5	25.5	13
Cottonwood, Cal., ...	21	4.5	23	12
			♀	
Santa Catalina Island, Cal.,	21.7	5	23.5	12.2
Salt Lake City, Utah, . . .	28.5	5.5	30.2	14.8

The Cottonwood individuals are similar to the Salt Lake specimens in general coloration, while the Santa Catalina series has, as a rule, the tegminal markings duller, less contrasted and less sharply defined, the whole coloration being somewhat more grizzled and less generally contrasted, particularly in the female, than is the case with Great Basin and Mohave Desert specimens. The color of the disk of the wing varies considerably in depth, in fact from very pale greenish blue to rather deep cerulean blue, while the fuscous band and spur is represented in some specimens by mere infuscations of the veins and in others by a well-defined and rather deep cloud which falls but little short of the caudal margin. The caudal tibiæ exhibit a considerable amount of variation in the depth of the coloration.

This species has been recorded from localities extending from Washington to Montana and Wyoming south to southern California and Arizona. The previous Californian records are from Los Angeles, Claremont, Santa Catalina Island and Sisson.

Trimerotropis cyaneipennis Bruner.

Two males and one female of this species were taken on volcanic foothills of bare black rock with hardly any vegetation near the North Range of the Providence Mountains, August 12.

These individuals measure as follows:

	Length of body.	Length of pronotum.	Length of tegmen.	Length of caudal femur.
♂ . .	19 mm.	3.9 mm.	20 mm.	10.6 mm.
♂ . .	21 "	3.9 "	21 "	11 "
♀ . .	24.5 "	4.7 "	25.5 "	12.5 "

In general coloration the Providence Mountains specimens resemble individuals from Salt Lake City, although considerably smaller.

The wing-band is narrow in all the Californian specimens, while the apex of the wing is hyaline. The color of the disk is similar to that seen in specimens from the Huachuca Mountains, Arizona.

The previous records of the species cover localities extending from northern Utah to southern New Mexico and Arizona, this being the first record of the species from California. The elevation at which the Providence Mountains specimens were taken, 2,000 to 2,300 feet, appears to be lower than any from which the species has previously been recorded. The species was found to be scarce.

Trimerotropis pseudofasciata Scudder.

A pair of specimens from Coronado Beach, where they were taken in beach vegetation among sand dunes, August 15 and 16, are referred to this species. These specimens have a distinct but rather weak wing-band which reaches the caudal margin, but is hardly continued at all toward the anal angle. This band is narrowly severed immediately caudad of the spur, the latter extending nearly half the distance to the base, while the apex is hyaline except for the infuscation of some of the veins.

The measurements of the Coronado Beach specimens are as follows:

	Length of body.	Length of pronotum.	Length of tegmen.	Length of caudal femur.
♂ . . .	19 mm.	4 mm.	19.5 mm.	11 mm.
♀ . . .	25 "	6 "	29.5 "	15 "

The species has been recorded from localities extending from Washington to southern California, east to Colorado. The specimens taken were quite feeble, probably due to recent emergence.

Circotettix shastanus Bruner.

Three males of this species were taken on bare, almost precipitous walls of rock at 4,800 feet elevation in the Yosemite Valley, September 1. In such locations specimens were plentiful, keeping up a constant loud clattering. Owing to their vigorous flight and the character of the environment they were very difficult to capture. The specimens are quite uniform in coloration, though exhibiting some little individual variation in size, agreeing fully in all respects with Bruner's and Scudder's descriptions of the species.

Originally described from Hazel Creek, Shasta County, California, the species has since been recorded by Scudder from Siskiyou, Oregon, and Yosemite Valley.

Circotettix splendidus n. sp.

Types: ♂ and ♀; Mt. Lowe, 5,300 to 5,600 feet, San Gabriel

Mountains, Los Angeles, California, August 8 (♂) and September 1 (♀), 1907. Hebard (♂) and Poling (♀), collectors. [Hebard Collection.]

Related to *C. shastanus* Bruner and *rabula* Rehn and Hebard, differing from the former in the broader tegmina, the free upper branch of the first subjacent radial vein and in the more deeply sulcate frontal costa, while from the latter it differs in the narrower interspace between the eyes, in the more distinct wing-band and decided general color pattern and in the glaucous caudal tibiæ.

Size large; form moderately robust; surface finely rugulose. Head with the occiput distinctly arcuate, interocular space distinctly narrower than the shortest diameter of the eye in both sexes, not quite as high as the summits of the eyes; fastigium considerably declivent, slightly longer (♂) or no longer (♀) than broad, divided longitudinally into two parts by a marked medio-longitudinal carina which extends caudad becoming obsolete on the occiput, each side of the fastigium independently concave in section, lateral margins moderately elevated; lateral foveolæ trigonal, elongate (♂) or subequilateral (♂), moderately impressed; frontal costa of moderate width,

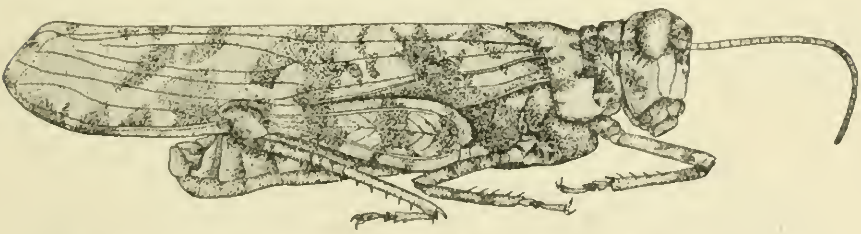

Fig. 13.—*Circotettix splendidus* n. sp. Lateral view of male type. (× 2½.)

slightly (♂) or considerably (♀) narrowed dorsad and ventrad of the ocellus, the margins very slightly or considerably divergent ventrad, around the ocellus and ventrad of the same the surface is deeply and rather broadly sulcate; accessory facial carinæ prominent; eyes not very prominent, of moderate size, ovate subreniform in outline, in length slightly (♀) or distinctly (♂) longer than the infraocular sulcus; antennæ somewhat longer than the head and pronotum together. Pronotum deplanate dorsad, the caudal transverse sulcus rather deeply impressed, the metazona quite broad; cephalic margin very slightly angulate, the caudal margin acute (♂) or rectangulate (♀), lateral shoulders noticeable only on the metazona and there rather heavy and well rounded; metazona about twice the length of the prozona, median carina distinct, more elevated on the prozona than on the metazona; lateral lobes distinctly deeper than long, impressed mesad, ventro-caudal angle well rounded. Tegmina four and one-half times as long as the greatest dorsal length of the pronotum, the greatest width, which is nearly median when the tegmen is flattened, being equal to the length of the pronotum, the distal third of the tegmina extending caudad of the apex of the abdomen; costal margin with the expansion broad and low, the distal fourth decidedly arcuate, the apical portion narrowed and the apical margin oblique-truncate, the true apex well rounded. Wings moderately broad, the width being about three-fifths of the length, the shape hardly falcate; costal margin arcuate in the distal fourth; humeral field with the apex well rounded acute-angulate; axillary field with the margin

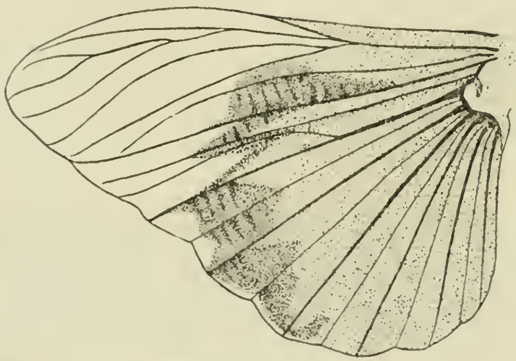

Fig. 14.—*Circotettix splendidus* n. sp. Wing. (× 5.)

very slightly arcuate, not at all lobate; posterior axillary vein with its ramus paralleling the anterior ulnar vein very closely for a considerable distance or by variation coalescing with it mesad for the length of a single cell; radiate veins considerably thickened. Caudal femora somewhat slender, the ventral carina arcuate, sublamellate; caudal tibiæ with nine to ten spines.

General color cream strongly and conspicuously speckled with numerous annular and quadrate spots of olive, becoming blackish on portions of the male type. These maculations are distributed roughly as follows: three transverse poorly defined and broken bars on the tegmina, the median narrower than the others; a central patch on the disk of the prozona and cephalic portion of the metazona, obsolete caudad; sprinklings on the occiput, genæ and face; several rather solid blotches on the lateral lobes of the prozona, a postocular bar on the head and some mottlings on the pleura; three more or less distinct annuli on the lateral, internal and dorsal faces of the caudal femora, the genicular region of similar coloration. Ventral sulcus of the caudal femora blackish except for a distinct pale pregenicular section; caudal tibiæ glaucous blue (paler in the female than in the male), blackish at the genicular extremity with a pale patellular spot and a distinct pale pregenicular annulus. Eyes raw umber. Wings with the disk citron yellow, apex hyaline, the longitudinal veins more or less brownish, the cross veins and often some of the longitudinal veins cream, transverse band well indicated but with rather indefinite boundaries and very weak at the posterior anal vein, hardly following the caudal margin.

Measurements.

	♂	♀
Length of body,	28 mm.	27 mm.
Length of pronotum,	6.2 "	6.5 "
Length of tegmen,	29 "	30 "
Length of caudal femur,	13 "	15 "

The types alone have been examined.

The special collection by the junior author was taken toward noon on the shady path leading to the top of Mt. Lowe. It did not seem particularly vigorous and was captured before its flight and clatter could be noted.

Anconia integra Scudder.

This desert-loving species was taken at three localities: Cottonwood, September 9, two males; Las Vegas, Nevada, August 10, seven males, one female, one immature individual; Kelso, August 12, one male; Indio, July 29, seventeen males, four females.

The series exhibits a considerable amount of individual variation in size, at least in the male sex, while the color variations are extensive as usual in the species. Specimens with green or very pale greenish in their coloration comprise half (Las Vegas) or slightly less than half (Indio) of the larger lots, while the greenish individuals from both of the localities are more maculate than is the case with greenish individuals from Arizona. The Indio and Cottonwood individuals are as a rule more uniformly maculate than the Las Vegas specimens. The decussate pronotal markings are present more or less distinctly in more than half the series. The Kelso individual has the entire body and proximal portion of the tegmina chalky-white washed and lined with pinkish-red.

The range of the species is now known to extend from Las Vegas, Nevada, and Death Valley, California, to Indio and Yuma, and from the western portion of the Mohave Desert to at least the vicinity of Tucson.

Heliastus californicus (Thomas).

A single female of this species taken at Pasadena, May 23, 1898, by Fordyce Grinnell, Jr., has been examined. It is inseparable in structure from San Diego individuals, but is decidedly different in coloration, being hoary whitish with a little buff washing and marked with umber, instead of being wholly deep wine-red with faint maculations as in four individuals from the latter locality. The color adaptation of this species appears to be as great as or even greater than in *H. aridus*.

Heliastus aridus (Bruner).

This species seems to make its appearance as the true deserts, both Upper and Lower Sonoran, are reached, encroaching perhaps in less desert-like surroundings in the San Jacinto Mountains.

After comparing the original measurements of *H. californicus* and *aridus* and examining a large series of material, although unfortunately containing few *californicus*, it appears that several of the best characters for separating the two species have been overlooked. The pronotum of *H. californicus* is considerably more expanded laterad, and the whole width of the thorax at the insertion of the median limbs is considerably greater in proportion to the length than in *aridus*, while the caudal femora are much slenderer and more elongate in *aridus*.

The length of the tegmina, a character previously used in a diagnostic sense, appears to be quite reliable, but the other differences given here are probably of greater importance.

The following measurements of individuals of *californicus* and *aridus* may prove of interest:

H. californicus.

	Length of body.	Length of pronotum.	Length of tegmen.	Length of caudal femur.
	mm.	mm.	mm.	mm.
♀				
Southern California, Type (from Thomas),	....	....	20.3	12.7
San Diego, Cal.,	20.5	5.4	20.6	12.6
♂				
San Diego, Cal.,	15	3.2	14.5	8.7

H. aridus.

	Length of body.	Length of pronotum.	Length of tegmen.	Length of caudal femur.
		♀		
	mm.	mm.	mm.	mm.
Albuquerque, N. M., Type (from Bruner).	27	5.1	25	14.5
El Paso, Tex.,	29	5.5	26.5	14.8
El Paso, Tex.,	29	5	24.3	14
		♂		
Albuquerque, N. M., Type (from Bruner).	15	3	17	9
El Paso, Tex.,	18.1	3.5	18.5	10.8
El Paso, Tex.,	17.5	3.6	18.7	10.9

The series examined in this connection embraces the following localities: Kenworthy, San Jacinto Mountains, 5,000 feet elevation, June 9, F. Grinnell, one female: Dos Palmos, Santa Rosa Mountains, 3,500 feet, May 26 to June 1, F. Grinnell, five females; Kelso, August 12, one male; Cima, August 12, two males; North Range, Providence Mountains, August 12, four males, one female; foothills Bird Spring Mountains, Cal., August 11, one female; same locality in Nevada, three males, one female.

The individuals from Kenworthy and Dos Palmos are quite peculiar in coloration, being shades of pale ochraceous gray with well-defined brownish and blackish maculations, occasionally involving nearly the whole of the disk and dorsal halves of the lateral lobes of the pronotum. The other individuals are very similar in color to specimens from the desert regions of Arizona, New Mexico and western Texas.

The previous Californian records of the species are from Panamint Valley and Claremont. This latter may refer to *H. californicus.*

Heliastus minimus Scudder

This little known species is represented by material from near the foothills of the Bird Spring Mountains, both in California and Nevada, a series of seventeen males, eight females and one immature specimen being taken on August 11. Three individuals of each sex were also taken the same day in Nevada, immediately over the line from Lyons, California.

All the specimens examined are distinctly, some very considerably, larger than the measurements given by Scudder of typical material from Palm Springs, California, but in every other respect the individuals before us are typical. Measurements of the extremes of the series in hand are as follows:

	♂	♂	♀	♀
	mm.	mm.	mm.	mm.
Length of body,	13	14	21.5	23.3
Length of pronotum,	2.5	2.7	4	4.7
Length of tegmen,	12.3	13.3	19.3	21.5
Length of caudal femur,	8.9	8.9	12	13.6

Specimens examined by the senior author[15] from Bill Williams Fork, Arizona, were also noted as being larger than the type measurements.

The coloration varies chiefly in the depth of the buffy base color, some individuals having considerable reddish, chiefly on the proximal portion of the tegmina and the disk of the metazona. The femoral bars are decidedly marked in all the specimens.

The specimens were all collected among dry grass growing in deep sand near the border of a borax flat. Nowhere else was the species to be found, but in this location it was plentiful. The species has a quick short flight, and when resting on the sand often appears to rely on its protective coloration. The situation in which the specimens were taken was frightfully hot.

The species is only known from Palm Springs, Colorado Desert, California, Bill Williams Fork, Arizona, and foothills of the Bird Spring Mountains, near the California-Nevada boundary.

Tytthotyle maculata (Bruner).

This peculiar locust was taken at three localities, and in every instance it frequented volcanic rock fragments, flying long distances, somewhat like species of the genus *Schistocerca*, alighting precipitately on the bare volcanic rocks, and almost invariably climbing upon one of the higher fragments. The insects were, however, easily approached when due caution was used.

The series comprises six males and two females, taken as follows: Kelso, August 12, one male; North Range, Providence Mountains, August 12, one male, one female; foothills Bird Spring Mountains, August 11, four males, one female, specimens being taken in both California and Nevada.

In size the specimens exhibit but slight variation, but in color the prevailing tone is pinkish-brown in some specimens and drab-gray in others, the maculations being variable in intensity and pattern. The caudal angle of the disk of the pronotum varies from rectangulate

[15] *Trans. Kansas Acad. Sci.*, XIX, p. 224.

to distinctly acute-angulate. The bluish cast of the wings was very noticeable in flight. The previous records of the species are from Needles, California, and Bill Williams Fork and Yuma, Arizona.

Dracotettix californicus Bruner.

Four specimens apparently belonging to this species have been examined in this connection. These are an adult male from Echo Mountain, 2,700 to 3,500 feet, taken August 8; an adult male from Hemet Peak, 7,065 feet, San Jacinto Mountains, taken June 4 by F. Grinnell, Jr.; an adult female from the South Fork of the Santa Ana, 6,400 feet, San Bernardino Mountains, taken July 20, 1906, by J. Grinnell, and an immature female taken on Mt. Lowe, 4,300 feet, on August 8. In addition to these specimens typical material of the allied species, *D. monstrosus* and *plutonius*, from the collection of the U. S. National Museum have been examined.

Logically *D. californicus* appears to be the intermediate connecting the other types of the genus (*plutonius* and *monstrosus*) and at present it is not clearly defined. The general form of the fastigium, shorter proportionately in this than in the allied species, of the pronotal carina, of the caudal femora, and the general appearance of the insect seem to be the most useful points, the color of the internal face of the caudal tibiæ and the form of the accessory carinæ on the occiput being of little or no use. The material before us in addition to the above listed specimens consists of the following:

D. monstrosus, Los Angeles County, two males. San Diego, one immature female. Claremont, one female. "Cal.," one female.

D. plutonius, Panamint Valley, one male, *type*. Coso Valley, one female, *type*.

D. californicus, Claremont, one male. Mountains near Claremont, one female. San Bernardino County, two males.

Of the series of eight specimens of *californicus* before us, one male from San Bernardino County and the San Bernardino Mountains female have the internal face of the caudal tibiæ uniform purplish, in one male from the San Jacinto Mountains there is a trace of reddish and in the remainder the red is marked, at least distad.

The previous records of the species are from Santa Cruz Mountains, Gilroy and Napa, California, and southern Arizona.

Schistocerca vaga (Scudder).

A single male from Altadena, August 8, and two females from Pasadena, taken April 23 and June 18, 1898, by F. Grinnell, Jr., are in the series before us.

The species has been recorded from a number of localities in southern California.

Schistocerca venusta Scudder.

At Indio, on July 29, this species was very plentiful in tall weeds along a watercourse, two males and three females being taken. A female from an elevation of 3,000 feet in the San Gabriel Mountains, taken October 9, 1908, by F. Grinnell, Jr., is also in hand. The pronotal stripe is narrower in the San Gabriel Mountains individual than in the female from Indio, while the specimens from the latter locality, and to a lesser degree in the San Gabriel individual, are much paler than Huachuca Mountains, Arizona, representatives. The species has previously been recorded from Palm Springs, Indio, Tulare and Gazelle, California, while specimens from San Diego and Cuyamaca, San Diego County, are also before us.

Schistocerca shoshone (Thomas).

Three males of this species were taken at Las Vegas, Nevada, August 10, where the species was found in clumps of green weeds near water. The habits and habitat of this species seemed to be exactly the same as those of *Schistocerca venusta*, but we have never found the two at the same place.

The only previous records of the species from Nevada are either indefinite or from the northern section of the State (Truckee Valley).

Hesperotettix festivus Scudder.

At Indio this species was abundant on July 29, a series of eighteen males and twenty-five females being taken. At Cottonwood, September 9, the species was found in small numbers on rabbit-weed, two males and one female being taken, while a single female was secured in the Arroyo Seco at Pasadena, August 1. At Las Vegas, Nevada, August 10, a series of twelve males and seven females was secured.

There is a striking amount of individual variation in size in both sexes of the Indio series, but particularly in the female. Of the same series, six males and six females are decidedly brownish in color or show a marked tendency in that direction. Both Cottonwood males are decidedly brownish, while the single female is green. All the green individuals in the series have more or less distinct pinkish or pinkish-red femoral annuli, the majority of the brown or brownish specimens having these obsolete. The green of the Las Vegas series is pale and decidedly yellowish, all from that locality being uniformly colored. The Cottonwood female has a very faint bluish cast to the entire tegmina. The median whitish cephalic and pronotal line is bordered laterad with blackish or dark green in a number of specimens.

The only previous Californian records of the species are from Los Angeles County and Indio.

Æoloplus tenuipennis Scudder.

A single male of this species was taken at Summit House, September 3. The measurements—length of body 16 mm.; length of pronotum 3.5; length of tegmen 13; length of caudal femur 8.3—are slightly larger than those of the type as given by Scudder.

The record of this species from Tucson, Phoenix and Yuma, Arizona, made in a recent publication by the authors,[16] requires correction when comparison of the Summit House specimen of typical *tenuipennis* is made with the Tucson, Phœnix and Yuma specimens, all formerly placed under that name being richly and contrastingly colored individuals of *Æ. arizonensis.*

The only previous published records of this species are from Fort Grant (type) and Bill Williams Fork, Arizona.

Æoloplus arizonensis Scudder.

This species appears to be the commonest one of the genus over a considerable extent of country, ranging from southeastern Arizona[17] to southern Nevada and the Colorado Desert. The California and Nevada series before us consists of seventy-seven specimens distributed as follows: Indio, July 29, twenty-seven males, twenty-six females; Cima, August 12, two females; Las Vegas, Nevada, August 10, ten males, twelve females. This species exhibits a remarkable amount of variation in size and considerable diversity in coloration; sometimes, however, a series from one locality will be more uniform in this respect than an equally large one from another region. The Las Vegas series, while showing the instability of the species in these two respects, averages smaller and is more uniform than the Indio series, which shows great diversity in both sexes. Some have the body very pale buffy without distinct markings save on the femora, while others have the stripes on the head and pronotum moderately distinct, the ground color varying greatly in depth. The femoral bar are distinct in all the specimens, but the color of the caudal tibiæ may be purplish (solferino, rose purple, lilac or heliotrope purple), pale glaucous, a mixture of the two or some one of several tones of either.

The Las Vegas series has rose purple or a shade of it the predominating color of the caudal tibiæ, while the Indio series has glaucous the color in all the specimens. The two Cima specimens are quite small

[16] *Proc. Acad. Nat. Sci. Phila.*, 1908, p 391.

[17] See above under *Æ. tenuipennis.*

and dark in color, the pattern being strongly marked and the tibiæ purplish in color.

In the locations where this species was captured it was found plentiful among desert plants, excepting at Cima where individuals were scarce and were found in thick thorny bushes.

The previously published records of the species are from Fort Whipple and Yuma, Arizona, and the Mohave Desert.

Æoloplus oculatus Scudder.

This interesting species, previously known only from Mohave, Arizona, is represented in the series before us by six specimens, two males and four females, taken at Cottonwood, September 9. The prominent character of the eyes, mentioned by Scudder in his original description of the species which was based on a unique male, is by no means as pronounced in the female as in the male sex, although when compared with females of *Æ. arizonensis* the same sex of this species can be separated with little difficulty. The species is quite as variable in size as most of the others of the genus, but the specimens before us are quite constant in coloration.

These insects were fairly plentiful in a low white desert bush, which they would not leave and were in consequence difficult to capture.

Melanoplus herbaceus Bruner.

At Indio, July 29, this species swarmed in an irrigated alfalfa field and in high weeds, a series of twelve males and nine females being taken. A pair of this species was also taken on vegetation on irrigated land at Las Vegas, Nevada, August 10. This is one of the most active species of the genus *Melanoplus*.

The Indio males are nearly equally divided between the typical form and that called *flavescens* by Scudder, while several specimens are perfectly intermediate in character. All of the specimens are in the green phase with more or less distinct postocular bars or no traces of the same, except one in the brown phase and several approaching the same.

The species has previously been recorded from California at San Diego and Indio, this constituting, however, the first Nevada record.

Melanoplus devastator Scudder.

The collections made in California in 1907 contain an extensive series of this very variable species, representing the following localities: Mill Valley, August 23, nine males, nine females; Santa Cruz Mountains, August 28, one male, one female; Merced, August 30, thirteen males, ten females; Raymond, September 3, five males, thirteen females; Summit House, September 3, one male, three females; Sentinel, August 31 and September 1, seventeen males, thirty-five females; Pasadena (San Rafael Hills), August 1, ten males, fifteen females; Altadena, August 8 and 25, six males, two females; Miramar, July 31, one female; Alamitos Bay, July 31, nine males, seven females; El Toro, August 20, four females; Coronado Beach, August 15, one male, one female; Santa Catalina Island, August 3 and 7, three males.

This series exhibits such a great amount of variation in size and color, and to an extent in minor structural characters, that we have not attempted to place the specimens in the four forms of the species recognized by Scudder, as it appears probable that more than four types must be recognized if all the variants are distinguished by name. The desirability of doing this seems questionable, at least at the present time.

The smallest specimens in the series are from Summit House, Pasadena and Altadena, while the largest are from El Toro, Alamitos Bay, Merced and Raymond. One male and four females taken at Stanford University, October 17, 1903, by Fordyce Grinnell, Jr., have also been examined.

Melanoplus aridus (Scudder).

Three males and one female of this species were taken at Cima, August 12.

When compared with Florence, Arizona, individuals of both sexes, the Cima specimens are found to agree very fully in all points except the position of the tegmina, these being attingent or at least sub-attingent in the Arizona specimens and considerably separated in the California individuals.

This is the first record of the species from California.

The specimens were taken in the tree yucca area where they were scarce. They were found in a hilly location inhabiting the lowest bushes.

Melanoplus varicus Scudder.

Four males and three females from elevations between 4,000 and 5,600 feet on Mt. Lowe, taken August 8 and 25, and a single female from the slopes of the San Rafael Hills at Pasadena, taken August 1, are provisionally referred to this species, described from specimens from Tehachapi, Kern County, California, unique to this writing.

The Mt. Lowe specimens appear to differ from the original description in having the furcula of the male hardly divergent, in fact parallel in several of that sex, while the cerci appear to be slenderer at the apex than in the types, although of essentially the same form. The interspace between the mesosternal lobes appears to be broader and less longitudinal in both sexes of the Los Angeles County material. It is possible that a comparison of typical material with the series in hand may make necessary their separation.

There is a considerable amount of individual variation in size, which is not at all correlated with any particular elevation. The coloration is somewhat deeper in several individuals than in the others, but it is quite characteristic in all. The species was not common.

Melanoplus sonomaensis Caudell.

A single pair of this species was taken in a garden at Santa Cruz, California, August 28. The only previous record of the species is that of the types from Glenellen, Sonoma County, California.

In the garden the species was noticed to be extremely plentiful, especially about the strawberry bed.

Melanoplus gracilipes Scudder.

A single female from Miramar, July 31, is referred to this species, which was previously known only from Los Angeles. The individual was taken near the shore, along the border of a field of dry trampled grass. Further extensive search failed to reveal any other specimens.

Melanoplus pacificus (Scudder).

An interesting series of twenty specimens of this species were collected in the Yosemite National Park, between 4,000 and 6,000 feet elevation, at the following localities: Yosemite Valley, 4,100 to 4,500 feet, September 1, two males, one female; Sentinel, August 31, two males, six females; Eight-Mile Camp, September 1, one male, four females; Grouse Creek, September 1, one male, one female.

When compared with a pair of this species from Sissons and Dunsmuir, Siskiyou County, California, the Yosemite males have the caudal margins of the cerci more thickened and terminating rather abruptly about two-thirds the distance from the base, the apical third being equally slender in males from both localities. A single male in the Academy collection from the Yosemite Valley, date and collector unknown, fully agrees with the larger series in the above mentioned character.

The coloration shows little variation except in the depth of the light and dark colors, most of the palest individuals being from Sentinel. The postocular bar is strongly marked in all the males and a number of the females, being distinctly or hardly indicated in the remainder of the latter sex. In several females the postocular bar is represented only by a very narrow and broken line bordering the ventral side of the lateral carinæ. In size there is considerable individual variation, females from Eight-Mile Camp alone showing five millimeters difference in the length of the body.

At Sentinel the specimens were all captured in a small area of herbs beside the Merced River, while at Eight-Mile Camp and Grouse Creek the specimens were taken in a forest of conifers. The insects were active but heavy and easily captured, although the series taken at Sentinel was secured only after long and continued search.

The previous records of the species are from Dunsmuir, Edgewood, Mt. Shasta and Sissons, Siskiyou County, Shasta County, Santa Cruz Mountains, and mountains near Lake Tahoe, California.

Melanoplus borckii (Stål).

One male and two females of this species were taken on Mt. Tamalpais, August 23, one female at 1,500 feet elevation, the other individuals at 2,100 feet. The former specimen was found along the railroad track, while the latter were on the ground among huckleberry bushes. The individual from 1,500 feet elevation has a most peculiar coloration, the general tone of the insect being brownish black with a rather broad arcuate bar of coral-red crossing the dorsal portion of the lateral lobes of the pronotum. The ridge of the metathoracic episterna is yellowish as in normally colored specimens, while the dorsal face of the caudal femora is ochraceous-rufous, blackish proximad and distad with the median bar indicated on the internal half.

The only exact localities from which this species has been recorded are in the coast region of California between Sonoma County and Los Angeles.

Melanoplus tenuipennis Scudder.

Four adult and one nearly mature female taken between June 28 and July 20, 1906, at elevations of from 6,200 to 6,400 feet, on the South Fork of the Santa Ana River, in the San Bernardino Mountains, by Dr. Joseph Grinnell, are now before us. They agree quite well with Scudder's description of the species, which is very close to *M. missionum*. The coloration is fairly constant except for the ventral extension on the prozonal lobes of the blackish postocular line, as well as the variable character of the lateral face of the caudal femora. The latter may be nearly solid blackish, yellowish-green darkened distad and dorsad or faintly oblique fasciate. Very weak pregenicular annuli are present in one individual.

The species has been recorded from Guadelupe and Los Angeles, and Monterey, Los Angeles, San Bernardino and Kern Counties, California.

Melanoplus missionum[18] Scudder.

A series of seventeen specimens of this species are in the collection before us, all taken in a comparative small area. The localities represented are the following: Arroyo Seco at Pasadena, one male, July 20, F. Grinnell, Jr., one female, August 1; Arroyo Seco, San Gabriel Mountains, elevation 3,000 feet, October 8, F. Grinnell, Jr.; Altadena, August 8, one male; Mt. Lowe, 4,000 to 5,600 feet, August 8, six males, seven females. There is considerable individual variation in size, specimens from the highest elevation on Mt. Lowe showing the following extremes:

	♂	♂	♀	♀
	mm.	mm.	mm.	mm.
Length of body,	15.8	19	25	26.5
Length of pronotum,	4.2	5	5.2	6
Length of tegmen,	3.2	3.8	3.5	3.8
Length of caudal femur,	10.2	11.8	13	·14

The exposed portion of the tegmina varies considerably in length, in one case hardly more than half the average exposed area being visible. The general coloration shows considerable variation, ranging from quite uniform greenish yellow to dull olive and ochraceous-buff and vandyke-brown. The last mentioned type predominates, the females, however, being much duller than the males. The yellow type is represented by one female from 3,000 feet elevation in the Arroyo Seco, while the single olive specimen is from the Arroyo Seco at Pasadena. The yellowish postocular line is distinct in the majority of the specimens and faintly indicated in the remainder. The femoral bars are distinct in all the males and faintly indicated in all the females except the greenish-yellow specimen, which also has the caudal tibiæ yellowish externally and glaucous internally instead of nearly uniform glaucous as in the others. A more or less distinct yellowish pregenicular annulus is present in the majority of the series.

Specimens were never taken in numbers, but single individuals were occasionally noticed.

The only previous record of the species is from Los Angeles. This reference probably should stand as Los Angeles County.

Melanoplus fuscipes Scudder.

Two females of this species were taken in the San Gabriel Range

[18] The senior author's *Œdaleonotus truncatus* (*Ent. News*, XVIII, p. 353) from the San Gabriel range near Claremont, California, is a synonym of this species.

on August 8, one at an elevation of 4,400 feet on Mt. Lowe, the other in Rubio Canyon, between 2,200 and 3,000 feet.

The specimens, while quite similar in coloration except for a rufous tone to the lighter color of the large individual, show considerable individual variation in size, the measurements being as follows:

	Length of body.	Length of pronotum.	Length of tegmen.	Length of caudal femur.
	mm.	mm.	mm.	mm.
Rubio Canyon,	18.5	4	3.5	10
Mt. Lowe,	22	5.5	4.5	12

The previous records of this species are from localities along the coast and coastal valleys of southern California, from between Luis Obispo and San Simeon Bay south to San Diego County and at least as far east as Claremont. The species has also been recorded from San Bernardino County, but from which portion of that quite diverse area is not mentioned.

In habitat and actions these specimens greatly resembled *Melanoplus missionum*.

Melanoplus ablutus Scudder.

A single male of this species was taken at El Portal, August 30, at an elevation of 2,050 feet on a steep mountain side, among dry leaves, under manzanita and other bushes. The specimen was taken at daybreak, and no other Orthoptera were noted at that time.

The antennæ of this individual are quite short, not quite four millimeters long and slightly less than half the length of the caudal femur, the tips being perfect and unbroken. In the type measurements Scudder gives the length of these appendages as six and one-half millimeters or more than two-thirds the femoral length. In every other character the specimen in hand is perfectly typical. The type locality is Wawona, Mariposa County, California.

Melanoplus nanus Scudder.

One male and two females of this species, taken at Mill Valley, August 23, are in the series. They are closely related to the following species and require considerable study for their proper separation. The shorter and apically broader cerci and more divergent furcula are of the greatest comparative value.

The species was found on a dry grassy hillside.

The original and only previously published records of the species are from Mill Valley, San Francisco, Berkeley and Baden, San Mateo County, California.

Melanoplus ligneolus Scudder.

Two males and a single female of this species were taken at 2,100 feet elevation on Mt. Tamalpais, among low bushes.

Both this and the preceding species were extremely scarce.

The previous records are from Berkeley and Benicia, California.

Melanoplus cinereus Scudder.

An interesting series of thirty-three specimens of this species from the following localities is contained in the collection: Sentinel, August 31, one male; Pasadena, August 1, nine males; Altadena, August 8, one male, one female; Rubio Canyon, 2,200 to 3,000 feet, August 8, three males; Alamitos Bay, July 31, four males, one female; Coronado and South Coronado Beach, August 16, five males, one female; Tia Juana, August 16, three males, one female; Santa Catalina Island, August 7, two males, one female.

The series exhibits a surprising amount of variation in size, this being to a great extent individual, but in a measure apparently due to geographic factors. Average males from the localities represented measure as follows:

	Length of body.	Length of tegmen.	Length of caudal femur.
Sentinel,	20.5 mm.	15.5 mm.	10.5 mm.
Pasadena,	17.5 "	16.2 "	11 "
Altadena,	16.5 "	15 "	10.5 "
Rubio Canyon,	19.2 "	15.8 "	10.8 "
Alamitos Bay,	20.8 "	18.2 "	12.5 "
Coronado Beach,	16.8 "	16 "	11 "
Tia Juana,	16.5 "	14.8 "	10 "
Santa Catalina Island,	16.5 "	13.5 "	10 "

The cerci and furcula show a number of modifications of the essential type of the species, but none of the specimens are typical of the closely related *M. cyanipes*, although this is approached by certain individuals. The coloration varies considerably, the Sentinel, Pasadena, Altadena and Rubio Canyon series being darker than the Coronado Beach and Tia Juana specimens, while the Alamitos Bay and Santa Catalina Island individuals are nearly intermediate, although nearer the dark type. The Tia Juana and Coronado Beach females are very pale, as is also the case with one male from the latter locality.

This is essentially a species of the drier sections, and although a common species it was never found to be gregarious.

Melanoplus complanatipes Scudder.

Three males and one female from Cottonwood, September 9, and one female from the foothills of the Bird Spring Mountains, Nevada, August 11, are inseparable from this species, previously known only from Cape San Lucas, Lower California, and Sonora, Mexico.

The appendages of the males are identical with Scudder's figure, but it would seem as if the typical material was shrunken from immersion in spirits, as Scudder states the figured male "is . . . . somewhat distorted by preservation in spirits," and the same medium has apparently rendered some points of the coloration obscure. The dimensions of a Cottonwood pair and the Nevada female are as follows:

	Length of body.	Length of pronotum.	Length of tegmen.	Length of caudal femur.
	mm.	mm.	mm.	mm.
Cottonwood, ♂.	21	4.5	19.5	12
Cottonwood, ♀.	25.5	5	22.2	13.2
Foothills Bird Spring Mountains, ♀	27	6	25	14.5

The postocular bar is faint in one specimen and distinctly marked in the others, while the entire dorsum, except for a pair of narrow lateral more or less distinct yellowish carinal lines, is sprinkled and clouded with umber. The caudal femora bear traces of transverse bars, in fact quite distinct ones dorsad, while the ventral and internal faces of the same portions are orange or orange-red. The caudal tibiæ are glaucous, varying from very pale to quite deep in shade.

This was one of the extremely vigorous and scarcer desert species. In habits it closely resembled *Melanoplus bowditchii*, being quite as active and shy.

Melanoplus marginatus form **pauper** Scudder.

At Ahwahnee, September 3, this interesting insect was found common in a rank growth of high tarweed, a series of six males and seven females being taken.

Considerable individual variation in size is exhibited by these specimens, the extremes being as follows:

	♂	♂	♀	♀
	mm.	mm.	mm.	mm.
Length of body, ...	15.5	17	19	22.8
Length of pronotum, ...	3.3	4	4	4.5
Length of tegmen, ...	4	4.2	4.2	5.2
Length of caudal femur, ...	8.7	10	10.2	11.2

In general coloration some specimens are distinctly darker than others, but the pattern is essentially the same in all the series.

The species has previously been recorded from Natoma Vineyard, Folsom, Atwater, Fort Tejon, Chico, Guadelupe and southern California.

Melanoplus femoratus (Burmeister).

This species was found in numbers at both Sentinel, August 31 and September 1, and Mariposa Grove, September 2, ten males and nine females being taken at the former locality and seven males and two females at the latter.

The specimens average decidedly smaller than individuals from the eastern United States, while the amount of contrast of the yellow postocular bars and of the ventral half of the caudal femora is quite variable, several of the males being very strikingly colored.

The previous Californian records of the species were from Mt. Shasta district and Los Angeles. This latter record is probably meant to cover the entire county, as it is hardly possible that this species could be found in the vicinity of Los Angeles.

TETTIGONIDÆ.

Hormilia elegans Scudder.

Three adult males and four immature individuals of this species were taken from greasewood at Cottonwood, September 9. The specimens were found only by long and constant search. They flew from one greasewood bush to another, but were easily approached and captured, apparently relying on their coloration for protection. These individuals possess strongly contrasted maculations, the base green being deep in two males, while the third has the dorsal section of the tegmina blackish-brown, the white spots, which are decided, distinctly outlined and regularly placed, being washed with pale greenish in one individual. The darker portions of the limbs are olive-brown in the male with blackish-brown on the tegmina. In size the Cottonwood adults are about equal to specimens from Florence, Arizona.

This is the first record of the species from California.

Scudderia mexicana (Saussure).

Three California males of this species have been examined, one from Avalon, Santa Catalina Island, taken August 7 by Hebard, another from Pasadena, taken July 28, 1899, by F. Grinnell, Jr., and a third from Santa Monica, taken August 1, 1906, by the same collector.

The previous Californian records of the species were from Los Angeles, Coronado and Claremont. The single specimen from Avalon was found in the afternoon, resting on a frond of a palm growing in a garden.

Scudderia furcata Brunner.

A single male of this species was taken at Ahwahnee, September 3. This is the most southern record for California. The insect was taken in a rank growth of tarweed.

Conocephalus[19] **spinosus** (Morse).

Three males and one female of this species were taken on salt marsh vegetation at South Coronado Beach, August 16. In life the specimens were deep green in color. The species was described from Coronado, and has not been reported from elsewhere. At the time these specimens were taken adults were extremely scarce.

Conocephalus occidentalis (Morse).

In a meadow of deep rank grass at Sentinel, Yosemite Park, August 31, five males and five females of this species were taken. At Mariposa Grove, September 2, three males and seven females were also taken, while at Mill Valley, August 23, two females were secured in a dry ditch. The females exhibit considerable diversity in the length of the ovipositor, the extremes, however, being well within those given by Morse, while the wings do not quite reach the apex of the abdomen in any of the males and range from one-half to three-fourths the length of the abdomen in the females.

One of the specimens taken at Mill Valley was caught ovipositing in a grass straw.

Conocephalus vicinus (Morse).

Two males of this species were taken among grasses on sand dunes directly back of the ocean beach at Alamitos Bay, July 31.

Neduba convexa Caudell.

Four males of this form were taken at 2,100 feet elevation on Mt. Tamalpais, on ground covered with leaves and bark. They were very quiet and when found could be picked up easily. One specimen is slightly smaller than the original measurements, the other three, however, being almost identical with the type male in dimensions.

The color form of the type male, viz., "light yellowish-brown," is not represented in the four specimens before us, two of these being red-brown and the others umber-brown. The abdominal pattern found in *N. carinata* is marked in the two red-brown males, hardly

[19] For remarks on the use of this name in place of *Xiphidium* of authors see Rehn, *Proc. Acad. Nat. Sci. Phila.*, 1907, p. 389.

indicated in one of the brown males and no traces are present in the other. The lateral lobes of the pronotum are blackish-brown in all the specimens, but this is more extensive cephalo-ventrad in some than in others.

After comparison of the genitalia of this form with the figures of that of *N. carinata* we are forced to the conclusion that specific rank must be accorded *convexa*.

The type localities were Mt. Shasta and Napa County, California.

Aglaothorax sierranus n. sp.

Types: ♂ and ♀: Yosemite Valley, 4,500 feet (♂) and Grouse Creek, 6,000 feet (♀), Yosemite National Park, California. September 1, 1907. Collected by Morgan Hebard. [Hebard Collection.]

Related to *A. diabolicus* (Scudder) from Monte Diablo, California, but differing in the somewhat shorter caudal femora, which are much less inflated proximad, and in the more decidedly and sharply dentate apex of the ovipositor. No doubt other differences exist in the male sex, but this cannot be determined until the male of *A. diabolicus* is known.

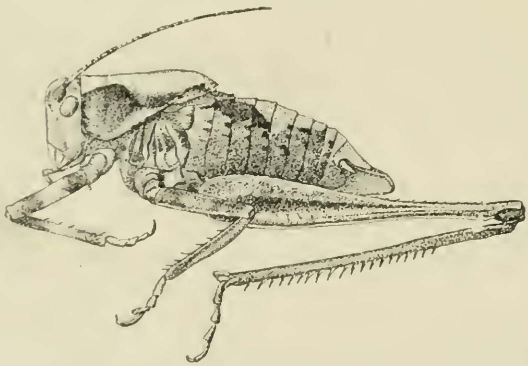

Fig. 15.—*Aglaothorax sierranus* n. sp. Lateral view of male type. (× 2.)

Size moderately large; form robust. Head well seated in the thorax, the interocular space very broad and mesad with a pair of more or less distinct converging rugæ which unite with the lateral margins of the fastigium; fastigium about equal to the basal antennal joint in width, narrowing ventrad, with a distinct very narrow sulcus on the dorsal surface terminating abruptly cephalad; eyes small, ovoid, quite prominent for their size; antennæ exceeding (♂) or at least as long as (♀) the body. Pronotum with the greatest width of the disk contained about one and one-half times in the length; cephalic margin slightly arcuate emarginate (♂) or subtruncate (♀), caudal margin strongly arcuate; lateral carinæ hardly marked cephalad, quite strong mesad and caudad, arcuate divergent then rounding to the caudal margin, the arcuation being more pronounced in the male than in the female, the greatest width of the metazona over twice the cephalic width of the same portion; median carina precurrent, weak; caudal portion of the metazona shallowly rugoso-punctate; prozona but little more than a fourth the length of the metazona, transverse sulcus shallow but distinct, not severing the median carina; lateral lobes with the greatest dorsal length half again as much as the depth, the caudal margin hardly (♂) or slightly (♀) sinuate. Tegmina of the male hardly projecting caudad of the pronotum, inflated. Abdomen considerably inflated proximad, tapering caudad, the segments moderately keeled dorsad; terminal dorsal abdominal segment of the male broad at the base, produced, somewhat depressed distad, the lateral margins subparallel caudad of the cercal emarginations, the distal margin sinuato-truncate; cerci robust and subequal proximad and mesad, tapering distad, the robust portion subscabrous, the entire length about half that of the terminal dorsal abdominal segment; infracercal plates projecting caudad of the terminal dorsal abdominal segment by nearly half the length of the latter, the lateral margins rounding to the apex which is at the internal margin; subgenital plate large, compressed, deep, projecting beyond the infracercal plates less than the length of the latter, the apical section carinate ventrad and with the apical margin arcuate on each side of the V-


Fig. 16.

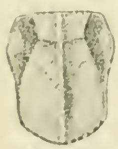
Fig. 17.


Fig. 18.


Fig. 19.

Fig. 16.—*Aglaothorax sierranus* n. sp. Dorsal view of pronotum of male type. (× 2)
Fig. 17.—*Aglaothorax sierranus* n. sp. Dorsal view of pronotum of female type. (× 2)
Fig. 18.—*Aglaothorax sierranus* n. sp. Ovipositor. (× 2)
Fig. 19.—*Aglaothorax sierranus* n. sp. Dorsal view of apex of male abdomen. (× 3)

shape which the plate there assumes; cerci of the female similar to those of the male; supra-anal plate strongly arcuate; ovipositor about two-thirds the length of the caudal femora, considerably arcuate, tapering, the apical portion of each margin armed with moderately sharp erect teeth, those of the dorsal margin numbering about fourteen and those of the ventral margin about half that number; subgenital plate of the female moderately produced, subtrigonal, strongly arcuate in section, the apical margin obtuse. Prosternum armed with a pair of moderately long spines. Cephalic femora about two-thirds the dorsal length of the pronotum, moderately robust, the dorsal face armed with two spines cephalad and three to four caudad, the ventral margins unarmed, the cephalic genicular lobe with a single spine, the caudal unarmed; cephalic tibiæ very slightly longer than the femora, the dorsal face with two spines, one tympanal, the other apical, the ventral margins each with seven spines. Median femora slightly longer than the cephalic femora, the dorsal face armed with six spines in the male, one being apical, a smaller number present in the female, ventral margins unarmed; median tibiæ slightly longer than the femora, armed dorsad with three spines on the cephalic margin and five on the caudal, ventral margins each armed with eight spines. Caudal femora nearly two and one-half times the length of the pronotum, quite robust proximad, the distal third slender and subequal, the dorsal face of the inflated proximal section with numerous fine depressed spines, ventral margins unarmed; caudal tibiæ slightly shorter than the femora; free plantula present in the caudal tarsi.

General colors of the male buff dorsad, clay color laterad and ventrad, of the female dull chocolate-brown. The face, greater portion of the lateral lobes of the pronotum, abdominal bars and annuli and clouds on the limbs shining seal-brown. The two proximal joints of the antennæ are blackish beneath, while the remainder of the antennæ are regularly annulate with buff and seal-brown, the buff annuli distinctly narrower than the seal-brown ones, the latter regularly increasing in length distad. Eyes hazel-brown. A bar on the ventro-caudal portion of the lateral lobes of the pronotum of the lighter general color of the respective sexes, while the caudal margin of the disk of the pronotum is narrowly checked with the darker color. The main abdominal pattern consists of lateral bars becoming evanescent laterad, broad and parallel on the three proximal exposed segments, on the next two segments arching laterad and returning to nearly the same degree of separation distad as proximad, the bars at the expansion and caudad of the same much weaker than cephalad. Male genitalia chestnut; ovipositor of the general colors mottled. Caudal femora marbled on the dorsal aspect, a conspicuous medio-longitudinal line, more or less undulate in character, of seal-brown present on the lateral face and extending the length of the inflated portion.

Measurements.

	♂	♀
Length of body,	23 mm.	25.5 mm.
Length of pronotum,	8.5 "	8.5 "
Greatest dorsal width of pronotum,	5.5 "	6 "
Length of caudal femur,	20.5 "	21 "
Greatest width of caudal femur,	4 "	4.6 "
Length of ovipositor,		15.5 "

A paratypic male from Yosemite Valley and another of the same sex from Wawona, taken September 1, have been examined in addition to the types. The paratypic male is slightly larger than the type male and has the pale general color darker, more vinaceous-cinnamon, while the Wawona specimen is similar to the type in size and is almost uniform pale cinnamon in color, the seal-brown limited to the femoral line and scattered clouds, spots and points, the pronotum being practically uniform except for the beading on the caudal margins. The antennæ are similar in pattern in all the specimens.

The two specimens taken in the Yosemite Valley were captured during the morning, hiding in the cracks in the bark of some tall fir trees. They were quiescent, apparently resting for the day. The individual taken at Grouse Creek was found on a steep hillside, among a very few low green plants growing in a conifer forest. The insect jumped about actively, but only for short distances. The Wawona representative was taken from the stem of a small shrub, where it was stridulating at dusk. Other specimens were heard in the forest, usually in low trees. The stridulation is remarkably faint for so large an insect, the sound produced being a weak zip-zip-zeeeeee repeated several times, reminding one strongly of the stridulation of *Orchelimum minor*.

Cyrtophyllicus chlorum Hebard.[20]

The type of this recently described genus and species, taken at El Portal, August 30, is contained in the collection.

The original association of the genus with *Zacycloptera* Caudell is correct, although the number of apical spurs on the caudal tibiæ was there stated in a way liable to confuse, the number of one side of the tibiæ or of pairs being given and not the total for the limb.

Anoplodusa arizonensis (Rehn).

On August 11, while crossing the volcanic flats overgrown with greasewood at the foot of the Bird Spring Mountains of the McCol-

[20] *Ent. News*, XIX, p. 156, figs. 1-3.

lough range, on the Nevada side of the California boundary line, a specimen of this very rare species was flushed from a greasewood bush. It flew up in a way reminding one of the swift flight of a *Schistocerca* and did not alight for at least two hundred yards, when it perched on the top of another greasewood bush. The specimen was captured and proved to be the first known female of the genus. When compared with the male type of the species the Nevada specimen does not appear to be separable, such differences as do exist, as larger size and slightly different proportionate width of the fastigium, being easily attributable to sexual differences. The ovipositor curves distinctly but not at all decidedly ventrad, the apex being acute and the margins not spined. The measurements are as follows:

Length of body (exclusive of ovipositor),	25.5 mm.
Length of pronotum,	7.2 "
Width of pronotum (caudad).	4.5 "
Length of tegmen,	47 "
Greatest width of tegmen,	7 "
Length of caudal femur,	28 "
Length of ovipositor,	25.8 "

The coloration is much paler than in the type, although the pattern is essentially the same, all the paler spots and markings on the pronotum and tegmina being ivory white and the remainder of the surface pale yellowish buff, becoming yellowish on the distal portions of the femora and on the tibiæ, the darker portions of the tegmina being brownish-clay color becoming paler distad. The line pattern on the pronotum is essentially the same as and more distinct than in the type, while no green is present on the specimen.

The type locality and only previously published record of the species is Florence, Arizona.

Eremopedes gracilis (Rehn).

An adult pair of this form was taken at Cottonwood, September 9, frequenting low growth, where they were much protected by their coloration. The tegmina of the male, projecting two and one-half millimeters beyond the pronotum, are considerably convex with the internal margin of the apex obliquely arcuate, the external margin straight with the apex rounded subtruncate, the tympanum being almost entirely hidden. The ovipositor of the female is slightly shorter than the length of the caudal femora, while the tegmina are minute pads, well hidden under the pronotum.

The terminal dorsad abdominal segment of the male is deeply and acutely fissate mesad with a pair of acute finger-like lobes bordering the same. The supra-anal plate, which is visible ventrad of the incision of the abdominal segment, is acute-angulate. The cerci are slender, tapering, nearly straight, the apical portion substyliform, the apex rather blunted, the usual tooth on the internal margin is hidden by the supra-anal plate when the cerci are together. The subgenital plate has a small median rectangulate emargination, the styles being extremely short.

The measurements of the two specimens are as follows:

	♂	♀
Length of body,	22 mm.	21 mm.
Length of pronotum,	5.5 "	5 "
Greatest caudal width of pronotum,	3.5 "	3.8 "
Length of exposed tegmen,	2.5 "	
Length of caudal femur,	18.5 "	20.5 "
Length of ovipositor,		19.5 "

It is seldom that one can take exception to any portion of the excellent work of Caudell in his study of the North American Decticinæ, but to his assignment of this name to the synonymy[21] we are compelled to disagree. No actual comparison was made, as far as we can learn, of Scudder's type of *E. albofasciata* and that of *gracilis*, and specimens examined at different times may be considered the same when real differences exist. The characters given by Rehn for separating *gracilis* from *albofasciata* hold true in the material before us, and as far as memory serves the type of *gracilis* was similar to the one in hand, which is undoubtedly adult, although Caudell assumed it to be immature. The bars on the head, pronotum and abdomen are broader in this form than in a number of New Mexican immature individuals of *albofasciata*, the size is less than that of Scudder's type and the caudal femora appear to be slenderer and are considerably longer in proportion to the ovipositor. The immature specimen from Phœnix, Arizona, which Caudell says is similar to the type of *gracilis*, is probably the same as the Cottonwood specimens, as it is quite probable that one form is limited to the Eastern Desert or Chihuahuan Tract and the other to the Western Desert or Sonoran Tract.

The type locality of *E. gracilis* is Bill Williams Fork, Arizona.

Idiostatus æqualis Scudder.

A single female of this species was taken in the Arroyo Seco at Pasadena, August 1, while two males, one adult and the other not

[21] *Proc. U. S. Nat. Mus.*, XXXII, p. 339.

quite mature, taken at 6,000 to 6,500 feet elevation in Strawberry Valley, San Jacinto Mountains, July 17, by F. Grinnell, Jr., have also been examined. The Arroyo Seco specimen was beaten from low bushes.

Clinopleura minuta Caudell

At Raymond, on September 3, this species was found swarming, invariably on the ground, especially in a stubble field. The insects jumped farther than any species of North American Orthoptera taken by us, but owing to their tremendous numbers a large series was easily secured. A series of fourteen males and thirty-one females was taken at this locality, a single female also being secured at Summit House the same date in a situation similar to that frequented at Raymond. The series contains several females which slightly exceed Caudell's maximum measurements for the caudal femur and ovipositor. There is considerable variation in the general shade of coloration in the series, some individuals being decidedly more testaceous than others, the usual dark area on the lateral lobes of the pronotum being hardly or only partially indicated in some of the pale specimens. The previous records of the species were from Ahwahnee, Calaveras and Raymond, California.

GRYLLIDÆ.

Ellipes minuta (Scudder).

A single individual of this species was taken along the nearly dry bed of the Mohave River at Cottonwood, September 9. Although considerable beating was done but one specimen was found.

The species has been taken at Palm Springs, San Bernardino and Ahwahnee, California.

Ectatoderus occidentalis (Scudder)?

A single male individual of this genus was taken at Cottonwood, September 9. We have assigned it provisionally to this species, originally described from damaged female specimens taken at Cape San Lucas, Lower California. The original description of Scudder's species is so brief and the sex differences of many species of this genus so great, that in the absence of females the determination is not at all positive. No relationship exists with *E. borealis* Scudder, known from California and New Mexico, the produced pronotum of the Cottonwood male suggesting that of *Liphoplus mexicanus* Saussure,[22] but the tegmina are much shorter, rather different in character and the facial scutellum is not distinctly divided.

[22] *Biol. Cent. Amer. Orth.*, I, pl. XI, fig. 37.

The measurements of the specimen are as follows: Length of body 7.2 mm.; length of pronotum 3.2; greatest width of pronotum 2.8; length of tegmina caudad of pronotum 1.5; length of caudal femur 4.3.

At dusk and later, this insect was heard on every side stridulating. It was found that the musicians were hidden at the roots of greasewood bushes where they were almost inaccessible. The single specimen was captured by suddenly pulling a small bush up by the roots, and luckily turning the insect out of his home. The stridulation was similar to that of the genus *Gryllus* but shriller, an incessant zeee-zeee-zeee. This ceased upon approach, even when the disturber was yards distant.

Nemobius mormonius Scudder.

Two males and one female of this species were taken from grass beside a stream at Las Vegas, Nevada, August 10. The species was rather well distributed in this situation.

Miogryllus lineatus (Scudder).

Two males of this species were taken at Las Vegas, Nevada, August 9, on an ore pile, where a colony of these were chirping incessantly. The type of the species was taken between Virgin River and Fort Mohave, Arizona.

Œcanthus niveus (DeGeer).

A single male of this species was taken on geraniums after dark, August 3, on Santa Catalina Island. Three females from Stanford University, California, taken October 3 to 23, 1903, by F. Grinnell, Jr., have also been examined.

Œcanthus californicus Saussure.

A single male from El Portal, taken August 30, and a female from Mt. Wilson, 5,000 feet elevation, San Gabriel Mountains, taken September 19 by F. Grinnell, Jr., belong to this species. The general color is pale ochraceous in the male and olive-green in the female, the male having the head, except the mouth parts, and dots on the pronotum red, the first and second joints of the antennæ are also reddish but duller, while the third to seventh or eighth are dark brownish fading distad. The female bears no red except a wash of red-brown on the two proximal antennal segments, the brownish area on the antennæ found in the male being present in the female as well. The El Portal specimen was taken at night in a tangle of bushes by means of a lantern.

NOVEMBER 2.

The President, SAMUEL G. DIXON, M.D., LL.D., in the Chair.

Twenty-nine persons present.

The meeting was held for the first time in the new Reading Room. The following circular had been issued October 1:

"The removal of the Library of the Academy to the new building has been completed, and the books have been permanently arranged in the steel stacks.

"While the old Library Hall is dismantled, the new Reading Room, in which the ordinary meetings of the Academy will hereafter be held, cannot be prepared for the purpose in time for the October sessions.

"Attendance of members will not, therefore, be expected at either of the October stated meetings."

The Secretaries, the Librarian and the Curators reported on the work accomplished during the summer.

The Publication Committee reported that papers under the following titles had been presented for publication since the meeting held May 18:

"On the Spinnerets, Cribellum, Colulus, Tracheæ and Lung Books of Araneads," by Thomas H. Montgomery, Jr. (May 21).

"The Polychætous Annelids dredged by the U. S. S. Albatross off the Coast of Southern California in 1904. I. Gryllidæ, Sphærodoridæ, Hesionidæ and Phyllodocidæ," by J. Percy Moore (May 24).

"Notes on the Habits of the Birds of San Domingo, with a list of species obtained, including a new Hawk," by A. E. Verrill and A. Hyatt Verrill (May 26).

"An Orthopterological Reconnoissance of the Southwestern United States. Part III. California and Nevada," by James A. G. Rehn and Morgan Hebard (June 22).

"A new species of Scalpellum from British Columbia," by Henry A. Pilsbry (July 5).

"Note on the Morphology of Fulgur," by Burnett Smith (July 15).

"Antiquities of the Ouachita Valley," by Clarence B. Moore (July 26).

"Report on an additional collection of Skeletal Remains from Arkansas and Louisiana," by Dr. Aleš Hrdl čka (July 26).

"On the true status of the Genus Cacopoides," by Thomas Barbour (September 9).

"A new species of Fish of the Genus Atopichthys, with notes on New Jersey Fishes," by Henry W. Fowler (September 17).

"Thomas Meehan," by Stewardson Brown (September 24).

"Notes on the Flora of Bermudas," by Stewardson Brown (October 18).

"Mollusca of the Southwestern States. III. The Huachuca Mountains, Arizona," by Henry A. Pilsbry and James H. Ferriss (October 25).

"A new Sonorella from the Rincon Mountains, Arizona," by Henry A. Pilsbry and James H. Ferriss (October 25).

"Unionidæ of the Panuco River System, Mexico," by Henry A. Pilsbry (October 25).

"Melanidæ of the Panuco River System, Mexico," by Henry A. Pilsbry and A. A. Hinkley (October 25).

"New Land Shells from Mexico," by Henry A. Pilsbry (November 2).

The deaths of the following members were announced: J. Dickinson Sergeant, June 10; William G. Binney, August 2; Henry Cadwallader Chapman, M.D., September 7; Christopher James Cleborne, M.D., October 2; Henry Charles Lea, October 24.

November 16.

Arthur Erwin Brown, Sc.D., Vice-President, in the Chair.

Twenty-one persons present.

The deaths of Benjamin W. Richards, a member, December 16, 1908, and of Theodore R. Wolf, a member, June 22, 1909, were announced. The deaths of the following correspondents were also announced: Rudolf Berg, June 20; R. E. C. Stearns, June 27; Kakichi Mitsukuri, September 17, and Anton Dohrn, September 26, 1909.

Officers, Counsellors and members of the Committee on Accounts were nominated, to be balloted for at the Annual Meeting.

Theodore de Thodorovitch, LL.D., and James A. G. Rehn were elected members.

Oscar Drude, of Dresden, was elected a correspondent.

The following were ordered to be printed:

NOTES ON THE FLORA OF THE BERMUDAS.

BY STEWARDSON BROWN.

The present flora of the Bermudas, aside from the plants known to have been introduced through the agency of man, probably numbers about two hundred species, of which thirteen vascular forms are endemic, and has undoubtedly been derived through the usual agencies producing insular floras. On the stretches of sandy beach the same species are met with as characterize similar locations in the West Indies or Florida: *Ipomœa pes-capræ* (L.) Sweet, *Canavalia obtusifolia* (L.) D. C., *Sesuvium portulacastrum* L., *Croton punctatus* Jacq., *Scævola Plumieri* (L.) Vahl. and *Cakile lanceolata* (Willd.) O. E. Schultz, while on the rocky shores are *Borrichia arborescens* (L.) DC., *B. frutescens* (L.) DC., *Chamæsyce buxifolia* (Lam.) Small, and the two characteristic shrubs *Suriana maritima* L. and *Tournefortia gnaphalodes* (L.) R. Br. On the shores of the quiet bays and lagoons the mangrove *Rhizophora mangle* L. and *Avicennia nitida* Jacq. are the dominant species, while in the marshes *Osmunda spectabilis* Willd., *O. cinnamomea* L., *Pteridium caudatum* (L.) Maxon, *Cladium jamaicense* Crantz, *Eleocharis interstincta* (Vahl.) R. and S., *Kyllinga brevifolia* Rottb., *Typha angustifolia* L., *Myrica cerifera* L. and *Baccharis glomerulifolia* Pers. are more or less generally distributed. The plants of the higher ground seem more restricted in their distribution for the most part. *Dodonæa angustifolia* Sw. is generally distributed through the hills, *Randia aculeata* L. is known only on the Paget Sand Hills, while the following are found almost exclusively in the Walsingham Tract: *Adelia segregata* (Jacq.) Kuntze, *Psychotria undata* Jacq., *Trema Lamarkiana* (R. and S.) Blume, *Eugenia monticola* D. C. and *Zanthoxylum flavum* Vahl., the last known only from two trees, one on a hill east of Paynter's Vale (B. and B., No. 357, 1905), with several young ones surrounding it, and the other discovered by the writer in one of the sinkholes near the caves at Walsingham. These, so far as known, are all that survive of the "yellow-wood" of the islands, referred to by early writers as growing in such abundance.

With the exception of the cedar (*Juniperus bermudiana* L.), which is very abundant in the islands, by far the commonest plants to-day are those introduced by man. A number of weeds on the roadsides and in the "gardens" and others which do not belong to this class, but have been introduced for their beauty or utility and are now so thoroughly naturalized as to have become an integral part of the flora. Among these plants the most abundant is the common sage, *Lantana involucrata* L., said to have been introduced from the Bahamas more than a century ago as a fuel, to take the place of the cedar which was being extensively used for lime burning. It is now so general throughout the islands that were it not known to be an introduction it might easily be mistaken for a native plant. *Lantana camara* L., introduced as a garden flower from Madeira in 1819, is as generally distributed though not quite as abundant, and when in flower is one of the striking plants of the roads and hillsides. The fiddlewood, *Citharexylon quadrangulare* Jacq., introduced at Paynter's Vale in 1830 by Archdeacon Spencer, is now abundant everywhere on the main island, having spread from the original tree, which is still standing. Another of Archdeacon Spencer's introductions at Paynter's Vale in 1840 was the myrtle, *Jasminum simplicifolium* Forst, which now festoons the trees and rocks, forming almost impenetrable tangles throughout the Walsingham Tract, where it has become a great nuisance by smothering many of the more desirable plants, especially the cedar. Without doubt the birds have played an important part in the spread of these four species through the islands, as all bear a profusion of berries. Other introductions are prominent features in the vegetation of the islands, but two of the most striking which are integral parts of the flora are the oleander, *Nerium oleander* L., introduced in 1790 as a rare exotic and now planted extensively for hedges and windbreaks, which is naturalized on the hillsides, and while in flower during the summer months is a gorgeous display of color, and the Life Plant of the Bermudians, *Bryophyllum pinnatum* (Lam.) S. Kurz, introduced as a curiosity in 1813 and now abundant everywhere on the roadsides and in the woods, when flowering during the winter months, is hardly less a feature than the oleander.

In 1905, the writer, in company with Dr. and Mrs. Nathaniel Lord Britton, of the New York Botanical Garden, visited the islands between August 31 and September 20, when a collection of more than four hundred species was made, principally in the several marshes and in the Walsingham Tract. The writer made two subsequent visits to the islands,[1] from February 10 to March 9, 1908, and May 22 to June

[1] Investigation prosecuted with the aid of a grant from the Esther Herrman Fund of the New York Academy of Sciences.

2, 1909, when collections of more than three hundred species were made, a majority of which were not included in the former gatherings.

In the present paper, which is based on the observations and collections made during these several visits, only the endemic species among the flowering plants are considered, together with such as have been added to the hitherto published lists.

Juniperus bermudiana L.

B. and B., No. 1, September, 1905. Mt. Langdon, north shore. The most abundant tree, growing everywhere throughout the islands, in dry and rocky ground as well as in the marshes. At the time of flowering during March and early April the staminate trees are a golden color, presenting a striking contrast with the rich blue-green of the pistilate trees.

Thalassia testudinum Koenig & Sims.

B. and B., No. 185, September, 1905. Spanish Point and Hungry Bay. Found abundantly in all the shallow bays, and is probably the basis for the record of *Zostera marina* L. of the lists, as that species was nowhere observed.

Andropogon virginicus L.

B. and B., No. 225, September, 1905. Paget Marsh. Not observed elsewhere.

Syntherisma violascens (Link) Nash.

B. and B., No. 57, September, 1905. Hills north of Hamilton.

Polypogon littoralis L.

B. and B., No. 301, September, 1905. Roadside near Warwick Marsh, S. B., No. 698, 1909. Middle Road. Frequent on the roadsides throughout the islands.

Erogrostis major Host.

B. and B., No. 308, September, 1905. In cultivated ground near Warwick Pond.

Poa pratensis L.

S. B., No. 670, May, 1909. On top of cliffs, south shore, west of Tuckers Town. Frequent.

Briza maxima L.

B. and B., No. 346, September, 1905. Field near Gibbs Hill Light. S. B., No. 679, May, 1909. Middle Road near Wesleyan Church. Observed at a number of places throughout the island, in the lawns and on the hillsides.

Bromus unioloides (Willd.) H. B. K.

S. B., No. 685, May, 1909. St. David's Island, growing abundantly in a field.

Hordeum pusillum Nutt.

S. B., No. 695, May, 1909. St. David's Island. Abundant on the roadsides and around St. David's Light.

Cyperus alternifolius L.

S. B., No. 578, March, 1908. Marsh near Tuckers Town. S. B., No. 726, June, 1909. Pembroke Marsh. Although undoubtedly an escape from cultivation, it is thoroughly naturalized and spreading in the localities noted.

Cyperus flavescens L.

B. and B., No. 334, September, 1905. Pembroke Marsh.

Cyperus filicinus Vahl.

B. and B., No. 101, September, 1905. Serpentine Marsh.

Scirpus Olneyi A. Gray.

B. and B., No. 304, September, 1905. Warwick Marsh.

Eleocharis cellulosa Torrey.

B. and B., No. 305, September, 1905. Warwick Marsh.

Eleocharis pratincola Britton.

S. B., No. 723, June, 1909. Pembroke Marsh.

Carex bermudiana Hemsley.

B. and B., No. 224, September, 1905. S. B., No. 649, March, 1908. Paget Marsh. At the time of the preparation of the "Challenger" report, this interesting species was known only from a specimen in the Sloan Herbarium at the British Museum, and as no subsequent collections had been made up to that time, Prof. Hemsley expressed some doubt as to whether the species described by him was really collected in the islands. Our rediscovery of it in September, 1905, at what is likely to be the original locality in Paget Marsh, settles the correctness of Sloan's label beyond a doubt. The species appears restricted at the present time to this one locality, where, however, it is growing in some abundance.

Carex albolutescens Schwein.

S. B., No. 702, May, 1909. Eastern end of Devonshire Marsh. Abundant. Not observed elsewhere.

Sabal Blackburniana Glazebrook.

B. and B., No. 217, September, 1905. Throughout the islands, but varying considerably in appearance according to situations.

On the dry exposed hillsides it is more or less dwarfed and of a yellowish color, while in moist rich ground and the marshes it is a handsome tree with rich green foliage. It is recorded as at one time an abundant tree, forming extensive groves, but it is now found for the most part only in the lawns where it has been preserved. The finest natural grove observed by us is in Paget Marsh, where hundreds of examples may be seen in varying stages of growth. Some fine specimens are also to be found in the Devonshire Marsh, probably taller than any others in the islands.

Juncus bufonius L.

S. B., No. 675, May, 1909. Cultivated ground, Harrington House. S. B., No. 725, June, 1909. Pembroke Marsh.

Nothoscordium bivalve (L.) Britton.

No. 415, 1905. Mr. Nicholas Peniston, Paynter's Vale. S. B., No. 696, May, 1909. Abundant in a cultivated field near Devil's Hole.

Sisyrinchium bermudianum L.

B. and B., No. 2 (fruit). Mt. Langdon, north shore. S. B., No. 661, May, 1909. Harrington House. "The Bermudiana," by which name it is known throughout the islands where it is everywhere abundant, growing in all kinds of situations. During April and May it is a striking flower of the hills, roadsides and lawns.

Peperomia septentrionalis n. sp.

Plant smooth, green throughout, except the peduncles and stems which are frequently rosy when exposed to strong light. Stems rather stout, 2 to 4 dm. long, ascending at the tips; leaves alternate, blades leathery, entire, dark green and shining above, glandular punctate, oval to ovate or obovate, slightly emarginate, 4 to 6 cm. long, 9 to 11 nerved, decurrent at the base, with the petioles 1 to 3 cm. long; spikes terminal or axillary in the upper leaves, simple or several times branched, .5 to 1.5 dm. long with peduncles shorter than the leaves, rather densely flowered; nutlets oblong, slightly papillose, 1 mm. long with a straight or slightly curved beak one-third their length.

In woods usually on moist or shaded rocks, frequent throughout the island from the Causeway to Tuckers Town, among the rocks and around the caves, sinks and fissures; also in the shaded portion of Paget Marsh, growing on the damp ground and over the stones, flowering from late autumn to spring. Probably most nearly related to *P. magnoliæfolia microphylla* Dahlstedt, from which it differs in the relatively broader leaves and the less strongly papillose nutlets which are oblong instead of ovate-globose.

Type, S. B., No. 428, March, 1908. Herb. A. N. S. Philadelphia. From shores of Castle Harbor, Walsingham.

Alternanthera maritima St. Hil.

S. B., No. 487, March, 1908. Long Bird Island. Abundant in a little cove on the Castle Harbor side of the island, about a quarter of a mile from the end of the Causeway.

Phytolacca decandra L.

B. and B., No. 219, September, 1905. Paget Marsh.

Alsine Baldwinii Small.

S. B., No. 580, March, 1908. Sand Hills, Tuckers Town. Apparently an abundant plant in this portion of the island, but not observed elsewhere.

Sagina procumbens L.

S. B., No. 585, March, 1908. Top of cliffs near Tuckers Town.

Tissa marina (L.) Britton.

S. B., No. 591, March, 1908. South shore near Spittle Pond. Abundant.

Silene nocturna L.

S. B., No. 583, March, 1908, and No. 671, May, 1909. Top of cliffs, south shore, near Tuckers Town. Frequent.

Silene noctiflora L.

S. B., No. 682, May, 1909. At western end of Causeway. This species was also observed sparingly near Harrington House, in a piece of grassy woods.

Ranunculns acris L.

B. and B., No. 244. Grassy woods, south shore road, Devonshire.

Papaver Rhocas L.

S. B., No. 530, March, 1908. Cultivated ground, St. Georges, near swinging bridge.

Diplotaxis mnralis (L.) D. C.

S. B., No. 686, May, 1909. St. David's Island. Abundant.

Pedicellaria pentaphylla (L.) Schr.

B. and B., No. 70, September, 1905. Cultivated ground north shore.

Potentilla reptans L.

B. and B., No. 211, September, 1905. South shore road, Devonshire.

Laurocerasus caroliniana (Mill) Roem.

B. and B., No. 220, September, 1905. Paget Marsh. A number of trees of various sizes, intermixed with the cedar and Palmetto. Not observed elsewhere.

Phaseolus lunatus L.

S. B., No. 680, May, 1909. In an open cave near Tuckers Town, growing to a height of 5 to 8 meters, over the cedars and fiddlewoods; flowers white, yellow in fading. S. B., No. 719, June, 1909. Joyce's Dock Cave. Abundant, growing over the trees and rocks; flowers purple. A Phaseolus from this locality, which is without doubt the same, is recorded in Lefroy's list without specific name.

Poinsettia cyathophora (Murray).

B. and B., No. 296, September, 1905. Cultivated ground, Walsingham. Abundant throughout the northern end of the Walsingham region and around Bailey's Bay. Not observed elsewhere in the islands.

Cissus sycioides L.

B. and B., No. 223. Paget Marsh, climbing over the trees.

Elæodendron Laneanum A. H. Moore.

B. and B., No. 274, September, 1905 (fruit), Walsingham, near caves. S. B., No. 453, March, 1908 (flowers). Walsingham, near caves. Frequent throughout the Walsingham Tract between Paynter's Vale and the Causeway. Most abundant in the vicinity of the caves, where it becomes a handsome tree 7 to 10 meters high. The flowers appear early in March.

Abutilon abutilon (L.) Rusby.

B. and B., No. 183, September, 1905. Cultivated ground, Spanish Point.

Malvastrum americanum (L.) Torr.

B. and B., No. 248, September, 1905. Roadside near Devil's Hole.

Sida rhombifolia L.

B. and B., No. 272, September, 1905. Walsingham. Abundant throughout the Walsingham Tract.

Turnera ulmifolia L.

S. B., No. 546, March, 1908; No. 713, May, 1909, Walsingham; and Miss Delia Marble, No. 739, April, 1909, Knapton Hill.

Isnardia palustris L.

B. and B., No. 337, September, 1905. Pembroke Marsh. Abundant.

Hartmannia speciosa (Nutt.) Small.

S. B., No. 715, May, 1909. In a cultivated field at Tuckers Town, very abundant.

Pimpinella aniseum L.

S. B., No. 535, March, 1908. On the tops of cliffs, St. George's Island.

Diospyros virginiana L.

B. and B., No. 401, September, 1905. Naturalized on the border of Warwick Marsh and spreading by suckers.

Gomphocarpus physocarpus E. Meyer.

S. B., No. 690, May, 1909. Escaped to roadside St. David's Island.

Chiococca bermudiana n. sp.

A straggling, weak-stemmed shrub seldom more than a meter high. Leaves lustrous coriaceous 5 to 12 cm. long, 2 to 6 cm. broad, elliptic to ovate, abruptly narrowed at both ends, acute or short acuminate at the apex, cuneate at the base; flowers numerous in racemose panicles, pedicels rather stout 4 to 6 mm. long, hypanthium 1 to 1.5 mm. long during anthesis, sepals triangular shorter than the calyx tube, slightly ciliate, corolla light yellow becoming darker with age, 8 to 10 mm. long, tube funnel form, lobes ovate-lanceolate less than one-third the length of the tube, stamens at the base of the tube, filaments 1 mm. long, anthers 2 to 5 mm. long, style the length of the corolla tube; fruit subglobose pure white and lustrous, 7 to 8 mm. long, slightly broader than long, flattened.

Type, B. and B., No. 181, September, 1905, in Herb. A. N. S. Phila. Shaded hillsides, north shore near Flatts. Frequent throughout the Walsingham Tract from the Causeway to Tuckers Town and sparingly on the wooded hillsides through the central part of the island.

Differs from *C. racemosa* L., to which it is most nearly related, in the larger leaves, stouter and longer pedicels and larger berries.

Galium bermudense L.

B. and B., No. 31, September, 1905. Paget Sand Hills. Hillsides and woods throughout the islands, though nowhere abundant.

Galium aparine L.

S. B., No. 461, March, 1908. Cultivated ground. Paynter's Vale. S. B., 640, March, 1908. Somerset Island.

Urospermum picroides (L.) Schmidt.

S. B., No. 695, May, 1909. St. David's Island. In the open ground generally distributed over the eastern end of the island.

Reichardia picroides (L.) Roth.

S. B., No. 716, May, 1909. Among the sand hills on the south shore a mile west of Tuckers Town.

Eupatorium adenophorum Spreng.

S. B., No. 541, March, 1908. Roadside in St. George's, near the docks.

Erigeron Darrellianus Hemsley.

B. and B., No. 26, September, 1905. Rocks, north shore road, S. B., No. 497, March, 1908. Roadside near Harrington House, and No. 598, March, 1908. Wooded hillside near Tuckers Town. On rocks and hillsides more or less generally distributed throughout the islands, varying from a low tufted plant a decimeter or less high to a much branched straggling shrub frequently more than a meter high, flowering during March and April and occasionally with a second flowering in the autumn.

Gnaphalium purpureum L.

S. B., No. 588, March, 1908, and No. 672, May, 1909. Top of cliffs, south shore, near Tuckers Town.

Galinsoga parviflora Cav.

S. B., No. 645, March, 1908. A weed in the Public Gardens.

Achillea millefolia L.

B. and B., No. 403, September, 1905. Grassy woods, south shore road, Devonshire; also observed in cultivated ground near Hamilton.

MOLLUSCA OF THE SOUTHWESTERN STATES, III: THE HUACHUCA MOUNTAINS, ARIZONA.

BY HENRY A. PILSBRY and JAMES H. FERRISS.

The Huachuca Mountains stand in the southwest angle of Cochise county, Arizona, their southern foothills reaching over the international boundary. The highest summits do not quite attain 10,000 feet. Northward the Whetstone range looms up, a fine if arid mountain mass, as yet unexplored for shells. On every side lies the desert, barren of molluscan life. Our purpose is to give an account, incomplete as it now may be, of the molluscan life of this range.[1]

The Huachucas have not yet been accurately mapped. The sketch

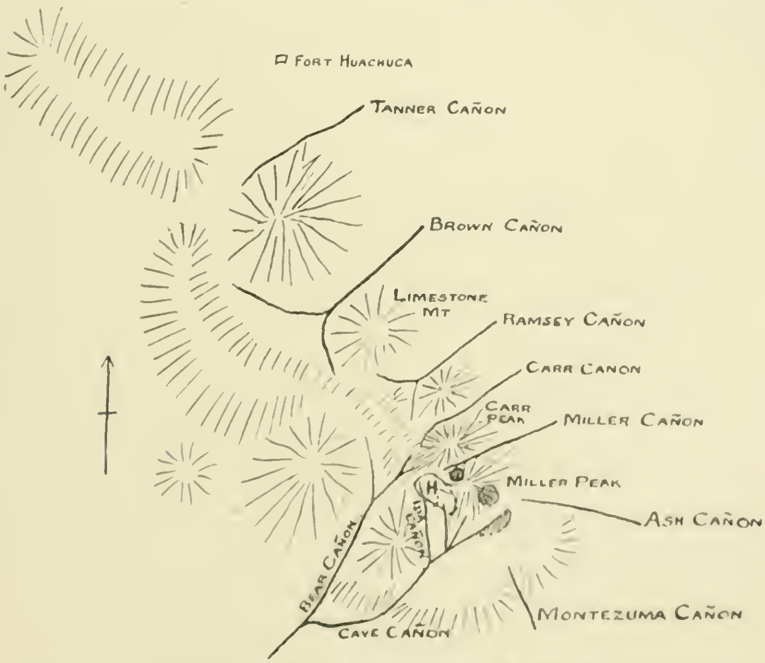

Fig. 1. Sketch-map of Huachuca Mountains.

[1] A few new records are added of species taken in river drift at Benson, Cochise county, some distance northward from the Huachuca range. These forms were derived from some other district. Other records from Benson may be found in our *Mollusca of the Southwestern States*, II, 1906, and in Dall, *Proc. U. S. Nat. Mus.*, XIX, 1896.

here given shows the general positions of localities mentioned in the text.

The first mollusks collected in the Huachucas were taken by a Mr. Cox, who sent some Helices to Dr. Isaac Lea many years ago, with the locality "Tucson." These shells are what we now call *Ashmunella varicifera*. Nothing is known of Cox beyond his name on the label. At the time these shells were collected Tucson was no doubt the nearest settlement or post to the Huachucas, and hence was put down as the locality. It is not unlikely that Cox picked up these shells in the course of a chase from the army post at Tucson after marauding Apaches. Be this as it may, *Ashmunella varicifera* is an indubitable Huachucan snail, and was collected at a time when hostile and dangerous Indians occupied that country. On the death of Dr. Lea the specimens came into the possession of the National Museum, where they are now preserved.

In 1880 Mr. Bland described a snail, *Triodopsis levettei* (now *Ashmunella levettei*), collected by Dr. G. M. Levette, and thought to be from near Santa Fé, New Mexico. Explorations in that region have shown that the Ashmunellas there are of a somewhat different type, and the true habitat of the species was not known until Mr. Ferriss rediscovered the species in the Huachucas, where it is restricted to the heads of certain canyons. It is certain, therefore, that Dr. Levette had forgotten where he procured the original specimens, which are now in the American Museum of Natural History, New York.

The first snails actually reported from the Huachucas were collected by Dr. Edgar A. Mearns, U. S. A., a member of the party surveying the Mexican boundary in 1892-1894. They were described by Dr. W. H. Dall in two papers,[2] published in 1895 and 1896. Six species were obtained in the Huachuca range:[3]

Polygyra levettei [= *Ashmunella l. angigyra*].

Polygyra mearnsi [= *Ashmunella mearnsi*].

Epiphragmophora hachitana, depressed variety from Tanner Canyon [= *Sonorella dalli*].

Patula strigosa var. [= *Oreohelix s. huachucana*].

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[2] Diagnoses of new mollusks from the survey of the Mexican boundary, in *Proc. U. S. Nat. Mus.*, XVIII, 1895, p. 1, and Report on the mollusks collected by the International Boundary Commission of the United States and Mexico, 1892-1894, same *Proc.*, XIX, pp. 333-379.

[3] Dr. Dall's pioneer work on southern Arizona shells was published prior to the anatomical researches which led to the establishment of new genera for the Helices of that region. He had only dry shells to deal with, and hence followed the generic nomenclature current at that time.

Patula s. concentrata [= *Oreohelix s. concentrata*].
Cionella lubrica [= *Cochlicopa lubrica*].

Several Huachucan species were figured by Mr. Paul Bartsch in his monograph of *Sonorella*, 1904, and *S. dalli* n. sp. was described.

The seven species of snails mentioned above sum up all that was known of Huachucan mollusks prior to the visit of Mr. Ferriss in 1902. In 1904 the range was again visited,[1] and again in 1907 Messrs. Ferriss and L. E. Daniels made extensive collections. Dr. Henry Skinner, the well-known entomologist, made a useful collection of shells in Carr Canyon, in August, 1905, and Mr. C. R. Biederman has contributed a few species from the same place.

The present report is based upon practically all of the material ever collected in the Huachucas. Through the unfailing kindness of Dr. Dall, the series in the National Museum has been examined. Dr. Gratacap has permitted a re-examination of the types of *Ashmunella levettei;* and Dr. Bartsch has assisted with various helpful services.

HELICIDÆ.

Genus SONORELLA Pils.

The Huachucan Sonorellas are all distinct specifically from those of other ranges. So far as known anatomically, they belong to groups special to this range; hence speak for a long isolation.

Omitting *S. huachucana*, which is unknown anatomically, the species of the Huachuca and Patagonia Mountains can be determined by this key:

a.—Penis long (about 40 mm. in a shell 27 mm. diam.), with a short hollow papilla containing a tube; epiphallus long, 49-60 mm.; flagellum present. . . . . *S. dalli*.

a[1].—Penis and epiphallus short, the former containing a fleshy, cylindric papilla over half the length of penis; flagellum vestigeal or wanting.

b.—Vagina about as long as penis; spermatheca and duct about four times as long, ... *S. rowelli*.

b[1].—Vagina much longer than the penis; spermatheca and duct not differing greatly from vagina in length.

c.—Penis 5 to 7.5, papilla 3.3 to 5 mm. long; upper part of vagina muscular, swollen, usually fusiform. *S. granulatissima*.

c[1].—Penis 12 to 19, papilla 9 to 13 mm. long; vagina slender, with a small fleshy node midway. . . *S. danielsi*.

[1] See Southwestern Shells, *Nautilus*, XVIII, Sept., 1904, pp. 49-52, and Mollusca of the Southwestern States, *Proc. A. N. S. Phila.*, 1895, pp. 211-290.

Sonorella huachucana Pilsbry. Pl. XIX, figs. 16, 17.

S. virilis huachucana Pilsbry, Proc. A. N. S. Phila., 1905, p. 267, pl. 17, fig. 24.

This is a non-granulose species with conspicuous pale borders along the brown band. We formerly thought it a subspecies of *A. virilis* of the Chiricahua range, but since all the other Helices of this range are specifically distinct, it is not likely that *huachucana* will prove an exception. It comes from Brown's and Bear Canyons, and must be rare or very local. None were taken in 1907.

The soft anatomy is unknown. We therefore know nothing of its relationships with other species. Fig. 16 represents a shell from Bear Canyon. Fig. 17 the type from Brown's Canyon.

Group of S. dalli.

Sonorella dalli Bartsch. Plate XIX, figs. 1, 2, 3.

Sonorella dalli Bartsch, Smiths. Miscell. Coll., Vol. 47, p. 193, pl. 31, fig. 1 (Oct. 10, 1904).
Epiphragmophora hachitana, depressed variety from Tanner Canyon, Dall, Proc. U. S. N. M., XIX, pp. 339, 340, pl. 31, figs. 7, 10 (1896).

Specimens were taken only in Tanner Canyon, the type locality. It is probably restricted to this place. It is a fine species, distinguished by the broad, flattened shape, very open umbilicus and much deflexed last whorl. The largest specimen taken measures 28 mm., the smallest 23 mm. diameter. Compared with *S. granulatissima latior*, which also occurs in Tanner Canyon, *S. dalli* is more openly umbilicate, the aperture is flattened above, the oblique sculpture is coarser. In some old specimens the front edge of the parietal callus is thickened, a narrow ridge connecting the ends of the lip.

The penis (pl. XXII, fig. 4) is extremely long, slightly enlarged distally, its walls thin, with most minute and close transverse rugæ. It contains a smooth papilla, tapering to an obtuse apex, and about one-fifth the length of the penis. The papilla is hollow with rather thin walls. Within it a slender tube runs from the epiphallus to the apex, where it opens by a lateral pore. This tube is lightly attached to the wall of the penis-papilla. It is indicated by dotted lines in fig. 4. The epiphallus is extremely long, terminating in a short flagellum. The penis retractor muscle, 7 mm. long, is inserted upon it 4 mm. from the end of the penis. The long vagina has a slender neck, enlarging moderately above.

The spermatheca is globular, on a duct much shorter than the penis.

In one specimen dissected it bears a minute diverticulum about 1 mm. long, 2 mm. from the base of the duct. In another individual no diverticulum was found, so that it may possibly be abnormal or pathologic. The measurements of the organs in two individuals preserved in formalin follow:

	No. 94,384.	No. 94,358.
Length of penis,	39 mm.	41 mm.
" " penis-papilla,	8 "	9 "
" " epiphallus,	49 "	60 "
" " flagellum,	4 "	3 "
" " vagina,		25 "
" " spermatheca and duct,	34 "	27 "

The jaw (pl. XXII, fig. 6) has five strong ribs grouped in the middle half of its length.

The radula has about 41, 1, 41 teeth (pl. XXII, fig. 8). The central and lateral teeth have mesocones only; on the 17th an ectocone appears. On the outer marginal teeth the inner cusp or sometimes both cusps are bifid, but the ectocone is not split into several cusps as in some other species.

The excessive length of penis and epiphallus, and especially the hollow, thin-walled papilla containing a separate duct or tube (a structure unique in the genus), are characters which set *S. dalli* apart from all other known Sonorellas. It stands alone in its own line of differentiation.

Group of S. granulatissima.

These forms are closely related to the group of *S. hachitana*, but differ by the thick, quite cylindric penis-papilla, solid except for the minute perforation, and very obtuse or truncate at its distal end, and by having no flagellum or only a minute vestigeal one. In the *hachitana* group the papilla tapers, at least at the distal end, and a minute but distinctly developed flagellum is present in known forms. The distinction is only a small matter, but serves to distinguish the Huachucan forms. *S. rowelli* (Newc.), from a little farther west, belongs to the same group.

The dimensions of the genitalia in several specimens of each form are given in the accompanying table. Most of the specimens were preserved in alcohol in the field, and some variation is doubtless traceable to various degrees of contraction.

Species, Locality and Museum No.	Penis.	Papilla.	Epiphallus	Flagellum.	Vagina.	Spermatheca and duct.	Diam. of shell.
S. granulatissima.							
Ramsey, 83,257	7.3	4.8	6	0.7	21	24-25	19
Miller Cn., 94,336	6	4		0	28	22	21
Carr Cn., 90,404	5.5	1		0	16		18
S. g. latior.							
Tanner Cn., 94,387	6	3.5	5	0	17	16	21-22
Brown Cn., 94,356	6	4.5	6	0	21	....	18.5
Brown, w. fork, 94,359	5	3.3	4	0	14	......	18
Salvation, 94,395	7	5	.	0	27		20
Limestone Mt., 94,393	7.5		..	0	21		23
S. danielsi.							
Head of Bear, 94,318[5]	18.5	13	10	0	27.5	22	19
Ditto, 94,317	15	10	...	0	....		18.5
E. fork Cave, 94,352	12	8.5	...	0	17.5		19
Miller Pk., 94,337	13.5	9	10	0	19	25	18-19

Sonorella granulatissima Pilsbry. Pl. XIX, figs. 7, 8, 9; pl. XXI, figs. 1-4.

Proc. A. N. S. Phila., 1905, p. 262, pl. 17, figs. 21-23; pl. 18, figs. 11-13, 51-54.

The typical form is found in Ramsey (figs. 7, 8), Carr and Miller (fig. 9) Canyons. Types were from Ramsey. The shell is distinguished by its very dense beautiful granulation and the faintness or absence of spiral lines, though on some specimens they are present, but very weak.

I have examined the genitalia in a number of individuals from each of the three canyons mentioned above. Figs. 1, 2, 3 represents one of the two cotypes. Fig. 4 is from an example from Miller Canyon. The chief feature is that the *upper part of the vagina has thick muscular walls*, the outer layer consisting of glossy circular muscular fibers. Usually this part is *more or less swollen and fusiform*. The lower part of the vagina is thin-walled. This feature was conspicuous in every one of about 20 individuals of 12 lots of *S. granulatissima* and *S. g. latior* which were examined. The penis is short, its length contained 3 or 4 times in that of the vagina. It is abruptly truncate distally. The penis-papilla is quite short, 3.3 to 5 mm. long, cylindric, truncate at the end, and coarsely wrinkled. It is fleshy, perforated by a minute pore, which opens at the end. The rather short epiphallus has no flagellum in any example opened with the exception of one of the cotypes, in which there is a minute, vestigeal flagellum about 0.7 mm.

[5] Measured from a fresh, drowned example.

long, and bound to the vas deferens by the outer muscular fascia. As a rule, with rare exceptions, therefore, the flagellum is absent.

Sonorella granulatissima latior Pils. Pl. XIX, figs. 4, 5, 6.

Proc. A. N. S. P., 1905, p. 264, pl. 18, figs. 24–28.

Usually a larger shell than *S. granulatissima*, the last whorl more depressed, approaching *S. dalli* in shape. Originally described from Brown's Canyon, it is now known also from the south side of Limestone Mountain, east fork Salvation Ridge[6] and from Tanner Canyon. Three cotypes are figured.

The genitalia have been examined in numerous examples from Tanner Canyon (pl. XXI, fig. 6), Brown's Canyon, east fork of Salvation Ridge and Limestone Mountain. The characters are identical with those of *S. granulatissima*. All of them have the upper part of the vagina swollen, and there is no flagellum. Measurements of several alcoholic specimens are given in the table.

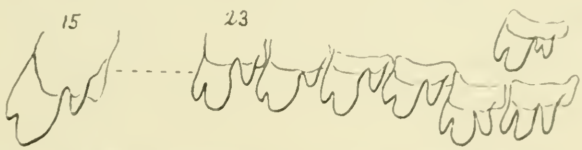

Fig. 2. Marginal teeth of *S. g. latior*, Tanner Canyon.

The radula has 38, 1, 38 teeth, with 10 laterals. The outer marginal teeth have the inner cusp deeply bifid, the outer one sometimes split (fig. 2, No. 94,383, Tanner Canyon).

Sonorella granulatissima parva Pils. Pl. XIX, figs. 10, 11, 12.

No further information on this small race from the northwestern end of the range has been received. *S. mearnsi* Bartsch, from 4 miles south of the international boundary, a few miles east of the San Pedro river, is another form which will probably prove to be closely allied to *granulatissima* and *rowelli* when the anatomy can be examined.

Sonorella danielsi n. sp. Pl. XIX, figs. 13, 14, 15; pl. XXI, figs. 5, 7.

S. granulatissima (in part), Pilsbry, Proc. A. N. S. P., 1905, p. 263, pl. 18, figs. 39, 40, 44; pl. 11, fig. 10 (Miller Cn.); also pl. 18, figs. 36, 37, 38 (Ida Cn.).

The shell is more depressed than *granulatissima*, yellow with a conspicuous dark band without pale borders, the early whorls flesh-colored; surface glossy, the granulation of the last whorl very weak,

[6] Salvation Ridge forms the divide between Brown and Tanner Canyons on the northeast side and what we supposed to be Salvation Camp Canyon on the south. We collected only on the ridge, which is shown on the map at the heads of Brown and Tanner Canyons.

nearly effaced, spiral incised lines well developed above the periphery. Umbilicus wider than in *granulatissima.*

Alt. 10, diam. 19 mm.; whorls 4½.

The animal is slaty-blackish, the back paler, brownish-gray, collar of mantle dark slate. The sole is slate colored at the sides, the middle gray, but the areas are not bounded by lines. The lung has faint venation; pulmonary vein breaking up into several large branches.

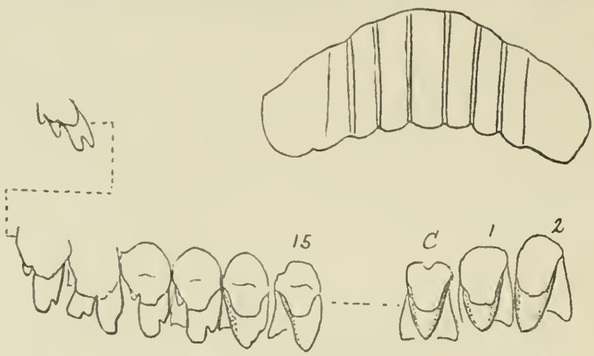

Fig. 3. Jaw and teeth of a cotype of *Sonorella danielsi.*

Genitalia.—The penis is very large, stout, subcylindric, half the length of the vagina or longer. It collapses at the base, where not filled by the papilla, and has several strong longitudinal folds inside. It contains a long cylindric papilla which is abruptly truncate at the end and wrinkled throughout. There is no flagellum. The long vagina is rather slender throughout, with an annular swelling or node about midway of its length. It is longitudinally rugose within, the rugæ coalescent at the node. Other organs as usual. Fig. 7 was drawn from a drowned specimen which had not been in alcohol (No. 94,318).

The jaw has six or seven very low, wide ribs, parted by narrow intervals. The radula has about 47, 1, 47 teeth. In most rows the fifteenth tooth has an ectocone. *No marginal teeth with the ectocone bifid* were seen. The nineteenth tooth, in the radula figured, is abnormal. One of the outer marginals is shown above it.

Types No. 94,318 A. N. S. P., from head of Bear Canyon; also Miller Peak and east fork of Cave Creek.

Similar forms, but with the ground-color not yellow but pale brown (as in *granulatissima*), occur in Ida Canyon, Cave Creek and Ash Canyon (pl. XIX, fig. 18).

This species replaces *granulatissima* on the south side and east end of the Huachuca range. It differs from *S. granulatissima* chiefly in the genitalia, the larger penis and the shape of the vagina being constant features in the series of both species dissected. Specimens have been dissected from five lots, from the head of Bear Canyon (fig. 7), east fork of Cave, and from Miller Peak (fig. 5). One individual of several from the latter place seems to have the very minute bud-like vestige of a flagellum.

The shell will be recognized by its yellow, glossy surface and depressed shape. The brownish forms from Ida and Ash Canyons, mentioned above, require more study, with better fresh or alcoholic material than we can command at this time. One from Ash Canyon is figured, fig. 18.

Named in honor of Mr. L. E. Daniels, who accompanied Mr. Ferriss in the expedition of 1907.

Genus **ASHMUNELLA** Pils. and Ckll.

The Ashmunellas of the Huachuca range, while very diverse in appearance, belong to a single closely related group. Probably all descended from an ancestral stock not unlike *A. levettei angigyra*, the most widely distributed form, and the one showing most affinity to species of the Chiricahua and other ranges. The common ancestry of the whole series is demonstrated by the intermediate stages found among the shells, and by the soft anatomy, which is so much alike in all that it would probably be impossible to tell the species apart without the shells, yet differing characteristically from the soft parts of all Ashmunellas of the Chiricahuas or other ranges by the sacculated or varicose spermatheca and the shape of the penis.

The species and races form a beautiful chain of variations, pretty completely connecting those having most complicated apertures with those in which the aperture is toothless, thus: *bifurca—levettei—ursina—heterodonta—varicifera.*

Evolution has proceeded from fully toothed apertures towards toothless apertures. In other words it has been retrogressive, marked by degeneration of complex structures.

Soft Anatomy of Ashmunella.—Time has not admitted a full examination of the anatomy, but the genitalia of many individuals have been studied. These organs are so similar in all of the forms that one description will suffice. The penis (P.) is rather large for an Ashmunella. Inside it has six unequal fleshy longitudinal ridges, interrupted in the middle (pl. XX, fig. 6). This point is marked externally by a slight constriction. The epiphallus (*epi.*) is very long, terminating in a minute flagellum (*fl.*). The retractor muscle (*rp.*)

is attached to the epiphallus, but sends down a band to the apex of the penis. The vas deferens (*vd.*) is very long and free. The vagina is short. Spermatheca (*sp.*) is not distinctly divided into head and duct. The distal two-thirds or more is of about equal caliber, and *distinctly varicose or sacculated.* The proximal portion is a little contracted. This form of spermatheca is special to the Huachucan species, and unlike those of other districts. The other organs show no peculiar features. The dimensions of the organs in millimeters are as follows:

Species.	Penis.	Epiphallus and flagellum.	Flagellum.	Vagina.	Spermatheca and duct.	Diam. of shell.	Museum No.
A. angigyra, Ramsey Cn.	6	24	1.3	3	22	13–14	83,269
A. angigyra, east fork Salvation	5	28	......	4.5	22.5		94,396
	......	28	......	......	21		
A. bifurca, Tanner Cn.	5	34	1.5	4	29	15	94,388
	4.5	31	......	4	......		
A. ursina	7	42	......	4	28	16–18	94,351
	8	43	......	3.5	26		
A. ursina, Bear Cn.	5	46	1.5	4	32	16	94,349
A. heterodonta, Cave Creek	7	34	......	5	24	16	94,350
A. microdonta, Cave Creek	8	40	1	7.5	26	19	94,347
A. varicifera, Wickersham Rock	7.5	35	1.5	5	27	18	94,340
	6	29	1.8	4	25	17	94,341

All the specimens were measured from alcoholic preparations except *A. levettei ursina*, 94,349, which was dissected fresh.

The figures on plate XX represent the following species:

A. levettei ursina, No. 94,351, head of Bear Canyon (pl. XX, fig. 1).

A. levettei ursina, No. 94,349, head of Bear Canyon (pl. XX, fig. 4). Atrium protruding.

A. l. angigyra, No. 83,269, Ramsey Canyon; type lot (pl. XX, fig. 2).

A. l. heterodonta, No. 94,350, head of Cave Creek.

A. microdonta, No. 94,347, head of Cave Creek; type lot (pl. XX, fig. 7).

A. varicifera, No. 94,340 and 94,341, Miller Peak, Ash Canyon side (pl. XX, fig. 3). Atrium protruding. Fig. 6, the penis opened. Fig. 5, spermatheca of another individual.

Ashmunella varicifera Ancey. Fig. 4.

Polygyra chiricahuana, in part, Dall, Proc. U. S. Nat. Mus., XIX, pl. 32, figs. 9, 10, 12.

A. chiricahuana var. *varicifera* Anc., Journ. of Malacology, VIII, Sept. 30, 1901, p. 77 (near Tucson, Cox). *A. l. heterodonta* or *chiricahuana*, Pilsbry, Proc. A. N. S. Phila., 1905, p. 242, pl. 15, figs. 94, 95.

The shell is depressed, the spire low, varying from convex to low-conoidal, the periphery of the last whorl situated above the middle, obtusely subangular in front. Color rather light-brown and opaque; or corneous-brown and somewhat transparent (sometimes pure white). Surface rather glossy, lightly marked with growth-lines and faint traces of incised spiral lines. Umbilicus rather narrow but open. Aperture oblique, at about 45° with the axis. Peristome rather narrow,

Fig. 4. *Ashmunella varicifera* Ancey.

reflexed, recurved at the edge, having a low, indistinct thickening of the inner rim of the outer lip, and sometimes the very slight indication of an outer basal tooth.

At resting stages young shells form a callous thickening within the lip, which shows through as a radial streak in some adult shells.

Alt. 8, diam. 16½ to 17 mm.; whorls 5½.

" 10½, " 18½ " " 6.

South side of Miller Canyon near its head; Wickersham Rock, Miller Peak, and in the east fork of Cave Creek Canyon; also a mountain on the south side of the mouth of Ash Canyon. These localities, except the last, are indicated by three areas of vertical shading on the map. Miller Peak is about 9,800 feet high.

This species has not been fully described before. The "varices" to which the name is due are only occasionally present in adult shells. They are also seen in *A. chiricahuana*, which is so similar that until now the Chiricahuan and Huachucan snails were supposed to belong to one species. The soft anatomy shows at once that we have to do with two species. *A. varicifera* has genitalia exactly like *A. levettei* except that the epiphallus is somewhat shorter. The spermatheca is not differentiated from its duct, the whole form a long somewhat varicose cylindric body, while in *chiricahuana* the duct is extremely long, swollen at the end. The proportions vary widely in the two species, as follows:

	A. varicifera.	*A. chiricahuana*
Length of penis, epiphallus and flagellum,	37 to 44 mm.	73 mm.
Length of spermatheca and duct, . . .	25 to 27 "	56 "
Length of vagina, ...	4 to 5 "	9 "

The size of the shells is about equal. It appears from this that *A. varicifera* is a simplified member of the *A. levettei* stock, while *A. chiricahuana* belongs to another group of species.

The type locality of *A. chiricahuana* is Fly Park, Chiricahua Mountains.

Extract from Mr. Ferriss' Field Notes.—On the Cave Creek side we found *A. varicifera* larger than the lot from Wickersham's Rock on the peak, and generally albino. Out of one hole containing 29, only two were dark colored. On the other side of the east fork of Cave Creek they were larger but all dark. On the south side of the range there is a strong tendency to albinism in the Ashmunellas, Sonorellas and Oreohelix.

Ashmunella microdonta n. sp. Fig. 5.

The shell resembles *A. varicifera* in general appearance, but differs by having fewer whorls, the last wider viewed from above; umbilicus much wider, exposing more of the penultimate whorl. The lip is toothless except for a very low vestige in the basal margin in some specimens; but there is a minute tubercular parietal tooth in over

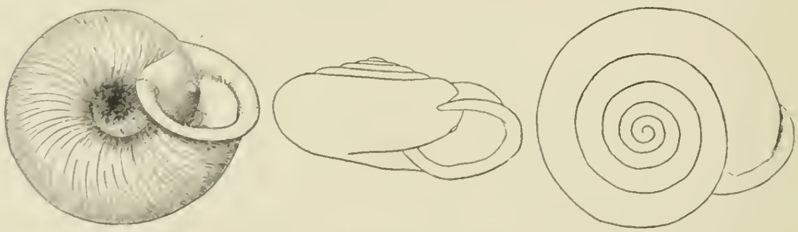

Fig. 5. *Asmunella microdonta.* Cotype.

half of those examined, while it is perceptible as a faint thickening in all. The shell is chestnut colored, usually with one or two varix-streaks on the base; lip white or with its upper half reddish-brown.

Alt.	9.5	8.6	8.8	8.2 mm.
Diam.	20	19	19	17 "
Whorls	$5\frac{1}{2}$	$5\frac{1}{3}$	$5\frac{1}{2}$	$5\frac{1}{3}$ "

Cave Creek Canyon, for one-eighth of a mile at the head.

This is another modification of the *levettei* stock, differing from *heterodonta* and *varicifera* by its wider umbilicus and less closely coiled whorls, from the former by deficient lip teeth, and from the latter by the usual presence of a minute parietal tooth. In genitalia it does not differ from typical *levettei*. While not conspicuously differentiated, we have thought it well to give the form specific rank.

Ashmunella levettei heterodonta Pils. Fig. 6.

Proc. A. N. S. Phila., 1905, 241, pl. 15, figs. 81–91. Nautilus, XVIII, p. 51.

This form has the shape of *A. levettei*, and typically has a low, straight-topped tooth within the outer lip, a small tubercular tooth at junction of outer and basal margins, and a faint prominence in the position of an inner basal tooth. The parietal tooth is minute or wanting. There are barely over 6 whorls, which therefore are a little wider than in *A. levettei*.

We have elsewhere noted the extreme variability of the teeth in *heterodonta*. They may be much more developed than described above, or so degenerate that only faint traces of teeth are discernible. A form-chain connecting *levettei* and *varicifera* exists. Whether hybridism plays a part here remains uncertain.

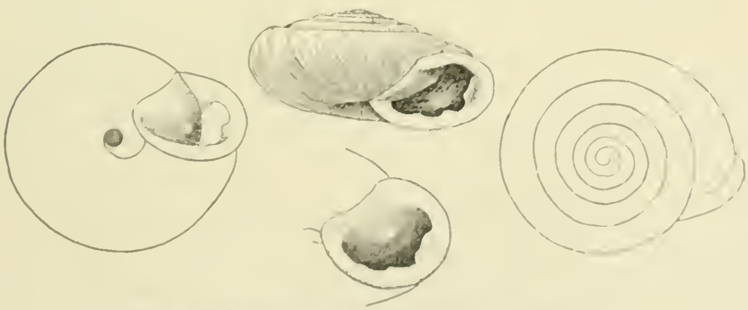

Fig. 6. *Ashmunella levettei heterodonta*. Cotype.

This form occurs in the heads of Ida and Cave Canyons. In one place *heterodonta* goes over the divide two or three hundred feet, but in no other case do these species cross to the other side of the range. *A. levettei* or *heterodonta* are not found in *varicifera* territory. There is no mingling of Ashmunellas except large and small forms of *levettei*. The peculiarities of habit, variation, etc., of the Ashmunellas, Oreohelices, etc., is worthy of a year's study in the Huachucas. The area of *heterodonta* is marked H on the map. Cave Creek Canyon, like that of the same name in the Chiricahua range, has a large basin and many branches.

Ashmunella levettei ursina n. subsp. Fig. 7.

A. levettei Pilsbry, Proc. A. N. S. Phila., 1905, p. 238, pl. 15, figs. 72–78.

The shell is like *A. levettei*, capacious and glossy. The aperture is less obstructed by the teeth. *The parietal tooth is smaller, straight*, not curving inward at the axial end, or almost imperceptibly so, and *without an outer branch* running towards the upper insertion of the lip.

Alt. 9, diam. 18, diam. aperture 8.5 mm.; whorls fully 6½.
" 7.2 " 16 mm.; whorls 6⅓.

Fig. 7. *Ashmunella levettei ursina.* Type.

Head of Bear Canyon, about 7,500 feet elevation. Types No. 87,089 A. N. S. P. It also occurs in the head of Miller Canyon. In Bear Canyon there are many beautiful albino specimens, occurring with others of the normal chestnut color. The range of *ursina* lies westward from that of *heterodonta*.

This is the race formerly referred by us to typical *A. levettei*.

Ashmunella levettei (Bland). Fig. 8.

Triodopsis levettei Bland, Annals of the New York Academy of Sciences, II, 1882, p. 115, cuts. Binney, Manual of American Land Shells, p. 385, fig. 119. Gratacap, Bull. Amer. Mus. Nat. Hist., XIV, p. 383.

The type specimen of this species (fig. 8) was supposed to come from Santa Fe Canyon, New Mexico, but it is distinctly of Huachucan type. The periphery is rounded. The glossy surface is marked with fine growth-wrinkles, and on the last whorl very fine and very faint spiral lines. The parietal callus is distinct, but thin at the edge. The parietal tooth is long, high, straight, but at the axial end it becomes low and *curves strongly inward*. From the distal end of the tooth a low but distinct branch runs towards the outer termination of the lip. This branch is brownish, like the callus it rests upon, hence might easily be overlooked. The outer lip-tooth is slightly emarginate at the top, and curves inward. The outer basal tooth is compressed and larger than the inner one, which is also somewhat compressed.

Alt. 8, diam. 16 mm.; diam. of aperture 7.9 mm.; whorls 6½.

Description and figure from the type specimen, No. 1,274 of the Binney and Bland Collection, American Museum of Natural History, New York. We owe the opportunity of studying this specimen to the kindness of Dr. L. P. Gratacap.

Some specimens from Miller Canyon are identical in characters with the type of *levettei*. It probably was collected in that canyon.

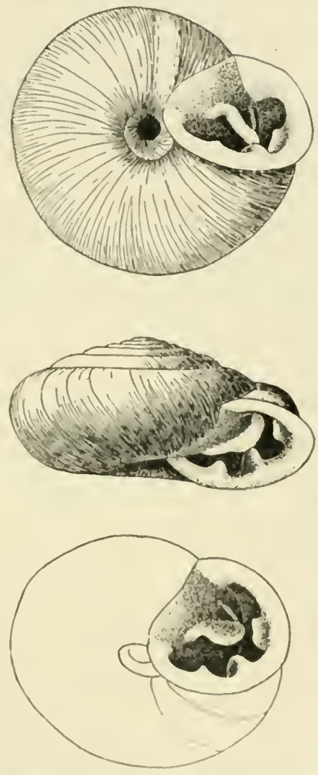

Fig. 8. *Ashmunella levettei* (Bland). Type specimen.

In Carr Canyon there is a similar race having some differential characters. Dr. Henry Skinner collected a series of several hundred shells. They were taken about midway of the canyon as shown in the map. These shells vary in size:

Alt. 6, diam. 13 mm.; whorls 6¼.
" 7 " 13 " " 6⅓.
" 7.5 " 15 " diam. aperture 7 mm.; whorls 6½.

The last whorl is rather depressed and periphery is slightly angular in front, these being the main differences from typical *A. levettei*. In some specimens the shape of the aperture and of the parietal tooth is exactly as in *levettei*, but most examples have the aperture smaller, the lip-ends approaching somewhat more, and connected by the *thickened* edge of the parietal callus. The parietal tooth almost always is recurved at the axial end, and bears a more or less distinct recurrent branch from the distal end, as in *levettei*. In some examples, however, the parietal tooth is straight and there is no perceptible outer branch; the upper margin of the lip descends more deeply on the parietal wall than in the type of *levettei*. The young snails form a very thick lip-callus at resting stages.

This Carr Canyon race is intermediate between typical *levettei* and *bifurca*.

Ashmunella levettei bifurca n. subsp.

In Tanner Canyon the shells resemble those of Carr Canyon. They are glossy, dark chestnut colored, depressed, the last whorl angular in front. The aperture is small, the lip-ends connected by a distinct, often heavy parietal cord. The outer lip-tooth is pushed farther back into the mouth. The parietal tooth curves inward at its axial end, and usually gives off a distinct branch from the distal end, though this may be weak or wanting in some examples. The umbilicus is usually wider than in other forms of *levettei*. The whorls coil closely.

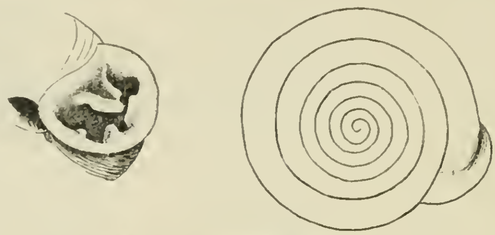

Fig. 9. *Ashmunella levettei bifurca*. Type.

Alt. 6.6, diam. 15, diam. of aperture 6.9 mm., whorls fully 6½.

This race is intensified in the development of apertural teeth. *A. mearnsi* (Dall) is more depressed and has less numerous, less closely coiled whorls.

The spermatheca is more slender, scarcely sacculate or less conspicuously so than in other Huachucan species, and is a little enlarged towards the end, the lower part of the duct slender.

Ashmunella levettei angigyra Pils.

Proc. A. N. S. Phila., 1905, p. 240, pl. 14, figs. 47–54 (shell); pl. 21, fig. 28 (genitalia); pl. 22, fig. 12 (teeth); pl. 23, fig. 14 (jaw).

Smaller, more depressed than *levettei*, and more or less angular at the periphery, teeth contracting the aperture more.

The types, described and illustrated as above cited, were from Ramsey Canyon (called "Conservatory Canyon" in the original paper). Those from northwestward and along the warm dry slopes of the ridge are more typical of the race, being smaller and more angular. The parietal tooth is straight and rather small, without an outer branch. It occurs along the northeastern side of the range from northwest to southeast as follows: Babokomari Creek; Fort Huachuca; Tanner Canyon, over the range, west fork, and along cliffs south of the canyon; Brown's Canyon; Limestone Mountain, 9,000 feet; Ramsey Canyon; also over the range on the foothills of Bear Canyon at about 5,000 feet, where it is very widely separated from other known localities, and very small, diam. 9.5 to 11 mm.

The race from Carr Canyon is intermediate between *angigyra* and *levettei* in size and shape of the last whorl. The examples from Lime-

Fig. 10. *Ashmunella levettei angigyra*. Cotype.

stone Mountain and Salvation Ridge approach those of Carr Canyon in size and apertural teeth, and would probably be grouped with that race rather than with typical *angigyra*, if the two be separable.

A. l. angigyra is the common and widely distributed *Ashmunella* of the Huachucas. The other forms are very local.

The epiphallus is curiously flattened, dumbbell-shaped in section in several individuals (alcoholic) from east fork of Salvation Canyon, and the lower part of the spermatheca duct is slender.

Ashmunella mearnsi (Dall).

Polygyra mearnsi Dall, Proc. U. S. Nat. Mus., XVIII, 1895, p. 2 (Hachita Grande and Huachuca Mountains); XIX, 1896, p. 343, pl. 32, figs. 7, 8, 11.

This species was described as from two widely separated localities. It differs from all other Huachucan species by having fewer, less closely coiled whorls. In these features it belongs to a small group of forms from southwestern New Mexico, composed of *A. walkeri* Ferriss and *A. kochi* Clapp. We have much to learn about the snails of these alluring desert mountains, but it seems likely that there was a mistake in the locality Huachuca Mountains, and that the species really came from the Hacheta Grande Mountains only.

Genus **OREOHELIX** Pilsbry.

The Huachucan Oreohelices have been described and illustrated as fully as possible to us in the first paper of this series.

Oreohelix strigosa concentrata (Dall).

Carr Canyon, 7,000 feet; Limestone Mountain, 8,000 feet; Miller Peak, Ash Canyon. The shells from Miller Peak are rather openly umbilicate and have a peculiar facies. Some greenish-white ones remind one of *Circinaria concava*.

Oreohelix strigosa huachucana (Pils.).

Ramsey, Brown, Carr, Miller, Cave Creek and Ida Canyons; north side of Miller Peak.

Genus **THYSANOPHORA** Strobel.

Thysanophora hornii (Gabb).

Manilla mine, near the northwest end of the range.

UROCOPTIDÆ.

Holospira ferrissi Pils.

Manilla mine, near the northwest end of the range. The locality Fort Bowie, formerly cited by us, was an error.

LIMACIDÆ.

Agriolimax hemphilli ashmuni Pilsbry and Vanatta.

Nautilus, XXII, p. 108.

Limaces are rare in Arizona, but Mr. Ashmun took specimens at Nogales, Pima county, 4,000 ft. elevation, and they were found by one of us in Miller, Brown and Tanner Canyons in the Huachucas.

These slugs belong to the very widely distributed group of *Agriolimax lævis*, but we have not been able to refer them directly to any described race. By the development of entocones on the lateral teeth they differ from *A. campestris* (including *montanus* Ing.), and agree with *A. hemphilli* (Binney),[7] *A. stenurus* (Strebel)[8] and *A. berendti* (Strebel).[9] Whether these forms are specifically distinct or not remains to be determined. Their distinctive characters do not seem important.

The alcoholic specimens from Miller Canyon have the general aspect externally of *A. campestris*. The rounded back is black, flanks sooty brown. The mantle is large, and more than half of it is free, so that when lifted and turned back it more than covers the posterior adnate portion. Under it the surface is yellowish. The sole is very narrow, conspicuously tripartite. The central tooth is tricuspid. Laterals have a small entocone elevated on the side of the mesocone; ectocone

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[7] *Limax hemphilli* W. G. Binney. *Third Supplement to Terrestrial Mollusks*, V, 1890, p. 201, pl. 1, fig. 13; pl. 2, fig. 3; pl. 8, fig. E (Julian City, Cal.). *Fourth Supplement*, p. 166, pl. 3, fig. 1 (var. *pictus* Ckll., San Tomas River, L. Cal.).

[8] *Limax stenurus* Strebel, *Beitrag Mex. Land und Süsswasser Conchyl.*, IV, 1880, p. 21 (State of Vera Cruz, Mexico).

[9] *Limax berendti* Strebel, t. c., p. 22 (Coban, Guatemala). Cf. also *L. jalapensis* Strebel, *l. c.*

well developed. There are 13 lateral teeth, the 13th being transitional to the marginals, which are simple, thorn-shaped. Jaw as usual. The penis is large, much twisted, terminates in an obtuse "flagellum" or blind sack, and it has a fleshy sensory papilla in the anterior enlargement, shown by dotted lines in fig. 8 *c*. In front of this enlargement it is very slender. It has an extremely slender retractor muscle (*p.r.*). Other organs as usual in the group.

Examples from Tanner Canyon have the same genitalia, but differ

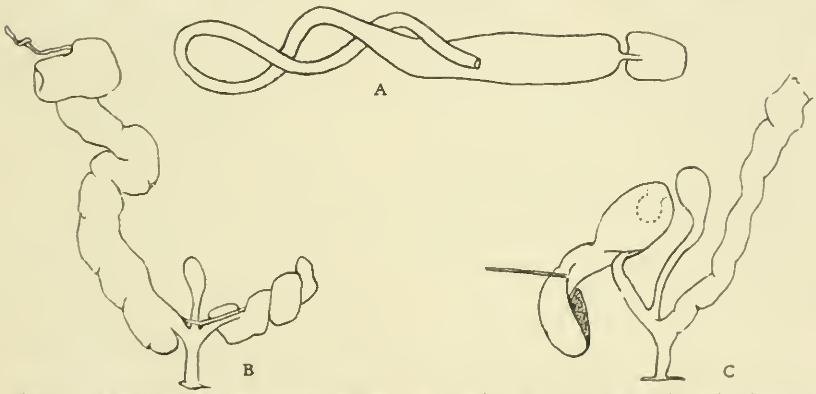

Fig. 11. *Agriolimax hemphilli ashmuni*. *a*, *b*, alimentary canal and genitalia of a specimen from Nogales. *c*, genitalia of the type from Miller Canyon.

in external color. They are pale soiled buff, with a slightly darker reticulation back of the mantle, which is closely flecked with gray. These slugs are therefore not unlike *A. hemphilli pictus* Ckll.

According to Mr. Binney, *A. hemphilli* has 50, 1, 50 teeth with 10 laterals. This is somewhat unlike our slug, which has more lateral teeth, though of the same shape; moreover, the penis of *A. hemphilli* seems to differ from the Arizona form, which occurs in a region otherwise wholly diverse in its mollusk population. *A. stenurus* and *A. berendti* of Strebel belong to the tropical fauna. Since the Arizona form differs materially in dentition from the described alpine slugs of Colorado, we have thought it safest to give a special name to the mountain slug of Arizona, until such time as the several forms can be actually compared by some observer, and their relations to one another elucidated.

The types of *A. hemphilli ashmuni* are No. 94,366 A. N. S. P., from Miller Canyon, Huachuca Mountains.

ENDODONTIDÆ.

Pyramidula (Gonyodiscus) cronkhitei (Newc.).

Wickersham's, Miller Peak; Carr Canyon.

Pyramidula (Gonyodiscus) shimeki cockerelli Pils.

"Reef," Carr Canyon, at 5,000 feet (C. R. Biederman).

Radiodiscus millecostatus Pils. and Ferr.

Carr Canyon; Miller Peak, near the top and on the north side, and in Wickersham's Gulch; Wickersham's.

Helicodiscus eigenmanni arizonensis Pils. and Ferr.

Found in 1904, no special locality recorded.

ZONITIDÆ.

Zonitoides arborea (Say).

Wickersham's Rock, Miller Peak; Tanner Canyon; Ash Canyon.

Zonitoides minuscula (Binn.).

Wickersham's, Miller Peak; Tanner Canyon; Benson.

Zonitoides minuscula alachuana (Dall).

Ash Canyon; Wickersham's.

Zonitoides milium meridionalis Pils. and Ferr.

Wickersham's.

Vitrea indentata umbilicata (Ckll.).

Tanner Canyon; Wickersham Gulch; Miller Canyon, one very large example, diam 6.7 mm.; Ash Canyon.

Euconulus fulvus alaskensis Pils.

Wickersham's rock, Miller Peak.

Vitrina alaskana Dall.

Wickersham's, Miller Peak.

SUCCINEIDÆ

Succinea avara Say.

Tanner and Ash Canyons.

VALLONIIDÆ.

Vallonia perspectiva Sterki.

Tanner, Pine and Ash Canyons; Wickersham's, Miller Peak.

Vallonia cyclophorella Ancey.

Wickersham's, Miller Peak.

PUPILLIDÆ.[10]

Pupilla hebes (Ancey).

Wickersham's, Miller Canyon.

[10] *Pupoides hordacea* (Gabb) and *Pupilla syngenes* (Pils.) were found in river drift at Benson. Of the latter both dextral and sinistral shells, one of each.

Bifidaria quadridentata Sterki.

Wickersham's, Miller Canyon. One specimen.

Bifidaria ashmuni Sterki.

Ash Canyon.

Bifidaria cochisensis Pils. and Ferr.

Tanner Canyon, abundant. This form and the following will be described in the next paper of this series, in connection with a general review of the group of *B. ashmuni*.

Bifidaria cochisensis oligobasodon Pils. and Ferr.

Ash Canyon.

Bifidaria pilsbryana Sterki.

Wickersham's, Miller Peak.

Bifidaria tappaniana (C. B. Ad.).

Tanner Canyon, 6,000 feet; also San Pedro drift at Benson.[11]

Vertigo ovata Say.

Ash Canyon; Tanner Canyon, 6,000 feet; also San Pedro drift at Benson.

Vertigo modesta parietalis Anc.

Wickersham's, Miller Peak.

Vertigo concinnula Ckll.

Wickersham's, Miller Peak; one immature shell.

Vertigo milium Gld.

Tanner Canyon, 6,000 feet; drift of San Pedro river at Benson.

FERUSSACIDÆ.

Cochlicopa lubrica (Mull.).

Tanner Canyon, 6,000 feet; Carr Canyon; Wickersham's, Miller Peak

LYMNÆIDÆ.

Lymnæa parva Lea.

Ash Canyon; a few very young specimens.

PHYSIDÆ.

Physa virgata Gld.

Small, slender, long-spired examples, clearly of the *virgata* type, were taken in Tanner Canyon, in a spring at about 6000 ft.

[11] *Bifidaria pentodon* (Say) was taken in San Pedro drift at Benson, Cochise county, Arizona.

AMNICOLIDÆ.

Paludestrina stearnsiana Pils.

Ash Canyon, one bleached specimen; spring in Tanner Canyon, numerous living examples.

PELECYPODA.

Pisidium abditum huachucanum Pils and Ferr.

Stream in Carr Canyon (C. R. Biederman, type loc.); spring in Carr Canyon, 7,000 feet; springs in Tanner Canyon at 6,000 and 7,000 feet; spring at the mouth of Ash Canyon, 4,500 feet; artificial pond at the mouth of Hunter Canyon, 4,500 feet (L. E. Daniels, October, 1907).

This is, we believe, the only *Pisidium* recorded from Arizona.

Explanation of Plates XIX to XXI.

Plate XIX.— Figs. 1, 2, 3—*Sonorella dalli* Bartsch. Tanner Canyon.
Figs. 4, 5, 6—*Sonorella granulatissima latior* Pils. Cotypes.
Figs. 7, 8—*Sonorella granulatissima* Pils. Cotypes.
Fig. 9—*Sonorella granulatissima* Pils. Miller Canyon.
Figs. 10, 11, 12—*Sonorella granulatissima parva* Pils. Cotypes.
Figs. 13, 14, 15—*Sonorella danielsi* Pils. and Ferr. Cotypes.
Fig. 16—*Sonorella huachucana* Pils. Bear Canyon.
Fig. 17—*Sonorella huachucana* Pils. Type.
Fig. 18—*Sonorella danielsi* P. and F., brown variety. Ash Canyon, No. 94,385.

Plate XX.—Fig. 1—*Ashmunella levettei ursina* Pils. and Ferr. No. 94,351.
Fig. 2—*Ashmunella l. angigyra* Pils. No. 83,269.
Fig. 3—*Ashmunella varicifera* Anc. No. 94,341.
Fig. 4—*Ashmunella levettei ursina* P. and F. No. 94,349. Atrium and ends of penis and vagina protruding.
Fig. 5—*Ashmunella varicifera* Anc. Spermatheca of another individual.
Fig. 6—*Ashmunella varicifera* Anc. Penis opened.
Fig. 7—*Ashmunella microdonta* Pilsbry and Ferriss. No. 94,347. One of the cotypes.

Plate XXI.—Fig. 1—*Sonorella granulatissima* Pils. No. 83,257. Cotype.
Fig. 2—Ditto. Penis opened to show papilla.
Fig. 3—Ditto. Penis, epiphallus and flagellum.
Fig. 4—Ditto. No. 94,336. Miller Canyon.
Fig. 5—*Sonorella danielsi* Pilsbry and Ferriss. No. 94,337.
Fig. 6—*Sonorella danielsi* Pilsbry and Ferriss. No. 94,318. Type.
Fig. 7—*Sonorella g. latior* Pils. No. 94,387. Tanner Canyon.

Plate XXII.—Figs. 1, 2, 3—*Sonorella rinconensis* Pils. and Ferr. Central, lateral and marginal teeth.
Fig 4—*Sonorella rinconensis*. Type, genitalia. × 2.
Fig. 5—*Sonorella dalli* Bartsch. No. 94,384, genitalia. × 2.
Fig. 6—*Sonorella dalli* Bartsch. Jaw.

A NEW SONORELLA FROM THE RINCON MOUNTAINS ARIZONA.

BY H. A. PILSBRY and J. H. FERRISS.

The Rincon Mountains lie near the western border of Cochise County, Arizona, north of the Whetstone Mountains, which are north of the Huachuca range.

In 1907 one of us (Mr. Ferriss) visited the range and procured specimens of a large *Sonorella*, the first mollusk known from these mountains.

Fig. 1. *Sonorella rinconensis.* Cotypes, nat. size.

Where visited the range is rather dry. The rock is granitic, of pre-Cambrian age.[1] Besides *Sonorella rinconensis* only a few shells were taken, minute forms common to the region. *Sonorella rinconensis* was found sticking to large rocks and boulders, a habit not hitherto noticed in the genus. They are rare, the biggest bag made being six in one day.

Sonorella rinconensis n. sp. Pl. XXII, figs. 1–4, 7

The shell resembles *S. ashmuni* Bartsch in shape. It is pale brown fading to white around the umbilicus, with a broad chocolate shoulder-band, widely whitish-bordered above and below. The surface is smoothish, marked with delicate growth-lines and under the lens some faint spiral lines may be traced on the last whorl near the suture. The embryonic whorls have sculpture of the *S. hachitana* type. The whorls increase rather slowly to the last, which is much widened, and well rounded peripherally. It descends a little in front. The aperture is rotund-lunate; peristome slightly expanded, dilated at the columella as usual. Umbilicus about as in *S. ashmuni*.

Alt. 16, diam. 26.5, width of umbilicus 4 mm.; whorls fully 5.

The penis is extremely long and slender, and contains a very long papilla. Its lower end is enveloped in a sheath. The retractor

[1] *Cf.* W. P. Blake, Some Salient Features in the Geology of Arizona, with Evidences of Shallow Seas in Paleozoic Time *American Geologist*, Vol. 27, 1901, p. 160.

muscle is inserted distally on the lung-floor, as usual. The vagina is excessively long, longer than the penis, and of about equal diameter throughout (slightly over 1 mm.). The spermatheca is globular, its duct much shorter than the vagina. The organs of an individual drowned and dissected fresh measure as follows:

Length of penis,	55	mm.
" " " papilla,	31	"
" " " sheath,	7	"
" " epiphallus,	22	"
" " flagellum,	1.2	"
" " vagina,	70	"
" " spermatheca and duct,	31	"

The liver is maroon colored when fresh.

Types No. 94,313 A. N. S. P., from Rincon Peak, Rincon Mountains, Cochise County, Arizona; cotypes in coll. Ferriss. Specimens were also taken on Mt. Mica and Wrong Mountain, Rincon range.

The jaw (pl. XXII, fig. 7) has six or seven strong ribs, projecting on both margins.

The radula has 26, 15, 1, 15, 26 teeth (pl. XXII, figs. 1, 2, 3). The central and lateral teeth are unicuspid, the cusps stout and obtuse, longer than the basal plates. At about the sixteenth tooth an ectocone appears. Towards the outer edge of the radula the inner cusp becomes bifid; and in many but not all of the outermost six or eight marginals the ectocone is split into two or three denticles (fig. 3).

Conchologically this form stands very close to *S. ashmuni* Bartsch, from Richinbar, south of Prescott, Arizona; also found at Jerome, and at Purtyman's ranch on Oak Creek, 40 miles from Jerome. It would probably be scarcely possible to separate the two species by the shells alone. The genitalia, however, are widely diverse. *S. ashmuni* (Oak Creek) has genitalia of the type found in *hachitana*-like Sonorellas of the Peloncillo, Florida and Dos Cabezas ranges, while *S. rinconensis* has the penis and vagina excessively lengthened While quite unlike any known form, it seems nearer to *S. virilis* than to other species which have been dissected, but differs from that by its far shorter penis-papilla and by the vagina, which is much longer than the penis, while in *S. virilis* the penis is longer.

Plate XXII.—Figs. 1, 2, 3—*Sonorella rinconensis* Pils. and Ferr. Central lateral and marginal teeth.
Fig. 4—*Sonorella rinconensis.* Type, genitalia. × 2.
Fig. 5—*Sonorella dalli* Bartsch. No. 94,384, genitalia. × 2
Fig. 6—*Sonorella dalli* Bartsch. Jaw.
Fig. 7—*Sonorella rinconensis.* Jaw.
Fig. 8—*Sonorella dalli.* Teeth.

MELANIIDÆ OF THE PANUCO RIVER SYSTEM, MEXICO.

BY H. A. PILSBRY and A. A. HINKLEY.

The Pachycheili of the Panuco River system are all, so far as known, special to that drainage.[1] These waters are remarkably rich in fine species, which though not so large as some from Central America, are more varied in shape and sculpture. In a few species the spire is so short that the shell has a globular or oval shape, like *Anculosa* or *Paludomus*; yet in the structure of the aperture and operculum these aberrant forms agree with more normal species of the same region. One species, *P. pleurotoma*, has a Pleurotomoid sinus in the outer lip, somewhat like that of *P. dalli* Pils., but situated farther up.

The whole group of the Panuco drainage differs from the southern forms of *Pachycheilus* in the weakness or absence of the regular and close microscopic spiral striation characteristic of the typical species.

The shells are generally abundant. Of most of the forms several hundred shells at least of each species have been examined. All were collected by Mr. Hinkley during the past winter. The descriptions are the joint work of both authors. The figures are natural size. Cotypes of the new forms are in the collections of the Academy of Natural Sciences of Philadelphia and of Mr. Hinkley.

Since many of the localities mentioned herein are not indicated on maps available in this country, we give here a sketch of the lower portion of the Panuco River System.[2]

[1] It is possible that *P. pluristriatus* is an exception, but the record of that species from a West Mexican lake seems improbable.

[2] Localities where mollusca were collected during the winter of 1908 and 1909 are marked on the map with numerals. These numbered stations are as follows:

No. 1. LaBarra.
" 2. Tampico.
" 3. Cave from which the Choy River issues.
" 4. Taninul, flag station for Hot Spring.
" 5. Hot Spring.
" 6. Catamas Lake.
" 7. Pujal Lake.
" 8. El Abra.
" 9. Valles Station.
" 10. Valles.
" 11. Small falls of the Valles River.
" 12. Ranch of Mr. Willis.
" 13. Chaimi Creek.
" 14. Pujal, Pujal ferry and ford.
" 15. Ford or ferry of the Coy River.
" 16. Alligator Lake.
" 17. First rill in the mountains south of Valles.

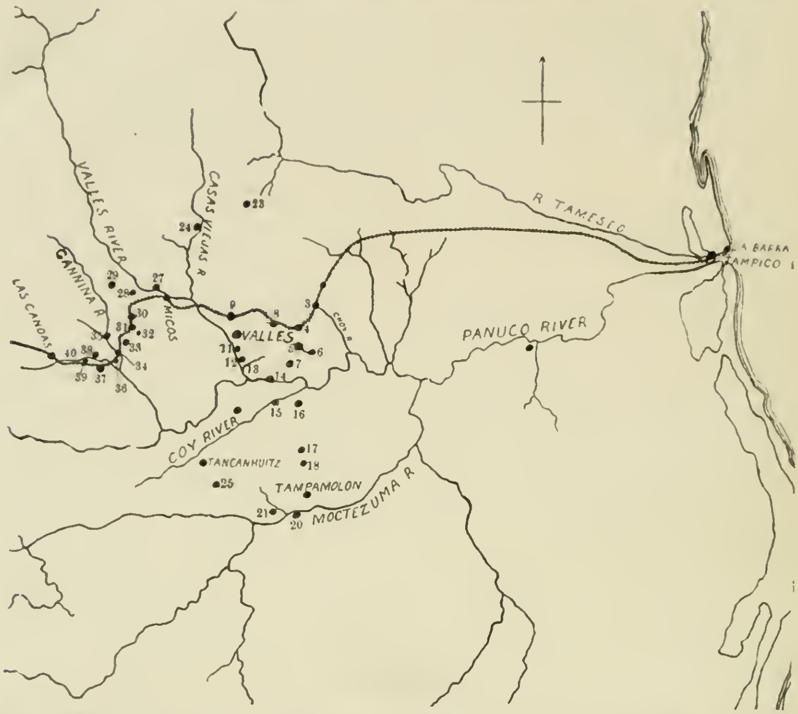

Fig. 1. Map of a portion of the Panuco River system, showing localities mentioned in this paper.

No. 18. Second rill in the mountains.
" 19. Tampamolon.
" 20. Ford and ferry of Moctezuma River.
" 21. Creek near the ford of Moctezuma River.
" 22. Tancanhutz.
" 23. Choy ranch.
" 24. Casas Viejas River.
" 25. Coxcantlan.
" 26. Mecos (Micos) and Mecos falls.
" 27. Rapids above Mecos.
" 28. Lagoon five miles west of Mecos.
" 29. Lagoon between mountains, no outlet.
" 30. Bluffs north of San Dieguito.
" 31. San Dieguito.
" 32. Cave.
" 33. Bluff southwest of San Dieguito.
" 34. Ganina River.
" 35. Tributary of Ganina River.
" 36. Rascon.
" 37. Tamosopo.
" 38. Mill of Tamosopo Sugar Co.
" 39. Natural Bridge and Verastagu.
" 40. Canyon.
" 41. Las Canoas.

According to the railroad map, the elevation of Valles is about 200 feet above the sea; El Abra, 700 feet; Mecos, over 1,000 feet; Tamosopo, 1,300 feet; Los Canoas, 3,300 feet.

Pachycheilus pila n. sp. Pl. XXIV, figs. 1–5.

The shell is solid and strong, irregularly *globose*, black, smooth but for inconspicuous growth-lines (except the very young shells which are delicately, closely striate spirally); *spire very short*, mainly eroded in adult shells, but concavely acuminate when preserved in the young. Only 2 or 3 whorls remain in adult shells, the last very globose throughout, more or less flattened below the suture near the aperture. The aperture is large, black within; outer lip thin, much more arcuate than the inner lip, which is only slightly arcuate. Columellar margin heavily calloused throughout, black, with a white lining on the inner border.

Length 19, diam. 16½ mm., longest axis of aperture 13 mm.
" 20, " 15½ " " " " 13 "
" 19, " 17 " aperture 13½ x 12¼ mm.
" 20, " 17 " " 13 x 10 mm.

Tamosopo River above and below the "Natural Bridge," near Verastagu, State of San Luis Potosi, Mexico.

The water in the basin above the bridge is in constant agitation, caused by the falls of several small streams feeding it and the narrow outlet, so there are several inches of the rock walls alternately covered and exposed. The positions occupied by the different species of *Pachycheilus* were quite diverse, the *P. pila* always being submerged, while *P. atratus* and *humerosus* were higher up and often entirely beyond the reach of the water. Below the bridge *P. pila* was on submerged rocks, while the other species were most plentiful at or near the surface.

This is the shortest, most globose species of *Pachycheilus* known, having the contour of an *Anculosa* or *Paludomus*. The youngest stage examined is about 2 mm. long, at which time the shape is ovate-conic. At 5½ mm. long, with the spire of 5 whorls still perfect, the last whorl has become inflated, and traces of very fine delicate spiral striæ remain. The types (pl. XXIV, figs. 1 to 5) are from below the "Natural Bridge." Some examples apparently adult are smaller than the dimensions given above, alt. 13½, diam. 13 mm.

Specimens from a tributary of the Tamosopo River at the Tamosopo Sugar Company's plantation are all smaller. Specimens measure:

Length 14, diam. 12, length of aperture 9 mm.
" 12, " 11, " " 8.8 "

Examples from a rill on the mountain side above the banana plantation at the "Natural Bridge" are very small, adults measuring 8 to 11 mm. long. This small race might be distinguished as *P. pila pilula* n. var. (pl. XXIV, fig. 6).

Pachycheilus tristis n. sp. Pl. XXIV, figs. 7–10.

The shell is *short, ovate*, brown, the last whorl smooth when adult. Spire conic but deeply eroded in adults, rarely showing more than 3 whorls distinctly. The last whorl is convex. Aperture bluish-white inside. Outer margin thin, strongly arched, forming half a circle; inner margin slightly arcuate, heavily calloused, white throughout or with a brown edge.

The neanic stage, length 10–11 mm., is conic with an elevated spire sculptured with spiral carinæ, 3 on each whorl of the spire, one ridge being just below the suture, another below the middle, and the third just above the succeeding suture. On the last whorl there are 4 or 5 spiral ridges, the lowest one weak, below the periphery. Subsequently the whorls become more inflated and the spiral sculpture weakens, either disappearing in the penultimate whorl or a single subsutural ridge and sulcus may persist until the beginning of the last whorl.

Length	21,	diam.	13.7 mm.;	aperture	11.5 x	9 mm.
"	20,	"	14 "	"	11.2 x	9.2 "
"	23.5,	"	16 "	"	12.5 x	10 "
"	16.2,	"	12.5 "	"	9.5 x	8 "

Tamasopo River at the "Natural Bridge," near Verastagu, State of San Luis Potosi. Very few found above the bridge, but quite plentiful below.

Adult shells of this species resemble *P. pila* in shape, but they differ by the brown color, bluish-white aperture and white columella. Old shells which have lost most of the spire by erosion are hard to distinguish from *P. pila*. The characters of the young are wholly diverse, and show *P. tristis* to be related to *P. humerosus* and *P. atratus*. Compared with *P. humerosus*, *P. tristis* differs in lacking a shouldered last whorl, the more ovate shape and the color. It differs from *P. atratus* in shape, sculpture and color.

Pachycheilus moctezumensis n. sp. Pl. XXIV, figs. 11, 12.

The shell is *globose-oval*, solid, purplish-black. The *spire is very short*, the apex slightly projecting; earlier whorls light brown, the apex eroded. Whorls of the spire sculptured with several low spiral ridges. Last whorl oval, smooth, aperture ovate, angular above, broadly rounded below, dark within, black near the lip edge. Inner margin calloused, white, usually with a brown edge.

Length	20½,	diam.	14½,	aperture	13 x 11 mm.,	4 whorls remaining.	
"	17½,	"	13,	"	11½ x 9 "	4 "	"

Moctezuma River at the ford south of Tampamolon, State of San Luis Potosi; taken from rocks in shallow water where there was considerable current. They were scarce.

With some resemblance to *P. pila*, this species differs by its more oval shape, the last whorl being less convex and larger, the aperture less wide. *P. pila* has quite a different facies from the great expansion of the last whorl.

In some examples the spire is longer than in those selected as typical: length 23, diam. 15, aperture 14 mm., whorls 6, the spire being perfect.

Pachycheilus pluristriatus (Say). Pl. XXIII, figs. 1–5.

Melania pluristriata Say, New Harmony Dissem., Dec., 1831; Complete Writings, p. 140.
Pachycheilus pluristriatus Say, v. Martens, Biologia Centrali Amer., Moll., p. 419, pl. 26, fig. 1.
Melania rubida Lea, Obs. Gen. Unio, etc., XI, p. 77, pl. 22, fig. 16.
Melania labiosa Wiegmann, in Berlin Mus.

This species is solid, straightly conic, light slate or drab to nearly black in color, glossy, usually with a yellowish band below the suture and sculptured with numerous acute spiral cords narrower and much lighter colored than their intervals, usually 10 to 15 on the last, 6 on the penultimate whorl. The embryonic whorls are smooth, following ones have a keel above the suture, and soon a thread above the keel; additional threads soon appearing. The suture is either rather inconspicuous throughout or moderately impressed at the later whorls. The last whorl is convex. Aperture purple-brown inside, ovate, acutely angular above. Outer lip thin, retracted above. Columella rather narrow. Parietal callus is rather heavy, or sometimes very thick, white, brown at the edge.

Length	37,	diam.	17,	aperture	15 mm.;	whorls	8.
"	33,	"	16,	"	14 "	"	7½.
"	35,	"	15,	"	13.3 "	"	9.

Coy River, San Luis Potosi, on a long water plant in the stream and at the water's edge, quite abundant.

The exact locality of Say's type of this species is not known. It was taken by Mr. Maclure, who went to Mexico by the Tampico route, and therefore may have obtained the shells from the Coy River or its neighborhood. The examples taken by Mr. Hinkley agree fully with Say's. The locality of *M. rubida* Lea was also unknown. Prof.

von Martens figured a specimen from the Berlin Museum, taken by Ferdinand Deppe between 1824 and 1837. These examples were labelled as from Lake Chapala, at the western edge of the Mexican plateau, and draining into the Pacific. It seems unlikely that this snail has any such range, and we are disposed to believe that some mistake about the locality of Deppe's shells has crept in. They agree fully in shape and sculpture with the Coy River examples, but, like *M. rubida* Lea, are dead shells, of a reddish color.

Pachycheilus pluristriatus longus n. subsp. Pl. XXIII, figs. 11, 12.

The shell is longer than *pluristriatus*, black, sometimes fading to flesh color towards the apex, not glossy. The keel above the suture is more prominent and the other spirals are fewer and unequal, part of them being very weak, and they are black like the ground color. The suture is deeply impressed; the base of the last whorl is smooth or weakly sculptured.

Length	37.3,	diam.	14.3,	aperture	13.5 mm.;	whorls	9½.
"	36,	"	14.5,	"	13.3 "	"	12.

Ganina River, there miles southwest of San Dieguito, San Luis Potosi.

Pachycheilus pluristriatus tamasopensis n. subsp. Pl. XXIII, figs. 6–10.

The shell is glossy, black, shaped like *P. pluristriatus*. Sculpture weaker, the whole last whorl or its basal half being smooth, without spiral cords, but generally a few spirals persist below the suture.

Length	36½,	diam.	17,	aperture	14 mm.;	whorls	5½.
"	38,	"	15,	"	15 "	"	7½.
"	34,	"	13,	"	14 "	"	7½.

Small stream north of the mill of the Tamasopo Sugar Co., San Luis Potosi.

Some small examples with the upper whorls eroded show no spirals whatever, and may possibly belong to another species (pl. XXIII, fig. 8). More perfect adult shells or the young stages must be examined. Examples measure:

Length	25,	diam.	13,	aperture	11.7 mm.;	whorls	3.
"	26.5	"	15.2,	"	11 "	"	4½.

Pachycheilus atratus n. sp. Pl. XXIII, figs. 13–18.

The shell is ovate-turrited, solid, covered with a *very smooth*, dense, glossy brownish-black cuticle. The spire is somewhat acuminate; early whorls smooth; intermediate whorls often showing a few weak spiral cords below the suture and a weak angle at the shoulder. Last whorl flattened below the very deep suture, elsewhere very convex and smooth, though on some examples faint traces of very minute spiral lines may be discerned. The aperture is rounded-oval or rounded-ovate, somewhat livid and translucent within but generally with a black band bordering the lip. It projects beyond the general outline of the cone. Outer and basal margins of the peristome are thin, black, and well rounded; inner margin straightened more or less, white within, with a black or brown-black edge; 5 or 6 whorls remain in adult shells, only the tips being eroded.

Length 30, diam. 16 mm.; aperture 13 x 9 mm.
" 27, " 15½ " " 13 x 11 "
" 27, " 14 " " 12⅓ x 10 "

Tamosopo River near Verastagu, San Luis Potosi, above and below the "Natural Bridge" (pl. XXIII, figs. 13 to 15).

While clearly related to *P. humerosus*, this species is easily distinguished by its rounded whorls. A large quantity of each was taken. The type lot consists of beautifully perfect, clean shells from above the bridge. Those found below the bridge are not so clean.

Specimens from a rill issuing from a cave on the mountain side above Los Canoas are incrusted with a gray calcareous deposit so that adults resemble pebbles, but when cleaned the shell within is found to be almost or entirely perfect (pl. XXIII, figs. 16, 17, 18). Fig. 18 represents a cleaned specimen. They are smaller than the type lot, about 24 mm. long.

A lot taken in the rill on the mountain above the "Natural Bridge" consists of dwarf shells, adults measuring 19 to 21 mm. long. *P. pila* in the same stream is even more dwarfed.

Pachycheilus atratus ganinus n. subsp. Pl. XXIII, figs. 19, 20.

A race of *P. atratus* occurs in the Ganina River three miles southwest of San Dieguito. The black shell is dull with the middle and lower whorls of the spire ridged or coarsely striate spirally, usually with 5 to 8 striæ on the penultimate whorl. Several of these spiral cords usually continue on the last whorl below the suture. The upper whorls of the spire are smooth and convex. The aperture is shaped as in *P. atratus*. Fig. 19 represents a cleaned shell, fig. 20 one incrusted.

Length 24, diam. 13, aperture 11½ mm.

There are some abnormally shortened shells, length 17, diam. 12, aperture 10½ mm. The spire is generally covered with a hard calcareous crust, difficult to remove. *P. pluristriatus lorquus* occurs in the same place.

This form resembles *P. a. suprastriatus* closely, but differs by having smooth post-embryonic whorls. It is also constantly black in color.

Pachycheilus atratus suprastriatus n. subsp.

The shell resembles *P. atratus* in shape and aperture. It is less glossy, brownish black, dark brown or corneous-brown, the whorls of the spire spirally striate, the striæ sometimes persisting on the last whorl below the suture. The earliest post-embryonic whorls are acutely carinate, the carina continuing downward above the suture as additional acute cords arise above it. On the third from the last whorl, in a cotype, there are 5 equal acute striæ.

Length 30½, diam. 15, aperture 13 mm.; 6 whorls remaining.
" 24, " 13, " 11½ " 5 " "
" 24½ mm.; 7½ whorls remaining.
" 34, diam. 16 mm.; aperture 13 x 10 mm.
" 24, " 13 " " 10 x 7 "

Valles River at Mecos falls, and some rapids two miles west of Mecos, State of San Luis Potosi, Mexico.

The only species of *Pachycheilus* found in the vicinity of Mecos. The young differ from those of *atratus* and *ganinus* in being carinate; the early whorls of the spire enlarge more regularly, and the color is a dull horn or light shade of brown without the polish of the young *atratus*.

Taken from the bed of the river in a moderate current, and sheltered pools where there was no current.

Mecos falls are a number of small falls and rapids where the Valles River comes from the mountains to the valley. Standing on the railroad track and looking east and a little to the right, Valles can be seen as a spot in the valley, and still farther in the next range of mountains is seen the rock face of the cut through which the railroad passes and in which lies the village of El Abra.

Pachycheilus humerosus n. sp. Pl. XXIII, figs. 21-25.

The shell is ovate-turrited, solid, black with pale spiral bands on the ridges, the cuticle smooth and dense. Spire acuminate when not eroded, the earliest whorls (in young shells) clear brownish, first 5 whorls smooth and not very convex, then two spiral ridges appear, rapidly becoming stronger, a third ridge appearing below the suture about the 8th whorl, and sometimes others between the primary ridges. A specimen 9 mm. long with 8 whorls has 7 spiral ridges on the last whorl, each showing as a white band within the aperture. One 15 mm. long with 9 whorls has 7 such ridges and bands on the last whorl. The whorls then enlarge very rapidly, the suture deepens. On the penultimate whorl of an adult there are about 5 spiral pale ridges, the lower ones wider and lower. On the last whorl the ridges weaken, leaving it smooth or nearly so, or they may persist below the suture and at the base; *the suture becomes very deep*, the whorl below it *horizontal, shouldered*, the shoulder bounded by a ridge or angle. The aperture is rounded-ovate, blackish within but pale or banded in the throat; outer and basal margins thin, black, broadly rounded; inner margin more or less straightened, appressed or free and continuous, brown at the edge, the callus white. 3½ to 6 whorls usually may be counted in adult shells.

Length	28,	diam.	18,	aperture	13½ x 10	mm.
"	27,	"	17.	"	14 x 12	"
"	25,	"	18½.	"	14⅓ x 12	"
"	25,	"	16½.	"	14 x 10⅓	"

The operculum is ovate, with the nucleus about one-third across from the columellar side and below the middle.

Tamosopo River, near Verastagu, above and below the "Natural Bridge."

The light colored cords alternating with purple-black bands makes it a conspicuous shell when seen in the water. While the general shape is that of *P. atratus*, this species differs from that by its conspicuous sculpture. It is more allied to *P. tristis*, though very distinct.

Pachycheilus monachus n. sp. Pl. XXIV, figs. 21–25.

The shell is solid, cylindric with conic spire, or turrite-conic, black. The earliest whorls appear to be smooth; then sharp spiral cords much narrower than their intervals appear, evenly spaced, and five on each whorl; these disappear on the last two whorls, or one to three persist only below the suture, where the whorl is more or less tumid or shouldered. The spire is rather long and conic; suture deep; last whorl convex or flattened laterally. The aperture is ovate, whitish inside, black near the lip. Outer lip sharp and strongly arcuate. Columellar lip more straightened, heavily white-calloused, usually brownish at the edge.

Length	32,	diam.	14.3,	aperture	13 mm.;	whorls	remaining	8.
"	28,	"	13.3,	"	12 "	"	"	4½.
"	25½,	"	14,	"	12 "	"	"	4½.

Coy River, three miles south of Los Palmas, State of San Luis Potosi, Mexico.

The Coy River issues from a cave at the foot of the mountain below the railroad track. Specimens taken near the cave and a short distance within average smaller than those taken lower down the stream, but agree with them in other characters. They measure 20 to 28 mm. long.

P. monachus has some resemblance to *P. a. suprastriatus*, but in that the spiral striæ are coarser and less regular, the aperture is less angular above, and projects more laterally beyond the outline of the cone, as in *P. atratus*.

Pachycheilus vallesensis Hinkley.

Nautilus, XXI, p. 25, pl. 5, figs. 1–3, 5–7, 10 (July, 1907).

This species was taken in the Valles River at Valles; most abundant where there is but little current. Also at the ranch of C. P. Willis. In all kinds of situations. In some places the young were very numerous. The largest ones were on rocks and in the bed of the river where there was little or no current. The large typical form also occurred in the Panuco River at Pujal, on a rock outcrop in the bed of the river. This is a wide shallow stream in which there is a large amount of shifting sand. Few shells were found where the stream was visited.

Very large shells, some 37½ x 18½ mm., were taken in the Moctezuma River at the ford, in the bed of the stream.

P. vallesensis differs from the other stout species of the region by its bluish, ashy or blackish-gray color, reminding one of *Goniobasis livescens*, and by the white columellar callus.

Pachycheilus vallesensis attenuatus n. subsp.

The shell is livid bluish when clean, smaller and much more slender than *vallesensis*, with a comparatively longer spire. Whorls 8 or 9, the upper ones weakly striate spirally, last whorl smooth. Aperture ovate, acutely angular above. Parietal callus thick and white, the appressed edge often yellowish or brownish.

Length 26, diam. 11, aperture 9 mm.
" 28, " 13½, " 12½ "

Chaimai Creek (about halfway between Valles and Pujal) and Casas Viejas River, a tributary of the Valles River, coming from the north of Valles, and emptying into the Valles River some miles east of Mecos falls.

These shells were at first thought to be *P. suprastriatus*, but they differ in the striæ of the young being finer and more numerous; there is also a difference in the aperture and columellar callus, and the outer lip is never extended beyond the line of the spire as in *suprastriatus*.

In 1907 this form was included in the description of *P. vallesensis* and figured (see *Nautilus*, Vol. 21, figs. 4, 8 and 9 of pl. 5). They are more acute in the spire and thinner than typical *vallesensis*, also smaller. The shells taken the past winter were from farther up the stream than those taken two years before. Not one could be found at the place where they were then.

Chaimai Creek is about two miles down the Valles River from the Willis ranch (where typical *P. vallesensis* occurs), and begins with a spring about a mile from the river. The water of the spring is a little warm and the pool there contains no *Pachycheilus*. Lower down they were often on and among decaying leaves.

Pachycheilus suturalis n. sp. Pl. XXIV, figs. 16–20.

The shell is turrited, regularly and slowly tapering, moderately solid though rather thin, black, blackish-brown or brown. In perfect shells the first (embryonic) 2½ whorls are smooth and convex; four or five following whorls have an acute carina below the middle, with an acute thread above and one below it; on subsequent whorls the carina is reduced and the number of spiral threads increases, so that there is a brief stage of about one whorl where the convex surface has about 6 subequal spirals; the lower spirals then diminish, leaving the last 3 or 4 whorls nearly smooth except for *a group of usually three or four spiral cords just below the suture.* Some weak traces of spiral striæ may often be seen on the smoothish portion, under the lens. The aperture is broadly ovate, narrower above, but rounded there in adults, broadly rounded below. The peristome is thin, blackish, noticeably retracted just below the columella, and the outer lip is sinuous, being somewhat retracted above. The parietal callus is brown or blackish, rather heavy.

Length	28,	diam.	13,	aperture	11	mm.;	whorls	remaining	5½.
"	28,	"	11½,	"	11	"	"	"	6½.
"	24½,	"	11,	"	10	"	"	"	6½.
"	26,	"	11⅓,	"	9⅓	"	"	"	7.

Creek near Tampamolon, with *P. pleurotoma*. Also found in the creek at Coxcantlan, a creek one mile above the ford of the Moctezuma River, and in the first and second brooks crossed on the road through the mountains to the Moctezuma River; all in the State of San Luis Potosi.

This species is related to *P. pleurotoma*, which differs chiefly by its Pleurotomoid sinus. The only other related species is *P. saussurei* (Brot),[3] of which two of the original lot, received from Dr. Brot, are

[3] See Küster's Conchylien Cabinet, *Melanaceen*, p. 43, pl. 5, fig. 7; type locality a swamp in the woods bordering the Rio Grande, which empties into the Laguna de Meztitlan, State of Hidalgo. It has no outlet to the sea.

in the collection of the Academy of Natural Sciences of Philadelphia. In *P. saussurei* several whorls following the embryonic shell are *convex and smooth*, not keeled as in *P. suturalis*; and lower down the whorls have in addition to the subsutural group of striæ a weak longitudinal plication, which is wanting in *P. suturalis*.

The largest examples are from a creek about a mile above the ford of the Moctezuma River. Two measure:

Length 34, diam. 15, aperture 13 mm.; whorls remaining 4.
" 33.2, " 12.2, " 12 " " " 7½.

Those from the creek at Coxcantlan are not quite so large as the type lot, and the shells from the two rills in the mountains are small; those from the first rill have the lip slightly expanded, and are quite slender, measuring:

Length 18.2, diam. 7, aperture 6.2 mm.; whorls 8½.
" 20, " 7.3, " 7 " " 10 (apex perfect).

They live in the same stream with *P. pleurotoma*, but were not noticed feeding with that species, seeming to prefer the rocks where there is considerable current.

Those from the second rill are slightly larger and less slender, about 21 x 10 mm.

Pachycheilus pleurotoma n. sp. Pl. XXIV, figs. 13–15.

The shell is slender, turrited or spire-shaped, rather thin, hair-brown or greenish-olive. Spire long, slightly attenuate above. The earliest whorls are smooth and rounded; then some spiral threads appear, one near the lower suture rapidly increasing to a projecting carina, with one thread below, one to three above it; this stage continuing 3 or 4 whorls. The carina then disappears, leaving the whorls rounded with about 5 threads, and sometimes a low, indistinct longitudinal plication. The spiral threads then disappear, leaving the *last 2 to 4 whorls convex and smooth except for 3 or 4 spiral cords just below the suture.* The last whorl usually becomes a little shouldered near the aperture. The aperture is small, very broadly ovate, being somewhat narrower but rounded above. The outer lip, close below the suture, is retracted to form *a deep rounded sinus*, much as in the marine genus *Drillia*. Elsewhere the lip is thin and simple. The basal lip is broadly rounded. Columellar margin straightened or much less arched than the outer margin, moderately thickened.

Length 36½, diam. 12½, length of aperture 11½ mm.; whorls 10.
" 29, " 10½, " " " 9⅔ " " 10.

Mountain rill on the road going north from Tampamolon, and several small streams not far from Coxcantlan. Types from the first rill on the road to the Moctezuma River. The shells were found where there was little or no current and seemed to be feeding on decaying vegetation, chiefly on fruit of the wild orange.

This species is distinguished from others of its group by the deep Pleurotomoid notch. In *Pachycheilus* this structure is known only in *P. dalli* Pils., a species very different in other characters. Perfect shells may have as many as 12 whorls, but the tip is generally lost in adults.

Explanation of Plates XXIII, XXIV.

Plate XXIII.—Figs. 1–5—*Pachycheilus pila* n. sp. Cotypes.
Fig. 6—*P. pila pilula* n. subsp. Cotype.
Figs. 7–10—*Pachycheilus tristis* n. sp. Cotypes.
Figs. 11, 12—*Pachycheilus moctezumensis* n. sp. Cotypes.
Figs. 13–15—*Pachycheilus pleurotoma* n. sp. Cotypes.
Figs. 16–20—*Pachycheilus suturalis* n. sp. Cotypes.
Figs. 21–25—*Pachycheilus monachus* n. sp. Cotypes.

Plate XXIV.—Figs. 1–5—*Pachycheilus pluristriatus* (Say). Coy River.
Figs. 6–10—*Pachycheilus pluristriatus tomasopensis* n. subsp. Cotypes.
Figs. 11, 12—*Pachycheilus pluristriatus longus* n. subsp. Cotypes.
Figs. 13–15—*Pachycheilus atratus* n. sp. Cotypes.
Figs. 16, 17, 18—*Pachycheilus atratus* n. sp. Los Canoas.
Figs. 19, 20—*Pachycheilus atratus ganinus* n. subsp. Cotypes.
Figs. 21–25—*Pachycheilus humerosus* n. sp. Cotypes.

UNIONIDÆ OF THE PANUCO RIVER SYSTEM, MEXICO.

BY HENRY A. PILSBRY.

The extensive river system emptying by the Panuco River into the Gulf of Mexico at Tampico has a rich mollusk fauna, in which the *Melaniidæ* and *Unionidæ* are particularly well developed. A few of the mussels were collected by Dr. Blanding many years ago and described by Dr. Isaac Lea. Many more were taken by Mr. A. A. Hinkley in January and February of the present year. All of the species known from the Panuco drainage are included in the following list. The localities mentioned may be found on the map, p. 520.

Only four Panuco species are now known to extend southward into the rivers of the neighborhood of Vera Cruz. There is more affinity with the fauna of the Rio Salado.

The generic relationships of eastern Mexican *Unionidæ* are very uncertain, since Simpson, in his great systematic work, knew the soft parts of very few Mexican forms, and there are no definite generic characters in the shells alone distinguishing the genera *Unio, Nephronaias* and *Lampsilis*. Some species which have been referred to the two former genera seem to me to belong to *Lampsilis*. Under these circumstances, it will be understood that the generic references herein are made with reserve, and subject to revision by those who may study these mussels in the flesh.

Quadrula nickliniana (Lea).

Unio n. Lea, Obs., I, 140; III, 72.

Moctezuma River (Dr. Blanding). This large and handsome plicate species was not found by Mr. Hinkley.

Quadrula semigranosa v. d. Busch.

Unio semigranosus v. d. Busch, in Philippi, Abbild., I, p. 19, pl. 1, figs. 1–3. Martens, Biologia, p. 493, pl. 30, figs. 1–4.

Rio Panuco at Tampico, type loc. It has not been found by Mr. Hinkley.

My record of this species from Rio Tuliga in Tabasco, copied into the *Biologia* by Prof. von Martens, was erroneous, the specimen from that place being *U. corium* Sowb. and not *semigranosus*. This leaves only the Panuco locality on record for the species, though related forms are known from southern Mexico. It is an alien in northeastern Mexico.

Lampsilis aztecorum (Phil.).

Philippi, Abbild., III, p. 27, pl. 6, fig. 2. Martens, Biologia, p. 502, pl. 36, figs. 2–4*a*; pl. 37, figs. 3, 3*a*,*b*.

Zimapan, on the Rio San Juan, a southern confluent of the Panuco (Schiede). Not taken by Mr. Hinkley.

Lampsilis strebeli (Lea).

Obs., XII, p. 78, pl. 51, fig. 131; Martens, Biologia, p. 503, pl. 37, figs. 1, 2 (as a variety of *aztecorum*). *Nephronaias medellinus* Simpson, Synopsis, p. 592, footnote 2.

Valles River, two miles above Mecos, at the head of the rapids. Taken from crevices in the bed of the stream, where the water was deep and the current so strong that it was difficult to hold one's position.

The shells in this place were so badly eroded that a third were discarded.

This species was described from the State of Vera Cruz. It has been united with *medellinus* by Mr. Simpson, and with *aztecorum* by von Martens, but I think it specifically distinct.

Lampsilis fimbriata Frierson.

Nautilus, XXI, p. 86, pl. 12, figs. 1–3, Dec., 1907. *L. salinasensis* Simpson, in Dall, Proc. U. S. Nat. Mus., 1908, p. 101, pl. 30, fig. 3.

Valles River at Valles, at the ranch of Mr. Willis, between Valles and Pujal, and two miles above Mecos, where it occurs with *L. strebeli*. "At Valles the water was very shallow, and nearly the whole bed of the stream could be waded. The shells were found between and under rocks in mid-stream, and a few were taken from a muddy bank across the river from the town." This fine Lampsilis is related to *L. strebeli* on the one side, to *L. discus* on the other.

Lampsilis discus (Lea).

Unio discus Lea, Obs., II, p. 71; III, p. 72. Von Martens, Biologia, p. 509, with var. *connectens* and *panucoensis*, p. 510.
Unio lapidosus Villa in Kobelt.

Moctezuma River. "Just below the ford the river is divided by a large island. The stream on the right has a strong current; that on the left is checked to some extent by a rock outcrop at the lower end of the island. In this part of the stream quite a bed of this species was found." (A. A. H.)

The type locality is the Rio Moctezuma. The varieties described by Prof. von Martens cannot be sustained. They occur together and fully intergrade. It is a magnificent species, one of the largest in *Lampsilis*. The nacre may be white, salmon or purple.

Lampsilis tampicoensis (Lea).

Unio tampicoensis Lea, Obs., II, p. 24. Von Martens, Biologia, p. 511, pl. 33, fig. 1.

Valles River at Mr. Willis' ranch, about halfway between Valles and Pujal.

Lampsilis moctezumensis n. sp. Pl. XXV, figs. 1, 2, 3, 4.

The shell is oblong, the dorsal and ventral margins both arched, the former a little more so; altitude decidedly more than half the length, diameter more than one-third the length; moderately strong but not thick. The beaks are small and low, near the anterior fourth of the length. In young shells they show one or two low, short undulations, being nearly smooth. Color yellowish brown. Adult shells hardly showing rays, even by transmitted light, but the young have narrow green rays posteriorly, on a yellow ground, marked with dark concentric streaks. Both ends are rounded. Sculpture of growth-wrinkles only, weak on the middle of the valve, but rather emphatic anteriorly. The interior is white, the nacre thinner and iridescent posteriorly. The pseudocardinal teeth are moderately stout, blunt and nearly smooth. In the left valve the posterior cardinal is larger than the anterior. In the right valve the single cardinal is small. The lateral teeth are short and widely separated from the cardinals. The cavity of the beaks are rather deep.

Length 68, alt. 38½, diam. 24 mm.

Moctezuma River, State of San Luis Potosi. Very few specimens were found.

This species has some resemblance to *spatulatus* (Lea). It differs from the related species by wanting corrugation on the posterior slope.

Lampsilis iridella Pilsbry and Frierson.

Nautilus, XXI, pl. 12, figs. 4, 5 (Dec, 1907); XXII, p. 81 (Dec., 1908).

Very abundant in the Valles River at Valles and Mr. Willis' ranch. Also taken in the Casas Viejas River, the Coy River, and Tampamolone Creek.

Most specimens from Valles are larger than the types, brownish-yellow or olive-yellow with rays only on the posterior half, when adult, or sometimes rays are entirely wanting. An adult shell measures, length 61, alt. 31, diam. 19.5 mm.

Lampsilis semirasa n. sp. Pl. XXVI, figs. 7, 8, 9.

The shell is oblong-reniform, the ventral margin being a little concave in the middle or straight, the upper margin strongly arched; the posterior end is wider in female shells, scarcely so in males. The altitude is contained about 1¾ times in length, diameter about 3 times in the length. The surface is smoothish except for growth-lines which are strongest near the lower margin and anterior end. Color various shades of brown, with rather indistinct darker or greenish rays, chiefly on the posterior half. The beaks are low, at the anterior fifth of the length. When perfect they have double-looped concentric sculpture. Valves thin, lined with nacre which is whitish in the cavity and anteriorly, but pink and very iridescent posteriorly (sometimes suffused with pink throughout, darker and purplish below the pallial line, or sometimes silvery white throughout). Pseudocardinal teeth compressed, rather small; lateral teeth very short, about one-third the shell's length. Ligament short.

Length 47, alt. 26½, diam. 16½ mm.
" 47, " 26, " 15 "

Ganina River three miles southwest of San Dieguito, in mud and gravel in clear water about knee-deep, where there was no current. Also in the Valles River two miles above Mecos.

Some specimens of the type lot are larger, length 55, alt. 28, diam. 16 mm. There is also some variation in the teeth, which may be more or less stout.

In the Valles River at Mecos the shells are rather small and not incrusted; nacre white, iridescent posteriorly, but not suffused there with pink or purple. Some of the half-grown specimens are quite fully rayed.

Two miles above Mecos in the Valles River there are large shells with but little incrustation, and rather dull, opaque, white nacre, with but little iridescence. Two measure:

Length 58, alt. 34, diam. 19 mm.
" 56, " 28½, " 19½ "

L. semirasa differs from *L. signata* and *L. undiraga* by lacking corrugation on the convexity of the valves and on the posterior-dorsal slope. It apparently lives with the shell nearly half buried, somewhat more than the posterior half projecting, and in most localities covered with a hard calcareous coat, as in pl. XXVI, fig. 9. Fig. 7 represents a cleaned specimen.

Lampsilis popei (Lea).

Unio popei Lea, Obs., VIII, p. 51 (Devils River, Texas, and Rio Salado, Nuevo Leon, Mexico).

Valles River at Valles, Willis' ranch, and two miles above Mecos. Abundant. Tampamolon Creek, one specimen. The shells have fine purple nacre, coppery and iridescent posteriorly. I have compared them with the types of *popei* in U. S. National Museum.

Lampsilis signata n. sp. Pl. XXV, figs. 5, 6.

The shell is oblong with subparallel dorsal and ventral borders, twice as long as wide, the diameter contained about three times in the length. The anterior border is rounded, posterior border truncate below, sloping and more or less convex from the truncation to the posterior end of the hinge. In some specimens the posterior truncation is indistinct, or that extremity may be rounded. The beaks are low and situated near the anterior fourth of the shell's length. Adult shells are blackish, but by transmitted light numerous green rays may be seen, fading out towards the lower border; and when unworn the beaks shows a pretty pattern of distinct green rays on a pinkish or creamy ground. The surface has but little gloss; the cuticle is roughened by growth-lines, which near the edge and on the posterior slope often form cuticular laminæ; the middle part of the valves is smoother, but marked with one or more *small patches of short corrugations*, at right angles to the growth-lines, and near the beaks there are some acute fine radial wrinkles on the posterior-dorsal slope.

The beaks are sculptured with two radial series of short concentric wrinkles separated by a slight depression. The valves are rather thick in the anterior half, becoming abruptly thinner posteriorly. The nacre is purple, fading in the cavity, or bluish white, becoming purplish and iridescent posteriorly. The pseudocardinal teeth are stout, the anterior one in the left valve wedge-shaped, a rather broad rugose heel below it, the posterior one lying directly under the beak; lateral teeth double as usual. The right valve has a stout, rugose pseudocardinal with a fossa and then a very small, compressed laminar tooth above it; lateral tooth single.

Length 73, alt. 37, diam. 23 mm.

Valles River, "near a small falls about three miles below Valles, in the muddy banks of a pool caused by low water. Feb. 4, 1909." (A.A.H.) A few smaller specimens were taken in the Moctezuma River, Casas Viejas River and Tampamolon Creek. A young shell with the corrugation unusually well developed is figured, pl. XXVI, figs. 5, 6.

Lampsilis undivaga n. sp. Pl. XXVI, figs. 1, 2, 3, 4.

The shell is oblong, the altitude about three-fifths of the length, diameter slightly over one-third the length; solid, dull blackish brown, without rays. The anterior end is rounded, posterior end more or less truncate below, sloping steeply above. Surface of the valves with sculpture of distinct growth-lines, and sometimes having a patch of very indistinct vertical corrugations near the posterior ridge on the most convex portion. There is also some fine oblique corrugation on the posterior-dorsal slope near the beaks, when not worn off. Beaks low, between the anterior fifth and sixth of the length; when perfect the tip is acute and sculptured with a series of short folds on the posterior ridge. The interior is fleshy-purplish, iridescent posteriorly; nacre in the anterior half is *very thick,* posteriorly thin. Cavity of the beaks deep and angular. The pseudocardinal teeth are stout, otherwise formed as in *L. signata*; laterals curved.

Length 54, alt. 33, diam. 19 mm.
" 54, " 30, " 18 "
" 50, " 30, " 18 "

Valles River two miles above Mecos, in a muddy bank just above rapids.

This species is closely related to *L. signata*, but the valves are thicker and heavier, the teeth are heavier, and the proportions differ. It is apparently related to *L. aztecorum* (Phil.),[1] but that is described as thin, "*valvulis satis tenuibus*," whereas in *L. undivaga* the valves are quite heavy and strong for a *Lampsilis* of this size.

The nacre is nearly white in a few examples. It abruptly becomes thick in the posterior half of the shell. Young shells are conspicuously rayed with green.

One young shell from the Valles River at Valles (pl. XXVII, fig. 5), seems to belong to this species, though I am not quite sure of the identity. It is 41 mm. long, yellowish, nearly covered with green rays, the nacre is pale purple, with a wide darker purple margin posteriorly.

Lampsilis novileonis n. sp. Pl. XXVII, figs. 1, 2.

The shell is oblong, rather compressed, the upper and basal margins slightly and about equally arcuate, anterior end rounded, posterior end sloping above, truncate and somewhat biangular below, beaks at the anterior two-sevenths of the length. The surface is convex, without angle or ridge bounding the posterior slope, not very glossy, smoothish for the greater part, but on the posterior slope there is some oblique corrugation in the upper part of the disk. The epidermis is yellow, sparsely marked in the posterior half with narrow green rays. The very low beaks are eroded in the type specimen. The interior is white, thicker anteriorly, very gradually becoming thinner at the posterior end, where opalescent tints are beautifully produced. The cavity of the beak is rather deep. The lateral teeth are short and rather widely separated from the stout cardinals, which are double and about equally prominent in the left valve.

[1] *Unio aztecorum* Philippi, *Abbildungen und Beschreibungen neuer oder wenig bekannter Conchylien*, III, pl. 6, fig. 2.

Length 78, alt. 43.5, diam. 22.5 mm.

Casas Viejas River, State of San Luis Potosi.

With some resemblance to *L. moctezumensis*, this species differs by the slight corrugation of the posterior slope and the more compressed form. Some young specimens (pl. XXVII, fig. 7) from the type locality, which seem referable to this species, have the whole valves ornamented with wide green rays. The beaks have a minute area sculptured with about four concentric wrinkles, which are very weakly bilobed. Outside of this sculptured portion the green rays are very distinct, as in allied species. A faint rib or green stripe radiates from the beak in the middle of the posterior slope, which is in part obliquely corrugated. These specimens measure from 17½ to 36 mm. long.

Lampsilis coyensis n. sp. Pl. XXVII, figs. 3, 4.

The shell is oblong, with beaks at the anterior fourth of its length, slightly wider posteriorly, the posterior end sloping above, biangular below; anterior end rounded; basal outline moderately curved, convex. There is a rather distinct angulation from the beak towards the posterior-basal angle, and the indistinct trace of a ridge to the posterior-median angle. The beaks are low, with minute, recurved tips sculptured with a few coarse double-festooned wrinkles, the connection between the two curves almost interrupted. The sculptured portion is not quite two mm. long. Subsequent growth is marked with growth-lines only, or with a very slight oblique corrugation in places on the posterior slope. The epidermis is rather smooth but not glossy, and is shortly and finely lamellose towards the margins. Color obscure greenish yellow, indistinctly marked all over with green rays. Near the beaks the rays are very distinct on a light ground. By transmitted light it is light yellowish, very profusely marked with green rays. The interior is white and somewhat thick anteriorly, thin, blue and slightly iridescent in the posterior half. The teeth are moderately strong.

Length 36, alt. 21, diam. 13.5 mm.

Coy River, State of San Luis Potosi, Mexico, collected by Mr. A. A. Hinkley, January, 1909.

These Lampsilis from the Coy River were found where there was a long mosslike plant growing, the current of the stream keeping it in a constant waving motion. The water was two to four feet deep. The Lampsilis were found by feeling in the roots of this moss.

On the moss and bed of the stream were *Pachycheilus* and *Lithasiopsis*, but the former were more numerous lower down the stream in a small recess where there was no current. In this recess were also found the small species taken in this stream. They were in the sediment, and on water plants and near the water's edge. The stream is clear, deep and with a strong current.

This may turn out to be a small, rayed variety of *L. novileonis*, yet specimens from 28 to 36 mm. long have every appearance of adult shells. The cardinal teeth in the left valve are stouter and their crests are more united than in *L. novileonis*.

While *L. undivaga*, *coyensis* and *novileonis* are closely related species, they seem, with present material, to be distinct.

Lampsilis metallica ganina n. subsp. Pl. XXVII, fig. 6.

The shell resembles *L. metallica* (Say) (*Unio cuprinus* Lea) in general appearance, but is constantly smaller, more compressed and more reniform. Near the beaks there are green rays on a pale ground, the rest of the valve being brownish black.

Length	47,	alt.	25,	diam.	13½	mm.
"	47½,	"	26½,	"	16	"
"	39,	"	21,	"	13	"

Ganina River, three miles southwest of San Dieguito. The specimens are heavily incrusted with calcareous matter posteriorly, but are free from erosion.

Glabaris strebeli (Lea). Pl. XXVII, fig. 8.

Anodonta strebeli Lea, Obs., XII, p. 82, pl. 52, fig. 135 (Vera Cruz).

Tampamolon Creek, two specimens. Casas Viejas River, one young shell.

The epidermis is very glossy anteriorly, but dull and shortly lamellose on the posterior half. In the median part there are several rays composed of short threads in the direction of growth-lines, but caught up and interrupted in the middle, as though scored upward when soft. These peculiar markings occur on some other species of *Glabaris*, and are constant in all the specimens of *G. strebeli* I have seen from Vera Cruz and San Luis Potosi. The anterior end of the shell has a sculpture of threads along the lines of growth. The sinulus, or glossy area at the posterior end of the hinge-line, is triangular, pointed below, as in *Glabaris*, not shallow, as in *Anodonta*; so that Mr. Simpson's reference of the species to *Glabaris* is justified. It ranges north farther than any other species of the genus. *G. cylindraceus* (Lea), from the Medellin River, is evidently an allied form.

NEW LAND SHELLS FROM MEXICO.

BY HENRY A. PILSBRY.

Most of the species here described were collected by Mr. A. A. Hinkley early in 1909. The localities mentioned may be found marked on the map on p. 520.

Schasicheila xanthia n. sp. Fig. 1.

The shell is conic, thin, of a uniform maize yellow or pale lemon color, rather weakly marked with fine growth-striæ; whorls $4\frac{1}{2}$, very convex, parted by a deep suture, the last whorl well rounded throughout, slightly descending at the aperture. Aperture slightly oblique; outer lip very slightly expanded. Inner lip straight, continuous. Columellar area small, white, the umbilical region deeply impressed. The operculum is thin, white, a little sunken at the nucleus, the lower angle projecting in a short point beyond the basal lip.

Fig. 1.

Alt. 4.9, diam. 4.9 mm.

Canyon below Las Canoas, State of San Luis Potosi, in crevices and on ledges of the bluffs, under stones and débris. Types 99,024 A. N. S. P.

This snail is related to *S. minuscula* Pfr., but on comparison of specimens it is seen that in the new form the spire is higher, more acute, and the suture is deeper. The operculum is in place in the figured type.

Helicina vanattæ n. sp.

The shell is turbinate-globose, similar to *H. chrysocheila* Binn., white, the upper whorls often flesh colored, the last whorl often having a wide dull purplish or dull red band above the periphery, and partly exposed above the suture on the spire; marked with a bright scarlet streak behind the lip, with usually, in large shells, a more conspicuous streak at the last third of the last whorl, and another on the penultimate whorl. The spire is conic, apex rather acute. Whorls 6, slightly convex, the last rounded peripherally. Sculpture of faint growth-lines, very fine, close spiral striæ (sometimes subobsolete), and very weakly developed, short, forwardly-descending wrinkles. Aperture quite oblique; peristome narrowly expanded, white, with a red streak inside. Basal callus white, weak and small, having a small pit behind the columellar lip.

Alt. 9.5, diam. 10.5 mm.; whorls 6.

On the sides of the canyon below Los Canoas, San Luis Potosi, under loose rocks and leaves on shelves and in crevices of the bluffs. Also on the bluff near the mill of the Tamosopo Sugar Co., and on the side of the highest peak south of Mecos falls. Types No. 99,025 A. N. S. P.

This species differs from *H. chrysocheila* chiefly in coloration, being marked with scarlet streaks behind the lip and at former growth-arrest periods, and in having a white lip, that of *chrysocheila* being yellow, as the name denotes. Some examples are very small, but have an expanded lip, diam. only 8 mm., with 5½ whorls. The largest specimen seen measures alt. 12.2, diam. 12.7 mm.

Named for Mr. E. G. Vanatta.

Polygyra matermontana jaliscoensis n. subsp.

The shell is larger than *P. matermontana*, brown, the last whorl or 1½ whorls weakly rib-striate, with faint traces of spiral striæ near the periphery, previous whorls finely striate; umbilicus larger, the central cavity well-like, contracting very slowly, more than half the total width; at the last whorl the umbilicus expands rapidly, and has a nearly vertical side wall. Whorls 6, the last very deeply and steeply descending in front, and having a rather deep and long spiral furrow within the umbilicus. The aperture is subhorizontal, the basal and upper margins parallel; teeth somewhat larger than in typical *matermontana*, similar in shape, but the sinus between the outer and basal teeth is a little narrower.

Alt. 6, diam. 12, width of umbilicus 3 mm.
" 5.8, " 11, " " " 2.9 "

Guadalajara, State of Jalisco, Mexico. Types No. 99,512 A. N. S. P.

This form differs from *matermontana* in the coarser sculpture, wider umbilicus which is more deeply grooved within, narrower last whorl (viewed from above), more deeply descending at the aperture, etc. It has a wider umbilicus than *P. nelsoni* Dall.

A similar shell except that the color is pale yellowish-corneous with a very faint supraperipheral band, and the sculpture of the last whorl is not quite so coarse, was collected by Mr. C. H. T. Townsend at Zapotlan, Jalisco, in July, 1902. It is evidently a very closely related race.

Polygyra guadalajarensis n. sp.

The shell is depressed, with slightly convex spire and moderate umbilicus (contained about 4½ times in the diameter of shell), which is well-like and *enlarges very little at the last whorl*, where but a very narrow area of the preceding whorl is exposed. Surface glossy, marked with growth-wrinkles, more distinctly striate behind the lip; pale brown. Whorls 4¾ to 5, convex, the last subangular in front of the aperture, soon becoming rounded, with the periphery well above the middle; it is deeply contracted behind the outer and basal lips, and descends abruptly in front; within the umbilicus it is flattened but not furrowed. The aperture is transversely oblong. Parietal tooth V-shaped both branches curved, the outer one slender and nearly but not quite reaching the upper termination of the lip; lower branch stronger, nearly reaching the termination of the columellar lip. Within the outer lip there is a compressed tubercle with a callous buttress or concave plate above it. In the basal margin there is a similar compressed tubercle, with a weak callus (scarcely a tooth) between it and the columella.

Alt. 4.2, diam. 8.8, width of umbilicus 2 mm.

" 4, " 8 mm.

Guadalajara, State of Jalisco. Types No. 99,513 A. N. S. P.

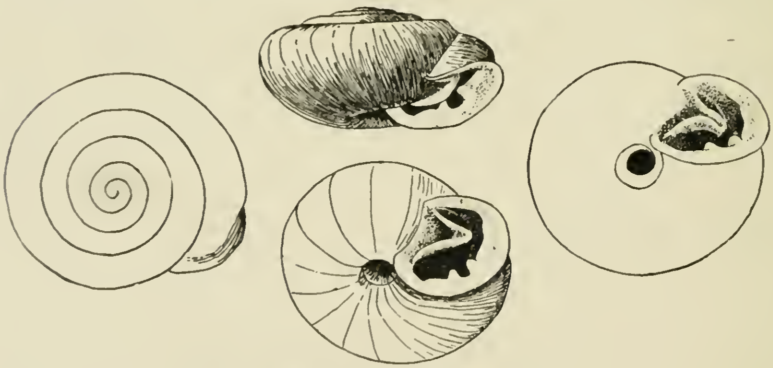

Fig. 2. *Polygyra guadalajarensis* n. sp.

This species is related to *P. ventrosula hindsi* (Pfr.), from which it differs chiefly by the much larger cavity of the umbilicus, which enlarges at the last whorl less than in any of the related species known to me.

The two species described above belong to the group of *P. ventrosula*, —the most difficult group of Mexican Polygyras.

This group includes shells in which the parietal tooth is distinctly V-shaped, and the outer lip has a well-developed concave plate or buttress above and joined to the outer lip-tooth, basal lip with one or two teeth. The following species belong here:

P. plagioglossa (Pfr.)	*P. guadalajarensis* Pils.
P. suprazonata Pils.	*P. bicruris* (Pfr.)
P. couloni (Shuttl.)	*P. matermontana* Pils.
P. richardsoni Marts.	*P. mat. jaliscoensis* Pils.
P. richardsoni lingualis Pils.	*P. nelsoni* Dall.
P. ponsonbyi Pils.	*P. nelsoni collisella* Dall.
P. ventrosula (Pfr.)	*P. euglypta* Pils.
P. ventrosula hindsi (Pfr.)	*P. albicostulata* Pils.

Of these forms I have not seen *P. bicruris* and *P couloni*, or typical specimens of *P. ventrosula* or *richardsoni*.

This group of species is especially developed in western and northern Mexico. Towards the southeast it is in large measure superseded by the group of *P. yucatanea*, of which *P. helictomphala* is a common form. In this group there is no distinct plate or buttress above the outer lip-tooth, and the parietal tooth is reduced.

Northward, the group of *P. texasiana* replaces the *ventrosula* group. *P. texasiana*, *P. triodontoides*, *P. mooreana*, *P. latispira* and their subspecies compose the *texasiana* group.

The old records, on Sowerby's authority, of *P. ventrosula* and *hindsi* from Texas must be erroneous. *P. ariadnæ*, which forms another group somewhat related to that of *ventrosula*, has been reported from Texas, but it certainly has not been collected there recently.

Polygyra oppilata implicata 'Beck' Martens.

This is a common snail in the Panuco River basin. Dead shells are abundant in river débris at Tampico. Living shells were found by Mr. Hinkley inland. *P. implicata* has usually been ranked as a distinct species, but it differs from *oppilata* in only trifling details. When fresh the shell is sparsely hairy.

Mingled with *implicata* in the river débris, but probably from separate localities or stations, there are specimens in which the upper angle of the peristome is built out from the whorl, somewhat as in *P. auriculata;* the two lip-teeth are slightly more developed, the space between them being narrower. This form I have called *P. o. complicata*.

P. oppilata has been reported from Florida (Shuttleworth), at Cedar Keys (W. G. Binney); but some similar form of *P. postelliana* must have been mistaken for it. Of about the same size, and belonging to a closely related group of species, such a mistake might easily be made.

The Mexican group of *P. ariadnæ* is composed of species in which there are two more or less compressed lip-teeth, a lamina or buttress above the upper one, and a well-developed biramose parietal tooth, both rami of which are strongly developed, more or less curved or sinuous, and connect with the ends of the peristome, thereby differing from species of the group of *P. ventrosula*. This group is very closely related to Floridan forms, such as *pustuloides*, *espiloca*, *auriformis*, etc., differing chiefly by the armature of the outer lip. The following species are included:

P. oppilata Morel
P. o. implicata 'Beck' Marts.
P. o. complicata Pils.
P. ariadnæ (Pfr.)
P. aulacomphala Pils. and Hinkl.
P. rhoadsi Pils.
P. polita Pils. and Hinkl.

Euglandina cymatophora n. sp. Fig. 3.

The shell is cylindric-oblong, of a yellowish brown or fallow color, very glossy. The apex is rounded; first 3½ whorls are smooth; the following whorls have short, regular folds below the suture, distinct and rather strong near the suture but rapidly becoming very weak, the surface becoming smooth. On the latter part of the last whorl strong, regular folds continue to the base. The distance from crest to crest of these folds is about one millimeter. Besides this sculpture, there are conspicuous places of growth-arrest, marked by an impressed light line, preceded by a darker streak, which follows a rather wide opaque streak. There are three such variceal marks on the last whorl of the type. The spire has nearly straight outlines and a well impressed suture. The whorls increased slowly and regularly to the last, which descends more rapidly. The aperture is more than half the length of the shell, its upper half very narrow. The outer lip retracts rather strongly above, and arches forward in the middle. The columella is moderately concave.

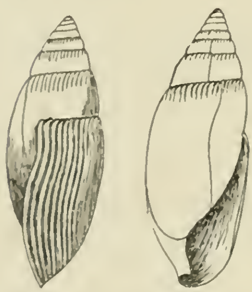

Fig. 3. *E. cymatophora.*

Length 38, diam. 14, length of aperture 22.5 mm.: whorls 9.

Side of the canyon below Las Canoas, State of San Luis Potosi. Type No. 98,612 A. N. S. P

One living and two dead specimens were taken. It is quite distinct from other known species by the sculpture, long spire, etc.

Streptostyla supracostata n. sp. Fig. 4.

The shell is oblong, with the aperture about half the total length, spire conic, very obtuse at the summit; thin, corneous. First 2½ whorls are smooth and convex; then regular, distinct fold-like striæ appear below the suture. These striæ are a little protractive and do not extend quite to the suture below. On the last whorl there are 3 or 4 striæ in the space of a millimeter; they weaken downwards, and fade out below the middle of the whorl. Whorls 5½ to 5¾, convex, the last slightly compressed laterally, convex below. The aperture is small, outer lip arching forward in the middle; columellar fold is very strong and short.

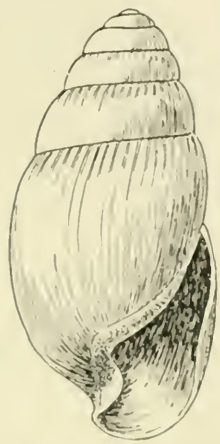

Fig. 4. *S. supracostata.*

Length 10, diam. 4.9, aperture 5 mm.
" 9.6, " 4.8, " 5 "

State of San Luis Potosi, at the cave near San Dieguito; types No. 99,031 A. N. S. P. Also at El Abra and the canyon below Las Canoas.

This is quite distinct by its comparatively long but very obtuse spire, regular sculpture and very strong columellar fold. It is somewhat related to *S. physodes* Shuttl.

Streptostyla bartschi Dall, one of the finest species of the genus, was taken in the canyon below Los Canoas.

Streptostyla minuta n. sp. Fig. 5.

The shell is oblong-conic, amber colored, somewhat transparent; spire long, with slightly convex outlines and very obtuse summit. Surface smooth and glossy. Whorls 5½, slightly convex, parted by a well-impressed suture, narrowly margined by transparence. The aperture is about half the total length of the shell, narrow; outer margin of the peristome arched forward in the middle. Columella short, *very strongly twisted*, the fold having a *heavily calloused* rounded edge. The edge below the spiral fold is deeply concave and thin. Length 5.5, diam. 2.3, length of aperture 2.6 mm.

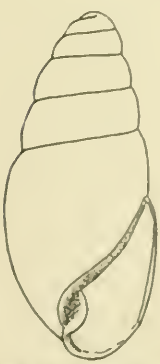

Fig. 5. *S. minuta.*

Mountain sides of the canyon below Los Canoas, State of San Luis Potosi. Type No. 98,595 A. N. S. P.

This is by far the smallest species of the genus known. It is chiefly remarkable for the small aperture, long spire and the very strong columellar fold. In size and general appearance it resembles *Cochlicopa lubrica*. Two specimens were taken.

Succinea panucoensis n. sp. Fig. 6.

The shell resembles *S. luteola* in shape, is very thin, translucent, pale yellow or amber colored, rather roughly sculptured with growth-wrinkles on the last whorl. There are nearly 3½ convex whorls, the last having its greatest convexity below the middle. Aperture oblique, ovate.

Fig. 6.

Length 13, diam. 7.2, length of aperture 10 mm.
" 14, " 8, " " " 10 "

Pujal, Alligator and Catamas Lakes, State of San Luis Potosi; types from Alligator Lake, No. 99,504 A. N. S. P. Also taken at Tampico in 1907.

This species stands between *S. luteola* and *S. concordialis*. It has much the contour and the pointed apex of *luteola*, but the thin, translucent shell is unlike that earthy, opaque species. *S. concordialis* differs from both by its decidedly more obtuse apex. It is also somewhat more convex at the base.

The specimens from Pujal Lake are smaller and more slender than the types. One measures:

Length 12, diam. 6, aperture 8 mm.

DECEMBER 7.

The President, SAMUEL G. DIXON, M.D., LL.D., in the Chair.

Twenty-nine persons present.

The deaths of Henry C. Wood, a member, February 12, 1908, and of George C. Harlan, M.D., a member, September 25, 1909, were announced.

DR. BENJAMIN SHARP made a communication on Early Arctic Voyages. (No abstract.)

DECEMBER 21.

The President, SAMUEL G. DIXON, M.D., LL.D., in the Chair.

Thirty-four persons present.

The death of William H. Jenks, a member, February 2, 1909, was announced.

The Publication Committee announced the reception of a paper entitled "Notes on Cyprinoid Fishes," by Henry W. Fowler.

The following was ordered to be printed:

FURTHER STUDIES ON THE ACTIVITIES OF ARANEADS, II.

BY THOS. H. MONTGOMERY, JR.

The following observations were made at Woods Hole, Mass., during the Summer of 1909. For the identification of certain species my thanks are due to Mr. Nathan Banks and to Prof. G. W. Peckham.

1. The Process of Sperm-Induction.

It will be recalled that Lister in 1678 discovered that the male spider in coition applies his pedipalpal bulb to the genital aperture of the female; and that Menge in 1843 found that the male charges his palpi by depositing a drop of sperm upon a specially constructed inclined sheeting, and then touching this drop with his palpal organs. The latter process, termed by me sperm-induction, was seen by Menge in *Linyphia*, *Agelena*, *Tapinopa* and *Micrommata;* by Blackwall (1863) in *Agelena;* by Ausserer (1867) in *Dictyna* and *Linyphia;* by Bertkau (1875, 1876) in *Philoica*, *Linyphia* and *Clubiona;* by Westberg (1900) in *Linyphia;* and by me (1903) in *Tegenaria*, *Theridium*, *Dictyna* and two species of *Lycosa*. The exact literature references are given in my paper of 1903;[1] consequently they need not be repeated here. The process has been observed, accordingly, in only ten genera, representatives of six families, so that the following new observations on representatives of two other families are not without interest. It is difficult to see this act, and success is obtained only by long continued watching of spiders kept in cages.

The first species to be described is the common large Attid, *Phidippus purpuratus* K. One male, No. 1524, was placed on 20 June in a cage with two females, and copulated the same day with one of them. The next day he avoided his mates, and at 5.32 P.M. was seen spinning a small sheeting, from the floor to the side of the cage and inclined at 45°; four minutes later he deposited a minute drop of sperm upon it, barely visible to the naked eye; then extending his body over the sheeting, reached his palpi downward and backward, applying them in alternation against the drop; the palpal organs were pressed, not against

[1] Studies on the Habits of Spiders, particularly those of the Mating Period, *Proc. Acad. Nat. Sci., Philadelphia*, LV, 1903, p. 59.

the free surface of the drop, but against the reverse surface of the sheeting. At 5.43 he was interrupted by a feeding female, and he moved away from the sperm-bridge with a minute droplet of sperm at the apex of his right palpus and another left on the bridge. Another ♂, No. 1508, of the same species, copulated on 17 June, and the day following was observed at the close of the sperm-induction at 7.10 P.M.; he had spun from one vertical wall of the cage to the other, in an angle, a narrow transverse ribbon of silk, with its flattened surface in the vertical plane; against this he placed his ventral surface, with his cephalic end elevated and the abdomen flexed, applying his palpi gently and alternately against that surface of the sperm-bridge directed away from his body. He ceased at 7.15, went into a corner of the cage and there rested quietly. With a hand lens a thin film of sperm could be seen upon the bridge, and next day the sperm was found with the aid of the compound microscope. The same male (1508) copulated on 20 June in the morning, and at 6.20 P.M. was found forming another sperm-bridge like the first; at 6.24 he dropped a minute globule of sperm upon it, and then applied his palpi in alternation to it as in the preceding cases; this palpal application lasted six minutes, when he turned away, but he seemed to be prematurely interrupted by the movements of a grasshopper.

The other case was that of a male of *Drassus neglectus* (Keys.), No. 1527. He and a ♀, No. 1528, were caught together in a closed nest on 17 June, placed in a cage, and there he built a beautiful and spacious saccular nest around both. On 23 June, at 11.37 A.M., he was observed in nearly vertical position within this nest, moving the ventral surface of his abdomen repeatedly against an inclined sperm bridge built against the inner surface of the nest and with its upper edge free. In half a minute he discharged a droplet of sperm upon it, then lowered his body to bring his jaws about on a level with the upper margin of the bridge, reached his palpi over this free margin and rubbed them gently many times against the reverse side of the sperm-bridge. One palpal bulb was thus rubbed at a time, then raised in the air while the other was rubbed. The application of the palpi continued for 17 minutes.

In all the cases so far described there is quite general uniformity in the process of sperm-induction; a special sperm-bridge is spun, a droplet of sperm placed upon it on the side next the spider's body, then the palpi applied alternately against the opposite side. The cephalothoracal end is always raised. In the case of *Phidippus*, No. 1508, this act was seen twice, each time after observed copulation, and since the process must have occurred before the first coition, this particular individual must have accomplished the process at least three times. But I have seen no evidence that a replenishing of the palpal organ is necessary after each copulation; the charging of them is generally sufficient for a number of copulations, the number probably varying with their duration.

2. The Atypical Habits of Ariadna.

In all cases of egg-laying so far known in Araneads the process is strangely uniform even though the finished cocoons may differ greatly in form and texture. A base is first spun, a drop of viscid secretion emitted from the genital aperture upon it, the eggs discharged into this drop, then a cover spun around the egg mass. I have watched the details of this process in so many instances, and in such a variety of forms (Aviculariids, Thomisids, Drassids, Lycosids, Epeirids, Theridiids, Sicariids, Agelénids, Dictynids, Attids, Filistatids, Pisaurids), that I had come to believe it was the universal process in spiders. But in the interesting Dysderid *Ariadna* (*Pylarus*) *bicolor* (Hentz) a form was found that builds no cocoon at all, and that lays its eggs in a drop of salivary secretion.

This species is common in certain open fields at Woods Hole, where it makes its nest on the under side of stones. No adult males were found from early in June until the middle of September, when I ceased my observations. It constructs a firm and rather tough silken tube, up to nearly three inches in length in the case of large individuals, quite viscid, so that foreign objects readily adhere to its outer surface. Generally the tube has a single opening that flares outwards something like a funnel, and has been figured and described by McCook[2], but sometimes there is an opening at each end, and this is not infrequent in the case of nests spun in captivity. Kept in artificial cages the spiders sometimes wander out of their nests at night; but for the most part they remain within them, at the enlarged entrance, with the three anterior pairs of legs extended forwards ready to seize prey and drag it into the nest,—as well described by Hentz.[3] Frequently a colony of them is found beneath a single stone, and then their nests are sometimes contiguous with each other and with those of *Phidippus* and *Drassus;* but they are not strictly colonial, for they are cannibals whenever an opportunity offers. In captivity they appear to spin

[2] *American Spiders and Their Spinning Work*, Vol. II, Philadelphia, 1890.

[3] *The Spiders of the United States*, ed. Burgess, Boston, 1875.

usually between midnight and dawn. A nest is the product of several days of labor and is probably added to and lengthened from time to time. The spiders can barely walk upon smooth glass, even when horizontal. They feed within their nests and remove the remains of the food outside. They exhibit death-feigning to a considerable degree.

To observe the egg-laying a number of individuals were isolated in small vials; groups of others were also placed in large cages each made of two glass panes 12 x 8 inches, separated by a wooden frame ¾ inch thick; food could be introduced and air provided by holes in the wooden frame.

No egg masses were found in wild nests before 20 June, and the individuals observed had not oviposited.

The oviposition is carried out within the nest. The entire process was seen in the case of two individuals, and parts of it in other instances. It may be described from the case of 1534 B, caught and placed in a cage on 26 June. On 4 July she spent the afternoon spinning against the inner surface of her nest, thickening it, but making no special cocoon base. At 6 P.M. she became quiet except for a movement of the palpi against the jaws that I first interpreted as a cleaning operation, but watching her attentively with a hand lens, I saw that both palpi were flexed, their free ends rubbing her chelicera rather slowly but regularly, and at 6.11 a minute drop of fluid could be seen at the apices of the chelicera. The two palpi steadily continued to rub the jaws, the chelicera and maxillæ moving backwards and forwards as well as opening and closing, and the drop slowly increased in volume by the addition to it of droplets that merged with it; the drop was viscid, as shown by its form, and evidently issued from the vicinity of the mouth. Thus the drop slowly grew in size, and was slowly pushed caudad beneath her cephalothorax, until it extended like an ovate pearl from the mouth back to the anterior border of the abdomen; it was transparent at the periphery, but more opaque in the centre, while the newly issuing droplets, to be added to it, were all transparent. Consequently the opacity of the interior may have been due to a change in consistency. This process lasted continuously from 6.11 to 6.37, then the abdomen was quickly flexed downward slightly, and the viscid drop suddenly clouded—due to successive discharge of the eggs into it. This discharge of the eggs occupied almost 3 minutes. The spider then commenced to sway her body slowly back and forth over the egg mass in the drop, and continued to do so for almost an hour. This movement was the attempt to free her chelicera and the ventral surface of her cephalothorax from the surface of the viscid drop. The spider was horizontal, dorsum uppermost, the feet fixed against the inner surface of the nest.

Another female (1534 C) occupied the time from 7.45–8.16 P.M. to produce the viscid drop. Another one (1534 D) worked from 5.54-6.32 P.M. to make the drop, occupied 5 minutes in the discharge of the eggs into it, then took more than an hour to free herself from it.

In not a single instance of the egg masses laid in captivity (13 cases) was either a special base spun for the egg mass or a cover spun around it. The inner surface of the nest serves as a base, there is no silken cover, but the eggs are held together insecurely by the hardening of the salivary drop; insecurely, because the egg mass readily rolls out of the nest, and the eggs are easily shaken apart by light handling.

It remains to be determined just what glands furnish the viscid drop into which the eggs are discharged. It may be composed of a secretion issuing from the mouth, or from the unpaired gland of the rostrum or the salivary glands of the maxillary plates.[4]

Of the 13 timed egg masses deposited in captivity, 8 were made between 6 and 8 P.M., 3 about 5 P.M., and only 1 in the early morning.

The time from egg laying to hatching is unusually long in this species, at least for eggs laid in the summer.[5] If we consider as hatching the time when the spiderlings first commence locomotion, the 8 timed cases in *Ariadna* presented time intervals between egg laying (in last week of June and first week of July) and hatching of from 63–70 days.

Not more than one egg mass was made by any of my captives, and to test whether any individuals may oviposit twice in the same year I caught on 22 August 9 females, each from a nest with a single mass of eggs or young, and kept them together in a large cage until 12 September, but no further eggs were laid. Since the first eggs are laid after the middle of June and do not hatch until September, and since the middle of September brings in cooler weather, it seems probable that they oviposit only once in a year—a condition rare in spiders.

It is general, though not invariable, that at the time of oviposition the spider closes the entrance to the nest by spinning over it, and all my captives that had so closed their nests kept them sealed until after the young had hatched. How long the young remain in the nest after hatching was not determined. But wild spiders, in natural

[4] On the glands in the vicinity of the mouth cf. especially: Plateau, 1877, Recherches sur la structure de l'appareil digestif, etc., chez les Aranéides dipneumones, *Bull. Acad. Roy. Belg.* (2), 44; and Bertkau, 1884, Verdauungsapparat der Spinnen, *Correspondenzbl. Naturh. Ver. preuss. Rheinlande.*

[5] In certain Epeirids, whose eggs are laid in the autumn, hatching does not take place until the following spring, the cold arresting the development.

conditions, always seem to have an opening to the nest even when the eggs or young are in it.

Ariadna thus resembles its congener *Dysdera* in having no special cocoon for the eggs,[6] though both build nests. This would suggest that the nest may be a racially older structure than the cocoon, and that the Dysderids may be one of the most primitive groups of living araneads.[7] The use of a mouth or salivary secretion to agglutinate the eggs has never been seen before in spiders, though Bertkau (1884, *l. c.*) has described such a process for the acarine *Ixodes*.

3. The Habits of Pisaurina.

The Pisauridæ closely resembles the Lycosidæ in structure, but differ from them in being arboreal during the cocooning season rather than terrestrial, and in carrying the cocoon by the chelicera and not suspended from the spinnerets.

The fullest account of the habits of any Pisaurid is given for the European *Dolomedes fimbriatus* Clerk by Pappenheim.[8] He saw the cocooning only once; a spider spun a funnel-shaped cylinder of silk, the closed roof of which was the upper surface of the glass cage; "in the cavity so bounded the eggs were laid. . . . Immediately after the oviposition the cocoon, that was at first cylindrical, took on gradually the form of a hollow sphere from its continuous working by the extremities and the abdomen." Pappenheim does not make it clear whether he saw the actual egg discharge and cocooning, or only the finishing of the cocoon within an infundibular nest, but apparently he saw only the latter. No other naturalist has described the cocoon-making for any member of the family.

Pisaurina mira (Walck.), more generally known as *Ocyale* (*Micrommata*) *undata* (Hentz), is unusually abundant in the woodland at Woods Hole, even at places far removed from water, though those kept in cages require water daily. Males are very rare (I have seen only one, from the collection of Mr. Emerton), and not a single one was found during the past summer. The large, white, globular cocoons of this species are well known, and so are the nests that the mother spins around the young at the time of hatching, and have been sufficiently

[6] According to Simon's statement concerning *Dysdera* in his *Histoire Naturelle des Araignées*, 2d ed., Paris, 1892, T. 1, p. 311.

[7] Reasons have been recently presented by me showing that the tetrapneumonous spiders (Theraphosæ) are not primitive: On the Spinnerets, etc., *Proc. Acad. Nat. Sci. Philadelphia*, 1909.

[8] Beitrage zur Kenntnis der Entwicklungsgeschichte von Dolomedes fimbriatus Clerck, *Zeit. wiss. Zool.*, 71, 1903.

described by Emerton,[9] McCook (*l. c.*) and myself (1903), and have been figured by the last two. But their method of construction has not yet been described, nor has any reference been made to a curious nest in which the cocoon is placed and which may be called the "cocoon-nest," in distinction from the "progeny-nest."

The Cocoon-nests.—These are found most frequently, as are the progeny-nests, on the poison-ivy (*Rhus toxicodendron*), where three terminal leaves are spun together to serve as a roof. The cocoon-nests are much less frequent than the others, and most of the spiders carrying cocoons in their jaws are not in such nests; therefore, it is probable they are vacated by the spider before the hatching of the young, for I have found the majority of the nests without spiders in them. The wild nests are each an arched or bellied sheeting of silk placed in the shelter of the under side of three poison-ivy leaves, each such sheeting varying in dimensions from 1 x 1¼ inches to about 2 x 2½ inches according to the size of the mother (which varies greatly), and with two or three apertures at its margins. Two of the spiders only of those that formed cocoons in captivity constructed cocoon-nests, and each of them not until three or four days after the cocoon was formed; these two nests were beautiful inverted domes, fastened to the glass roofs of the cages with a wide aperture below of about two inches diameter. The latter two nests were quite unlike the natural cocoon-nests found in the woods, and seemed to represent an attempt on the part of the spider to replace the roofing of ivy-leaves; it was probably a similar construction that Pappenheim observed in the case of *Dolomedes*. The cocoon-nests found in the state of nature are probably receptacles constructed by the spider in which to make her cocoon, and indeed the most heavily pregnant female caught was taken from such a nest.

The Cocooning.—Spiders are found with cocoons in early June, and they construct at least two during the summer. The cocoons vary much in diameter, are held by the mother by her chelicera and pedipalpi and also frequently by one or more pairs of legs, and are at the same time generally fastened by a few lines to the cocoon-nest or to the plant on which she lives. They are rarely left by the mother before the young hatch. Nine females were kept isolated in large glass cages for the observation of the cocooning; six of them made cocoons, all constructed in the early morning hours between midnight and 7 A.M. This particular time of the day is unfortunate for the observer, for after midnight one naturally seeks repose. But in one case a considerable

[9] New England Lycosidæ, *Trans. Connecticut Acad. Sci.*, 1885.

portion of the process was seen, as follows: Female No. 1571 was caught 31 July in a natural cocoon-nest. Placed in a cage she spun some lines that night, and on 2 August spun quite a network of lines from 7.30 P.M. up to 1 A.M., frequently stopping to bite lines that impeded her movements and taking the relatively long period of from several seconds to half a minute to make a line attachment. On 5 August at 3.10 A.M. I found her in the act of beginning the cover to a freshly laid mass of eggs. She had constructed a flat scaffolding of silk, inclined at an angle, extending from a twig to the wall of the cage. The egg mass had been laid upon this scaffolding, and probably only a short time previously, for the eggs were but thinly covered with silk. The cocoon was not regularly circular in outline, but irregularly polygonal, and its diameter was less than the length of the spider. When first seen she was holding its edges with her feet and was applying the thread by raising and lowering the abdominal apex, and this method she pursued throughout, which accounts for the cocoon being loose in texture and with no dense outer layers.[10] When she had accomplished spinning the cover to the eggs the cocoon had the form of a plano-convex lens, quite different from the spherical shape when fully completed. At 3.55 she commenced to free the margins of the cocoon from the scaffolding by biting certain threads, mainly of the lower portion, of the scaffolding, alternating (for 10 minutes) this biting with spinning on the surface so freed. At 4.10 she fastened a line from the cocoon to the roof, then continued her spinning. From 4.20–5.00 she was occupied in again biting the lines that held the cocoon to the scaffolding, finally leaving the cocoon suspended by its upper margin within a freed space. It had now become nearly circular.

The general process of cocooning is thus as described by me for Lycosids, but different in that the upper margin of the cocoon is left attached and suspended until after it is completed (in some cases this attachment is maintained for a couple of days afterward), whereas Lycosids finish their cocoons while held beneath their bodies.

Hatching and Progeny-nests.—Of three cocoons made in confinement (between 31 July and 6 August) and kept to hatching, the young emerged in 25, 26 and 30 days respectively. The mother holds the cocoon until a day or two before the young hatch, then waits until the first young come out before she makes the nest around them; none

[10] It need hardly be recalled that such application of the spinnerets always produces architecture of soft consistency, while sweeping of the spinnerets without elevation produces a firmer and tougher mesh.

of my captives made the progeny-nest before emergence of the young. As the young emerge the mother builds a network of lines around them, she remaining on the outside of the nest, and increases the number of the lines with the number of the young hatching. In this way the progeny-nest, a real nursery, is gradually built around the spiderlings and the empty cocoon, the mother working on it for as much as three days. In natural conditions such nests are placed generally at a height of about two feet above the ground, rarely as high as four feet, most frequently on a terminal branch of poison-ivy or oak, or the frond of a large fern, the leaves closely spun together to form a protecting and hiding roof over the network of lines below. The mother seems to leave the nest and wander off shortly after she has completed it; thus, on 2 August, I found about forty progeny-nests along a path in the woods, and though fully half of them contained young the mother was on the nest or in near vicinity to it in only two cases—and in these two the young were in process of emergence from the cocoon. In the one case timed the young left the nest on the ninth and tenth day after hatching.

The Mother's Abstinence from Food.—These relatively large spiders are remarkably timorous, seeming to fear grasshoppers of a size that much smaller spiders will quickly seize, and this timidity seems to be increased in the periods when they are holding cocoons—possibly because the maternal solicitude inhibits the desire for food, as it certainly impedes the search for it. All my captives drank water eagerly each day, though still holding to the cocoon by the feet, but in most cases refused all insect food until about the time when the young hatch; in most instances they made no attempt whatsoever to grasp insects walking near them. Evidently it is the hunger for food that takes them away so soon from the progeny-nest. The ability to undergo long fasts is well known for the females of a number of species of spiders, while males appear to need food at more frequent intervals—just as they generally require more water.

Effects of Removal of the Cocoon.—Females with cocoons, when caught roughly and separated from their cocoons, will frequently feign death admirably, lying quite limp and suffering handling without moving. No case of death-feigning was seen in any individual holding a cocoon. If the cocoon be returned to them within a few minutes they generally grasp it immediately in their jaws and seek escape. But there may well be individual differences in this behavior. Thus with a pencil I removed the cocoon two inches away from one of my captives; she showed no death-feigning, but walked about feeling for it. When I pushed it until it touched her she jumped away, and though she soon thereafter felt it once or twice she each time sprang away and remained quiet. I then pushed her gently so that one of her palpi rested on the cocoon; she remained quiet in this position for a quarter of an hour, then suddenly grasped it with her jaws and feet. In this case the maternal instinct did not seem so strong as that of self-protection.

4. Experiments to Determine Whether Lycosid Spiderlings can Emerge Unaided from the Cocoon.

It has previously been shown by me (1903, *l. c.*) that Lycosid mothers bite open the cocoon along the line of the junction of base and cover, so as to allow the young to emerge. The following observations prove conclusively that the young are unable to bite their own way out of the cocoon:

Twenty-nine cocoons were removed from as many females of a small *Pardosa*, found running in a wood, and kept about six weeks on my desk in open bottles out of the direct sunlight. In eleven of these cocoons the young failed to hatch, due either to the handling of the cocoons or to lack of fertilization of the eggs; while in eighteen the young hatched normally, but failed to emerge, died and shrivelled. In two cocoons taken from females of *Lycosa lepida* and kept in the same way the young also hatched, but died within the cocoons.

5. Apparent Mimicry and Stridulation in Certain Drassids.

Geotrecha (*Thargalia*) *bivittata* (Keys.), *G. pinnata* Emerton, and *G. crocata* (Keys.) are found fairly abundantly during the summer running on the ground in cloudy weather, *crocata* more in open fields and the others in shaded places in the woods. The first two resemble rather closely in form and movements the macroergates of a large mound-building ant; and the particular locality at which I found *bivittata* and *pinnata* most abundant was within twenty feet of such an ant nest, there being found also many wingless nymphs of the hemipteron *Alydus*, which also resemble this ant. This seems to constitute a complex case of mimicry. But when these ants are placed together with individuals of *Geotrecha* they quickly bite and kill the latter, so that the ants are not in any way deceived and there is no myrmecophily.

In defining the genus *Geotrecha* Emerton states, in speaking of the abdomen: "It sometimes has a small, hard patch at the front end which is of the same color as the rest of the back and not easily seen." This I have found in all three species mentioned, where it occurs at the antero-dorsal aspect of the abdomen and is a thickened chitinous plate, slightly protuberant, of oval form. Now these species all show a peculiar movement of the abdomen, such as I have never seen so pronounced in any other spiders; they raise and lower the abdomen, slightly rotating it on its pedicel, and continue this movement for several seconds at a time. This movement is exhibited generally just when the spider comes to rest after a run, and is exhibited equally by both sexes. An individual frequently rotates the abdomen immediately before starting on a run, on meeting another unexpectedly or on coming into contact with a large living insect. It is sometimes seen when the spider is quietly cleansing itself, but not when the cage is given a sudden rap. The hardened abdominal plate at such times rubs against the posterior border of the cephalothorax; accordingly, it is a stridulation movement. But if any sound is produced it is quite inaudible to the human ear, and if one individual stridulates in the close vicinity of another the latter does not respond by any movement whatsoever and therefore does not appear to be affected by any sound. It is in no way a sexual call, for the male hunts the female and finds her by touch, and neither he nor she stridulate during the mating. The ants they resemble do not show this movement.

This genus then exhibits a good case of stridulation, but if any sound is produced thereby it seems to cause no effect on other individuals and, therefore, is probably not perceived by them. The presence of a stridulation apparatus need not imply the power of hearing in the species concerned, and indeed the studies of Wagner and Pritchett seem to have definitely determined that spiders do not possess hearing—they possess in its place a most acute sense of touch.

These spiders run with perfect ease on smooth glass.

6. Notes on Modes of Copulation.

Phidippus purpuratus K.

The pairing was observed in 26 instances. The male stands over the female, his ventral surface against her dorsal, their heads in opposite directions, their body axes not in the same line, but his bent obliquely toward one side of her abdomen. Only one palpus is inserted at a time, and one alone may be employed through the act, or the two may be alternated one or more times. The female remains motionless. In the cases timed the act lasted less than one hour in 5 instances, and more than one hour in 9 instances, the longest noted being more than 8¾ hours continuously. It may occur in the morning (7 cases), afternoon (11 cases), or after 6 P.M. (8 cases). The same pair have been seen to mate in captivity as many as 6 successive times, as the pair ♂ 1500 x ♀ 1501 with copulation on 13, 20, 21 and 28 June, and 18 and 21 July; the same female has been seen to mate with two males, and the same male with two females. In two instances females were seen to copulate after making the first cocoon: thus ♀ 1519 mated with ♂ 1518 on 20 and 21 June, cocooned 29 June, then mated with ♂ 1519 A on 4 July; and ♀ 1521 mated with ♂ 1522 on 26, 27, and 30 June, cocooned 2 July, then mated again 23 July. This repetition of copulation after oviposition is most unusual, for generally in spiders the males die by the time the first cocoons are made. Equally unusual is the fact that heavily pregnant females will receive males as late as four and even two days before oviposition, whereas it is the rule that pregnant females are extremely aggressive towards males (except in *Theridium*). But we shall see a case in *Geotrecha pinnata* of copulation during cocooning. Another unusual incident, though I have described elsewhere similar occurrences in some other species, was that ♂ 1504 copulated with ♀ 1505 and she moulted a few hours afterwards. Early in June males are quite as numerous as the females, and pairs are frequently obtained in the same nest beneath a stone, but males decrease in number during the summer, though I captured two as late as 22 August. The first ♂ caught, No. 1500 on 13 June, was kept continuously in a cage with ♀ 1501, and copulated with her six times (the last time on 21 July), until 12 September; then I killed her, but kept him, and he lived until the end of October. This longevity of a male after the breeding season is without parallel in my experience. In one case a male (1504) after copulating with a slightly smaller female (1505) on 17 June, ate her on 25 June. This is a rare happening among spiders, though McCook (*l. c.*, Vol. II, p. 24) cites similar instances in Epeirids and Agalenids. This male was, however, killed and eaten by another female (1544) on 11 July, so was ♂ 1524 by a gravid ♀ 1525 and ♂ 1502 by ♀ 1503 (after living together for nearly a month). Five other males that were kept with females, and all of which mated with them one or more times, died without being eaten and with little or no evidence of injury; they seemed to have become physically weakened, and one that I gently removed from his mate to use for another experiment expired a few minutes after the removal. Accordingly, in this species, where the males are about as large and strong as the females, it is by no means the rule that the males end by being eaten. The matings observed in captivity took place in almost every instance outside of nests.

Drassus neglectus (Keys.).

With regard to this species, common under stones in open fields

Emerton (*l. c.*) states (under the name of *D. saccatus*): "In the early summer a male and female live together in the nest, the female often being immature." During June I found several such pairs, as well as males in separate nests, but after that month found no more males. The copulation was observed in two cases. The first instance concerns ♂ 1510 (an unusually large individual) and ♀ 1511, found in different nests on 7 June and placed in one cage; he was larger than she. The same day copulation was observed from 5.31–5.38 P.M., one palpus applied at a time, the right three times and the left once, each palpus being held in the epigynum for 1–2 minutes, then withdrawn for about a minute, then the same or the other palpus inserted. He left her at 5.42, but returned two minutes later and inserted the left palpus for 15 seconds, then he left her again and she moved away five minutes later. The position of the two was about the same as in *Phidippus*. This pair were observed again in mating attitude at 3.30 P.M., 24 June, 8.10–8.17 P.M., 25 June, and 9.P.M., 29 June; he died (not eaten by his mate) on 4 July. The other instance was that of ♂ 1506 and ♀ 1507 caught in the one nest on 16 June and placed together in a cage. On 23 June, at 9 A.M., I found him copulating with his right palpus; she had moulted within the preceding half hour, was still soft and near her old exuvia. He kept his right palpus inserted for 39 minutes, and when he withdrew it she struggled away from him. But he found her again, at 9.42 inserted the same palpus for a few seconds, again at 9.46 for a minute, and again continuously from 9.48 to 10.25, when I was obliged to leave, and on my return at 11.12 they were separated. Both escaped from the cage before the end of the month.

This instance of mating with a female just at the time of her moulting is interesting, for it gives the timorous male his opportunity while she is helpless. It is probably full-grown males that seek out still immature females and live with them in the same mating nest.

Geotrecha crocata (Keys).

The mating was observed only once, in the case of a female caught 3 August, and a male ten days previously, placed together in a small cage on 4 August. In copulation the male stands over the female, his ventral surface opposed to her dorsal, their body axes obliquely inclined, his head a little to one side of the anterior end of her abdomen. One palpus is inserted at a time. On 4 August they were observed in copulation at 7.58 P.M. (three minutes previously they were separate), and he kept his left palpus inserted for two minutes, the left for nearly two minutes again, the same for one minute, then the right for a few seconds, when she suddenly rose and he jumped away. She moved slightly after each palpal withdrawal, and he quieted her by rapid tapping with his fourth leg pair. On 7 August he died from her bite.

Geotrecha pinnata Emerton.

One male and three females were found running in an oak wood on 31 July and placed in a large cage. Two copulations were observed on that day and on the next respectively, the attitude being the same as in *G. crocata*. In the first case the male inserted his palpi each twice and successively from 5.42–5.43 P.M., then he turned away from the female, returned and inserted the right palpus for a few seconds, turned away, returned and inserted each palpus once, moved off, returned and inserted both once, then moved away from her again; but when he sought her again at 5.51 she had gone off. What is remarkable in this species is that the male, after one or two short palpal insertions, departs an inch or more from the female, stands still for a minute or more shaking his palpi, then turns and seeks her again (wholly by touch unaided by sight), the female generally waiting motionless for his return. He always mounts over her head. The next day the same male copulated in a similar fashion, from 11.35–11.44 A.M., with eight palpal insertions.

On 22 July five other individuals of this species were caught and placed in one large cage. Two were males, one of them lacked one palpus, and for convenience may be called A, while the other perfect individual we may call B; these males were combative on meeting each other, but not aggressive to the females nor these to one another. ♂ B at 5.20 P.M. met and copulated with a gravid female, inserting his palpi about four times; then ♂ A touched her, she at first repulsed him but half minute later accepted two palpal insertions from him; at 5.36 both males were an inch away from her. Between 5.37 and 5.50 she received both males in the following order: ♂ A, ♂ A, ♂ B, ♂ A, ♂ B, ♂ B, ♂ B, ♂ A, ♂ A. Then she rose and moved away, returned to the same place, and repulsed further advances. After cleansing herself she began at 7.20 P.M. to spin her cocoon. Between 8 and 9 P.M. she was interrupted by ♂ A five times, but drove him off each time. At 9.06 ♂ B found her and copulated, and between then and 9.15 copulated eight times. Between 9.22 and 9.35 ♂ A made five advances, but was driven away each time. ♂ B copulated twice at 9.42, and at 9.44 she repulsed ♂ A. I then kept both males away from her in order to see the cocooning. This is a very remarkable case of a female accepting copulation from two males alternately;

and of interruption of the cocooning process by such mating. Only an hour and a quarter after the last copulation she oviposited. During the cocooning she was aggressive, raising her fore-legs, but ♂ B pressed them down by rapid tapping and mounted over her head; the mating was forced upon her against her maternal instinct.

Prosthesima atra (Hentz).

One male and four females were caught 7 August and placed in a large dish, all unable to walk on the vertical glass side. On 9 August the male was seen in mating attitute, but without palpal insertion, for a quarter of an hour; this was at 5.20 P.M., and at 6.55 he was again motionless upon a female, but without insertion of the palpi. Could it have been that he was waiting for her to moult? On 15 August a copulation was observed, the attitude as in *Geotrecha;* the pair was first seen at 8.40 P.M. (they were not in copula a quarter of an hour before), and during the succeeding 19 minutes he inserted his left palpus 4 times and his right 3 times, each insertion lasting from 1 to 2 minutes. Another copulation was seen on 20 August at noon.

Misumena aleatoria (Hentz).

The male of this Thomisid is many times smaller than the female. A pair were placed together in a cage on 27 August. In the copulation both palpi are inserted simultaneously, and the male is placed upon the ventral surface of the abdomen of the female with his head pointed in the same direction as hers; the ventral surfaces of the two are apposed. The male, after discharge of the sperm, may remain upon the female's venter or may climb to her dorsum. He continues to hold to the female for astonishingly long periods, for he is so small and nimble that she is unable to displace him. Thus at one time he remained upon her for 22 hours, even though I disturbed them by removal to a bottle, and I found it difficult to push him off with a pin; at another time he remained continuously upon her from 4.57 P.M., 30 August, until 7.30 A. M., 1 September, when he left her, but regained her at 9 A.M. and remained upon her until the following morning, when she was found dead. Even her walking around the cage did not seem to disturb him. Palpal insertions occupied only a small part of these periods.

Xysticus nervosus Banks.

Two adult males and an immature female were placed in one cage on 5 September. She repulsed their advances, and after moulting on 11 September, was placed again with the males. One male found and embraced her, then the other drove him off, or the first left the female to fight the other male, and this fighting of the two males upon and around her body continued for half an hour, when I separated them. The next day the same fight was renewed over her motionless body for 50 minutes, when the female rose and walked away, the males, thereafter, avoiding her. The copulatory attitude is like that of *X. stomachosus*, previously described by me (1903). The males appeared as eager to fight as to mate.

Ceratinopsis interpres Em.

Two males and a female of this small theridiid were placed in a vial on 12 July. The males were savage on meeting and grappled with each other. Within a few minutes the three had spun a maze of lines. Twice it happened that both males simultaneously seized and tried to embrace the female, and once one male copulated while the other endeavored to do so; in each case the female shook both off at the end of a minute or two. Finally one male inserted both palpi continuously for 21 minutes; their heads were in the same direction and ventral surfaces apposed, the male held her with his first two pairs of legs and had his head a little posterior to her epigynum.

7. Nesting and Cocooning.

The architectural habits of *Ariadna* and *Pisaurina* have been described above.

Phidippus purpuratus K.

We have mentioned that during June a male and female are frequently found together in one nest, and such mating nests are well known for the Attids; these are perhaps the same as the nests which the females occupy during the Winter. But on bringing home such pairs and placing them in cages no such mating nests were made, but the male and the female each built a thin-walled nest with two apertures, during which they remain mostly only at night; the two would also use the nests interchangeably, and would usually copulate outside of them. Before cocooning each of my captive females spun in an angle of the cage a much larger, entirely closed nest, so thick-walled that she can scarcely be seen through it, and within this spun all the cocoons of one season. Whether under natural conditions, on the lower side of a stone, the female would employ her mating-nest as a cocoon-nest, or whether the two are separate structures, I have not ascertained. The male may enter the cocoon-nest after the female has made an opening to it, to copulate with her, but he never remains long therein, but usually spins a smaller nest of his own on its outer surface. The special cases observed of cocoon-nest construction, and of cocooning, were the following. ♀ 1519 made a thin nest on 28 June, and during the night made it very thick-walled with a narrow aperture at one end. On the following day she was found at 12.30 P.M. spinning vigorously across a vertical circular area, of greater diameter than her own length, of the inner surface of the nest; this was a distinct cocoon-base made upon the wall of the nest. She ceased suddenly at 1.10, rested quietly until I left at 1.30, and on my return at 2.50 was again spinning on the circular base, and worked through the afternoon. At 8.10 P.M. she oviposited upon the base, holding her head down and her feet on the margin of the base. She remained quiet until 8.32, when she began to spin the cover for the eggs, swinging the spinnerets from side to side and revolving her position from time to time; this cover-spinning continued to the next day after 7 A.M. On the 30 June she left the nest for the first time, from 8 July on left the nest daily to hunt for food and made a second aperture for egress. The young began to leave the nest on 15 August, and at that time I found a second cocoon containing eggs within the nest (the young of which hatched 12 September). ♀ 1521 laid a mass of eggs within a thin-walled nest on 2 July, but she ate them. On the 26 and 27 July she worked continuously spinning a perfectly closed cocoon-nest in an upper corner of the cage, then from 3 P.M. on for three hours spun a cocoon-base within it, this base spun in an oblique position and its diameter somewhat less than her own body length. She oviposited about 9 P.M. (during my absence). Next morning at 8.00 she was spinning a cover, but it was still very thin; consequently there must have been a long pause between the oviposition and cover-spinning. She did not leave the nest until fourteen days later; and when I opened the nest on 12 September it contained hatched young. ♀ 1525 was found on 17 July spinning a cocoon-base within an entirely closed, thick nest from 3–5 P.M.; this base was vertically inclined, extending from the floor to the roof of the nest, not against its side. She rested quietly for an hour and a quarter, spun again on the base for ten minutes, then occupied eleven minutes in oviposition. Then she seemed exhausted, and not until 10.34 began the cover-making, which was completed next morning. She did not leave the nest until seven days later. On 26 August she had again closed the nest, probably to make another cocoon. On opening the nest 12 September I found that only two eggs of the first cocoon had hatched, and none of the second.

These cases are given somewhat in detail, for they illustrate a considerable range of individual difference. The cocoon-nests are viscid and very thick-walled, excellent homes for the young; the mother closes them tightly before making each cocoon, and generally does not emerge for food until a lapse of several days or even a fortnight; she always returns to them after her hunts, and remains there with the young until they leave. It is quite probable the young of the second cocoon, when it is made late in the summer, may overwinter in the nest.

Emerton says of this species (under the name of *mystaceus*):[11] "The largest of the New England Attidæ . . . . It lives under stones at all seasons. In winter or when moulting or laying eggs it hides in a thick white bag of silk, in which the cocoons are made early in the summer. The young become nearly full grown before winter."

Drassus neglectus (Keys).

These spiders, as Emerton has noted, are to be found in pairs in silken bags, and the following observations would show that such mating-nests are probably always spun by the males. A pair (♂ 1506, ♀ 1507) were taken from a nest on 16 June and placed in a cage. During that afternoon and evening he spun a thin, closed nest around them both, next day copulated within it, and both remained in the nest until their escape twelve days later. Another pair, ♂ 1510, ♀ 1511, from separate nests were put into one cage, and the male alone did the spinning of the nest. Another pair, ♂ 1527, ♀ 1528, were taken from one nest and placed in a cage; he built a beautiful and spacious saccular nest, entirely closed, in which he charged his palps with sperm and she moulted; she ate him in it three days later. Still a fourth male, of another pair (♂ 1529, ♀ 1530) from one nest, spun a mating nest. In only one case have I seen the cocooning, though several individuals were kept under observation. ♀ 1530 was on 24 July within a cylindrical closed nest, which was her enlargement of the mating nest constructed by ♂ 1529; in this species, then, the mating-nest may become the cocoon-nest. At 7.30 A.M. I found she was spinning within the nest upon a cocoon-base, that was a horizontally placed, slightly concave saucer of silk fastened by two opposed edges to the sides of the nest; the beginning of this base was not seen, but it must be either a modified partition of the nest or else a separate structure, and in either case not a part of the wall of the nest. I was unfortunately obliged to leave before the egg-laying, and on returning at noon found the cocoon was completed. The cocoon is always large, snow white, of a flattened biconvex shape, its circumference polygonal; the mother holds it tenaciously with her feet until the

[11] New England Spiders of the Family Attidæ, *Trans. Connecticut Acad. Sci.*, 8, 1891.

young emerge, though she may carry it about within the nest. In no case have I seen the mothers with cocoons taking food before the young hatch; the nest is kept closed through this period, and the spiders pay little attention to insects moving on its outer surface.

Geotrecha.

G. crocota and *G. pinnata* were not observed to make any nests in confinement, while *G. bivittata* constructs a very thin, small saccular nest. The conclusion of the cocooning was described by me (1903) for *G.* (*Thargalia*) *bivittata*, and this summer I have seen the act several times in the case of *G. pinnata*, and as follows: The cocoons are discoidal, excessively flattened and scale-like, their free surface (cover) very tough in consistency and difficult to tear open; under natural conditions they are spun against a stone, while all of the six cocoons made in my glass cages were placed at the junction of the floor and the side; thus they were circular discs bent in the middle at a right angle. ♀ 1566 on 22 July began spinning a cocoon-base at 7.20 P.M. She spun slowly, sweeping the spinnerets from side to side, over an area of about one and a half times her body length, at the junction of the wall and the floor, so that half the base was horizontal and half vertical. Half an hour later her labor had accomplished a ring of pearly silk, most beautiful to behold, slightly elevated and with almost no silk in the enclosed space. At 8.35 she began spinning rapidly on this central space, then from 8.55–9.45 she was repeatedly interrupted by the males A and B (as previously described) At 10.45 she ceased to sweep her spinnerets across the base, and instead raised and lowered them in applying silk near the middle of the disc, at the same time swaying her body backward and forward, thus producing a central cushion of softer texture. After each spinneret application the abdominal apex was elevated to a height equal to about two-thirds the length of her cephalothorax, then the spinnerets again applied. She ceased this abruptly at 10.57, stood over the centre of the base, discharged from her genital aperture a clear globule of viscid fluid upon it, and in this discharged in succession 8 large yellow eggs, this whole oviposition occupying two and a half minutes. But she attempted in vain to liberate herself from the viscid drop, and began to eat the eggs; this miscarriage may have been due to the late copulation. In the case of another individual (♀ 1572) the work on the cocoon base lasted from 9.45–10.57 P.M., the oviposition for a minute and a half, and the cover-spinning from 11.00 P.M. to after 12.45 A.M., when I left for weariness. The first ten minutes of the cover-making were occupied in carrying thread from the edge of the base on to and across the egg mass, with swinging of the abdomen from side to side; the remainder of the time in brushing the spinnerets to and fro without raising them, which resulted in the dense structure of the outer surface of the cover. Next morning the cocoon was partly covered with small débris (bits of earth and wood, fragments of insects), and rendered much less conspicuous. The free surface of the cocoon is always furnished in this manner; it is never enclosed in a nest, and the mother does not remain by it. The cocoon is not only partially hidden in this way, but it is so closely adherent, so flattened and so tough, that the eggs are most excellently protected, and this explains why so few eggs are laid. Two cocoons were found with 8 eggs each, and three with 9. The method of applying the foreign objects to the cocoon was seen clearly in the case of two cocoons made by other females during the night of 26 July, some time between 10.30 P.M. and 7.30 A.M. These cocoons were placed only an inch apart, the mothers did not seem to distinguish their own from the other's, and proceeded to furnish either impartially. Each mother hunted around the cage by touch, for small objects, carried them in the chelicera to a cocoon, also found by touch (though there appeared to be some memory of its situation), then dropped them upon a cocoon. Then the mothers chewed these objects into smaller particles, and agglutinated them to the cocoon evidently by some salivary secretion, and to this secretion is also probably due the change in color of the cocoon surface from a beautiful opaline, or pearly, lustre to a dull brown.

So far as I know this is the first instance described of the application of some salivary secretion to the cocoon surface; very likely the bluish or greenish colors of the outer layer of Lycosid cocoons are also due to a similar secretion from the mouth, for the silk employed is white, and the cocoon does not change its white color until the mother holds it beneath her and carefully applies her mouth parts to all of its surface. This secretion may have the value of a varnish, a finish smoothing over all irregularities.

Phrurolithus alarius (Hentz).

As Emerton (1889) notes, this drassid "lives on and under stones in dry, open ground and runs with great swiftness short distances at a time." The spiders are much less frequently seen than their cocoons. The latter are tightly fastened to stones, scarlet in color, probably due to a salivary secretion, much flattened and scale-like, of greater diameter than the spider's length, and are sometimes covered with foreign matter. They are not guarded by the mother, and it was only by keeping these spiders in cages that the makers of these cocoons were determined. One cocoon that I opened contained only 13 eggs.

Prosthesima atra (Hentz).

These common drassids live beneath stones in small, thin-walled nests. A remarkable habit was seen on several occasions during the nest-making in cages: the spider spins first upon the floor of the cage beneath her, then at intervals stands nearly vertical with the head down rotating the elevated abdomen on its pedicel, or else bending it quickly from side to side; the abdominal apex then describes circles in the air with the spinnerets actively moving. This is done for a few seconds at a time, and alternated irregularly with spinning on the floor. Such an attitude has not been seen by me before. Is it an attempt to find some roofing object against which to spin, or is it a throwing or casting of a line? Emerton (*l. c.*) has observed that the "cocoon is flat on one side, by which it is attached, and convex on the other. It is white, or sometimes a little pink." The cocoon is sometimes, but not always, thinly covered with foreign particles, and is guarded by the mother, who rests upon it; but she does not hold it nearly so tenaciously as *Drassus* does. Wild cocoons are found first in the early part of August, and sometimes two are found superimposed.

Poecilochroa.

A female of *P. variegata* (Hentz) was placed in a vial, where she made an incomplete nest at one end. On 27 July at 7.30 A.M. she was standing in a small cell within this nest upon a nearly completed cocoon-base; this base was thin, roughly circular in outline, its diameter about one and a half times her body length, and placed almost vertical, with its margins fastened to the inner wall of the nest. She oviposited upon the centre of this base from 8.02 to 8.04, then spun until 9.15 constructing the cover. Until 1 September, when the young emerged, the cocoon remained in the same position, attached by its edges to the nest, with the mother holding it continuously. A female of *P. bilineata* (Hentz) was caught on 11 July, and on the night of 13 July made a cocoon: a flattened circular disc, placed horizontally, its diameter greater than her length with outstretched legs, its color glistening ivory-white with a pearly lustre. She subsequently made a closed nest around it, did not change its position, but remained upon it; she left the nest for the first time four weeks later, but returned to it; the young hatched 17 August. A wild cocoon of this species contained 22 eggs.

Range of Architecture in Drassids.—The observations just described show an interesting series: *Pœcilochroa*, which leaves the cocoon attached to the nest and holds it until hatching; *Drassus*, which cuts loose the cocoon from the nest wall, but which also holds the cocoon continuously until hatching; *Prosthesima*, which makes a much thinner nest and holds the cocoon within it, but not tenaciously, and occasionally places foreign objects on its surface; and *Geotrecha*, which makes only a very slight nest (*bivittata*) or no nest at all (*pinnata*), and which does not guard the cocoon, but regularly garnishes it with foreign matter. The last condition is probably the most modified, for it represents the loss of the maternal instinct. At the end of this series the number of eggs is least.

The following Reports were ordered to be printed :

REPORT OF THE RECORDING SECRETARY.

It is gratifying to be able to report that, notwithstanding the important and, it might be supposed, disturbing building operations of the past year, the routine work of the Academy has been but little interfered with. The October meetings, indeed, had to be omitted, because, while the old Library Hall was dismantled, the new Reading Room was not quite ready. The meetings of the Academy will hereafter be held here, except on occasions of extraordinary and therefore large attendance, when the Lecture Hall on the floor below will be available. Fourteen meetings were, therefore, held during the Academic year, at which the average attendance was forty-four. Verbal communications, for the most part illustrated, were made by Messrs. F. Creighton Wellman, John W. Harshberger, F. Lynwood Garrison, Philip P. Calvert, Thomas H. Montgomery, Jr., J. M. MacFarlane, Henry Skinner, Frank F. Keeley, Arthur Erwin Brown, Edwin G. Conklin, Henry A. Pilsbry, Stewardson Brown, Gilbert Van Ingen, Edwin T. Wherry, Benjamin Smith Lyman, and the Secretary.

Thirty-six papers have been received for publication from the following authors: Henry A. Pilsbry, 4; H. A. Pilsbry and James H. Ferriss, 2; H. A. Pilsbry and E. G. Vanatta, 1; H. A. Pilsbry and C. Montague Clark, 1; H. A. Pilsbry and Y. Hirase, 1; H. A. Pilsbry and A. A. Hinkley, 1; R. V. Chamberlin, 3; Thos. H. Montgomery, Jr., 2; Stewardson Brown, 2; J. P. Moore, 2; John W. Harshberger, 2; James A. G. Rehn and Morgan Hebard, 2; F. Creighton Wellman, 1; Charles S. Boyer, 1; G. E. Crampton, 1; Nathan Banks, 1; F. J. Keeley, 1; F. W. Weymouth, 1; Robert T. Young, 1; A. E. Verrill and A. H. Verrill, 1; Burnett Smith, 1; Clarence B. Moore, 1; Aleš Hrdlička, 1; Thomas Barbour, 1; Henry W. Fowler, 1. Twenty-nine of these have appeared as portions of the sixty-first volume of the PROCEEDINGS; four have been returned to the authors, and action has been deferred on one. The two papers by Messrs. Moore and Hrdlička form the first part of the fourteenth volume of the quarto JOURNAL. The number is beautifully illustrated by text figures and eight plates of Indian pottery. The latter are superb specimens of color printing and present as faithful a representation of the objects, themselves of quite unexpected beauty, as art can at present secure. The Academy is indebted for this continuation of the JOURNAL to the liberality and devotion to his chosen branch of science of Mr. Clarence B. Moore.

As evidence that the building operations and movings have not curtailed the work of the Publication Committee, it may be noted that the issue of the various serials now sent out under the auspices of the Academy is 129 pages in excess of that of last year, which itself was unusually productive. The number of illustrative plates, however, is 38 less than reported in 1908. The record is as follows: PROCEEDINGS, 636 pages and 27 plates; JOURNAL, 252 pages and 8 plates; ENTOMOLOGICAL NEWS, 444 pages and 22 plates; TRANSACTIONS OF THE AMERICAN ENTOMOLOGICAL SOCIETY (The Entomological Section of the Academy), 486 pages and 12 plates; MANUAL OF CONCHOLOGY, 250 pages and 26 plates, making a total of 2,068 pages and 95 plates.

The index to the publications of the Academy has been completed up to and including the volume of the PROCEEDINGS for 1905.

The short history of the Academy prepared as a contribution to the Founders' Week Memorial Volume and read at the meeting of the Academy held April 6 has been published. It will be issued in a separate edition and distributed to members, correspondents and others interested, in the hope that it may elicit comment, criticism and perhaps correction, which will render of more permanent value the detailed history in course of preparation for the Centenary of the Academy in 1912.

The accumulated stock of the PROCEEDINGS, JOURNAL and miscellaneous publications, held for sale and exchange, has been removed from the upper story of the middle building to cases prepared for storage in the basement. This is the fourth time this material has been moved to provide for the requirements of other interests since the occupancy of the corner building in 1876. It has been well said that three movings are as bad as a fire, and it is earnestly to be hoped that the present resting place will be permanent until the parts are distributed in fulfilment of their legitimate purpose as contributions to science. Incidentally an account of stock has been taken.

Ten members and five correspondents have been elected. The deaths of fourteen members and six correspondents have been announced. Messrs. J. H. Austin and Henry Pemberton have resigned. The loss sustained by the Academy in the death of Henry Cadwalader Chapman, so intimately concerned for many years with the scientific and administrative interests of the society, requires more than passing mention, and the Recording Secretary has been charged with the preparation of a biographical notice which, it is hoped, will be ready for presentation early the coming year.

The birth of Charles Darwin and the publication of the *Origin of Species* were fittingly commemorated by a well attended meeting on February 16, at which addresses were made by the President, Dr. Arthur Erwin Brown, and Dr. Edwin G. Conklin.

A successful meeting of the American Museums Association was held in the Academy, May 13.

EDWARD J. NOLAN,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

During the year six correspondents of the Academy died and five were elected. Those deceased are Prof. Jean Albert Gaudry, Prof. Perceval de Loriol Le Fort, Prof. Rudolph Bergh, Dr. Robert E. C. Stearns, Dr. Anton Dohrn and Prof. Kakichi Mitsukuri; and those elected, Dr. John Mason Clarke, Dr. Robert F. Scharff, Dr. Albert Leon Charles Calmette, Dr. Sven A. Hedin and Prof. Oscar Drude.

In accordance with the award of last year the Hayden Gold Medal was, on December 11, transmitted to Dr. John Mason Clarke, and an acknowledgment of the same duly received, together with an official copy of a minute appreciative of the Academy's action passed by Dr. Clarke's associates on the Board of Regents of the University of the State of New York.

Among the events of importance to the scientific world in which the Academy was invited to participate were the following: The presentation of an international testimonial in honor of Amedeo Avogadro, the student of the molecular constitution of gases; the Fiftieth Anniversary of the founding of the Botanical Institute of Brandenburg; the Three hundred and fiftieth Anniversary of the foundation of the University of Geneva; the Darwin Centenary exercises of the New York Academy of Sciences; the International Congress of Mining, Metallurgy and Practical Geology; the Seventeenth International Congress of Americanists; the dedication exercises of the Lamarck Centenary memorial statue in Paris; the Jubilee of the Geological Society of Glasgow, and the presentation by President Taft of medals in recognition of their services to æronautics to Wilbur and Orville Wright. As delegates representing the Academy at the Glasgow jubilee and the University of Geneva celebration, Sir Archibald Geikie and Dr. Auguste Forel, both correspondents, were respectively appointed. While no delegates were appointed to represent the Academy on the other occasions, suitable letters of congratulation or expressions of interest were in each case forwarded.

As a mark of appreciation of our contribution toward defraying the expenses of its project, the Lamarck Memorial Committee in Paris presented the Academy with the interesting bust of the great French evolutionist that now adorns the Reading Room.

Numerous letters and notices were answered or referred to the proper officers of the Academy, as their nature required.

Following is a tabulated statement of the statistics of the correspondence for the year:

Communications Received.

Acknowledging receipt of the Academy's publications,	209
Transmitting publications to the Academy,	82
Requesting exchanges or the supply of deficiencies,	3
Invitations to learned gatherings,	13
Notices of deaths of scientific men,	16
Circulars concerning the administration of scientific institutions, etc.,	10
Biographies and photographs of correspondents,	21
Miscellaneous letters,	103
Total received,	457

Communications Forwarded.

Acknowledging gifts to the Library,	1,199
Acknowledging gifts to the Museum,	86
Acknowledging photographs and biographies,	14
Requesting the supply of deficiencies in periodicals,	93
Letters of sympathy and congratulation, etc.,	9
Miscellaneous letters,	83
Annual Reports sent to correspondents,	234
Circular letters,	91
Diplomas and notices of election of correspondents,	13
Total forwarded,	1,825

Respectfully submitted,

J. Percy Moore,

Corresponding Secretary.

REPORT OF THE LIBRARIAN.

Notwithstanding the interruptions occasioned by the building operations and the removal of the Library, the accessions for the current year exceed in number those of 1908. There have been received of pamphlets and periodicals 6,256, volumes 943, maps 147, and one engraving, making a total of 7,347.

They have been received from the following sources:

Societies	2,754
I. V. Williamson Fund	2,611
Editors	503
United States Department of Agriculture	409
General Appropriation	254
United States Department of the Interior	162
Authors	152
James Aitken Meigs Fund	149
United States Treasury Department	42
University of Chicago	30
Thomas B. Wilson Fund	27
United States Department of Commerce and Labor	22
Geological Survey of Canada	20
Department of the Interior of the Philippines	18
Department of Mines, Canada	16
Department of Agriculture, Cape of Good Hope	16
Botanical Survey of India	14
Geological Survey of India	14
Pennsylvania Department of Agriculture	13
Ministry of Public Works, France	13
Geological Committee of Russia	12
H. A. Pilsbry	12
Corps of Mining Engineers of Peru	12
Edward J. Nolan	12
Department of Agriculture, Netherland India	11
United States War Department	9
Geological Survey of Japan	8
British Museum	8
Geological Institute of Mexico	7
International Union of American Republics	6
Ministry of Colonization, etc., Bolivia	6
Geological Survey of Wisconsin	6
Geological Survey of Western Australia	6
Department of Mines, New South Wales	5
Library of Congress	4
Department of Agriculture in India	4
Mississippi State Geological Survey	4
Madame Léo Errera	4
Department of Mines, Victoria	4
Thomas Biddle	4
Geological Survey of Connecticut	3
Missouri Bureau of Geology, etc.	3
Commissioners of Fisheries and Game, Massachusetts	3
Publication Committee, Academy	3
South African Central Locust Bureau	3
Bureau of American Ethnology	2
Illinois Bureau of Labor Statistics	2
Albert I. of Monaco	2
Special Exchange	2
Geological Survey of Georgia	2
Geological Commission, Cape of Good Hope	2
Board of Scientific Advice for India	2
New Zealand Geological Survey	2
Duc de Loubat	2
Superintendent of Public Documents, Washington	2
Geological Bureau, Roumania	2
Hawaii Agricultural Experiment Station	2
Guatemalan Government	2
Geological Survey of Virginia	1
Geological Survey of Oklahoma	1
Henry R. Wharton	1
Philip P. Calvert	1
Department of Fisheries, Pennsylvania	1
Trustees of the Indian Museum	1
William W. Keen	1
Department of Mines, Nova Scotia	1
Geological Survey of Iowa	1
Geological Survey of Illinois	1
Foote Mineral Co.	1
Department of Agriculture, Trindad	1
Commission for the Scientific Exploration of the German Seas in Kiel	1
Government of India	1
Commission of Mines of Carvao de Pedra, Brazil	1
Bentham Trustees, Kew Gardens	1
A. E. Outerbridge, Jr.	1
Agricultural Faculty of La Plata	1
Game Commissioners of Pennsylvania	1
Geological Survey of New Jersey	1
Department of Geology, Indiana	1
Geological Commission of Portugal	1
Colorado Geological Survey	1

They were distributed to the several departments of the Library as follows:

Journals	5,602	Mineralogy	28
Agriculture	319	Medicine	25
Geology	278	Helminthology	22
Botany	249	Mammalogy	22
General Natural History	152	Physical Science	18
Geography	130	Bibliography	17
Voyages and Travels	117	Ichthyology	15
Entomology	98	Chemistry	10
Anatomy and Physiology	73	Mathematics	4
Anthropology	66	Encyclopedias	1
Conchology	36	Unclassified	29
Ornithology	36		

Fifteen hundred and seventy-eight volumes have been bound since the last report.

Among the new books acquired during the year that are worthy of special mention are the following:

J. D. Hooker's *Botany of the Antarctic Voyage of H. M. Discovery Ships Erebus and Terror*, in seven quarto volumes.

A complete set of thirty-two volumes of the periodical *Kosmos*, published in Lemberg.

Kops and Van Eeden's *Flora Batava*, a complete set to date of twenty-three quarto volumes.

Ungarische Revue from 1885 to 1895, received from the Hungarian Academy of Sciences in response to an application for deficiencies.

Journal of the Anthropological Society of Bombay. Volumes 1 to 7.

The publications of the Scottish National Antarctic Expedition.

Transactions of the Leicester Literary and Philosophical Society from 1835 to 1895.

Volumes 1 to 13, inclusive, of *Forest and Stream*, completing our set of that periodical.

A set of the *Jahresbericht über die Fortschritte der physischen Wissenschaften (der Chemie und Physiologie)*, in thirty volumes.

The following new journals have been added to the list:

Archiv für die Geschichte der Naturwissenschaften und Technik, Leipzig.

Zeitschrift fur induktive Abstammungs- und Vererbungslehre, Berlin.

Zeitschrift für Botanik, Jena.

Dörfleria, Vienna.

Mannus, Wurzburg.

Natur, Leipzig.

Prähistorische Zeitschrift, Berlin.

The current year is probably the most important in the history of the Library, marked, as it has been, by a radical change in the manner of shelving and preserving the books.

The rear portion of the building, completed during the summer, will ultimately contain seven tiers of steel stacks for the accommodation of the Library. The five of these now in place provide more than twice the former shelfing, upon which approximately 120,000 volumes can be placed, so that at the present rate of growth it is not likely that the two additional stacks will be required during the lifetime of any but the youngest members of the Academy.

The first armful of books, a collection of Academy lists, catalogues, biographies, histories and the five bound volumes of Leidyana, was carried to the new building at 4.30 P.M., August 25. The following day the cases in the Reading Room were filled. After an unavoidable interruption work was resumed on the 30th, and, with the help of a corps of six reliable and intelligent men, by September 22d the books were all in place, three weeks having been devoted to the work. The position of the several sections of the library had been determined on before the moving began, and they were placed at once where they are to remain, care being taken to leave space for growth. More time was, of course, thus consumed than if the books had been carried over and piled up to await a later arrangement; but the gain in the end was of importance, as the work was complete as far as it went. The books were always accessible, and, as a matter of fact, the use of the Library was not interfered with for a single hour.

The cases have been numbered, and the several sections are indicated by neatly lettered signs at the ends of the stacks. A printed guide to the arrangement will further assist those consulting the collection. It has not, so far, been necessary to make any special legislation regarding admission to the stacks. Those working in the Academy seem to have no difficulty in finding what they want, and books desired by casual readers are promptly supplied by the attendants. The catalogues will be revised as soon as time can be secured for the work.

There has been but one departure from the old classification: the special journals have been grouped under their subject headings; transactions of general societies and other publications dealing with more than one branch of science being arranged geographically, as before.

The new arrangement, although sacrificing in some minor particulars the convenience so enthusiastically recognized by all who had access to the old hall, is eminently satisfactory. Three well-lighted and convenient apartments between the Reading Room and the stacks have been assigned for the use of the Recording Secretary and Librarian and his Assistant.

The spacious Reading Room has been surrounded by bookcases, in which are placed the books most likely to be frequently called for—a portion of those on general natural history, recent accessions, dictionaries and bibliography. With the exception of the cases for the temporary reception of new books, this is more a matter of furnishing than of library convenience, as no difficulty is experienced in securing any work desired from the stacks, which are sufficiently lighted by the windows in ordinarily fine weather, the electric lights provided in the aisles being required only on cloudy days and late in the afternoon.

A room on the stairway leading to the Lecture Hall has been appropriated for the storage of duplicates and of journals not immediately germane to the work of the Academy.

The rooms vacated by the Library, to the east of the Race street entrance, have, on the recommendation of the Council, been assigned for the use of the State Department of Health during the term of office of the present State Commissioner, the President of the Academy, and are now so occupied.

There has been no interruption of current work. Books have been ordered, received and catalogued, exchanges have been made and accessions displayed as usual on the Library tables for the use of those compiling bibliographies or desirous of keeping up their knowledge of the progress of science.

Acknowledgment is due the Assistant Librarian, William J. Fox, for most intelligent and efficient service in the moving of the books to the new building and of the stock of publications to the new storage cases, as well as for the faithful discharge of his current duties in connection with the Library and the Publication office.

We are indebted to the Free Library of Philadelphia for the loan of the trucks used in the transportation of the books to the new building.

It is believed that the portion of the year's work with which the Library Committee and the Librarian are charged may be regarded as a subject of warm congratulation.

Edward J. Nolan,
Librarian.

REPORT OF THE CURATORS.

The additions and alterations to the Academy buildings, begun in the spring of 1908 under an appropriation of $150,000 from the Commonwealth of Pennsylvania, have been completed.

The entrance from Race street has been remodeled and now presents a commanding hallway which leads directly to the main Museum building, through the space formerly occupied by the old Lecture Hall.

The stairways in the main Museum building have been removed to the Nineteenth street entrance, from which a new vestibule has been constructed, shut off from the galleries of each floor by fire-walls and automatic fire-doors.

On the lot situated at Nineteenth and Cherry streets, 50 x 130 feet in size, has been erected a handsome fireproof building, now occupied by the Hall of the Academy, the Library stack and Reading Room.

The third floor, with the top floor of the main Museum building, have been divided into a number of study rooms and laboratories. All are reached by an electric elevator.

In the old Museum all the iron columns have been fireproofed and fire escapes provided to comply with the legal requiremements.

New vaults for the storage of the alcoholic collections have been constructed and the collections transferred to them.

The increased room and accommodations now provided have long been needed for the protection and accommodation of the invaluable Library and Museum of the Academy and the collections of the Commonwealth of Pennsylvania and the American Philosophical Society, deposited in its keeping.

At this year's session of the State Legislature an additional appropriation of $60,000 was made to the Academy, with which it is proposed to encase the walls of the original greenstone building, which are becoming badly weathered, with brick and terra cotta, and to add such terra cotta facings to the middle wing as will make the entire building uniform in appearance.

The Museum, which had been closed to the public during the alterations, was reopened early in the year, and much of the time of the Museum staff has been devoted to the cleansing and rearrangement of the specimens.

A radical rearrangement has been effected on the mammal floor and many of the osteological specimens temporarily removed from exhibition.

All the water birds were removed while the cases were being cleansed and repainted and were then rearranged.

The immense series of jars containing the alcoholic collections have been thoroughly cleansed before being arranged in the new vaults.

Notwithstanding this unusual amount of routine work, considerable local field work was done by members of the Museum staff and several more extended trips were made. Largely through the liberality of Mr. Morgan Hebard. Mr. Rehn was enabled to accompany him on a trip through the Western States, and a large collection of Orthoptera and some other specimens were secured.

Through the Esther Hermann Research Fund of the New York Academy of Sciences, Mr. Stewardson Brown was enabled to make another botanical exploration of Bermuda during May in the interests of the New York Botanic Garden and this Academy. Dr. J. P. Moore spent the summer collecting marine invertebrates at Martha's Vineyard and Woods Hole. Mr. Clarence B. Moore has continued his explorations of the Indian mounds of the Southern States, and has added many valuable specimens to the collection made by him since 1893. The Moore collection now contains over 5,000 specimens, all systematically arranged and labelled by Mr. Moore.

Among the more important accessions of the year may be mentioned the Clemens collection of Philippine birds, the Hinkley collection of Mexican mollusca, a collection of Brazilian insects made by Miss H. B. Merrill—all secured by purchase—and the Commons Herbarium, an unusually complete collection of the flora of Delaware, made by Mr. Albert Commons, and presented to the Academy by his nephews, Messrs. Frank W. and Howard W. Commons.

One mahogany and plate glass exhibition case has been added to the bird hall, and forty-three storage cases and 158 Schmidt insect boxes have been purchased.

In addition Dr. J. P. Moore has cared for the collection of annelids and Mr. H. W. Fowler the fishes, while Miss H. N. Wardle has arranged portions of the archæological specimens.

To Mr. Sam'l S. Van Pelt in the Herbarium and to Mr. E. T. Cresson, Jr., in the Entomological department the Curators are indebted for valuable assistance.

Specimens have been loaned during the year to A. S. Hitchcock, C. J. Pennock, Dr. Ludwig Neumayer, J. H. Fleming, F. C. Baker, Mary J. Rathbun, Robert Ridgway, Dr. Paul Bartsch, H. C. Oberholser, Merritt Cary and W. W. Eggleston.

Samuel G. Dixon,
Curator.

Report of the Department of Mollusca.

Work during the past year has been chiefly directed to the preparation, determination and labelling of new material added to the collections, and to the preparation of an illustrated monograph on the family *Partulidæ*, which has been published in the MANUAL OF CONCHOLOGY.

Very large accessions of the mollusca of Louisiana and southeastern Arkansas we owe to Mr. Clarence B. Moore. Mr. Stewardson Brown has further augmented the series from Bermuda, and the study of Arizona snails collected by J. H. Ferriss and the Curator has nearly reached completion; reports thereon are now in course of publication by the Academy.

The shells collected by Mr. A. A. Hinkley in Mexico have been determined, and the new forms described in several papers.

Mr. John B. Henderson, Jr., has contributed a series of Cuban shells collected this year, and Dr. Arnold Ortmann gave a set of western Pennsylvania freshwater mussels, especially valuable on account of the rapid destruction of the faunas of these streams by mine water. A large series of mollusks from Tonkin has been purchased, in order to afford material for comparison with those of China, Korea and Japan, which the Curator is working upon.

Accessions hardly less valuable have been received from many correspondents of the Department, as noted in the *Additions to the Museum.*

H. A. PILSBRY,
Special Curator, Dept. of Mollusca.

REPORTS OF SECTIONS.

BIOLOGICAL AND MICROSCOPICAL SECTION.

The Section has held nine regular meetings during the year, with an average attendance of nine members. Ten informal meetings have also been held.

The Conservator reports the donation of six boxes of slides from the estate of the late Dr. Henry C. Chapman.

The work of the year consisted chiefly in the exhibition and description of mounted slides and material by each member present, and in the exchange of specimens for mounting, among which may be mentioned a valuable series of about seventy rare minerals in microscopic crystals distributed by Mr. Keeley.

Among the papers presented are the following: "Microscopical Image Formation," by Mr. F. J. Keeley, published in the PROCEEDINGS; "The Hookworm Disease," by Dr. T. S. Stewart.

Mr. Palmer described a new form of *Pinnularia* which he has named *Pinnularia socialis*, found in groups of four.

Mr. Van Sickel devised a new form of opaque mounting slide, and, at the request of members, several thousand were manufactured from his design for general use.

Mr. Shulze discovered several new forms of *Diatomaceæ* in the Barbadoes deposit, one of which has been named and described by Mr. Boyer in the PROCEEDINGS.

Mr. Schumo presented various specimens and gave a talk on Mosses, illustrated with lantern slides.

Communications were also made by Mr. Bilgram on *Myxomycetes;* Dr. Owen, on salt solutions; Mr. Davies, on various vegetable preparations; Mr. Van Sickel, on the crystallization of Platinum; Mr. Boyer, on local diatoms, and by Messrs. Keeley, Rothermel, Ray and other members, on miscellaneous subjects.

An increased interest is apparent in the preparation of specimens and in the manipulation of the microscope and much original work has been accomplished during the year.

The officers for the year 1910 are as follows:

Director, . . .	J. Cheston Morris, M.D.
Vice-Director, . .	T. Chalkley Palmer.
Recorder, . . .	Charles S. Boyer.
Corresponding Secretary, .	Silas L. Schumo.
Treasurer, . . .	Thomas S. Stewart, M.D.
Conservator, . .	F. J. Keeley.

CHARLES S. BOYER,

Recorder.

ENTOMOLOGICAL SECTION.

The usual meetings of this Section have been held with an average attendance of nine persons. During the year upwards of 3,000 specimens have been added to the collection. Eight new cases and 158 boxes have been purchased to accommodate the growth of the cabinet. The orders Hemiptera and Neuroptera and the family Tenthredinidæ of the order Hymenoptera have been rearranged. Part of the American Rhopalocera has been transferred to new cases. The publications of the Section have been successfully continued. One member and two associates have been elected.

At a meeting held December 23 the following officers were elected:

Director,	Philip Laurent.
Vice-Director,	H. W. Wenzel.
Treasurer,	E. T. Cresson.
Secretary,	E. T. Cresson, Jr.
Conservator and Recorder,	Henry Skinner, M.D.
Publication Committee,	E. T. Cresson,
	E. T. Cresson, Jr.

Botanical Section.

Early in the year the work of putting the species of flowering plants into covers was completed, which will prove not only a convenience in studying, but will also secure a decrease in the possible breakage of specimens.

The most notable addition during the year has been the Albert Commons Herbarium of Delaware plants, representing his collecting during half a century. It is probably the most complete series of the flora of the State, including not only the flowering plants and ferns, but also the lower forms, fungi, etc. The collections were presented to the Academy by Messrs. Frank W. and Howard W. Commons, of Minneapolis, Minn.

Other donations include a collection of 50 species of Bucks County, Pa., *Cratægus* from Dr. C. D. Fretz; 160 *Cratægus* and other trees and shrubs from the Arnold Arboretum; 250 specimens of plants from the eastern United States from E. B. Bartram, and smaller collections, aggregating about 150 specimens, which will be noted in detail in the *Additions to the Museum*.

The Section has purchased 500 specimens of California and Nevada plants from A. A. Heller; 40 specimens of *Cratægus* from Willard W. Eggleston and 100 Mexican mosses from C. G. Pringle.

The Conservator spent the time from May 22 to June 2 of the present year in the Bermudas, where a collection of about 250 plants was made, and, though not large in species, enabled him to determine some uncertain records, besides adding a number to the known flora of the islands. The results of this and two previous trips are embodied in a paper in the current number of the Proceedings.

The Philadelphia Botanical Club has continued to hold its meetings in the herbarium of the Academy during the year, and through the energy of its members 2,100 sheets have been added to the local collection, in the care of which Mr. Samuel S. Van Pelt has continued his valuable services as Curator.

Acknowledgment is made of the services of Miss Ada Allen as assistant in the herbarium during the year.

At the annual meeting of the Section the following were elected as officers for the coming year:

Director,	Benjamin H. Smith.
Vice-Director,	Joseph Crawford.
Secretary and Recorder,	Charles S. Williamson.
Treasurer and Conservator,	Stewardson Brown.

Respectfully submitted,
Stewardson Brown,
Conservator.

The Mineralogical and Geological Section.

The Section held seven meetings in 1909, with an average attendance of six. Communications were made by Prof. O. C. S. Carter, on earthquakes; Dr. E. T. Wherry, on fossil plants at Holicong, Bucks County, with a report on them by Dr. David White; Mr. T. C. Palmer, on minute beryls at Avondale, Delaware County; B. S. Lyman, on the need of instrumental surveying in practical geology, and on advantages of not exaggerating the vertical scale in geological cross-sections; Col. Joseph Willcox, on fossil elephants, Glyptodon, manatee and horses in Florida; Mr. F. J. Keeley, on asteriated sapphire from Ceylon; Miss E. Walter, on sub-fossil Sequoia in San Francisco.

The Section also met in conjunction with the Academy on the evening of May 18th, and made through its members three communications to the meeting.

There were six field excursions of the Section, with an average attendance of about 29. On all the excursions, except the third, the parties visited crystalline rocks and their minerals, namely: (1) Between Woodlane and Ardmore, Montgomery County; (2) between Elwyn and Newtown Square, Delaware County; (3) New Red rocks and trapdikes, between Camp Hill and Three Tuns, Montgomery County; (4) near Moylan, Strath Haven, Avondale and Crum Creek, Delaware County; (5) near Cynwyd, Mill Creek and Bryn Mawr, Montgomery County; (6) near Glen Mills, Lenni, Chester County, and Blackhorse, Delaware County.

Besides the meetings and excursions of the Section, there was, by its invitation, a numerously attended meeting of geologists of the northeastern part of the United States held at the Academy on the afternoon and evening of April 23d, at which six highly valuable communications were read, followed, the next day, by a very profitable field excursion of 23 participants, under the guidance of Prof. Bascom, to typical places of pre-Cambrian and early Paleozoic rocks, from Lafayette up the Schuylkill to Norristown, and thence to Henderson, Gulf Mills and Bryn Mawr.

The membership of the Section has increased during the year by three associate members. The field excursions lead to joining it as associate members; and sometimes immediately, or later through interest in the meetings, to becoming members of the Academy. The full membership is now 25 members and 15 associate members, 40 in all.

The following officers of the Section have been elected for the year 1910:

Director, ... Benjamin Smith Lyman.
Vice-Director, ... Frank J. Keeley.
Recorder and Secretary, . . . Silas L. Schumo.
Treasurer and Conservator, . . . George Vaux, Jr.

Respectfully submitted by order of the Section.

BENJAMIN SMITH LYMAN,
Director.

ORNITHOLOGICAL SECTION.

Work in the Ornithological department has been seriously hampered during the past year by the alterations to the top floor of the Museum, which necessitated the disarrangement of most of the cases for nearly six months, while the demands upon the Conservator's time in looking after other departments of the Museum and the absence of Mr. Rehn in the West also interfered with the work of the department.

The cases have now, however, been permanently placed, all the drawers examined and the specimens arranged, while the rooms have been thoroughly cleaned.

The remainder of the Tristram and Porter collections, comprising several thousand skins, have been systematically distributed, and the Van der Pol collection has been catalogued, while the *Limnicolæ* or shore birds have been critically studied, reidentified and arranged in standard metal cases.

It was found necessary to remove a large part of the exhibition series from the cases, so as to permit of the cleansing of both specimens and cases. A portion of this work has been accomplished, and one new exhibition case secured. For the study collection of skins ten additional metal and four large wooden cases were procured, which enables us for the first time to place the entire study series in standard cases. A number of valuable additions to the collection have been made during the year, the most important being the Clemens specimens from Mindanao, Philippine Islands.

The Delaware Valley Ornithological Club and the Pennsylvania Audubon Society have held their meetings in the Ornithological rooms during the year, and have done much to further the interests of the department. To Mr. J. A. G. Rehn the Conservator is indebted for valuable assistance in labelling and cataloguing.

The officers elected at the annual meeting, December 2, 1909, are:

Director,	Spencer Trotter, M.D.
Vice-Director,	George Spencer Morris.
Corresponding Secretary,	William A. Shryock.
Recorder,	Stewardson Brown.
Conservator and Treasurer,	Witmer Stone.

WITMER STONE,
Conservator.

The annual election of Officers, Councillors and Members of the Committee on Accounts to serve during 1910 was held, with the following result:

PRESIDENT,	Samuel G. Dixon, M.D., LL.D.
VICE-PRESIDENTS,	Arthur Erwin Brown, Sc.D.,
	Edwin G. Conklin, Ph.D., Sc.D.
RECORDING SECRETARY,	Edward J. Nolan, M.D.
CORRESPONDING SECRETARY,	J. Percy Moore, Ph.D.
TREASURER,	George Vaux, Jr.
LIBRARIAN,	Edward J. Nolan, M.D.
CURATORS,	Arthur Erwin Brown, Sc. D.,
	Samuel G. Dixon, M.D., LL.D.,
	Henry A. Pilsbry, Sc.D.,
	Witmer Stone.
COUNCILLORS TO SERVE THREE YEARS,	Philip P. Calvert, Ph. D.,
	Thomas Biddle, M.D.,
	Frederick Prime,
	Frank J. Keeley.
COMMITTEE ON ACCOUNTS,	Charles Morris,
	Samuel N. Rhoads,
	John G. Rothermel,
	Thomas H. Montgomery, Ph.D.,
	Frank J. Keeley.

COUNCIL FOR 1910.

Ex-officio.—Samuel G. Dixon, M.D., LL.D., Edwin G. Conklin, Ph.D., Sc.D., Arthur Erwin Brown, Sc.D., Edward J. Nolan, M.D., J. Percy Moore, Ph.D., George Vaux, Jr., Henry A. Pilsbry, Sc.D., Witmer Stone.

To serve three years.—Philip P. Calvert, Ph.D., Thomas Biddle, M.D., Frederick Prime, Frank J. Keeley.

To serve two years.—Charles B. Penrose, M.D., Charles Morris, Henry Tucker, M.D., Spencer Trotter, M.D.

To serve one year.—Thomas H. Fenton, M.D., John Cadwalader, Edwin S. Dixon, Henry Skinner, M.D.

Curator of Mollusca, . .	Henry A. Pilsbry, Sc.D.
Assistant Librarian, . .	William J. Fox.
Assistants to Curators, . .	Henry Skinner, M.D.,
	Stewardson Brown,
	J. Percy Moore, Ph.D.,
	Edward Vanatta,
	Henry W. Fowler,
	James A. G. Rehn.
Assistant, ...	H. Newell Wardle.
Taxidermist, ...	David N. McCadden.
Jessup Fund Students, . .	H. Newell Wardle,
	Ezra T. Cresson, Jr.
Janitors, ...	Charles Clappier,
	Daniel Heckler,
	James Tague,
	Jacob Aebley,
	Adam E. Heckler.

ELECTIONS DURING 1909.

Members.

January 19.—George H. Clapp, Charles M. B. Cadwalader, Herbert Fox, M.D., William Redwood Wright, Lewis W. Steinbach, M.D.
March 16.—William Welsh Welsh.
April 20.—John Gribbel, Mrs. Elizabeth B. Gribbel.
November 16.—Theodore de Thodorovitch, LL.D., James A. G. Rehn.

CORRESPONDENTS.

January 19.—Albert Calmette, Ph.D., of Lille; John Mason Clarke, LL.D., of Albany; Sven A. Hedin, Ph.D., of Stockholm; Robert F. Scharff, Ph.D., of Dublin.

November 16.—Oscar Drude, of Dresden.

ADDITIONS TO THE MUSEUM.

Mammals.

C. R. Biederman. Skin of Civet Cat (*Bassariscus astutus flavus*), Arizona

J. G. Dillen. Skin of Brewer's Mole (*Parascalops breweri*), Bucks County, Pa.

Hebard-Academy Expedition of 1909. One young Rabbit (*Lepus* sp.), Montana.

Miss Dora Keene. Skull of Leopard (*Felis pardus*), Burma.

B. W. Orin. Skull of Woodchuck (*Marmotta monax*), Chester County, Pa.

Robert Shearer. Skull of Horse (*Equus caballus*).

John B. Stetson Co. Skin of Duckbill (*Ornithorhynchus anatinus*).

Witmer Stone. Skull of varying Hare (*Lepus americanus virginianus*), Sullivan County, Pa.

Zoological Society of Philadelphia. Specimens prepared as follows: Mounted, Panda (*Ailurus fulgens*), Cape Hunting Dog (*Lycaon pictus*). Skin and skeleton, Red Langur (*Presbytis rubicundus*), Asiatic Tapir (*Tapirus indicus*), Brazilian Ocelot (*Felis chibigouazou*); skin and skull, Fishing Cat (*Felis viverrina*), Senegal Galago (*Galago senegalensis*); skin, Mexican Deer (*Odocoileus* sp.); skeleton, European Lynx (*Lynx lynx*); skull, Arctic Fox (*Vulpes lagopus*).

Birds.

Miss Anna Busch. Razor-billed Auk (*Alca torda*), Sea Isle City, N. J.

W. B. Crispin. European Starling (*Sturnus vulgaris*), Salem, N. J.

J. W. Holman. Adult Black Duck (*Anas rubripes*) and young (mounted), Tuckerton Bay, N. J.; Black Hawk (*Archibuteo lagopus sancti-johannis*), Stafford's Forge, N. J.

Luther D. Lovekin. Loon (*Gavia imber*), Wayne, Pa.

Joshua Parker. Dovekie (*Alle alle*), Parkertown, N. J.

Miss Wiegand. Birds' eggs.

Wm. D. Winsor. Swan (*Olor columbianus*).

Zoological Society of Philadelphia. Mounted, single wattled Cassowary (*Casuarius uniappendiculatus*). Skins, spotted Eagle Owl (*Bubo maculosus*), Satin Bower-bird (*Ptilonorhynchus violaceus*); skin and skeleton, Cassowary (*Casuarius casuarius*); skeletons, South African Ostrich (*Struthio australis*), Crowned Hornbill (*Anthracoceros coronatus*).

Delaware Valley Ornithological Club. Several nests and eggs added to the local collection.

Purchased. The Clemens collection of Birds from the Island of Mindanao, P. I.

Reptiles and Batrachians.

O. H. Brown. Red Salamander (*Spelerpes ruber*), Cape May, N. J.

J. T. Bryan. Young Black Snake (*Bascanion constrictor*), Pitman, N. J.

H. W. Fowler. Musk Turtle (*Kinosternon*) and Toad (*Bufo*), Cape May, N. J.; several collections of reptiles and amphibians, New Jersey and Pennsylvania.

H. W. Fowler and H. L. Mather, Jr. One Frog (*Rana*), Pitman, N. J.

H. W. Fowler and H. L. Mather, Jr. Collection of reptiles, Montgomery County, Pa.

John H. Greenwood. Painted Turtle (*Chrysemys picta*), Chestertown, Md.

B. W. Griffiths and H. W. Fowler. Collection of amphibians and reptiles, Atco, N. J.

H. W. Hand and H. W. Fowler. Collection of reptiles and amphibians, Cape May County, N. J.

George W. Harper. DeKay's Snake (*Storeria dekayi*).

Hebard-Academy Expedition of 1909. Fifty-nine reptiles and batrachians, Western United States.

J. W. Holman. Three snakes, Stafford's Forge, N. J.

C. J. Hunt. DeKay's Snake (*Storeria dekayi*), Tinicum, Pa., two Dusky Salamanders (*Desmognathus fusca*), Frankford, Pa.

T. D. Keim. *Diadophis punctatus*, New Jersey.

H. L. Mather, Jr. Garter Snake (*Thamnophis sirtalis*).

Dr. H. A. P. Neil. Water Snake (*Natrix sipedon*), Holmesburg, Pa.

Joseph Parker. Ground Snake (*Carphophiops amoenus*), Stafford's Forge, N. J.

Dr. H. A. Pilsbry. Two Salamanders (*Plethodon*) and one Tree Frog (*Hyla pickeringi*), Bartonsville, Pa.; two Speckled Turtles (*Chelopus guttatus*), Swede's Run, N. J.

Purchased. Six western Painted Turtles (*Chrysemys marginatus*).

Evan Rhoads. Ribbon Snake (*Thamnophis saurita*), Sussex County, N. J.

Dr. G. S. Robinson. Two Snakes (*Lampropeltis doliatus triangulus* and *Thamnophis sirtalis*), Pennsylvania and New Jersey.

Mr. W. P. Seal. Red-bellied Terrapin (*Pseudemys rubriventris*), New Jersey; local Frogs and tropical *Hyla*.

J. F. Street. Copperhead (*Agkistrodon contortrix*), Frenchtown, N. J.; Sticky Salamander (*Plethodon glutinosus*), Kingwood, N. J.

E. G. Vanatta. *Rana pipiens*, Ocean City, N. J.

Zoological Society Philadelphia. Mexican Heloderma (*Heloderma horridum*).

R. W. Wehrle. Several lots of reptiles and amphibians from Indiana and Pennsylvania.

Fishes.

Dr. C. C. Abbott. Several collections of fishes, Bordentown, N. J.

Dr. Bellows. Chub (*Semotilus bullaris*), Montgomery County, Pa.

C. H. Conner. *Seriola zonata*.

W. P. Davis. Two *Bufo fowleri*, New York.

H. W. Fowler. Seven lots of fishes, New Jersey and Pennsylvania.

H. W. Fowler and B. W. Griffiths. Collection of fishes, Chester County, Pa.

H. W. Fowler and H. L. Mather, Jr. Collection of fishes, Pitman, N. J.

H. W. Fowler and H. L. Mather, Jr. Collection of fishes, Montgomery County, Pa.

H. W. Fowler and D. N. McCadden. Collection of fishes, Ocean City, N. J.

E. N. Fox. Skate (*Raja ocellata*), Sea Isle City, N. J.

W. J. Fox. Eel Pout (*Zoarces anguillaris*), Sea Isle City, N. J.; Angler (*Lophius*); *Paralichthys dentatus*, Leaming, N. J.; *Echeneis*, *Mugil* and *Leiostomus*, Sea Isle City, N. J.; two Hake (*Merlucius*).

H. W. Hand. One *Sciænops ocellatus*, Cape May, N. J.

H. W. Hand. Sunfish (*Eupomotis*) from salt water, Cape May, N. J.

Hebard-Academy Expedition of 1909. Two Flying Fish (*Cypselurus californiensis*), Santa Catalina Island, Cal.

T. D. Keim and H. W. Fowler. Several collections of fishes, Pennsylvania and New Jersey.

T. D. Keim. Small collection of fishes, New York.

David McCadden. Tautog (*Tautogolabrus adspersus*), Ocean City, N. J.; *Paralichthys dentatus*, Ocean City, N. J.

H. L. Mather, Jr. Collection of fishes, Maryland.

H. L. Mather, Jr. *Petromyzon marinus*, Maryland.

Dr. R. J. Phillips. Eight collections of fishes, Corson's Inlet, N. J.

Dr. R. J. Phillips and H. W. Fowler. Small collection of fishes, Corson's Inlet, N. J., and Tinicum, Pa.

R. Potter. Two Swordfish swords, Gloucester, Mass.

Purchased. Specimens of *Dasyatis* and *Raja*.

Dr. G. S. Robinson. *Spheroides maculatus*.

F. M. Siggins. *Umbra*, Meadville, Pa.

Eugene Smith. One Cut-lip Minnow (*Exoglossum maxillingua*), Hoboken, N. J.

U. S. National Museum. Five specimens of *Notropis hudsonius selene*.

E. G. Vanatta. Sunfish (*Enneacanthus*), Chestertown, Md.

R. W. Wehrle. Collection of fishes, Indiana, Pa.

H. A. Widdifield. Cow-nosed Ray (*Rhinoptera*), Great Egg Harbor, N. J.

Insects.

W. Beutenmueller. Six Cynipidæ, United States.

F. E. Blaisdell. Eight *Agabus lineolus*, California.

Ignacio Bolivar. Fifty-five Orthoptera, Spain and Africa (exchange).

W. E. Britton. Thirty-five insects, United States.

D. M. Castle. Eighteen Coleoptera, United States.

A. N. Caudell. Three Orthoptera, Georgia and Virginia.

Paul Cheney. One Mantis, Florida.

E. T. Cresson, Jr. Ninety-eight Diptera, United States; eleven Lepidoptera, New York; seven Neuroptera, New York; twenty-four Diptera, New York; fifty-eight Hymenoptera, New York; three Odonata, New York; six Orthoptera, New York; fifty insects, California.

W. T. Davis. Fourteen Orthoptera, Newfoundland and New Jersey.

H. T. Fernald. One Orthoptera, British Honduras.

H. W. Fowler. Four insects, New Jersey.

G. M. Greene. Thirty-five Hymenoptera, Philadelphia; two hundred and fifty Coleoptera, Germany.

Morgan Hebard. Fifty-three Coleoptera, United States; one hundred and twenty-four insects, United States; one hundred and forty Hymenoptera, Michigan; forty-two Orthoptera, Florida; forty-four Orthoptera, Arizona; three hundred and fifty-seven Orthoptera, Western States and Florida; thirty-two Orthoptera, Colorado, Utah and Yellowstone Park.

Hebard and Rehn. One thousand three hundred and seventy-five Orthoptera, Academy Expedition; ten Orthoptera, United States.

F. M. Jones. Thirty-one Orthoptera, Bermuda.

C. W. Johnson. Thirty-six Diptera, United States.

R. R. Myers. Two Hymenoptera, Pennsylvania.

Purchased. Five hundred and twenty-one Orthoptera, Tropical America and Africa; two hundred and forty Orthoptera, Para, Brazil; one hundred Orthoptera, Amboina; five hundred and twenty-five Orthoptera, Natal.

J. A. G. Rehn. Seven Orthoptera, New Jersey.

S. A. Rohwer. Twenty Hymenoptera, Colorado.

Henry Skinner. Twenty-one *Argynnis*, Utah; twenty-one insects, New Jersey; eighteen Lepidoptera, New Mexico; twenty-seven Lepidoptera, North Carolina; thirteen Lepidoptera, California; eight Coleoptera, Pennsylvania; six *Satyrus pegala*, Alabama.

J. B. Smith. One Orthoptera, New Jersey.

H. A. Surface. Two Lepidoptera, Pennsylvania.

J. F. Tristan. Twenty-five Orthoptera, Costa Rica.

F. Weigand. *Cucullia phila*, Pennsylvania.

H. A. Wenzel. Four *Diplotaxis*, Arizona; two *Cicada*, Philadelphia; two Coleoptera, Canada.

John Woodgate. Forty-one Hymenoptera, New Mexico; ten Orthoptera, New Mexico; fourteen Neuroptera, New Mexico; twenty-three Diptera, New Mexico; nineteen Coleoptera, New Mexico.

Recent Mollusca.

John A. Allen. Nine lots of Tahitian shells.

Joshua Baily, Jr. *Viviparus* from lake in Fairmount Park.

F. C. Baker. Cotypes of *Lymnæa nashotahensis*; *Pisidium*.

Mrs. L. Baker. *Polygyra uvulifera*, Osprey, Florida.

S. S. Berry. Lot of Californian freshwater and land shells.

J. Chester Bradley. Several lots of *Pisidium* from British Columbia.

Stewardson Brown. Eighty-nine trays of Bermudan shells.

L. R. Cary. Five species shells from Delaware and Raritan Canal.

G. H. Clapp. Five species land shells; cotype of *Holospira bartschi*.

W. H. Dall. Species of *Holospira*, *Epirobia* and *Apcrostoma*.

L. E. Daniels. *Pisidium* and *Physa* from Arizona.

James H. Ferriss. Two hundred and thirty-four lots of land shells from Arizona.

W. H. Fluck. Sixteen lots of Nicaragua shells.

H. W. Fowler, R. J. Phillips and H. L. Mather. Fifteen lots Pennsylvania and New Jersey shells.

W. J. Fox. Series of eighteen marine mollusks from Sea Isle City, N. J.

John H. Greenwood. Jug with oysters growing in and upon it.

George W. Harper. *Lampsilis parvus* and *tetralasmus*, Dallas, Texas.

Morgan Hebard and J. A. G. Rehn. Eleven lots of shells from Montana, etc.

J. B. Henderson, Jr. Sixty-three lots of Cuban land shells.

A. A. Hinkley. One hundred and ninety-eight lots of Mexican shells.

Y. Hirase. Eighty-three lots of Japanese shells.

L. A. Keene. Collection of Unionidæ, Fox River, Ill.

Mrs. A. F. Kenyon. One hundred and thirty-six lots marine mollusks Australia.

H. W. Lermond. *Bela* and *Nucula* from Maine.

H. N. Lowe. *Chlorostoma* and Helices from California.

John H. Matthews. *Xesta citrina*, Amboyna.

William G. Mazyck. *Sonorella* from Salt River Mountains, Arizona; *Helicella terrestris*, Charleston, S. C.

Clarence B. Moore. Two hundred and eighty-five lots of shells from Louisiana and Arkansas.

A. E. Ortmann. Seventy-eight lots Unionidæ, Western Pennsylvania.

W. H. Over. Twenty-five lots fresh-water shells, South Dakota.

Maj. J. Peile. *Helix pisana* and *Zonitoides bermudensis*, Bermuda.

H. A. Pilsbry. One hundred and eighty-six lots Arizona shells; twenty-three species from Monroe County, Pa.

Evan Rhoads. Twenty-five lots of shells from northern New Jersey.

S. N. Rhoads. Sixty-five lots of shells from Adirondacks, etc.

S. L. Schumo. Thirty lots of shells from Santiago, Cuba.

Alvin Seale. Fifteen lots of shells from Gulf of Davao, Mindanao.

H. H. Smith (purchased). Thirty-three lots Alabama shells.

V. Sterki. Five species of Pupillidæ.

Witmer Stone. Six species of land shells from Sullivan County, Pa.

U. S. National Museum. *Viviparus* from Mindanao; *Polygyra* from Mexico.

E. G. Vanatta. Six lots of shells, Pennsylvania and New Jersey.

George Wagner *Ianthina exigua*, California.

Bryant Walker. Cotypes of *Planorbis bicarinatus royalensis*, *Lymnæa pilsbryana*, *L. petoskeyensis* and *Somatogyrus virginicus*. *Succinea*, *Viviparus*, etc.

R. W. Wehrle. Three species land shells, Indiana County, Pa.

H. W. Wenzel. *Planorbis bicarinatus*, Scotia Junction, Ont.

J. E. Whitfield. *Pœcilozonites*, Bermuda.

A. P. Willits. Six lots shells from Santo Domingo.

Helen Winchester. Seven species land shells, Susquehanna, Pa.

Purchased. Four hundred and ninety-four species of exotic mollusks.

Worms.

Stewardson Brown. Two species of Oligochaeta.

Dr. H. C. Chapman. *Phyllobothrium*.

Erich Daecke. *Ascaris megalocephalus*.

H. W. Fowler. *Macrobdella decora*.

Dr. J. Percy Moore. Three hundred and twenty-nine bottles of Annelids; eighteen bottles of Polychæta, California.

Walter Pfeiffer. Blood worm (*Caudina arenata*), Townsend's Inlet, N. J

Dr. H. A. Pilsbry. Two species of *Ascaris* and Oligochæta.

J. A. G. Rehn. *Ascaris* sp.

E. G. Vanatta. *Lumbricus*, *Euchytræus* and *Helodrilus*.

U. S. National Museum. Fifty-six bottles of Polychæta, Nova Scotia and Labrador.

Other Invertebrates.

Stewardson Brown. Two jars of Centipedes, Bermuda.

Archie T. Campbell. Star-fish (*Asterias* sp.), Great Egg Harbor Bay, N. J.

H. W. Fowler. Collection of Crustacea, Sea Side Park, N. J.

W. J. Fox. Sea-urchin, Sea Isle City, N. J.

H. W. Hand and H. W. Fowler. Collection of Crustacea, Cape May County, N. J.

Mrs. A. F. Kenyon. Three jars of invertebrates, Australia; three jars of Crustacea, South Australia.

H. A. Pilsbry. Three invertebrates, New Jersey.

Dr. R. J. Phillips and H. W. Fowler. Small collection of invertebrates, Corson's Inlet, N. J.

Purchased. Specimens of *Limulus*.

S. N. Rhoads. One tray of shrimps, Riverside, Cal.

Louis H. Schmidt. Malformed claw of Crab.

U. S. National Museum. Seven trays of barnacles, Labrador; seven jars of barnacles, South America.

R. W. Wehrle. Crayfish (*Cambarus*), Indiana, Pa.

Fossils.

Dr. J. C. Merriam. Skull of *Canis* sp., California.

Alan G. Smith. *Scolithus linearis* in Cambrian quartzite.

Dr. Stahle. Bones of *Belodon*.

Joseph Willcox. Pliocene Coral, Osprey, Fla.

Ethnological Material.

Mrs. Charles Schaeffer. Collection of Ainu wearing apparel and household objects; collection of clothing, personal ornaments and baskets from wild tribes of Formosa.

Chas. E. Brooks. Lucayan Indian remains.

F. Lynwood Garrison. Specimen of pottery, Colombia.

Clarence B. Moore. A number of specimens from Indian mounds of Southern States, added to the Clarence B. Moore Collection.

Plants.

Arnold Arboretum. One hundred and sixty specimens of shrubs and trees.

Edwin B. Bartram. One hundred and fifty plants, Eastern United States.

Frank W. and Howard W. Commons. Albert Commons Herbarium. Plants of Delaware.

Dr. C. D. Fretz. Fifty Cratægus from Bucks County, Pa.

Alfred S. Haines. *Camptosorus rhizophyllus* and photograph.

Miss Parmalee. Collection of sea weeds.

Philadelphia Botanical Club. Two thousand one hundred and sixty sheets of local plants.

S. L. Schumo. Fifteen West Indian plants.

Charles S. Williamson. Fifty plants.

Academy Expedition to Bermuda (Stewardson Brown). Two hundred and fifty Bermudan plants.

Hebard-Academy Expedition. Twenty Western United States plants.

Botanical Section. Purchased the following collections:

W. W. Eggleston. Forty Cratægus.

A. A. Heller. Five hundred California and Nevada plants.

C. G. Pringle. One hundred Mexican plants.

Minerals.

Morris Breithaupt. Non-pyrites in calcite, Philadelphia.

E. S. Fitler. Gold ore, Nevada.

Daniel Fitler. Gold-bearing quartz, cinnabar ore and samples of sand

Charles D. Norton. Two specimens of galena.

Charles E. Ronaldson. Garnets in schist rock, Maine.

Albert Stevens. Several specimens of local rocks.

F. Lynwood Garrison. Ten minerals, various localities.

A. E. Outerbridge. Series of ores from Jamaica.

William S. Vaux Collection. Seventy-five specimens of minerals, purchased.

INDEX TO GENERA, SPECIES, ETC., DESCRIBED AND REFERRED TO IN THE PROCEEDINGS FOR 1909.

Species described as new are indicated by heavy-faced, synonyms by italic figures.

GENERAL INDEX.

1909

CRAMPTON. MORPHOLOGY OF SCLERITES.

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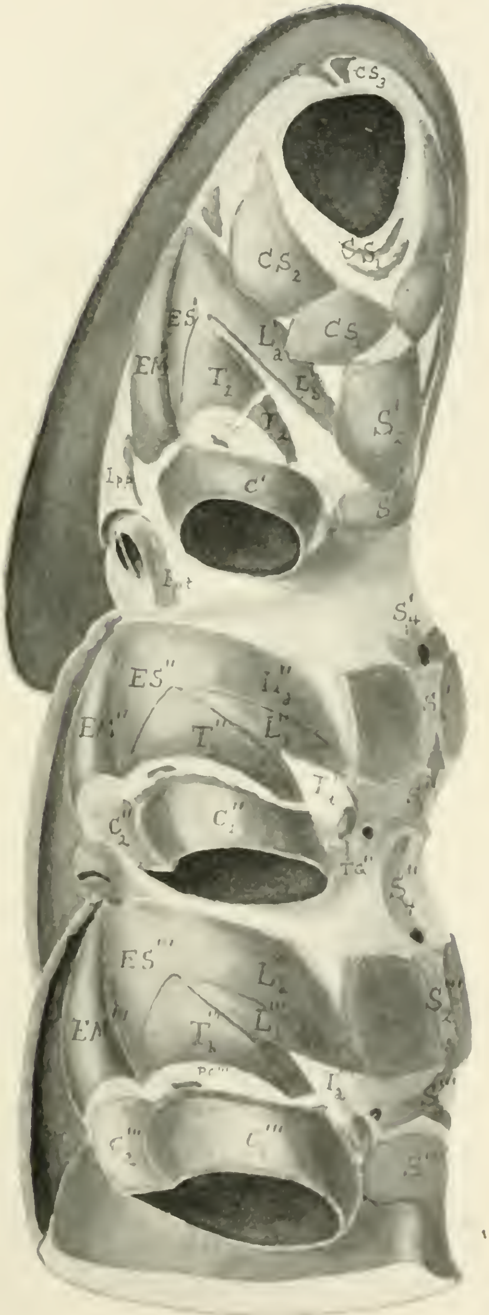

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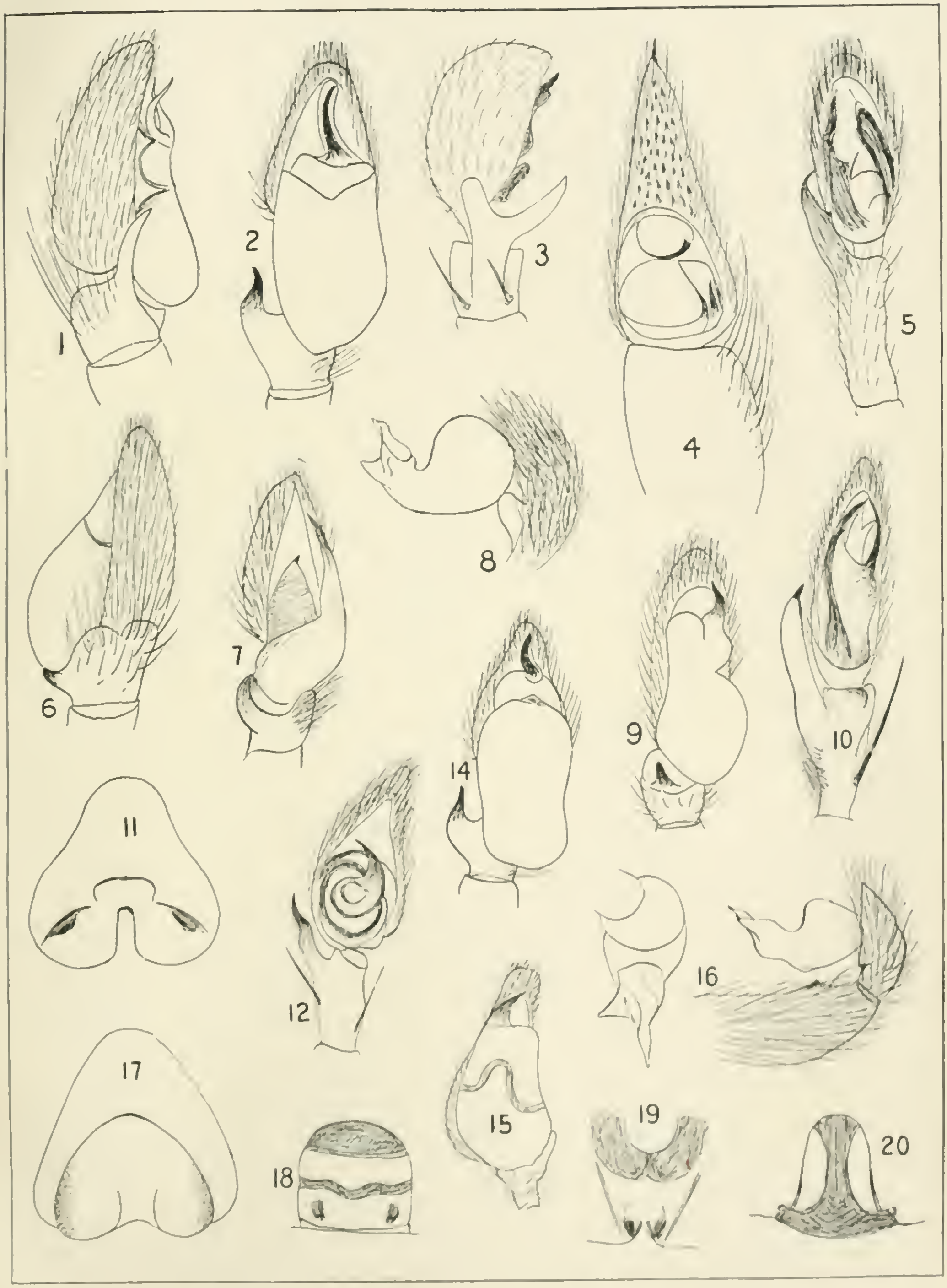

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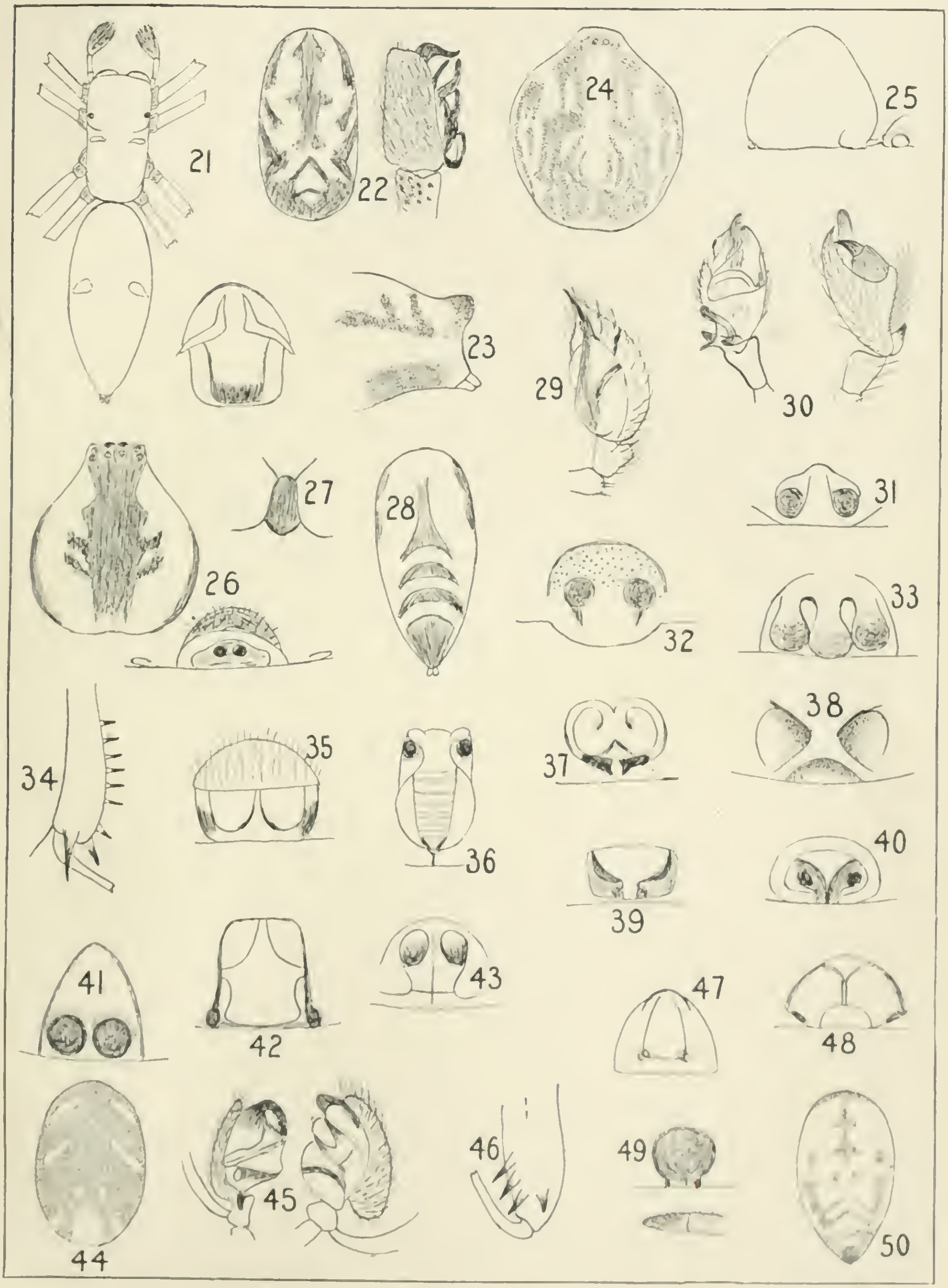

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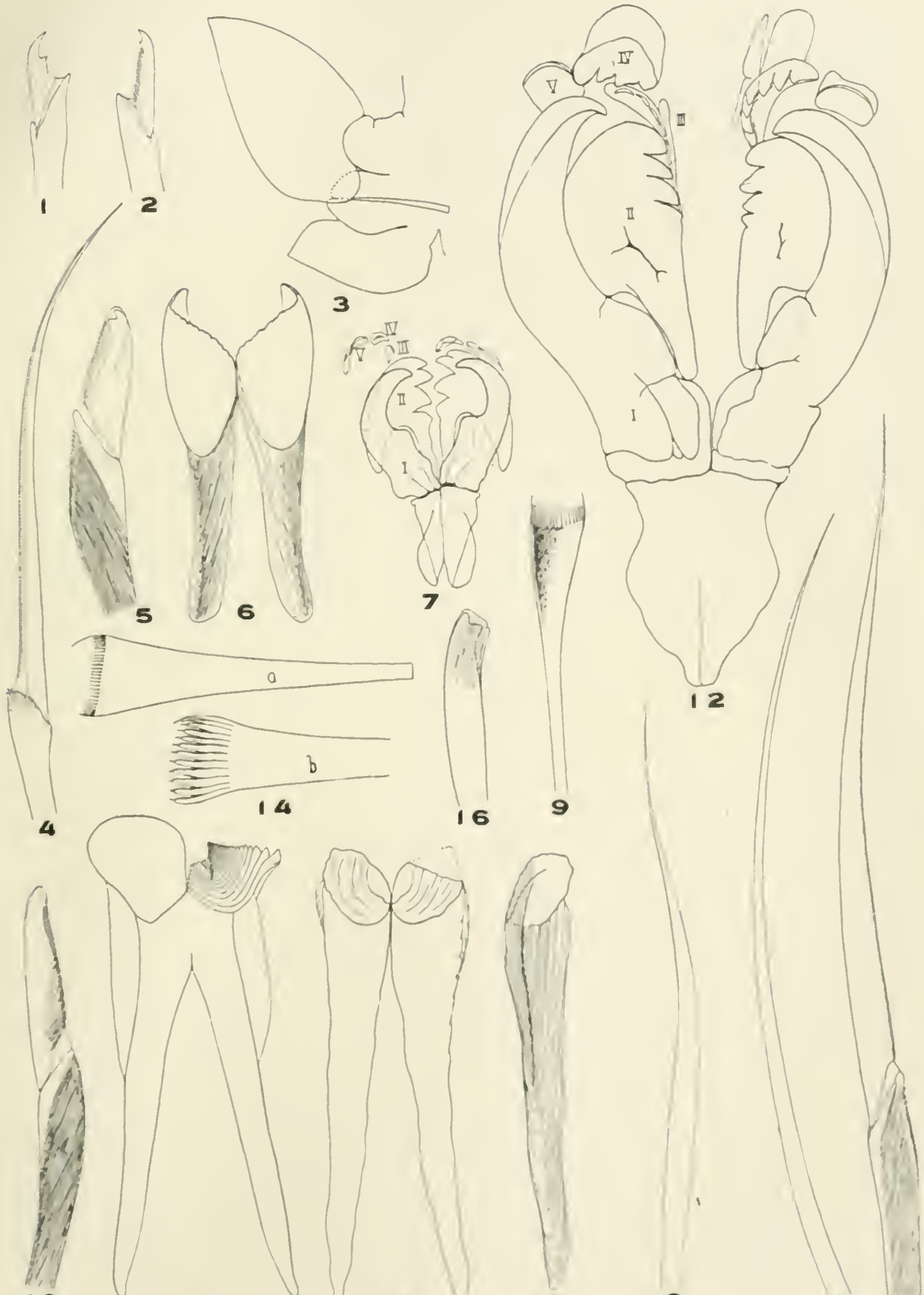
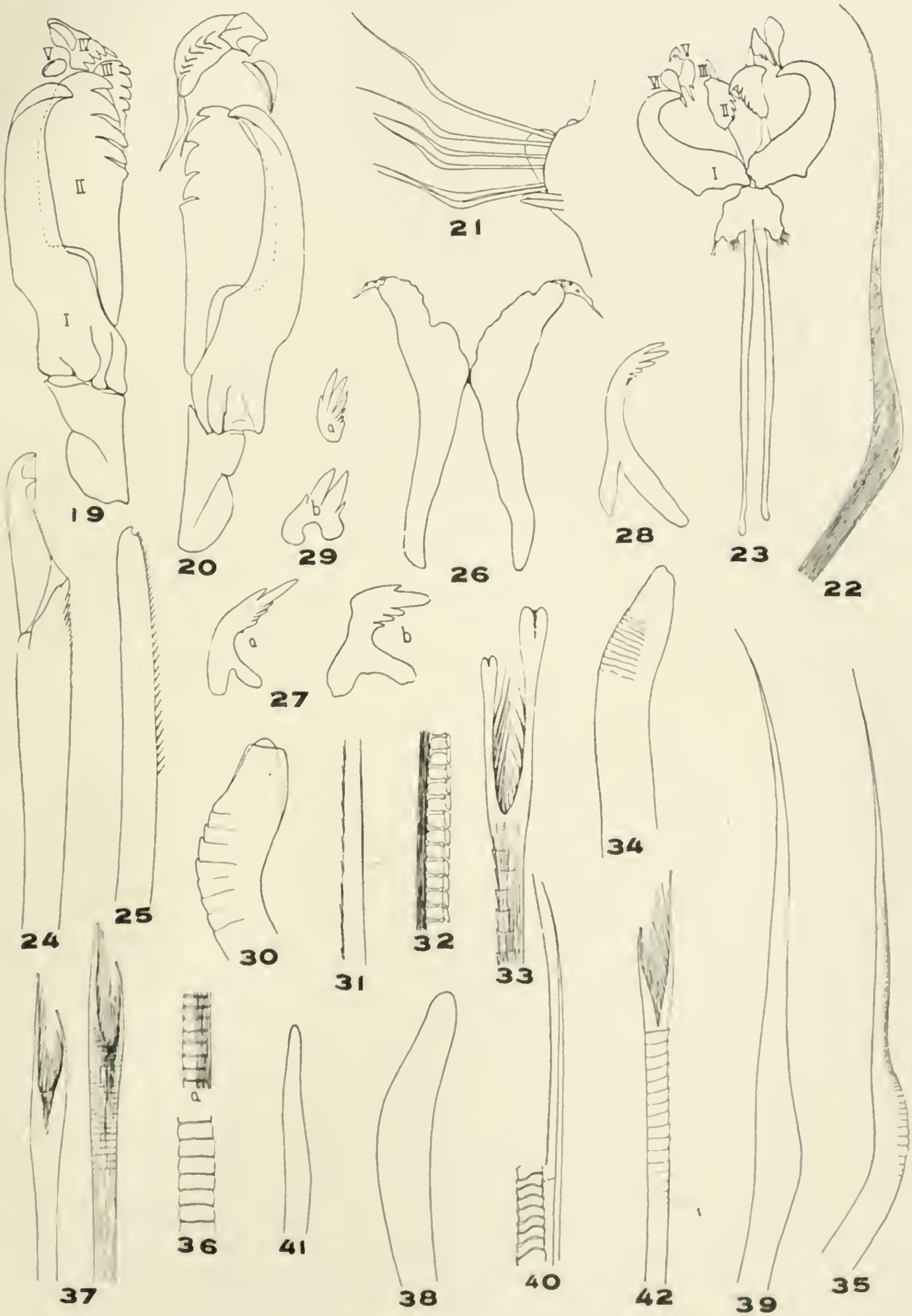


MOORE CALIFORNIA POLYCHÆTA



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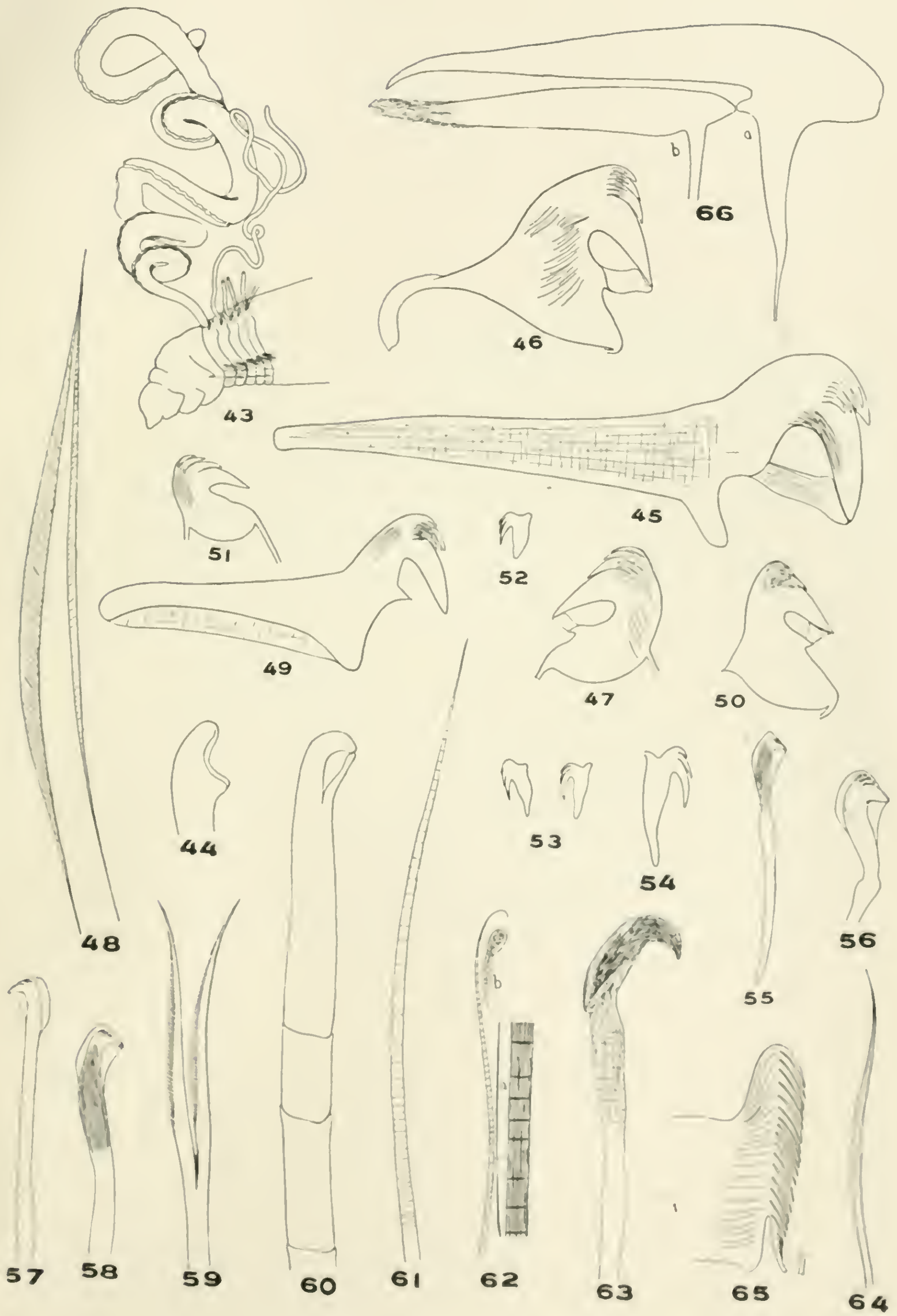

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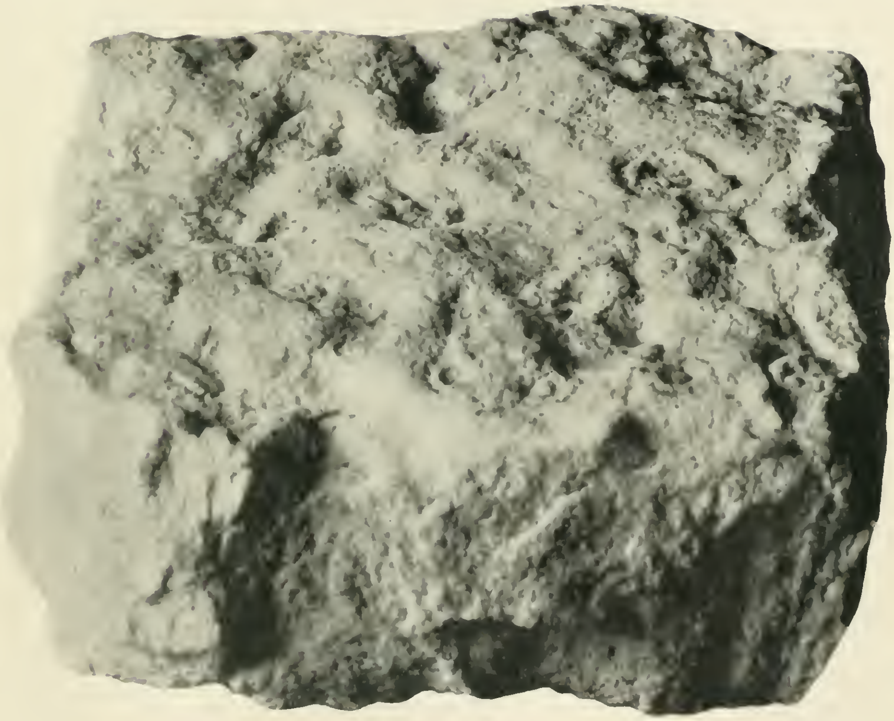

LYMAN: SCOLITHUS LINEARIS


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2.G.
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Lam.1
P.St.
3.Ap.
Ect.
Coel.
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Lam.1
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P.Cav.
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Bl.Cav.
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P.Cav.
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P.St.
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Mes.
Bl.Cav.
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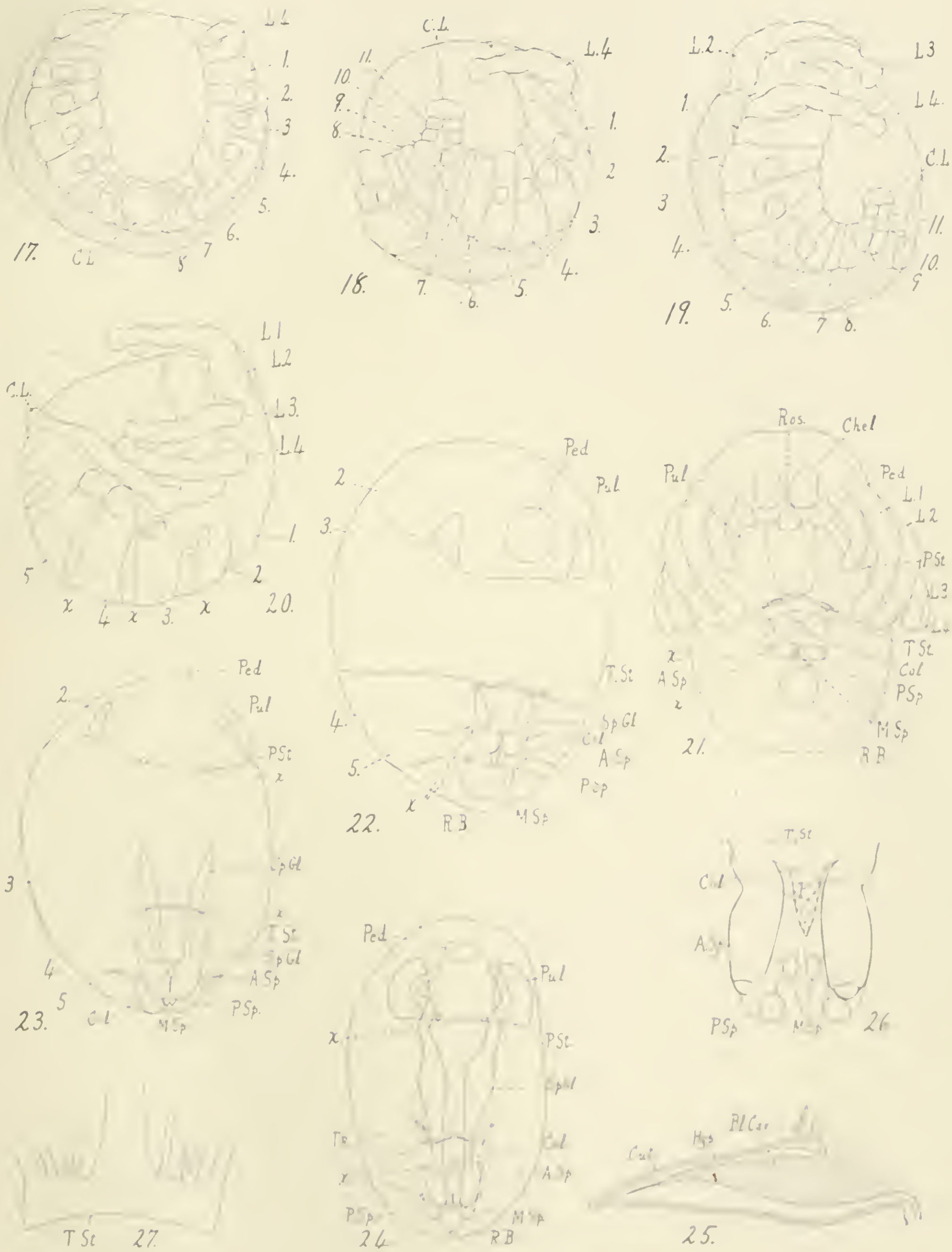
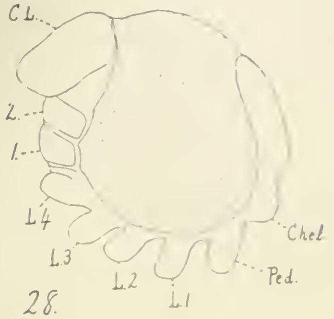
MONTGOMERY. THE SPINNERETS, ETC., OF ARANEIDS.



MONTGOMERY: THE SPINNERETS, ETC., OF ARANEIDS.



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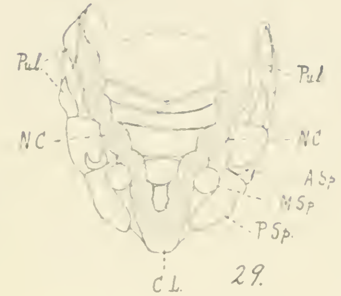

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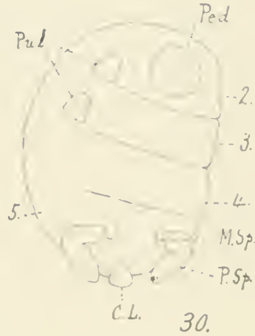

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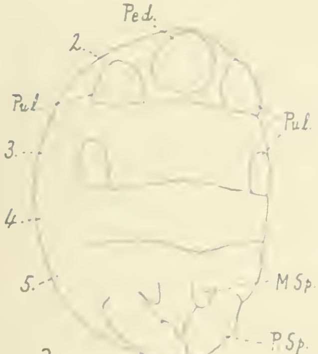

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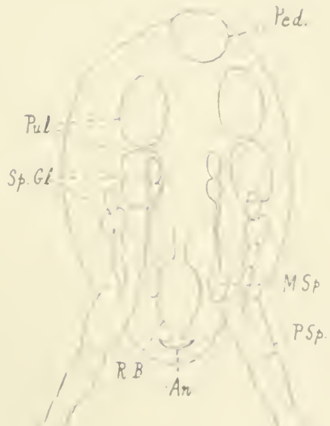

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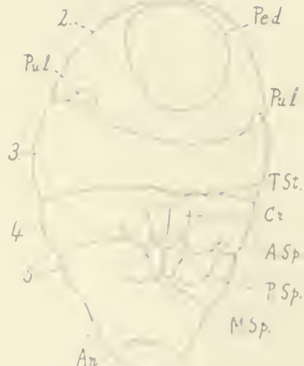

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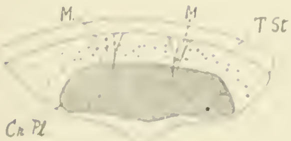

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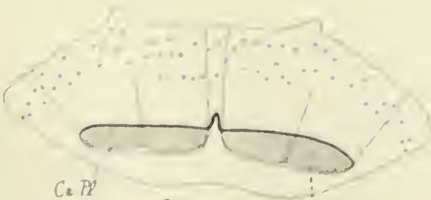

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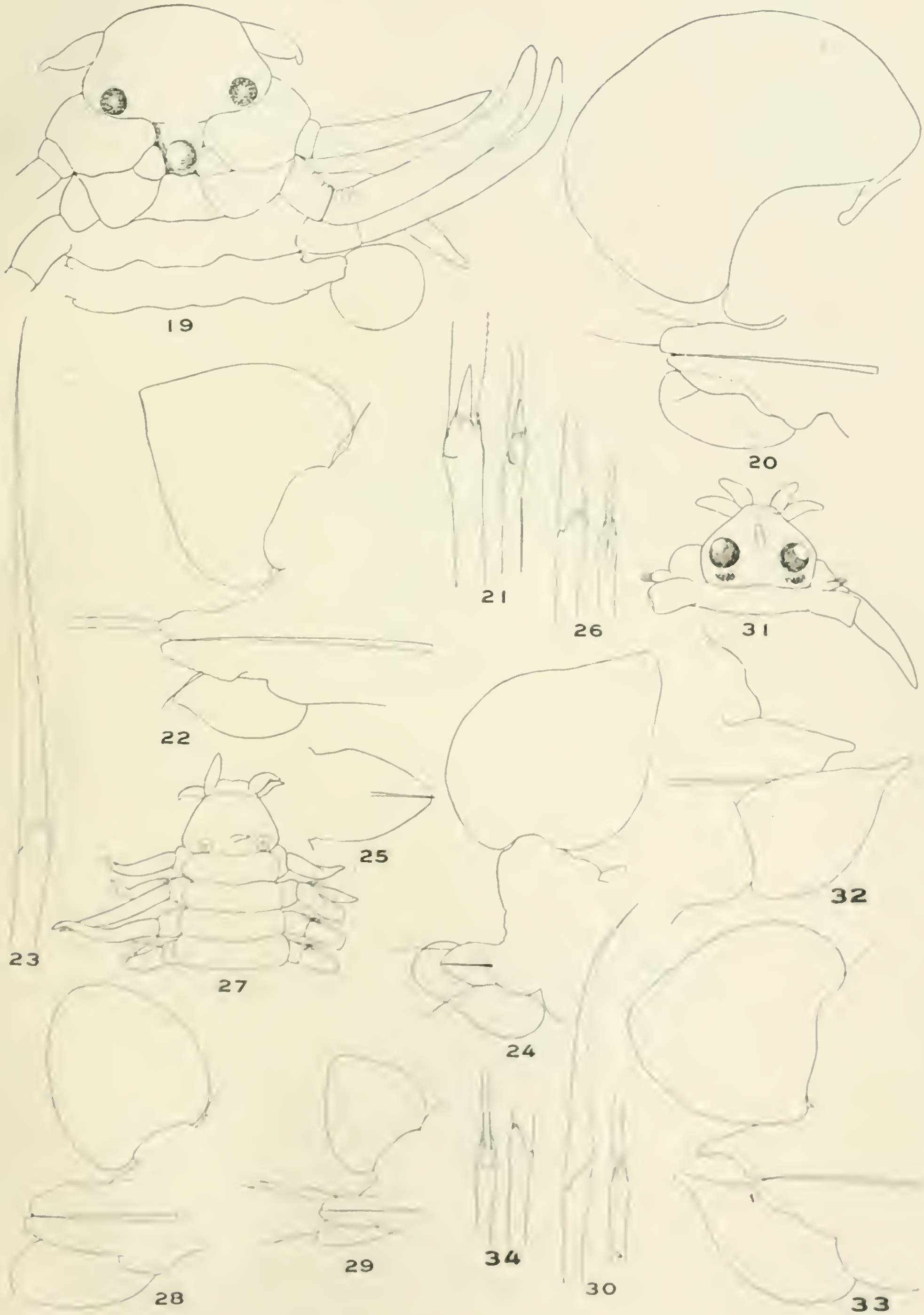
MONTGOMERY. THE SPINNERETS OF ARANEIDS.

MOORE. POLYCHAETOUS ANNELIDS



MOORE: POLYCHÆTOUS ANNELIDS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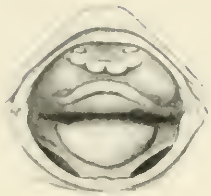
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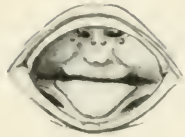
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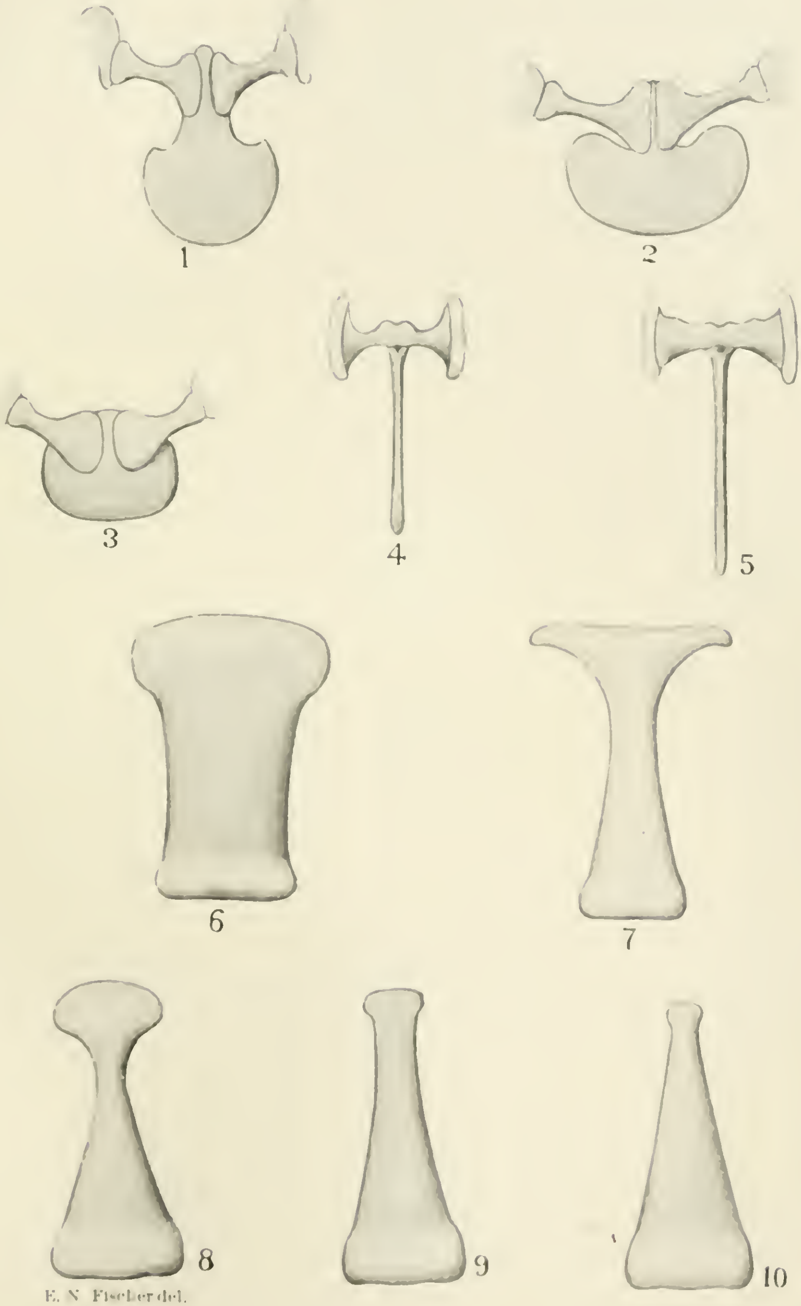
E. N. Fischer del.

BARBOUR ON THE GENUS CACOPOIDES



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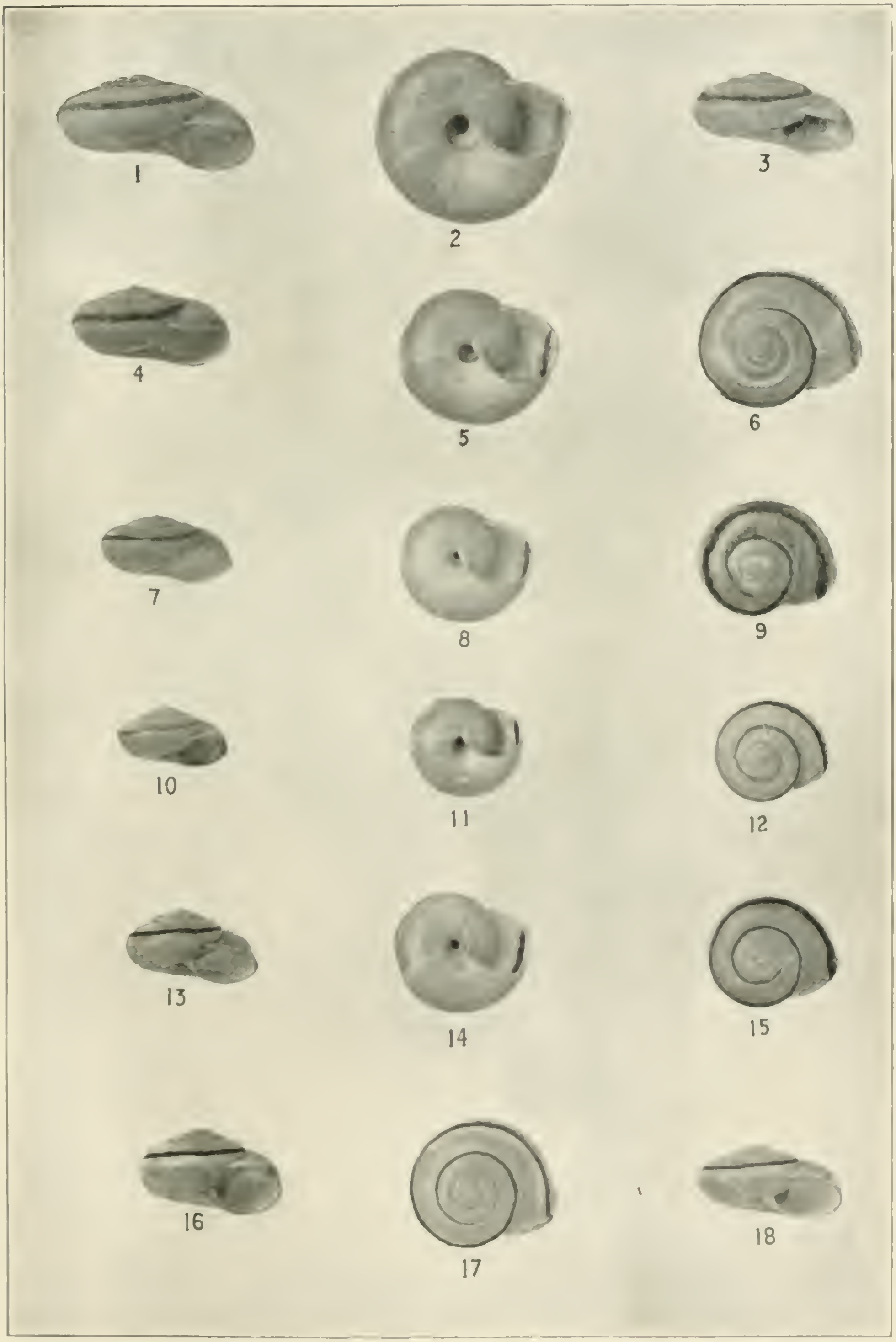
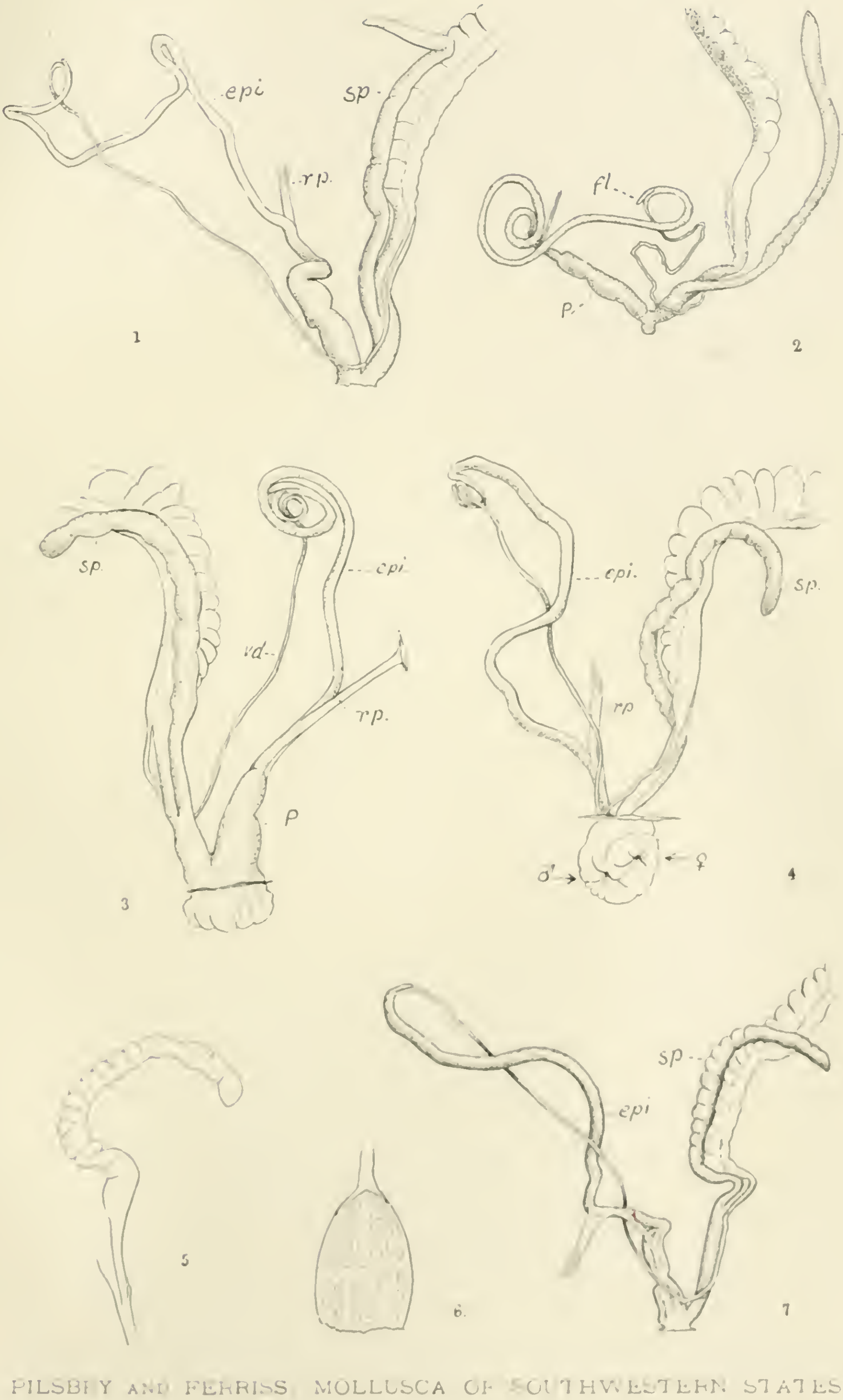


PILSBRY AND FERRISS MOLLUSCA OF SOUTHWESTERN STATES.



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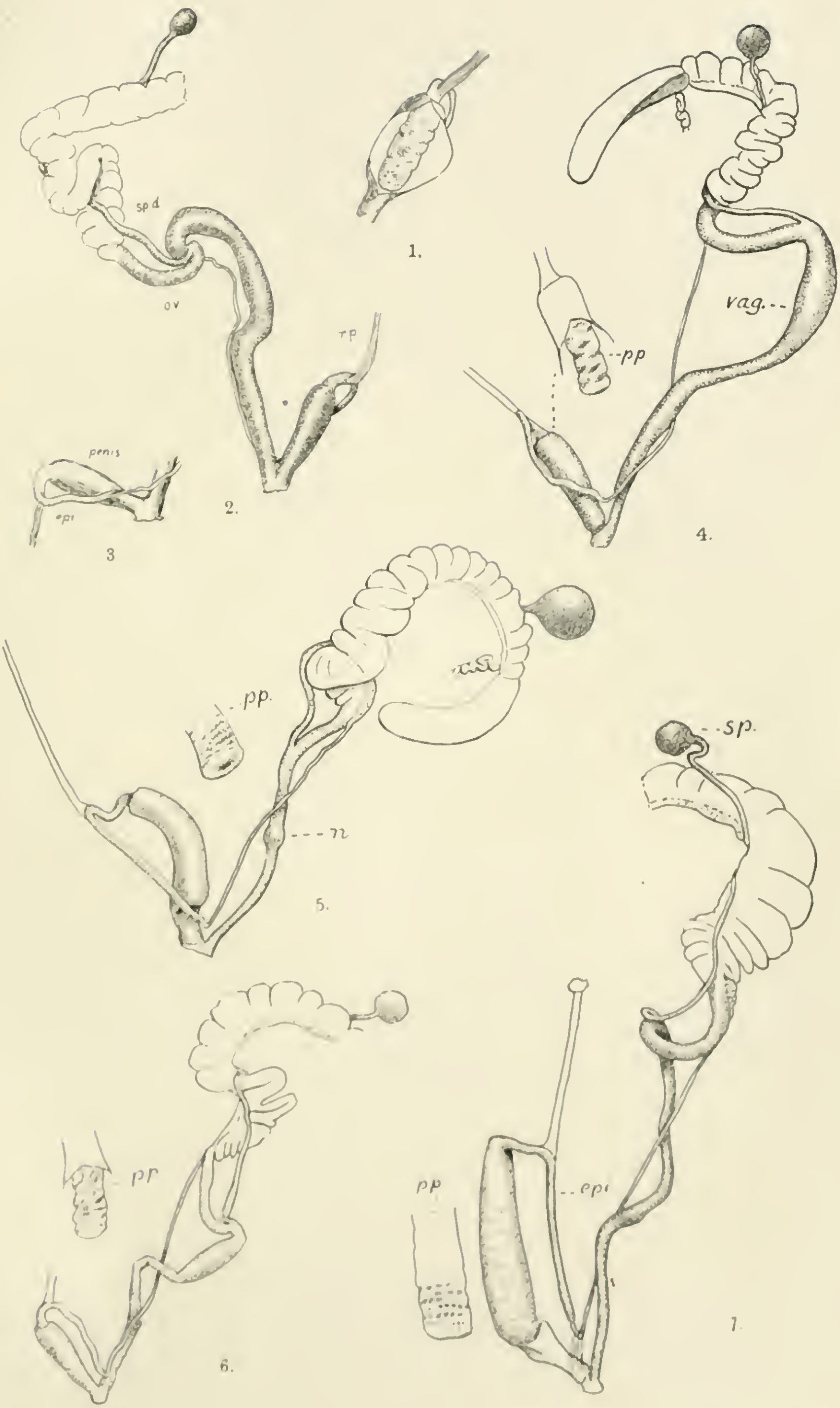
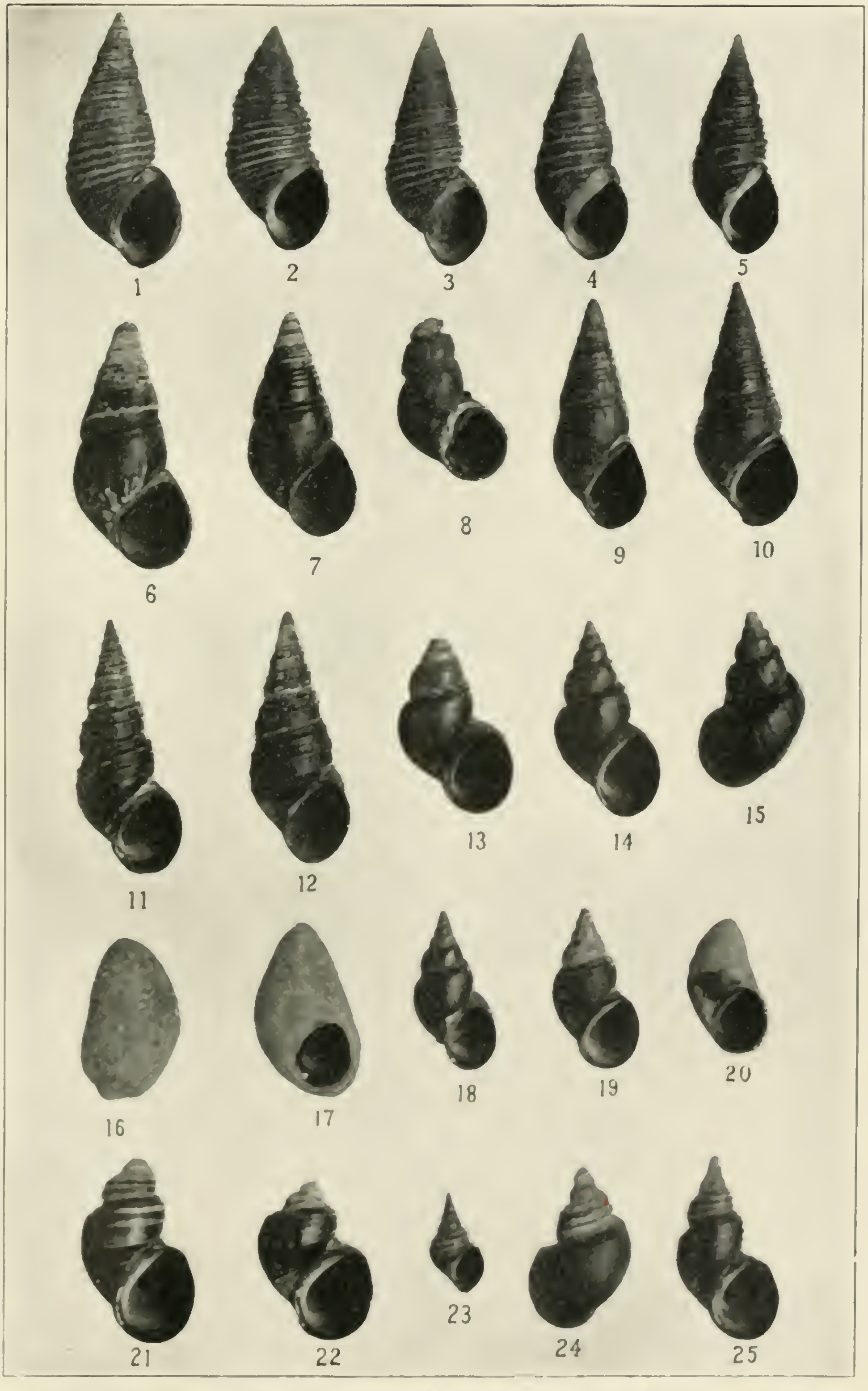
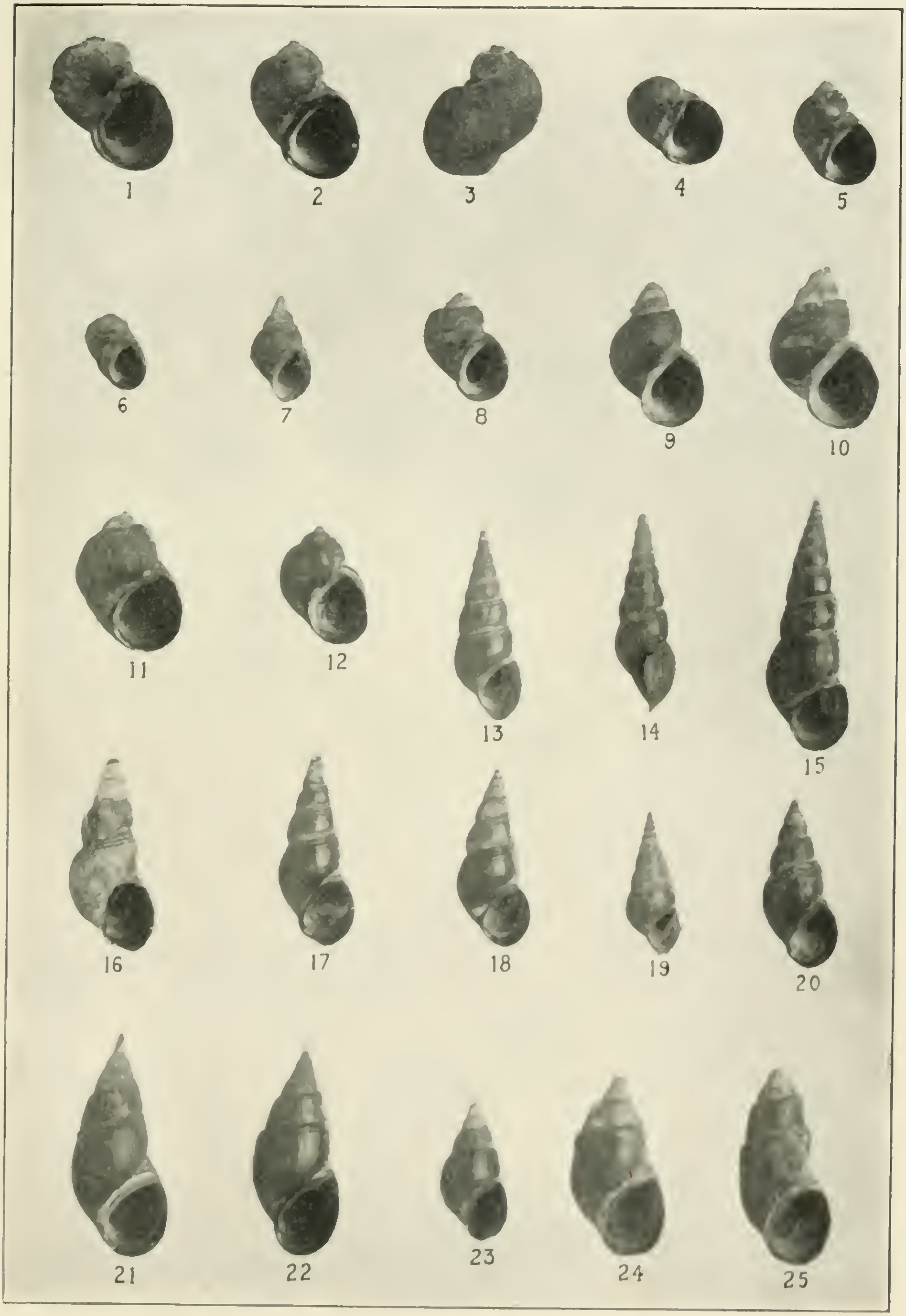


PILSBRY AND FERRISS MOLLUSCA OF SOUTHWESTERN STATES

PILSBRY AND FERRISS SONORELLA FROM THE RINCON MTS. ETC



PILSBRY AND HINKLEY MELANIIDÆ OF THE PANUCO RIVER.



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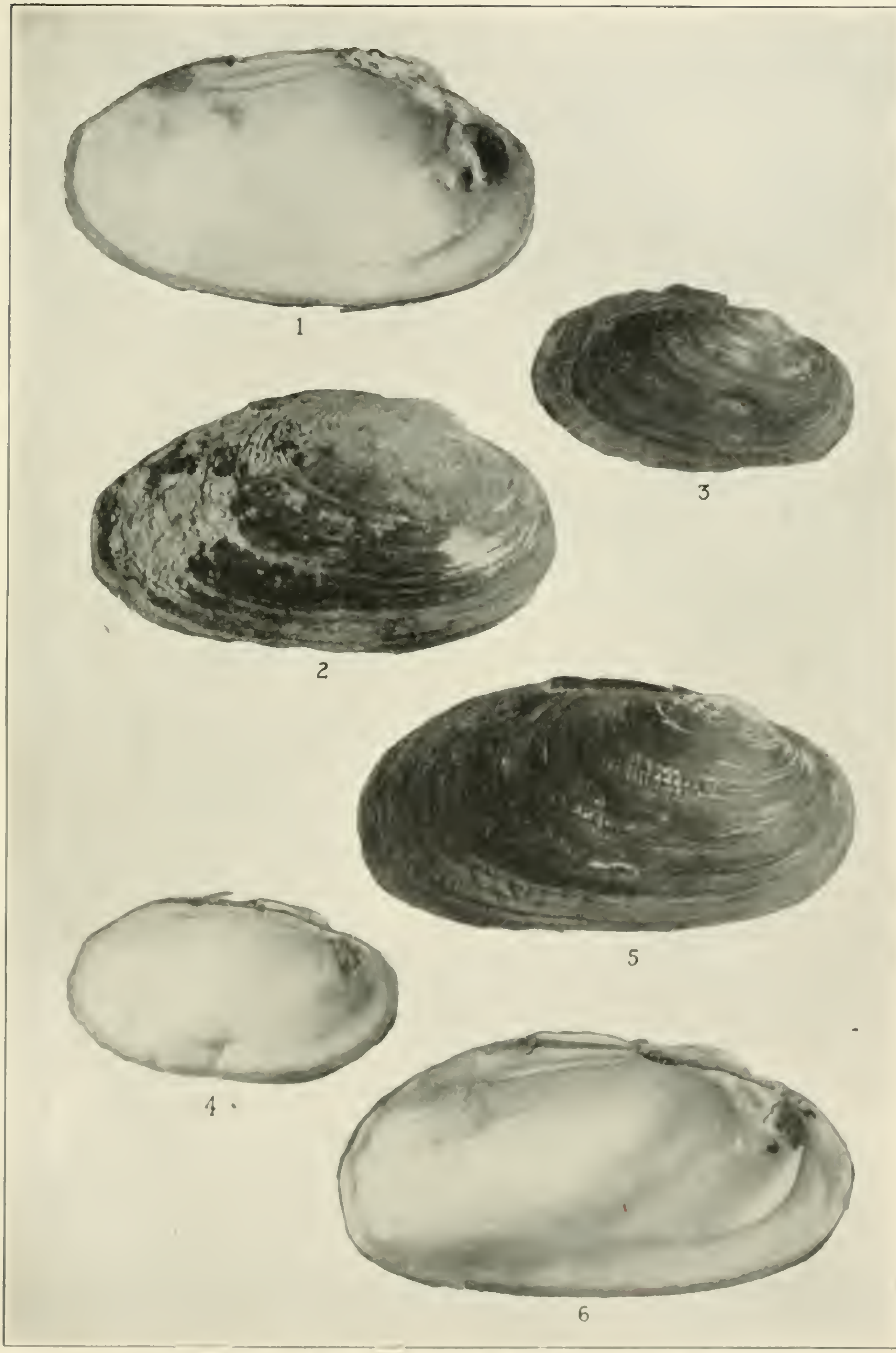

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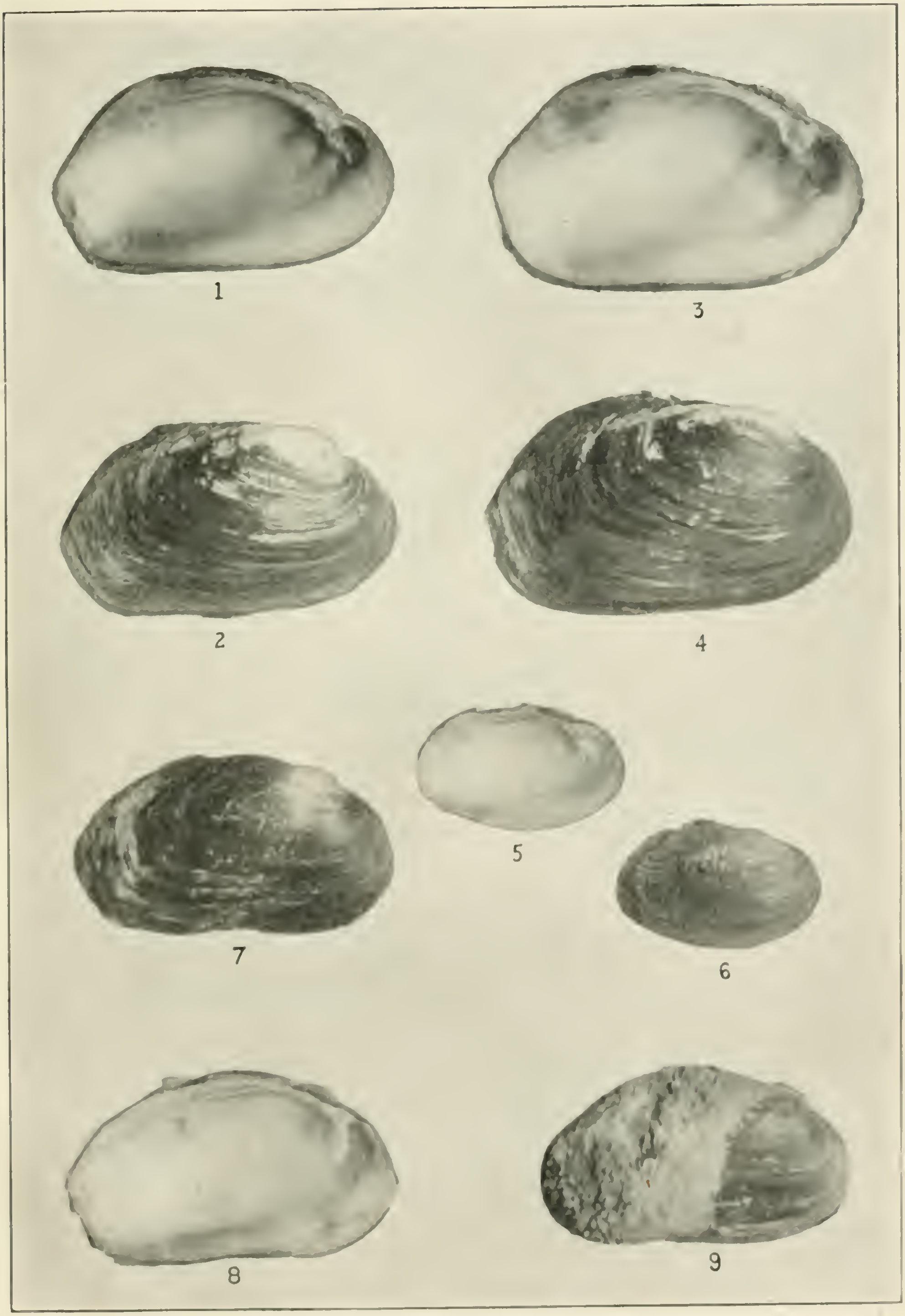

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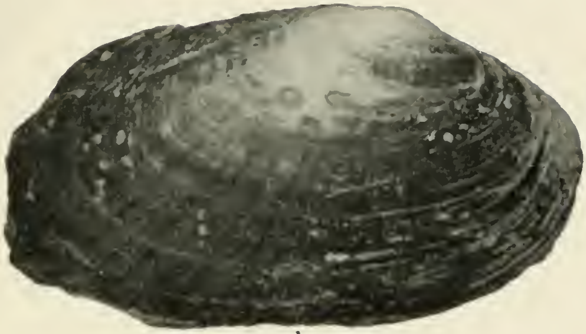
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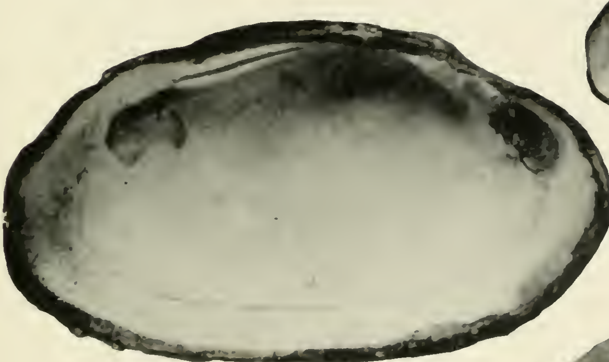
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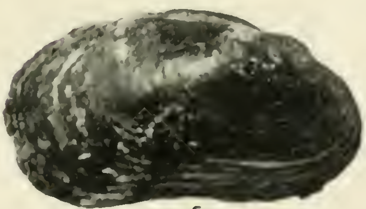
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PILSBRY: UNIONIDÆ OF THE PANUCO RIVER, MEXICO.