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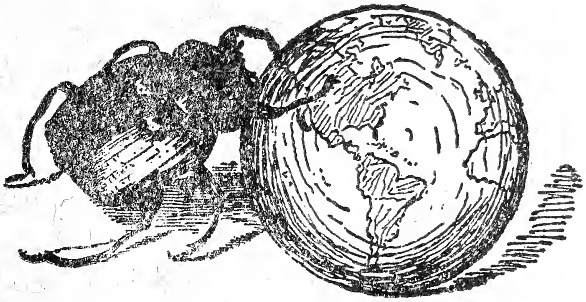
Editor Emeritus HARRY B. WEISS



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HARRY B. WEISS

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New York Entomological Society

Vol. LVIII March, 1950 No. 1

HONORARY MEMBER ELECTED

At the annual meeting of the New York Entomological Society, January 3, 1950, Mr. Harry B. Weiss was elected to honorary membership. He has also been appointed editor emeritus. The following tribute was read at the annual meeting.

In recommending that there be conferred upon Harry B. Weiss the distinction of honorary membership—the highest within the power of the New York Entomological Society to bestow—it is fitting to cast a brief glance over the varied and significant services rendered to our science by this distinguished fellow member. Through his labors in the field, and in the study, and in such posts of high executive responsibility as Chief Inspector of the New Jersey Department of Agriculture from 1916 to 1920, as Chief of the Bureau of Statistics and Inspection, and subsequently as Director of the Division of Plant Industry from 1920 until the present, he has left an inspiring record of accomplishment.

He has coped not only with the practical problems of entomology, keeping abreast with up-to-date knowledge and modern technique, but he has never permitted the past to be forgotten. With tireless industry he searched the record of earlier centuries and culled therefrom items of entomological interest. Sometimes these items were merely bizarre, tending to emphasize the vast advance that our science has made since the time when men accepted ingenious fancy for established fact. Much oftener, however, the product of Weiss's research tended to emphasize the continuity of effort over the years in building up, little by little, entomology as we know it today. Not only was he interested in entomology, he was also interested in entomologists. Studies such as he made of Thomas Say, Dru Drury, Jan J. Swammerdam, are cases in point. Yet in the aggregate he performed an even larger service in gathering information regarding a host of the lesser figures of entomology. By publishing accounts of them in his Pioneer Century of American Entomology and elsewhere, he gave these earlier workers, in a field that is today our heritage, their place in history.

Although Weiss used as channels of publication several of the leading scientific journals, and even in some cases printed his contributions privately, it was through the Journal of the New York Entomological Society above all others that he disseminated his researches. The members of this society will lastingly think of him not only as a brilliant contributor to our periodical but especially as its perfect editor, a role he carried with distinguished success for a quarter of a century.

When Weiss took over the editorship of our Journal in June 1924, he had been preceded by several able editors. William Beutenmuller had served in that capacity from 1893, when the publication was launched, through 1903. He was succeeded by Harrison G. Dyar, whose editorship extended from 1904 through 1907. In 1908 William Morton Wheeler assumed responsibility and conducted the Journal until 1913. From 1913 to 1915 the Journal was entrusted to a Publication Committee, but this divided responsibility terminated in 1916, and in that year and subsequently through 1919 the Journal appeared under the editorship of Charles Schaeffer. From 1920 to 1924, when Weiss took over the direction of the magazine, Howard Notman was the editor.

To all of these men who carried the responsibilities of editorship the Society owes a debt of gratitude, and yet, if one were to estimate the services of Harry B. Weiss merely in terms of years,—a quarter of a century compared with a decade in the case of his nearest rival—no one else could approach his long record of devotion. Yet it is not merely the length of his service that counts. His vigilance, his tact, his high editorial standards, his practical acumen that carried the Journal through the dismal years that followed 1929, through the trying period of the Second World War, and the perplexities of the present,—all of these qualities, in addition to his tireless labors in perfecting the contents of the Journal and making it as error-proof as possible, account for the fact that he occupies a place of almost unique distinction in our group. He has served the Society not only as Editor but as Vice President from 1921–1923 and again in 1941, and as President from 1923 to 1925 and again in 1942. It seems fitting that, as a culmination of his great contribution of thought and labor on behalf of the Society as well as his distinguished services to entomology in general, he be elected to honorary membership in our organization.—Herbert F. Schwarz.

SOME EARLY SCIENTIFIC JOURNALS THAT CARRIED ENTOMOLOGICAL PAPERS

Entomologists have always scattered their papers around in various magazines. There was some excuse for this in the early days before there were journals devoted exclusively to entomology. Many papers on natural history, including entomology appeared in the Transactions and Proceedings of the American Philosophical Society, but after the founding of the Academy of Natural Sciences of Philadelphia in 1812, less attention was paid to natural history by the Society. The short lived Transactions of the Society for the Promotion of Agriculture, Arts and Manufactures (Albany 1792–99); The Medical Repository (1797–1824); The Philadelphia Medical and Physical Journal; The American Monthly Magazine and Critical Review (1817–1819), with its section on natural science edited by C. S. Rafinesque; the Annals and Proceedings of the Lyceum of Natural History of New York, organized in 1817; the American Journal of Science which started in 1818; the Western Quarterly Reporter of Medical, Surgical and Natural Science to which Say contributed descriptions of new insects; the Boston Journal of Philosophy and the Arts, which carried descriptions of new species by T. W. Harris; and the Proceedings of the Maclurian Lyceum of Philadelphia (1827–1829) all carried papers on entomology.

The Journal of the Academy of Natural Sciences of Philadelphia first appeared in 1817 and in 1841 its Proceedings was started. The American Academy of Arts and Sciences, organized in Boston in 1779, began its Memoirs in 1785 and its Proceedings in 1848. With the formation of the Boston Society of Natural History in 1830, its natural history activities declined, but were revived in the fifties and sixties. To the Proceedings of the California Academy of Sciences, Dr. H. Behr was the only entomological contributor before 1866. The Entomological Society of Philadelphia was organized in 1859 and its first Proceedings appeared in 1861. In Canada there was the Canadian Naturalist and Geologist which was started in 1856, and previous to this the Canadian Journal of Industry, Science and Art, and in 1868 The Canadian Entomologist started on its long career.—H. B. W.

THE FIRST PHOTOGRAPHIC EXHIBIT OF THE NEW YORK ENTOMOLOGICAL SOCIETY

On March 15, 1949 the Program Committee of the New York Entomological Society sent a notice to all members informing them of the plans for a photographic exhibit to be held in the American Museum of Natural History during the week of May 15th to 23rd inclusive. Dr. Lucy W. Clausen, Dr. Roman Vishniac, and Dr. James Forbes were in charge of the exhibit.

It was realized that there was not too much time for preparation, and in most cases members would be submitting photographs which they already had on hand. More members responded with material than there was available space for the exhibition. The committee was very well pleased with the cooperation manifested by the members, and the time of the exhibition was extended to June 5th by the Museum.

Space was allotted for the exhibit at the first floor entrance of the Roosevelt Memorial wing of the Museum. The photographs were arranged on both sides of Beneker blocks in the center of the entrance hall. The exhibit was the first display to attract the visitors who used this entrance.

The following is a list of exhibitors and the titles of prints exhibited by each:

Mr. Albro T. Gaul

Female mosquito, *Aëdes canadensis*
Second instar larva of mosquito, *Anopheles punctipennis*
Dragon fly larva
Nymph of pentatomid bug
Moth and her eggs
Hornet larva, *Vespula maculifrons,* making pupal cup
Hornet, *Vespula squamosa,* removing a pupa from its cocoon
Tent caterpillar, 2nd and 3rd instar larvæ in tent
Tent caterpillar, adult recently emerged

Dr. Albert Hartzell

A series of twenty-four photographs of insect life and insect anatomy

Egg-mass of tent caterpillar
Nest of tent caterpillar
Cecropia larva
Cases of bagworm
Tracheæ of normal tomato horn worm
Tracheæ of tomato horn worm sprayed with soap and water solution, showing tracheal penetration
Cankerworm larva
Cecropia moth on cocoon
Larvæ of Io-moth
Larva of 17-year cicada, just hatched
17-year cicada, moulting
17-year cicada, moulting completed
Vector of peach yellows, male *(Macropsis trimaculata)*
Vector of peach yellows, nymph *(M. trimaculata)*
Vector of peach yellows, female *(M. trimaculata)*
Normal integument of meal worm
Integument of meal worm killed with pyrethrum
Japanese weevil
Normal cross-section of brain of meal worm
Cross-section of brain of meal worm killed with pyrethrum, note lesions
Holly leaf miner
Holly leaf miner, eggs
Mines produced by Holly leaf miner
Mines produced by Holly leaf miner, enlarged

Señor José Oiticica, Jr.* (Museu National, Rio de Janeiro, Brazil)

A series of six photographs of the genital apparatus of moths (photographs submitted by Dr. Richard Blackwelder)

Adelocephala purpurascens (Schaus)
Castnia fonscolombe (Godart)
Hepialus humuli (Linneaus)

* Señor Oiticica's picture, "Male Genitalia, ventral view, of *Citheronia mogya* (Schaus)," received honorable mention in the black and white division of the 3rd International Photography-in-Science Salon sponsored by THE SCIENTIFIC MONTHLY and the Smithsonian Institution during September 1949.

Phassus giganteus (Herr-Sch.)
Dysdæmonia lemoulti (Schaus)
Citheronia mogya (Schaus)

Mr. Cyril F. dos Passos
Four prints covering the unpublished life history of Polygonia gracilis

The egg shell
Mature larva
Chrysalis
Imago feeding on Everlasting (a grass)

Mr. Arthur Roensch
Head and antennæ of Cecropia moth
Praying mantes emerging from egg capsule
Eyed elater beetle, *Alaus oculatus*
Adult Cecropia moth

Dr. Theodore C. Schneirla
Four prints of army ants of Barro Colorado Island, Canal Zone

Nest cluster, bivouac, of a colony of *Eciton hamatum*, a tropical American army ant; vegetation cleared away around the bivouac in preparation for the capture of the colony queen
Close-up of outer wall of bivouac of *E. hamatum*
Bivouac of colony of *E. burchelli*, the swarm-raiding ant
Queen of *E. burchelli*, photographed after having been extracted from the nest of her colony during one of her regular but brief periods of egg production.

Dr. Ralph B. Swain
A series of three tempera and watercolor paintings by Susan N. Swain for THE INSECT GUIDE by Ralph B. Swain, (Doubleday and Co., June 1948)

Mr. Edwin Way Teale
Honey bee tapestry
Great spangled fritillary
Potato beetle
Foam castle—a frog-hopper making a mass of bubbles

Caterpillar hunter—a bug attacking a tent caterpillar
Milkweed trap—a fly caught in a slit trap of milkweed flowers
Insect pussywillows—cottony maple scale insects
Insect antlers—spread antennae of May beetle
Portrait of a white faced hornet
Robber fly, clinging to rose where it rested during night
Praying mantis
Crane fly

Dr. Roman Vishniac
Buffalo tree-hopper, nymph
Red-spotted purple butterfly (color print)
Aëdes ægypti, male (Kodachrome print)
Aëdes ægypti, female (Kodachrome print)
Aphis lion, larva devouring plant lice (color print)
Robber fly, catching a caterpillar (color print)
Jumping spider, poised to leap (color print)
Shield bug, stabbing a caterpillar (color print)
Click-beetle on wheat (color print)
Red aphids (color print)
Mexican bean-beetle on leaf (color print)
Leaf-hopper (color print)
Squash-bug (color print)
Katydid, feeding (color print)

As this note about the results of the 1949 exhibit goes to press, plans are already under way for a second, and more inclusive, exhibit. The fine cooperation of the members and the success of the first exhibit has encouraged the Society to lay plans for a larger and a more ambitious exhibition to be held during May 1950, again at the American Museum of Natural History.

THE COMMITTEE

THE GENUS EUARESTA IN THE UNITED STATES (DIPTERA: TEPHRITIDÆ)

BY BENSON F. QUISENBERRY
OKLAHOMA A. AND M. COLLEGE
STILLWATER, OKLAHOMA

INTRODUCTION[1]

No previous attempt has been made to bring together all the species of the genus *Euaresta* Loew that occur in the United States. It is the purpose of this paper, therefore, to present redescriptions of all the species, to attempt to establish more firmly the limits of the genus, and to offer a key and illustrations as aids in identification and separation.

Since Loew's (11) proposal of *Euaresta* a large number of species have been placed in the genus with much disagreement among authors as to the generic limits. Benjamin (1) in his study of the Tephritidæ of Florida gave a partial review of the literature concerning *Euaresta* and proposed a new subgeneric name, *Setigeresta,* for *æqualis* Loew. He also considered *Camaromyia,* a genus proposed by Hendel for *bullans* Wiedemann, as being a subgenus of *Euaresta.* In the same year Curran (7) proposed the inclusion of *Euaresta* under *Tephritis* citing the intergrading of the wing patterns as a basis for the synonomy, with a reduction of the brown color leading to *Tephritis.* Previous to this Cresson (6) had suggested that *Euaresta* be placed as a subgenus of *Tephritis,* but that plan was not followed in his paper. Only one key for the separation of the species occurring in the United States has appeared in the literature, and that being given by Phillips (12) in her study of the Tephritidæ of Northeastern America.

The writer wishes to express his sincere appreciation and thanks to the following persons for assistance given during this study: to Dr. F. A. Fenton under whose direction this study was carried out; to Dr. Alan Stone whose kindly interest, helpful

[1] A thesis submitted as partial fulfillment of the requirements for the degree Master of Science in Entomology at Oklahoma A. and M. College.

suggestions, criticisms, and valuable information concerning the Coquillett types have contributed much to this study; to Dr. J. Bequaert for making comparisons with certain of the Loew types; to Dr. C. H. Curran for information concerning the type of *jonesi;* to Ester Norman, reference librarian at the University of Kansas, for information concerning certain of the literature; to Dr. H. B. Hungerford and Dr. R. H. Beamer for their kind cooperation given the writer while studying the cotypes of *bellula* Snow in the Snow Entomological Collection; to Dr. M. T. James for many helpful suggestions and criticisms; and to the following institutions and individuals for the loan of material: the United States National Museum, the American Museum of Natural History, the California Academy of Sciences, Utah State College, Washington State College, Colorado A. and M. College, Texas A. and M. College, the University of Kansas, Kansas State College, the University of Nebraska, Stanford University, and Mr. S. C. Jones, Corvallis, Oregon.

THE ILLUSTRATIONS

Accuracy of proportion of the wings was obtained by the use of a sixteen millimeter projector. The wings were mounted on slides and from these images were focused directly on the drawing paper. The outlines of the veins and patterns were then traced and the details put in with the aid of a binocular microscope. The same procedure was used in preparing the drawings of the antennæ and palpi except that a drawing prism attached directly to a compound microscope was used in place of a projector in producing a magnified image. Drawings of the heads and male genitalia were made with the aid of a micrometer disc ruled in squares and coordinate paper.

SPECIES INCORRECTLY PLACED IN THE GENUS

Euaresta tricolor Doane, a specimen of which was kindly loaned by Dr. M. T. James, belongs to *Gymnocarena,* a genus proposed by Hering (9) for *diffusa* Snow.

The correct generic position of the following three Coquillett species is not known to the author: *Euaresta munda, Euaresta mundula,* and *Trypeta* (*Euaresta*) *californica.* The presence of but one pair of scutellar bristles, however, would exclude them from *Euaresta* as the genus is defined here. Specimens sent to Dr. Stone for comparison with the type of *munda* proved to agree closely with that species except that the legs were somewhat lighter than exhibited by the type. The genitalia of the males assigned to *munda* by the author do not possess the striations on the distal area as found in *Euaresta.*

Benjamin (1) placed *Euaresta pura* Loew and *Euaresta subpura* Johnson in *Tephritoides* a subgenus of *Trupanea.* Hering (10) places these species in *Tephritis* and the author is inclined to agree with this treatment.

Several authors have followed Coquillett (2, 3, 5,) in placing the following species in *Euaresta: Tephritis webbii* Doane, *Tephritis rufipennis* Doane, and *Trypeta* (*Euaresta*) *araneosa* Coquillett. A comparison of specimens of these species with the genotype of *Tephritis, arnicæ* Linnæus, has led the author to consider them congeneric.

Tephritis angustipennis (Loew) : This species, a true *Tephritis,* was placed in *Euaresta* by Phillips (12).

THE GENUS *EUARESTA* LOEW

Trypeta (*Euaresta*) Loew, Smithsn. Inst. Misc. Collect., 11 (256) : 296, 1873.

Euaresta Loew: Coquillett, Proc. U. S. Nat. Mus., 37 (1719) : 540, 1910. (Genotype, *Trypeta festiva* Loew).

Camaromyia Hendel, Wiener Ent. Ztg., 33 (3–4) : 95, 1914: (Dresden) K. Zool. u. Anthrop.—Ethnog. Mus Abhandl. u. Ber., Bd. 14, Nr., 3, 63, 1914. (Genotype, *Trypeta bullans* Wiedemann.)

Euaresta Loew: Phillips, Jour. N. Y. Ent. Soc., 31 (3) : 145, 1923.

Euaresta (*Camaromyia*) Hendel: Benjamin, U. S. Dept. Agr. Tech. Bul., (401) : 50, 58, 1934.

Euaresta (*Setigeresta*) : Benjamin, U. S. Dept. Agr. Tech. Bul., (401) : 50, 1934. (Subgenotype, *Trypeta æqualis* Loew).

Tephritis Latreille: Curran, Amer. Mus. Nov., (556) : 1, 1932; The families and genera of North American Diptera, Ballou Press, New York, p. 291, 1934. (in part)

Generic characters.—Head: Higher than long and wider than high; width of vertex across median ocellus usually slightly more than half the maximum head width, but occasionally slightly less; frons tapering anteriorly, varying from a nearly flattened to a quite tumid condition; face slightly concave; oral cavity rounded, drawn up anteriorly; eyes ovate; antennæ rather short, not extending beyond the oral margin (except occasionally in males of *bullans* (Wiedemann); second segment with a rather conspicuous median seta; arista very finely pubescent; palpi flattened, ventral margin somewhat convex; proboscis short, moderately fleshy; two pairs lower frontoorbitals;[2] two pairs upper frontoorbitals, the posterior pair weak; one pair strong ocellars; one pair inner verticals; one pair outer verticals which are shorter than inner pair, usually between one-third to two-thirds their length; one pair postverticals; postocular cilia rather stout, interspersed with some shorter setæ; genal bristle slender, inconspicuous.

Thorax: Dorsum, propleura, mesopleura, sternopleura, and pteropleura with short, flattened setæ; a small spot on each side below postalar bristle is black; scutellum flattened dorsally; two pair dorsocentrals, one pair near transverse suture and well ahead of a transverse line through supraalars, and one pair lying slightly ahead of a transverse line through intraalars; one pair intraalars; one pair humerals; one pair presutrals; one pair supraalars; two pairs notopleurals; one pair postalars; two pairs marginal scutellars,[3] one pair near apex, one pair near base; one pair mesopleurals; one pair pteropleurals; one pair sternopleurals.

Legs: Front femora with a row of strong setæ on ventral side and two somewhat parallel rows of shorter setæ laterodorsally; middle femora with a row of shorter setæ on anterior side that extend from near the base to about the center; hind femora with a few suberect, short setæ at apex dorsally; middle tibiæ each with one strong apical spur; hind tibiæ with a fringe of short setæ laterodorsally; front femora swollen in males.

[2] Two specimens, one each of the following species, *stigmatica* and *bellula*, were found to have a third bristle present on the left side only.

[3] One specimen of *bella* possessed an extra, though somewhat weaker, marginal bristle on the left side.

Wing: The dark design marked with rounded spots and marginal indentations which form a somewhat radiate pattern at apex; first posterior cell usually with a distinct bulla, but occasionally absent, variable; two strong costal setæ; first longitudinal vein strongly setose except on a short area below apex of auxiliary vein, third with scattered weak setæ on dorsal and ventral sides that are quite variable in size and number.

Abdomen: About equal in length with thorax; ovipositor sheath conical or flattened, tapering apically; male genitalia rather large, claspers stout and bearing two short teeth on either side on inner posterior surface (usually hidden in side view by the hoodlike extension of the apical ends of the claspers), conspicuously striated on either side of anal area.

Benjamin (1) separated *Camaromyia* and *Setigeresta* from *Euaresta* s. str. by the lack of a bulla in the first posterior cell in the case of *Camaromyia,* and by the presence of a knob at the junction of the second and third veins, a definitely bristly third vein, and the lack of a bulla in the first posterior cell in the case of *Setigeresta.*

Evidence gained in a study of one hundred and ninety-two specimens of *æqualis* has shown that the number and size of setæ found on the third vein is subject to much variation. The extent of variation ranged from those individuals in which no evidence of setæ could be found, to those in which the vein was definitely setose. A comparable condition was found to exist in specimens of *festiva.* In general the remaining species included in this study exhibited a lesser number of setæ on the third vein, but here again the number was found to be quite variable.

The enlargement at the junction of the second and third veins seemed to offer no basis for the separation of *æqualis* from the other species. The same enlargement was found in the others but with the exception of *festiva* was somewhat more difficult to ascertain, probably due to the smaller size of the individuals.

The series of specimens of *æqualis* revealed one (a female from Three Rivers, California, August 5, 1940 (E. E. Kenega), in the Snow Entomological Collection at Kansas University) in which there was a small but conspicuous bulla in the third posterior cell of the left wing only. No trace of a bulla was found in those specimens of *bullans* which were examined, while the remaining six species were found to have a definite bulla present in most cases. This character was quite variable in *tapetis,* however, and in many specimens of this species the bulla was completely absent.

The structure of the ovipositor sheath was found to vary quite markedly between a flattened and a conical condition. Females in each species studied showed a wide range of variation between these two conditions. In most cases the tendency seemed to be towards a conical condition and it is probable that in these cases the flattened condition was due to the effect of drying or perhaps the stage at which the insect was killed.

The structure of the head revealed remarkable variations (Fig. 1, C–G). In a profile view *æqualis* and *tapetis* appear much the same in general outline but the broad cheeks and parafacials of the former distinguishes that species. While the frons of *tapetis* are normally quite tumid, individuals were found in which the character was so reduced that the head appeared much as that shown in the figure of *festiva.* The tumid condition of the frons in *æqualis* is normally more pronounced than is shown in the figure. In *bullans* the frons usually bulges somewhat beyond the eyes anteriorly and the face is somewhat more receding than found in the other species. The structure of the heads of the remaining species conform more to that shown in the figure of *festiva* except for *stigmatica* (Fig. 1, D) which has the frons slightly more flattened.

The structure of the male claspers (Fig. 1, A–B) shows a series of conspicuous, oblique striations on the distal surface that will serve to set this group apart from otherwise closely related genera. The whole external genitalia are large and conspicuous and except for size seemed to vary but little in general structure in all of the species examined.

The structure of the arista and the presence of but one subhyaline spot at the apex of the submarginal cell in *bullans* are in contrast to the typical condition of *Euaresta.* However, the possession by the males of the peculiarly constructed genitalia leads the author to refrain from removing that species from the genus.

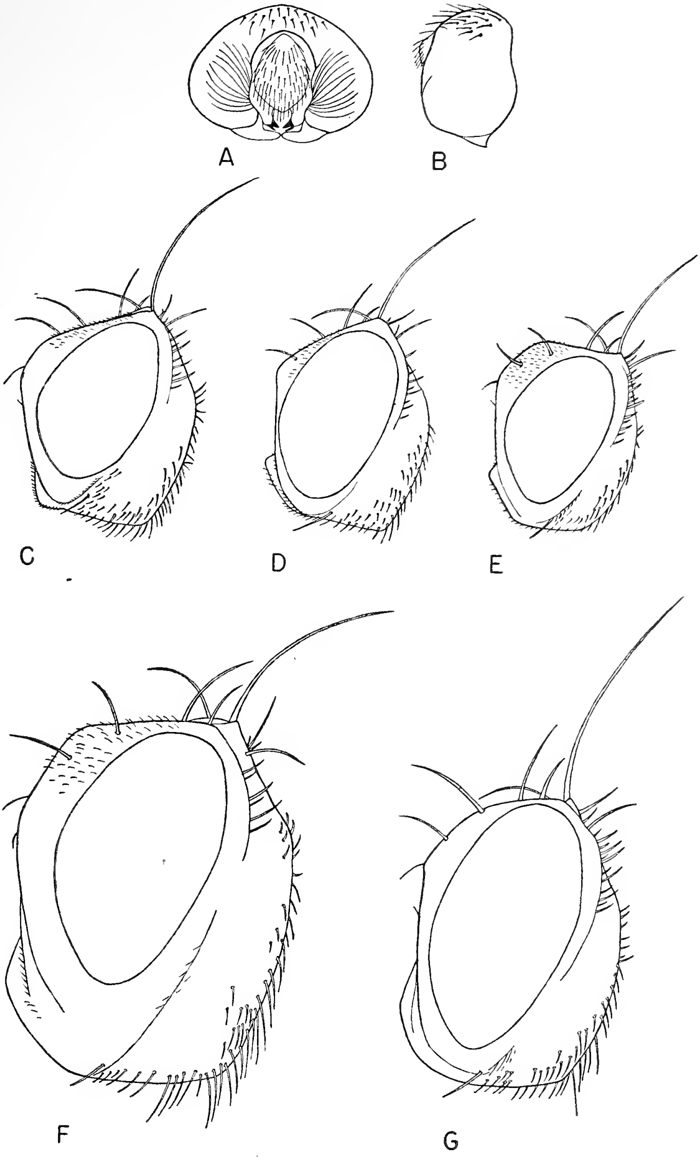

Figure 1. A, Male genitalia of *E. festiva* (anal view); B, male genitalia of *E. festiva* (side view); C, head of *E. bullans* (side view); D, head of *E. stigmatica* (side view); E, head of *E. tapetis* (side view); F, head of *E. æqualis* (side view); G, head of *E. festiva* (side view).

KEY TO THE SPECIES OF *EUARESTA* FOUND IN THE UNITED STATES

1—Thorax mainly yellow in ground color 2
—Thorax mainly black in ground color (this color is often nearly obscured by the whitish or yellowish pollen) 3
2—Width of cheek at least twice width of third antennal segment; whitish spot at apex of first posterior cell separated from wing margin by a distinct brown band .... *æqualis* (Loew)
—Width of cheek about width of third antennal segment; whitish spot at apex of first posterior cell broadly joined to wing margin *festiva* (Loew)
3—First posterior cell without a bulla; arista brownish at apex, yellowish at base, with central portion distinctly whitish *bullans* (Wiedemann)
—First posterior cell usually with at least a small bulla, if bulla absent then arista is brown with a yellowish base 4
4—Wing with a narrow brownish band that extends posteriorly from costa, at a point midway between humeral crossvein and apex of auxiliary vein, to apex of sixth vein and a single large whitish spot crossing submarginal cell at anterior apex of small crossvein *tapetis* (Coquillett)
—Wings without such markings 5
5—Whitish spot, in submarginal cell, above and slightly apicad of small crossvein, broadly joined to whitish area crossing marginal cell at apex of first vein 6
—Whitish spot, in submarginal cell, above and slightly apicad of small crossvein, never broadly joined to whitish area crossing marginal cell at apex of first vein, but usually separated by at least a narrow margin 7
6—First basal cell with a large, subapical, nearly quadrate, whitish spot that extends completely across cell and joins broadly to third vein. *jonesi* Curran
—First basal cell with a large, rounded, subapical spot that is separated from third vein by at least a narrow margin, when this margin is so narrow as to cause doubt then the rounded condition will distinguish it .... *bellula* Snow
7—Wing rather narrow, width about half or less than half the distance from humeral crossvein to apex; usually with a clearly defined brownish spot near center of stigma; ovipositor sheath of female at least 0.62 mm. in length[4] .... *stigmatica* Coquillett
—Wing rather broad, width more than half the distance from humeral crossvein to apex; stigma never with a median brownish spot; ovipositor sheath of female at most 0.52 mm. in length. *bella* (Loew)

[4] Lengths of the ovipositor sheath as given in this study represent measurements taken dorsally from the dry specimen.

DESCRIPTION OF SPECIES[5]

Euaresta æqualis (Loew)

Trypeta æqualis Loew, Smithsn. Inst. Misc. Collect., 6 (1) : 86, tab. 2, fig. 20, 1862.

Trypeta (*Euaresta*) *æqualis* Loew, Smithsn. Inst. Misc. Collect., 11 (256) : 308, tab. 10, fig. 20, 1873.

Tephritis æqualis (Loew) : Coquillett, Jour. N. Y. Ent. Soc., 7 (2) : 264, 1899.

Tephritis gemella Coquillett, Jour. N. Y. Ent. Soc., 10 (4) : 181, 1902. (new synonomy).

Ensina æqualis (Loew) : Snow, Kans. Univ. Sci. Bul., 2 (5) : 219, 1903.

Camaromyia æqualis (Loew) : Hendel, (Dresden) K. Zool. U. Anthrop.-Ethnog. Mus. Abhandl. u. Ber., Bd. 14, Nr. 3, 63, 1914.

Euaresta (*Setigeresta*) *æqualis* (Loew) : Benjamin, U. S. Dept. Agr., Tech. Bul., (401) : 50, 1934.

Head (Fig. 1, F) : Width 1.14–1.88 mm., width of vertex across median ocellus 0.66–1.06 mm., length of antennæ 0.39–0.53 mm.; yellow, subshining, paler on lower half of occiput, lunula and face; usually with very thin whitish pollen except on frontale and vertex; cheeks very broad, at least twice width of first antennal segment, usually much wider; frons tumid; antennæ yellow, first segment with pale setæ, that on second yellowish brown to blackish, variable, third (Fig. 3, H) ; arista dark brown with yellowish base; palpi (Fig. 3, K) pale yellowish, tips darker, with pale yellow setæ basally and dark brown ones apically; proboscis yellow to brownish yellow, labellum with mixture of pale yellow and pale brownish hair; bristles yellowish.

Thorax: Mesonotum 1.54–2.66 mm. long; yellow in ground color, subshining, covered with a fine whitish to dull yellow pollen, often a spot on each side, mesad of presuturals, and a narrow area laterad of dorsocentrals is dark yellow to yellowish orange; the short flattened setæ are whitish, pale yellow, or some-

[5] A description of the structure of the palpus and third antennal segment is not given in the descriptions of the species. The details of these are to be found in fig. 3. The figures attempt to show the normal condition of the structures as encountered in this study, however, some variation does occur.

times with reddish tint, sparse on scutellum; scutellum usually with dark spots at basal corners, but these are occasionally absent, variable; bristles yellowish.

Legs: Wholly yellow except for front femora of males which usually have a large dark brown or black subdorsal stripe (in one male from Nampa, Idaho, 2489 feet, July 17, 1944 (W. E. Shull), this stripe is purplish); with thin whitish pollen; the setæ pale yellow to yellowish brown except for a few very short black ones on tarsi of middle and hind legs.

Abdomen: Wholly yellow, subshining, usually somewhat paler on hind margins of tergites, occasionally with dark markings on tergum, or venter, or both, often with small, dark, central spot on second tergite; with thin whitish to yellowish pollen; the short, flattened setæ whitish to pale yellow except ones on hind margin of apical tergite which are yellowish brown, that on venter fine and much shorter than on tergum; ovipositor sheath 1.06–1.76 mm. long, dark yellow, black at apex, shining, with scattered, fine, pale yellow setæ; male claspers very conspicuous, yellow, with fine brownish setæ.

Wings (Fig. 2, H): Length 4.00–6.10 mm.; brown with milky white spots and marginal indentations, darkest along anterior margin; whitish spots have tendency to become confluent and are quite variable in size; the two subapical whitish spots in discal cell are usually joined so as to form one large spot; number of setæ on third vein quite variable; first posterior cell usually without a bulla, however, rarely a faint one may be present; halteres pale yellow.

Type localities.—Of *æqualis,* Illinois, of *gemella,* Las Vegas and Hot Springs, New Mexico.

Type of *æqualis,* in the Museum of Comparative Zoology; of *gemella,* in the United States National Museum.

Food plant.—*Xanthium* sp.

Distribution.—A common and widespread species. Previously recorded from Alabama, California, Colorado, District of Columbia, Idaho, Illinois, Indiana, Iowa, Kansas, Maryland, Minnesota, Nebraska, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, Virginia, and Washington. Specimens examined in this study were from the following localities—ARKANSAS: Scott County. CALIFORNIA: Onyx; Winters; Three Rivers; Big Clear Lake; Lake County; Riverside; Costa Mesa; San Diego; Stockton; Palo Alto. COLORADO: Trinidad; Grand Junction; Maybell; Canon City; Colorado Springs; Roggen; Springfield; Agate; Sterling; Fruita. IDAHO: Lewiston; Deer Field. ILLINOIS: Chicago. IOWA: Webster City; Ames. KANSAS: Atchison County. MISSISSIPPI: Oxford. MONTANA: Whitehall. NEBRASKA: Lincoln; Broken Bow; War Bonnet Canyon; Glen; South Sioux City; Omaha. NEW JERSEY: Salt Meadows; Newark. NEW MEXICO: "Southeast of Raton." NEW YORK: Babylon; Irving; N. Evans; East Aurora; Lancaster. OHIO: Summit County. OKLAHOMA: Stillwater; Shattuck; Optima. OREGON: Prineville; Nyssa; Nampa. PENNSYLVANIA: Philadelphia. UTAH: Roy; Syracuse; Kaysville; Taylor; Tremonton; Sunset; Dry Lake; Duchesne; Spanish Fork; Moab; Ogden; Logan Canyon; Vernal; Myton; Springfield; Blue Creek. VIRGINIA. WASHINGTON: Coulee City; Wawawai. WISCONSIN. WYOMING: Cody; Buck Creek. Early May to late September.

One hundred and ninety-two specimens of this species were examined in this study.

A specimen of *æqualis* was sent to Dr. Stone for comparison with the type of *gemella* and the two were found to be identical. While this synonomy has apparently been recognized previously by other workers a published account of it has not been found by the author.

Euaresta festiva (Loew)

Trypeta festiva Smithsn. Inst. Misc. Collect., 6 (1): 86, tab. 2, fig. 21, 1862.

Trypeta (*Euaresta*) *festiva* (Loew), Smithsn. Inst. Misc. Collect., 11 (256): 309, tab. 10, fig. 21, 1873.

Euaresta festiva (Loew): Coquillett, Proc. U. S. Nat. Mus., 37 (1719): 540, 1910. (designated genotype).

Head (Fig. 1, G): Width 0.95–1.55 mm., width of vertex across median ocellus 0.48–0.78 mm., length of antennæ 0.34–0.45

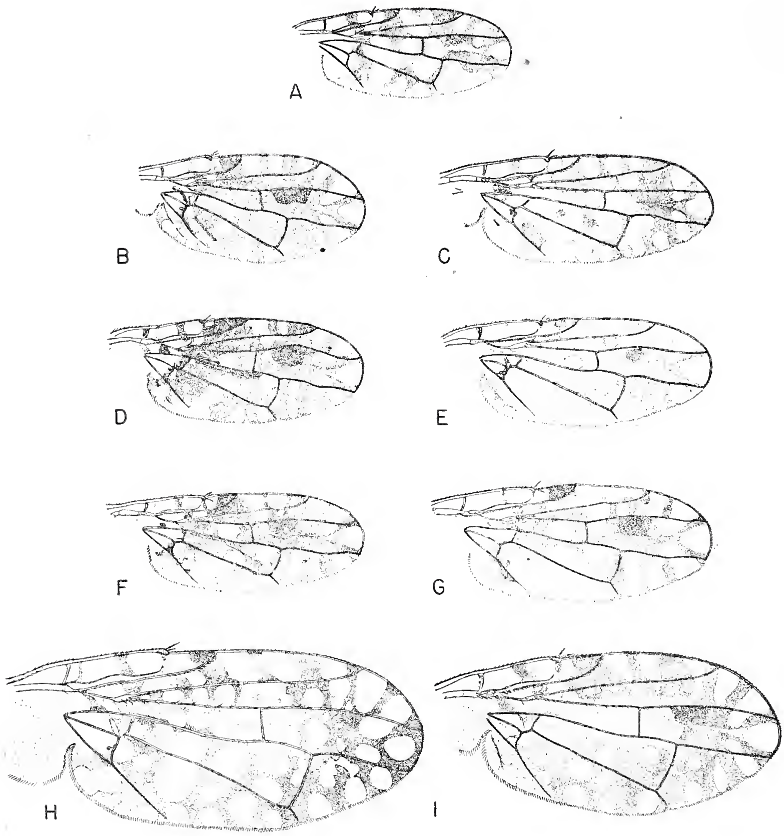

Figure 2. Wings of species of *Euaresta*. A, *E. tapetis;* B, *E. bella;* C, *E. bullans;* D, *E. bellula;* E, *E. stigmatica;* F, *E. jonesi;* G, *E. jonesi;* H, *E. æqualis;* I, *E. festiva*.

mm.; yellow, paler on lower half of occiput, cheeks, face, parafacials and parafrontals; with dull yellow pollen on upper half of occiput, and whitish to pale yellow on remaining areas, except frontale which is bare; antennæ yellow, first segment with pale yellow setæ, second with yellowish brown, third (Fig. 3, E); arista brown with yellowish base; palpi (Fig. 3, L) pale yellow, with pale setæ basally and brown ones apically; proboscis dark yellow, labellum with pale yellowish hair; lower frontoorbitals, anterior pair of upper frontoorbitals, ocellars, inner verticals and genal yellowish brown, remaining bristles and short setæ pale.

Thorax: Mesonotum 1.04–2.07 mm. long; wholly yellow except for a small, dark spot, on either side of scutellum at basal corners, which may or may not be present, variable, and the usual dark spot behind wing base; densely golden yellow pollinose except on upper half of postnotum which is bare (occasionally propleura, sternopleura, and fore half of mesopleura somewhat whitish); the short, flattened setæ pale yellow, sparse on scutellum; bristles yellowish brown except for posterior notopleurals, sternopleurals, and pteropleurals which are pale.

Legs: Wholly yellow; all coxæ and the front femora whitish pollinose, rather thin on latter; the setæ pale yellow to brownish.

Wings (Fig. 2, I): Length 2.88–4.84 mm.; pale to dark brown with milky white spots and marginal indentations; stigmal markings variable as follows: wholly whitish except for a brownish subtriangular spot on costal margin, wholly brownish except for a basal whitish spot, a basal and a subapical whitish stripe each of which crosses the cell completely, or marked as shown in the figure; that portion of apical whitish stripe in marginal cell that extends into submarginal cell often divided in latter; occasionally two small, faint spots present, one on either side of small crossvein next to the third vein; occasionally a small whitish spot may be present either apicad or basad of large subapical whitish spot in first basal cell; bulla in first posterior cell sometimes faint in those specimens in which brownish color is rather pale; the setæ on third vein quite variable in number and size; halteres yellow.

Abdomen: Wholly yellow, except for occasional dark markings on venter, subshining, with very thin pale yellow pollen; tergum with short, fine brownish setæ, that on hind margin of apical tergite longest; venter with very fine, pale yellow setæ; ovipositor sheath 0.78–1.29 mm. long, flattened or conical, yellow, brownish yellow, or occasionally dark brown, the apex black; with fine yellowish brown setæ; male claspers yellowish to dark brown, shining, with fine yellowish brown setæ.

Type locality.—Pennsylvania.

Type in the Museum of Comparative Zoology.

Food plant.—Unknown.

Distribution.—Previously recorded from Connecticut, Illinois, Kansas, Minnesota, Nebraska, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Dakota, and Virginia. Specimens examined in this study were from the following localities—ARKANSAS: Polk County. COLORADO: La Porte. IOWA: Iowa City. ILLINOIS: Chicago. KANSAS: Douglas County; Osborne County; Smith County. KENTUCKY. NEBRASKA: South Sioux City; Omaha; Sowbelly Canon; Sioux County; Phillips; Brookings. NEW YORK: New York City; Flushing; Ithaca. OHIO: Summit County. VIRGINIA: Charlottesville; Great Falls. WYOMING: Lusk. Early June to late August.

One hundred and ten specimens of this species were examined during this study including two females and one male labeled, "homotype, compared by S. C. Harriot."

Euaresta tapetis (Coquillett)

Trypeta (*Euaresta*) *tapetis* Coquillett, Canad. Ent., 26: 75, 1894.
Euaresta tapetis (Coquillett), Kans. Univ. Sci. Bul. 2 (5): 219, 1903. (lapsus).

Head (Fig. 1, E): Width 0.81–1.18 mm., width of vertex across median ocellus 0.42–0.62 mm., length of antennæ 0.27–0.34 mm.; front usually quite tumid, but occasionally only slightly so, variable; frontale yellow to yellow orange; face, parafrontals, parafacials and cheeks usually pale yellow; lunule whitish to pale yellow; ocellar triangle and a somewhat V-shaped spot on upper half of occiput black, with cinereous pollen, this color also forming a narrow stripe on each side of ocellar region to upper frontoorbitals; antennæ yellow, first and second segments with pale setæ, third (Fig. 3, D); arista brown with yellowish base; palpi (Fig. 3, M) pale yellow to yellow, with short, pale setæ basally and brownish ones apically; proboscis yellowish brown, labellum with pale hair; lower frontoorbitals, anterior pair of upper frontoorbitals, ocellars, inner verticals, and genal yellowish, remaining bristles and short setæ pale.

Thorax: Mesonotum 0.90–1.40 mm. long; black except for following yellowish areas: humeri, notopleura, propleura, prosternum, mesopleura except for large, central, dark spot that extends upward from sternopleural suture, wing base, scutellum (sometimes marked with blackish at base), and upper half of postnotum (occasionally wholly dark); cinereous pollinose on dark areas, this color occasionally replaced with yellowish on dorsum; yellowish areas with pale yellow to thin cinereous pollen except on upper half of postnotum which is bare; rather thinly covered with short, flattened, pale yellow (occasionally reddish) setæ that are densest on dorsum, usually absent on scutellum, longest on propleura and sternopleura; bristles on dorsum yellowish, those on pleura pale.

Legs: Wholly yellow, with whitish pollen on front femora and all coxæ, densest on latter; coxæ and femora of front pair of legs with whitish setæ, that on remainder of legs pale yellowish except for some brownish intermixed on tibiæ and tarsi of middle and hind legs.

Wings (Fig. 2, A): Length 2.60–3.61 mm.; brown with milky white spots and marginal indentations; two or three spots in marginal cell between apices of first and second veins, variable; spot in apex of submarginal cell, two spots lying just before large marginal spot in first posterior cell, and apical spot in second posterior cell often uniting to form a narrow subapical band; first posterior cell usually with a small inconspicuous bulla which is quite often absent; second posterior cell usually with three narrow spots, basal pair often uniting to form one, or occasionally all three uniting as figured; two or three large spots in discal cell, variable; whitish band crossing wing from apex of auxiliary vein to apex of sixth vein often interrupted by brownish color filling base of submarginal cell; halteres yellow.

Abdomen: Wholly shining yellow except as follows: occasionally with brown or black markings on anterior portion of tergites, and a dark brown, nearly black, central spot on first sternite; with very thin cinereous pollen; setæ pale yellow, longest laterally and on hind margin of apical tergite; ovipositor sheath 0.36–0.52 mm. long, shining brown or black, variable, with very short, fine, brownish setæ; male claspers mainly dark brown, occasionally yellowish dorsally, with fine, short, yellowish brown setæ.

Type locality.—New Mexico.

Type in the United States National Museum.

Food plant.—Unknown.

Distribution.—Previously recorded from Colorado, Kansas, and New Mexico. Specimens examined in this study were from the following localities. COLORADO: Roggen; La Porte; Boulder County; Fort Collins; Canon City; Grand Junction; Colorado Springs; Palisade; Maybell. IDAHO: Bliss Wieser. KANSAS: Morton County. NEW MEXICO: Espanola; Albuquerque; Las Vegas; Jemex Springs. OREGON: Hood River. UTAH: Lusk; Clinton; Myton; Knab; West Point; Provo; Ogden; Duschene; Zion National Park; Moab; Bothwell; Cornish. FLORIDA: Yankeetown. Dr. Stone has furnished the following additional locality—WASHINGTON: Wawawai (one specimen in the U. S. National Museum). Early June to late August.

Fifty-eight specimens were examined including a female compared with the type by Dr. Alan Stone.

This species appears to be closest to *bullans* (Wiedemann) in regards to the wing structure and pattern, but shows rather marked differences in the head characteristics.

Euaresta bullans (Wiedemann)[6]

Trypeta bullans Wiedemann, Auss. Zweifl. Ins., 2, p. 506, 1830.

Euaresta adspersa Coquillett, Invertebrata Pacifica, 1: 30, 1904. (new synonomy).

Camaromyia bullans (Wiedemann): Hendel, Wiener Ent. Ztg., 33 (3–4: 95, 1914.

[6] The description of the head and thoracic bristles of *bullans* will serve for the remaining species also and thus are not repeated.

Tephritis wolffi Cresson, Ent. News, 42 (1) : 5, 1931. (new synonomy).

Euaresta (*Camaromyia*) bullans (Wiedemann) : Benjamin, U. S. Dept. Agric. Tech. Bul., (401) : 50, 58, 1934.

In this synonomy only those proposed species that appear to occur in the United States are listed.

Head (Fig. 1, C): Width 1.06–1.26 mm., width of vertex across median ocellus 0.56–0.67 mm., length of antennæ 0.39–0.45 mm.; mainly white or pale yellow; frontale dark yellow to yellow orange, this color often extending posteriorly on to occiput; ocellar triangle and a pair of elongate spots on occiput, which extend diagonally towards inner verticals and are often united at occipital foramen to form V-like structure, black; pollen mainly whitish, that on upper half of occiput usually mixed with dull yellow; both sexes with first antennal segment whitish or pale yellow and second yellowish brown, third segment in female usually slightly darker than second, in male (Fig. 3, F) black except for brownish base; apical half of arista black and very slender, the more thickened basal half white except for extreme base which is yellowish; palpi (Fig. 3, P) very pale yellow, tip usually somewhat darker, with short, pale setæ that are occasionally intermixed with a few brownish ones at apex; proboscis mainly pale yellow, labellum darker, with fine, pale hair; lower frontoorbitals, anterior pair of upper frontoorbitals, ocellars, inner verticals, and genal brown; remaining bristles and short setæ pale.

Thorax: Mesonotum 1.23–1.62 mm. long; black in ground color except for following yellowish areas: humeri, prosternum, scutellum, and upper half of postnotum; propleura, notopleura, and fore part of mesopleura yellowish or dark, variable; with rather dense cinereous pollen on dark areas, this color occasionally somewhat obscured on dorsum with yellowish, except at extreme anterior region of prescutum, that on pale areas mostly yellowish; with short, flattened, yellowish setæ which are denser on dorsum, those on lower pleural areas somewhat whitish; bristles brown except for posterior notopleurals, sternopleurals, and pteropleurals which are pale.

Legs: Yellow, coxæ paler; with thin grayish pollen which is densest on coxæ; the setæ mainly whitish and pale yellow, with some brownish intermixed on tibiæ and tarsi.

Wings (Fig. 2, C): Length 2.91–3.86 mm.; dark brown with large milky spots and marginal indentations as figured; halteres yellow.

Abdomen: Yellow, subshining, first to fifth tergites marked with black on anterior half, this color usually most pronounced laterally, with pale yellow and whitish setæ which are longest on lateral margins and on hind margin of apical segment; cinereous pollinose; venter yellow, anterior half of sternites blackish, with a brown shiny spot on first visible sternite; thinly cinereous pollinose; with very fine pale setæ; ovipositor sheath 0.64–0.73 mm. long flattened or conical, color variable, usually black, often brown, or a combination of brown or black, with pale setæ (as found on abdomen) on basal three-fourths dorsally and ventrally, apex bare or with very fine, short setæ; male claspers yellow, occasionally marked with brown laterally, with fine pale setæ.

Type locality.—Of *bullans*, Montevideo, Uruguay; of *adspersa*, Stanford University, Palo Alto, California; of *wolffi*, Pomona and Visalia, California.

Type of *adspersa* in the United States National Museum; of *wolffi*, in the Academy of Natural Sciences at Philadelphia; of *bullans*, in the Naturhistorisches Museum at Vienna, Austria.

Food plant.—Unknown.

Distribution.—Previously recorded only from California, as *adspersa* and *wolffi*. Specimens examined in this study were from the following localities. CALIFORNIA: Alhambra; Salinas; Lower Lake, Clear Lake; San Joaquin County; Monterey; Los Angeles; Santa Clara County; Redondo Beach. Late April to early September.

In addition to the above localities material was examined from —CHILE. BRAZIL: Rio de Janeiro. URUGUAY. AUSTRALIA: Botany Bay and Illawarra, New South Wales.

Twenty-nine specimens of this species were examined in this study including a female compared with the type of *adspersa* by

Dr. Alan Stone, and a female compared with the females in the type series of *wolffi* by Dr. E. T. Cresson, Jr.

Two females (Alhambra, California, 6–3–1919 (R. E. Campbell), in the United States National Museum) were sent, one to Dr. Alan Stone, and one to Dr. E. T. Cresson, Jr. for comparison with the types of *adspersa* Coquillett and *wolffi* Cresson respectively. In each case the specimens being compared were found to be in good agreement with the types, with Dr. Cresson stating that the female received by him was identical with the females in the type series of *wolffi*. Since both these specimens agree with each other in every respect there seems to be no reason for doubting that *wolffi* and *adspersa* are the same species. The specimens, from the localities outside the United States, received from Dr. Stone and Dr. Hering and which are determined as *bullans* Wiedemann, are identical with the above mentioned females from Alhambra, California. Those received from Hering were determined by him while those from Stone bear determination labels of Kertesz, Bezzi, Malloch, and Stone. A comparison of the wing patterns of the Alhambra females with the figure of *bullans* as given by Hendel (8) revealed that they were identical. In addition these specimens were found to agree quite well with the description of *bullans* as given by Hendel. With such evidence at hand there seems no reason to doubt that *adspersa* and *wolffi* are actually *bullans*.

Euaresta jonesi Curran

Euaresta jonsi Curran, Amer. Mus. Nov., (526): 9, Fig. 7, 1932.

Head: Width 1.01–1.18 mm., width of vertex across median ocellus 0.56–0.64 mm., length of antennæ 0.34–0.39 mm.; mainly pale yellow, frontale dark yellow, a spot on upper half of occiput and ocellar triangle black; occiput and ocellar triangle with cinereous and dull yellow pollen intermixed, this color forming a narrow stripe on either side of ocellar triangle to upper fronto-orbitals; antennæ yellow (second segment occasionally with dark marks laterally), first two segments with short, brown setæ, third (Fig. 3, B); arista brown with yellowish base; palpi (Fig. 3 N) pale yellow, with whitish setæ basally and brownish ones apically;

proboscis yellow, with fine yellowish hair; oral margin occasionally with a few brownish setæ anteriorly.

Thorax: Mesonotum 1.15–1.60 mm. long; black in ground color except for humeri, upper half of postnotum, and tip of scutellum which are yellowish; covered with cinereous pollen which is often thinly intermixed with dull yellow on dorsum, mesopleura, and notopleura; dorsum with short, flattened, pale yellowish setæ which extends only sparsely onto scutellum, a few at extreme anterior region of prescutum and those on humeri and pleural areas more whitish.

Legs: Brownish yellow, outer side of front femora darkest, front and middle coxæ usually marked with black; coxæ, femora, and tibiæ cinereous pollinose, densest on front and middle coxæ; setæ on coxæ and front femora whitish, that on remainder of legs varying from yellowish to brown.

Wings (Fig. 2, F–G): Length 2.97–3.58 mm.; dark brown, with milky white spots and marginal indentations which are quite variable in size and are often confluent; the variations shown in the figures were found in specimens from both the De Lake, and Sand Lake areas; the small whitish area shown in apex of the marginal cell (Fig. 2, F) is also present in the paratype examined in this study; there is often a small yellowish spot near apex of stigmal cell in addition to spot at base; halteres pale yellow.

Abdomen: Shining brownish yellow except as follows: apical two tergites of females usually marked with brown, males with first and fifth tergites dark brown to black; the short, flattened setæ on lateral margins and whole of anterior two tergites pale yellow, that on remaining tergal areas brownish to black; venter yellowish, subshining, with small, shiny brownish spot on first visible sternite; cinereous pollinose; with fine, pale yellow setæ; ovipositor sheath 0.78–1.00 mm. long, flattened or conical, shining black, with fine brownish setæ; male claspers shining black, with very fine brownish setæ.

Type locality.—De Lake, Oregon.

Type in the American Museum of Natural History.

Food Plant.—*Franseria* sp. (= *Gærtneria*).

Distribution.—Previously recorded only from the type locality.

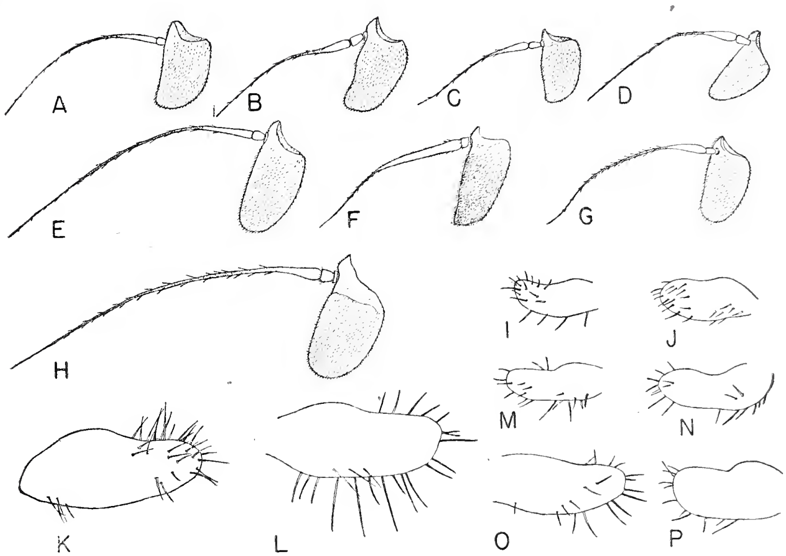

Figure 3. A through H, showing third antennal segment; I through P, showing palpus, of species of *Euaresta*. A, *E. stigmatica;* B, *E. jonesi;* C, *E. bellula;* D, *E. tapetis;* E, *E. festiva;* F, *E. bullans;* G, *E. bella;* H, *E. æqualis;* I, *E. bellula;* J, *E. bella;* K, *E. æqualis;* L, *E. festiva;* M, *E. tapetis;* N, *E. jonesi;* O, *E. stigmatica;* P, *E. bullans.*

Specimens examined during this study were from the following localities. OREGON: De Lake; Sand Lake, Tillamook County. WASHINGTON: Westport. Early June to late August.

Twenty specimens of this species were examined in this study including one of the paratypes which was kindly loaned by Dr. C. H. Curran.

This species is closest to *bellula* Snow, differing, in addition to the characters indicated in the key and the figures, by having a somewhat longer ovipositor sheath.

Euaresta bellula Snow

Euaresta bellula Snow, Kans. Univ. Quar., 2 (3): 172, January, 1894.

Trypeta (*Euaresta*) *stelligera* Coquillett, Canad. Ent., 26 (3): 74, March, 1894. (new synonomy).

Head: Width 0.62–1.18 mm., width of vertex across median ocellus 0.34–0.64 mm., length of antennæ 0.22–0.35 mm.; mainly pale yellow, frontale dark yellow, occasionally narrowly brownish next to lunula; lunula whitish to pale yellow; a large spot on upper half of occiput and occasionally a portion of the lower half, usually a small spot directly behind postverticals, and ocellar triangle black; whole of occiput and ocellar triangle with cinereous and dull yellow pollen intermixed, this color forming a narrow stripe on either side of ocellar triangle to upper fronto-orbitals; antennæ yellow, second segment often marked with faint dark spots, first segment with pale setæ, that on second dark, third (Fig. 3, C); arista dark brown with yellowish base; palpi (Fig. 3, I) pale yellow, with pale setæ basally and dark brown ones apically; proboscis brownish yellow with fine, pale yellow hair; oral margin occasionally with a few short brownish setæ anteriorly.

Thorax: Mesonotum 0.67–1.48 mm. long; subshining, black in ground color except for apex of scutellum which is yellowish; humeri and a narrow area extending ventrally, upper half of postnotum, and notopleura yellowish or dark, variable; covered with cinereous pollen, that on dorsum, notopleura, and a spot on mesopleura, usually intermixed with, or occasionally nearly replaced by, yellowish; the short, flattened setæ are usually whitish but occasionally are yellowish or tinged with reddish, variable.

Legs: Color quite variable, but mainly yellow; coxæ wholly yellow or with dark markings; femora occasionally marked with brown or black as follows: front femora on posterior side except at apex, and middle and hind femora ventrally on basal half; coxæ and femora cinereous pollinose, densest on former; setæ of coxæ and front femora whitish to pale yellow, that on remainder of legs yellowish brown to brown except for a few on tarsi of middle and hind legs which are nearly black.

Wings (Fig. 2, D): Length 1.85–3.53 mm.; brown with milky white spots and marginal indentations; occasionally there is a small whitish spot at apex of marginal cell; large round whitish spot in first basal cell not reaching third vein; whitish spots in discal cell varying from one to four; whitish spots in second posterior cell variable in size, usually two or three in number, or often joined to form one large spot; with or without a small pale brownish spot on alula; halteres pale yellow.

Abdomen: Subshining, varying from bright yellow to brownish yellow in ground color, and usually variously marked on dorsum with brown or black, at least one or more of tergites showing these colors in all cases and especially in the males in which the apical segment was found without exception to be marked with some dark brown or black; thinly whitish to grayish pollinose; venter colored much as on dorsum except first sternite always with median dark brown spot; the setæ on dorsum varying from pale yellowish to dark brown, that on lateral margins usually wholly pale, that on venter very fine and pale to light brownish; ovipositor sheath 0.50–0.90 mm. long, brown or black, flattened or conical, with short, fine, brownish yellow to brown setæ; male claspers dark brown to black, occasionally paler dorsally, with fine brownish setæ.

Type locality.—Of *bellula,* Arizona; of *stelligera,* Southern California.

Type of *stelligera* in the United States National Museum; of *bellula* in the Snow Entomological Collection at the University of Kansas. The cotype series of *bellula* is composed of one male and three females as opposed to the information given by Snow (14).

Food plant.—Unknown.

Distribution.—Previously recorded from Arizona, California, and Oregon. Specimens examined in this study were from the following localities. ARIZONA: Tucson; Douglas; Baboquivari Mountains; Prescott; Chiricahua Mountains; Chiricahua National Monument; Bill Williams Fork. CALIFORNIA: Santa Cruz; San Onofre; San Francisco; San Diego; Carmel; Mulege Baja; Ventura; Huntington Beach. NEW MEXICO: Cloudcroft; Magdalena; Ruidoso. WASHINGTON: Puyallup; "Whidby I."; Seattle. Early May to early September.

One hundred and forty-one specimens of this species were examined during this study including a male compared with the type of *stelligera* by Dr. Alan Stone.

The cotypes of *bellula* were examined and a male specimen that agreed well with the males of the cotype series was sent to Dr. Stone to be compared with the type of *stelligera*. Dr. Stone considered the specimen to agree very closely with the type of *stelligera* except for the number of whitish spots in the discal cell. Since this character has proven to be quite variable it does not seem to be significant. Also in answer to a question concerning the glabrous condition of the abdomen of *stelligera* as originally described by Coquillett (2), Dr. Stone has written, "Coquillett was apparently using glabrous in the sense of polished or he was not using enough power, since the type shows abundant fine hair on the abdomen." In addition, the coloration of the abdomen has been found to be so variable as to be of no significance in attempting to separate the species in question. With the above information at hand it seems necessary to treat *stelligera* as a synonym of *bellula*.

Certain structural differences were noted, in addition to the color variations mentioned in the descriptions, namely the narrower condition of the cheeks and the somewhat less elongate ovipositor tip in the females from Arizona and New Mexico. These differences seemed, however, to be more of a degree of variation than of sharp divergence. Further examination of a longer series in addition to a study of the biology may, however, reveal this to be a complex of more than one species.

Euaresta stigmatica Coquillett

Euaresta stigmatica Coquillett, Jour. N. Y. Ent. Soc., 10 (4): 180, 1902.

Head (Fig. 1, D): Width 0.84–1.06 mm., width of vertex across median ocellus 0.36–0.50 mm., length of antennæ 0.26–0.36 mm.; mainly yellow, face, cheeks, parafacials, and parafrontals paper; lunula whitish; ocellar triangle, occiput, except for upper and lower margins, black, densely cinereous pollinose; sometimes a small brownish spot is present at base of postverticals; antennæ brownish yellow, first segment with pale setæ, second with brownish, third (Fig. 3, A); arista dark brown with yellowish base; palpi (Fig. 3, O) pale yellow, with pale yellow setæ basally and brownish ones apically; proboscis brownish yellow, with fine pale hair; oral margin occasionally with a few short brownish setæ anteriorly.

Thorax: Mesonotum 0.90–1.48 mm. long; black in ground color except for humeri, anterior margin of mesopleura, occasionally a small portion of notopleura, and apex of scutellum which are tinged with brownish yellow, and upper half of postnotum which is pale yellow; mainly cinereous pollinose (a few specimens showed a tendency for pollen on dorsum to be dull yellow) often with an inconspicuous, pale brownish spot on mesopleura; the short, flattened setæ whitish, pale yellow, or reddish, variable.

Legs: Yellow to brownish yellow; cinereous pollinose, densest on coxæ and femora; setæ on coxæ and front femora whitish, that on front tibiæ and tarsi, and middle and hind legs pale yellow and brownish intermixed.

Wings (Fig. 2, E): Length 2.80–3.64 mm.; brown pattern with milky white spots and marginal indentations; brown spot in stigma varying in size, occasionally crossing cell entirely (one specimen with stigma wholly dark); first posterior cell often with a few small spots in addition to large ones near apex; spots in discal cell variable but usually with three large ones arranged as figured; basal spot in second posterior cell may be divided so as to form two spots; halteres yellow.

Abdomen: Shining yellow, dorsum marked with brown or black as follows: fifth tergite in male dark brown to black on anterior half or more, tergites one to four of males and all tergites of female occasionally irregularly marked with brown, this color usually on anterior margin of tergites; dorsum with pale yellow setæ which are usually intermixed with some brownish except on tergites one and two, longest on lateral margins and on posterior margin of apical segment; with very thin cinereous pollen; venter with short whitish setæ; a small spot on first visible sternite is brownish; cinereous pollinose; ovipositor sheath 0.62–0.84 mm. long, flattened or conical, dark brown or black, variable, with very fine brownish setæ that are densest basally; male claspers dark brown to black, with very fine pale setæ.

Type locality.—Flagstaff and Williams, Arizona.

Type in the United States National Museum.

Food plant.—*Franseria acanthicarpa* (Hook) Coville.

Distribution.—Previously recorded from Flagstaff and Williams Arizona, type series. Specimens examined in this study were from the following localities. ARIZONA: Tucson; Mesa; Bill Williams Fork; Chiricahua Mountains; Flys Peak, Cochise County; Oak Creek Canyon; Mustang Mountains; Santa Rita Mountains; Coconino County. CALIFORNIA: San Jacinto Mountains; (Famosa?); Palmdale; Whitewater; Big Bear Lake; Onyx. NEW MEXICO: Espanola; Mesilla; Magdalena. UTAH: Zion National Park; Pintura. Early June to early December.

Sixty-nine specimens of this species were examined in this study including a male compared with the type by Dr. Alan Stone.

This species is close to *bella,* differing in the characters indicated in the key and by the figures.

Euaresta bella (Loew)

Trypeta bella Loew, Smithsn. Inst. Misc. Collect., 6 (1) : 88, pl. 2, fig. 23, 1862.

Trypeta (*Euaresta*) *bella* (Loew), Smithsn. Inst. Misc. Collect., 11 (256) : 311, pl. 10, fig. 23, 1873.

Euaresta (*Euaresta*) *bella* (Loew) : Benjamin, U. S. Dept. Agr. Tech. Bul., (401) : 50, fig. 35, 1934.

Head: Width 0.67–1.20 mm., width of vertex across median ocellus 0.31–0.59 mm., length of antennæ 0.22–0.36 mm.; face, cheeks, parafacials and parafrontals usually pale yellow (occasionally whitish), frons, vertex and occiput darker yellow; ocellar triangle and a V-shaped mark on upper half of occiput black; occiput and ocellar region with cinereous and dull yellow pollen intermixed, this color forming a narrow stripe (often hardly distinguishable) on either side of ocellar triangle to upper fronto-orbitals; antennæ yellow, third segment often tinged with brownish, first with pale setæ, second with dark, third (Fig. 3, G); arista black with yellowish base; palpi (Fig. 3, J) mainly pale yellow, apex darker, with pale yellow setæ basally and brownish ones apically; proboscis yellow with pale yellow hair.

Thorax: Mesonotum 0.78–1.57 mm. long; ground color black except for following yellowish areas: humeri, notopleura, a narrow area above front pair of coxæ that extends upward to humeri (occasionally obscured by cinereous pollen), wing base, upper half of postnotum, and apex of scutellum; heavily cinereous pollinose on dark areas, yellow pollinose on light areas (except for upper half of postnotum which is bare) this color usually extending over upper half of mesopleura, dorsum and scutellum so as to nearly obscure cinereous appearance; the short, flattened setæ, whitish to pale yellow; one specimen (a female from Oak Creek Canon, Arizona, 6,000 feet, August (F. H. Snow), in the Snow Entomological Collection at Kansas University) has an additional, rather pale, bristle on left margin of scutellum.

Legs: Yellow to brownish yellow; coxæ heavily whitish to grayish pollinose, femora thinly so; coxæ and front femora with whitish setæ (occasionally a few in ventral row of latter are yellowish), those on remainder of legs mostly brownish with some yellowish intermixed.

Wings (Fig. 2, B): Length 3.02–3.81 mm.; brown with milky white spots and marginal indentations; whitish stripe across basal area of stigmal cell usually slightly wider than shown in figure; whitish area across apex of marginal cell occasionally divided so as to form two spots; a small, round, whitish subbasal spot is present in submarginal cell of one specimen (a male from Douglas County, Kansas, in the Snow Entomological Collection at Kansas University); whitish spots in discal cell vary from two to five in number with the usual condition as figured; occasionally a small whitish spot in base of first posterior cell; halteres yellowish.

Abdomen: Shining yellowish to brownish yellow in ground color, with dark markings on tergal areas as follows: female—tergites five and six each with two dark brown to blackish spots, those on sixth usually confluent and nearly covering whole of tergite, those on fifth quite variable in size, remaining tergites with or without dark markings, variable; male—apical tergite usually wholly dark brown or black except for a small, yellowish, spot on hind margin, occasionally dark marking is reduced to a spot at each anterolateral corner; preceding tergites with or without dark markings, variable; setæ mainly whitish to pale yellow that on hind margin of apical tergite brownish, longest laterally and on hind margins of tergites; pollen thin, whitish, and usually discernible only on dark areas; venter yellowish, first sternite with dark brown, shiny spot, remaining sternites often marked with some darkish; thinly whitish pollinose; with pale yellow setæ; ovipositor sheath 0.45–0.52 mm. long, shining black, flattened or conical, with very fine, short, pale brownish setæ; male claspers brown or black, with fine, pale brown setæ.

Type locality.—Washington and New York.

Type in the Museum of Comparative Zoology.

Food plant.—Unknown.

Distribution.—A common and widespread species. Previously recorded from District of Columbia, Florida, Georgia, Illinois, Iowa, Kansas, Michigan, Minnesota, Nebraska, New Hampshire, New Jersey, New York, North Carolina, South Dakota, Tennessee, Texas, Washington and Wisconsin. Specimens examined in this study were from the following localities: ARIZONA: Oak Creek Canon; "Southern Arizona." DISTRICT OF COLUMBIA. COLORADO: Boulder; La Porte; Fort Collins. CONNECTICUT: New Haven. FLORIDA: Lower Matecumbe Key; Orlando. ILLINOIS: Chicago; Calumet. KANSAS: Lawrence; Leavenworth County; Douglas County; Decatur County; Norton County; Republic County; Atchison County; Harvey County; Doniphan County; Smith County; Coffee County; Osborne County; Trego County; Onaga; Mitchell; Fort Logan; Riley County. MAINE: Orono. MASSACHUSETTS: Riverside; Auburndale; Greenfield; Belmont. MISSISSIPPI: Pass Christian. NEBRASKA: Lincoln; Glen; Sand Hills; War Bonnet Canyon; South Sioux City. NEW JERSEY: Riverton. NEW YORK: Washington Heights; Lancaster; Irving; Crugers; Boston; N. Evans; Ithaca; New York City; Rochester; Babylon. NORTH CAROLINA: "Black Mountains"; Franklin. OHIO: Summit County. PENNSYLVANIA: Swarthmore; Dupont; Philadelphia. SOUTH DAKOTA. TENNESSEE: Knoxville. TEXAS: Donna; Brazoria County; Hidalgo County. UTAH: King's Station; Springville; Spanish Fork. WISCONSIN: Milwaukee. WYOMING: Lance Creek; Lusk. Early March to early October.

Two hundred and forty-seven specimens were examined including a female compared with the type by Dr. Joseph Bequaert.

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TWENTY-FIVE WEEVILS IN ONE SEED

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The amazing number of twenty-five large brown Bruchidæ (6–7 mm.) were packed into a seed, similar to the one photographed, of a diameter of one inch. The seed is from the vine *Mucuna rostrata* Benth., and is called locally Ojo de Venado (Deer's Eye), no doubt because of its size and warm brown color. It was collected by Charles M. Bogert of the American Museum of Natural History on his recent trip to Honduras in April, 1949, on the Rio Yeguaré, at the Hacienda San Francisco, in Morazan Province.

The Bruchid was kindly identified by H. S. Barber as *Caryedes faldermanni* Mannerheim, which at one time was considered a synonym of *C. brasiliensis* Thunberg, a more southern species. Both species were formerly in the genus *Pseudopachymerus*, formerly *Bruchus*.

When dug out of the seed, the Bruchids unfolded their legs and ran about quickly, some attempting to fly. One, sex unknown, did fly off and escape. Of the remaining twenty-four exactly half proved to be males. The male has a small prominence, or pimple, on the pygidium just above the middle, which is lacking in the female. The insects were covered with particles of what was left of their habitation. The walls of the seed, as would be expected from such a numerous brood, had been eaten quite thin and the partitions between each individual's cavity were no thicker than tissue paper.

The photograph, posed with a relaxed insect, was taken by John C. Pallister of the American Museum of Natural History.

THE LINNÆAN SUBGENERIC NAMES OF PHALÆNA (LEPIDOPTERA, HETEROCERA)

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In 1758 in the tenth edition of the "Systema Naturæ" Linnæus established seven subdivisions of the genus *Phalæna,* which he named *Bombyx, Noctua, Geometra, Pyralis, Tortrix, Tinea* and *Alucita.* On page 496 is a key to the divisions, which would seem to establish the names of the divisions as available and of subgeneric value. However, in 1936 the International Commission on Zoological Nomenclature promulgated Opinion 124, the summary of which states: "The various Subdivisions of genera published by Linnæus in 1758 are not to be accepted as of this date (1758) as of subgeneric value under the International Rules." Basically, Opinion 124 is inadequate, for although it settled certain troublesome problems, it created uncertainty and confusion in other groups in which the names of the Linnæan subdivisions had been long accepted and well established. Apparently the Commission recognized this possibility, for it stated a willingness to take up individual cases in those groups in which the Opinion produced greater confusion than uniformity. There appears to be no logical way of "stretching" Opinion 124 to cover the works of Linnæus subsequent to 1758, and even if that were done there would still remain the problem of determining the status of the Linnæan names used by other authors. Inasmuch as the Commission made no reference to the status of the Linnæan "subgeneric" names in any work later than 1758, although it must have been aware of at least some of them, it appears necessary to consider in detail the use of the various names subsequent to 1758, both by Linnæus and by the authors that immediately followed him. Discussions, in chronological sequence, of the various works, which have a bearing on this problem are as follows:

1760—Langius, J. J.: "Caroli Linnæi Systema Naturæ. . . . Editionem Decimam. . . ." I do not consider this a separate work, merely another printing of the original Tenth Edition, and not entitled to separate recognition nomenclatorially.

1761—Linnæus, C.: "Fauna Suecica", Second Edition. In this work the seven subdivisions of *Phalæna* are used in the same sense as in 1758. If the names were accepted from this work, five of the seven would fall readily into their customary and recognized usages, while two, *Bombyx* and *Pyralis,* would be used in unfamiliar associations. If we are to maintain the traditional usage of *Bombyx* as the generic name of the silk moth, it will be necessary to petition the International Commission on Zoological Nomenclature for a suspension of the Rules. Without doubt all workers in Entomology would agree to this action, as there is perhaps no other name which has had the amount of literature built up around it as *Bombyx mori.* This action will be necessary, regardless of the author or the work from which the name is dated, because Blanchard designated *Phalæna Bombyx quercus* Linnæus as the type of the genus in 1845 (Histoire des Insectes, vol. 2, p. 373). This same species is the type of *Lasiocampa* Schrank 1802, the type of the Family Lasiocampidæ. There is an earlier selection of *Phalæna Bombyx pavonia* Linnæus as the type by Latreille in 1810 (Considérations Générales sur l'Order Naturel des Crustacés, des Arachnides et des Insectes, p. 441). This I do not regard as valid, as I think it is excluded from consideration by the wording of the summary of Opinion 136 of the International Commission. Some workers accept the instances in which the word "ejusdem" was used by Latreille as falling within the meaning of "one only of the species included in the genus by the original author thereof." This particular point was one of the three questions submitted to the Commission on the 1810 Latreille type designations, but no answer was given. If *Pyralis* is accepted from this date, the type designation of Curtis in December 1834 (British Entomology, vol. 11, p. 527) will be valid, as the species selected, *barbalis,* is included. This species was not included in *Pyralis* in 1758; it was not described until the following year by Clerck. Earlier Curtis had said, ". . . , it will be better to take the first species of Linnæus as the type, . . ." (British Entomology, vol. 6, p. 288, 1829). Near the end of February 1834 Stephens (Illustrations of British Entomology, Haustellata, vol. 4, p. 25) quoted Curtis' statement of 1829 and pointed out that the first species placed in *Pyralis* in 1758 was *farinalis* and that the first species placed in *Pyralis* in 1761 was *tentacularis*. Stephens thus gives us an idea of the ambiguity of Curtis' initial attempt to fix the type of *Pyralis*. Unfortunately Stephens did not at that time (February 1834) clearly designate a type for *Pyralis*, though criticizing Curtis for not doing so, and when he finally designated *farinalis* as the type of *Pyralis* in January 1835 (Illustrations of British Entomology, Haustellata, vol. 4, p. 395), his action was antedated by Curtis' citation of *barbalis* as type.

1761—Poda von Neuhaus, N.: "Insecta Musei Graecensis, . . ." I can find no evidence as to which work appeared first in 1761, this or the Second Edition of the Fauna Suecica. However, if the names are used from this work, only three could be used in their traditional usages and four, *Bombyx, Geometra, Tortrix*, and *Alucita*, would be used in unfamiliar associations.

1762—Linnæus, C.: "Systema Naturæ", Eleventh Edition. This is a reprint of the Tenth Edition, and is said to abound in errors, but to have been recognized by Linnæus as another edition of his work. I have not seen it, but I assume that it will not differ from the Tenth Edition. Thus if the names were used from this date, they would have the same application as if used from 1758.

1763—Scopoli, J. A.: "Entomologia Carniolica . . ." The subgeneric names are used in the plural at the head of sections of the genus *Phalœna*. If plural names were to be accepted, the names would be available from this work.

1764—Linnæus, C.: "Museum Ludovicæ Ulricæ". In this work four of the names proposed in 1758 are used, namely *Bombyx, Noctua, Geometra*, and *Pyralis*. If these names were to be used as dating from this work, they would come to be applied in senses wholly foreign from any in which they have been used.

1767—Linnæus, C.: "Systema Naturæ, Editio Duodecima Reformata". The Twelfth Edition of the Systema Naturæ is similar in construction to the Tenth Edition. All the names proposed as subdivisions of *Phalœna* in 1758 recur in the same sense in this work with the addition of one more, *Attacus*. As in 1758, a key to the divisions of *Phalæna* is given (page 809). If the names were used from this work they would have the same application as 1758.

1770, 1773 and 1782—Drury, D.: "Illustrations of Natural History," vols. 1, 2 and 3. The subdivisions are used in an abbreviated form in this work, and are thus unrecognizable without reference to previous usage. If the names should be used from this work, none could be applied in the accepted sense, as this work deals with non-European species.

1775—Fabricius, J. C.: "Systema Entomologiæ." From all the available evidence it appears that this work of Fabricius appeared earlier in the year 1775 than the "Ankündung eines systematischen Werkes von den Schmetterlingen der Wiener Gegend". In his autobiography Fabricius says that his "Systema Entomologiæ" appeared at Easter time in 1775[1]. The Denis and Schiffermüller work was not reviewed until December 8, 1775[2], in the Jenaische Zeitungen von Gelehrten Sachen. The "Systema Entomologiæ" is the first work in which the names appear in a strictly generic sense. If the names are accepted from this work, considerable confusion will arise. Fabricius used *Pyralis* for the species which Linnæus placed in *Tortrix,* placing the species which Linnæus had under *Pyralis* along with those he had under *Geometra* in *Phalæna,* and suppressing the Linnæan names *Geometra* and *Tortrix.* In addition he employed *Alucita* of Linnæus for part of *Tinea* of Linnæus and for *Alucita* of Linnæus he used *Pterophora* of Geoffroy. If *Noctua* in the insects is dated from this work, it will fall as a homonym of *Noctua* Gmelin (1771) in the birds.

1775—Denis and Schiffermüller: "Ankündung eines systematischen Werkes von den Schmetterlingen der Wiener Gegend." Like Fabricius' work the names are used in a strictly generic sense. If the names were accepted from this work, the same situation would be met with as would obtain in accepting the names from the Fauna Suecica.

[1] Julius Schuster, Linné und Fabricius zu Ihrem Leben und Werk, p. 102, 1928. (Facsimile.)

F. W. Hope, Trans. Ent. Soc. Lond. 4: Appendix, 1845–47. (Translation of Fabricius' autobiography.)

[2] L. B. Prout, Ann. Mag. Nat. Hist. (ser. 7) 6: 159, 1900.

Following is a discussion of each of the names with the citations of all pertinent genotype designations.

ATTACUS

Phalæna Attacus Linnæus, Systema Naturæ, ed. 12, vol. 1, pt. 2, p. 808, 1767. 17 included species.

Type designations:

Phalæna Bombyx atlas Linnæus, 1758 = *Attacus atlas* (Linnæus)

Designated by [Duponchel], *in* d'Orbigny, Dictionnaire Universal d'Histoire Naturelle, vol. 2, p. 320, 1842.

Phalæna Bombyx pavonia major = *Bombyx pyri* Schiffermüller = *Attacus pyri* (Schiffermüller)

Designated by Blanchard, Histoire des Insectes, vol. 2, p. 372, 1845.

Cramer in 1779 (Papillons Exotique, vol. 1, p. 12) uses *Attacus* in the same manner as Linnæus for the single species, *atlas*. The first use of *Attacus* in a strictly generic sense is by Germar 1810 (Systematis Glossatorum Prodromus, sect. 1, p. 9). I have not been able to consult this work, and I am unable to determine the included species. This name does not fall within the wording of Opinion 124.

BOMBYX

Phalæna Bombyx Linnæus, Systema Naturæ, ed. 10, p. 495, 1758. 58 included species.

Type designations:

Phalæna Bombyx pavonia Linnæus, 1758 (as: Bombyx pavonia Fab.; ejusd. *B. quercus, mori* etc.) = *Bombyx pavonia* Linnæus.

Designated by Latreille, Considérations Générales sur l'Ordre Natural des Crustacés, des Arachnides et des Insectes, p. 441, 1810. (See the discussion of this under "1761—Linnæus, C.: 'Fauna Suecica' ")

Phalæna Bombyx quercus Linnæus, 1758 = *Bombyx quercus* Linnæus.

Designated by Blanchard, Histoire des Insectes, vol. 2, p. 373, 1845.

Phalæna Bombyx mori Linnæus, 1758 = *Bombyx mori* Linnæus.

Designated by [Blanchard], *in* Cuvier, Le Règne Animal, Disciples Edition, Insectes, pl. 151, 1846.

Should the Latreille type designation be considered valid, then *Bombyx* would fall in the Saturniidae and would be isogenotypic with *Heræa* Hübner, 1806 and 1822, with type *Bombyx carpini* Schiffermüller = *Phalæna Bombyx pavonia* Linnæus = *Heræa pavonia* (Linnæus) and with *Eudia* Jordan, 1913, with type *Bombyx pavonia* Linnæus = *Eudia pavonia* (Linnæus). If the 1845 type designation of Blanchard is accepted as final, *Bombyx* will replace *Lasiocampa* Schrank, 1802, the names being isogenotypic. The traditional type of *Bombyx* is *mori*[3], but this species was not designated as type until 1846.

The first use of the name subsequent to 1758 is by Linnæus 1761 (Fauna Suecica, ed. 2, p. 291) for 48 species including *pavonia* and *quercus*, but not *mori*. The first use in a strictly generic sense is by Fabricius 1775 (Systema Entomologiæ, p. 556) for 13 species including *pavonia, quercus,* and *mori.*

NOCTUA

Phalæna Noctua Linnæus, Systema Naturæ, ed. 10, p. 508, 1758. 68 included species.

Type designations:

Phalæna Noctua typica Linnæus, 1758 = *Noctua typica* Linnæus.
Ipso facto. (See Article 30b of the Règles.)

Phalæna Noctua pronuba Linnæus, 1758 = *Noctua pronuba* Linnæus.
By tautonomy. In the second edition of the Fauna Suecica under species "1167 PH. NOCTUA *pronuba*" Linnæus cites a reference to Goedart followed by "Noctua". This seems to fall within the bounds of the provisions for type by tautonomy.

Phalæna Noctua pronuba Linnæus, 1758 = *Noctua pronuba* Linnæus.
Designated by Latreille, Considérations Générales sur l'Ordre Naturel des Crustacés, des Arachnides et des Insects, p. 441, 1810.

[3] *Sericaria* Latreille, in Cuvier, Le Règne Animal, ed. 2, vol. 5, p. 404, 1829, often used with *mori* as type, is incorrect as *mori* was not one of the originally included species.

Phalæna Noctua exclamationis Linnæus, 1758 = *Noctua exclamationis* Linnæus.

Designated by Duponchel, *in* Godart, Histoire Naturelle des Lépidoptères de France, vol. 7, pt. 2, p. 71, 1829.

The first use of the name subsequent to 1758 is by Linnæus in 1761 in the Second Edition of the Fauna Suecica, page 305; 85 species are listed including *typica, pronuba,* and *exclamationis.* The first use in a strictly generic sense in the insects is by Fabricius in 1775 in the Systema Entomologiæ, page 590; 122 species are listed including *typica, pronuba,* and *exclamationis.* This name has also been used in the birds, and I have considered all the references carefully, and I find the first valid usage in that group to be Gmelin's in the Novi Commentarii Academiæ Scientiarum Imperialis Petropolitana 15: 447, 1771, for *Noctua minor* = *Stryx accipitrina Pallas.* 1771.[4]

In 1923 Barnes and Benjamin (Contributions to the Natural History of the Lepidoptera of North America, vol. 5, pt. 2, p. 55) stated that the long established and familiar family name Noctuidæ should be replaced by Phalænidæ. Their reasons were that *Phalæna* Linnæus, 1758, and *Noctua* Linnæus, 1758, were isogenotypic, having *Phalæna Noctua typica* Linnæus, 1758, as type (see Article 30b of the Règles), and that *Noctua* was in effect the typical subgenus of *Phalæna* (see Articles 9 and 29 of the Règles). The promulgation of Opinion 124 in 1936 (Smithsonian Miscellaneous Collections 73 (8): 1–2) has put their reasoning in an entirely different light, because both names no longer have the same type, and one is free to select the type of *Noctua.*

If we accept *Noctua* Linnæus as of 1761, *typica* Linnæus, 1758, cannot be construed as the type because it is not a new species in this work (see Article 30b of the Règles). The type will be *pronuba* Linnæus 1758 by tautonomy and also as subsequently designated by Latreille in 1810. Duponchel's subsequent type

[4] Tams, Insects of Samoa, Part 3, Lepidoptera, Fasc. 4, p. 171, 1935, refers to *Noctua* Linnæus 1766. In this usage (Amœnitates Academicæ, vol. 7, p. 450) the name is a *nomen nudum*; it is a combination (*Noctua daurica*) of an undescribed species and an undescribed genus. The first date of this use is 1764 (Dissertatio Academica Demonstrans Necessitatem Promovendæ Historiæ Naturalis in Rossia, p. 16), and it should be credited to Karamyschew, not Linnæus. It has no nomenclatorial validity.

designation of *exclamationis* Linnæus 1758 will be invalid. *Noctua* Linnæus 1761 would then take precedence over *Triphæna* Ochsenheimer with the same species, *pronuba*, designated as type by Curtis in 1831 (British Entomology, vol. 8, p. 348).

The generic name *Noctua*[5] has had slightly varying applications within the subfamily Agrotinæ (recte Noctuinæ) of the family of which it is the type. In America the name has been applied to the group of moths typified by the species related to *c-nigrum;* this was the usage of John B. Smith and was based upon the Guenée (1852) and Meigen (1829) use of the name. The correct name for this group is *Amathes* Hübner [1821] with type *Noctua baja* Schiffermüller. Hampson, on the basis of the "first species rule," used the name *Noctua* with type *strix* Linnæus, 1758, in place of *Thysania* Dalman, 1825, and substituted the subfamily name Noctuinæ for Erebinæ.

The recognition of the technically correct position of *Phalæna* and *Noctua* and the change of the family name Noctuidæ to Phalænidæ has led to confusion and to the interjection of the name Agrotidæ[6] as a substitute for Phalænidæ. The inherent confusion lies in the application that the names *Phalæna* and Phalænidæ had prior to the change made by Barnes and Benjamin in 1923. *Phalæna* was restricted by Fabricius in 1775 to include the species placed by Linnæus in *Phalæna Geometra* and *Phalæna Pyralis.* Latreille, accepting this restriction, made his family Phalænites in Sonnini's Buffon, Insectes, in 1802, (vol. 3, p. 411) and in 1810 (Considérations Générales sur l'Ordre

[5] For a comprehensive discussion of *Noctua* see Grote, Proc. Amer. Phil. Soc. 41: 4–12, 1902. For a bibliography see Barnes and Benjamin, Contributions to the Natural History of the Lepidoptera of North America, vol. 5, pt. 2, pp. 56–57, 1923.

[6] The family name Agrotidæ was proposed by Grote in 1895 (Abhandl. naturwiss. Vereins zu Bremen 14: 43) to replace the family name Noctuidæ. Grote considered it arbitrary to begin zoological nomenclature with the tenth edition of the "Systema Naturæ", and thus, to his way of thinking, *Noctua* Linnæus, 1758, was preoccupied by *Noctua* Klein 1753 (see, Can. Ent. 28: 65–66, 1896). Actually the first use of Agrotidæ was by Heinemann in 1859 (Schmetterlinge Deutschlands und der Schweiz, vol. 1, p. 488) and was based upon, and equal in concept to, Agrotides of Rambur, proposed in 1848 (Ann. Soc. Ent. France, 2nd series, 6: 67). Agrotidæ in the sense of Rambur and Heinemann is equal to the modern subfamily Agrotinæ (Phalæninæ) *recte* Noctuinæ.

Naturel des Crustacés, des Arachnides et des Insectes, p. 441) he designated *Phalæna Geometra sambucaria* Linnæus, 1758, as the type of *Phalæna.* Leach in 1815 (Brewster's Edinburgh Encyclopædia, vol. 9, pt. 1, p. 134) proposed the tribe Phalænides in which he included five families—Phalænida, Geometrida, Herminida, Platyptercida and Tortricida. The first two families equal the present family Geometridæ. Samouelle in 1819 (Entomologist's Useful Compendium, p. 252) combines the two names of Leach for the "Geometrids" and uses Phalænidæ. Curtis in his "British Entomology" published between 1823 and 1840 divides the species between Geometridæ and Phalænidæ without any apparent reasons. Duponchel in 1829 and Guenée in 1857 used Phalænites for the "Geometrids." Packard published his "Monograph of the Geometrid Moths or Phalænidæ of North America" in 1876. The name has been used by other workers, but almost always referring to the "Geometrids," never to the Noctuids. A small group of workers, who apply the "first species rule" rigidly, have asserted that the family name Phalænidæ is the correct name for the family called Saturniidæ (Testout, Bulletin Mensuel de la Société Linnéene de Lyon, p. 153, 1941).

If we accept the reinstatement of *Noctua* Linnæus, 1761, as a name acceptable under the strict interpretation of the provisions of the Règles and the Opinions of the International Commission on Zoological Nomenclature, Noctuidæ could be used in place of the very ambiguous, though older, family name Phalænidæ. In view of the great amount of literature that has been built up for Phalænidæ in the sense of the Geometrid moths and because the use of the name for the Noctuid moths has had very little acceptance generally, I do not think it will contribute anything to stability to continue to advocate the use of Phalænidæ in place of Noctuidæ. As a family name Noctuidæ, proposed as Noctuælites by Latreille in 1809 (Genera Crustaceorum et Insectorum vol. 4, p. 224), has had universal usage for one concept, and it is still generally used by most workers other than those in England and in North America.

GEOMETRA

Phalæna Geometra Linnæus, Systema Naturæ, ed. 10, p. 519, 1758. 75 included species.

Type designation:

Phalæna Geometra papilionaria Linnæus, 1758 = *Geometra papilionaria* Linnæus.

Designated by Duponchel, *in* Godart, Histoire Naturelle des Lépidoptères de France, vol. 7, pt. 2, p. 106, 1829.

The first use subsequent to 1758 is by Linnæus in 1761 in the second edition of the Fauna Suecica, page 322 for 81 species including *papilionaria.* The first use in a strictly generic sense is by Schiffermüller in 1775 in the Ankündung eines systematischen Werkes von den Schmetterlingen der Wiener Gegend, page 95 for 191 species including *papilionaria.*

PYRALIS

Phalæna Pyralis Linnæus, Systema Naturæ, ed. 10, p. 533, 1758. 8 included species.

Type designations:

"First species of Linnæus"

Designated by Curtis, British Entomology, vol. 6, p. 288, 1829.

Phalæna barbalis Clerck, 1759 = *Pyralis barbalis* (Clerck)

Designated by Curtis, British Entomology, vol. 11, p. 527, 1834 (December).

Phalæna Pyralis farinalis Linnæus, 1758 = *Pyralis farinalis* Linnæus.

Designated by Stephens, Illustrations of British Entomology, Haustellata, vol. 4, p. 395, 1835 (January).

Tortrix fagana Schiffermüller, 1775 = *Pyralis fagana* (Schiffermüller).

Designated by Latreille, Considérations Générales sur l'Ordre Naturel des Crustacés, des Arachnides et des Insectes, p. 441, 1810.

The first use of *Pyralis* subsequent to 1758 is by Linnæus in the Fauna Suecica (Ed. 2, 349 p. 1761.) for 13 species including *farinalis* and *barbalis.* If the name is accepted from this work, it will fall in the noctuids and replace *Herminia* Latreille, the type of the subfamily Herminiinæ. The first use of the name in a strictly generic sense was by Fabricius in 1775, Systema Entomologiæ (p. 645) for 57 species. These were the species which

Linnæus placed under *Tortrix.* If the name is accepted from this source, it will replace *Tortrix* or one of the closely related genera. Blanchard (1840 and 1845) was apparently the last worker to use *Pyralis* in the sense of Fabricius, but he also used *Tortrix* in the Linnæan sense.

TORTRIX

Phalæna Tortrix Linnæus, Systema Naturæ, ed. 10, p. 530, 1758. 24 included species.

Type designation:

Phalæna Tortrix viridana Linnæus, 1758 = *Tortrix viridana* Linnæus.

Designated by Curtis, British Entomology, vol. 16, p. 763, 1839.

The first use subsequent to 1758 is by Linnæus in 1761 in the second edition of the Fauna Suecica, page 342, for 40 species including *viridana.* The first use in a strictly generic sense was by Schiffermüller in 1775 in the Ankündung eines systematischen Werkes von den Schmetterlingen der Wiener Gegend, page 125 for 104 species including *viridana.*

TINEA

Phalæna Tinea Linnæus, Systema Naturæ, ed. 10, p. 534, 1758. 56 included species.

Type designations:

Phalæna Tinea pellionella Linnæus, 1758 = *Tinea pellionella* Linnæus. Designated by Latreille, Considérations Générales sur l'Ordre Naturel des Crustacés, des Arachindes et des Insectes, p. 441, 1810.

The first use subsequent to 1758 is by Linnæus in 1761 in the second edition of the Fauna Suecica, page 352 for 95 species including *pellionella.* The first use in a strictly generic sense is by Geoffroy in 1762 in his Histôire Abrégée des Insectes (vol. 2, p. 25 and 173). In this work there are no *nomina trivialia;* the species included under this name are represented by a descriptive polynominal phrase. Geoffroy spelled the name *Tinæa.* Fabricius first used the name with included *nomina trivialia* in 1775 in the Systema Entomologiæ, pages 655 for 66 species including *pellionella.*

ALUCITA

Phalæna Alucita Linnæus, Systema Naturæ, ed. 10, p. 542, 1758.
6 included species.
Type designations:

Phalæna Alucita hexadactyla Linnæus, 1758 = *Alucita hexadactyla* Linnæus.

Designated by Curtis, British Entomology, vol. 15, p. 695, 1838.

Tinea striatella Schiffermüller, 1775 = *Alucita striatella* (Schiffermüller).

Designated by [Blanchard] *in* Cuvier, Le Règne Animal, Disciples Edition, Insectes, pl. 157, 1846.

Phalæna Tinea De Geerella Linnæus, 1758 = *Alucita degeerella* (Linnæus).

Designated by Walsingham, Biologia Centrali-Americana, Insecta, Lepidoptera-Heterocera, vol. 4, p. 89, 1911 (as the type of *Alucita* Fabr. *nec Alucita* Linnæus).

The first use subsequent to 1758 was by Linæus in 1761 in the second Edition of the Fauna Suecica, page 370 for 7 species including *hexadactyla.* The first use in a strictly generic sense was by Fabricius in 1775 in the Systema Entomologiæ, page 667 for 20 species. These were part of the species which Linnæus included under *Phalæna Tinea,* thus if the name were used from this work it would come to be applied in a different association than the customary one.

CONCLUSIONS:

In view of the uncertainty about the choice of the work from which to date the names, and to maintain the names in the same sense as that in which all the pertinent literature has been built up, the International Commission on Zoological Nomenclature will be requested to suspend the Rules and

1. Validate the following names as of 1758, the Tenth Edition of the Systema Naturæ, and designate as their types the species indicated below:

a. *Bombyx* Linnæus—type *mori* Linnæus, Family Bombycidæ
b. *Noctua* Linnæus—type *pronuba* Linnæus, Family Noctuidæ

c. *Geometra* Linnæus—type *papilionaria* Linnæus, Family Geometridæ
d. *Tortrix* Linnæus—type *viridana* Linnæus, Family Tortricidæ
e. *Pyralis* Linnæus—type *farinalis* Linnæus, Family Pyralididæ
f. *Tinea* Linnæus—type *pellionella* Linnæus, Family Tineidæ
g. *Alucita* Linnæus—type *hexadactyla* Linnæus, Family Alucitidæ

2. Suppress for all time the generic name *Phalæna* Linnæus 1758, give preference to its typical subgenus *Noctua* Linnæus 1758, and declare Noctuidæ[7] the correct name for the family with this genus as type;

3. Validate the following name as of 1767, the Twelfth Edition of the Systema Naturæ, and designate as type the species indicated,

a. *Attacus* Linnæus—type atlas Linnæus, Family Saturniidæ.

If the above actions are taken, it is believed that stability in the use of these names will result and the growing confusion in the nomenclature of the Lepidoptera Heterocera will be materially reduced.

[7] This would involve the suppression of the family names Phalænidæ as used in America and of Agrotidæ as used in England.

BOOK NOTICE

Insects Affecting Forest Products and Other Materials, by W. J. Chamberlin. O. S. C. Cooperative Association, P. O. Box 491, Corvallis, Oregon, 1949. $10\frac{3}{4} \times 8\frac{1}{4}$ inches. ix + 159 p. 101 figs. Processed. $2.75.

This book by Professor Chamberlin, forest entomologist of the Oregon State College, is apparently an outgrowth of his lectures on forest insects, and embodies his experience, over a period of more than thirty years, with the forest insect problems of the North West. It consists of 12 chapters. The first is one on insect life in general and on the kinds of insect damage found in wood products. The next nine deal, on an Order basis, with particular species, and include descriptions of the adults and larvæ, their seasonal history, life-history and habits, nature of injuries, economic importance, hosts and distribution, and control. Chapters 11 and 12 are concerned with insects attacking metals and with marine borers. Each chapter is terminated by a bibliography and at the final end there is a general bibliography on Coleoptera injurious to forest products.

The book was written especially for persons interested in the practical side of forest entomology and foresters, mill men, manufacturers of wood products, structural engineers, etc., will find therein, the type of information they need, in answer to the insect problems likely to confront them. It is authentic, intensely practical throughout, and full of concise information on various forest insects and insects injurious to seasoned products, and the latest methods of control. Numerous photographs illustrate various species and types of injury. It is highly convenient to have this information between two covers and to know that it has been brought together by an authority upon the subject.—H. B. W.

GEORGE WARE BARBER

George Ware Barber (1890–1948), American naturalist, educator and writer, and member of the New York Entomological Society, died in his 59th year in New York City, December 5th 1948. He was descendant of an early New England family, and was born at Hyde Park, Massachusetts, August 3, 1890. He early manifested an interest in natural history and in every phase of outdoor life, and particularly in entomology and ornithology. He was graduated B.Sc. from the then Massachusetts Agricultural College in 1913, and M.S. and Sc.D. from Harvard in 1925 and 1927 respectively. He entered the service of the U. S. Department of Agriculture, in its then Bureau of Entomology January 1st, 1914, and worked thereafter on wireworms in Missouri, on range caterpillar in New Mexico, and on Hessian fly in Kansas and Maryland. During World War I, he was on furlough from the Department as Lieutenant of Cavalry in the U. S. Army, November 25, 1917 to May 19, 1919. On its termination and his return to the Bureau, his assignments thereafter included investigations of the European corn borer in New England and Ohio and of corn earworm in various Eastern States from New England to Georgia. He retired from the Government service at the age of 55 on November 15th, 1945, though he continued thereafter as Bureau collaborator without pay. Shortly thereafter, he entered upon special investigations of the behavior of the house fly and the toxicity of new insecticides notably DDT under the auspices of Rutgers University and was located at New Brunswick, New Jersey, and in this capacity he served until death.

Dr. Barber performed much work of lasting value in the course of his various assignments during his long period of service. Doubtless, however, his most outstanding single achievement and that of greatest practical usefulness was the discovery and development during his Bureau service of oil-insecticide treatments of sweet corn for earworm control. In 1936 his tests showed that a little highly refined white mineral oil injected into the silk at the tips of the corn ears would protect them from injury. Until this discovery was made, no satisfactory treatment

GEORGE WARE BARBER

for the protection of corn ears from damage by this insect was known. By 1939 Dr. Barber had improved the efficiency of this oil treatment by adding a very small percentage of pyrethrins, without producing an undesirable flavor or residue. He also developed a practical method of applying the treatment profitably not only to small plantings of sweet corn by home growers but also to commercial plantings of sweet corn and seed corn by means of hand-force oilers or by atomization onto the silks. By 1942, Dr. Barber had demonstrated that a very small percentage of dichloroethyl ether or styrene dibromide could be substituted for war-scarce pyrethrins. Following his discoveries extensive and profitable use has been made of the oil-insecticide method by sweet corn growers in Florida, New Jersey, Texas, California, Idaho and other states. He received a meritorius promotion in recognition of this accomplishment and was cited for it by the U. S. Department of Agriculture in its Research Achievement Sheet No. 16-E, January 8, 1945. His work at Rutgers University also amply demonstrated his unusual qualities as scientist and as educator. He had a profound influence on his associates and especially on the graduate students in entomology. His broad knowledge and wide experience and his insatiable capacity for work were a continuous source of wonder to his associates there. Although he was deeply interested in ornithology, it was not often possible for Dr. Barber to spare time from more pressing entomological studies for more than non-continuous field observations as opportunity afforded in various western and southwestern States, as well as in Virginia, Georgia and Florida, therefore his notes of necessity are somewhat fragmentary. His library, however, was particularly rich in many of the more important and more valuable contributions in ornithological literature.

During his approximately 36 years of research work Dr. Barber was author or joint author of 98 publications on entomological and related subjects. Even a cursory survey of these reveals abundant evidence of the high character and thoroughness of his work, his close and thoughtful observation, and the wide range of his interests.

No biographical sketch of Dr. Barber would be complete that did not at least make mention of his very unusual insect collection and his magnificent scientific library. During his many and varied assignments, he always took every opportunity to make noteworthy or worthwhile collections of adult and larval material wherever found. In course of time this insect collection expanded to several hundred Schmitt boxes of pinned specimens and many thousands of specimens in alcohol, most of which was taxonomically classified and arranged, and all accompanied by full notes. He spent countless hours of labor thereon and in care of light traps often until late at night, following long days of field work.

But it was Dr. Barber's library that was really notable: From boyhood he had been a passionate lover of books, and with the passing of the years he gradually formed a large and increasingly valuable collection of several thousand volumes, this being particularly strong in natural science and in general literature. The scientific portion comprised not only an unusually large working collection of the type of books and pamphlets ordinarily found on the work-table of an average investigator, but it also contained numerous rare taxonomic classics and many complete sets of scientific periodicals as well. General literature too was represented, in addition to the usual items of general interest, by many beautifully bound illustrated standard sets in Classical, English and American literature. An enthusiastic philatelist, he likewise accumulated a large and valuable stamp collection, having particular emphasis on the more artistic forms. In addition to his interest in science, he was also an accomplished musician, could perform creditably on several instruments, formed a collection of sheet music, and was actively identified with various musical activities.

On July 28, 1919, Dr. Barber married Miss Estelle Hulse of Chattanooga, Tennessee, who, with their only child, George Winston, survive him. The son is now a research associate in chemistry in the Medical School of the University of Pennsylvania, after having recently completed academic and graduate work at Yale, obtaining his Ph.D. degree in June 1949. For the past several years Dr. Barber and family have made their home at 20 Edgewood Avenue, New Haven, Connecticut.

In addition to the New York Entomological Society, his membership or fellowships also included the American Association for the Advancement of Science, the American Association of Economic Entomologists, the Entomological Society of America, the Ecological Society of America, the Agricultural History Society, the American Academy of Arts and Sciences, and the American Ornithologist's Union.

On the whole, Dr. Barber's record has been that of performance of unusual usefulness. The native bent from boyhood for observation of nature gradually was developed by him into a great enthusiasm. Possessing a strongly marked individuality and much personal charm, he attained a most enviable gift for making and keeping friends and he had many of them. The writers of this notice are thankful not only for having had his friendship but also with full hearts are grateful for the high privilege of having been counted by him among his intimate colleagues. We mourn his passing, and we cherish his memory.
—J. S. WADE AND B. B. PEPPER

PRESERVATION OF BIOLOGICAL SPECIMENS IN PLASTICS

The United States Department of Agriculture recently published, as Miscellaneous Publication No. 679, a comprehensive bulletin on the "Preservation of Agricultural Specimens in Plastics," by G. R. Fessenden of the Bureau of Agricultural and Industrial Chemistry. This bulletin deals with preservation of plant specimens and with the embedment of biological specimens in plastic blocks, all in considerable detail. The procedure for embedding biological specimens in blocks of methacrylate plastic involves the removal of the inhibitor from monomer; the addition of a catalyst to monomer; the preparation of partially polymerized casting sirup; casting plastic base in mold for specimen; dehydration and preparation of specimen for embedment; embedding specimen and polymerizing plastic around it; heat-treating polymer to prevent surface cracks later; removing cast blocks; and machining and polishing the finished block. Methyl and ethyl methacrylates in the monomeric state are mobile, inflammable liquids which give off toxic and combustible vapors. Because these monomers polymerize at room temperatures the manufacturer adds hydroquinone as a stabilizer or inhibitor. This has to be removed by distillation or by alkali extraction before the methacrylate monomer can be hardened. Next, in order to facilitate polymerization, benzoyl peroxide as an oxidizing catalyst has to be added, and this also is a fire hazard. Then the catalyzed monomer is converted to a sirupy form by moderate heat by means of a water bath. Specimens for embedment have to be cleaned and dehydrated and many other operations are needed before the work is completed. Some of the work must be done under a fume hood provided with an exhaust fan, and where an exhaust system is lacking the operator should be protected by an air-line gas mask. Fire extinguishers should be handy. Open flames are out; concentrations of vapor must not be inhaled; and various other precautions are necessary. After reading Mr. Fessenden's detailed and explicit bulletin, I have come to the conclusion that the preservation of specimens in plastics is not, by any means a kitchen hobby. It should be done only where adequate laboratory facilities are available and by persons who are fully aware of the characteristics of the materials with which they are working.—H. B. W.

LIST OF PUBLICATIONS ON ENTOMOLOGICAL AND RELATED SUBJECTS, BY GEORGE WARE BARBER, 1918 ET SEQ.

COMPILED BY J. S. WADE

1918. ON THE LIFE-HISTORY OF *Sarcophaga eleodis* Aldrich. Jour. Econ. Ent., 11: 268.

1919. ON THE BITE OF *Arilus cristatus*. Jour. Econ. Ent., 12: 466.

—— A NOTE ON MIGRATION OF LARVÆ OF THE HOUSE FLY. Jour. Econ. Ent., 12: 466.

—— THE GRAIN BUG. (with D. J. Caffrey.) U. S. D. A., Bul. 779, 24 pp., illus.

1920. THE BEETLES OF THE FAMILY CUPEDIDÆ OF AMERICA NORTH OF MEXICO. (with W. O. Ellis.) Jour. N. Y. Ent. Soc., 28: 197–208.

—— CONCERNING THE DISTRIBUTION OF NORTH AMERICAN CICADELLIDÆ. Canad. Ent., 52: 116–118.

—— NOTES ON THE OVIPOSITION AND FOOD OF THE WHEEL-BUG (*Arilus cristatus* Linn.,) (Hemiptera: Heteroptera.) Ent. News., 31: 107.

—— THE OCCURRENCE OF THE CHINCH BUG (*Blissus leucopterus* Say) IN EASTERN MASSACHUSETTS. Jour. Econ. Ent., 13: 369–370.

—— A 1919 COLLECTION OF CICADELLIDÆ IN THE ENVIRONS OF BOSTON. Psyche. 27: 146–150.

1921. COLLECTING ABOUT WALDEN POND. Canad. Ent., 53: 145–146.

—— POSSIBLE USE OF A TRAP TO CONTROL LEAF-HOPPERS INJURIOUS TO FRUIT TREES. Jour. Econ. Ent., 14: 240.

—— CONTROLLING THE ARMY WORM IN SOUTHWEST MISSOURI. Jour. Econ. Ent., 14: 486–488, Illus.

—— LEAFHOPPERS INJURING WOODBINE. Jour. Econ. Ent., 14: 502–503.

—— *Cicadella gothica* Sign. A CORRECTION. Psyche. 28: 130.

1922. EGGS OF THREE CERCOPIDÆ. (With W. O. Ellis.) Psyche. 29: 1–3. illus.

1923. NOTES ON *Sinæ diadema* (F.) Psyche. 30: 74–76.

—— NOTES ON A NEW ENGLAND *Aradid.* Psyche. 30: 120–122. illus.

—— A NOTE ON A RECENTLY INTRODUCED LEAF-HOPPER. Psyche. 30: 155–157. illus.

—— THE IMMATURE STAGES OF THE CATNIP LEAF-HOPPER (*Eupteryx melissæ* Curtis.) (with M. D. Leonard.) Jour. N. Y. Ent. Soc., 31: 181–184. illus.

1924. THE EUROPEAN CORN BORER *Pyrausta nubilalis* Hbn., versus THE CORN EARWORM *Heliothis obsoleta* F., Jour. Agr. Res., 27: 65–70. illus.

—— MIGRATION—AN IMPORTANT HABIT OF THE EUROPEAN CORN BORER. Jour. Econ. Ent., 17: 582–589. illus.

—— *Doratura stylata* Bohm IN MASSACHUSETTS. Psyche. 31: 170.

—— NOTES ON *Piesma cinerea* Say. Psyche. 31: 229–232. illus.

—— THE IMPORTANCE OF WINTER MORTALITY IN THE NATURAL CONTROL OF THE EUROPEAN CORN BORER IN NEW ENGLAND. Psyche. 31: 279–292. illus.

1925. A STUDY OF THE CAUSE OF THE DECREASE IN THE INFESTATION OF THE EUROPEAN CORN BORER (*Pyrausta nubilalis* Hbn.,) IN THE NEW ENGLAND AREA DURING 1923. Ecology. 6: 39–47.

—— OBSERVATION ON THE RESPONSE OF ADULTS OF THE EUROPEAN CORN BORER TO LIGHT IN EGG LAYING. An. Ent. Soc. Amer., 18: 419–431. illus.

—— REMARKS ON THE NUMBER OF GENERATIONS OF THE EUROPEAN CORN BORER IN AMERICA. Jour. Econ. Ent., 18: 496–502.

—— NOTES ON THE CORN EARWORM IN EASTERN MASSACHUSETTS. Jour. Econ. Ent., 18: 548–549.

—— THE EFFICIENCY OF BIRDS IN DESTROYING OVERWINTERING LARVÆ OF THE EUROPEAN CORN BORER IN NEW ENGLAND. Psyche. 32: 30–46, illus.

1926. SOME FACTORS RESONSIBLE FOR THE DECREASE OF THE EUROPEAN CORN BORER IN NEW ENGLAND DURING 1923–24. Ecology. 7: 143–162.

—— A SHORT LIST OF SCUTTELLAROIDEA COLLECTED IN NEW MEXICO IN 1916. Ent. News. 37: 43–44.

—— A TWO-YEAR STUDY OF THE DEVELOPMENT OF THE EUROPEAN CORN BORER IN THE NEW ENGLAND AREA. Jour. Agr. Res., 32: 1053–1068.

—— THE MENACE OF THE EUROPEAN CORN BORER. Mtg. Bank. Asso. Amer., 13th An. Conv. Proc., pp. 150–157.

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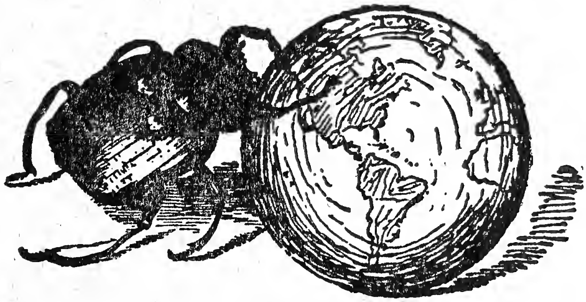

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A NEW SPECIES OF MITOURA SCUDDER FROM THE PINE BARRENS OF NEW JERSEY (LEPIDOPTERA, LYCÆNIDÆ)

By George W. Rawson and J. Benjamin Ziegler

Summit, New Jersey

The discovery of a new species of butterfly in the eastern portion of the United States has come to be an uncommon event. It is, therefore, with a feeling of great good fortune, not unmixed with surprise, that we are able to announce such a discovery from Lakehurst, New Jersey, which has been the Mecca of collectors in this part of the country for many years.

A single female specimen of this species was taken by one of us (J.B.Z.) at Lakehurst in 1942, but owing to his unfamiliarity with *Mitoura gryneus* (Hübner) (1) which the new species resembles, the specimen was mistakenly identified as a member of that species. During a week's collecting trip at Lakehurst in late April and early May of 1949 we were fortunate enough to take a fairly long series and, upon comparison with authentic *M. gryneus* from a number of different localities, it was at once evident that the Lakehurst material was quite distinct in color and markings. Slides of the male genitalia (four specimens) were then made and compared with a like number of genitalic mounts of *M. gryneus* from different localities, and it was found that distinct and apparently constant differences existed between the two series.

We have examined long series of *M. gryneus* at the American Museum of Natural History and in private collections, taken from a number of localities in Connecticut, New York, Pennsylvania, northern New Jersey, Maryland, the District of Columbia, southern Ontario, and Texas, and have found that in none of these specimens do any significant number of the distinguishing characteristics of the new species appear.

Since our new species bears such a close superficial resemblance to *M. gryneus*, it was of course essential to establish as definitely as possible that the former had not previously been described under the synonymy of the latter. This was by no means an easy task because of the general inadequacy of the original descriptions and the unavailability of the types of many of these names. However, with the invaluable assistance of Mr. William Field of the United States National Museum in Washington, D. C. and Messrs. William P. Comstock and E. Irving Huntington of the American Museum of Natural History in New York City, we have been able to examine the types or typical specimens of some of these names, together with the pertinent literature concerned with all of them, and, as a result, have satisfied ourselves that our new species has not been described under any of the synonyms or valid subspecific names of *gryneus*.

In this connection it should be remarked that, in the opinion of Messrs. Wm. Field and Wm. Comstock, the correct name for the common eastern *Mitoura* is *gryneus* Hübner and not *damon* Cramer (2), contrary to the nomenclature adopted in certain recent lists (3), (4). The name *damon* was first applied by Schiffermüller and Denis (5) in 1776 to a "blue"; *damon* Cramer (1782) is therefore a homonym and must give way to *gryneus* Hübner, which becomes the first available name for the insect in question.

A new form of *Mitoura* was described (6) in 1944 by F. H. Chermock from St. Augustine, Florida, as a species under the name of *sweadneri*. Through the kindness of Mr. Wm. P. Comstock we were able to examine two paratypes of this species, or well- marked race of *gryneus*, and to determine that it is not the same as our new species.

This new species, while generally similar in appearance and apparently closely related to *M. gryneus*, appears to differ somewhat from that species in habits and ecological preference. *M.*

gryneus, while it may sometimes be taken at flowers and even at damp places in the road, is often found flitting about the tips of its food plant, the red cedar (*Juniperus virginiana* L.), which is in turn often found in rather dry, sometimes hilly, locations. In contrast, the new species is taken at Lakehurst in low, swampy areas and always in close proximity to the white cedar or cypress (*Chamaecyparis thyoides* (L) (BSP). In our experience this is a very difficult butterfly to see on the wing. We almost invariably saw and took it, both males and females, at shrubby flowers, in the spring at the sand myrtle (*Leiophyllum buxifolium* (Berg.) Ell.) and the shadbush (*Amelanchier canadensis* (L.) Medic.) and in the summer at the sweet pepperbush or white alder, (*Clethra alnifolia* L.). The blossoms of various species of blueberries and huckleberries (*Vaccinium*) were not attractive. It was discovered by approaching a patch of flowers and examining each flower head closely; this was not always easy, especially at the shadbush which often showed a small, triangular section of leaf tip protruding above a flower head, displaying a deceptive resemblance to the greenish underside of the butterfly. It was almost always seen at the flowers, not arriving at or leaving them. Because of the well-known habit of *M. gryneus* of flying about the tops of the red cedar, we made an especial effort to observe the new species at the tops of the medium-sized white cedars, but to no avail.

The life history of the new species is as yet unknown and it is our hope that this deficiency will soon be remedied. We should like to suggest at this time, without unequivocal proof, that the white cedar previously mentioned is very possibly the food plant of the new species, for the following reasons:

(1). The new species appears to be closely related to *M. gryneus,* whose food plant is known to be the red cedar.

(2). The white cedar is a member of the same family (*Pinaceæ*) as the red cedar, to which it appears to be closely related.

(3). The new species has always been found in close proximity to the white cedar.

(4). The red cedar does not appear to be indigenous to the Pine Barrens proper, i.e., the inland portion thereof.

Discussion of point four above may be appropriate here. We have not been able to observe the red cedar at Lakehurst except for one or two examples in the town itself. Mr. John E. Cantlon of the Department of Botany of Rutgers University has very kindly supplied us with information concerning the distribution of the red cedar and the white cedar in southern New Jersey. In part he quotes from Whitmer Stone's 1911 publication entitled "The Plants of Southern New Jersey" from the Annual Report of the New Jersey State Museum for 1910. This authority (Stone) states that the red cedar is common in dry, sandy localities in northern New Jersey and in the middle district and is particularly characteristic of the coastal strip and the coast islands. However, according to Stone, it is found in the Pine Barrens only in cultivated areas where it has been introduced. Mr. Cantlon adds that it appears to him that the red cedar, while rather widely distributed in cultivated places in all of the counties of the Pine Barrens region, is in process of being crowded out by the oaks in abandoned fields due to its intolerance to shade. Mr. Cantlon further informs us that the white cedar is widely distributed in low, wet places and along streams in the Pine Barrens, where it often forms extensive cedar swamps, and that it also grows in the lower spots on the coastal strip and coastal islands.

It thus appears that the coastal strip and coastal islands might support fairly extensive growths of red and white cedar in close proximity to one another. It would be of interest to collect in such regions where *gryneus* and the new species might be sympatric.

The new species is double-brooded, the broods appearing at the same times as those of *gryneus*. The types and paratypes were captured from April 29 to May 3, 1949, when a total of about fifty specimens were taken by us and by Mr. Sidney A. Hessel. We made a second trip to Lakehurst on July 23–24, 1949, when eight specimens were seen, of which five were taken. These figures make it seem likely that the second brood is only partial, as is known to be the case with *gryneus* (3). In appearance the summer brood of the new species is very similar to its spring brood; the upper side of the summer brood is somewhat darker, tending toward black, with a rather pronounced greenish-purple iridescence in certain lights, while the brown markings on the under side may be slightly more extensive and the black submarginal spots slightly more pronounced.

It is interesting to speculate on the reasons why the new species has been overlooked for so long. Certain considerations may serve to explain this. In the first place, the size of the population may be subject to great fluctuation, with periods of relative abundance alternating with other and possibly much longer periods of scarcity. Also, it may be extremely local in its distribution although not actually uncommon when the proper locality is found. In our experience the presence of white cedar has been a necessary but not a sufficient condition for finding it. Should these assumptions of extreme local occurrence coupled with relative scarcity be correct, the result may have been the availability of too few specimens to make detailed comparison in series with *gryneus* and therefore in mistaken identification as that species. Specimens of *Mitoura* from Lakehurst do not appear to be common in collections and we feel it to be highly probable that most of those in existence will be referable to the new species. This is probably the situation with regard to the Lakehurst record given by Comstock (loc. cit.), which was based on a sight record in the vicinity of white cedar made by Mr. Sidney A. Hessel and Mr. Frank Watson in the spring of 1931. (Personal communication from Mr. Hessel). At the time Mr. Watson informed Mr. Hessel that he had occasionally taken *gryneus* at Lakehurst, although it appeared to be quite rare, and that he believed that it sometimes fed on white cedar.

In this connection it should be mentioned that Mr. Otto Buchholz of Roselle Park, N. J., has located two specimens of Lakehurst *Mitoura* in his collection: one *M. gryneus*, ♀, 5–7–39, coll. Otto Buchholz, and one of the new species, ♀, 5–15–? coll. Otto Buchholz. Each of these specimens is typical. Also, Mr. Wm. P. Comstock of the American Museum of Natural History informs us that he has located a hitherto unrecognized specimen of the new species in the collection there: one ♂, 5–12–49, Waretown, Ocean County, New Jersey, coll. Fred H. Rindge. Waretown is on the coast and is some distance to the south of Lakehurst.

As yet little is known of the distribution of the new species. Further research may indicate that it has a fairly extended range, as has been the case with *Incisalia polios* Cook & Watson, originally described from Lakewood, N. J., and now known to occur in northern Michigan and as far to the Northwest as Alaska (7). According to Sargent (8) the range of the white cedar extends from New Hampshire and Maine southward near the coast to northern Florida and westward to southeastern Mississippi.

We take pleasure in naming the new species in honor of Mr. Sidney A. Hessel, of Woodmere, N. Y., an enthusiastic collector and student of the Lepidoptera, in whose genial company we took our spring series.

MITOURA HESSELI new species

Male.

Upper side. Brownish-black to black, with rather diffuse, ill-defined yellowish-brown areas in the discal area of the fore wing and near the anal angle of the hind wing. The veins crossing these lighter shadings are not sharply outlined. On the hind wing, nervule M_1 projects beyond the border of the wing forming a short tail. A second, very rudimentary tail is found at M_2.

Under side. Generally greenish, rather bluish in tint, lightly speckled with chocolate brown. The fore wing is bordered on the outer margin by a series of white spots which tend to elongate somewhat as they approach the inner angle of the wing. This wing is crossed submarginally by a series of white bars, which remain rather distinctly separated, the two between the upper and lower radial veins and between the lower radial vein and the third median nervule being distinctly removed toward the base of the wing, thus causing the submarginal line to be bent inward rather strongly in this region. The inner margin of the first bar (nearest the costa) is approximately opposite the outer margin of the second bar.

A similar, sharply angled white line crosses the discal area of the hind wing. The second bar from the costa is displaced outwardly giving the line a jagged appearance in this region. This line is generally continuous near the inner margin since the crescent between the submedian and internal veins is nearly concurrent with that between the submedian vein and the first median nervule, being only slightly depressed toward the anal angle, with respect to which it is concave. Both of these submarginal white lines are heavily margined with brown internally, and lightly with black, also externally with brown on the fore wing, and on the hind wing between veins I and SM, between SM and nervule M_1, between veins UR and LR and between LR and nervule M_3. A rather pronounced black dash extends outwardly from the submarginal line between SM and M_1. A fairly large black spot is found on the hind wing near the margin between M_1 and M_2. Between this spot and the white, submarginal line a series of three or four black spots extends up toward the outer angle, roughly parallel to the outer margin.

A light-colored dash or spot is present near the base of the fore wing. The two white spots near the base of the hind wing are heavily margined with brown both internally and externally.

Female.

Upper side. Similar to the male, except that the lighter areas on the fore and hind wings are reddish-brown in color.

Under side. Generally similar to the male, except that the green color is somewhat brighter. The light marking near the base of the fore wing is somewhat larger.

DIFFERENTIAL DIAGNOSIS SEPARATING *M. HESSELI* FROM *M. GRYNEUS*

Because of the general similarity in color and markings between *gryneus* and *hesseli* which might cause difficulty in the proper identification of an eastern *Mitoura,* we have thought it wise to include the following outline of the criteria which may be used to separate the two species.

1. Upper side.

(a) *Gryneus* (spring brood) has rather sharply defined light areas on fore and hind wings, with the veins crossing these areas being sharply outlined with blackish. *Hesseli* (spring brood) is rather generally brownish-black, possessing only diffuse areas somewhat lighter in color. In general, the veins crossing these areas are not sharply defined. The upper side of the spring form of *hesseli* is rather similar in general darkness of color to the summer form (*smilacis* Bdv. & Lec.-*patersonia* Brehme) of *gryneus.* The summer form of *hesseli* is somewhat darker than the spring form.

2. Under side.

(a) Ground color. In *gryneus* this appears to be always green, somewhat yellowish in tint. It gives the impression of being completely, solidly green, especially on the hind wings. In *hesseli* it is usually greenish, but of a more bluish shade, and rather conspicuously if finely mottled with brown. In a small percentage of specimens this relationship is reversed and the ground color is brown with green specklings or shadings. This condition appears to be more common in males than in females.

(b) Marginal markings. Fore wing. In *gryneus* there is a series of thin white dashes here. In *hesseli* these markings take the form of a series of rounded white spots which tend to elongate somewhat as they approach the inner angle.

(c) Submarginal Line.

(1) Fore wing. In *gryneus* this is quite straight. In *hesseli* the second and third bars from the costal margin of the wing are translated toward the base of the wing, causing the line to bend strongly inward in this region.

(2) Hind wing. In *gryneus* the crescent nearest the inner margin of the wing is translated toward the anal angle and is convex with respect to the anal angle. The second bar from the costa is nearly concurrent with the first, being only slightly transposed toward the outer margin. The line is margined internally, but never externally, with reddish-brown. In *hesseli* the crescent nearest the inner margin of the wing is concurrent with the adjacent crescent and is concave with respect to the anal angle. The second bar from the costa is not concurrent with the first, being transposed some distance toward the outer margin. The line is heavily margined internally, and also externally in certain regions (see description) with chocolate brown.

(d) *Hesseli* almost always possesses a more or less prominent light marking near the base of the fore wing; this is especially prominent in the female. This marking is almost never present in *gryneus;* one or two of many specimens examined display it in very rudimentary form.

(e) In *gryneus* the two white spots near the base of the hind wing are lightly margined externally with brown. In *hesseli* these spots are heavily margined with brown both internally and externally.

Male Genitalia. The genitalia of four specimens each of *gryneus* (from two localities) and *hesseli,* all spring brood, were prepared and examined microscopically to determine whether any features existed which could be used to separate these two species. We have, however, not had the opportunity to examine or compare the male genitalia of other species of *Mitoura* and therefore the following applies only to *gryneus* and *hesseli.* In four pairs of genitalia examined we found that the most constant and characteristic difference was the relative elongation and narrowing of the saccus in *gryneus*. The average length in *gryneus*

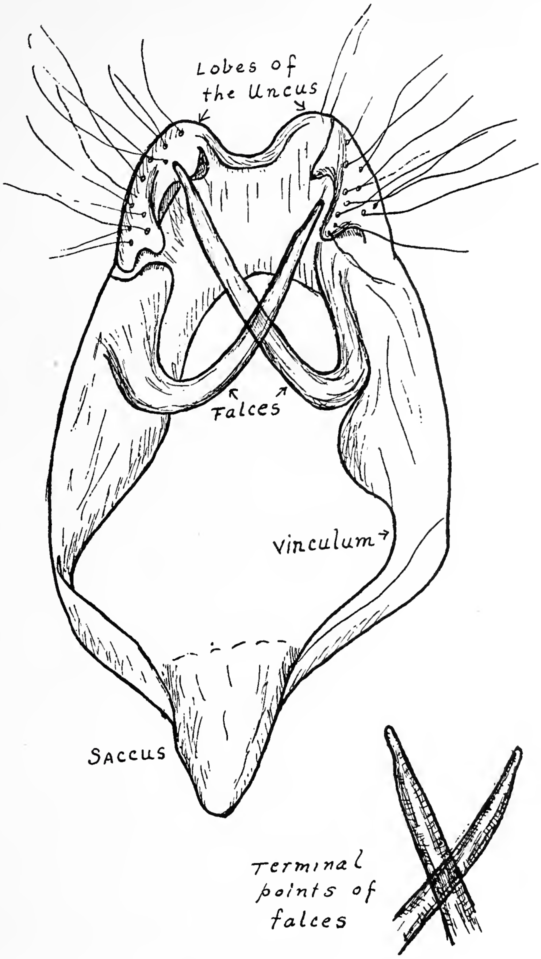

Fig. 1. Male genitalia. *Mitoura hesseli* n. sp. (Lakehurst, N. J., May 2, 1949)

was 660 μ whereas in *hesseli* it was 520 μ, or 140 μ shorter. Another feature (observed and commented on by Mr. Harry Clench. of Willow Run Village, Michigan) was that the terminal points of the falces in *gryneus* were comparatively shorter or "stubbier" than in *hesseli*. Figures 1 and 2, however, show these differences much more satisfactorily than verbal description.

We did not observe other features or characters that seem to be of any definite diagnostic value. Neither the socius nor the

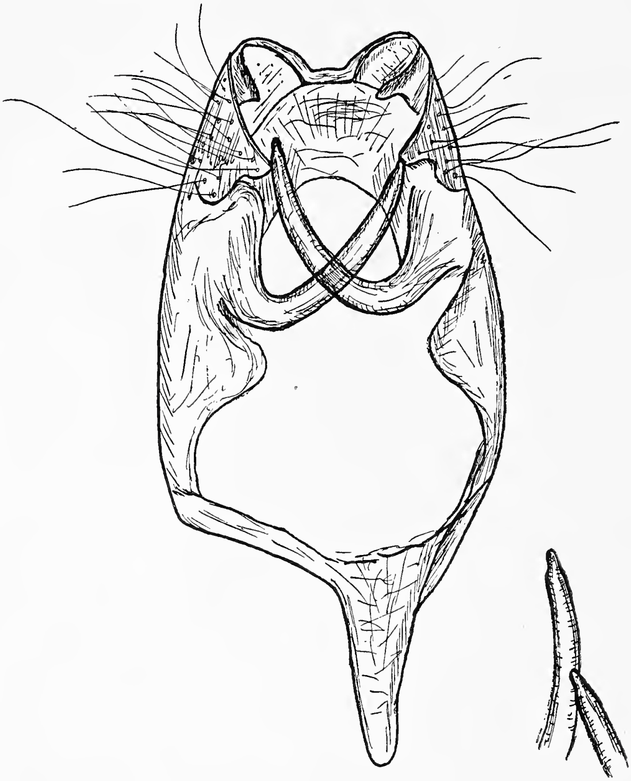

FIG. 2. Male genitalia. *Mitoura gryneus* Hübner. (Mount Peter, North Greenwood Lake, N. Y., May 4, 1949)

ædeagus appear to possess any constant or appreciable differences.

Type Material. Holotype, male, Lakehurst, Ocean County, New Jersey, May 1, 1949 (Coll. G. W. Rawson). Allotype, female, data of holotype (coll. J. B. Ziegler). Paratypes, thirty nine, all taken at Lakehurst, Ocean County, New Jersey, thirty four from April 29 to May 3, 1949, one on May 10, 1942, and four from July 23–24, 1949. The holotype and allotype have been deposited in the collection of the United States National Museum in Washington, D. C. One pair of paratypes (ex. coll. J. B. Ziegler) has been placed in the collection of the American Museum of Natural History in New York City. One paratype (ex coll. J. B. Ziegler) is in the collection of Otto Buchholz of Roselle Park, N. J., and one paratype (ex coll. J. B. Ziegler) is in the collection of D. P. Frechin of Bremerton, Washington. The remaining paratypes are located for the present in the collections of G. W. Rawson (13), J. B. Ziegler (14), and S. A. Hessel (8).

Additional Material Examined. In addition to the type material, there are thirteen other specimens of *hesseli* in the collection of one of us (J. B. Z.); these were all taken at Lakehurst, twelve from April 29–May 3, 1949, and one on July 24, 1949.

ACKNOWLEDGMENTS

We desire to express our appreciation to a number of colleagues who have given us invaluable assistance during the course of this investigation. We have profited greatly from the wholehearted and enthusiastic cooperation of several renowned authorities. Among these are Messrs. Wm. P. Comstock and E. I. Huntington of the American Museum of Natural History in New York City and Mr. William D. Field of the United States National Museum who placed at our disposal the expert knowledge and the facilities needed to check the synonymy of *gryneus*. Mr. Comstock also was good enough to secure paratypes of *Mitoura sweadneri* for our examination.

Mr. Harry K. Clench of Willow Run Village, Michigan, has been most generous with advice and comments. Professor Ivan M. Johnston, Associate Director and Supervisor of the Herbarium and Library of the Arnold Arboretum of Harvard University very kindly determined for us the identity of the white cedar, *Chamaecyparis thyoides* (L.) BSP, which we believe is very probably the host plant of *hesseli*. We are grateful to Mr. John Cantlon of the Department of Botany of Rutgers University for detailed information concerning the distribution of the red and white cedars in southern New Jersey.

We thank Mr. L. J. Sanford of the American Museum of Natural History for assisting us in the examination of the collections of that institution, and also Mr. Otto Buchholz of Roselle Park, N. J., who was, as always, most helpful in allowing us to examine his series. Lastly, but by no means least, Mr. S. A. Hessel has spared no effort to further this project.

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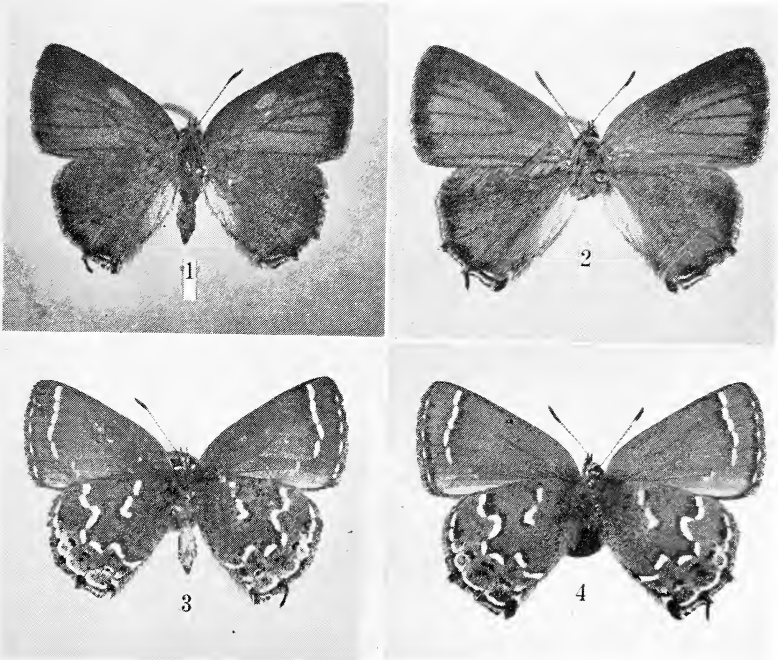

PLATE IX

Fig. 1. *M. gryneus* (Hübner) ♂, Point Pelee, Ontario, Canada. May 15, 1923. (upper surface)

Fig. 2. *M. gryneus* (Hübner) ♀, Point Pelee, Ontario, Canada. May 15, 1923. (upper surface)

Fig. 3. *M. gryneus* (Hübner) ♂, Point Pelee, Ontario, Canada. May 15, 1923. (under surface)

Fig. 4. *M. gryneus* (Hübner) ♀, Point Pelee, Ontario, Canada. May 15, 1923. (under surface)

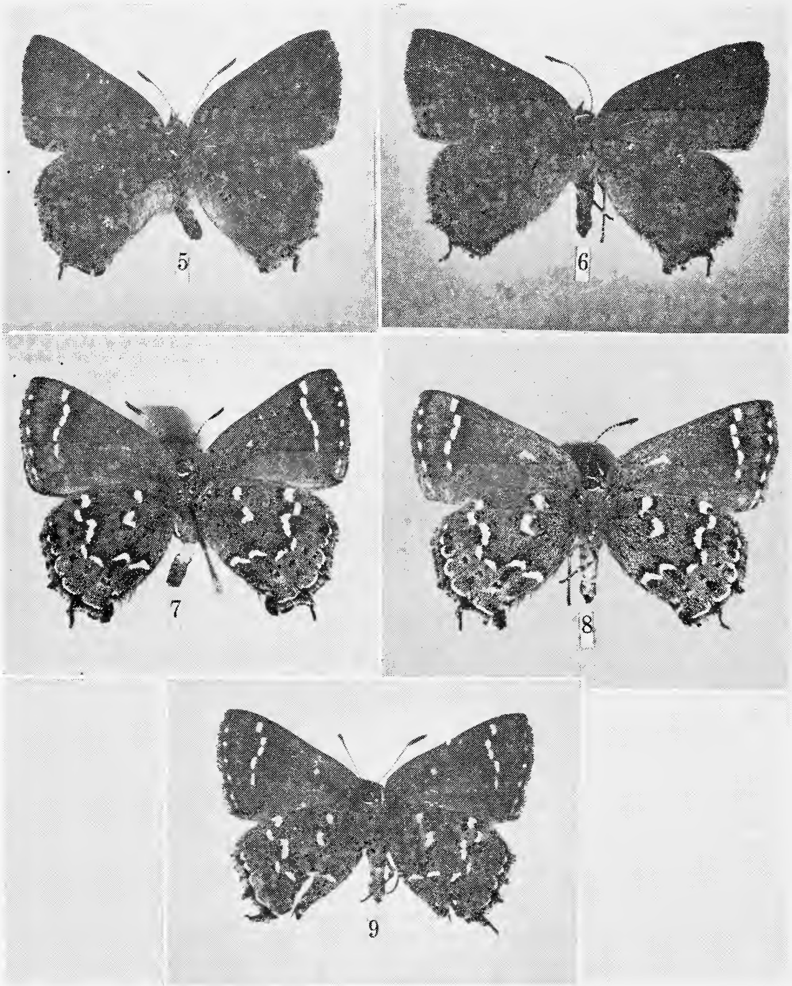

PLATE X

FIG. 5. *M. hesseli* n. sp. ♂, Holotype. Lakehurst, N. J., May 1, 1949. (upper surface)

FIG. 6. *M. hesseli* n. sp. ♀, Allotype. Lakehurst, N. J., May 1, 1949. (upper surface)

FIG. 7. *M. hesseli* n. sp. ♂, Holotype. Lakehurst, N. J., May 1, 1949. (under surface)

FIG. 8. *M. hesseli* n. sp. ♀, Allotype. Lakehurst, N. J., May 1, 1949. (under surface)

FIG. 9. *M. hesseli* n. sp. ♂, Reddish brown aberrant form. Lakehurst, N. J., July 23, 1949. (under surface)

BOOK NOTICE

Traité de Zoologie, Anatomie, Systématique, Biologie. Edited by Pierre-P. Grassé. Published by Masson et Cie., Paris (6^e). Tomes VI, IX and XI.

This monumental treatise on descriptive zoology is to be composed, when complete, of 17 volumes written by over 90 outstanding contributors. Only 3 volumes have appeared to date; they are reviewed below with especial attention to volume IX. This is a particularly propitious time for the appearance of such an exhaustive and scholarly resumé of the descriptive phases of zoology. For one reason, the attention of research workers has shifted largely from descriptive to experimental work in many groups of animals, and although this does not mean that the descriptive aspects of these groups are exhausted, it seems unlikely that a sufficiently great amount of change is forthcoming in the near future to materially change our knowledge of many of these groups. Second, the next latest comprehensive works on zoology comparable to the present work are: 1) E. Ray Lankester's *A Treatise on Zoology* (1900–1909), in which certain groups are omitted; and 2) Perrier et Perrier, *Traité de Zoologie* (1893–1928). These and other similar works were being prepared at a time when additions and changes were frequent in descriptive zoology; thus they were out-of-date before they were completed.

In the 3 volumes examined, the numerous illustrations, which are in part original, are clear and well integrated with the text. The language, despite its varied authorship, is unusually lucid and uniform, testifying to M. Grassé's ability as an editor. The quality of the paper is excellent and the bindings are quite satisfactory. The page size is $6 \times 9\frac{1}{2}$ inches.

Tome IX. *Insectes (Paléontologie, Géonémie, Insectes inférieurs et Coléoptères).* 1117 pp., 975 figs., 2 col. pls. 1949. Price: 4500 fr.

This volume, and the two companion volumes on insects to come, will surely be welcomed by all entomologists, as the next best work which begins to approach them is Chr. Schröder's famous *Handbuch der Entomologie* (1912–1929). Entomologists, by virtue of the bountiful supply of insect forms bestowed upon them, are far from completing their descriptive and classificational work. Thus the present treatise cannot be regarded as definitive, but it will undoubtedly point the way to further work as good inventories usually do.

Carefully selected bibliographies end each section, as space requirements forbid voluminous lists of references. It is evident in examining these bibliographies that few post-war titles are included. This is certainly understandable considering the difficulties under which most of the work must have been done. The editor's section on termites is one exception to the above-mentioned statement, as he listed the 1947 paper by Wilhelm Goetsch on vitamin T.

R. Jeannel wrote the first section (pp. 3–110) which treats the phylogeny of recent and fossil insects as well as geographical distribution and evolution. The section on the *Apterygota* (*Collembola, Diplura, Protura* and *Thysanura*) was written by R. Denis (112–275). In the *Pterygota* various authors were involved. The *Ephemeroptera* (279–309) was written by R. Despax. *Odonata* (311–354), *Blattodea* (355–385) and *Mantodea* (386–407) by L. Chopard. *Isoptera* (408–544) by P. Grassé. *Zoraptera* (545–555) by R. Denis. *Plecoptera* (557–586) by R. Despax. *Notoptera* (= *Grylloblattodea,* 587–593), *Cheleutoptera* (= *Phasmoidea* 594–616) and *Orthoptera* (617–722) by L. Chopard. *Embioptera* (723–744) by R. Denis. *Dermaptera* (745–770) by L. Chopard. *Coleoptera:* General Part (771–891) by R. Jeannel; Systematic Part (892–1077) by R. Paulian.

All the sections listed above are lucid and scholarly, but the one on termites by the editor, M. P. Grassé, stands out. An advanced system of classification is used throughout the book, and some of the authors erect new families in their sections. In general the section on morphology under each order occupies more space than is occupied by systematics and biology combined. The notable exception is in the Coleoptera, where the first section is shorter than the second. In the systematic section on the Coleoptera one finds much biological information of a more specific nature than was presented in the general part. Such information is arranged so that it follows the group to which it applies.

The arrangement varies somewhat under the different orders, but this is in reality a minor matter in consideration of the general excellence of the work.

The next volume, X, on insects is to appear this year. It will cover the higher insects except the Coleoptera. No date has yet been announced for the appearance of volume VIII, which is to cover generalities, anatomy, physiology and reproduction. It is certainly to be hoped that it will appear soon, for these three volumes will be one of the most useful single sets of books available to entomologists.

For the entomologist who is teaching courses in zoology, the following volumes may prove to be of interest from the standpoint of comprehensive references.

Tome VI. *Onychophores, Tardigrades, Arthropodes (généralités), Trilobitomorphes, Chélicérates.* By M. André, L. Berland, L. Cuénot, C. Dawydoff, L. Fage, J. Millot, L. Störmer, M. Vachon, A. Vandel and G. Waterlot. 979 pp., 870 figs. (some col.), 4 col. pls. 1949. Price: 5000 fr.

This volume will undoubtedly be of interest to entomologists, as the arthropods are treated admirably. Probably those in teaching, research and extension work will find the section (261–941) on the arachnoid forms especially useful, inasmuch as few laymen seem to be able to distinguish between 3 pairs of legs and 4 pairs.

Tome XI. *Échinodermes, Stomocordés, Procordés.* By P. Brien, M. Caullery, L. Cuénot, A. Dalcq, C. Dawydoff, P. Drach, H. Harant and G. Waterlot. 1077 pp., 993 figs. 1948. Price: 3800 fr.

These Deuterostomian groups are treated most adequately from the standpoint of any teacher needing reference material. The usual term for *Stomochordata* is *Hemichordata*, but this should cause little confusion as this group has had several names, e.g., *Enteropneusta* and *Branchiotremata*.

Three more volumes are due to appear this year. They are: Tome I. *Introduction, Protozoaires (Rhizopodes et Flagellés)*; Tome XII. *Vertébrés: Généralités, Embryologie topographique, Anatomie comparée;* and Tome XV. *Oiseaux.*

Congratulations are certainly due M. P. Grassé, the contributors, and last, but by no means least, the publishers, Masson et Cie. for presenting us with such an exhaustive and scholarly treatise. This entire set is absolutely essential for all libraries of institutions where research and teaching are being done. No doubt many individuals will want to purchase personal copies of one or more of these volumes in order to facilitate their research and teaching.—MERLE W. WING.

Leland Ossian Howard, 1857–1950

Dr. L. O. Howard, distinguished, honorary member of the New York Entomological Society died on May 1, at his home, 45 Pondfield Road, Bronxville, N. Y., at the age of 92. He was born in Rockford, Ill., June 11, 1857. He joined the U. S. Department of Agriculture in 1878 and following the retirement of C. V. Riley in 1894, he became Chief Entomologist of the Department of Agriculture in which position he was active in developing the entomological work of the department. After his retirement as chief of the bureau of entomology in 1927, he was appointed principal entomologist until 1931. His numerous and varied contributions to economic entomology, medical entomology and to parasitic Hymenoptera, and his influence on the development of entomology in America earned him world-wide recognition and he was honored many times, in this country and abroad, for his achievements.

Dr. Howard was admired and affectionately regarded by many entomologists. He always had time to be helpful, agreeable, and to be interested in the work of other entomologists. And his office in the old, red-brick Agricultural Building was always open to visitors, without any red-tape. His place in the history of entomology is enviable and assured.—H. B. W.

REQUIREMENTS FOR COLLECTING IN THE NATIONAL PARKS[1]

If you are planning on collecting insects, or animals generally, in the National Parks and Monuments this summer, you will be interested in the change in rules effected by Field Order 768, June 17, 1949 of the National Park Service.

The following requirements must now be met:

1. The collector must be a Federal employee
2. The collecting must be for the benefit of the Park or for science
3. The specimens must be deposited in a museum or in the collections of scientific or educational institutions and made available to the public

Items 2 and 3, above, have always been among the requirements. With respect to item 1, it is believed that a qualified specialist, working on a particular problem that involves National Park Service areas, would have little difficulty obtaining Federal appointment as ''collaborator without compensation.'' To receive such appointment, you should proceed by writing to the superintendent of the Park involved, stating the reason for desiring the unpaid collaborator appointment. This should be done well in advance of your trip, because the information is that there will be forms to fill out.—F. A. S.

[1] Abstracted from article by F. Martin Brown, Fountain Valley School, Colorado Springs, Colorado.

A NEW SPECIES OF PHEIDOLE FROM THE SOUTHWEST

BY ROBERT E. GREGG
DEPARTMENT OF BIOLOGY, UNIVERSITY OF COLORADO

The genus *Pheidole* is abundantly represented in Texas, New Mexico, Arizona, and California, but heretofore no member of the subgenus *Ceratopheidole* Pergande, has been recorded from the United States. A few specimens belonging to this group were received from Mr. C. P. Stroud, who collected them near Carrizozo, New Mexico, in the vicinity of the lava beds of the Tularosa Basin. All of the ants are workers, but as far as can be ascertained from the published descriptions of the several New World forms in the group, it appears they represent a new species.

Pheidole (Ceratopheidole) clydei sp. nov.

Worker. Length 2.8–3 mm.

Head, exclusive of the mandibles, slightly longer than broad, sides somewhat convex, and posterior margin straight; occipital angles evenly rounded. Eyes convex and located midway between the anterior and posterior borders of the head. Clypeus convex, produced anteriorly, its margin smooth, but sinuate or broadly emarginate in the middle. Mandibles of the usual shape, with two large, apical teeth, and five to six denticles along the incisor margin. Antennæ long and slender, the scape only slightly curved, and extending approximately $\frac{1}{3}$ its length beyond the occipital corners of the head. Funiculus with an elongated, 4-segmented club, the segments subequal in length, and each about $1\frac{1}{2}$ to 2 times as long as wide, or even slightly longer. The remaining funicular segments slender, and about $1\frac{1}{2}$ times as long as wide. Thorax narrow, prothorax a little more than $\frac{1}{2}$ as wide as the head; humeral angles rounded. Thorax is profile convex, but low; pro-mesonotal suture present and slightly impressed, meso-epinotal suture distinct. Epinotum long, flat, and nearly horizontal; declivity only $\frac{1}{2}$ to $\frac{2}{3}$ as long as the basal face. Spines long and sharp, fully $\frac{2}{3}$ as long as the epinotal base, and directed slightly upward and outward. Petiole long and narrow, almost 3 times as long as wide; the node in profile low, with a long, concave anterior slope, and much shorter posterior slope. Postpetiole about as long as wide, convex above and flat beneath, subglobose, and twice as wide as the petiole. Abdomen of the usual shape.

Front and gula shining, clypeus indistinctly granular, the remainder of the head sculptured with coarse punctures, giving a subopaque to opaque appearance. Fine, longitudinal rugulæ present on the genæ between the antennal insertions and the eyes, but easily discernible only under a magnification of 60 diameters. Frontal area subopaque, with one or two rugulæ. Dorsum and pleuræ of thorax coarsely punctate; opaque except the extreme anterior margin of the prothorax. Petiole and postpetiole more finely punctured, sub-

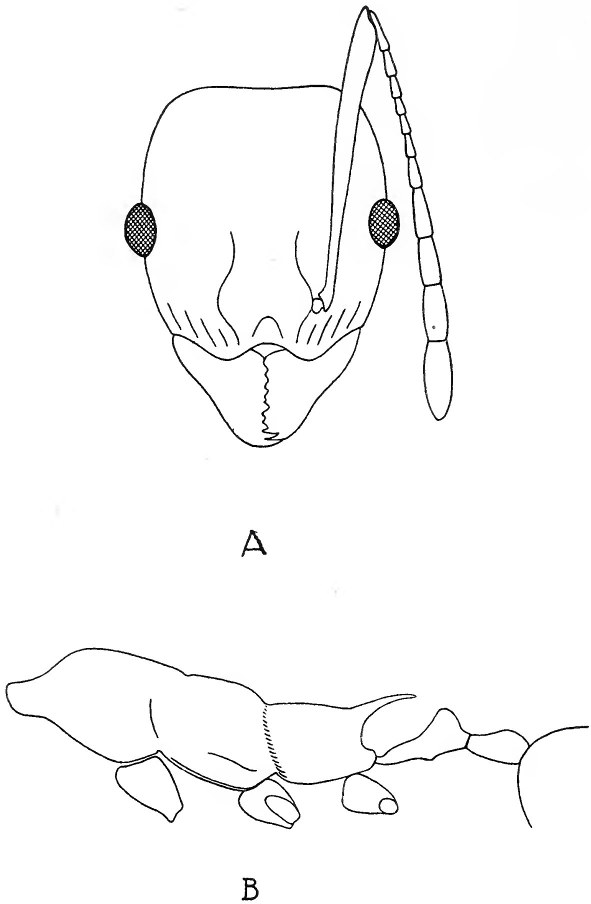

Fig. 1. *Pheidole (Ceratopheidole) clydei;* a. head, dorsal view, b. profile of thorax.

opaque to somewhat shining on the node. Gaster shagreened, but shining.

Hairs erect, fine, yellowish white, and scattered on all parts of the body except the scapes and funiculi. Pubescence inconspicuous or absent on most portions of the body, but abundant on the antennæ.

Color of head, thorax, petiole, postpetiole, and abdomen black; femora, tibiæ, and antennæ dark brown; tarsi, articulations of the legs, and mandibles yellow.

Holotype: worker; in the author's collection.

Paratypes: eight workers, deposited in my collection, the United States National Museum, and the Museum of Comparative Zoology.

From *Pheidole* (*C.*) *hecate* Wheeler, *clydei* differs in the following particulars. The clypeus is sinuate medially rather than entire, in the worker caste. The epinotal spines are definitely shorter than the base of the epinotum, and are nearly straight. In shape, the thorax is evenly rounded, and though low, it is not flattened. The pro-mesothoracic suture is definite, the epinotum is distinctly longer on the basal face than on the declivious face, and the humeral angles of the thorax are rounded but not tuberculate. The sculpture consists of coarse granulations, with the punctures on the head somewhat in rows, but the rugulæ between which the punctures lie, on the cheeks are so faint they cannot be distinguished without high magnification. Sharply defined rugæ are otherwise absent on the head, and are completely absent on the thorax. Thoracic punctures are large, dense, and entirely cover the thorax. The new form differs also from the subspecies of *hectate,* namely, *malevola* and *bruesi,* in the same general characters, especially in the lack of longitudinal rugulæ on head and thorax. It approaches *malevola* only in that the front is smooth and shining, while the latter has the whole upper surface of the head glabrous. While all forms of *hectate* are black to blackish red, this seems to be the chief point of similarity between them and *clydei.* The distribution of *hectate* and its subspecies, moreover, is West Indian, (Jamaica), and is therefore widely removed, geographically, from the type locality of *clydei.*

Pheidole (*Ceratopheidole*) *granulata* was described by Pergande, and the subgenus was erected on the basis of this species also. The type locality for *granulata* is Tepic, Mexico, and Pergande founded his species on two specimens which he took to be soldiers, although there is some doubt indicated in the original description as to the caste status of these specimens. It is possible that what he had were the intermediates of a polymorphic species of *Pheidole*. A few forms of *Pheidole* are thus known to be polymorphic, instead of the usual dimorphic condition, such as *Ph. vasliti, arizonica, instabilis, rhea,* etc., and the Indian *Pheidole smythiesii,* itself a member of the subgenus *Ceratopheidole*, is polymorphic. Since the original description of *granulata* pertains to some other size class, perhaps, rather than the stature of the fully developed soldier, and inasmuch as the true worker caste of this species has never been described, it is probably justified to draw comparisons between Pergande's description and the specimens of the new ant, *clydei.* With these limitations, *clydei* may be said to differ from *granulata* in the following respects. The anterior margin of the clypeus is sinuately and not angularly emarginate in the middle. The eyes are exactly in the middle of the head rather than in front of the middle. The segments of the antennæ, including those of the club, are about $1\frac{1}{2}$ to 2 times as long as wide, rather than about 4 times, but this difference may be only a reflection of allometric growth differences, and a discrepancy among the castes involved. The prothorax is slightly over $\frac{1}{2}$ as broad as the head, the declivious face of the epinotum is $\frac{1}{2}$ or more the length of the basal face, and the spines are at least $\frac{2}{3}$ as long as the base of the epinotum whereas in *granulata* they are only $\frac{1}{4}$ of this length. The head is granulate only on the sides, the occiput, the clypeus and between the frontal carinæ; striations or rugulæ are obsolete except for a few near the antennal insertions. The clypeus is without a median carina. The nodes, while granulate, are not densely so, and the abdomen is smooth and shining, whereas in *granulata* it is densely punctate, and the first segment bears elongated foveolæ. The hairs are stiff but are not dense, and are absent from the scape. In color, *clydei* is black almost throughout, while *granulata* is reddish-yellow.

Whether *Ph.* (*C.*) *clydei* is an entirely new species may be debatable, and the ant is described here with the full realization that its final status must be determined by the discovery of the soldier caste. A thorough search of several hundred vials of ants collected in the southwest during the spring of 1948, failed to reveal any members of this caste, so it is impossible to give its description or make the desirable comparisons. However, in view of the fact that *Ceratopheidole* has so far very few forms (two species only from America, and several from Asia), and since the Mexican *granulata,* though geographically adjacent to the locality of the new ant and may yet be taken within the borders of the United States, is obviously distinct from *clydei,* it is considered advisable to set forth a new species based only on the workers. Its locality provides our first record of the group, and furthermore, it may serve as a faint indicator of the northern limits of distribution of *Ceratopheidole* in this hemisphere.

I am indebted to Dr. M. R. Smith for examining the specimens, and for encouragement in proposing a new species. The ant is named for its collector.

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TWO NEW WORKS ON SIPHONAPTERA

The Department of Agriculture of the Dominion of Canada has recently issued as Publication 817, Technical Bulletin 70, a monograph of 306 pages on "The Siphonaptera of Canada" by George P. Holland. This is a summary of the present knowledge of 127 species and subspecies of Canadian fleas. It includes descriptions and discussions of families, subfamilies and genera. Except where new, species are not described in detail, but are identified in keys and in illustrations of which there are 42 plates with 350 figures. Geographical distribution is illustrated by 44 maps and there are discussions of host specificity, economic importance, flea taxonomy, together with a host-flea index, notes on collecting and mounting, and a bibliography, the whole constituting an impressive and important contribution to Siphonapterology.

During February, 1950, the Chicago Natural History Museum, published "Siphonaptera from Central America and Mexico," (Fieldiana: Zoology Memoirs, Volume 1, p. 1–127. Plates 1–54) by Robert Traub. This outstanding monograph which supplies an introduction to the fleas of Central America and Mexico is divided into three parts. Part I consists of descriptions of new genera and species including revisions of the genera Jellisonia and Pleochætis in all of which the taxonomic characters of the ædeagus are evaluated. Part II is devoted to a study of the comparative morphology of the ædeagus of 26 genera that are known to occur in Central America or Mexico. Part III consists of references, host index, index and list of abbreviations.—H. B. W.

ALAN S. NICOLAY

On January 29, 1950, Alan S. Nicolay, long a member of the New York and Brooklyn Entomological Societies, died suddenly of a heart attack, at his home on 18 Duryea Road, Upper Montclair, New Jersey. Mr. Nicolay was born in Brooklyn fifty-six years ago and had lived in Montclair for the past twenty-seven years. My friendship with Mr. Nicolay dates back to 1917. On December 1 of that year he was employed by the New Jersey Department of Agriculture, as a nursery inspector, and located in the Entomology Building on the Rutgers Campus at New Brunswick, New Jersey. He resigned on August 31, 1918 to enter the United States Army and after his return from France, he was re-employed by the New Jersey Department of Agriculture for a short period after which he entered the cotton goods business in New York City. While in the employ of the State of New Jersey, Mr. Nicolay compiled a digest of the laws and regulations governing the shipment of nursery stock from New Jersey to other states, that was published in January, 1918 as circular 19 of the Department of Agriculture.

During his residence at New Brunswick, we frequently inspected nurseries together and made many collecting trips to various parts of the state. Mr. Nicolay's entomological interests were always centered on the Coleoptera and he was a diligent collector of both specimens and literature of the groups in which he was interested. His first published paper appears to have been on the Mordellidæ of New York which was printed in the Bulletin of the Brooklyn Entomological Society in 1914. This was followed by lists of Maine and Long Island Buprestidæ and Cerambycidæ which appeared in the Bulletin in 1917 and 1919. In 1916 and 1917 his papers on "Rhynchophora in Maine" and a "Synopsis of the Anthophilax of North America" were printed in the Journal of the New York Entomological Society. After his return from France he wrote on "Observations made around Bar-Sur-Aube, France, with a list of the Carabidæ found there" that came out in the Brooklyn Bulletin in 1920.

After he had severed his connection with the New Jersey Department of Agriculture, Mr. Nicolay and I continued our collaboration, the results of which were reviews of the genus Buprestis in North America, and of the group Traches; a synopsis of the Cicindelidæ and several genera in the Carabidæ. These papers appeared in the Journal of the New York Entomological Society from 1918 to 1934 inclusive. Although Mr. Nicolay was not particularly interested in the biology of insects, during 1918 we worked together on the life histories of *Colophya nigripennis* (Jour. Econ. Ent., 11 (6): 467–471, 1918); *Brachys ovatus* and *Brachys ærosus* (Can. Ent., 51 (4): 86–88, 1919); *Zeugophora scutellaris* (Ent. News 30: 124–127, 1919); *Chalepus rubra* (Can. Ent., 50 (12): 398–400, 1918) and *Eumerus strigatus* (Ent. News, 30 (1): 27, 1919).

Mr. Nicolay was well known to eastern collectors of Coleoptera and museum curators. He as particularly friendly with the late Frank R. Mason of Philadelphia, whose collection of Coleoptera was willed to The Academy of Natural Sciences of Philadelphia following his death in 1927. Mr. Nicolay and Mr. Mason explored together the mountains of Tennessee and Virginia, the White Mountains of New Hampshire, Fairfax County, Virginia and numerous localities in New York and New Jersey. The results of these collecting trips were frequently summarized by Mr. Nicolay, in a humorous and entertaining fashion, before the members of the New York Entomological Society.

My own relations with Mr. Nicolay were happy ones. He was an agreeable collecting companion, with a strong sense of humor and we spent many pleasant hours together collecting in South Jersey. During the preparation of our systematic papers, we were advised on numerous occasions by the late Charles W. Leng, with whom Mr. Nicolay was in frequent touch. After 1935 our paths diverged and Mr. Nicolay and I met only infrequently at meetings of the New York Entomological Society. Although his publishing activities declined, I am sure that his interest in certain coleopterous groups, and in collecting, continued.

Mr. Nicolay was connected with Smith, Hogg & Co., of New York City in 1927 when that firm was liquidated and succeeded by the then newly organized Riegel Textile Corporation. Since that time he had been one of the most highly valued employees of the company, and at the time of his death he was the company's representative in New York City and in the New England States for their textile fabricated products.

According to the "Montclair Times" of February 2, 1950, Mr. Nicolay was buried on February 2 in Mt. Hebron Cemetery, Upper Montclair, New Jersey, and is survived by his wife, Mrs. Mildred Potter Nicolay; two daughters, Mrs. Andrew B. Adams of Arlington, Virginia, and Miss Cornelia Nicolay of Upper Montclair; his mother, Mrs. William A. Nicolay, and a brother John V. Nicolay, both of Upper Montclair.—HARRY B. WEISS.

A MYSTERY CLEARED UP

In the March, 1949 issue of this JOURNAL, page 50, under the title "Entomologists are Human Beings," mention was made of an anonymous plea, circulated in the United States during 1920, by a group of young entomologists who called attention to the indifference of many heads of departments of entomology to the salary needs of their assistants. I had often wondered about the authorship of this 4-page anonymous circular and it was not until March 1949 that my curiosity was satisfied. At that time, Harry L. Parker wrote to me from France and said that the circular was conceived, instigated and written by George Barber and that the idea was enthusiastically supported by many of the entomologists around Arlington and Melrose Highlands. The printing was done by the Owl Press (located at Somerville, Mass.) a nighttime venture of Harry L. Parker and W. O. Ellis. Bill Ellis set the type and H. L. Parker pedaled the press. This private press venture was abandoned after a year of night work and after the owners had lost money on a small book of poems called "Ballads and Grotesques," by Harold Hersey, a brother-in-law of D. J. Caffrey. According to Mr. Parker's recollection, only four copies were sold.—H. B. W.

BOOK NOTICE

Webs in The Wind, The Habits of Web-Weaving Spiders, by Winifred Duncan. A Volume of the Humanizing Science Series, The Ronald Press Company, New York, 1949. 387 pages, 74 plates, and 101 text figures. $4.50.

To the excellent books of the Humanizing Science Series has now been added "Webs in the Wind" by Winifred Duncan. The publication of such a monstrous caricature of spiders, their webs and lives, reflects not only adversely on the author and the naive publisher but upon all other books of the series. Through the eyes of the author (who by her own admission is without biologic training of consequence and without background in the subject matter) we are introduced to a strange world of spiders. "We, my readers and I, would wander like Adam and Eve before the Fall, into a world of unknown creatures and I would describe only what I saw with my own eyes." Thereafter, we wander through nearly four hundred pages of trivia which can have little appeal for any discerning reader and which is paraded before us as an accurate and scientific account and a "significant contribution to the field of nature study." Completely neglected by the author (who eschews all previous learning in the field as incomprehensible to the lay public) is the amassed knowledge in hundreds of papers written in many languages, many of them models of concise field reporting; and yet the author finds "it is the more amazing that so little work has been done in this field—an ideal one for amateurs." Some of the many drawings are seemingly attractive, but most of them suffer from inaccuracy of portrayal and detail. The pages are replete with spelling errors of scientific names and the names of authors. Of the many species portrayed, few can be identified by the verbal description or drawings of spider or web. The habits of some species are ascribed to others and the scientific names and common names are curiously garbled. Errors in fact, errors in interpretation, and erroneous implications are present in countless numbers. The author, no matter how sincere in her efforts to present the amazing lives of spiders for the general reader, has produced a book so bad it cannot be recommended for its intended audience.—WILTON IVIE

NOTES ON THE DISTRIBUTION, HABITS, AND HABITATS OF SOME PANAMA CULICINES (DIPTERA: CULICIDÆ)

BY ROSS H. ARNETT, JR.
ARLINGTON, VA.

(Continued from Vol. LVII, p. 233)

In the third part of this paper, I concluded the discussion of the habits, habitats, and distribution of the individual species of Panama mosquitoes. In this concluding part I am offering some general observations on the ecology of Panama mosquitoes.

PART IV

ECOLOGY

The Republic of Panama is that twisted, sigmoid-shaped ribbon of land lying between latitudes 8° and 10° north, which connects the American continents and separates the almost merging waters of the Atlantic and Pacific Oceans. The building of the canal disturbed such faunistic distinctions as the area might have had. Therefore, as much as it might be desired that the following discussion be limited to a natural faunistic area, for all practical purposes, the area under consideration lies within the present boundaries of the Republic of Panama, which extends from Costa Rica on the west to Colombia on the east, and from the Caribbean Sea on the north, to the Pacific Ocean on the south. The coast line is irregular longest on the Pacific side, some 674 miles, and about 379 miles on the Atlantic side. The isthmus is wider at the extremities, narrowing at the Canal Zone to about 35 miles. Spread over nearly all of its 32,000 square miles are mountains of varying heights, the highest about 11,000 feet located near the Costa Rican border. These gradually decrease on approaching the Canal Zone until they become a series of low hills ranging from fifty to several hundred feet in height. Then they again rise to higher elevations towards the Colombian border. There are, however, low stretches of land on the Pacific side extending in both directions from Panama City and forming natural grass plains. The drainage is primarily that of the Chagres river and its tributaries; however, numerous small rivers cut down between the hills and mountains draining into both oceans.

Considerable variation occurs in the climate in different parts of the Isthmus. In general, it is hot and humid with heavy rainfall. In the higher regions it is cooler, approaching temperate climates. In the Canal Zone, the days are hot, but the evenings are generally cool. The temperature varies between 70 and 85 degrees. Extremes of 60 to 100 degrees have occurred only on a few occasions. However, the constantly high relative humidity, which varies between 72% and 91% according to the location and season gives the feeling of great heat. The most extreme variation in the climate is that of rainfall. On the Pacific side of the continental divide the annual rainfall is 70 inches, while on the Atlantic side it is 130 inches or more. This leaves a marked effect on the vegetation, that of the Pacific side being much less rank than that of the Atlantic side.

From the middle of December to the first of May the trade winds blow from the north to the south, carrying away rain clouds, and thus contributing to the so-called "dry season." This period is characterized by clear cloudless skies and a constant breeze. It is then that the marked difference between the Atlantic side and the Pacific side is most noticeable. The vegetation on the Pacific side becomes parched and brown, while that of the Atlantic side remains green, for even during the dry season, the Atlantic side receives a fair amount of precipitation, while on the Pacific side it seldom rains. But during the other eight months of the year, known as the rainy season, the precipitation is much greater on both sides, reaching its height in November. This warm, humid climate favors the rapid growth of tropical vegetation and the abundance of water affords extensive areas suitable for the breeding of mosquitoes.

It is unfortunate that an extensive study of the fauna and flora of the Canal Zone was not made before the flooding of the Chagres valley, for even with what information we do have it is evident that considerable changes in the mosquito fauna have been wrought by the construction of the canal. Swamps have

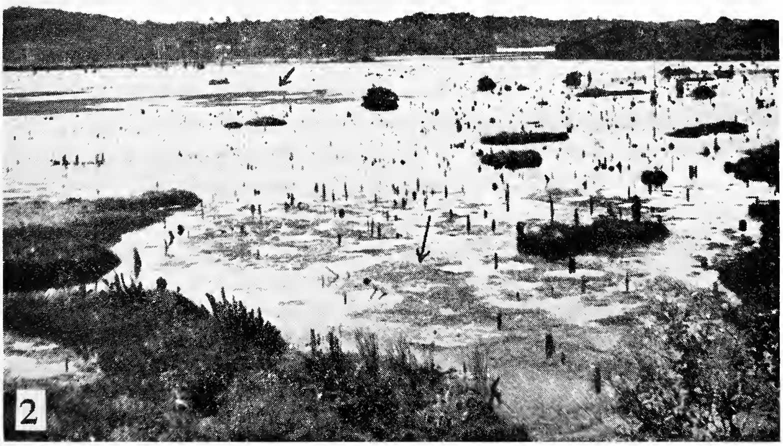

Fig. 1. Washing clothes in a stream near Puerto de la Chorrera. This stream is a favorite breeding place of *Anopheles punctimacula* D. & K. in spite of the frequently soapy water.

Fig. 2. Rio Gatun, near Gatun Lake, showing the extent of "Najas" beds breeding *Anopheles albimanus* Wied. at the rate of 10 per dip.

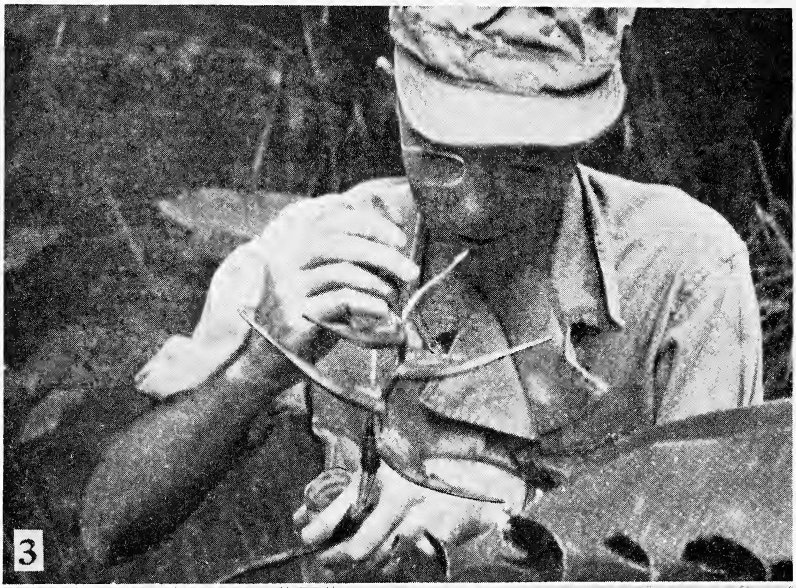

FIG. 3. Dr. K. E. Frick collecting the larvæ of *Wyeomyia pseudopecten* D. & K. from the flower bracts of *Heliconia* sp.

FIG. 4. The main street of Puerto de la Chorrera, a typical small Panamian town. This town had a high malaria index. (See vol. LV, p. 195 for information on the breeding of *Anopheles albimanus* Wied. near this town.)

been drained and filled in. Concrete drains have been laid to conduct the surface water to large streams and lakes. Ponds and small lakes in some cases have been eliminated. In many areas, therefore, few mosquitoes can now be found where formerly many species were recorded. Moreover, as pointed out by Knab, nearly all of the bamboo formerly growing along the Chagres river has been destroyed, with hardly a clump remaining. Several species of mosquitoes inhabited that plant. Comparing recent records with Busck's records, it is evident that these species have disappeared from the Zone and must be found in other areas. There is even the possibility that some species have been exterminated. On the other hand, such species as inhabit or are associated with aquatic plants have greatly increased in number due to the great increase in areas inhabitable by these plants, i.e. Gatun Lake.

The two primary factors, temperature and rainfall, affect mosquito habits and habitats. Temperature fluctuation will of course accelerate or retard the length of time for the species to complete its life cycle. Rainfall fluctuation will in most cases regulate the area in which a species may breed. The following chart showing rainfall and temperature variation in Panama will give a key to the relative abundance of a given species of mosquito throughout the year. For instance, a species that breeds in temporary pools will be most abundant during the beginning of the rainy season. Later, during the heavy rains, the species may be less abundant due to ''wash outs.'' Conversely, a species such as *Anopheles kompi* which is apparently restricted to drying, isolated pools in a stream bed, will be most abundant towards the end of the dry season. Leaf bract breeders such as species of *Wyeomyia* will show little variation in abundance throughout the year on the Atlantic side where the rainfall is sufficient the year around to keep water in the bracts. However, on the Pacific side where it is much dryer, leaf bract breeders will not be in evidence during the dry season. The effect of temperature is not so evident in Panama, there being a relatively slight fluctuation. However, the hot period at the end of the dry season on the Pacific side undoubtedly is a factor in the successful completion of the life cycle of such temporary pool breeders, as *Anopheles strodei* becomes during the dry season.

TEMPERATURE & RAINFALL 1934

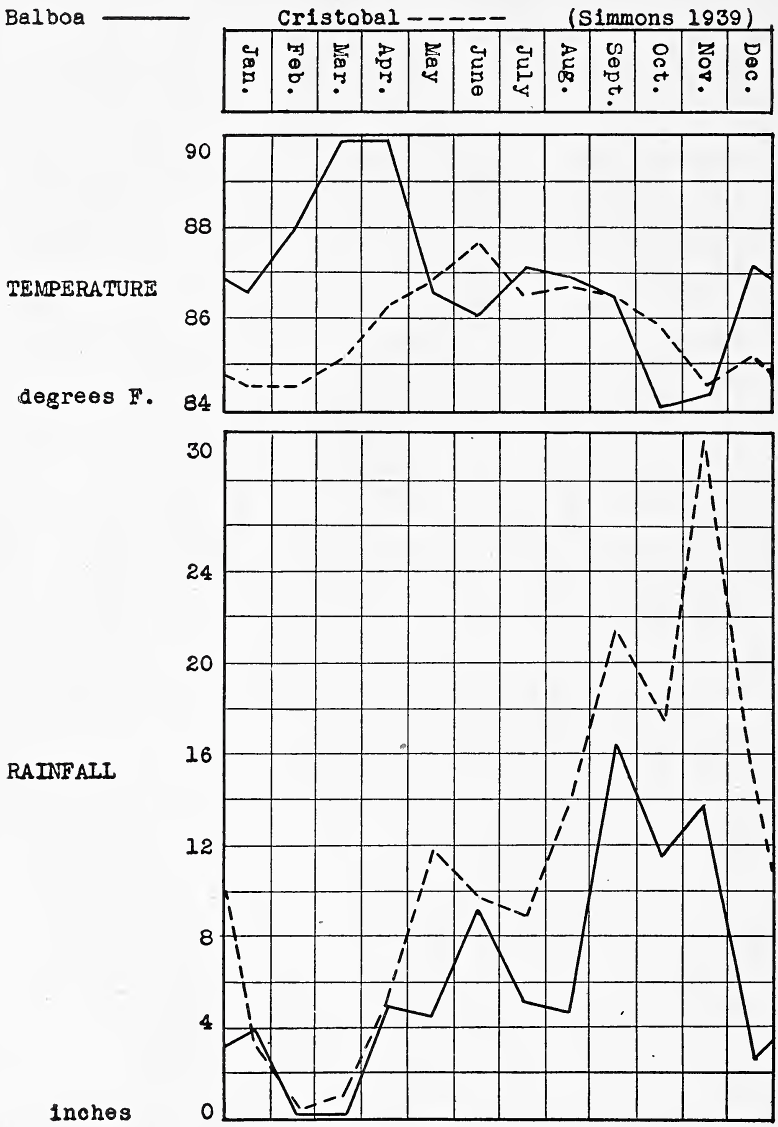

CHART I

Shannon (1931) restates a fundamental principle of mosquito biology, an original proposition of Howard, Dyar, and Knab, which is here quoted: "The larvæ of each species are more or less restricted to a special type of habitat; and further, the natural classification of the family as based on larval and adult characters is in accord with the natural classification of the habitats." He then goes on in his paper to show how this is true using as his example 86 Brazilian species. Further he shows how the larval habitats may be classed, based on location. The following study of 76 species of mosquito larvæ, from Panama follows Shannon's method and agrees with his work in all essential details.

Larval ecology. The striking differences between the larvæ of various habitats tempt one to undertake an elaborate ecological classification with or without special ecological terms, but one soon runs into difficulties. For example, it is difficult to draw precise limits between aerial habitats and surface habitats. It is also difficult to draw sharp distinctions on the basis of the nature of the habitats, since there are no precise limits between pools and lakes, or between swiftly running and more slowly moving water. This discussion is begun, therefore, with the following tabulation of the larval habitats.

LIST OF MOSQUITO LARVÆ OF PANAMA WITH THEIR PREFERRED HABITAT

Genus *CHAGASIA*

bathanus Dyar .... Shady, moderately swift streams.

Genus *ANOPHELES*

Subgenus *Stethomyia*

kompi Edwards .... Shady, drying pools or streams.

Subgenus *Anopheles*

eiseni Coquillett .... Rock holes, in shade.
pseudopunctipennis Theobald .... Sunny streams and pools with aquatic vegetation.
apicimacula Dyar & Knab .... Shady pools with debris.
neomaculipalpus Curry .... Sunny hoofprints or similar small ground pools.
punctimacula Dyar & Knab .... Sunny or shady surface water of many types.

Subgenus *Nyssorhynchus*

albimanus Wiedemann .... Sunny lakes with aquatic vegetation.
albitarsis Arribalzaga .... Sunny lakes usually with aquatic vegetation.
argyritarsis Robineau-Desvoidy .... Sunny pools and streams.
strodei Root .... Sunny or shady pools.
aquasalis Curry .... Salty or fresh water ponds.
triannulatus Neiva & Pinto .... Sun or shade, pools or lakes.

Subgenus *Kerteszia*

neivai Howard, Dyar & Knab .... Bromeliads.

Genus *URANOTÆNIA*

calosomata Dyar & Knab .... Shady, moderately flowing streams.
coatzacoalcos Dyar & Knab .... Shady rock pools and streams.
geometrica Lutz .... Small sunny pools with vegetation.
lowii Theobald .... Small sunny pools with vegetation.
pulcherrima Lynch Arribalzaga .... Floating river vegetation in sun.

Genus *MEGARHINUS*

hypoptes Knab .... Tree holes.
moctezuma Dyar & Knab .... Tree holes.
superbus Dyar & Knab .... Leaf bracts of wild pineapple.

Genus *CULEX*

chidesteri Dyar .... Open sunny swamps.
corniger Theobald .... Usually clear shady small temporary pools.
coronator Dyar & Knab .... Shady or sunny pools.
declarator Dyar & Knab .... Shady or sunny surface pools or above surface containers.
quinquefasciatus Say .... Artificial containers or foul pools.
inflictus Theobald .... Crab holes.
interrogator Dyar & Knab .... Sunny foul pools.
mollis Dyar & Knab .... Shady rock holes.
nigripalpus Theobald .... Sunny or shady foul pools.

Subgenus *Melanoconion*

aikeni Aiken .... Floating river vegetation in sun.
bastigarius Dyar & Knab .... Sunny streams with vegetation.
chrysonotum Dyar & Knab .... Sunny, grassy pools.
conspirator Dyar & Knab .... Shady rock pools.
dunni Dyar .... Sunny swamps with grass.
eastor Dyar .... Sunny foul pools.
educator Dyar & Knab .... Sunny pools and streams with grass.
egcymon Dyar .... Shady streams, no vegetation.
elevator Dyar & Knab .... Shady rock holes.
erraticus Dyar & Knab .... Ground pools and sluggish rivers.

Subgenus *Isostomyia*

conservator Dyar & Knab .... Tree holes.

Subgenus *Mochlostyrax*

hesitator Dyar & Knab .... Sunny pools with grass.
pilosus Dyar & Knab .... Sun or shade, salt or fresh water, permanent.

Subgenus *Lutzia*

allostigma Howard, Dyar & Knab... Rock holes.

Genus *DEINOCERITES*

cancer Theobald .... Crab holes.
pseudes Dyar & Knab .... Crab holes.

Genus *MANSONIA*

titillans Walker .... Attached to *Pistia*.

Genus *ÆDEOMYIA*

squamipennis L. Arrib. .... Associated with but not attached to *Pistia*.

Genus *ORTHOPODOMYIA*

fascipes Coq. .... Tree holes and sewage.

Genus *ÆDES*

Subgenus *Stegomyia*

œgypti Linn. .... Artificial containers.

Subgenus *Finlaya*

terrens Walker .... Tree holes.

Subgenus *Ochlerotatus*

angustivittatus Dyar & Knab .... Shady temporary pools.
serratus Theobald .... Shady temporary pools.
tœniorhynchus Wiedemann .... Salt marshes.

Genus *HÆMOGOGUS*

argyromeris Dyar & Ludlow .... Bamboo joints, tin cans, and tree holes.
chalcospilans Dyar .... Coconut shells.
lucifer Howard, Dyar & Knab .... Bamboo joints, tin cans, and tree holes.

Genus *PSOROPHORA*

lineata Humboldt .... Sunny, grassy pond, temporary.

Subgenus *Janthinosoma*

ferox Humboldt .... Shady pools, clear, temporary.

Subgenus *Grabhamia*

confinnis L. Arrib. .... Temporary pools.

Genus *TRICOPROSOPON*

digitatum Rond. .... Coconut shells, tin cans, and bamboo.
compressum Lutz .... Coconut shells.

Subgenus *Hyloconops*

longipes Fab. .... Leaves of "Skunk Cabbage."

Genus *WYEOMYIA*

scotinomus Dyar & Knab .... Bromeliads.
celanocephala Dyar & Knab .... Bromeliads.
quasiluteoventralis Theobald .... Bromeliads.
arthrostigma Lutz .... Bamboo and tin cans.

Subgenus *Dendromyia*

personata Lutz .... Tree holes, bamboo, tin cans and coconut shells.
pseudopecten Dyar & Knab .... Leaves and flower bracts of Heliconia.
ulocoma Theobald .... Flower bracts of Heliconia.
complosa Dyar .... Leaves of "Skunk Cabbage."

Genus *LIMATUS*

durhami Theobald .... Bamboo, tin cans and coconut shells.
asulleptus Theobald .... Artificial containers.

Genus *SABETHES*

cyaneus Fab. .... Tree holes.

Subgenus *Sabethinus*

undosus Coq. .... Bamboo.

From this list it may be seen that certain general statements may be made regarding the habitat *preferences* of mosquito larvæ. However, a few words of explanation as to the basis of these statements are necessary. As will be seen from the detailed listing under each species, there are a number of radical exceptions for a good number of species. These exceptions are treated in two ways in the literature. The first way is to list the exceptions as something new and interesting. The fault here lies in the reader's interpretation of such data. The tendency seems to be to attach a great amount of importance to these exceptions giving them undue emphasis. The second way is to omit the exceptions, to totally disregard and attach no importance whatsoever to them, considering these records to be some kind of mistake of nature which should be overlooked. The fault here is obvious. There certainly is some importance in the matter even if trivial, and the minutæ should not be entirely disregarded. In this discussion, the "middle road" has been followed. The exceptions are all listed under each species, but only the preferred habitat is considered; the preferred habitat as defined here is that habitat in which the great majority of individuals were found. Now that also has a serious disadvantage which is well illustrated by an example furnished in a collection of *Orthopodomyia fascipes.* In the course of the authors collecting, a great number of tree holes, the usual habitat of this species, was examined. A very few individuals were collected and this species is considered to be uncommon in the zone. However, one collection was made which yielded literally tens of thousands of larvæ. That was in a cement cess pool type latrine which held the sewage for natural digestion with an effluent into a nearby river. Obviously the habitat was well suited for the breeding of this species, yet it can hardly be called the "preferred" habitat. Still, it cannot be disregarded. The advantage of using the "preferred habitat" becomes apparent when one attempts to correlate the habitats of the species with the classification of the species based on morphology.

For convenience in discussion, the habitats of the larvæ are here divided into three groups. (1) Surface habitats, which include all water either of a permanent or a temporary nature which are impressions in the earth, such as lakes, pools, streams, swamps, rock holes, rain pools, whether or not they are man made, e.g. dams, borrow pits, etc., or animal made, e.g. hoofprints, crab holes, etc. Under this division have been included crab holes, but because of the specialized nature of the habitat they are considered separately instead of with the stagnant pools. The mosquitoes of this habitat have undergone distinct morphological changes which have enabled them to maintain a successful existence. (2) Aerial (above surface) habitats, which include all natural collections of water above the surface and in all cases surrounded by plant tissue. This includes hollow logs, stumps, tree holes and leaf and flower bracts of plants. (3) Artificial containers which include man made habitats such as tin cans, pots, dishes, machinery, etc. This habitat is distinct only in that it has existed in recent times. The mosquitoes breeding in such habitats certainly must, under normal conditions, breed in one or both of the other two types of habitats, and many species still do.

From the "preferred" habitat list then, we can make the following classification of the mosquitoes of Panama based on the larval habitats according to position.

I. Surface water
  A. Flowing
    1. Shady
      Chagasia bathanus; Anopheles punctimacula; Uranotænia calosomata, U. coatzacoalcos; Culex egcymon.
    2. Sunny
      Anopheles pseudopunctipennis, A. punctimacula, A. argyritarsis; Uranotænia pulcherrima; Culex aikeni, C. bastigarius, C. erraticus; Mansonia titillans; Aedeomyia squamipennis.
  B. Stagnant (Permanent)
    1. Shady
      Anopheles kompi, A. eiseni, A. apicimacula, A. strodei, A. triannulatus; Uranotænia coatzocoalcos; Culex coronator, C. declarator, C. mollis, C. nigripalpus, C. conspirator, C. elevator, C. pilosus, C. allostigma.
    2. Sunny
      Anopheles pseudopunctipennis, A. neomaculipalpus, A. punctimacula, A. albimanus, A. albitarsis, A. argyritarsis, A. strodei, A. aquasalis, A. triannulatus; Uranotænia geometrica, U. lowii; C. chidesteri, C. coronator, C. declarator, C. quinquefasciatus, C. interrogator, C. nigripalpus, C. chrysonotum, C. dunni, C. eastor, C. educator, C. hesitator, C. pilosus, C. allostigma; Aedes tæniorhychus.
  C. Stagnant (Temporary)*
      Anopheles neomaculipalpus; Culex corniger; Aedes angustivittatus, A. serratus; Psorophora lineata, P. ferox, P. confinnis.
  D. Crab holes.
      Culex inflictus; Deinocerites pseudes.
II. Aerial habitats

* Many species will breed in temporary bodies of water. This list includes only those especially addicted to temporary water collections.

A. Close to or on the ground (Buttress roots, bamboo sections, coconut shells, palm spathes, etc.)
Culex declarator; Hæmagogus argyromeris, H. chalcospilans, H. lucifer; Trichoprosopon digitatum, T. compressum; Wyeomyia arthrostigma, W. personata; Limatus durhami; Sabethes undosus.

B. Leaf and flower bracts of terrestrial plants.
Megarhinus superbus; Trichoprosopon longipes; Wyeomyia pseudopecten, W. ulocoma, W. chalcocephala, W. complosa.

C. Tree holes
Megarhinus hypoptes, M. moctezuma; Culex conservator; Orthopodomya fascipes; Aedes terrens; Hæmagogus argyromeris, H. lucifer, Wyeomyia personata; Sabethes cyaneus.

D. Epiphytic Bromeliads
Anopheles neivai; Wyeomyia melanopus, W. scotinomus, W. celanocephala, W. quasiluteoventralis.

III. Artificial containers
Culex quinquefasciatus; Orthopodomyia fascipes; Aedes ægypti; Hæmogogus argyromeris, H. lucifer; Trichoprosopon digitatum; Wyeomyia arthrostigma, W. personata; Limatus durhami, L. asulleptus.

Thus far only the position of the habitat has been considered. Further division of these habitats could be made by taking into account the type of water in the receptacles. For example, the salt content. Some species are known to be especially addicted to salt water. Of these, *Anopheles aquasalis, Culex pilosus* and *Aedes tæniorhynchus* are the Panama species collected in salt water. The first are commonly found in fresh as well as salt water. The last species is a well known salt marsh breeder and is seldom collected elsewhere. Another example of habitat division could take into account whether the water is foul, clear, or turbid, etc. However, it is the author's opinion that a great deal more observation and experimentation are necessary before any conclusions can be drawn regarding the role of these factors in the habitats of these mosquitoes.

Plant associations: The association of aquatic plants with mosquitoes is a fairly well known phenomenon. There is a considerable amount of literature on the subject, some dealing with the aquatic plant as a nursery for the immature stages and some as an inhibitor of mosquito breeding. There are three striking aquatic plant associations in Panama. The first is the breeding of *Anopheles albimanus* in extensive floating beds of *Najas*. These floating Najas beds are to be found in the Chagres and Gatun rivers and in Gatun Lake, especially during the dry season. These beds extend for miles in the quiet waters of these rivers and lakes. The high water during the rainy season breaks these beds and they sink below the surface. But during the dry season *albimanus* breeds in great numbers protected by the protruding leaves. Another association is that between *Mansonia titillans* and *Pistia stratiotes* Linn. The larvæ of *titillans* attach themselves almost exclusively to the roots of this plant. *Anopheles triannulatus* breeding in rivers is found nearly always inside the partly submerged rosettes of leaves of *Pistia*. *Aedeomyia squamipennis* is found closely associated with the roots of *Pistia,* but not attached to them as are the larvæ of *titillans.*

Predaceous larvæ: Some of the mosquito larvæ have ceased to be vegetable and small animal feeders and have developed a more active means of feeding. There are ten Panama species which we reared or observed feeding on other mosquito larvæ. Of these, some have the mouth-brushes modified for seizing prey and others have the mandibles and maxillæ modified. Three tribes are represented, the Megarhinini, the Culicini and the Sabethini. Of the first two mentioned, the hairs of the mouth-brushes are strong and rod-shaped, used for grasping other larvæ. The Sabethini do not have adapted mouth-brushes but rather the mandibles and maxillæ are changed to facilitate predaceous activities.

These predaceous mosquito larvæ are as follows: *Megarhinus hypoptes,* feeding on *Hæmogogus argyromeris, H. lucifer, Wyeomyia personata, W. arthrostigma; Megarhinus moctezuma* feeding on *Culex conservator, Hæmogogus argyromeris; Megarhinus superbus* feeding on *Wyeomyia scotinomus, W. quasiluteoventralis; Culex allostigma* feeding on *Chagasia bathanus, Anoph-*

eles kompi, A. eiseni, A. apicimacula, A. punctimacula, A. argyritarsis, A. strodei, Uranotænia coalzacoalcos, Culex coronator, C. corniger, C. declarator, C. mollis, C. conspirator, Hæmagogus argyromeris, H. lucifer; Psorophora lineata feeding on *Trichoprosopon digitatum; Trichoprosopon digitatum* is cannibalistic; *Trichoprosopon compressum* feeding on *Wyeomyia personata; Trichoprosopon longipes* feeding on *Wyeomyia pseudopecten, W. complosa; Sabethes cyaneus* and *Sabethes undosus* feeding on *Aedes ægypti* (in the laboratory).

From this list, it is observed that there is apparently little preference as to the food of these larvæ. They seem quite willing to eat any larvæ that happen to be in the same habitat with it, and as far as is known, none of the prey have developed modifications to protect themselves from their destroyers. However, some of the predaceous larvæ have developed moderately long and stout body hairs which undoubtedly prevent cannibalism. An example of this is the larva of *Sabethes undosus.*

Unfortunately there are no records from Panama as to other organisms which are eaten by these larvæ. Further observation is necessary to determine whether these larvæ are partial to other mosquito larvæ because of their characteristic motion, or whether they will readily eat any conveniently sized organism whose motion attracts their attention. In the laboratory, however, nine of the ten species listed were reared. Each of these species readily ate the larvæ of colony reared *Aedes ægypti.*

Adult ecology: The great change from an aquatic existence to a terrestrial mode of life, of course, greatly complicates the habits of any organism. This holds true for mosquitoes. Aside from the obvious morphological changes which take place, there are as great changes in the physiology. A new source of food has to be acquired and new habits developed in this new habitat.

Unfortunately, very little is known about adult mosquito habits as compared with larval habits. We are well aware of the fact that mosquitoes will make use of mammal blood. In addition, among the Sabethines a few species have been reported as feeding on reptile blood. But we do not know what their other feeding habits may be. What role does plant food play in the lives of these organisms? Do they have food preferences? If so, what effect does this have on the breeding habits of the larvæ? Does the female lay her eggs near her plant food?

Species known to bite man: Finally, there is one factor in adult ecology which has received attention. That is the human feeding habits of mosquitoes. The following species of the Panama fauna are known to bite man:

Anopheles pseudopunctipennis, A. apicimacula, A. neomaculipalpus, A. punctimacula, A. albimanus, A. neivai, Culex quinquefasciatus, C. nigripalpus, C. inflictus, deinocerites pseudes? (in houses), *Mansonia titillans, M. arribalzagæ, M. nigricans, M. fasciolatus, Aedeomyia squamipennis?* (in human bait traps), *Aedes ægypti, A. quadrivittatus, A. terrens, A. fulvus, A. serratus, A. tæniorhynchus, Hæmagogus argyromeris, H. lucifer, H. equinus, Psorophora lineata, P. ferox, P. lutzi, P. confinnis, P. cyanescens, Trichoprosopon digitatum, T. compressum, T. espini, Wyeomyia celanocephala, W. personata, W. melanocephala, Limatus durhami, Sabethes cyaneus, S. chloropterus, S. undosus.*

The preceding list contains only those species which have been observed actually to bite, with the exceptions so marked and explained in the following parentheses.

There are many other species which will and do no doubt feed on human blood. Many other species have been collected in horse traps which undoubtedly will feed on humans, but they are not listed because they have never actually been observed to bite man.

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——— 1942, The Anopheline Mosquitoes of the Caribbean Region, Nat. Ins. Health Bull., no. 179, U. S. Pub. Health Serv.

LANE, J., 1939, Catalogo dos Mosquitos Neotropicos, Bol. Biol., Ser. Mono., no. 1.

——— & N. CERQUEIRA, 1942, Os Sabethineos da America, Arq. Zool. Est. São Paulo, vol. III, art. IX, 473–849.

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RUSSELL, P. F., L. E. ROZEBOOM, & A. STONE, 1943, Keys to the Anopheline Mosquitoes of the world, Am. Ent. Soc., Phila.

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——— & T. H. AITKEN, 1942, The Anopheline mosquitoes of the northern half of the western hemisphere and the Philippine Islands, Army Med. Bull. no. 59.

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AN ENTOMOLOGICAL NUMBER PROBLEM
DIVISION OF INSECTS

A man died and left a box of Tabanids to his two sons. The sons sold the specimens for as much per specimen as there were specimens in the box. With the money from this sale the sons purchased Ichneumon Flies at ten cents per specimen, and one male Ant, which cost less than ten cents. The specimens were then divided equally between the two sons. How much did the son who got only Ichneumon Flies have to pay the son getting the male Ant in order to effect an equitable division?—M. W. WING.

THE SIPHONAPTERA IN 1835

The paucity of information about this order in 1835 is indicated by the article in the seventh edition of the Encyclopædia Britannica, published in that year, and in which the order is referred to as Suctoria DeGeer, although in a footnote, the names Aptera Linn., Siphonaptera Lat., and Aphaniptera Kirby are recorded. The genus Pulex Linn., composed the entire order and this was by no means numerous in species. Pulex irritans Linn., the "human flea" was known from various animals besides humans but among humans it was supposed to prefer "children and the gentler sex, owing to the superior softness of their skin."—H. B. W.

THE OLD WORLD MEMBRACIDAE

BY FREDERIC W. GODING

(Continued from Vol. LVII, p. 272)

LIST OF SPECIES

australis Fairmaire, Rev. Memb. p. 518. (1846). Gosford, N. S. W.; Victoria; Tasmania; Williamstown, S. Australia.
castaneus Distant, Ann, Mag. N. H. xviii, p. 25. (1916). Australia.
insularis Distant, Ann, Mag. N. H. xviii, p. 26. (1916). New Britain Is., New Guinea.
obstans Walker, List Hom. B. M. Suppl. p. 162. (1858). Tasmania.
binotatus Walker, Ins. Saund. Hom. p. 81. (1858). New Holland.
hospes Kirkaldy, Bul. Exp. Sta. Haw. S. P. Assoc. (1), ix, p. 378. (1906). Sydney, N. S. W., Australia.
affinis Distant, Ann. Mag. N. H. xviii, p. 25. (1916). New South Wales, Australia.

Centruchus

Stål, Hemip. Afric. iv, p. 93. (1866); *Leucothorax* Buckton, Tr. Linn. Soc. Lond. Zool. (2), ix, p. 334. (1905).

KEY TO SPECIES

1(4). Suprahumerals broad, at least long as the intervening space, tips truncate; pronotum black.
2(3). Suprahumerals horizontal, longer than intervening space, carinate on upper surface behind middle, legs pale brown; tegmina subopaque ferruginous, faint median whitish transverse band, apical veins slightly nodulose; 6 × 6 mm. .... **laticornis**
3(2). Suprahumerals weakly oblique, long as intervening space, not carinate above; tegmina subhyaline, pale transverse median band; legs black; 7 × 4.5 mm. .... **cuneatus**
4(1). Suprahumerals horizontal, slender, acuminate, not more than half as long as the intervening space, tips acute.
5(6). Head and pronotum bluish black, legs purplish red; suprahumerals one-fourth as long as the intermediate space, dorsum of posterior process straight; tegmina vinaceous hyaline, basal area black; 7 × 4 mm. .... **mutilis**
6(5). Head and pronotum piceous, legs ochraceous; basal half of posterior process ochraceous, dorsum depressed at base, middle elevated; tegmina subhyaline, basal area brown, median broad black transverse band; 7 × 4 mm. .... **decoratus**

LIST OF SPECIES

laticornis Funkhouser, Jour. Str. Br. Roy. Asiat. Soc. p. 9. (1918). Singapore.

cuneatus Distant, Faun. Brit. Ind. iv, p. 56, fig. 49. (1908). Sookna, India.

mutilis Distant, Faun. Brit. Ind. vi, App. p. 168, fig. 123. (1916). Maymyo, Burma.

decoratus Distant, Faun. Brit. Ind. iv, p. 58. fig. 50. (1908). Momeit, Burma.

Eufairmairia

Distant, Ann. Mag. N. H. xviii, p. 35. (1916).

KEY TO SPECIES

1(20). Suprahumerals oblique, multicarinate, posterior process tricarinate.

2(17). Posterior process long as tegmina or nearly so; suprahumerals distinctly obliquely elevated.

3(6). Suprahumerals evidently longer than the space between bases.

4(5). Suprahumerals more than twice as long as the intervening space, sides parallel, flat, broad, tips truncate; tegmina pale lurid, base and most of costal area ferruginous; 9 mm. .... **decisus**

5(4). Suprahumerals about one and a half times longer than space between bases, very robust, triquetrous, narrowed toward tips the latter truncate the hind angle acute; basal fourth of posterior process robust thereafter slender; black, very rugose; tegmina ferruginous opaque, large central area paler subopaque, white spot behind apex of clavus; 12 × 6 mm. .... **giganticus**

6(3). Suprahumerals about equal in length to the intervening space.

7(10). Tips of suprahumerals acute; tegmina pale hyaline.

8(9). Dark or pale brown, head and basal area of metopidium black; finely punctate; posterior process long as tegmina; 7–8 × 3.5–5 mm. .... **tepperi**

9(8). Black, rugose, suprahumerals slightly shorter, posterior process a little shorter than tegmina; 7 mm. .... **densus**

10(7). Tips of suprahumerals truncate or roundly truncate; tegmina pale hyaline, base and costal area ferruginous or brown.

11(14). Suprahumerals broad, flat, sides parallel; tegmina subhyaline.

12(13). Head, pronotum and basal area of costal margin dark purplish brown, legs paler; tips of suprahumerals roundly truncate hind angle acute; 7–8 × 5 mm. .... **consobrinus**

13(12). Entirely piceous, finely rugose, basal area of tegmina brown; tips of suprahumerals truncate; 8 × 5 mm. .... **relatus**

14(11). Suprahumerals narrowed from base, robust, tips slightly roundly truncate, apex of posterior process a little shorter than the tegmina.

15(16). Brown, head blackish, shining black spot above each eye, scutellum yellow, tibiæ yellowish brown; tips of suprahumerals lightly rounded outwardly; 8.5–9 × 5 mm. .... **acanthaspis**

16(15). Dull testaceous, legs paler; tips of suprahumerals straight, slightly obliquely roundly trucate; 7–8 × 4.5–5 mm. .... **fraternus**

17(2). Suprahumerals weakly oblique, lightly elevated.

18(19). Posterior process about as long as the tegmina, basal fourth thick, sides of suprahumerals nearly parallel, tips roundly truncate hind angle acute; brown, head darker; 7 × 5 mm. **curvicaudus**

19(18). Posterior process not passing apex of clavus, basal two-thirds robust thereafter slenderer, tips of suprahumerals roundly truncate hind angle acute; black, scutellum ochraceous; tegmina pale bronze with darker suffusions, base black, a pale subbasal transverse fascia; 7 × 5 mm. .... **distinctus**

20(1). Suprahumerals horizontal, posterior process almost as long as the tegmina, base thick, apical area slender.

21(22). Suprahumerals twice as long as the intervening space, broad, sides parallel, tips rounded and very briefly acute at middle; brown, metopidium very high with black spot above each eye; tegmina fusco-hyaline, base and costal area reddish brown; 9 × 6.8 mm. **laticornis**

22(21). Suprahumerals half as long as the intervening space, narrowed from base, tips obliquely truncate hind angle acute; piceous brown metopidium darker, rugose; tegmina colorless hyaline, base broadly ferruginous; 6 × 4 mm. .... **brevicornis**

List of Species

decisus Walker, List Hom. B. M. p. 621. (1851). New Holland; Murray Bridge, S. Australia.

giganticus Goding, Mon. Aust. Memb. p. 20, pl. 1, fig. 1. (1903). S. Australia.

tepperi Goding, Mon. Aust. Memb. p. 22. (1903). Bunbury, W. Australia.

cupreus Distant, Ann. Mag. N. H. xviii, p. 38. (1916). Yallingup, W. Australia.

densus Walker, Jour. Linn. Soc. i, p. 163. (1857). Sarawak, Borneo.

consobrinus Distant, Ann. Mag. N. H. xviii, p. 37. (1916). Gayndah, Rockhampton, Peak Downs, Queensland; Coolabah, N. S. W.; Mallee, Victoria, Australia.

relatus Distant, Ann. Mag. N. H. xviii, p. 36. (1916). Gayndah, Queensland, Austrlia.

acanthaspis Fairmaire, Rev. Memb. p. 515. (1846). Sydney, Tweed, R., Tamworth, Wellington, N. S. W.; Highfields, Queensland; Murray R., S. Australia.

harrisi Distant, Ann. Mag. N. H. xviii, p. 35. (1916). Queensland, Australia.

fraternus Distant, Ann. Mag. N. H. xviii, p. 36. (1916). Gayndah, Gatton, Queensland; Capertee, Rylstone, Lyndhurst, N. S. W., Australia.

curvicaudus Goding, Mon. Aust. Memb. p. 24. (1903). Tweed R., N. S. W., Australia.

acanthaspis Distant, Ann. Mag. N. H. xviii, p. 38. (1916). Rockhampton, Queensland, Australia.

distinctus Distant, Ann. Mag. N. H. xviii, p. 38. (1916). Port Darwin, N. Australia.

laticornis Funkhouser, Rec. Aust. Mus. xv, p. 307, pl. 26, figs. 5, 6. (1927). Fly River, New Guinea.

brevicornis Goding, Mon. Aust. Memb. p. 21. (1903). S. Australia; Mt. Barker, W. Australia.

Sextius

Stål, Hemip. Afric. iv, p. 88. (1886); *Pterosticta* Buskton, Mon. Memb. p. 230. (1903).

KEY TO SPECIES

1(12). Posterior process as long or longer than the tegmina.

2(7). Suprahumerals extended more or less obliquely forward.

3(6). Suprahumerals porrect, twice as long as width of base.

4(5). Brown, median carina black, tegmina milky hyaline, translucent, basal area brown; suprahumerals flat, bases not distant, tips truncate; 6 × 3 mm. .... **projectus**

5(4). Greenish or yellowish, median carina red, tegmina hyaline; suprahumerals distant between bases, tips obtuse, dark sometimes forming broad band across pronotum; 7–8 × 3–4 mm. **rubrilineus**

6(3). Suprahumerals lightly inclined forward, robust, tips subacute; greenish yellow, head and legs darker, tegmina concolorous, apical half more hyaline; 6–7 × 3–3.5 mm. .... **bucephalus**

7(2). Suprahumerals transversely oblique or horizontal, not inclined forward.

8(11). Suprahumerals horizontal, very short, about long as broad.

9(10). Pale testaceous, tegmina subhyaline, wrinkled, frequently some scattered black spots; apical area of posterior process recurved, tips of suprahumerals acute; 9 × 4 mm. .... **major**

10(9). Yellow or greenish, head, broad transverse band including suprahumerals and legs brown, apical area of tegmina hyaline; posterior process straight; 7 × 3 mm. .... **spretus**

11(8). Suprahumerals heavy, strongly oblique, twice longer than the basal width, tips blunt, front side only carinate; posterior process straight, depressed, heavy; tegmina hyaline; 6 × 3 mm. **occidentalis**

12(1). Posterior process shorter than the tegmina.

13(20). Suprahumerals transversely oblique or horizontal, not inclined forward.

14(19). Suprahumerals very short, horizontal.

15(18). Suprahumerals robust, tips straight, not depressed.

16(17). Ochraceous, head, transverse band between suprahumerals, and femora black; apical half of tegmina subyaline; 6.5 × 2.5 mm. **reticulatus**

17(16). Pale greenish, dorsum pale purplish red anteriorly between suprahumerals, legs ochraceous; tips of tegmina brownish, large black spot on upper basal area; 5–6 × 3 mm. .... **atromaculatus**

18(15). Suprahumerals about equal in size to humerals, conical, tips lightly depressed, obtuse; dorsum of posterior process strongly arcuate from base; apical half of tegmina reticulate; pale yellow, chest piceous; 5–7 × 2–3 mm. .... **depressus**

19(14). Suprahumerals weakly oblique, about twice as long as basal width, tips subacute, posterior process nearly straight; pale greenish yellow, with or without transverse fuscous band between suprahumerals, median carina often ferruginous; tegmina hyaline, basal area green or tawny; 7–8 × 4–4.5 mm. **virescens**

20(13). Suprahumerals lightly inclined forward, very short, pronotum deeply impressed above basal margin; entirely testaceous; 6.5–7.75 × 2.25–3.5 mm. .... **bipunctata**

LIST OF SPECIES

projectus Funkhouser, Rec. Aust. Mus. xv, p. 312, pl. 26, fig.16. (1927). King George's Sound, West Australia.

rubrilineus Buckton, Mon. Memb. p. 230, pl. 51, fig. 5. (1903). Bursaria, W. Australia.

xantha Buckton, Mon. Memb. p. 231, pl. 51, fig. 7. (1903). Bursaria, West Australia.

bucephalus Distant, Ann. Mag. N. H. xviii, p. 34. (1916). Peak Downs, Gayndah, Queensland, Australia.

major Distant, Ann. Mag. N. H. xviii, p. 34. (1916). Peak Downs, Gayndah, Queensland, Australia.

spretus Buckton, Mon. Memb. p. 230, pl. 51, fig. 5. (1903). Adelaide, S. Australia.

longinotum Kirkaldy, Rept. Exp. Sta. Haw. S. P. Assoc. ix, p. 377. (1906). Nelson, Queensland, Australia.

occidentalis Jacobi, Faun. S–W Australia, Hom. ii, p. 338, figs. 1, 2. (1909). Brown Station, Pinjarrah, W. Australia.

reticulatus Distant, Ann. Mag. N. H. xviii, p. 34. (1916). N–W Australia.

atromaculatus Distant, Ann. Mag. N. H. xviii, p. 35. (1916). N. Queensland, Australia.

depressus Goding, Mon. Aust. Memb. p. 12, pl. 1, fig. 24. (1903).

Blue Mts., Tweed R., Maitland, Kemsey, Sydney, N. S. W.; Townsville, Kuranda, Brisbane, Queensland, Australia.

virescens Fairmaire, Rev. Memo. p. 515. (1846); Goding, Mon. Aust. Memb. p. 10, pl. 1, fig. 2. (1903); Buckton, Mon. Memb. p. 228, pl. 51, fig. 3. (1903). Tarago, Clarence R., Gosford, Loftus, Wollongong, Bungendere, Homebush, Maitland, Sydney, Penrith, Kensey, Uralla, Newcastle, N. S. W.; Brisbane, Townsville, Queensland; Melbourne, Victoria; Adelaide, S. Australia.

suffusa Walker, List Hom. B. M. p. 530. (1851). Unknown.

assimilis Kirkaldy, Rept. Exp. Sta. Haw. S. P. Assoc. ix, p. 376. (1906). Sydney, N. S. W., Australia.

bipunctata (Fabr.) Kirkaldy, Rept. Exp. Sta. Haw. S. P. Assoc. ix, p. 376. (1906). Cairns, Bundaberg, Queensland, Australia.

kurandæ Kirkaldy, Rept. Exp. Sta. Haw. S. P. Assoc. ix, p. 377. (1906). Kuranda, Townsville, Queensland, Australia.

Periaman

Distant, Faun. Brit. Ind. iv, p. 37. (1908).

KEY TO SPECIES

1(12). Suprahumerals at least as long as space between bases, posterior process shorter than tegmina.

2(3). Suprahumerals twice as long as the intervening space, strongly oblique; pronotum brown, base and head piceous, basal area of posterior process ochraceous, apical area piceous, legs ochraceous; 6 × 3 mm. .... **pyropinus**

3(2). Suprahumerals long as the intervening space.

4(5). Front of pronotum with one central and two lateral longitudinal yellow tomentose stripes with common origin, the latter passing beneath suprahumerals and uniting on base of posterior process; suprahumerals moderately oblique the front margin laminate, posterior process heavy, apical half slender; brown, tegmina ochraceous, apical area bronze; 9 × 4.5 mm. .... **flavolineatus**

5(4). Front of pronotum destitute of tomentose stripes.

6(11). Suprahumerals moderately oblique, recurved.

7(10). Black.

8(9). Tegmina pale bronze hyaline, base and costal area to apex black; suprahumerals with front and hind margins broadly laminate, white tomentose stripe beneath each, posterior process heavy, apical half slender; 8.5–9 × 5 mm. .... **wallacei**

9(8). Tegmina bronze brown, basal area blackish, pronotum shining black, densely long pilose; posterior process gradually acuminate; 8 × 3 mm. .... **pilosus**

10(7). Purplish brown, head blackish, yellow pubescent, tegmina vinaceous hyaline; posterior process slender; 10 mm. .... **nitobei**

11(6). Suprahumerals weakly oblique, almost horizontal, triangular; tegmina vinaceous hyaline, base, costal and apical areas brown, median veins spined; black, legs brown; 7.7 × 4.8 mm. **rectidorsum**

12(1). Suprahumerals shorter than space between bases, posterior process shorter than tegmina.

13(14). Pronotum black with a central and two lateral longitudinal white tomentose stripes having a common origin at the base in front, the lateral stripes passing beneath suprahumerals and uniting on base of posterior process; tegmina gray hyaline; 8 mm. **limbatus**

14(13). Front of pronotum destitute of tomentose stripes; tegmina smoky hyaline, base black, tips fuscous.

15(16). Entirely black; suprahumerals distinctly oblique, front margin curved, posterior process heavy; veins of tegmina spined; 5.5 × 3.2 mm. .... **nigris**

16(15). Blackish brown, tarsi flavous; suprahumerals almost horizontal, posterior process robust, gradually acuminate, middle and apex lightly depressed; 7 × 3.6 mm. .... **brevifrons**

List of Species

pyropinus Distant, Faun. Brit. Ind. iv, p. 38, fig. 31. (1908). Ruby Mines, Burma.

flavolineatus Buckton, Mon. Memb. p. 247. (1903); Distant, Faun. Brit. Ind. iv, p. 38, fig. 30. (1908). Tenasserim, Myitta, Mergui, India.

wallacei Distant, Ann. Mag. N. H. xvii, p. 320. (1916). Sarawak, Sandakan, Borneo.

pilosus Distant, Faun. Brit. Ind. vi, App, p. 157. (1916). Kurseong, E. Himalayas, India.

nitobei Matsumura, Anot. Cic. Japan, viii, p. 17. (1912). Aomori, Sambogi, Japan.

rectidorsum Funkhouser, Bul. Brook. Ent. Soc. xxii, p. 107, pl. 6, figs. 4–6. (1927). Anai Kloof, Sumatra.

limbatus Walker, Jour. Linn. Soc. 1, p. 163. (1857). Sarawak, Borneo.

nigris Funkhouser, Rec. Aust. Mus. xv, p. 306, pl. 26, figs. 3, 4. (1927).

brevifrons Funkhouser, Phil. Jour. Sci. x, p. 383, pl. 1, fig. 8. (1915). Palawan, Puerta Princesa, Philippines.

Centrotypus

Stål, Hemip, Afric. iv, p. 88. (1866); *Ibiceps* Distant, Ann. Mag. N. H. xvii, p. 150. (1916); *Lestarches* Distant, Ann. Mag. N. H. xvii, p. 318. (1916).

Key to Species

1(40). Blue black or black.

2(25). Pronotum blue black, costal margin of tegmina blackish or brown.

3(22). Apical area of tegmina largely brownish or blackish, large central area more or less hyaline.

4(21). Suprahumerals at least as long as the space between bases.

5(10). Suprahumerals gradually acuminate.

6(7). Expanse of suprahumerals almost equal to entire length to tips of tegmina, posterior process nearly long as tegmina; 9 × 8.5 mm. .... **anchorago**

7(6). Expanse of suprahumerals distinctly less that length to tips of tegmina, posterior process extended some beyond apex of clavus.

8(9). Base of posterior process armed with a small tooth, suprahumerals shorter; 9 × 4 mm. .... **pactolus**

9(8). Base of posterior process not dentate; suprahumerals longer; 9 × 7 mm. .... **tauriformis**

10(5). Suprahumerals equally broad, tips obliquely trncate, rounded, roundly truncate, hind angle subacute.

11(14). Expanse of suprahumerals equal or almost equal to entire length of body to tips of tegmina; posterior process extended far beyond apex of clavus.

12(13). Suprahumeral expanse equal to total length of body, moderately broad, more than twice longer than broad, horizontal, tricarinate above, tips roundely oblique; 10 × 10 mm. .... **securis**

13(12). Suprahumeral expanse slightly less than total length of body, very broad, slightly less than twice longer than broad, lightly curved upwardly and recurved, strongly depressed, subfoliaceous anteriorly unicarinate above, tips rounded; 9 × 8 mm. .... **amplicornis**

14(11). Expanse of suprahumerals distinctly less than length of body to tips of tegmina.

15(20). Tips of suprahumerals broadly obliquely rounded in front.

16(19). Posterior process extended far beyond apex of clavus.

17(18). Suprahumerals horizontal, shorter, very lightly curved upwardly; 8.5 × 7 mm. .... **taurus**

18(17). Suprahumerals strongly curved upwardly, oblique, longer; 10–11 × 9.5 mm. .... **assamensis**

19(16). Posterior process extended to apex of clavus, suprahumerals subhorizontal, tips obliquely impressed; 8 × 5 mm. .... **siamensis**

20(15). Tips of suprahumerals obliquely truncate, apical area curved upwardly; posterior process extended far beyond apex of clavus; 10 × 8–8.5 mm. .... **flexuosus**

21(4). Suprahumerals shorter than the space between bases, broad, horizontal tips, truncately rounded; posterior process not passing apex of clavus; 8 mm. .... **neuter**

22(3). Apical area of tegmina concolorous hyaline; suprahumerals broadly expanded.

23(24). Suprahumeral expanse greater than total length of body to tips of tegmina, more than twice longer than the intervening space, broad, curved upwardly, gradually acuminate, carina above and beneath; posterior process far passing apex of clavus; tegmina smoky hyaline; 11 × 12 mm. .... **laticornis**

24(23). Suprahumeral expanse slightly less than total length, much longer than the intervening space, broad, oblique, unicarinate above, tips broadly truncate front angle rounded; tegmina ochraceous hyaline; 6.6 × 6 mm. .... **shelfordi**

25(2). Pronotum black, costal margin of tegmina blackish or brownish.

26(31). Apical area of tegmina largely blackish or brownish.

27(30). Suprahumerals long as the intervening space nearly horizontal, tips slightly recurved, acute; posterior process straight, extended beyond clavus.

28(29). Large; suprahumerals broad, posterior process gradually acuminate; base of tegmina black; 10–12 × 5 mm. .... **erigens**

29(28). Small; suprahumerals moderately broad, posterior process with broad, apical area slender; basal third of tegmina obliquely black; 5–6 × 3–4 mm. .... **belus**

30(27). Suprahumerals longer than space between bases, diverging, slightly ascending, very broad, tips obtuse; posterior process very slightly curved above scutellum, stout, tip slightly decurved beyond apex of clavus; 5–6 mm. .... **forticornis**

31(26). Apical area of tegmina concolorous hyaline not darker; suprahumerals about as long as space between bases, nearly horizontal, tips acute, slightly recurved.

32(35). Length to tips of tegmina more than 10 mm, suprahumerals slightly recurved.

33(34). Posterior process extended distinctly beyond apex of clavus, straight, suprahumerals a little longer than the intervening space; 11 × 7 mm. .... **ater**

34(33). Posterior process extended to apex of clavus, base slightly raised; suprahumerals about as long as the intervening space, bicarinate above; 11 × 8 mm. .... **ortus**

35(32). Length to tips of tegmina not exceeding 7 mm.

36(39). Posterior process extended beyond apex of clavus.

37(38). Blackish, suprahumerals reddish brown, (or entirely brown), subhorizontal, margins foliaceous, posterior carina continuous with lateral carina of posterior process whose tip far passes apex of clavus; legs ferruginous; tegmina lurid; 6 mm. .... **laminifer**

38(37). Deep black; suprahumerals broad, acuminate, margins not foliaceous, bicarinate above; posterior process extended slightly beyond apex of clavus; hind tarsi whitish; tegmina testaceous hyaline; 7 mm. .... **latimargo**

39(36). Posterior process extended to apex of clavus straight; suprahumerals moderately broad, obliquely curved upwardly, tips broadly subacute; tegmina shining brown hyaline; legs piceous; 7 × 5 mm. .... **bowringi**

40(1). Pronotum brown or ochraceous.

41(48). Tegmina vinaceous hyaline, costal margin blackish or brownish; tips of suprahumerals rounded.

42(45). Apical area of tegmina brownish or blackish.

43(44). Brown, frons ferruginous; suprahumerals very broad, dilated toward tips, longer than the intervening space; posterior process about as long as the tegmina, the latter hyaline with base, costal and apical areas ochraceous; 11 × 9 mm. ....**alatus**

44(43). Shining dark brown; suprahumerals short, hardly as long as the space between bases, broad, auriculate, unicarinate above; posterior process slender, extended beyond clavus; 8 mm. ....**javanensis**

45(42). Apical area of tegmina concolorous hyaline.

46(47). Brown; suprahumeral expanse equal to total length to tips of tegmina, tips lightly curved upwardly, upper surface bicarinate; posterior process nearly long as tegmina; 10 × 10 mm. **longicornis**

47(46). Ochraceous; suprahumeral expanse distinctly less than total length to tips of tegmina, long, moderately broad, recurved tips brown and carinate; posterior process extended beyond apex of clavus; 10 × 7.5–8 mm. ....**flavescens**

48(41). Entirely brown including the tegmina which has three discoidal cells; suprahumerals long as the space between bases, slightly curved upwardly, bicarinate, rugose above, bicarinate below, tips acute; posterior process slender, slightly sinuate, much longer than clavus; 8 × 6 mm. ....**adunctus**

List of Species

anchorago Guerin, Icon. Reg. Anim. Ins. iv, p. 367, pl. 69, fig. 4. (1838). Java. *pronotalis* Distant, Ann. Mag. N. H. xvii, p. 317. (1916). Java.

pactolus Buckton Mon. Memb. p. 233, pl. 52, fig. 7. (1903). Perak, Malacca.

tauriformis Distant, Ann. Mag. N. H. xvii, p. 317. (1916). Java.

securis Buckton, Mon. Memb. p. 238, pl. 54, fig. 4. (1903). Sikhim, Mungphu, Naga and Nilgiri Hills, Bombay; Trichur, Cochin State, India. Ruby Mines, Burma. Sandakan, Borneo.

amplicornis Stål, Bid. Memb. K. p. 285. (1869). Cambodia, French Indo-China. Siam. Anei Kloof, Sumatra.

taurus Distant, Ann. Mag. N. H. xvii, p. 316. (1916). Siamese Malay States.

assamensis Fairmaire, Rev. Memb. p. 517. (1846); Distant, Faun. Brit. Ind. iv, p. 34, fig. 28. (1908). Assam, Sikhim, Pankabar, Myitta, Tenasserim, India. Rangoon, Burma. Siam. Malacca.

costalis Walker, Ins. Saund. Hom. p. 82. (1858). Unknown.

siamensis Distant, Ann. Mag. N. H. xvii, p. 316. (1916). Bulsit Behra, Siamese Malay States.

flexuosus Fabricius, Syst. Ent. iv, p. 12. (1794); Buckton, Mon. Memb. p. 237, pl. 54, fig. 1. (1903); Distant, Faun. Brit. Ind. iv, p. 33, fig. 27. (1908). Sylbet, Sikhim, Shillong, Sibsagar, Tenasserin, Myitta, India. Arrakan, Burma, Perak, Malacca.

neuter Fairmaire, Rev. Memb. p. 517. (1846). Java.
laticornis Funkhouser, Bul. Brook. Ent. Soc. xvi, p. 44, figs. 3, 4. (1921). Riviere Claire, Haut-Tonkin, Madon, N. Indo China.
shelfordi Distant, Ann. Mag. N. H. xvii, p. 315. (1916). Sarawak, Sandakan, Borneo.
erigens Walker, List Hom. B. M. p. 614. (1851). Philippines.
mounseyi Distant, Ann. Mag. N. H. xvii, p. 150. (1916). Philippines.
belus Buckton, Mon. Memb. p. 232, pl. 52, fig. 3. (1903). Unknown.
asmodeus Distant, Faun. Brit. Ind. iv, p. 36. (1908). Tenasserim, Myitta, India. Singapore. Sandakan, Sarawak, Kapit, Borneo.
forticornis Walker, Jour. Linn. Soc. x, p. 185. (1868). Celebes Is.
ater Buckton, Mon. Memb. p. 238, pl. 54, fig. 5. (1903). Ruby Mines, Burma.
ortus Distant, Faun. Brit. Ind. iv, p. 35. (1908). Trivandrum, Madras, India.
laminifer Walker, Jour. Linn. Soc. i, p. 93. (1856); Buckton, Mon. Memb. p. 240, pl. 55, fig. 3. (1903). Sarawak, Borneo, Singapore.
latimargo Walker, Jour. Linn. Soc. i, p. 163. (1857). Sarawak, Borneo.
bowringi Distant, Ann. Mag. N. H. xviii, p. 291. (1916). Penang, Malacca.
alatus Buckton, Mon. Memb. p. 237, pl. 54, fig. 2. (1903). Perak, Malacca.
perakensis Distant, Ann. Mag. N. H. xvii, p. 318. (1916). nom. nud.
javanensis Fairmaire, Rev. Memb. p. 517. (1846). Java.
longicornis Vuillefroy, Ann. Soc. Ent. Fr. (4), iv, p. 142, pl. 1, fig. 8. (1864). Malay Islands. Sarawak, Borneo.
flavescens Distant, Faun. Brit. Ind. iv, p. 35. (1908). Dehra Dun, N. India.
adunctus Buckton, Mon. Memb. p. 236, pl. 53, fig. 6. (1903). Luzon, Philippines.
brunneus Funkhouser, Jour. Str. Br. Roy. Asiat. Soc. No. 82, p. 207, figs. 1, 2. (1920). Sandakan, Borneo.

Pogon

Buckton, Mon. Memb. p. 248. (1903).

KEY TO SPECIES

1(6). Suprahumerals half as long as space between bases, oblique, posterior process longer than clavus, apex decurved.
2(5). Posterior process impinging upon scutellum and margins of tegmina.
3(4). Pale yellow, base of metopidium piceous, brown beneath suprahumerals; posterior process robust, with several elevated lines extended on disk and suprahumerals, straight, apical area slender; tegmina pale yellow hyaline; 5 × 2.5 mm. .... **flavescens**
4(3). Ferruginous, tegmina ferruginous hyaline; posterior process slender, weakly sinuate; 5 mm. .... **ferrugineum**

5(2). Posterior process slightly but distinctly elevated above the scutellum and margins of tegmina, slender, sinuate; ferruginous, tegmina pale ferruginous hyaline, base and costal area darker; 5.5×2 mm. .... **auriculatum**

6(1). Suprahumerals long as or longer than space between bases, posterior process substraight, slender, impinging upon scutellum and margins of tegmina, passing apex of clavus.

7(12). Suprahumerals oblique.

8(11). Brown.

9(10). Purplish brown, legs testaceous, tegmina purplish brown, apical area ochraceous; suprahumerals slightly longer than the intervening space; 5.5×3 mm. .... **cupreum**

10(9). Pale brown, tegmina pale brown with fuscous waved markings; suprahumerals long as the intervening space; 6×4 mm. .... **incurvatum**

11(8). Black, legs pale brown, tegmina bronze brown, large basal area and large spot behind clavus black, a white discal spot; suprahumerals slightly longer than intervening space; 5.5–6 mm. .... **albosignatum**

12(7). Suprahumerals horizontal, long as space between bases; black, legs brown, tegmina dark brown, apical area paler, veins pilose, pale spot near clavus; 6×3.5 mm. .... **atricoxis**

LIST OF SPECIES

flavescens Goding, Am. Mus. Novit. No. 421, p. 25. (1930). N. S. W., Australia.

ferrugineum Melichar, Hom. Ceylon, p. 114. (1903). Peradeniya, Heneratgoda, Ceylon.

auriculatum Stål, Bid. Memb. K, p. 285. (1869); Distant, Faun, Brit. Ind. iv, p. 44, fig. 36. (1908). Horton Plains, Madulsima, Ceylon.

cupreum Kirby, Jour. Linn. Soc. Zool. xxiv, p. 168. (1894); Buckton, Mom. Memb. p. 228, pl. 50, fig. 8. (1903). Badulla, Maskeliya, Kandy, Madulsima, Pundaluoya, Ceylon.

incurvatum Buckton, Mon. Memb. p. 248, pl. 58, fig. 6. (1903); Distant, Faun. Brit. Ind. iv, p. 42, fig. 34. (1908). Pattipola, Ceylon.

albosignatum Distant, Faun. Brit. Ind. vi, App. p. 161, fig. 119. (1916). Pundaluoya, Hakgala, Ceylon.

atricoxis Melichar, Hom. Ceylon, p. 113. (1903). (nec. Kirby); Distant, Faun. Brit. Ind. iv, p. 43, fig. 35. (1908). Peradeniya, Pattipola, Kandy, Nawalapitya, Ceylon.

Micreunini

Micreune

Walker, Jour. Linn. Soc. i, p. 94. (1856).

KEY TO SPECIES

1(2). Superior margin of summit of front process sinuate, notched at middle, lateral spines depressed, width between their tips about equal to width between the humerals, posterior lobes equally prominent; piceous brown, tips of lateral spines, posterior process except apex, body and legs yellow, or entirely ochraceous yellow; tegmina ochraceous; 6–7 × 2–2.5 mm. .... **monstrifera**

2(1). Superior margin of summit of front process strongly convex, not notched at middle.

3(4). Posterior margin of front process with a large lobe just beneath summit and another at base, lateral spines moderately depressed, width between their tips nearly equal to width between humerals; entirely dark brown, tegmina paler brown; 6 × 5 mm. .... cassis

4(3). Posterior margin of front process sinuate, emarginate at middle weakly lobed above and below it, width between tips of lateral spines distinctly less than width between humerals; piceous brown with reddish lines, basal half of posterior process and legs yellowish; tegmina ferruginous; 5 × 1.25 mm. .... clavata

LIST OF SPECIES

monstrifera Walker, Ins. Saund. Hom. p. 80. (1858); Goding, Mon. Aust. Memb. p. 34, pl. 1, figs. 10, 11, 26. (1903). Hunter and Tweed Rivers, N. S. W.; Morton Bat (Brisbane), Rockhampton, Queensland, Australia.

pondifer Walker, Jour. Ent. i, p. 316. (1862). Australia.

cassis Buckton, Mon. Memb. p. 60, pl. 9, fig. 3, (♀). (1903). North Australia.

diadema Kirkaldy, Rept. Exp. St. Haw. S. P. Assoc. ix, p. 372–3, pl. 30, figs. 2, 3. (1906). Kuranda, North Queensland, Australia.

cassis Buckton, Mon. Memb. p. 60, pl. 9, fig. 2, (♂). (1903). North Australia.

clavata Kirkaldy, Rept. Exp. St. Haw. S. P. Assoc. ix, p. 372–3, pl. 30, figs. 4, 5. (1906). North Queensland, Australia.

(to be continued)

PROFESSOR DR. HERMANN A. EIDMANN, AN OBITUARY NOTICE

Death came to Professor Eidmann on September 4, 1949, after an illness of several months. The fifty-two year old Professor of Zoology and Director of the Zoologischen Instituts der Forstlichen Hochschule Hann.-Münden was without doubt one of the foremost myrmecologists of our times. His researches in ants, which covered a period of twenty-five years, dealt primarily with ecology. Over fifty papers on ants, many of them very extensive, testify to his great energy and perseverance. During the last ten years a number of papers were produced under circumstances which would have stopped many a producer with less fortitude. Professor Eidmann not only produced in quantity, but his scholarship was of the highest quality.

In addition to his many works on ants, Professor Eidmann wrote numerous papers in other fields of Zoology. The ecology of the forest animals of the temperate, subtropical and tropical areas of the world took much of his time; so much, in fact, that at times his ant studies had to be put to one side. In a letter dated January 26, 1948, he wrote me that the field work connected with his investigations for the Imperial Bureau of Biological Control in behalf of the Canadian Government was taking most of his time, but "myrmecology has all my love and interest." One must not assume from this confession that his other work ever suffered, for he maintained the very highest of standards in all of his work.

During the months just preceding his final illness he was at work on the sceond edition of his *Lehrbuch der Entomologie,* which was originally published in Berlin in 1941. It was hoped that the new edition would be done by 1949. In addition to this revision, he was well along the way to completing his *Lehrbuch der Myrmekologie.* This latter work was to cover the whole field of myrmecology, including a section on history and biographies. Since Wheeler's famous classic, *Ants, Their Structure, Development and Behavior,* 1910, is the last truly comprehensive work on ants, it is evident how much myrmecologists need a work like the one planned by Professor Eidmann. At the time of this writing I am not informed as to the plans regarding these two books, but it is certainly to be hoped that one or more of Professor Eidmann's close colleagues will be able to carry at least the ant book through to completion.

I will always regret that I never had the opportunity to meet Professor Eidmann and know him personally. Our friendship grew up through our correspondence, which, with the exception of two or three letters written in 1939, existed from 1946 to just before his passing. His command of his own native German was superb, comparable, in fact, to that of a student of the language. This ability to use language well is unfortunately not universal among German scientists. His command of the English language was unusually good.

Professor Eidmann is survived by his wife, Hilda Bach Eidmann, two daughters, Elisabeth and Susi, and a host of friends throughout the world. The date September 4, 1949, marks the passing of a kind and generous man and a great scholar.—MERLE W. WING.

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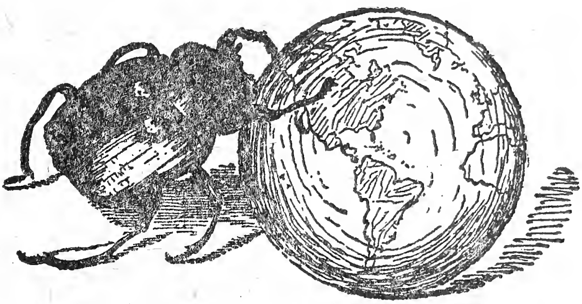

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THE CONTACT CHEMORECEPTORS OF ADULT YELLOW FEVER MOSQUITOES, *ÆDES ÆGYPTI*[1]

By Hubert Frings and Charles L. Hamrum
The Pennsylvania State College
State College, Pennsylvania

INTRODUCTION

Although a large amount of work has been done on chemical repellents for mosquitoes (Dethier, 1947a), little or nothing is known about the fundamental physiology of chemoreception in these insects. A necessary preliminary to such studies is the discovery of the chemoreceptors themselves. Frings and Frings (1949) have reviewed the literature on the location of contact chemoreceptors in insects, and they report, for the Diptera studied so far, that these are generally on the labella and tarsi. The present study on contact chemoreceptors of adult Yellow Fever Mosquitoes adds data on a family of Diptera, the Culicidæ, not previously so studied.

EXPERIMENTAL STUDIES

All mosquitoes used in the experiments were raised in our own laboratory. *A. œgypti* is a small species, but this handicap is offset by the ease with which it responds to laboratory rearing. The larvæ were raised in small jars, being fed a pinch of dog-biscuit daily. By using a constant ration which left no excess,

[1] We are happy to express our appreciation to Dr. Philip Granett, of Rutgers University, who supplied us with mosquito eggs when we needed them. This work was financed, in part, by the John Vogel Memorial Fund.

it was possible to rear the insects through to adulthood without change of water.

The first experiments were performed with mounted living insects. Newly emerged adults were anaesthetized with ether and mounted on tapering blades of wax paper fastened to the ends of glass rods (Frings, 1946). The thorax and wings of a mosquito were securely fastened by lightly touching a hot needle to the wax paper while it was held against the dorsal side of the animal. Mounted mosquitoes had complete freedom of movement of the head and legs; without this freedom, the reactions were impossible to interpret. Mortality as a result of mounting was greater in males than in females, because of the smaller size of the males. Newly emerged adults lived longer on the rods and endured the mounting ordeal much better than older specimens.

The locations of the chemoreceptors were determined by local stimulation methods (Frings and Frings, 1949). The animals were given 24 hours after being mounted to recover, after which they were offered all the water they would take. Following this, testing was begun. Test solutions on artists' brushes were brought to possible loci of gustatory organs, a separate brush being used for each solution. The test solutions were 1M sucrose which was accepted eagerly by the mosquitoes when sated with water, and 2N NH_4Cl which was not accepted even by thirsty mosquitoes. The responses of the animals were observed with a dissecting microscope. Between tests, and after each acceptance of sucrose solution, the animals were offered water to determine their responsiveness. Fatigue was avoided by allowing at least 10 minutes between successive tests with the same individual. The mosquitoes were not allowed to feed during the tests, except for the extremely short time needed to establish a response, and thus association between contacts with the brush bearing sugar solution and reward in the form of food was avoided.

When the labella of either a male or a female mosquito, which had been rendered non-reactive to distilled water by being given all it would take, were touched with sugar solution, the animal immediately started to drink. This positive response was clearly recognizable, because the animals spread the labella and exhibited rapid pumping movements of the throat. When the labella were touched, after such a response, with a brush bearing distilled water only, the insect ceased feeding immediately. When the labella were touched with NH_4Cl solution, the proboscis was withdrawn. In all, 8 females and 23 males were used in replicated tests, with 100% positive response for the females and 86% for the males. It is thus clear that the labella possess gustatory end-organs. The fact that the brush with sugar solution touched only the labellar hairs when positive responses were observed indicates that the receptors are hair organs.

The antennæ, labial palpi, and parts of the proboscis other than the labella were also tested and no positive responses were noted. The internal mouth-parts were explored by separating the labrum and stylet bundle from the labial sheath, using dissecting needles, and bringing sugar solutions to the parts. This technique gave no definite results, however, for the responses of mosquitoes in this condition were erratic.

When the tarsi of males, which were non-reactive to tarsal contact with a brush bearing only distilled water, were touched with a brush bearing sugar solution, the animals responded by moving the proboscis rather accurately toward the brush. If the proboscis touched the brush, they would immediately start to drink. These movements thus provided a clear-cut positive index of reception. On the other hand, when the tarsi of females were similarly tested, the movements of the proboscis were not so clear-cut. Furthermore, the females gave other responses which were quite confusing. One response given by almost all females at some time might best be described as an attempt to push the brush away. The tarsi were pressed violently against the brush and the body was bent almost double. In this way, the labella often accidentally touched the sugar solution on the brush, and the animal began to feed. This was performed so suddenly that it was almost impossible to remove the brush in time to prevent contact with the labella. Under these questionable circumstances positive responses were difficult to ascertain. Thus only clear-cut reaching movements, like those of the males, without bending of the body, were counted as positive. Another perplexing response of females was a persistent positive reaction to water vapor. Since the mosquitoes were offered water to satiety before the tests, all individuals were negative to water at the start. Some females, however, continued to reach with the proboscis for a moist object brought near them, though they would not drink when water was offered to their mouth-parts. In an effort to curb this reaction, the antennæ of some females were removed, since our observations indicated that the antennæ bear the receptors. The response persisted, however, after removal of the antennæ. Thus the antennæ, if they possess water-vapor receptors at all, are not the sole loci of these. In these tests, 122 males and 51 females were used. The males, in 360 trials, gave 178 (50%) positive responses. The females, in 136 trials, gave 31 (25%) positive responses.

The tarsi of other mosquitoes were stimulated with paired presentations of sugar solution and distilled water. Lack of response to either the water or the sugar solution, or responses to both were considered as equivocal results. Responses to water only and not to sugar water were considered negative. Responses to sugar water alone and not to water were considered positive. The latter two types were converted into a net percent positive by subtracting the former from the latter. In 205 tests, 46 males showed 44% net positive response to sugar solution, and, in 175 tests, 20 females showed 1% net positive. These results indicated that the females do not have tarsal receptors, or, if they do, the receptors are practically non-functional.

Since such a sex difference had never before been observed in the Diptera, another experiment was performed to test the validity of these results. A male and a female mosquito which had had water but no food for two days were placed on a circle of filter paper in a Petri dish. The filter paper had two spots moistened with distilled water and two spots moistened with sucrose solution. The mosquitoes, as they moved about, ignored the spots of water, but both stopped immediately and began to feed when the tarsi touched the spots of sugar solution. Only the tarsi were in contact with the sugar solution when the animals stopped and lowered the proboscis. This experiment, replicated with other individuals, showed that the response to the sugar solution is mediated solely through tarsal receptors and that males and females behave alike.

These results were so discordant. in the case of the females, with the tests using mounted insects, that a further series of experiments was performed. Male and female mosquitoes which had had water but no food for two days were allowed to walk about in a Petri dish on filter paper bearing drops of distilled water. They were non-reactive to the water. When an individual had become still, a drop of sugar solution was placed on the paper behind or to the side of it. As soon as the drop spread to the fore tarsus or the middle tarsus of the mosquito, the animal brought the proboscis to the spot and began to feed. There were many replications of this test, using many mosquitoes, with the same results. The evidence seemed abundant that females, as well as males, could recognize sugar solution by means of the tarsi.

Since a clear response could be observed when an acceptable solution contacted the tarsi, a similar experiment was set up to discover whether mosquitoes could be repelled by tarsal contact with an unacceptable solution. Several mosquitoes were anaesthetized lightly and placed in a Petri dish with a floor of two semi-circles of filter paper separated by a small space. One semicircle was moistened with distilled water, the other with 2N NH_4Cl solution. When the mosquitoes revived, they wandered about randomly, showing no obvious avoidance of the NH_4Cl solution. They made no attempt to ingest either the water or the NH_4Cl. The mosquitoes were restless on the NH_4Cl solution, agitatedly cleaning their wings, but they did not search about for a more acceptable substrate.

For comparison, blowflies (*Phormia regina*), known to have tarsal receptors and to reject NH_4Cl solution, were placed in a similar situation and their reactions observed. The responses of these insects were similar to those of the mosquitoes, except that the flies on the NH_4Cl-soaked paper rubbed the legs together agitatedly, in the familiar "cleaning" response. They moved off the NH_4Cl only by accident.

A 2N NH_4Cl solution was painted on a human arm which was offered to hungry mosquitoes in a cage. The mosquitoes alighted on the skin, explored with the proboscis, but made no attempt to bite through, until the NH_4Cl film was broken by evaporation of the water and crystallization of the salt. Since the bites were received only on unprotected areas of the skin, it is possible that salts might be effective as repellents, if some method for maintaining an unbroken moist covering on the skin could be developed.

The appearance of the report by Dethier (1947b) that contact chemoreceptors are found on the ovipositor of hymenopterous parasites led us to test the ovipositor of female mosquitoes. Solutions of NH_4Cl (1N and 2N) and NaCl (1N and 2N) were used. They were brought to the ovipositor of mounted mosquitoes on artists' brushes, following control tests with water on similar brushes. No consistent results could be obtained, and, after many tests, these trials were abandoned without conclusions being reached.

MORPHOLOGICAL STUDIES

For morphological studies, whole mosquitoes and heads of males and females were mounted on microslides in Diaphane. The labella and tarsi were examined and photographed (Plate XIII) with the compound microscope. The hairs at the end of the labella seemed worthy of investigation. Accordingly, mounted living mosquitoes were tested, using the compound microscope for observation. Micro-needles were dipped in sugar solution and brought to the long hairs at the tip of the labella. Whenever one of these hairs was touched, the mosquito moved the proboscis, but did not offer to drink. The same response was obtained when the hairs were touched with a dry needle, or with a needle moistened with distilled water. These hairs, therefore, are probably tactile receptors. The minute size of the other hairs on the labella and the difficulty in touching these without touching one of the larger hairs made further exploration by this method impractical.

There are four types of hairs found on the labella of both males and females (Plate XIII). The short epicuticular hairs (about 7 μ long) found thickly all over the labella are almost certainly non-sensory. The long, pointed hairs (about 40 μ long) in a fan-like pattern at the tip of the labella and scattered about otherwise over the labella, seem, from our experiments, to be tactile receptors. The medium sized, curved hairs (about 20 μ long) at the tip and on the ventral surface of the labella may be the contact chemoreceptors; these are similar to hairs shown to be gustatory end-organs on the labella of other Diptera (Frings and O'Neal, 1946; Frings and Frings, 1949). The short, blunt, peg-like hairs (about 6 μ long), about 14 of which are found on the dorsal surface of each labellum, are of unknown function, but may be either gustatory or possibly olfactory or water-vapor receptors. That the medium-sized hairs are active in contact chemoreception is indicated by the fact that, under the dissecting microscope, it was obvious that the brushes with solutions touched only the long and the medium-sized hairs when positive responses were obtained. Since the long hairs seem to be tactile, the medium-sized hairs are probably gustatory.

On the tarsi of the fore and middle legs, among non-sensory spines and scales, there are many long, slightly curved, probably tactile hairs. At the distal end of each segment of the tarsus there is a group of short curved hairs of approximately the same size and appearance as the medium sized hairs of the labella. These are most numerous on segments 3 and 4 and least numerous on segment 1. They may be the tarsal receptors, but experimental proof is lacking. The hind legs are banded with white or clear scales and, while well provided with spines and long hairs, have few, if any, of the shorter curved hairs like those on the other tarsi. On all the legs, the scales interfere with exact observations. The data from the morphological studies indicate that both males and females possess tarsal receptors, since the tarsi of both sexes have essentially the same possible sensory end-organs.

DISCUSSION

From the data presented above, it seems probable that the contact chemoreceptors of both male and female adult *Ædes ægypti* are on the labella and on the tarsi of at least the fore and middle legs. The receptors are probably medium sized, curved hairs on the labella and possibly similar hairs on the tarsi. With these receptors the mosquitoes seem to be able to distinguish between acceptable and unacceptable solutions. These results accord well with results on other species of Diptera.

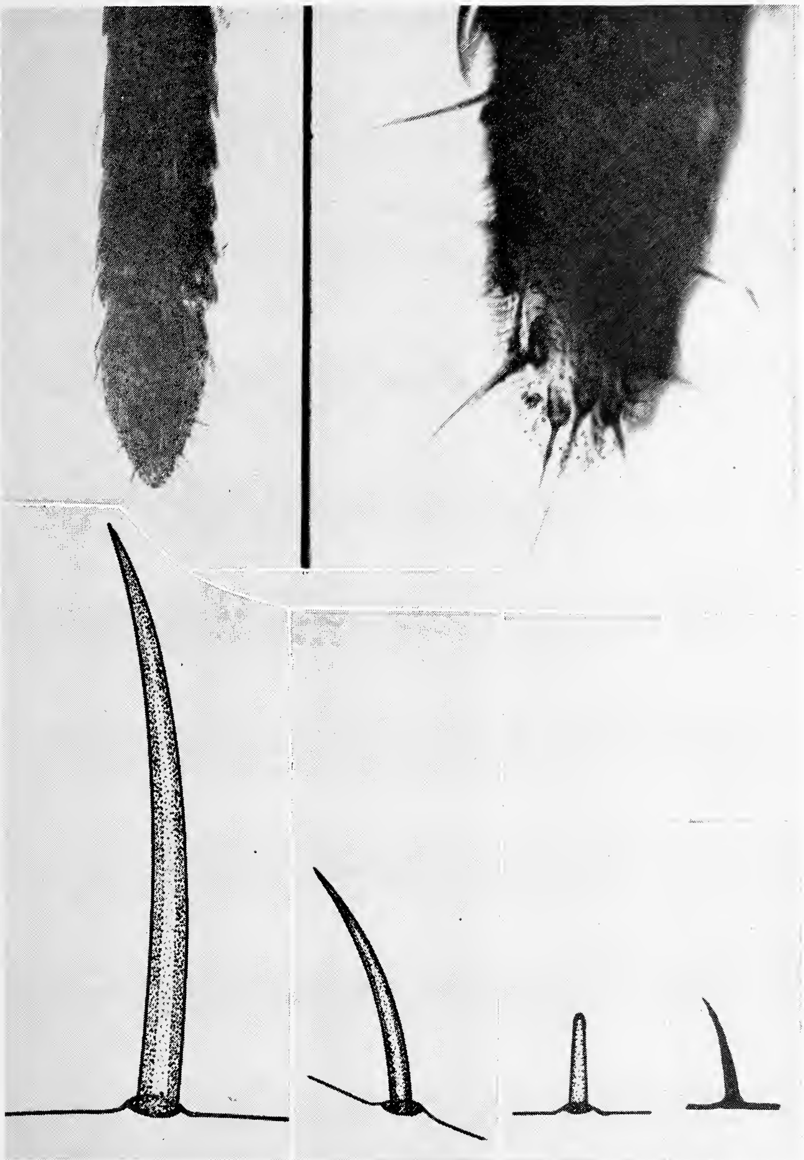
In view of the discord between the results on tarsal reception with mounted females and those with free individuals, the validity of results with mounted insects may be questioned. The discrepancy, in the case of the mosquitoes, was probably due to the fact that the positive reaction used in this study was often overshadowed by other reaction patterns, such as the violent thrusting away of the brush bearing a test solution. These results, then, would seem not to invalidate previous studies using mounted insects other than mosquitoes, but they do show that negative results with mounted forms require confirmation with free animals. This only further emphasizes the need for caution in interpreting negative results in these tests, as previously pointed out (Frings and Frings, 1949).

The results with semi-circles of filter paper bearing water and NH_4Cl solution are interesting from the standpoint of orientation. It is obvious that contact chemoreception, unless a concentration gradient be present, cannot result in a true tactic response, as defined by Fraenkel and Gunn (1940). Apparent orientation, however, would still be possible by klino-kinesis, as in the case of *Paramecium* (Gunn, 1941, 1942), if the animals were induced to move about by repellent substrata. It seems, however, that contact chemoreceptive stimulation by salts in the insects we tested brings about only movements, such as rubbing the legs together, and "cleaning" the wings. Since these movements do not bring about change of position, the animals remain distributed evenly on both the repellent and the neutral substrata. It might be noted that flies on DDT-treated surfaces react in an exactly similar manner, with cleaning and rubbing of the legs. It is possible, therefore, that DDT is a contact repellent, and the apparent lack of response to DDT-treated surfaces may simply be the result of the non-orienting nature of repellent contact chemical stimulation without a concentration gradient. This idea is supported by the results of Kennedy (1946).

PLATE XIII

Upper Left: Tip of proboscis of an adult female mosquito (175×). The long tactile hairs form a protective fan on the labella. The shorter, probably gustatory hairs are near the tip. Upper Right: Labella of an adult female mosquito (550×). Three types of hairs can be seen: 1. long tactile hairs; 2. two medium sized, probably gustatory hairs near the tip; 3. many short, non-sensory, epicuticular hairs.

Lower: Types of hairs found on the labella of *A. œgypti* (1860×). From left to right: long, probably tactile hair; medium sized, probably gustatory hair; short, sensory, peg-like hair; and short, epicuticular, non-sensory hair.



SUMMARY

The proboscis, palpi, and antennæ of adult Yellow Fever Mosquitoes, *Ædes ægypti,* which were mounted alive on wax-paper strips fastened on the ends of glass rods, were explored for the possible possession of contact chemoreceptors by bringing to them sucrose and NH_4Cl solutions. The labella of both males and females have these receptors, which are probably medium-sized curved hairs. The palpi, antennæ, and parts of the proboscis other than the labella probably do not have contact chemoreceptors. Tests with mounted insects indicated that males possess tarsal receptors, while females do not. Tests with mosquitoes allowed to walk freely on drops of distilled water and sugar water, however, showed clearly that both sexes possess tarsal receptors on the fore and middle tarsi at least. The end-organs on the tarsi may be hairs similar to the labellar hairs which are probably active, but no direct evidence about this was obtained. Results of tests on the ovipositor of females were inconclusive. NH_4Cl acts as a non-orienting repellent substance for this species.

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NOTES ON THE HABITATS OF SOME NORTH AMERICAN TIGER BEETLES

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The Cicindellidæ have long fascinated entomologists, not only for their beauty and taxonomic interest, but for the excitement of their capture. Thus, much has been published on where and under what conditions different species were taken and how they reacted to pursuers. Previous field notes on the habits and habitats of tiger beetles proved very helpful to my husband and me on two collecting trips for the American Museum of Natural History, one to the southwestern United States in 1948 and one to the north central states in 1949. Such notes can also be valuable in the systematics of *Cicindela*, since some species and subspecies are confined to certain definite types of habitat.

The present notes pertain to the 1949 trip, which was expressly for tiger beetles. The area covered included Iowa, Nebraska, eastern, southern and western Wyoming, extreme northwestern Colorado, northeastern Utah, western and northern Montana, North and South Dakota, and southern Alberta and Saskatchewan, Canada. We traveled 12,000 miles and did intensive collecting for ten weeks, from the middle of June to the end of August. Seven thousand tiger beetles were secured in well over a hundred localities.

There were three general habitats that almost always produced tiger beetles: 1. sand hills, pits, dunes, or blowouts; 2. alkali flats or lakes; 3. river sand banks or sand bars. Other places where the beetles might be found were shores of fresh water lakes, provided they were not too grassy or too stony; hills or prairies of sparse, short grass; gravel or clay pits or gullies; and small roads or paths in the woods. In these latter situations, tiger beetles, if present, were seldom numerous.

In the general habitats enumerated above, tiger beetles were generally found in specific parts of the area, such as near or away from the vegetation or water, on dry, wet, hard packed or loose soil, on the flat or on slopes. Where they were very abundant they often spread over the entire habitat and it was then sometimes difficult to judge what parts they preferred.

Typical species found under habitat 1 are, generally speaking: *formosa, lengi, lepida, limbata,* and *scutellaris;* under 2, *carthagena, circumpicta, fulgida, nevadica, togata,* and *willistoni;* under 3, *cuprascens, hirticollis, macra, oregona,* and *repanda.*

The three species with the most varied habitats were *punctulata, repanda,* and *tranquebarica* and they were taken, as might be expected, at more localities than any of the others, although not necessarily in larger numbers.

Nine of the 26 species were taken at night: *circumpicta, cuprascens, lepida, limbata, macra, nevadica, punctulata, repanda,* and *togata.* We did not, however, collect at night in every locality and possibly others might have come. But the following species were not found at night, even though they were present in daytime at the same spot: *formosa, fulgida, hirticollis, lengi, purpurea,* and *scutellaris.*

For convenience, the species are arranged alphabetically. The terms gregarious and solitary are relative and apply to the species only as we found them.

Cicindela carthagena—gregarious—taken in northwestern Wyoming on the banks of small streams running through strongly alkali, gravelly soil. The beetles were usually in the open, but occasionally in short, sparse grass.

Cicindela circumpicta—gregarious—taken in Lincoln, Nebraska, only, on the muddy alkali shores of the Salt Basin Lake, either on the damp bare spots between clumps of vegetation or out in the open on the somewhat dryer bars. They were very numerous and a few even extended into a corn field a couple of hundred feet from shore.

At night, when a lantern was set down in small open spots, within a few seconds the beetles began running towards it, coming from the vegetation on all sides.

Seen apparently mating in June.

Cicendela cuprascens—gregarious—taken in Iowa on the Missouri River, in central Nebraska, southwestern South Dakota, eastern Wyoming, and south central North Dakota.

The moist edges of river shores or sand bars seemed to be the preferred habitat of *cuprascens* and it was always encountered at least in the vicinity of water. A few individuals at Council Bluffs, Iowa, were found 50 to 75 feet from the water on a dry sandy path leading to the river and bordered by sparse vegetation.

In the middle of sand bars, at night, many specimens were captured by hand, when they were surprised in the light of a moving lantern. They also came to the light when it was put down near the vegetation at the back of the beach. Only one or two could be found near the water's edge at night.

Pairs were taken in June and July.

Cicindela cursitans—not gregarious—taken at Council Bluffs, Iowa, only, on moist caked loam, near tall grass, in the entrance driveway to a sand pit under tall bluffs.

Cicindela decemnotata—not gregarious—taken at Fort Bridger, Wyoming, only, among grass and stones on the shore of a new reservoir (1949) and below the reservoir on barren alkali ground at a large seepage area.

Cicindela duodecimguttata—gregarious—taken in Iowa, eastern and western South Dakota, northeastern Wyoming, northern Montana, northern and central North Dakota, and southern Saskatchewan.

It is difficult to generalize on the habitat of this species since it was taken in such a variety of places and usually in small numbers. Perhaps it was found more often in somewhat damp, muddy situations near water, yet it occurred also on dry, gravelly or sandy shores, or even far from water, as on bare spots in the grass by the highway. Usually it was by fresh water, but occasionally near alkali lakes, both full ones and dry ones. It never rested in the vegetation even though it might be found not far from it.

Cicindela formosa—gregarious—taken in Iowa, Nebraska, northern, southeastern and southwestern South Dakota, eastern Wyoming, northwestern Colorado, northern and southern North Dakota.

The first requisites for *formosa* are dry sand and vegetation. The presence of water is immaterial; it just happens that sand is often found along rivers. Except in southern Canada where, inexplicably, no *formosa* was found in many seemingly typical habitats, almost every sandy place investigated, with or near loose sand and with plant cover to hide under, yielded *formosa.* Some such places were sandy paths in woods or prairie, sandy shores of rivers, sandy pastures, fields, and hillsides, sandy cuts along highways, and, above all, sand pits, dunes, blowouts or blowholes. Upon arrival at its habitat, you rarely see *formosa* until you have walked in and sufficiently disturbed the grass or willows or tumbleweed or sagebrush or sunflowers or poison ivy, or whatever the vegetation may be. Then you either catch sight of one running ahead of you through the weeds or you hear a loud buzz like that of a bumblebee and a *formosa* flies up and out onto the sand in the open. They do not usually fly very far and if given a chance, soon return to the cover of some plant.

This is eminently a sun-loving species. Near Towner, North Dakota, on a cool, cloudy day, we searched for a good half hour without stirring up a single one, but on our return to the same spot later, after the sun had come out, we found them right away. It is also a late riser and does not come out too early before the sand is warmed. For instance, at Mobridge, South Dakota, on a clear, sunny day without clouds of any kind, we began investigating a sand dune at 8 a.m. (there had been a light rain in the night and the sand was a bit damp). With both of us searching, it was 8:15 before one was seen. At 8:30 a second one was caught, running through thick weeds by the dune; at 8:45, one more. By 9:30 quite a few had been captured and after that, until 12:30, they were all over the dune, hunting, flying, and very active. In fact, 130 individuals were taken, even though so few at first.

Pairs, apparently mating, were taken in July.

Cicindela fulgida—gregarious—taken in eastern Nebraska, eastern and northern South Dakota, eastern and southwestern Wyoming, northeastern Montana, North Dakota, and southern Saskatchewan.

This beautiful species was always associated with alkali places and with vegetation. On the shores of alkali lakes, whether wet or dry, it would be found at the general border line of vegetation, among short sparse plants that spread out towards the lake shore; on alkali flats or at saline spots by the highway, it was at the grassy edges of the small open areas, but in either situation it might also be farther back among the vegetation.

In many places, especially in the Dakotas, *fulgida* was taken far from any water and even when its habitat was near water, it stayed most often where the ground was dry and hard.

When pursued, *fulgida* usually ran quickly through the grass rather than take off into the open and when it did fly out, it did not go far and hurried back to cover. On a gray rainy day in Poplar, Montana, it was caught by hand and two were teased out of round holes in the ground. At this place there were numerous colonies of red ants, upon whose members *fulgida* was feeding.

A pair was seen in August.

Cicindela hirticollis—gregarious—taken in Iowa, central Nebraska, southwestern South Dakota, northeastern Utah, southwestern Wyoming, northwestern Montana, and northern and southern North Dakota.

Cicindela hirticollis was taken at all times on sand, almost invariably on river shores or sand bars, but sometimes around pools or moist places in sand pits. They were near the water's edge where the sand was damp, but spread out onto dry sand when disturbed. Thus, north of the Boar's Tusk Mountain, Wyoming, in a wild lonely area of miles of shifting sand hills, we found them all over the sand in the vicinity of moist places at the bases of the barren dunes. They were so swift and flew off so far up the sand slopes that we had to walk around them in wide circles to get them back down among some wiry grasses where they could be more readily caught. No other tiger beetle was found at this place.

Normally, *hirticollis* were not near vegetation but on one cloudy morning with some rain falling, they were found hiding among sparse plants along the Missouri River and near logs and debris.

Seen apparently mating in July.

Cicindela lengi—gregarious—taken in central Nebraska, southwestern South Dakota, eastern Wyoming, central North Dakota, and southern Alberta and southern Saskatchewan.

The ecological requirements of *C. lengi* seem to be identical with those of *formosa* and *scutellaris*. But an exceptional habitat was encountered at Lake Chaplin in Saskatchewan. This lake is extremely saline (sodium sulphate was being extracted from it) and has no sand on its shores. Two *lengi* were taken here, just before sunset among the short grasses at a gravelly patch about 300 feet from the water.

In the localities where *lengi* and *formosa* were both present, *lengi* was in far fewer numbers, but all through Canada, where only *lengi* was taken, it was very abundant.

Like *formosa* and *scutellaris, lengi* does not wander far from cover and when disturbed, flies a short distance only.

Cicindela lepida—gregarious—taken in western Iowa, central Nebraska, southwestern South Dakota, eastern Wyoming, and southern Saskatchewan.

Although seen occasionally in the daytime, *lepida* was always far more abundant at dusk or after dark, at which time it was taken by hand in the light of a lantern. Day or night, it was found on loose, dry, white sand away from vegetation, either on river sand banks or in sand blowouts. In the latter, it was more often on the sloping sides than at the bottom. The sand in some blowouts was so very fine and soft that even the feet of these "little ghosts" made tiny tracks in it.

Mating pairs were taken in June, July, and August.

Cicindela limbalis—not gregarious—taken in northeastern and southeastern Wyoming and northern North Dakota.

Solitary individuals of this species were always in close proximity of vegetation, usually in high altitudes, 5000 to 8500 feet, on stone, gravel or clay paths through pine woods. Two were taken by the sides of a small stream in Alva, Wyoming, but the rest were not found near water.

Cicindela limbata—gregarious—taken in central and western Nebraska, eastern Wyoming, southern Alberta and southern Saskatchewan.

Only once was this species found near water, on the shore of the Oldman River at Taber, Alberta, where a lone specimen was scooped up from hard packed sand, near the damp edge of the river. About 125 feet from the water was a five foot cliff of fine loose sand, grown over by young willows, which may possibly have been its actual habitat. In other places, *limbata* was taken far from any moisture, on the bare sloping sides of sand blowouts, or in sandy ditches or blowholes. Where they were quite numerous, they were found running through sparse vegetation or at its edges, but more often they were out in the open as in the case of *lepida*. They were more easily seen than the pale *lepida* because their metallic thorax glinted in the sun. Some were taken at dusk and a few at night by lantern light.

Cicindela longilabris—gregarious—taken in northwestern South Dakota, southeastern Wyoming, southern and northern Montana, northern and southern North Dakota, southern Alberta and Saskatchewan.

Throughout Canada and North Dakota, at relatively low altitudes (2000 to 3000 feet), almost any sparsely grassy place had a few *longilabris*. It might be the dry shore of an alkali lake, a saline spot by the road, an abandoned gravel pit, a sandy ditch, the side of a sand hill, a wheel track road or a path in the woods. It was found many times at the edges of gopher holes and was seen going into and coming out of them.

At 6000 and 8000 feet *longilabris* occurred on gravel or clay roads and on paths covered with pine needles in evergreen woods.

One cold grey morning in Banff, Canada, where they were definitely gregarious, they were picked up by hand from a sandy hillside, but when the sun came out and they became active, this technique had to be abandoned. Generally, they are quite elusive and fly long distances into the grass when disturbed, but surprisingly enough, even in full sunlight, occasional specimens let themselves be picked by hand on the edges of gopher holes.

Cicindela macra—gregarious—taken in Iowa, central Nebraska, and extreme southeastern South Dakota.

With one exception, *macra* was found close to the water where the soil was moist, on fresh water lake, river, or pool. At Elk Point, South Dakota, however, a single specimen was caught in the loose, dry sand of a shallow blowhole. The Missouri River, at this place, was $1\frac{1}{2}$ miles distant, but there was some moisture in a swampy area about 200 yards away.

Large series were taken by hand at night, on river sand bars.

Before it was quite dark, the beetles would run from the moving lantern, but after 9:30 p.m., they came to it, usually stopping suddenly in the circle of light.

Seen apparently mating in July.

Cicindela nevadica—gregarious—taken in eastern and central Nebraska, eastern Wyoming, northeastern Montana, and southern Saskatchewan.

This species was found on the alkali or saline shores of lakes, rivers or stagnant pools where it preferred the wet borders, near or even in the water and usually not close to any vegetation. At night, however, it came out of the vegetation to light.

Two individuals were taken in slightly different habitats from the above: one at Halsey, Nebraska, on a river shore that seemed to have no evidence of alkali, and one near Alliance, Nebraska, on a dry dusty road between two alkali lakes whose shores had disappeared under rising water.

On a large alkali flat in Montana it was seen going in and out of cracks in the moist caked mud blocks around a pool.

Pairs were secured in July and August.

Cicindela oregona—gregarious—taken in southern, western, and northwestern Wyoming, northeastern Utah, western and northwestern Montana.

Cicindela oregona was always found close to water, usually on river shores, but on many different types of soil, gravelly or stony as well as on sandy or muddy, whether moist or dry. It ran generally in the open, occasionally near, though not in, the vegetation. Sometimes it occurred on a black sand with little flecks of white in it—a situation that made it nearly invisible. Though not as a rule partial to alkali, it was taken on two occasions on strongly alkali, gravelly soil and once, at Fort Bridger, Wyoming, on the slopes of alkali pools.

This species was found more often on gravel stony banks than any other species.

Apparently mating pairs were seen in July.

Cicindela punctulata—largely solitary—taken in all the states visited.

This is, very largely, a grass loving species, although it was also found in habitats of all kinds away from grass. It was the only tiger beetle that came to electric lights in towns, but it was only once, at Hot Springs, South Dakota, attracted to a Coleman lantern.

When surprised in the vegetation, *punctulata* often clambered up on the grass stalks or low bushes. When caught, it gives off a fruity odor not encountered in any other species. It was seen apparently mating in August.

Cicindela purpurea—not gregarious—taken in eastern and western South Dakota, and northern and southeastern Wyoming.

Like *limbalis, purpurea* was quite solitary. The few specimens we took were in or near vegetation, or were flushed out of it onto open ground. They were thus found on river sand banks, at the back of the beach, on wheel track roads through grass or weeds, and in the short grass of saline spots by the highway. It was always found on dry soil.

Cicindela pusilla—not gregarious—taken in northern and southern Wyoming, northern Montana, northern and southern North Dakota, and southern Saskatchewan.

The main requirement for this species was grass or low plants, alternating with small open spaces. Individuals were often taken in alkali situations, such as the shores of alkali lakes, saline spots by the road, and alkali flats. At other times they were found on sandy, gravelly, or muddy river banks, on the sides of dirt roads, in grown over gravel pits, but always in or near vegetation. It evidently does not retire as early as some species as it was quite abundant at Bottineau, North Dakota, at 7 p.m., when the sun was quite low.

Cicindela repanda—gregarious—taken in every state visited.

In addition to being found near any kind of water, *repanda* was taken also far from water—in a sunken dry sandy ditch through a pasture, on a hard sandy road near weeds, and at the base of a sandy cut in the highway. It occurred most often, however, on river shores and bars, where it might be found about equally close to the water on damp ground, on the middle of the bar where the soil was dry, and among the willows and other vegetation at the shore line. It was taken on all types of soil.

On grey days there were always some *repanda* to be found, either in the open or among plants; at Ames, Iowa, it was taken in the rain. On other occasions when a storm was coming or when the sun suddenly vanished, *repanda* began digging into the sand or hurried up the river bank into the vegetation.

Although we collected at night on a number of sand banks where *repanda* had been present during the day, only once, at Council Bluffs, Iowa, did it come to the light. Pairs were seen in July.

Cicindela scutellaris—gregarious—taken in Iowa, eastern and central Nebraska, eastern Wyoming, southeastern South Dakota, northern and southern North Dakota, and southern Alberta.

This species, like *formosa,* inhabits only dry sandy places either in or near vegetation. In fact, in every locality (except two) where it was found, *formosa* also was found. The converse, however, was not true, *formosa* being taken in twice as many localities and in twice the numbers. At Elk Point, South Dakota, where both species were abundant in a sandy pasture, it was noted that *scutellaris* was mostly in the grassier parts where there were only small bare spots, whereas *formosa* was in the open blowhole area where there were larger expanses of sand, and the vegetation was quite widely spaced. The Elk Point *scutellaris* were in thicker grass than is usual for them, which may be why, when startled, they climbed up on it, much as *punctulata* does.

Also like *formosa, scutellaris* stayed indoors when the sky was overcast. We never were able to find the former's retreats at such times, but on a cloudy day in Vermillion, South Dakota, we did dig out a number of *scutellaris* from their slit holes. One hole was under a thin clump of wiry grass, the others were at the edge of a sandy road bordered by tall golden rod. When the sun came out, so did the *scutellaris.*

A pair was seen apparently mating at the end of June.

Cicindela sexguttata—not gregarious—taken in Alva, Wyoming, only, on an open path in the pine woods at about 5500 feet.

Cicindela togata—gregarious—taken in Lincoln, Nebraska, only, in the same habitat as *circumpicta.* At night *togata* acted more nervously than *circumpicta* and ran around crazily in the light, sometimes even flying off into the darkness.

 see correction p 246

Cicendela togata—gregarious—taken in Lincoln, Nebraska, central Nebraska, South Dakota, western and southeastern Wyoming, northern Montana, North Dakota, southern Alberta and Saskatchewan.

Although often taken on sand, this species, throughout Canada, Montana, and North Dakota, was found almost entirely on saline spots by the road and on alkali flats or the shores of alkali lakes, in places frequented by *fulgida*. On dry lakes it preferred the grassy shore line, but, unlike *fulgida,* was often found out in the open.

In non-alkali places it was taken in sand dunes, on sandy roads and pastures, sandy cuts in the highway and on river shores, whether sandy, stony, gravelly, or muddy. It occurred about as often near or in the vegetation as away from it.

In three localities: Nanton, Alberta, Spring Lake and Belle Fourche, South Dakota, *tranquebarica* was the only species found and these places seemed hardly suitable for tiger beetles. The first two were the shores of reedy lakes, consisting of matted dry grasses with no bare soil showing, the third was on the cindery shore of a rapidly dwindling reservoir, about 200 feet from the water.

Twice, on rainy days, *tranquebarica* was dug out of its hiding places in the bare sand on river banks. Pairs, apparently mating, were taken in August.

Cicindela willistoni—gregarious—taken in southeastern and southwestern Wyoming, on dry alkali ground, at one time among clumps of grass in a seepage area below a reservoir, at another on saline mud among low sparse plants, about 50 to 75 feet from the water of a large alkali lake.

INSECT FECULÆ

BY HARRY B. WEISS AND WILLIAM M. BOYD

The object of this paper is to present brief descriptions, together with illustrations, of the feculæ of various species of insects. Our interest in this subject was first aroused by reading the account of it in Dr. S. W. Frost's "General Entomology," and when Dr. Frost learned of our interest he generously turned over to us, for study, a small collection of thirty samples of the fecal discharges of various species of insects. Some of his material has been incorporated in this account and some of it still remains to be described and figured in a subsequent paper.

Although the literature on insect feculæ is not unduly extensive, there seems to be no point in summarizing it at this time especially in view of the excellent general account by S. W. Frost in the Annals of the Entomological Society of America (Vol. XXI, No. 1, pp. 36–46, 1928) under the title "Insect Scatology." However as the present paper is descriptive, attention may be called to several other papers dealing with descriptive accounts from practical viewpoints. Hans-Werner Nolte in his paper "Über den Kot von Fichten- und Kieferninsekten" (Tharandter forstl. Jahrb. 90 (10/11): 740–761, 10 figs. 1939) describes and figures the chararcteristics of the droppings of certain Lepidopterous and Hymenopterous larvæ occurring on spruce and pine, and supplies a key for the identification of the species. He states that the feculæ of the caterpillars of the same species vary greatly in form, color and size depending upon temperature, humidity, character of food and effect of poison. K. Eckstein in "Das Bohrmehl der Anobien" describes the size, shape, color and composition of the droppings of *Anobium molle, A. punctatum, Ptilinus pectinicornis, Xestobium rufovillosum*, and *Cœlestethus pertinax*. R. F. Morris in "The Use of Frass in the Identification of Forest Insect Damage" (Canad. Ent. Vol. 74, No. 9, pp. 164–166, Sept., 1942) presents a "frass key for certain spruce defoliators" in which are utilized, size, shape, texture, and markings. And finally Hugo Hartnack in his book "Unbidden House Guests" (Tacoma, Wash., 1943) from pages 106 to 148 includes photographic illustrations of feculæ from 11 species in several orders.

The shape or form of the fecal "pellets" in most free-feeding caterpillars and saw-fly larvæ is determined by the internal structure of the rectum which is impressed upon its contents. The rectum or posterior intestine is supplied with two principal forms of rectal organs, or rectal glands. R. E. Snodgrass ("Principles of Insect Morphology," New York, 1935) describes one form as oval or elongate, padlike, thickenings of the intestinal wall and the other as conical processes projecting from the intestinal wall into the lumen and known as rectal papillæ. The rectal pads, usually six in number are equally spaced around the anterior part of the rectal sac with their long axes longitudinal. In some instances there are three and in others, a much larger number. The papilliform type of rectal organs is found in the Diptera and Siphonaptera. The function of these pads and papillæ is not definitely known. Rectal pads occur in larvæ of the Plecoptera, Odonata, Orthoptera, Hymenoptera, Trichoptera, Neuroptera and Lepidoptera, but are absent in Ephemerida, Hemiptera and Coleoptera. Alvah Peterson in the "Anatomy of the Tomato-worm Larva" (Ann. Ent. Soc. Amer., Vol. 5, p. 246–272, 1912) states that two prominent longitudinal bands of muscle are located on the dorsal surface of the rectum. These "converge at the cephalic end of the rectum and connect at their caudal end to the body wall. By means of the contraction of the rectum the characteristic form is given to the excreta of the lepidopterous larva."

The texture, size, and color of the feculæ depend respectively upon the nature of the food, the stage of larval development, and the character of the food. However the color may change with age and exposure to sunlight, and desiccation causes furrows to widen and surface striations to weather away. The coarse texture of the waste material or undigested food of some caterpillars apparently fails to take some of the minor striations which are impressed upon it by the internal structures of the rectum. At least so it would appear from an examination of the feculæ of some species. For the descriptive account that follows an effort was made to use, for the most part, feculæ from mature larvæ. As may be noted from the illustrations extreme differences in shape occur in the feculæ of certain species, while as between other species the differences are not pronounced.

ORTHOPTERA

PHASMIDÆ

Diapheromera femorata Say, on oak, September.

Elongate, subcylindrical, log-like masses of excrement with truncate or bluntly pointed ends. Surface irregularly sculptured. Texture coarse. Color, grayish or greenish to blackish. Length 2–6 mm. Width 0.6–1.2 mm. (Figure 1).

TETTIGONIIDÆ

Microcentrum sp., on wild cherry, September 24.

Elongate, subcylindrical, log-like masses of excrement, with truncate or bluntly pointed ends. Surface rough, irregularly sculptured. Texture coarse. Color, light greenish to black. Length 3–5.8 mm. Width 1–1.5 mm. (Figure 2).

ACRIDIIDÆ

Dendrotettix quercus Riley, on oak September 28.

Elongate, narrow, subcylindrical, log-like masses of excrement, with one or both ends generally terminated by a thread-like portion of the matrix. Surface rough, irregularly sculptured. Texture coarse. Color, greenish gray to black. Length 3.5–7 mm. Width 0.8–1.2 mm. (Figure 3).

COLEOPTERA

ANOBIIDÆ

Lasioderma serricorne Fabr., on pipe tobacco, February 20.

Narrow, elongate, somewhat spindle-shaped. Broad at middle, tapering to a point at each end, generally constricted near middle. Texture fine. Color black. Markings indistinct. Under high power, faint longitudinal striæ are noticeable. Segments punctate. Length 0.1–0.4 mm. Width 0.1–0.2 mm. (Figure 4).

SCARABÆIDÆ

Cotinis nitida Linn., under horse dung, September.

Irregular, elongate, flattened, curved, more or less tapering, slab-like masses. Texture coarse. Color, black. Segmentation and markings absent. Length 3–5.5 mm. Width 2 mm. (Figure 5).

LEPIDOPTERA

LIMACODIDÆ

Euclea delphinii Bvd., on oak, August 17.

Subcylindrical or subconical pellet, with truncate end frequently hollowed out and into a hemispherical depression. Texture moderately coarse. Outer surface sculptured irregularly with traces of transverse striæ. Segmentation obscure, only traces present. Color, black, or rusty. Length 1.5–3.3 mm. Width 1.7–2.8 mm. (Figure 6).

PSYCHIDÆ

Thyridopteryx ephemeræformis Haw., on juniper, August 24.

Roughly cylindrical mass of excrement, usually truncate at both ends. Texture coarse. Segmentation absent, perhaps due to presence of large particles of fecal matter and undigested parts of plant bracts. Furrows and transverse and longitudinal striæ absent. Color, pale green. Length 3.5–4.3 mm. Width 2–2.5 mm. (Figure 7).

YPONOMEUTIDÆ

Yponomeuta multipunctella Clem., on Euonymus.

Roughly cylindrical, distorted mass of excrement. Texture moderately coarse. Coarsely sculptured. No visible segmentation or striæ. Color, black. Length 0.5–0.8 mm. Width 0.4 mm. (Figure 8).

PYRALIDÆ

Galleria mellonella Linn., on wax, December 19.

Flat, elongate, slab-like, 6-segmented mass. Segments compressed and more or less fused horizontally so as to form an elongate somewhat flattened mass, truncate at one end and gradually narrowing to a bluntly rounded opposite end. Each flat, outer surface with 2 parallel, longitudinal furrows. Transverse striæ present. Texture fine. Color black. Length, 1.5–3.0 mm. Width, 0.75–1.0 mm. (Figure 9).

Pyrausta nubilalis Hbn., in corn, September.

Irregular, shapeless bits and bubble-like masses of varying sizes, without definite shapes. These appear as conglomerations of empty, transparent cells. Color, white, or pale yellowish-white. Diameter 1.5 mm., more or less.

CERATOCAMPIDÆ

Citheronia regalis Fab., on walnut, August 9.

Roughly cylindrical, truncate at one end, somewhat rounded at opposite end. Texture moderately coarse. Six-segmented. Furrows deep. Outer surface of each segment with shallow, longitudinal median stria and with transverse striæ. Color, black. Length, 2–3 mm. Width, 1.5–2.3 mm. (Figure 10).

Basilona imperialis Dru., on scrub pine, September.

Roughly cylindrical, slightly narrowed at one end. Texture very coarse. Six-segmented; longitudinal furrows deep. Outer surface of each segment with a faint, longitudinal, median stria. Outer surface covered with flattened particles of pine needle tissue solidly and irregularly plastered on, giving the pellet, a spongy and porous appearance. Color, tan, dark brown, mahogany, depending upon food plant. Length 9 mm. Width, 7 mm. (Figure 11, a).

Basilona imperialis Dru., on red maple.

Roughly cylindrical, slightly narrowed at one end. Six segmented. Longitudinal furrows deep. Outer surface of each segment with a median shallow stria and with transverse striæ dividing the surface into irregular divisions. Texture coarse. Surface rough. Length 6 mm. Width, 4.5 mm. (Figure 11, b).

Basilona imperialis Dru., on bayberry.

Similar to above description, with a distinct narrowing of one end and with divisions more apparent and more regular. Surface smoother. Length 8 mm. Width, 5.5 mm. (Figure 11, c).

Basilona imperialis Dru., on sassafras.

Similar to 11 b, but median, longitudinal stria on outer surface of each segment, irregular. Transverse striæ absent. Surface coarsely sculptured. Length 6 mm. Width, 5.5 mm. (Figure 11, d).

Anisota senatoria S. and A., on scrub oak, September.

Roughly cylindrical; both ends truncate, one slightly narrowed and rounded. Six segmented. Longitudinal furrows deep, irregular. Outer surface of each segment with a pronounced, longitudinal shallow, median stria and with shallow irregular transverse striæ, that in some specimens are wanting. When present they break the surface into irregular squares. Texture coarse. Surface rough. Color, tan to black. Length, 2–4 mm. Width, 1.5–2.5 mm. (Figure 12).

Anisota stigma Fab., on oak, September.

Roughly cylindrical, frequently narrowed and rounded slightly at one end. Six-segmented. Longitudinal furrows deep. Outer surface of each segment with a single, pronounced, longitudinal stria and with transverse striæ that break up the surface, with more regularity than in Anisota senatoria, into more or less bead-like areas. Texture coarse. Color, greenish-tan to dark brown or black. Length, 3.5 mm. Width 2.75 mm. In cross section, similar to A. senatoria.

SATURNIIDÆ

Automeris io Fab., on black oak, September.

Roughly cylindrical, abruptly rounded at ends, often with central core protruding slightly. Texture, a mixture of coarse and fine bits of leaves. Six-segmented. Longitudinal furrows deep. Outer surface of each segment with transverse, shallow, striæ that divide the surface into four, irregularly square areas. Color, dark brown or brownish black. Length, 4–4.5 mm. Width, 3–4 mm. (Figure 13).

Tropæa luna L., on sweet gum, September 22.

Roughly cylindrical, slightly tapered at one end. Six segmented; longitudinal furrows, deep, narrow, often flaring, or widely spread apart. Outer surface of each segment with a longitudinal, irregular, median stria. Transverse striæ irregular and not pronounced. Texture coarse. Color, dark brown to blackish. Length, 3–5 mm. Width, 3–3.5 mm. (Figure 14).

Telea polyphemus Cr., on oak, September.

Roughly cylindrical, slightly narrowed at one end. Six segmented. Longitudinal furrows deep. Outer surface of each segment with a longitudinal, median stria and with transverse striæ that break up the surface into irregular squares. Texture coarse. Color, dark brown or blackish. Length, 4–5 mm. Width, 4–5 mm. (Figure 15).

Callosamia promethia Dru.

Roughly cylindrical, truncate at one end, slightly rounded at other end. Six segmented. Furrows deep and irregular. Outer surface of each segment without longitudinal median stria and transverse striæ. Texture coarse, consisting of bits of leaf tissue, giving it a sculptured appearance. Color, brown to black. Length, 3–5 mm. Width, 3–4.5 mm. (Figure 16).

Samia cecropia L., August.

Roughly cylindrical, slightly narrowed at one end. Six segmented. Longitudinal furrows deep and irregular. Outer surface of each segment deeply and irregularly sculptured resulting in an irregular series of flattened elevations and depressions with only a faint suggestion of a pattern. Texture very coarse. Color, black. Length, 5–8 mm. Width, 4–5 mm. (Figure 17).

LASIOCAMPIDÆ

Malacosoma americana Fab.

Subcylindrical, usually truncate at both ends. Six-segmented. Longitudinal furrows wide, but not deep. Outer surface of each segment with transverse striæ. Texture moderately coarse. Color, black. Length, 1–2 mm. Width, 0.3–1 mm. (Figure 18).

GEOMETRIDÆ

Alsophila pometaria Harr.

Cylindrical, irregular. Without apparent segmentation. Outer surface sculptured, without longitudinal or transverse striæ. Texture moderately coarse. Color, black. Length, 1 mm. Width, 0.5 mm. (Figure 19).

SPHINGIDÆ

Protoparce quinquemaculata Haw., July.

Roughly cylindrical. Six-segmented. Longitudinal furrows between segments, shallow. Outer surface of each segment without longitudinal, median, stria, but with transverse striæ. Texture moderately coarse. Color, black. Length, 2.5–4.8 mm. Width, 3 mm. (Figure 20).

Protoparce sexta Joh.

Roughly cylindrical. Six poorly defined segments except at ends where segmentation is more pronounced. Outer surface of each segment with irregular, longitudinal, median stria and irregular transverse striæ. Furrows between segments, shallow. Texture moderately coarse to coarse. Outer surface sculptured. Color, black. Length, 3 mm. Width, 2 mm. (Figure 21).

Ceratomia amyntor Hbn.

Roughly cylindrical, sometimes slightly narrowed at one end. Six-segmented. Longitudinal furrows deep. Outer surface of each segment varies from without longitudinal and transverse striæ to very definite longitudinal and transverse striæ, with intermediate gradations. Texture moderately coarse. Color, deep brown or black. Length, 3–6 mm. Width, 3.5–5 mm. (Figure 22).

Ceratomia catalpæ Bvd. (young caterpillar).

Roughly cylindrical, usually of equal width throughout. Six-segmented. Longitudinal furrows deep. Outer surface of each segment with median, longitudinal stria and transverse striations that break the surface into irregular squares. In some specimens all striæ are faint or lacking. Texture moderately coarse. Color, black. Length, 2–3 mm. Width, 1–2 mm. (Figure 23).

Sphinx drupiferarum S. and A., August.

Roughly cylindrical, very slightly narrowed at one end. Six-segmented. Longitudinal furrows narrow, not deep. Outer surface of each segment without longitudinal and transverse striæ. Texture coarse. Color, dark brown to black. Length, 9–12 mm. Width, 5 mm. (Figure 24).

Sphinx gordius Cram., on sweet fern, September.

Elongate, irregularly rounded, somewhat tear-drop shape, broad at one end and narrow at the other. Narrow end sometimes with a cup-shaped depression. Texture moderately coarse. Surface irregular and frequently glistening, finely to moderately coarsely punctate. Cross section without pattern or design. Color black. Length, 8–14 mm. Width, 5–8 mm. (Figure 25).

Paonias myops S. and A., on wild cherry, September.

Roughly cylindrical, truncate at one end, bluntly rounded at other. Six-segmented. Longitudinal furrows deep and wide. Outer surface of each segment with transverse striæ. Median longitudinal stria absent. Texture coarse. Color, black. Length, 2–4 mm. Width, 2–3.5 mm. (Figure 26).

Paonias astylus Dru., on blueberry, September 22.

Roughly cylindrical. Six-segmented. Longitudinal furrows between segments, deep and wide. Outer surface of each segment with median longitudinal stria and transverse striæ. Texture coarse. Color, tan to black. Length, 4–6 mm. Width, 2.5–3 mm. (Figure 27).

Ampelœca myron Cr., on grape.

Roughly cylindrical, sometimes gently rounded at one end and truncate at other. Six-segmented. Longitudinal furrows, shallow to deep. Outer surface of each segment with median longitudinal stria and transverse striæ. Texture moderately coarse. Surface roughly sculptured. Color, black. Length, 2–3 mm. Width, 2–2.3 mm. (Figure 28).

Celerio lineata Fab., on evening primrose, September 3.

Roughly cylindrical, frequently tapering to a rounded end. Opposite end truncate. Six-segmented. Longitudinal furrows deep. Outer surface of each segment with median longitudinal stria. Transverse striæ apparent only in dried specimens. Texture moderately coarse. Color, black. Length, 3–12 mm. Width, 2.5–4.5 mm. (Figure 29).

NOTODONTIDÆ

Ichthyura inclusa Hbn., on poplar: very dry specimens.

Roughly cylindrical or irregularly globular. Six-segmented. Segmentation not pronounced. Furrows shallow. Outer surface of each segment without longitudinal and transverse striæ. Texture coarse. Surface sculptured. Color, dark brown to black. Length, 1.5–2.5 mm. Width, 1.5–1.8 mm. (Figure 30).

Datana ministra Dru., on apple, September.

Subcylindrical, truncate at one end and gradually narrowing to opposite, bluntly rounded end. Six-segmented. Longitudinal furrows between segments vary from shallow to deep. Outer surface of each segment usually without median, longitudinal stria. Transverse striæ absent. Texture coarse. Color, dark yellowish-brown to black. Length, 2–3.5 mm. Width, 1.8–2.5 mm. (Figure 31).

Datana major G. and R., on stagger bush, September 22.

Roughly cylindrical, one end truncate, opposite end slightly narrowed and bluntly rounded. Six-segmented. Longitudinal furrows deep and wide. Outer surface of each segment without median stria and transverse striæ. Texture coarse. Color, reddish-brown. Length, 3–4.5 mm. Width, 2–3 mm. (Figure 32).

Datana sp., on pin-oak, September 5.

Roughly cylindrical, truncate at one end, tapering gradually to bluntly rounded opposite end. Six-segmented. Longitudinal furrows deep. Outer surface of each segment with transverse striæ. Median, longitudinal stria only present occasionally. Texture coarse. Color, gray, sometimes mottled with black. Length, 2.5–4.5 mm. Width, 2–3 mm. (Figure 33).

Symmerista albifrons S. and A., on oak, September.

Roughly cylindrical, truncate at one end, tapering slightly from about half its length to the bluntly rounded opposite end. Six-segmented. Longitudinal furrows deep. Outer surface of each segment without longitudinal stria and transverse striæ. Texture moderately coarse. Color, grayish brown. Length, 3 mm. Width, 2.5 mm. (Figure 34).

Hyparpax aurora S. and A., on oak, September.

Roughly cylindrical, tapering gradually from the truncate end to the opposite rounded end. Six-segmented. Longitudinal furrows between segments deep and pronounced. Outer surface of each segment without median longitudinal stria. Transverse striæ present. Texture moderately coarse. Color, dark gray to grayish brown. Length, 2.7 mm. Width, 2 mm. (Figure 35).

LYMANTRIIDÆ

Hemerocampa leucostigma S. and A., on oak, September 14.

Roughly cylindrical or cone-shaped, tapering gradually from truncate and to rounded opposite end. Six-segmented. Furrows shallow. Outer surface of each segment without median, longitudinal stria. Transverse striæ present, but irregular. Texture coarse. Color, brownish to black. Length 2–3 mm. Width, 1.8–2 mm. (Figure 36).

NOCTUIDÆ

Scolecocampa liburna Geyer, in decaying red-oak, October 20.

Cylindrical, slightly narrowed at one end. No trace of segmentation. Outer surface without striæ. Texture fine. Color, white or ash-colored. Mostly white flecked with black. Length, 3–3.5 mm. Width, 2 mm. (Figure 37).

Gonodonta nutrix Cramer, on Annoma.

Irregular, elongate masses. No visible segmentation or striations. Texture coarse. Outer surface coarsely sculptured. Color, black. Length, 0.8–2 mm. Width, 0.3–1.3 mm. (Figure 38).

Autographa brassicæ Riley, on plumbago, October 27.

Subcylindrical, usually not much longer than broad. Truncate at one end, bluntly rounded at opposite end. Six-segmented. Furrows between segments shallow and ill-defined. Outer surface of each segment with transverse striæ. Texture moderately coarse. Color, greenish to black. Length, 0.8–1.4 mm. Width, 0.8–1.3 mm. (Figure 39). In some specimens the segmentation is indistinct and external striæ are absent.

Acronycta (*Apatela*) *oblinita* S. and A., on vaccinium, October 10.

Roughly cylindrical, usually of equal width throughout. Six-segmented. Longitudinal furrows shallow. Segmentation poorly defined in cross-section. Outer surface of each segment with irregular transverse striæ. Texture fine. Color, reddish-brown to black. Length, 3.5–4 mm. Width, 2 mm. (Figure 40).

Acronycta sp.

Subcylindrical, irregular, frequently with both ends truncate, instead of one being bluntly rounded. Six-segmented. Furrows between segments, shallow, frequently missing. Outer surface of each segment without median, longitudinal stria. Transverse striæ absent also. Texture coarse. Surface coarsely sculptured. Length, 3.6–4.3 mm. Width, 2.5–3.0 mm. (Figure 41).

ARCTIIDÆ

Euchætias egle Dru., August 16.

Irregular, crystal-like masses, roughly cylindrical or square. Six-segmented. Longitudinal furrows shallow, ill-defined. Transverse striæ irregular, poorly defined. Texture coarse. Surface irregular. Color, black. Length, 2 mm. Width, 1 mm. (Figure 42).

Ecpantheria deflorata Fab., October 25.

Subcylindrical, frequently irregular in shape with truncate, or irregularly rounded, or pointed ends. Six-segmented, but segmentation indistinct. Outer surface rough, with no median longitudinal stria or transverse striæ. Texture very coarse. Color, black. Length, 3–5.3 mm. Width, 2.5–3.5 mm. (Figure 43).

Isia isabella S. and A., on buckwheat, October.

Roughly cylindrical, slightly hollowed at ends. Six-segmented. Segmentation visible only at ends. Furrows indistinct. Outer surface of segment with poorly pronounced longitudinal, median stria and transverse striæ. Surface sculptured. Texture moderately coarse. Color, black. Length, 1.5–3 mm. Width, 1.5–2 mm. (Figure 44).

Diacrisia virginica Fab., August 25.

Roughly cylindrical, slightly narrowed at one end. Both ends truncate. Six-segmented. Segmentation not pronounced. Longitudinal furrows shallow. Outer surface of each segment usually without median stria. Transverse striæ absent. Texture coarse. Color, reddish brown to black. Length, 2–3 mm. Width, 1.5–2 mm. (Figure 45).

HESPERIDÆ

Eudamus tityrus Fab., on black locust, October 1.

Roughly cylindrical or globular, with shallow concavity at each end. Six-segmented. Segmentation poorly defined, furrows shallow. Outer surface of segments without striations. Texture moderately coarse. Color, black. Length, 1.5–2 mm. Width, 1.5 mm. (Fig. 46).

PAPILIONIDÆ

Papilio polyxenes asterius Cram.

Roughly cylindrical to cup-like. Shallow cap-like pellets. Segmentation absent in most specimens; traces of segmentation in some specimens. Surface without striæ. Texture moderately coarse. Color, black. Length, 1–2 mm. Width, 2 mm. (Figure 47).

Papilio glaucus turnus L., on tulip poplar, September 14.

Somewhat irregular globular-shaped with hollowed out interiors. Open at one end, resulting in cup-like structures. Segmentation absent. External striæ absent. Two globules sometimes joined together. Outer surface coarsely sculptured. Texture coarse. Color, black, sometimes glistening. Length, 2.5–3 mm. Width, 2.5–3 mm. (Figure 48). Interior may have been semi-liquid at one time and finally dried out.

PIERIDÆ

Pieris rapæ L., on cabbage, October 23.

Roughly cylindrical or somewhat square, one end slightly concave. Surface sculptured. Texture moderately coarse. No visible segmentation. Outer surface pitted. Color, greenish black. Length, 1.2 mm. Width, 0.8 mm. (Figure 49).

NYMPHALIDÆ

Danaus plexippus L., on milkweed, August 7.

Type A. Roughly cylindrical sometimes sculptured more or less longitudinally and parallel. No segmentation. No striæ. Texture moderately coarse. Color, black. Length, 3.5 mm. Width, 2 mm. (Figure 50a).

Type B. Roughly cylindrical. Sculpturing absent. Longitudinal segmentation absent. Slight shallow, transverse fissures or folds present. Texture moderately coarse. Color, black. Length, 3.5 mm. Width, 2 mm. (Figure 50b).

Polygonia (Grapta) interrogationis Fab., on elm, September 1.

Roughly cylindrical, concave at both ends. Six-segmented. Longitudinal furrows between segments, shallow. Outer surface of each segment without median, longitudinal stria, but with faint transverse striæ. Texture moderately coarse. Color, black. Length, 1.5–2.5 mm. Width, 1.0–1.5 mm. (Figure 51).

Polygonia comma Harr., on elm.

Subcylindrical, usually truncate at each end. Six-segmented. Longitudinal furrows between segments, shallow. Outer surface of each segment without median, longitudinal stria, but with transverse striæ. Texture moderately coarse. Color, black. Length, 1–3.5 mm. Width, 0.5–1.2 mm. (Figure 52).

Precis (Junonia) cœnia Hbn., on buckeye, October.

Subcylindrical, somewhat narrowed and rounded at one end. Opposite end truncate. Segmentation absent. Longitudinal and transverse striæ absent. Texture coarse. Surface roughly sculptured. Color, black. Length, 1.8–2.8 mm. Width, 1.2–1.8 mm. (Figure 53).

HYMENOPTERA

DIPRIONIDÆ

Neodiprion lecontei Fitch.

Somewhat flattened, sub-rhomboid shaped, compact masses made up of particles of pine needles, the particles being arranged in more or less diagonal and parallel positions. Texture coarse. Surface rough. Color, greenish. Length, 1–2.7 mm. Width, 0.7–1.3 mm. Thickness, 0.3–0.8 mm. (Figure 54).

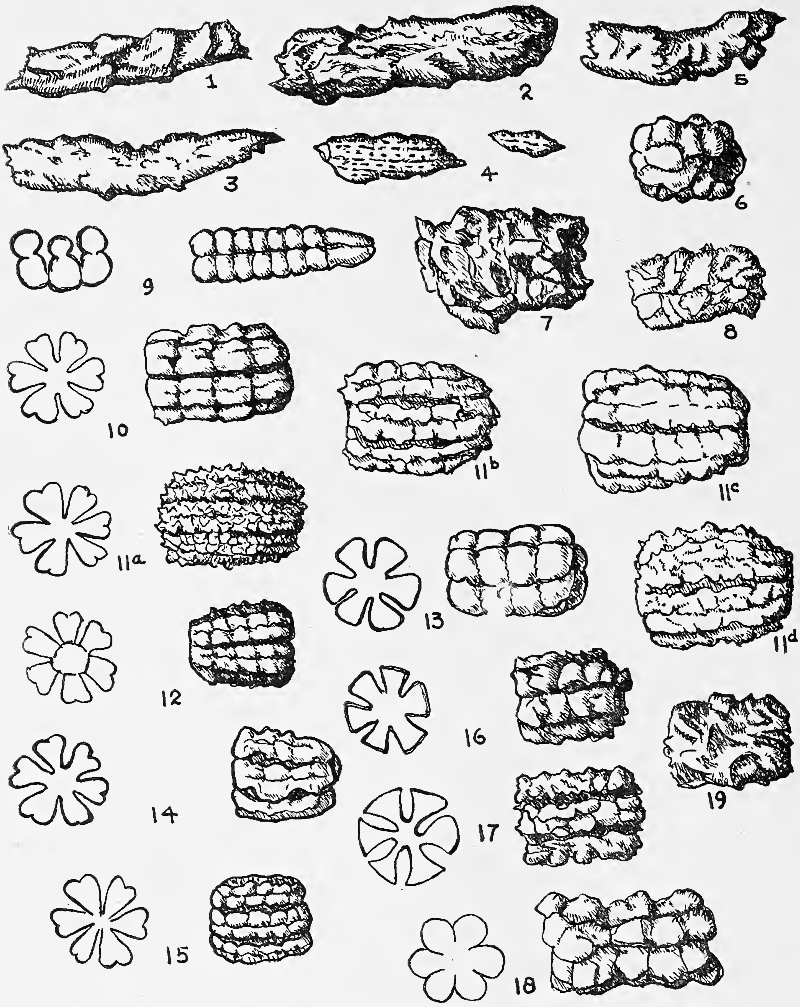

PLATE XIV

FIG. 1. *Diapheromera femorata* Say
FIG. 2. *Microcentrum* sp.
FIG. 3. *Dendrotettix quercus* Riley
FIG. 4. *Lasioderma serricorne* Fabr.
FIG. 5. *Cotinis nitida* Linn.
FIG. 6. *Euclea delphinii* Bvd.
FIG. 7. *Thyridopteryx ephemeræformis* Haw.
FIG. 8. *Yponomeuta multipunctella* Clem.
FIG. 9. *Galleria mellonella* Linn.
FIG. 10. *Citheronia regalis* Fab.
FIG. 11a. *Basilona imperialis* Dru.
FIG. 11b. *Basilona imperialis* Dru.
FIG. 11c. *Basilona imperialis* Dru.
FIG. 11d. *Basilona imperialis* Dru.
FIG. 12. *Anisota senatoria* S. and A.
FIG. 13. *Automeris io* Fab.
FIG. 14. *Tropæa luna* L.
FIG. 15. *Telea polyphemus* Cr.
FIG. 16. *Callosamia promethia* Dru.
FIG. 17. *Samia cecropia* L.
FIG. 18. *Malacosoma americana* Fab.
FIG. 19. *Alsophila pometaria* Harr.

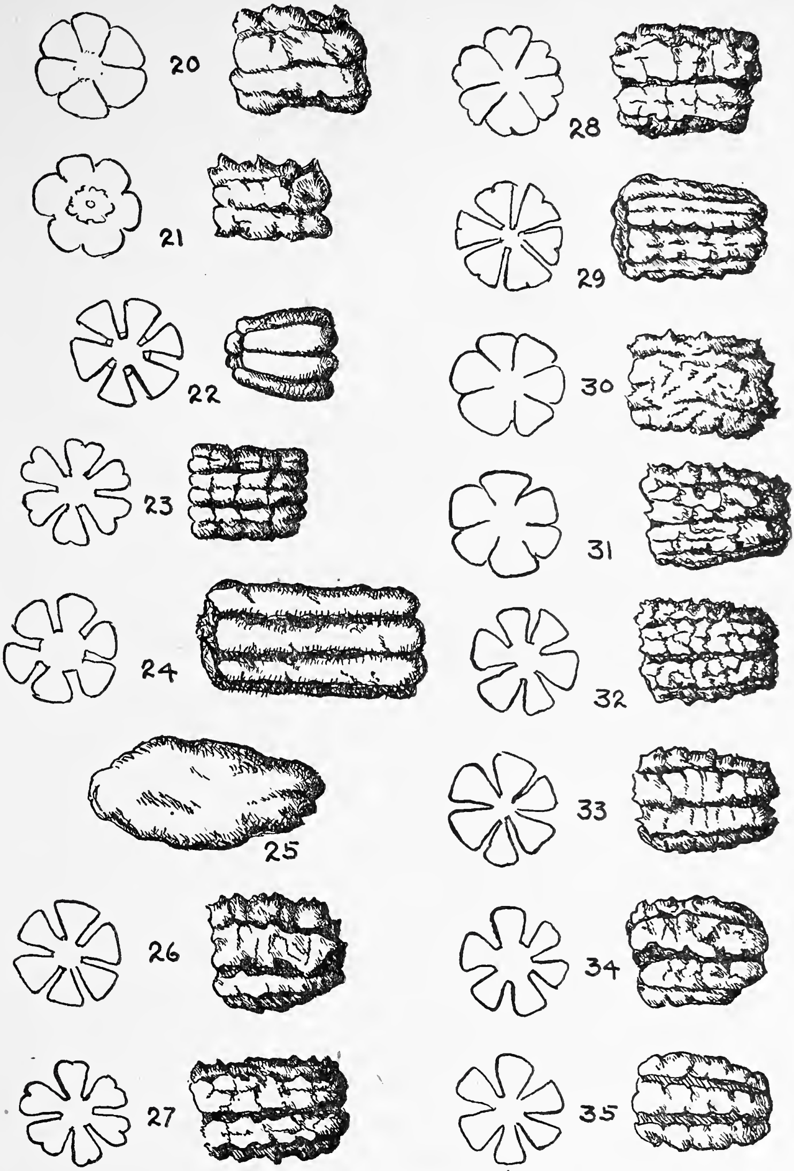

PLATE XV

Fig. 20. *Protoparce quinquemaculata* Haw.
Fig. 21. *Protoparce sexta* Joh.
Fig. 22. *Ceratomia amyntor* Hbn.
Fig. 23. *Ceratomia catalpæ* Bvd.
Fig. 24. *Sphinx drupiferarum* S. and A.
Fig. 25. *Sphinx gordius* Cram.
Fig. 26. *Paonias myops* S. and A.
Fig. 27. *Paonias astylus* Dru.
Fig. 28. *Ampelœca myron* Cr.
Fig. 29. *Celerio lineata* Fab.
Fig. 30. *Ichthyura inclusa* Hbn.
Fig. 31. *Datana ministra* Dru.
Fig. 32. *Datana major* G. and R.
Fig. 33. *Datana* sp.
Fig. 34. *Symmerista albifrons* S. and A.
Fig. 35. *Hyparpax aurora* S. and A.

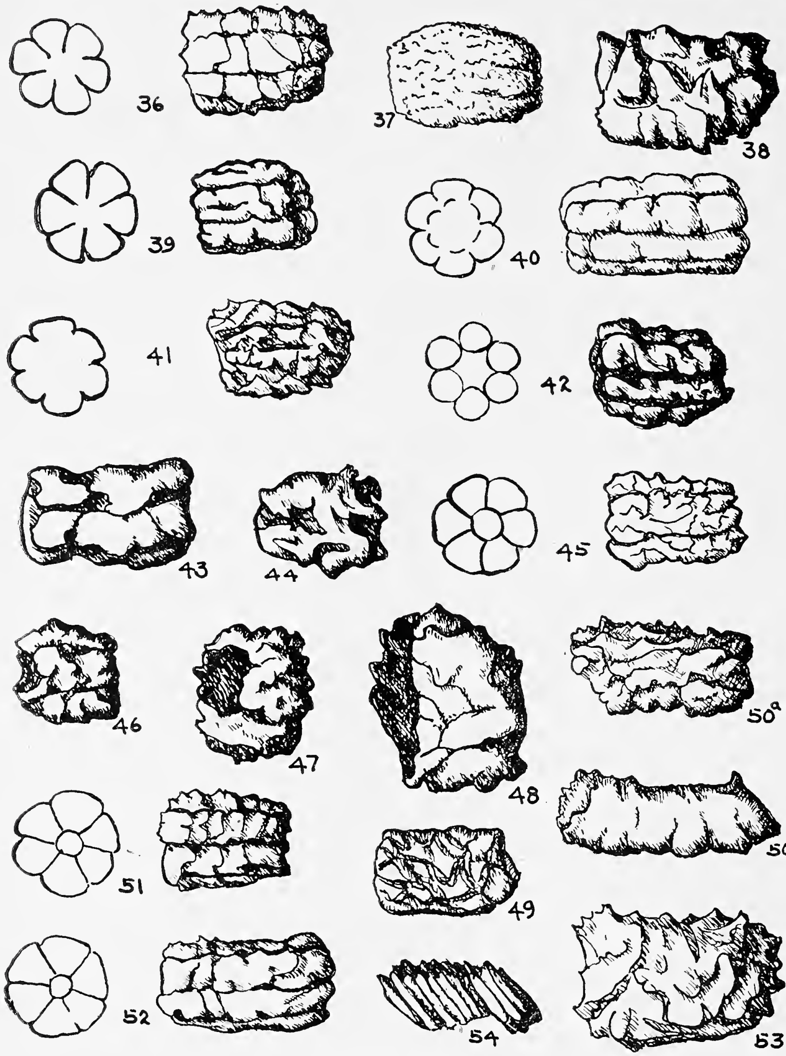

PLATE XVI

Fig. 36. *Hemerocampa leucostigma* S. and A.
Fig. 37. *Scolecocampa liburna* Geyer
Fig. 38. *Gonodonta nutrix* Cramer
Fig. 39. *Autographa brassicæ* Riley
Fig. 40. *Acronycta oblinita* S. and A.
Fig. 41. *Acronycta* sp.
Fig. 42. *Euchætiàs egle* Dru.
Fig. 43. *Ecpantheria deflorata* Fab.
Fig. 44. *Isia isabella* S. and A.
Fig. 45. *Diacrisia virginica* Fab.
Fig. 46. *Eudamus tityrus* Fab.
Fig. 47. *Papilio polyxenes asterias* Cram.
Fig. 48. *Papilio glaucus turnus* L.
Fig. 49. *Pieris rapæ* L.
Fig. 50. *Danaus plexippus* L.
Fig. 51. *Polygonia interrogationis* Fab.
Fig. 52. *Polygonia comma* Harr.
Fig. 53. *Precis cœnia* Hbn.
Fig. 54. *Neodiprion lecontei* Fitch

AN ASSEMBLAGE OF MONARCH BUTTERFLIES (*DANAUS PLEXIPPUS* L.) ON THE NORTH SHORE OF LAKE ERIE

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Several writers have recorded the occurrence of swarms of monarch butterflies along the north shores of the Great Lakes. Along Lake Erie, Saunders (3) records a swarm near Port Stanley, Moffat (2) reports seeing "the west shore of Long Point strewed for miles with their wrecks after a storm," and Moffat (1) and Saverner (4) record multitudes of monarchs assembling at Point Pelee. During a few days at the end of August, 1949, the writer witnessed a similar assemblage at Lake Erie not far from Dunnville, Ontario and a report on it is presented herewith.

The locality in which the main assemblage occurred is a wood-lot of mixed hardwoods, about 100 yards square, in the southwest corner of Dunn Township in Haldimand County, Ontario. Its southern border is about 50 yards from the lake and its western border about 200 yards from the road forming the boundary between Dunn and South Cayuga Townships. The butterflies were first noted at 5 : 00 p.m. on August 28, when 32 were found clustered on a low branch on the north side of a beech tree in the middle of the wood. They were in an active condition, fluttering about the tree and settling and re-settling on the branch which was on the lee side of the tree, there being a light southwest wind. After 5 : 00 p.m. light rain began to fall and continued throughout the night. During the morning of the next day, August 29, a brisk north wind was blowing, becoming light in the afternoon, and the weather was generally sunny. At about 9 : 00 a.m. one monarch was seen flying about the southern border of the wood, at noon 12 were found on the south side of a beech on the southern border of the wood, and during the afternoon about 25 were present in groups of two to six on the branches of trees along the southern border. During the night a heavy thunderstorm occurred followed by a strong southwest wind off the lake.

During the morning and afternoon of August 30 the southwest wind continued to blow strongly through the wood and did not slacken until 5:00 p.m. The sun was bright throughout the day and the only cloud was scattered cumulus, until after 5:00 p.m. when an overcast of altostratus formed. At 11:00 a.m. the lower branches of several trees along the northern border of the wood were found laden with monarchs and the following counts were made: red oak—16, white ash—15, ironwood (2)—6, 42, beech (2)—36, 143, sugar maple (5)—31, 36, 43, 50, 210, basswood (2)—56, 125, red cedar—115. In addition some fifty to one hundred butterflies were usually in flight, making a total of about 1000 in the wood. In any one cluster the insects were motionless except when a new arrival settled among them, causing a fluttering of wings. Throughout the day the clusters tended to remain on the same branches of the various trees on which they were first noted. When a stick was thrown into a cluster, the butterflies swirled off the branch and gyrated in the air, but after about ten minutes they began to reassemble on the same branch.

On August 31 the southwest wind remained brisk throughout the day. In the morning there were frequent showers, while in the afternoon clearing occurred. At 8:00 a.m. the monarchs were present in much the same numbers and distribution as on the previous day but were in a quiescent condition, there being little fluttering of wings and no flights from one cluster to another. As the day passed the insects became more active but maintained about the same distribution. At 10:00 a.m. another group of about 200 monarchs was found on trees near the lakeshore about one-half mile to the west in the neighboring township of South Cayuga. At 5:00 p.m. observations were discontinued owing to departure of observers from the vicinity.

In his discussion of the migrations of the monarch in North America, Williams (5) shows that these movements occur mainly toward the end of August and during September. The likelihood is that the congregation of butteflies recorded here was a pre-migratory assemblage and that they would shortly move off on their southward journey. During the four days that the butterflies were observed, they assembled in increasing numbers in the face of radical changes in the weather, and shifted about in the wood in such a way that they maintained positions on the leeward side. Shannon, as quoted in Williams (5), concludes that one of the four main migratory routes of butterflies in North America is along Lake Ontario and Lake Erie and southward. The locality at which this assemblage was noted lies along this route, being near the Niagara River, which joins the two lakes.

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THE DINA GROUP OF THE GENUS EUREMA IN THE WEST INDIES (LEPIDOPTERA, PIERIDÆ)

BY EUGENE G. MUNROE

The group of species allied to *Eurema dina* Poey has long been a source of trouble to students of the West Indian fauna. The authors of both the modern revisions of the American sections of the genus (Klots, 1929; d'Almeida, 1936) were handicapped by lack of adequate West Indian material, and their treatment of the Antillean forms was consequently somewhat cursory. Bates (1934, et seq.), with more extensive material at hand, was able to make substantial progress; his results, however, appeared in a series of scattered papers, and were never collated in such a way as to make ready identification of the various forms possible. Some novelties have been described since the completion of Bates' work, and additional information makes it seem probable that some of his views were erroneous. A reasonably clear understanding of all the known West Indian forms can, in fact, now be obtained, and the time therefore seems ripe for the present brief revisional paper. The exploratory work of d'Almeida suggests that much more complex problems will be encountered in the mainland fauna, for the resolution of which a vast accumulation of specimens, and perhaps of biological data, will be required. In the present paper, therefore, no attempt will be made to discuss continental populations, except as they directly affect the West Indian situation.

Eight valid species of the *dina* group may now be distinguished in the West Indies. Although this is three more than were even tentatively recognized by Klots, subsequent modifications in the classification have not shaken, but rather have somewhat strengthened, the phylogenetic views which he expressed in 1928. The distal armature of the valve is broadest and most complex, and consequently in Klots' scheme the most advanced, in *dina* itself. In the geographically complementary and structurally extremely similar *leuce,* the armature is only slightly less specialized, but in the broadly overlapping *nise,* and still more in *neda* and the structurally similar *chamberlaini,* it is noticeably narrower and simpler. In *lisa* the condition is still simpler, and is reminiscent of that which is found in the presumably ancestral *messalina* group. In the relict species *laræ* and *euterpiformis* the distal armature is very narrow, while the latter species is annectant in wing pattern as well as in genitalic structure to *messalina* and its allies. I hope to discuss the zoogeographic significance of these relationships in a later and more general paper; meanwhile it will suffice to point out the apparent existence of a fairly definite phylogenetic series within the group.

Although there has been much confusion in the classification of the West Indian forms, this has arisen mainly from difficulty in grouping the various populations to form species, rather than from difficulty in recognizing the populations themselves. Identification of subspecies is, in fact, quite easy, and now that an apparently satisfactory species grouping is available, the species may be identified with equal ease. Only in the *dina-leuce* complex will external characters lead primarily to subspecies rather than to species recognition, and there the affinities of all known populations have been determined on genitalic grounds or, in one case, on conclusive distributional evidence. The following key, therefore, should permit the identification to species of all known West Indian forms.

KEY TO THE WEST INDIAN SPECIES OF THE *Eurema dina* GROUP

1. Dark marginal band of fore wings evenly curved from just behind costa to near tornus, often very broad; apex of fore wing broadly rounded* .... 2.
   Dark marginal band of fore wings with its inner edge distinctly less curved opposite outer margin than opposite apex, or restricted to a small apical patch, or wanting; apex of fore wing often subacute .... 4.
2. Fore wing above with a small but definite dark discal bar .... **lisa**
   Fore wing above with no trace of a dark discal bar 3
3. Male with fuscous border of fore wing above as wide at tornus as at vein M_3. Female unknown. Hispaniola .... **euterpiformis**
   Male with fuscous border of fore wing above much narrower at tornus than at vein M_3. Cuba and mainland .... **neda**
4. Hind wings white or yellowish white above, paler, often contrastingly so, than the pale to bright yellow fore wings .... **nise**
   Ground color uniformly yellow, or with orange tints .... 5.
5. Delicate species, wings above with uniformly pale greenish yellow ground and narrow fuscous borders; rare and local in Cuba .... **laræ**

If ground color uniformly yellow, the hue is brilliant, and the greenish tint scarcely perceptible; the only Cuban form has parts of the wing suffused with orange .... 6.

6. Length of fore wing not over 15 mm.; male with a narrow, but not linear, fuscous fore wing border; within this a narrow zone differing in texture and sometimes in color from the rest of the wing. Bahamas. **chamberlaini**

Length of fore wing at least 18 mm.; male of Bahaman form with fuscous border of fore wings linear or obsolescent; no definite pale zone within the fuscous border .... 7.

7. Male genitalia with dorsal margin of valve forming an angle of nearly 90° with base** .... **dina**

Male genitalia with dorsal margin of valve forming an angle of about 70° with base .... **leuce**

Remarks: (*) Trinidad specimens of *leuce* and *nise* often have the marginal band more regularly curved than is the case in material from the Antilles proper, and some individuals might consequently key to couplet 2. None of the species of couplet 2 ranges south of Antigua (or doubtfully Dominica) in the Antilles.

(**) Both *dina* and *leuce* are subject to such wide geographic variation that no simple combination of external characters will separate them along species lines. In the West Indies the two species overlap only in Hispaniola, where the *dina* form is bright orange, while the *leuce* form is yellow with local orange suffusion. To the east only *leuce,* and to the west only *dina,* occurs.

NOTES ON THE SPECIES

1. *Eurema euterpiformis* Munroe

Terias euterpe: Hall, 1925: 163. *Err. det.*
Eurema euterpiformis Munroe, 1947: 3.

Hall's description indicates clearly that he recognized this species; unfortunately he misidentified it as *euterpe,* which Ménétriés' illustration shows plainly to be a dark form of *lisa.* The material examined by the writer was confused in one collection with *lisa* and in another with *neda.* There is a certain amount of resemblance to both these species, but *euterpiformis* may, as pointed out in the key, immediately be distinguished by the form of the dark border, which is reminiscent of the *messalina* group. From the members of that group, *euterpiformis* differs in lacking the characteristic black dots on the under side of the hind wing. The ground color of the wings is of a purer yellow than in any other New World *Eurema* known to the writer;

all the other yellow species appear faintly greenish in comparison. No doubt there is some chemical peculiarity in the yellow pigment of *euterpiformis*. The male genitalia show a considerable resemblance to those of *laræ;* this probably indicates no more than that neither species is far from the common ancestor of the *dina* group. There are significant differences in detail, while the two species differ radically in external appearance. Attention should be called to an error in the original description: reference is twice made on page 4 to the "anterior" process of the saccus; this is a careless mistake, the process actually being posterior, extending under the base of the valves.

The female and early stages are unknown.

The species is known only from Hispaniola, where it appears to be restricted to the higher altitudes, occurring, however, in both the southern and central cordilleras. Hall notes that he took it in a pine forest at La Vega. The holotype, a winter specimen from Kenscoff, has the marginal band of the wings much narrower than the two paratypes, which are late summer specimens from the central cordillera. It is not known whether this difference represents individual, seasonal, or local variation; it may be noted, however, that the direction of the variation is that which would be expected in seasonal forms.

2. *Eurema laræ* (Herrich-Schäffer)

Terias laræ Herrich-Schäffer, 1862: 120.

For many years this name stood in the synonymy of *dina.* The recapture of a delicately built, pale greenish-yellow form by Ramsden showed, however, that an entirely distinct form was concerned. Bates had already seen an old specimen, and published two notes on the species (1936; 1939); he was not able to examine the genitalia. These prove to be abundantly distinct from those of *dina,* and resemble those of *euterpiformis* in general proportions; the principal differences from *euterpiformis* lie in the uncus, which has a normal Y-shape instead of a V-shape, in the saccus, which is shorter and stouter, and in the dorsal ligament of the valve, which is shorter and broader.

The species is endemic in Cuba, where it is of very local occurrence. Gundlach records it from Loma Vigia in the Trinidad Range, and from Bayamo, near Holguin; Ramsden's specimens came from Jiguani, near Guantanamo. The species has been captured in both summer and winter.

The life history is unknown, but Gundlach (1881a) noted that he always found the species in groves of *Tecoma stans* (Bignoniaceæ), which he accordingly thought might be the food plant. However, a non-leguminous food plant would be most unusual for a species of this genus, so that it is possible that some associated legume, rather than *Tecoma* itself, will eventually prove to be the host.

Material examined: about a dozen specimens in the American Museum of Natural History.

3. *Eurema lisa* (Boisduval and Leconte)

Xanthidia lisa Boisduval and Leconte, 1830: 53.

Comstock (1944) has pointed out that on the average West Indian specimens are smaller in size and have narrower dark wing borders than those from North America. On this basis he recognizes the West Indian population as a distinct subspecies. The differences are rather nebulous, and individual specimens are not identifiable with any great accuracy; however, as the distinction may have some zoogeographic value, it is retained here.

a. *Eurema lisa euterpe* (Ménétriés)
Colias euterpe Ménétriés, 1832: 299.
Terias sulphurina Poey, 1851: 248.
Eurema lisa euterpe: Klots, 1929: 138.

As Comstock noted, the Puerto Rican and Lesser Antillean populations are most strongly differentiated from the North American form, those from Hispaniola and Cuba approaching it more closely in proportion of phenotypes. Conversely, there would appear to be some West Indian influence in the population of Southern Florida.

The species is abundant in open country throughout the Greater and the northern Lesser Antilles, at altitudes up to about 5000 feet. The West Indian distribution is almost exactly complementary to that of the equally common *Eurema nise,* which occupies similar habitats in the southern Lesser Antilles, and it is possible that competition prevents the co-existence of the two species.

The life history has been described in detail by Dethier (1940), on the basis of Cuban material. The food plant in the West Indies is *Cassia,* but other leguminous hosts have been recorded in North America.

Material examined: 891 specimens in the American Museum, the Carnegie Museum, the Museum of Comparative Zoology, Cornell University, and the Lyman Collection, from New Providence, Cuba, I. of Pines, Jamaica, Hispaniola, Puerto Rico, St. Thomas, St. Croix, St. Eustatius, St. Kitts, Antigua, and Dominica. The Dominica specimen is perhaps mislabeled, as the species is at least extremely rare south of Antigua. Carpenter and Lewis (1943) have recorded the species from Grand Cayman.

4. *Eurema neda* (Latreille)

Pieris neda Latreille, 1819: 135.
Terias stygmula Boisduval, 1836: 661.
Terias venusta: Lucas, 1857: 505.
Terias nelphe Felder, 1869: 446.
Eurema nise perimede: Klots, 1929: 105.
Terias neda: d'Almeida, 1936: 239.

This species and its close allies are widespread on the mainland, but the occurrence in the West Indies is very restricted, only one definite locality in Cuba being known. There is also a colony in southern Florida. More adequate material will be necessary before the subspecific status of these populations can be definitely determined, but they certainly resemble the typical Central American form quite closely. D'Almeida has figured the male genitalia (1936, pl. 4); the valves of Florida specimens examined by the writer had two or three additional distal teeth, but this character is not necessarily very significant.

The life history appears to be unknown, but the closely allied Brazilian species *tenella* feeds on *Mimosa pudica;* its life history has been described by d'Almeida.

Material examined: 5 males, 2 females in the Museum of Comparative Zoology from Soledad, Sta. Clara, Cuba; 1 male in the American Museum of Natural History labelled "Cuba", from the collection of Jacob Doll; also a series in the American Museum of Natural History from Royal Palm State Park, Florida. Bates states that the species was common during his stay at

Soledad; it is remarkable that it has not turned up elsewhere in Cuba.

5. *Eurema chamberlaini* (Butler)

Terias chamberlaini Butler, 1897: 295.

This little-known species is alike remarkable in being one of the few endemic butterflies of the Bahamas and in being one of the few to show conspicuous subspeciation within the Bahamas. The male genitalia are closely similar to those of *neda,* and the two species also agree, and differ from *dina,* in having an area of pearly white scales in the region anterior to subcosta of the hind wing. *E. chamberlaini* differs strikingly from *neda* in external appearance, however, and I consider the acute apex of the fore wings, the narrow and straight-bordered marginal band, and particularly the submarginal zone of modified scaling, as constituting characters of specific value.

a. *Eurema chamberlaini chamberlaini* (Butler)

Terias chamberlaini Butler, 1897: 295.

Eurema chamberlaini banksi Clench, 1942: 1. New synonymy.

This species was described on the basis of a single male collected in the Bahamas by Mr. (later the Rt. Hon.) Neville Chamberlain. Butler calls the ground color of the type "gamboge yellow", i.e., clear, brilliant yellow. The island on which the type was collected was not specified, but Petrie's (1938) biography of Chamberlain yields the information that, while he made a general tour of the outer islands in about the year 1890, he spent a period of at least five years at a sisal plantation on Andros. There is thus a very strong probability that the type of *chamberlaini* came from Andros, and, until definite evidence to the contrary appears, this view may be accepted.

Material from Andros has not been available for examination, but three summer males, two in the American Museum of Natural History and one in the Carnegie Museum, from New Providence, agree reasonably well with the original description, althought the ground color is sulphur, rather than gamboge yellow. Accordingly, the New Providence population may provisionally be considered to be equivalent to that of the neighboring island of Andros; that is, it may be referred to the typical subspecies.

These three examples have a fore wing length of about 15 mm. Another male in the American Museum of Natural History, also from New Providence, but collected in February, is somewhat smaller, and differs strikingly in having the wings irregularly flushed with orange, leaving, however, on the fore wings a definite narrow submarginal band of pale yellow. The writer regards this difference as representing a seasonal dimorphism. This winter specimen does not differ significantly from the holotype of *E. chamberlaini banksi* Clench, a male from Cat Island, also taken in February; without further material, therefore, there would appear to be no basis for the retention of Clench's name. The only female known of *chamberlaini chamberlaini* is the allotype of *banksi,* which has been fully described by Clench.

Two males from Watling Island and one male from Crooked Island differ in certain respects from typical *chamberlaini.* The writer agrees with Clench that in the absence of further material the importance of these differences cannot be assessed.

Material examined: 5 males, 1 female, as detailed above.

It should be noted that d'Almeida (1936: 258) has inadvertently substituted the original description of *Eurema dina helios* Bates for that of *chamberlaini* in his account of this subspecies.

b. *Eurema chamberlaini inaguæ* new subspecies

Eurema chamberlaini chamberlaini: Bates, 1934: 134. *Err. det.*

The type material of this subspecies has already been carefully described by Bates, who considered it to be equivalent to Butler's *chamberlaini.* The Inagua material, however, clearly disagrees with the original description of *chamberlaini* in having the ground color brilliant orange, and not "gamboge yellow". For this reason, and in view of the evidence adduced above as to the type locality of *chamberlaini,* Bates' identification cannot be sustained. The Inagua population is thus left without a name, and the name *inaguæ* is accordingly proposed, to parallel Bates' designation of the following subspecies.

Holotype male, allotype female, and four male paratypes in the Museum of Comparative Zoology, Cambridge, Mass., all taken on Great Inagua in February. Two specimens in the Carnegie Museum, Pittsburgh, taken at Matthew's Town, Great Inagua, in March, are similar, but as the writer has not compared these directly with the M.C.Z. series he refrains from including them in the type material.

c. *Eurema chamberlaini mariguanæ* Bates

Eurema chamberlaini mariguanæ Bates, 1934: 135.

Although known only from three specimens, this subspecies clearly represents a population distinct from the ones discussed above. The most characteristic feature is the presence of a definite dark discocellular dot on the upper side of the male fore wing. The female is orange shaded with yellow above, and uniformly yellow beneath. The subspecies is known only from Mariguana Island. The type series was collected in February.

Material examined: 2 males, 1 female (type series), in the Museum of Comparative Zoology.

6. *Eurema nise* (Cramer)

Papilio nise Cramer, 1775, **1**: 31, pl. 20.

Opinions have differed as to the correct application of this name. It is here used in the traditional sense for the species with bright yellow fore wings which normally contrast with the pale yellow or white hind wings. Cramer's figure, however, shows a female with a uniformly pale yellow ground color. On this account, Klots (1929) felt obliged to abandon the previously accepted usage and to apply the name *nise* to the Central American species here called *neda,* together with its South American representatives, leaving *venusta* Boisduval as the oldest name for the present species.

On the other hand, d'Almeida (1936: 245) states that he has seen Venezuelan females which are identical with Cramer's figure, whereas if it is to be identified with *neda* certain inaccuracies in the figure must be assumed. The writer was able to find similar specimens from the Guianas in the collection at Cornell University, and, in fact, it is not uncommon for somewhat worn females to have the ground color of the fore wing as pale as that of the hind wing, especially in the mainland populations. D'Almeida's return to the traditional concept of *nise* is therefore plausible.

An important supporting consideration not mentioned by d'Almeida is that of locality. Cramer gave the locality of his material as Jamaica. No similar form has appeared in modern collections from Jamaica, and it is reasonable to conclude that this locality was erroneous. Assuming this to be true, an examination of the sources of Cramer's Neotropical material shows that the most probable alternative locality is Surinam. Now, *neda* and its close relatives range from Central America to the São Paulo region of Brazil, but seem to avoid the northeastern coastal region of South America, apparently not being recorded from the Guianas or from Trinidad, although the present species is common in both those areas. The weight of probability would therefore appear to be in favor of d'Almeida's view, and it is accepted here.

The male genitalia, which have been illustrated by d'Almeida, are intermediate between those of *neda* on the one hand and *leuce* on the other, the broader and more complex distal armature of the latter already being presaged. The external appearance also shows an interesting ambivalence: the typical, continental populations, and to a lesser extent that of Trinidad, have broadly rounded fore wings and a broad, curved marginal band, essentially similar to that of *neda*. The populations of the Lesser Antilles proper, on the other hand, are characterized by fore wings with a narrow, wedge-shaped marginal band and in many individuals with a subacute apex, so that they bear a considerable resemblance to *dina* or *leuce*. This Antillean population has recently been named by Dillon.

a. *Eurema nise emanona* (Dillon) new combination

Terias deva: Godman and Salvin, 1884: 317.
Terias limbia: Godman and Salvin, 1896: 518.
Terias venusta: Slater, 1901: 223.
Terias nise: Röber, 1910: 83.
Terias deba: Dyar, 1914: 424.
Eurema venusta emanona Dillon, 1947: 100.

The Lesser Antillean populations of *nise* are uniformly characterized by the extremely narrow marginal band of the fore wings above. The apex of the fore wings is on the average more acute than in the continental forms, but this character is not sufficiently constant to be of diagnostic value. The ground color of the wings is normally at least faintly, and often conspicuously, deeper yellow than that of the hind wings, but occasional specimens fail to show this contrast. Such individuals might be confused with *leuce antillarum,* and as the writer has seen only a single specimen of the latter form he is not in a position to give definite diagnostic characters. Any specimen, however, with uniformly lemon yellow fore and hind wings can safely be considered *leuce;* those with uniformly very pale yellow ground color should be treated with reserve. Trinidad specimens of *leuce* often have a conspicuous rusty orange patch at the apex of the hind wings beneath; no such patch is found in *nise emanona.*

This subspecies was described from Dominica, where it occurs in overwhelming numbers, particularly in the open, cultivated ground of the lowlands; it is, however, common throughout the main chain of the Lesser Antilles from Grenada north to Guadeloupe. The life history, in spite of the abundance of the species, appears to be unknown.

Material examined: 96 specimens, including much of what has subsequently become the type material of *emanona,* in the American Museum of Natural History, the Museum of Comparative Zoology, the Cornell University Collection, and the Lyman Collection, from the following localities: Grenada, St. Vincent, St. Lucia, Martinique, Dominica, and Guadeloupe. In addition, there are published records from Barbados (Godman and Salvin) and St. Thomas (Klots); the first of these requires confirmation and the second is almost certainly erroneous. Godman and Salvin give the upper altitude limit as 1000 feet on St. Vincent.

7. *Eurema leuce* (Boisduval)

Terias leuce Boisduval, 1836: 659.

The relationship between this and the following species, *dina,* is very close, and has given rise to considerable confusion. Typical *dina* and typical *leuce* differ considerably in superficial appearance, the former having an extensive orange suffusion which is lacking in the latter, and the two were of course described as distinct species. In the course of time an assemblage of Central American and Antillean forms became associated in the synonomy of *dina,* while a similar accumulation of names of South American application gathered about *leuce.* With the enormous clarification of the relationships of the New World *Euremas* which accompanied Klots' revision (1928, 1929), the close affinity of the two assemblages became apparent, and Klots united all the *dina* and *leuce* forms in a single polytypic species.

D'Almeida in 1936, however, in a genitalic study of a considerable number of specimens, noted that the ædœagus of *leuce* tended to be longer and less sharply curved than that of the *dina* forms, and on this basis he separated the two species once more. On the other hand, Comstock (1944) was more impressed by the similarities in the genitalia and general appearance among the various forms than by the admittedly somewhat inconstant difference in the ædœagus, and rejected d'Almeida's separation. Meanwhile Bates (1939) had revealed a new element in the problem by his discovery that two quite distinct *dina*-like forms existed sympatrically in Hispaniola. One of these has a brilliant orange ground color and a linear marginal band, the other, *memulus* Butler, is closely similar in appearance to typical *dina*, having the ground color yellow washed with orange and the marginal band broad and curving along the costa. This superficial difference is not in itself astonishing, for equally large differences exist between apparently conspecific *dina*-like forms in Central America, but Bates was also able to demonstrate genitalic differences, relating chiefly to the proportional development of the valve armature, between the two forms. It was obvious that two species were involved, and Bates correctly associated the uniformly orange form, which he named *mayobanex*, with the Bahaman subspecies *helios*. The superficial similarity of *memulus* to typical *dina* misled him into considering them conspecific, and he was accordingly forced to consider the *helios-mayobanex* complex as a separate and self-contained species, with a decidedly anomalous distribution pattern.

If an attempt is made to extend the differences in proportional development of the armature which Bates observed between *memulus* and *mayobanex* to other populations in the *dina* complex, anomalous results are soon encountered. Thus, *dina dina* does indeed go with *memulus*, but the very similar Jamaican *parvumbra* must on this criterion be associated with *helios* and *mayobanex*. Another set of differences, however, distinguishes the genitalia of *memulus* from those of *mayobanex;* these are concerned with the overall proportions of different parts of the genitalia, notably of the valves, and are accordingly of the same class as the differences which distinguish such obviously separate species as *neda* and *nise* from the *dina-leuce* complex. The extension of these differences to the remaining populations reveals at once a clear and distinct separation into two groups, each with negligible internal variation, even between widely separated populations. These two groups, moreover, have a regular and entirely normal pattern of geographic distribution, the *dina* group extending from Central America into the Greater Antilles as far as Hispaniola, and the *leuce* group penetrating from South America up the Lesser Antilles to Puerto Rico and again to Hispaniola. It is obvious that this arrangement is the natural one, that the two groups represent distinct and partly sympatric species, and that d'Almeida's separation of *dina* and *leuce* was essentially correct.

The following table will outline the principal differences in valve proportions between *dina* and *leuce;* the values given are means, but there is remarkably little difference, either individual or local, in these basic proportions within the species. The measurements were made from specimens preserved in fluid, and will not be applicable to specimens flattened on slides; it is almost impossible to control the degree of distortion in specimens so flattened, and they are valueless for purposes of comparative measurement. Thus d'Almeida's figures, obviously based on slide material, reveal qualitatively the differences in proportion between *dina* and *leuce,* but obscure the actual constancy of these differences in undistorted material. The same difficulty was encountered in the study of some of Klots' original slide material, which is preserved at Cornell University, although in this case it is known that a special effort was made to minimize and standardize distortion. In the writer's opinion the dangers attendant upon distortion are equally great in almost all groups of the genus, and genitalic material of *Eurema* should invariably be studied and *preserved* in fluid, e.g., glycerine-alcohol, if critical differences are to be resolved.

Some explanation of the following measurements is necessary: the line representing the base of the valve is taken as a line connecting the dorsal and ventral angles, neglecting the slender dorsal articular process; the remaining lines were obtained by producing the longest approximately straight portion of the margin in question.

MEAN PROPORTIONS OF VALVE IN *Eurema dina* AND *leuce*

Measurement	*dina*	*leuce*
Angle between costa and base	84°	68°
Angle between distal margin and base	19°	27°
Angle between ventral margin and base	63°	70°
Ratio of distance between base of process "b" and base of process "d" to distance between base of process "d" and distal angle (terminology of Klots)	1.25	0.66

The ædœagus characters employed by d'Almeida segregate the populations along similar lines, as shown in the following table. The measurements again require explanation: the length of the ædœagus is taken in terms of the length of the valve considered as unity; the curvature was measured by drawing a chord connecting the basal and distal extremities of the ædœagus and dividing its length into the greatest perpendicular distance from the ædœagus to the chord. The populations are classified into species on the basis of the valve characters so that a ready comparison with the cleavage of the ædœagus characters can be made.

ÆDŒAGUS MEASUREMENTS OF VARIOUS POPULATIONS OF THE *dina-leuce* COMPLEX

Population	length	curvature
leuce pseudoleuce	1.66	0.30
" *sanjuanensis*	1.68	0.28
" *memulus*	1.80	0.33
dina mayobanex	1.45	0.28
" *helios*	1.45	not measured
" *parvumbra*	1.45	0.28
" *dina*	1.47	not measured
" *westwoodii*	1.43	0.30

The difference in relative length of the ædœagus in the two species is very obvious; that in curvature is one of means rather than an absolute one, and may not really be significant.

As here understood, the species *leuce* is represented in the Antilles proper by three subspecies, the subspecies *pseudoleuce* d'Almeida, recognized as distinct by Comstock (1944), being apparently confined to Trinidad and hence extralimital. These subspecies may be separated by the following key.

1. Ground color above yellow, locally flushed with orange; marginal band of moderate width. Hispaniola .... *memulus*
   Ground color above clear lemon yellow, without orange tints; marginal band extremely narrow 2
2. Maximum width of dark marginal band in male 1 to 1.5 mm. Lesser Antilles .... *antillarum*
   Maximum width of dark marginal band in male 0.5 mm. Puerto Rico .... *sanjuanensis*

The writer has seen no description of the life history.

a. *Eurema leuce antillarum* (Hall) new combination
Terias leuce antillarum Hall, 1936: 275.
Eurema dina antillarum: Comstock, 1944: 526.

In large part sympatric with *nise emanona,* but much scarcer. Differentiation between these two species is ordinarily possible by the uniform ground color in *leuce* as compared with the contrastingly pale hind wings in *nise.* Occasional specimens, particularly females, of *nise emanona* have a uniform ground color, and here trouble is likely to be encountered. In the Trinidad subspecies of *leuce* (*pseudoleuce* d'Almeida) there is usually a rusty patch at the apex of the hind wing beneath, which is never found in *nise emanona.* The only specimen of *leuce antillarum* examined by the writer, a female which he took in St. Kitts, now in the collection of Mr. René Lichy of Caracas, this patch was present; it is sometimes lacking in *leuce pseudoleuce,* however, and in the absence of further material it is impossible to give characters which will invariably separate the two species in the Lesser Antilles.

Material examined: 1 female, taken on Monkey Hill, St. Kitts, in June. Hall has also recorded the subspecies from Dominica and St. Lucia.

b. *Eurema leuce sanjuanensis* (Watson) new combination
Eurema sanjuanensis Watson, 1938: 1.
Eurema dina sanjuanensis: Comstock, 1944: 525.

The unique holotype of this species has been fully described and illustrated by Comstock (1944). His excellent figure of the genitalia (made from a specimen in fluid preservative) shows beyond question that it goes with *leuce* rather than with *dina.*

If the single specimen is representative of the population, *san-juanensis* is distinguishable from *antillarum* by its larger size and considerably narrower dark wing border.

Material examined: 1 specimen (holotype), San Juan, Puerto Rico, July.

c. *Eurema leuce memulus* (Butler) new combination

Terias memulus Butler, 1871: 251.

Terias citrina: Hall, 1925, 164.

Eurema dina memulus: Watson, 1938: 2.

The conspicuous orange flush and broad black borders of the wings of this subspecies give it a striking resemblance to *Eurema dina dina* from Cuba. On this account previous authors have associated it with that form, but the genitalia leave no doubt as to its real relationships. The subspecies has been taken at various altitudes and localities in Hispaniola, from 500 to 2500 feet above sea level. Like the other Antillean subspecies of *leuce*, it is rare.

Material examined: 3 males, 1 female, in the American Museum of Natural History and the Museum of Comparative Zoology.

8. *Eurema dina* (Poey)

Terias dina Poey, 1832, no. 11.

This species ranges through Central America and into the Greater Antillean area, with extensive color variation. Each of the Antillean populations is fairly uniform, although there is a little seasonal variation in the width of the dark border of the wings. The Central American population (*dina westwoodii* Boisduval) is, however, highly polymorphic, and individuals can be selected to match almost any of the West Indian subspecies. The relative uniformity of the West Indian populations may well be due to Wrightian scattering of variability; in the absence of more complete information as to the basis of the observed variability and the history and population numbers of the West Indian forms it is impossible to accept this conclusion with entire confidence, but the presence of a yellow form in the normally orange Bahaman population suggests that at least this color character may be determined by a single gene difference.

The life history of *dina* appears to be unknown.

The following key will separate the West Indian subspecies:

1. Dark border of fore wings linear or obsolete; ground color normally orange ... 2
   Dark border of fore wings at least 1 mm. wide at apex in male, represented at least by a definite apical patch in female; ground color normally yellow locally flushed with orange ... 3
2. Length of fore wing about 18 mm.; Bahamas ... *helios*
   Length of fore wing about 20 mm.; Hispaniola ... *mayobanex*
3. Dark border of fore wings little more than 1 mm. wide at apex in male; in female represented by a triangular apical patch; Jamaica. *parvumbra*
   Dark border of fore wings continuous in both sexes, broadly curved to form an apical patch 3 to 5 mm. in width; Cuba and I. of Pines *dina*

a. *Eurema dina dina* (Poey)

Terias dina Poey, 1832, no. 11.
Terias citrina Poey, 1852: 247.
Terias westwoodii: Lucas, 1857: 507.
Eurema dina: Gundlach, 1881: 112.
Eurema dina dina: Klots, 1929: 139.

Widely distributed in Cuba and the Isle of Pines up to an altitude of about 3000 ft. There is minor seasonal variation: winter specimens tend to have the marginal band somewhat narrower than those taken in the summer, and frequently lack its costal extension. Probably owing to local variations in the seasonal rainfall cycle, the correlation of variation with date of capture is not too precise. The name *citrina* applies to extreme specimens of the winter type. The species occurs in all parts of Cuba, but is apparently most common in Oriente.

Material examined: 118 specimens, in the American Museum of Natural History, the Carnegie Museum, the Museum of Comparative Zoology, and the Cornell University collection.

b. *Eurema dina parvumbra* (Kaye)

Eurema westwoodi: Fox and Johnson, 1893: 3.
Eurema citrina: Fox and Johnson, 1893: 3.
Terias dina parvumbra Kaye, 1926: 481.
Eurema dina parvumbra: Klots, 1929: 139.

The Jamaican subspecies is very similar to the Cuban one, differing principally in the great reduction of the marginal band, a characteristic Jamaican "dry" modification; the average size is also a little smaller. Females may lack any conspicuous orange flush, but are not likely to be confused with any other Jamaican species. Well distributed in Jamaica, up to about 5000 feet.

Material examined: 138 specimens in the American Museum of Natural History, the Carnegie Museum, and the Museum of Comparative Zoology. Most of these belong to the magnificent series collected by Avinoff and Shoumatoff.

c. *Eurema dina helios* Bates

Eurema dina helios Bates, 1934: 133.
Terias dina helios: d'Almeida, 1936: 223.
Eurema helios helios: Bates, 1939a: 44.

The Bahaman subspecies is unusually small, though decidedly larger than the various *chamberlaini* forms. The ground color is usually bright orange, but one specimen in the type series is clear yellow, though not differing otherwise. In summer specimens there is a linear fuscous border on the fore wing above; in winter specimens this is wanting or barely indicated. There is no evident difference between Andros and New Providence specimens.

Material examined: 56 specimens, including the type series of *helios,* from New Providence and Andros, in the American Museum of Natural History, the Carnegie Museum, and the Museum of Comparative Zoology.

d. *Eurema dina mayobanex* (Bates) new combination

Eurema helios mayobanex Bates, 1939a: 45.

The writer's reasons for not following Bates' treatment of this and the preceding subspecies have already been discussed. In superficial appearance *mayobanex* resembles *dina dina* far less than does the sympatric *leuce memulus. Mayobanex* does, however, closely resemble the orange form of *dina westwoodii,* as well as the Bahaman *dina helios,* being about intermediate in size between these two forms. Unlike the other *dina* subspecies, *mayobanex* appears to be extremely rare, perhaps suffering from the competition of *leuce memulus.*

Material examined: 9 specimens, including the type material of *mayobanex,* from Ennery, Haiti, 2500 feet, and San Lorenzo, Dominican Republic, all taken in August, in the American Museum of Natural History, the Carnegie Museum, and the Museum of Comparative Zoology. The Carnegie Museum specimen is without precise data.

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NOTES ON THE PSEUDOPHOTOPSIDINÆ (MUTILLIDÆ) WITH DESCRIPTION OF THE FEMALE SEX

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The anomalous genus *Pseudophotopsis* differs from all other described Mutillid genera that lack an aculeiform hypopygium, in the presence of an anal lobe of the hind wing. For that reason it has been generally isolated by itself. Bradley and Bequaert (1928) first separated it as a subfamily from the Mutillinæ (s. str.), but unfortunately called that group the Photopsidinæ, possibly under the erroneous impression that the Photopsidoid wasps also possessed an anal lobe. Krombein (1939) rectified this by calling the group defined by Bradley and Bequaert as possessing an anal lobe of the hind wings, but no aculeus of the hypopygium, the Pseudophotopsidinæ. To my knowledge, Krombein therefore should be cited as the authority for that group. The writer (1946) more fully commented on the relationships of the Pseudophotopsidinæ, and agreed with Krombein that the group certainly deserved separation from the other Mutillinæ. I there also called attention to some of the other structural anomalies of the sole included genus, and commented on the erroneous affiliation of the genus to *Ephutomma* as indicated by Bischoff.

Bischoff (1920) diagnosed the genus *Ephutomma* Ashm. as having anal lobes of the hind wings. The material of *Ephutomma* examined by the writer lacks an anal lobe of the hind wings; it differs furthermore from *Pseudophotopsis* in the following fundamental characteristics:

a. lateral pronotal faces with the lower, anterior corner not bearing a depressed, foveate densely pubescent area, analogous and perhaps homologous with the felt lines of the second segment of the abdomen (true for both sexes).

b. tarsal claws lacking the internal tooth present in *Pseudophotopsis* (true for both sexes).

c. eyes deeply emarginate within in male (shallowly or not in *Pseudophotopsis*).

d. the tegulæ large, more or less conchiform in male (small and subcircular in *Pseudophotopsis*).

e. the petiole relatively short and stout in male, sessile or subsessile (generally elongate and nodose in *Pseudophotopsis*).

By definition then, the genus *Ephutomma* cannot be placed in the subfamily *Pseudophotopsidinæ*. Critical study of the genitalia furthermore reveals profound differences, of subfamily status, between the two genera. The dilated, broad parameres of *Pseudophotopsis* allying that genus with the Apterogyninæ rather than with the Mutillinæ or Sphæropthalminæ.

André, as early as 1903, emphasized another of the very basic differences between *Ephutomma* and *Pseudophotopsis*: the wing venation. The complete cells R_3 and M_2 of *Ephutomma,* together with the hyaline, reduced stigma, differentiate it remarkably from the undefined or scarcely indicated (by color lines) cells R_3 and M_2 of *Pseudophotopsis,* where the stigma is very large, deeply sclerotized and pigmented.[1]

Bischoff's statement that the two genera may well be found to be merely subgenerically different is therefore to be interpreted rather as an indication of superficial treatment of the group, rather than as a valid statement. Apparently Bischoff (1920) mixed the genera *Pseudophotopsis* and *Ephutomma,* and his diagnosis in the key was possibly partly or entirely based on an individual or individuals of *Pseudophotopsis* which he considered to be males of *Ephutomma.* This leaves one in the position of not knowing where to put the various species in the two genera, since the lines between these distinct groups have obviously not been sharply differentiated.

Critical subsequent study of the male genitalia reveals that the gap between *Ephutomma* and *Pseudophotopsis* males is indeed very great. The slender form of the parameres in *Ephutomma* clearly allies it with the other Mutilline (and Sphæropthalmine) genera, whereas the broad, flattened, oval or lanceolate parameres of *Pseudophotopsis* in many ways approach those of the

[1] The more complete venation of *Ephutomma* also indicates a direct derivation of that genus from *Pseudophotopsis* is quite impossible.

Apterogyninæ. The unique form of the ædœgus, however, isolates it from the Apterogyninæ, as well as all other mutillid groups known to me. The anomalous position of *Pseudophotopsis* is therefore even more clarified. In the armed tarsal claws, as well as in the nature of the hind wings, and in the form of the genitalia, it approaches the Apterogyninæ. It may therefore well be considered an annectant genus, related to the other Mutillids lacking a hypopygial aculeus, but also standing near to the common ancestral form that led to the Apterogyninæ.

The genus *Pseudophotosis* therefore may be considered as one of the critical points about which our whole classification of the Mutillidæ pivots. Since it occupies that critical position there has been considerable speculation as regards the form of the female sex. Radoszkowski as early as 1887 described a female he believed to belong to *Pseudophotopsis.* Bischoff (1920) comments as follows regarding this female: "Als Weibschen der *Agama caspica* bescrieb Radoszkowski . . . eine Form, die mir im Typus vorliegt. Dieses Weibschen ist dem der *Ephutomma incerta* Rad. so ausserordentlich ähnlich, dass es André fûr die gleiche Art hielt. Ob dieses Tier überhaupt eine *Pseudophotopsis* und nicht eine echte *Ephutomma* ist, muss noch, das bisher keine weiteren zur Gattung *Pseudophotopsis* gestellten Weibsehen bekännt sind, dahingestellt bleiben." This uncertainty could have been resolved by Bischoff, had he clearly differentiated between the two genera in the male sex, since the females of *Pseudophotopsis* possess two unique characteristics, that are shared with the male, not found in either male or female in other related groups. These characters are the foveate depressions, filled with hairs, of the anteroventral corners of the sidepieces of the pronotum, and the strong inner tooth of the tarsal claws. These, though occurring in both male and female of *Pseudophotopsis,* do not occur in *Ephutomma* males and females, or any other genus of the Mutillinæ or Sphæropthalminæ. Bischoff, however, stated that: "Die Gattungen *Pseudophotopsis* und *Ephutomma* stehen sich aber so nahe, dass es immerhin denkbar wäre, dass das vorliegende Weibschen (i.e., the female described by Radoszkowski, and above referred to) tatsächlich hierher gehört. Es wäre dann allerdings zu erwägen, ob man nicht die Gattang *Ephutomma* besser als Untergattung zu *Pseudophotopsis* stellen würde, zumal generische Unterschiede nur im männlichen Geschlecht vorhanden zu sein scheinen.'' In the writer's opinion, however, essential differentiating characters exist between *Euphutomma* and *Pseudophotopsis* in both sexes that make the disposition of *Pseudophotopsis* in an isolated subfamily, while *Ephutomma* is placed in the Mutillinæ, justified. It is not to be denied that there is considerable similarity of an obvious nature between the two groups, especially in the female sex (which, with the possible single exception of the individual described by Radoszkowski, has been universally confused with *Ephutomma*). However, the male genitalic characters, as well as the external characteristics of both male and female (especially the apparently critical presence of armed tarsal claws), indicates that the obvious relationships are largely of a superficial, perhaps partly of a homoplastic, rather than fundamental nature. It appears more likely that both of these genera are relatively archaic, but that *Pseudophotopsis* is much more so, while *Ephutomma* evolved from it (or from near it) essentially by loss of the anal lobes, loss of the lower epaulets, and loss of the armature of the tarsal claws, together with the innovation of some new characters (that have become characteristic of the whole subfamily Mutillinæ), such as a sessile male petiole, reduction of the stigmatic cell, increase in size of the tegulæ, and more obvious development of the excision of the inner orbits of the eyes. Such a concept closely follows the linear pattern outlined by the writer (1946) in both the male and female sex, though at that time the female sex was unknown to the writer.

The relatively inadequate material of this entirely Old World group available makes a revision of the two genera impossible at the present time. It is hoped, however, that the following generic diagnoses, covering both sexes, will adequately separate both male and female in the future. Since I have not had enough material, I cannot cite the synonymy for most of the females previously placed in *Ephutomma* (though several of these will certainly be found to represent *Pseudophotopsis*). European students, with adequate material available, however, should easily be able to prepare such a catalogue, which is certainly desirable.[2]

[2] Since Bischoff (1920, p. 23) diagnoses *Ephutomma* as possessing anal lobes of the hind wings, study of the male sex would also be profitable, since

Subfamily PSEUDOPHOTOPSIDINÆ

Male: Head with large ovate to ovate-elliptical eyes, usually approaching the mandibles (i.e., malar region suppressed), with the inner orbits not or slightly excised; facettation distinct. Clypeus simple, the epistomal suture not bearing the anterior tentorial pits (these somewhat dorsad of the suture). Antennal tubercles distinct (i.e., the lamellate, rim-like expansions of the vertex bounding the antennal ossæ distinct). Ocelli large, salient. Mandibles with a strong ventral excision, subtended by a salient ventral tooth. Antennæ with scape extremely elongate (contrasted to the Apterogyninæ).

Alitrunk with pronotum reduced (as in Sphæropthalminæ), with dorsal face reduced along midline because of encroachment of mesoscutum; lateral pronotal faces on lower anterior corners with a conspicuous depressed, densely puberulent pit-like region (the ventral ''epaulets''), perhaps representing the opening of a gland. Parapsidal furrows deep, complete. Metatergum usually with a pair of distinct, erect teeth. Tegulæ small, subcircular, not hiding the axillary wing-sclerites beneath them. Wings with lamina pale, the fore-wings with only two cubital and one discoidal cell; stigma large, distinct, pigmented and sclerotized throughout. Hind wings with a distinct, small anal lobe, but no pre-axillary incision; cubitus inserted basad of transverse median vein. Legs with calcaria 1–2–2; tarsal claws very distinctly armed, near middle of inter edges, with a small tooth. Metapleura rectangular, oblique sclerites, subequally wide throughout, divided into a dorsal portion and ventral portion by a horizontal suture ending posteriorly in the endophragmal pit; metapleural-propodeal suture nearly straight, not angled towards the meso-metapleural suture.

Gaster with petiole elongate, rather slender, at most subsessile with second tergite. Second segment with both dorsal and ventral felt lines. Hypopygium flat, unarmed, well-developed. Genitalia highly specialized, the parameres laterally compressed and flattened (as in Apterogynine-Typhoctine developmental line, but quite unlike the Sphæropthalmine-Mutilline developmental line); ædœagus with the two lateral halves also strongly dorsiventral, laterally compressed, flattened plates (except for the arm-like apodemes), the distal portions with a group of stout peculiar spine-like, socketted teeth.

Female: Head narrower than thorax, usually rather well developed behind

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it is almost certain that Bischoff confused the two genera in the male sex, as well as in the female sex. Bischoff's *Ephutomma pallipes,* with a uniformly sclerotized stigmatic cell, will probably be found to represent a species of *Pseudophotopsis.* Indeed, Bischoff speaks of that species as forming, in several ways, a transition to *Pseudophotopsis.* It is possible that that species was before Bischoff, when he made his key to genera, since every male unquestionably belonging to *Ephutomma* that I have had occasion to study lacked all trace of anal lobes.

the eyes, very coarsely sculptured; vestigial ocelli present; clypeus short and transverse; mandibles large, ventrally strongly emarginate and armed with a large, rounded tooth. Thorax subrectangular, but narrower posteriorly than anteriorly because of a slight dilation of the prothorax and a rather distinct constriction in the mesonotal area; a distinct dorsal division of the alitrunk into pro-, meso- and metapleural portions occurs, but the sutures are obviously so reduced as to be non-functional; the lateral faces of the prothorax are nearly flat, largely devoid of sculpture. The legs have distinctly armed tarsal claws. The petiole is broad, sessile; the gaster (in species seen) has distinct felt lines of both sternum and tergum; the pygidium is not sharply defined; foveate and densely hirsute depression of the lower angles of the prothorax developed similarly as in male sex.

The definition of both sexes is quite similar to that of *Ephutomma*, but the diagnosis differs from the latter genus in that both male and female have armed tarsal claws, and both have the prothorax with the anteroventral depressed, foveate pubescent region. Bischoff (1920) indicates several other differences between the male sex, which, however, represent mere tendencies. A further distinction may occur in the female sex, which will have to be checked with more adequate material, namely, the form of the thorax. In *Pseudophotopsis syriaca* (= *Ephutomma syriaca* auct.) the prothorax is relatively narrow, but little wider than the rest of the alitrunk, and the thorax has a more rectangular appearance than characteristic for *Ephutomma;* it is furthermore more elongate and nearly twice as long as its greatest width. Whether this character of the alitrunk, which occurs constantly in all females I can refer to *Pseudophotopsis*, is a valid generic character is still uncertain, however.

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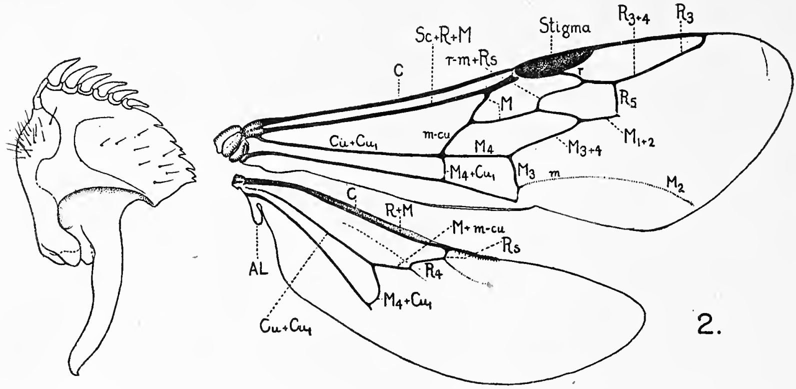

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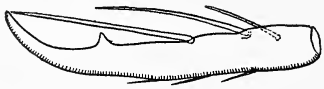

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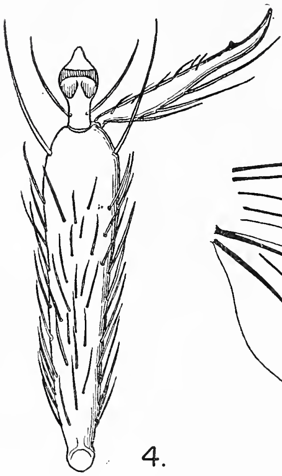

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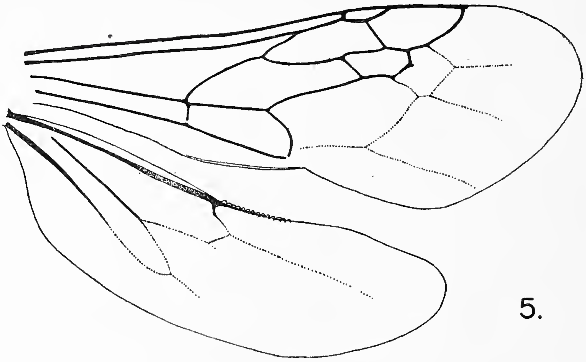

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Plate XVII

Fig. 1. Ental face of ædœagus of *Pseudophotopsis komarowii.*

Fig. 2. Wings, with veins lettered, of *Pseudophotopsis komarowii.*

Fig. 3. Tarsal claw of *Pseudophotopsis komarowii.*

Fig. 4. Metatarsus, tarsal claw, and pulvillus, of *Pseudophotopsis komarowii.*

Fig. 5. Wings of *Ephutomma elongata* Rad.

PROCEEDINGS OF THE NEW YORK ENTOMOLOGICAL SOCIETY

Meeting of October 5, 1948

A regular meeting of the Society was held October 5, 1948 in the American Museum of Natural History. President Dr. Hagan called the meeting to order at 8: 00 P. M. There were 12 members and five visitors present.

The field committee reported on the two Society outings of the past summer, held on the grounds of Mr. Chris Olsen at West Nyack, New York, and of Mr. Teale at Baldwin, Long Island, that were favored with good weather, and well attended. Mr. Olsen and Mr. Teale again proved themselves fine hosts. An informal talk on European entomology was presented by Olaf Ryberg of Sweden at the outing on Mr. Teale's grounds.

Dr. Hagan reported the resignation of the society treasurer, Dr. James C. King, which was forced by illness. He expressed the appreciation of the society for the time and effort so freely given by Dr. King in the performance of his duties as treasurer and instructed Mr. Pallister to draft a letter to Dr. King extending to him the well wishes of the society in his illness, and expressing the hope for early recovery. It was also announced that Mr. John C. Pallister had been appointed treasurer for the remainder of the year, and that Mr. Leonard J. Sanford would continue as assistant treasurer. The auditing committee presented a report, as of September 30, 1948, of the books of the former treasurer, that was adopted.

Mr. Teale called to the attention of the society the death of entomologist Phil Rau in St. Louis.

A letter was read by Mr. Pallister from a Gerhard A. Holzbauer of Stuttgart, Germany, addressed to the Museum, asking for correspondents on Lepidoptera.

Dr. James Forbes, chairman of the program committee, spoke on the results of his survey to determine the desires of the membership for a program of maximum interest and benefit. The president assured the program committee that it had a free hand in making the arrangements.

The meeting was then opened for general discussion of summer activities of the membership. Mr. Teale reported observing the herding of a treehopper (both adult and immature forms) by carpenter ants. He also observed an increase in the numbers of the native mantid *Stagmomantis carolina* around Baldwin, Long Island. He mentioned a trip he had taken to Oscoda County in Michigan to observe the Kirkland Warbler. He found this bird feeding its young on ant lions, which were very abundant. Mr. Teale also read several philosophical observations from the journal which the late William T. Davis had kept for some 50 years. The Staten Island Institute is publishing a biography of Mr. Davis.

Mr. Vishniac reported observing a black wasp of the genus *Astata* stocking its nests with pentatomids. He was surprised to find the paralyzed bugs still alive after four weeks in the nests, since they live only a few days above ground.

Dr. Spieth made mention of his continuing work on the mating behavior of fruit flies.

Some further comments on armchair collecting were contributed by the members.

FRANK A. SORACI, *Secretary.*

MEETING OF OCTOBER 19, 1948

A regular meeting of the Society was held October 19, 1948 at the American Museum of Natural History. President Dr. Hagan called the meeting to order at 8:00 p. m. There were 16 members and 25 visitors present. The reading of the minutes of the previous meeting was dispensed with, so that the speaker of the evening, Dr. Ralph B. Swain, was able to proceed with his paper on "The Mormon Cricket." This paper, described the work of several years in studying the biology and habits of the insect, surveying damage, and devising and putting into practice control measures. The thorough study of this migratory long-horned grasshopper (*Anabrus simplex* Haldeman) was performed during 1938–1939, at the peak of the last major outbreak. Heroic measures were used at that time in the attempt to alleviate the depredations of the past. During the last 10 years poison baiting has replaced metal barriers and sodium arsenite dust, and an even greater advance can be expected with the advent of DDT and other new organic insecticides. Sound motion pictures of the project were shown.

FRANK A. SORACI, *Secretary.*

MEETING OF NOVEMBER 16, 1948

A regular meeting of the Society was held November 16, 1948, at the American Museum of Natural History. President Dr. Hagan presided. There were 12 members and 15 guests present.

Dr. Hagan spoke on the need of the Society for additional income, especially because of increased JOURNAL costs.

There being no further business, the speaker of the evening, Dr. T. Schneirla proceeded with his paper "Additional Observations on Army Ants (*Eciton* sp.)" an abstract of which follows:

In the continued studies of army ants on Barro Colorado Island, a new technique which proved to be valuable was the "marking" of the colonies by making a very small nick with iridectomy scissors in a given part of the edge of one of the queen's abdominal sclerites. About 20 *E. hamatum* colonies were thus marked, in a total of 32 colonies investigated; 12 *E. burchelli* colonies were marked in a total of 20 colonies studied on the Island. For example, our colony H-12 of *E. hamatum* was "let go" at Wheeler 20 on Nov. 23, after the queen had been marked; then on Dec. 24 after our return from Candelaria this colony was found at Shannon 3, and a valuable sample of eggs was obtained from a brood which developed into a sexual (male and fertile female) brood,—our first record for the year. Followed and studied until early February, colony H-12 gave us highly useful records on queen-production and colony division.

The facts concerning queen-production in the Ecitons were checked in the study of a number of colonies. We find the number of young queens matured to be very small, probably less than a dozen as a rule. They are fully developed in advance of the males, typically about three days, we find. This fact of female precocity proves to be very important for the process of colony division. Since the young queens are present as adults before the males begin to emerge from their cases, it is possible for sub-sectioning of the colony to occur on a chemical-attraction basis before emergence of males arouses the colony into a move from its statary bivouac site. We find that the ''old'' colony queen is likely to be present in one of the sub-sections which becomes a new colony, one of the young ''new'' queens in another; these move off divergently and thenceforth behave as new colonies. The other young queens, through an interesting behavior process in the workers, are ''sealed off'' and eventually are abandoned.

Much information was obtained which throws further light on the environmental conditions under which these ants form their ''bivouacs'' or temporary nests. Many ecological records were obtained from *Eciton* bivouac sites, in comparison with nearby control locations. These show that army-ant colonies are generally successful in approximating a highly ''stable environment'' as concerns temperature and humidity through the day. This fact explains the regularity of the nomadic-statary behavior rhythm in *Eciton* colonies, since the phases of this rhythm are conditioned upon the duration of developmental phases of the brood. If the colony environment were more variable, the brood-development process would vary more from case to case than we have found.

As a result of our findings, it is now clear that but one sexual brood (per colony) appears annually in the army ants, and that the pre-conditions of this brood are peculiar to the dry season. With further information about the timing of the one sexual brood per year and the conditions of its production, the implications of the army-ant situation for problems of caste- and sex-determination now become clearer. We find that the single sexual brood of 2,000–3,000 males and a dozen or less queen-type individuals is somehow produced by a functional queen which otherwise delivers very large all-worker broods at regular intervals throughout the year.

Additional developmental series of males were obtained from egg to callow alate, as well as queen developmental stages including prepupal and pupal forms. Our Bouin-fixed material from BCI and from Darien opens the possibility for further investigations on these little-known individuals, and particularly on the reproductive tissues of the queen, both as to their development in the embryo and their function in the adult.

Frank A. Soraci, *Secretary.*

Meeting of December 7, 1948

A regular meeting of the Society was held in the American Museum of Natural History, December 7, 1948, at 8: 15 p.m. About 25 members and guests were present.

Dr. Olaf Ryberg, eminent Swedish entomologist, spoke on the Biology and Metamorphosis of Bat-Flies (Nycteribidæ). This family belongs to the group Pupipara of the Diptera; they are wingless, spider-like, blood-sucking flies, parasitic on bats, and give birth to full grown larvæ which are ready to pupate. There are about 2,000 species of bats and about 100 species of bat-flies. The family is comparatively rare in the United States, where there are more of another family in the same group, also parasitic on bats, the Streblidæ. Dr. Ryberg showed slides depicting the metamorphosis of several species of Nycteribidæ and gave interesting details of their habits and morphology.

Dr. Ryberg concluded with comments on entomology and entomologists in the Scandinavian countries.

Patricia Vaurie, *Asst. Sec'y.*

Meeting of December 21, 1948

A regular meeting of the Society was held December 21 at 8: 10 p.m., in the American Museum of Natural History. Twenty-two members and guests were present.

In the absence of the secretary, the minutes of the previous meeting were dispensed with. The president, Dr. Hagan, appointed an auditing committee composed of Dr. Gertsch, chairman, Mrs. Vaurie and Dr. Schneirla. A nominating committee, appointed at the previous meeting, was announced as consisting of Mr. Schwarz, chairman, Dr. Klots and Mrs. Vaurie.

The speaker of the evening was Mr. David Bigelow, whose subject was "Collecting and Rearing Larvae of Saturnid and Sphingid Moths." Mr. Bigelow told of his collecting in Oyster Bay, New York, and in other localities, with hints on how to find the larvæ. He was especially interested in a survey of the food plants and the frequency of parasitism. He had transformed his back porch in Oyster Bay into a huge breeding cage. Slides were shown of many of the larvæ.

Patricia Vaurie, *Asst. Sec'y.*

Meeting of January 4, 1949

An annual meeting of the Society was held January 4, 1949 in the American Museum of Natural History. President Dr. Hagan called the meeting to order at 8: 00 P. M. There were 21 members and six guests present. The minutes of the meetings of December 21, 1948, December 7, 1948 and November 16, 1948 were approved as read. The minutes of the Executive Committee of November 16, 1948 were also read.

The president then asked for committee reports. The report of the treasurer was read by Dr. Schneirla. The Auditing Committee reported that the books had been examined and found in order. These reports were adopted.

The Program Committee reported that it hopes to arrange a photography exhibit for a May meeting, and that programs had been arranged through February.

The Field Committee reported that Mr. Olsen's grounds would probably not be available for future field trips.

Mr. David M. Bigelow, Architecture Department, American Museum of Natural History, was welcomed back to active membership.

Mr. Arthur Roensch, 1350 Fulton Ave., Bronx 56, New York, was elected to active membership.

The Nominating Committee submitted its report which was adopted and the following officers were elected.

President	Dr. Theodore Schneirla
Vice-President	Dr. James Forbes
Secretary	Frank A. Soraci
Asst. Secretary	Mrs. Patricia Vaurie
Treasurer	David M. Bigelow
Asst. Treasurer	Dr. Lucy W. Clausen
Editor	Harry B. Weiss

Trustees

Dr. Mont E. Cazier
Dr. Harold R. Hagan
E. Irving Huntington
Dr. T. C. Schneirla
E. W. Teale

Publication Committee

Harry B. Weiss
John D. Sherman, Jr.
Edwin Way Teale

Doctor Hagan then thanked the officers and membership for their co-operation throughout his term of office, and turned over the chair to the incoming president.

There being no further business the meeting adjourned in order to do justice to the refreshments of coffee and cookies served by the Program Committee.

FRANK A. SORACI, *Secretary.*

MEETING OF JANUARY 18, 1949

A regular meeting of the Society was held January 18, 1949 at the American Museum of Natural History. The president, Dr. Schneirla called the meeting to order at 8:00 P. M. There were 14 members and 18 guests present.

Doctor Schneirla made mention of the need of the Society for funds, reporting briefly on the meeting of the Executive Committee, earlier in the day. The secretary then read the resolution recommended for passage by the Executive Committee.

> "Be it resolved that the annual dues for membership be raised from \$3.00 to \$4.00, making the total cost of membership and Journal \$6.00 annually."

Notice of the resolution was to be given by mail, to the membership; the resolution to be voted at the regular meeting of the Society on February 15, 1949.

The following action of the Executive Committee was also read:

> "It was moved, seconded and approved that the price of the Journal be raised to \$5.00 per volume, net to the Society, for all new subscriptions

starting February 1, 1949, and for all except member subscriptions beginning with Vol. 58 (1950).''

The speaker of the evening, Dr. Henry Svenson, then presented his talk on ''Insect Hosts of the New York Region.'' He was especially interested in the Lepidoptera of this region, and spoke of the plant hosts of many of the more common, spectacular forms. A large number of aged, but well preserved specimens of the various plants was shown.

Frank A. Soraci, *Secretary.*

Meeting of February 1, 1949

A regular meeting of the Society was held February 1, 1949 in the American Museum of Natural History. In the absence of the president, the vice-president, Dr. James Forbes was in the chair. He called the meeting to order at 8: 00 P. M. There were 16 members and 55 visitors present.

Mr. Lucien Pohl, 215 West 83rd Street, New York City, was proposed for active membership by William P. Comstock and elected under suspension of the rules.

Mr. Teale made a correction of the minutes of the meeting of October 7, 1947. Whereas, he was reported to have observed bats attracted to the green light of a neon sign, ignoring that portion of the same sign emitting a red glow, he stated that actually insects were attracted in large numbers to the green light and that apparently the bats were attracted to the insects.

It was moved by Mr. Teale, seconded by Mr. Schwarz and approved that the by-laws of the Society be amended to include an associate editor as an officer of the Society.

There being no further business, Dr. Forbes introduced Mr. Irving Huntington, speaker of the evening, who talked on the subject, ''The Grand Canyon.'' The location, size and history of the canyon were described. Its three national parks: Grand Canyon, Zion, and Bryce, were discussed. The merits of the south and north rims, thirteen miles apart as the crow flies, and 230 miles separated by automobile, were given. The talk was well illustrated with a series of outstanding color slides.

Frank A. Soraci, *Secretary.*

Meeting of February 15, 1949

A regular meeting of the Society was held February 15, 1949 at the American Museum of Natural History. President Dr. Schneirla called the meeting to order at 8: 00 P. M. There were 15 members and 16 visitors. The president acknowledged with thanks the receipt of $50 in voluntary contributions from several members. He also reported the appointment of Mr. Soraci as associate editor, stating that the help that will be provided the editor by this new appointment is long overdue.

Dr. Schneirla also reported that Mr. Teale has been receiving encouraging response to his solicitations for advertising in the Journal. Entomological supply houses have shown definite interest.

Dr. Forbes reminded the membership that the second meeting in May will be one of photographic exhibits, and that its success will depend upon the co-operation of our photographers.

It was announced that Dr. Carl Von Frisch would give three lectures at the American Museum of Natural History early in April, on the ''Visual, Chemical and Language Senses in Bees.'' It was likely that the April 5 meeting of this SOCIETY would be turned over to one of his lectures.

The following were proposed for membership:

Bernard Heineman, Jr., 175 West 72nd Street, New York City.

Charles Pomerantz, 20 Hudson Street, New York.

Prof. Ashur E. Treat, 137 Amsterdam Avenue, New York 31, N. Y.

Upon certification by the secretary of the presence of a quorum a vote was taken on the resolution pertaining to dues as presented to the Society at the January 18 meeting.

It was moved by Mr. George Becker, seconded by Doctor Cazier, and passed unanimously that the by-laws of the Society be amended as follows:

Article VII (dues) of the by-laws shall be changed to read: ''The dues of active members shall be four dollars ($4.00), per annum, payable in advance on the first day of January of each year.'' The rest of article VII remains unchanged.

Dr. C. H. Curran, speaker of the evening, was then introduced by the Chairman of the Program Committee. His topic ''Some Aspects of Insect Control'' touched on his work in the control of house flies and mosquitoes at the Bear Mountain Inn, beginning in 1944. He spoke of his early work with DDT stressing its use as a residual insecticide. The use of this material in aerosols should be discouraged because of possible harmful effects to man. Space spraying, as practiced with the older insecticides is not prescribed for DDT.

FRANK A. SORACI, *Secretary.*

MEETING OF MARCH 1, 1949

A regular meeting of the Society was held March 1, 1949 at the American Museum of Natural History. President Dr. Schneirla called the meeting to order at 8:10 P. M. Seventeen members and 11 guests were present.

Dr. Forbes asked that anyone with photographs, to submit for the second meeting in May, get in touch with him or the other members of the committee, Mr. Vishniac or Doctor Clausen, as the committee must have the photographs by the end of April or the first of May.

The three people proposed for membership at the last meeting were elected to membership, Bernard Heineman, Jr., 245 Church Street, New York City (business), 175 West 72nd Street, New York City; Charles Pomerantz, Bell Extension Company, Incorporated, 20 Hudson Street, New York City, and Prof. Ashur E. Treat, City College of New York, 137th Street & Amsterdam Avenue, New York City 31, New York.

Dr. Swain announced that the membership committee was eager for suggestions to promote members getting better acquainted. He proposed, and the suggestion was followed upon, that each person present give his name and official connection or special interest.

Dr. Forbes introduced the speaker of the evening, Mr. Henry Fleming, who spoke on "Ecology of Northern Venezuela." Mr. Fleming made a plea for more accurate locality labels for insects, saying that a difference of a few miles often made a big difference in rainfall, thus quite changing the type of habitat. Mr. Fleming spoke of the various areas of northern Venezuela, the eastern part, which has a fauna related to that of British Guiana, the xerophytic regions along the coast, the deciduous zone, the semi-deciduous, which latter seemed most prolific of insects, the cloud forests, and the high llanos area. He found the greatest variety of insects in the high mountain region which included Rancho Grande and the City of Caracas.

PATRICIA VAURIE, *Asst. Sec'y.*

MEETING OF MARCH 15, 1949

A regular meeting of the Society was held March 15, 1949 at the American Museum of Natural History. President Dr. Schneirla called the meeting to order at 8: 00 P. M. There were 15 members and nine visitors present.

Dr. Schneirla called on Mr. Teale to report on his investigations of the possibility of procuring advertising for the JOURNAL. Mr. Teale said that after interviewing several prospects, he was quite sure the SOCIETY would have no trouble in obtaining this support for its JOURNAL. It was his opinion that the effort of the previous year was not successful because soliciting was by mail. He stressed the need for personal calls on prospects. Dr. Schneirla thanked him, for the SOCIETY, for his efforts in the matter.

Mr. Comstock remarked that JOURNAL costs might be cut by use of the offset printing process. The president thanked him for his suggestion and asked that the associate editor look into this possibility.

The program committee announced its plans for the attendance of the SOCIETY at the von Frisch lecture on April 5. It was approved that the SOCIETY hold its "regular meeting" of that night with the scientific staff of the museum at the von Frisch lecture in the auditorium.

There being no further business, Dr. James Forbes, chairman of the program committee introduced Dr. Herman Spieth, speaker of the evening, who spoke on the "Mating Behavior of *Drosophila pseudoobscura* and its Relatives." This work was undertaken in the hope that it might throw some light on evolution in the group. The *willistoni* group could not be used because inter-specific breeding does not occur in that group. The courtship and mating behavior of eight species of the *obscura* and *affinis subgroups* were described. Antennal tapping and posturing by the male are important features of the courtship. As the male postures, the female indicates acceptance or rejection in various ways. Dr. Spieth found that species that interbreed have similar mating behavior.

FRANK A. SORACI, *Secretary.*

MEETING OF APRIL 5, 1949

The regular meeting of the Society for April 5, 1949, was adjourned to the main auditorium of the American Museum of Natural History, so that the membership could hear the lecture of Dr. Karl von Frisch, visiting European entomologist, who spoke on his work with "The Chemical Senses (Taste and Smell) of Bees."

FRANK A. SORACI, *Secretary.*

MEETING OF APRIL 19, 1949

A regular meeting of the Society was held April 19, 1949 in the American Museum of Natural History. President Dr. Schneirla called the meeting to order at 8: 00 P. M. There were 14 members and 13 visitors present. The treasurer, Mr. Bigelow, mentioned that he had submitted a report to the Executive Committee at a meeting on that day, and that the Society might be able to operate within its income for this year.

The chairman of the Program Committee asked for volunteers to assist in arranging the photographs to be exhibited at the regular meeting on May 17, 1949.

Mr. Teale reported that volunteers were needed to solicit advertising for the JOURNAL. The cost of advertisements was announced as $100 per full page per volume; $55 per half page and $30 per ¼ page; to appear in four consecutive issues.

There being no further business, the speaker of the evening, Prof. Franz Schrader of Dept. of Zoology, of Columbia University was then introduced. He spoke on "The Special Developments in the Reproductive Organs of Tropical Pentatomids."

Cytologically, the Hemiptera have been more thoroughly investigated than any other animals or plants. Of the Hemiptera, the family Pentatomidæ has been the one most frequently studied. The chromosome condition is very uniform among known representatives in the temperate zone. Approximately 120 species have been investigated and 110 of these are uniform. Commonly the male chromosome make up is $12 + X + Y$, dividing so that the sperm becomes $6 + X$ and $6 + Y$. In fertilization the joining of $6 + X$ with $6 + X$, gives $12 + 2X$, producing a female. The male results from a $6 + X$ and $6 + Y$ fertilization, producing $12 + X + Y$.

Practically all the work on the Pentatomids has been done with North American and European species. And representatives of the family can be considered genetically stable. Yet, in other areas, such as South America and Central America they are decidedly not stable.

Males of some Pentatomids have "harlequin" lobes in the testes, the cells of which contain irregular numbers of chromosomes. As example, some are $2 + X + Y$, $3 + X + Y$, $4 + X + Y$ and up to $11 + X + Y$. It is likely that sperm having other than 6 + the sex chromosomes are not as efficient as the standard sperm. When an individual is found with other than 12 + sex chromosomes, the individual is abnormal and a new form is produced.

In the Hemiptera, harlequin lobes are found only in the Pentatomidæ.

They are common in some tribes, being rare or unknown in others. No northern Pentatomids have harlequin lobes, yet 20 of 50 spp. Professor Schrader has seen from Mexico, south, have such lobes.

The preponderance of spp. of the Pentatomidæ occur from Mexico southward. Harlequin lobes are tropical in occurrence, but there is a lack of taxonomic and other data from South America as well as other places. Professor Schrader suggested that entomologists should converge on such areas to obtain the necessary information, but also expressed his opinion that the financial consideration has probably been responsible for the meager work to date.

F. A. SORACI, *Secretary.*

MEETING OF MAY 3, 1949

A regular meeting of the Society was held May 3, 1949 in the American Museum of Natural History. The president, Dr. Schneirla, called the meeting to order at 8:00 P. M. There were 11 members and seven visitors present.

Dr. Lee Ling, plant pathologist with F A O, located at Washington, D. C., and Dr. Archer of the Geological Survey of Alabama, at the University of Alabama in Tuscaloosa were introduced and made welcome by the president.

Dr. James Forbes, assistant professor of Embryology at Fordham University, speaker of the evening, was introduced by Dr. Lucy Clausen. He spoke on the subject "Some Insects of New Guinea."

This island, second in size only to Greenland, is 1,500 miles long by 400 miles wide at its widest point. It is divided into three parts, (1) Dutch territory, (2) Australian territory, and (3) Australian mandated territory. Dr. Forbes served with a malaria survey detachment during World War II. The detachment collected 55 spp. of mosquitoes representing the genera *Anopheles, Bironella, Culex, Aëdes, Armigeres, Uranotaenia, Mansonia, Harpagomyia, Megarhinus* and *Tripteroides.* He travelled from Milne Bay to Oro Bay to Biak, then to Hollandia.

The mosquitoes of importance as carriers of human malaria were *Anopheles punctulatus* and *A. farauti.* The former was prevalent in clay soils. Its eggs hatch in two and one-half days; the larvæ are very active, pupating in six to 11 days. The latter species breeds in sandy soil; its eggs hatching in three and one-half days; the sluggish larvæ mature in seven to 18 days. The malaria incidence in South New Guinea ranges from 50 per cent to 98 per cent. On Biak the incidence is only 10 per cent.

Aëdes (Stegomyia) scutellaris, one of the Dengue fever carriers, also was taken in abundance.

At Hollandia night blood surveys resulted in finding 30 per cent of the natives positive for filariasis, another mosquito-borne disease.

Some interesting slides were shown, and after a question period the meeting was adjourned at 9:30 P. M.

F. A. SORACI, *Secretary.*

MEETING OF MAY 17, 1949

A regular meeting of the Society was held at the American Museum of Natural History. The meeting was called to order by Dr. Schneirla at 8: 10 P. M. About 40 members and guests were present.

It was mentioned that the SOCIETY'S annual summer outing will probably take place in late August or early September, but that members would be notified by mail.

Dr. Schneirla called the attention of the SOCIETY to the citation given to Mr. Weiss by the New Jersey Agricultural Society and copies of the citation were passed around.

The talk of the evening, "Photographic Problems and Techiques," was given by Dr. Lucy W. Clausen, Mr. Roman Vishniac, and Mr. Ellwood Logan. Mr. Vishniac talked on his preference for taking pictures of the live insect only, a technique which calls for much patience and a certain philosophic approach to the insect. He showed the equipment he used and explained some of the problems of light, exposure, etc. Mr. Logan, whose job at the American Museum is usually the taking of dead insects' pictures, spoke on the advantages of this technique over the other. Doctor Clausen showed the camera she used and why she preferred it. A showing of kodachromes of the members followed, after which the SOCIETY adjourned to the first floor to see the exhibit of entomological photographs there displayed.

PATRICIA VAURIE, *Asst. Sec'y.*

The
New York Entomological Society

Organized June 29, 1892—Incorporated February 25, 1893

Reincorporated February 17, 1943

The meetings of the Society are held on the first and third Tuesday of each month (except June, July, August and September) at 8 P. M., in the AMERICAN MUSEUM OF NATURAL HISTORY, 79th St., & Central Park W., New York 24, N. Y.

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Members of the Society will please remit their annual dues, payable in January, to the treasurer.

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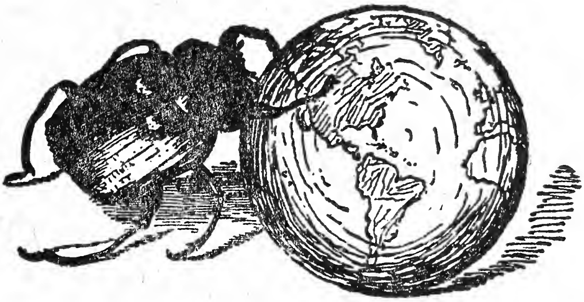
Editor Emeritus HARRY B. WEISS



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THE SYSTEMATICS OF CALISTO (LEPIDOPTERA, SATYRINÆ), WITH REMARKS ON THE EVOLUTIONARY AND ZOOGEOGRAPHIC SIGNIFICANCE OF THE GENUS

By Eugene G. Munroe

Institute of Parasitology, Macdonald College, Quebec

The remarkable Satyrine genus *Calisto* has rightly been given special attention by recent students of the West Indian lepidopterous fauna. It is one of the few endemic genera of butterflies in the West Indies, and it is the only genus of its subfamily which can be considered established in that region—a contrast to both North and South America, where the Satyrine fauna is numerous and varied. Recent work has shown that *Calisto* contains an unexpectedly large number of, for the most part, sharply distinct species. The geographic distribution of these species is without parallel in the remainder of the butterfly fauna, and suggests the action of unusual processes of speciation or dispersal.

A discussion of this zoogeographic problem is the principal object of the present paper; before this can be profitably undertaken, however, some unification and amendment of the present classification seems necessary. The latest general study of the genus is that of Michener (1943), based on the outstanding monograph of Bates (1935), but incorporating additional forms which Bates had meanwhile described, as well as new ones described by Michener himself. By a singular misfortune, Clench had been working independently on the genus at the Museum of Comparative Zoology, and almost simultaneously published descriptions of several new species and subspecies, making Michener's synopsis and key incomplete when scarcely off the press. Beyond a nomenclatorial note by Clench (1943a), no further work on the genus has appeared. Since I have been able to re-examine virtually all of the material studied by Bates, by Michener, and by Clench, supplemented by additional series of some of the forms, and as a result find certain minor revisions in the classification warranted, I venture to present the following key and synopsis as a guide to identification and as a basis for the zoogeographic consideration.

I wish to express thanks to my kind friends at the American Museum of Natural History, the Carnegie Museum, the Museum of Comparative Zoology, and Cornell University, who have given me every facility for the study of the magnificent material contained in the collections of those institutions. My visit to the Museum of Comparative Zoology was particularly valuable, as it allowed the inspection of the Bates and Clench types. Unfortunately time did not allow me to make genitalic preparations of three of the forms described by Clench; with the exception of these three and of *C. sibylla,* of which only the female is known, all of the species have been studied on the basis of male genitalia as well as of external appearance and structure. It has accordingly been possible to reach fairly definite conclusions as to the taxonomic status of most of the forms.

SYSTEMATICS OF THE GENUS

Genus *Calisto* Hübner

Genotype: *Papilio zangis* Fabricius

Calisto Hübner, 1823, 2: 16.

As a consequence of intensive collecting in the West Indies in the past thirty years, our knowledge of the taxonomy of *Calisto* has made rapid progress. Lathy's monograph (1899) included seven species; Bates (1935) performed the somewhat remarkable feat of more than doubling this number, raising the total to fifteen, all but one of which are recognized in the present paper. Michener (1943) recognized eighteen, while at the present time twenty named species can be distinguished. Several of the forms are known from single specimens or single lots, and it is probable that further collecting, particularly in Hispaniola, will yield a few more species or subspecies.

Despite advances in our knowledge of the species, Bates' classification has proved to be fundamentally sound. In his 1935 monograph Bates recognized two sections, comprising seven species groups. I have added one extra group to accommodate *C. arcas,* and have subdivided the *hysius* group on a pattern character; because of the somewhat doubtful status of *C. montana,* and the absence of supporting characters in the male genitalia, I have expressed this division in terms of subgroups, rather than of species groups equivalent to the others. I have also reduced the *herophile* group of Bates to subgroup rank, so that the total number of groups still stands at seven.

The differences in sex scaling and particularly in the structure of the male genitalia among some of the species are profound. The genitalic differences are especially striking in view of the uniformity of these organs in most of the remainder of the Satyrinæ. No doubt some workers would wish to emphasize these differences by making *arcas, pulchella, nubila, eleleus,* and *zangis* the types of monotypic genera, and proposing a new name for the genitalically more homogeneous remainder. The genus as here understood, however, is undoubtedly monophyletic, is reasonably constant in external structure, and forms a compact ecological and zoogeographic unit. The details of its structural variation and geographic distribution are well expressed by the system of infrageneric categories, and in my opinion no useful purpose would be served by dividing it.

The phylogeny of the genus is rather clearly indicated. As Bates pointed out, Section I is the more primitive, with R_1 not stalked with RS in the fore wing, and with the eye spot of the hind wing symmetrical. The *archebates* group has genitalia of the normal type, with an elongate, tapering valve and a beak-like uncus; the juxta is very large, and the ædœagus is bent in the form of an obtuse sigmoid. In *C. arcas* these characters are considerably modified, the genitalia being very heavily sclerotized, the uncus being dorso-laterally expanded and having a heavy ventral keel, the valve being terminally truncated and inturned, the juxta being enormously hypertrophied, and the ædœagus having a medial constriction followed by a thick, bulbous expansion.

In Section II, subgroup A of the *hysius* group is the most primitive, having the ocellus of the hind wing symmetrical. *C. tragius* retains the large juxta and sigmoid ædœagus of Section I and may be considered the most primitive species. *C. grannus* has a reduced juxta and an almost straight ædœagus, as in *hysius* and its derivatives. The genitalia of *micheneri* have not been examined, but in external appearance this species shows similarities to *grannus*. *C. montana* is directly annectant to *C. hysius,* which may thus be placed at the base of the remaining series of species, all of which have the eye spot of the hind wing unsymmetrical.

From *hysius* several distinct lines of development proceed. *C. lyceius* and an unnamed form which is probably related to it have the under side broadly suffused with red. *C. confusa, debarriera,* and *obscura* form a compact assemblage, from which subgroup C of the *hysius* group (*herophile* and its allies) appears to be immediately derived, differing chiefly in the relatively elongate genitalia. *C. eleleus* resembles the *confusa* complex in external appearance, although differing radically in genitalic structure, and no doubt represents an aberrant side branch of this stock.

The remaining three species, *zangis, pulchella,* and *nubila,* differ widely from one another and from the norm in both genitalia and androconial distribution. The three species are so similar in pattern, however, that females might easily be confused in the absence of locality data. It is very possible that the wide differences in sexual characters represent an unusual evolutionary plasticity, and that the three species had a common derivation from the *hysius* stock.

The various forms have for the most part been fully described by their authors, so that only a limited amount of descriptive material has been necessary here. A key to the species is, however, given, followed by an annotated catalogue.

KEY TO THE SPECIES AND FORMS OF *CALISTO*

1. Hind wing with a definite anal lobe .... *chrysaoros* Bates
   Hind wing with inner margin excavated before anal angle, but with outer margin not excavated to define an anal lobe .... 2.
2. Disc of the hind wing traversed beneath by a broad, contrasting, pale band .... *archebates* Ménétriés
   Hind wing beneath without such a band, and disc some shade of brown or gray .... 3.
3. Hind wing beneath with a prominent ocellus in cell M_1 .... 4.
   Hind wing beneath with no ocellus in cell M_1 .... 5.
4. A large species, with conspicuous fulvous patches on both pairs of wings above .... *arcas* Bates
   A rather small species, with no trace of fulvous patches on the wings above .... *grannus* Bates
5. Basal half of fore wing beneath marked or suffused with red .... 10.
   Basal half of fore wing beneath without red marking or suffusion .... 6.
6. Ocellus on under side of hind wing circular, with white dot central. *loxias* Bates
   Ocellus on under side of hind wing oval, with white dot basad of its centre .... 7.
7. White dot in cell M_2 of hind wing beneath adjacent to postmedial line; no white spot in M_3; this wing often broadly suffused with fulvous .... *pulchella* Lathy—8.
   White dot of cell M_2 of hind wing beneath either absent or distinctly removed from postmedial line; if there is a white spot in cell M_2 there is also one in M_3 .... 9.
8. Fulvous suffusion of hind wing beneath not reaching costa in discal area; Southern Haiti .... *pulchella pulchella* Lathy
   Fulvous suffusion of hind wing beneath reaching costa in discal area; Central Dominican Republic .... *pulchella darlingtoni* Clench
9. Wings above suffused with dark red, at least at anal angle. *zangis* Fabricius
   Wings with no red suffusion above .... *sibylla* Bates
10. Red of basal area of fore wing beneath obscure and ill-defined .... 11.
    Red of basal area of fore wing beneath conspicuous, though not necessarily sharply defined .... 13.
11. Fore wing beneath with a reddish patch beyond the middle, immediately behind the ocellus .... *tragius* Bates
    Without such a patch .... 12.
12. Ocellus of hind wing round, with white dot central .... *loxias* Bates
    Ocellus of hind wing oval, with dot displaced towards base. *zangis* Fabricius
13. Fore wing beneath marked with red beyond postmedial line .... 14.
    Fore wing beneath not marked with red beyond postmedial line .... 18.
14. Distal red patch of fore wing beneath well separated from basal one, which does not reach postmedial line .... *hysius* Godart—15.

Distal red patch of fore wing beneath separated from basal one only by postmedial line .... 16.

15. Red of under side orange-tinted; white dots in front of ocellus of hind wing beneath inconspicuous, usually two in number; Central Hispaniola .... *hysius batesi* Michener

Red of under side dark; white dots in front of ocellus of hind wing beneath conspicuous, usually three or four in number; Southern Cordillera of Hispaniola .... *hysius hysius* Godart

16. A small form; hind wing beneath with four white dots of approximately equal size, arranged in a straight line anterior to the ocellus. *lyceius* Bates

Hind wing beneath with not more than two white dots anterior to the ocellus .... 17.

17. A large form; hind wing beneath with a minute white dot in each of cells M_2 and M_3; these dots are of approximately equal size, or occasionally obsolete .... *nubila* Lathy

A moderate-sized form; hind wing beneath with a conspicuous white dot in cell M_2, that in M_3 minute or obsolescent. unclassified form no. 1

18. Red patch of fore wing beneath extending behind cell, though sometimes only very slightly so .... 19.

Red patch of fore wing beneath confined to cell .... 22.

19. Cellular patch of fore wing beneath light brick red; ground color pale brown with an olive tinge; region between the two subterminal lines of the hind wing not contrastingly pale .... *obscura* Michener

Cellular patch of fore wing beneath dark brick red; ground color moderately dark brown; posterior half of region between the two subterminal lines of the hind wing beneath contrastingly pale .... 20.

20. Ocellus of hind wing beneath with bluish white pupil nearly at centre. *montana* Clench

Ocellus of hind wing beneath with pupil markedly eccentric .... 21.

21. Postmedial line of fore wing beneath not, or very faintly, bordered with whitish; ædœagus slightly sinuate, and about seven times as long as deep .... *debarriera* Clench

Postmedial line of fore wing beneath conspicuously bordered with whitish, at least over part of its length; ædœagus almost straight, and about four time as long as deep .... *confusa* Lathy

22. Ocellus of hind wing beneath minute, about $\frac{1}{4}$ the diameter of that of the fore wing .... 23.

Ocellus of hind wing beneath of normal size, at least $\frac{1}{2}$ the diameter of that of the fore wing .... 24.

23. A large species, length of fore wing over 20 mm. .... *eleleus* Bates

A small species, length of fore wing under 15 mm. .... *micheneri* Clench

24. Large forms, length of fore wing about 20 mm.; ground color of under side chocolate brown .... 25.

Smaller forms, length of fore wings not greatly exceeding 15 mm.; ground color of under side drab .... 28.

25. Outer edge of ocellus of hind wing below nearer to postmedial band than to outer margin of the wing; Hispaniola .... *eleleus* Bates

Outer edge of ocellus of hind wing below nearer to outer margin of the wing than to postmedial band; Cuba .... *smintheus* Bates—26.

26. Red patch of discal cell of fore wing below margined distally by a faint brown line, *or* all pale markings below greatly obscured, the ground color exceptionally dark, and the transverse lines not bordered by pale shades .... 27.

Red patch of discal cell of fore wing below not margined distally by a brown line; markings below of normal intensity, and transverse lines bordered by prominent pale shades; mountains of central Cuba .... *smintheus muripetens* Bates

27. Ocellus of fore wing below with posterior white pupil strongly displaced basad; first subterminal line of hind wing below crenate, but not strongly offset on the veins; mountains of western Cuba.
smintheus bradleyi Munroe

Ocellus of fore wing below with posterior white pupil at most slightly displaced basad; inner subterminal line of hind wing below offset at each vein, especially toward the anal angle; pale markings below sometimes obscured; mountains of eastern Cuba.
smintheus smintheus Bates

28. Postmedial line of hind wing beneath sharply bent just before reaching the posterior margin .... 29.

Postmedial line of hind wing beneath little if at all bent just before reaching the inner margin .... unclassified form no. 2

29. Postmedial lines beneath clearly bordered in most specimens by an external zone of pale yellowish brown .... *herophile herophile* Hübner

Postmedial lines beneath in most specimens not bordered externally with pale yellowish brown .... 30.

30. Ground color dull; Trinidad Mts. of central Cuba ...unclassified form no. 3

Ground color slightly paler and brighter; Bahamas.
herophile apollinis Bates

SECTION I

R_1 of fore wing arising from end of cell; eye spot of hind wing symmetrical.

archebates group

Genitalia of male normal; hind wing below with a single eye spot.

This group contains three species, all characterized by having on the under surface of the hind wing a definite pattern of pale areas, apart from the usual transverse elements. In *archebates* and the male of *chrysaoros* this pattern is conspicuously cream colored, sometimes tinted with orange or green; in *loxias* and the female of *chrysaoros* it is infuscated, but still recognizable. *C. loxias* and *archebates* are geographically representative and resemble each other closely; they might well be considered subspecies of a single species, but because of minor differences in the proportions of the genitalia I have kept them separate. *C. chrysaoros* is much more distinct, and its range covers that of the other two species.

1. *Calisto archebates* (Ménétriés)

Satyrus archebates Ménétriés, 1832: 431.
Euptychia archebates: Westwood and Hewitson, 1851, 2: 374.
Calisto archebates: Butler, 1868: 97.
Calisto archebates: Lathy, 1899: 223, pl. 4, f. 4.
Calisto archebates: Hall, 1925: 165.
Calisto archebates: Bates, 1935: 234, f. 1 (venation).

Easily recognized by the broad, regular, white or pale discal band on the under surface of the hind wing. The genitalia are normal for the group, with tapering valve, sigmoid ædœagus, large juxta, and beak-like uncus. The life history is unknown.

Range: Hispaniola. The material in American collections comes from the La Selle Range of southern Haiti, at altitudes from 5000 to 7000 feet. Hall's record from Puerto Plata, on the north coast of the Dominican Republic, may well represent another subspecies.

Material examined: 30 specimens, in the Museum of Comparative Zoology and the collection of Cornell University.

2. *Calisto loxias* Bates

Calisto loxias Bates, 1935: 233.

Very close to the preceding, resembling it in the pattern and in the general features of the genitalia. The transverse discal band of the hind wing below is, however, infuscated, instead of being contrastingly pale. The life history is unknown.

Range: the species is known only from the type series, from Roche Croix, La Hotte Mts., southern Haiti.

Material examined: 6 specimens (type series) in the Museum of Comparative Zoology.

3. *Calisto chrysaoros* Bates

Calisto chrysaoros Bates, 1935: 235, f. 2 (venation).

The irregular creamy white pattern of the under side of the male hind wing is very conspicuous. In the female the same pattern can be traced, but it is infuscated, and does not contrast with the ground color. The uncus of the male is unusually slender, and bears a pair of thorn-like projections on the latero-ventral margins near the base. The juxta is very large, and is reflexed dorsad; the valve is slender and tapering. The life history is unknown. It is possible that there are two subspecies (see Bates, 1939a).

Range: Hispaniola; from 3000 to 7000 feet in the Central and Southern Cordilleras.

Material examined: 16 specimens in the Museum of Comparative Zoology, the American Museum of Natural History, and the Cornell University collection, including the type series.

arcas group

Male genitalia strikingly modified; uncus deeply carinate; juxta hypertrophied, with a pair of ribbon-like rami extending dorsad from the posterior angles; valves distally truncate and callused; ædœagus greatly inflated beyond middle. Under side of hind wing with two ocelli; upper side of fore and hind wings with conspicuous fulvous patches. Only one species is known.

4. *Calisto arcas* Bates

Calisto arcas Bates, 1939a: 48.

The more striking characters have been given above. The life history is unknown.

Range: Central Cordillera of Hispaniola, in the region of Constanza, 6000 to 7000 feet.

Material examined: 12 specimens, in the Museum of Comparative Zoology (including the type series).

SECTION II

R_1 of fore wing stalked with RS.

hysius group

Male genitalia normal, with tapering valve and beak-like uncus. Three subgroups are recognized, which differ in minor characters.

subgroup A

Ocellus of under side of hind wing with pupil central, or nearly so. Four species are known, all from Hispaniola.

5. *Calisto tragius* Bates

Calisto tragius Bates, 1935: 236, fig. 3 (venation).

The large juxta and sigmoid ædoœagus place this species close to Section I; the genitalia are not very different from those of *loxias* or *archebates*. This is a dark species with the markings largely obscured. The life history is unknown.

Range: Haiti, in the La Selle Mts., 5000 to 7000 feet.

Material examined: 7 specimens, in the Museum of Comparative Zoology (type series).

6. *Calisto grannus* Bates

Calisto grannus Bates, 1939a: 49.

The genitalia are much as in *hysius*. Easily recognized by the presence of two ocellate spots on the hind wing below and the absence of fulvous patches on the upper surface of the wings. The life history is unknown.

Range: Central Cordillera of Hispaniola, 7000 to 8000 feet.

Material examined: 5 specimens (type series), in the Museum of Comparative Zoology.

7. *Calisto micheneri* Clench

Calisto batesi Clench, 1943: 23. Homonym of *C. hysius batesi* Michener, 1943.

Calisto micheneri Clench, 1943a: 115.

The genitalia have not been examined. The species will perhaps prove to be most closely related to *C. grannus*.

Range: the unique type is from near Santiago, Dominican Republic.

Material examined: one specimen in the Museum of Comparative Zoology, with labels "*Calisto batesi* Clench TYPE" and

"*Calisto hewitsoni* Clench TYPE," presumed to be the type of *C. micheneri.*

8. *Calisto montana* Clench new status

Calisto hysius montana Clench, 1943: 24.

The genitalia have not been examined, but *montana* differs from *hysius* in the absence of a postmedial red patch on the under side of the fore wing and in the fact that the white pupil of the ocellus on the under side of the hind wing is almost central, rather than strongly eccentric; both characters are in this genus likely to be of specific value. In confirmation it may be noted that Michener has described a more conformable subspecies of *hysius* from the same general region.

Range: Mt. Basil, Haiti, 4500 feet.

Material examined: 1 specimen (type) in the Museum of Comparative Zoology.

subgroup B

Ocellus of under side of hind wing with white pupil displaced basad; juxta small, ædœagus only slightly sinuate, uncus at most three times as long as deep.

Five or six species, of which *hysius* forms a clear link with *montana* of subgroup A; the male genitalia of all are similar in type, differing only in the proportions of the various sclerites; they show no essential difference from those of *grannus.* The subgroup is very compact, but *confusa, debarriera,* and *obscura* are particularly closely related, and have until very recently been confused. The subgroup is confined to Hispaniola.

9. *Calisto hysius* (Godart)

Satyrus hysius Godart, 1823: 525.

Two subspecies are known from Hispaniola. One occurs in the Southern, the other in the Central and Northern Cordilleras.

a. *C. hysius batesi* Michener

Calisto hysius batesi Michener, 1943: 4.

Differs from typical *hysius* in the smaller size, the reduction of the red areas above, and in the paler under side, with less strongly contrasting pale markings. The life history is unknown.

Range: apparently well distributed in the less highly cultivated regions of Hispaniola, north of the Plaine Cul-de-Sac; altitude range from (possibly) sea level up to about 5000 feet.

Material examined: 5 specimens, all paratypes, in the American Museum of Natural History and Cornell University.

b. *C. hysius hysius* (Godart)

Satyrus hysius Godart, 1823: 525.
Calisto hysius: Kirby, 1871: 103.
Calisto hysius: Bates, 1935: 236.
Calisto hysius hysius: Michener, 1943: 2, 4, 6.

The life history is unknown.

Range: Southern Cordillera of Hispaniola, 1800 to 7000 feet.

Material examined: 17 specimens, in the Museum of Comparative Zoology, the American Museum of Natural History, and Cornell University.

10. *Calisto confusa* Lathy

Satyrus lysius: Ménétriés, 1832: 237 (misdetermination and misspelling of *hysius* Godart).
Calisto confusa Lathy, 1899: 227, pl. 4.
Calisto confusa, variety A: Bates, 1935: 240 (in part).
Calisto confusa: Michener, 1943: 4, f. 1 (genitalia).

The technical question of the validity of Ménétriés' *lapsus* is perhaps best left in obscurity, since the Lathy name is well established in the literature. This species is common and widespread in Hispaniola, apparently flying side by side with the closely similar *obscura.* The life history is unknown.

Range: throughout Hispaniola, at altitudes from sea level up to at least 5000 feet.

Material examined: 53 specimens, in the American Museum of Natural History, the Carnegie Museum, the Museum of Comparative Zoology, and the Cornell University collection.

11. *Calisto debarriera* Clench new status

Calisto confusa, variety B: Bates, 1935: 240.
Calisto confusa debarriera Clench, 1943: 25.

This form is identical with *confusa* in pattern, but the ground color is very dark and the markings of the under side more or less obscured. I rank it as a species chiefly because of a slight difference in the ædœagus shown by the genitalic preparations examined. In the slides of *confusa* the ædœagus was about four times as long as broad, and in those of *debarriera* this organ was about six times as long as broad. No fresh material was examined, and such a difference might conceivably be the result of distortion of the preparations; however, six slides in all were examined, and even neglecting the probability that different degrees, rather than two distinct classes, of distortion would be seen in truly homogeneous material, the probability is only one in thirty-two that the distribution of the genitalic difference would coincide with that of the pattern difference in all six specimens, if the two characters were really independent. In support of this evidence it may be noted that the material of *debarriera* comes from a limited altitude range, which is entirely contained in both the altitudinal and geographic range of the widely distributed *confusa*. The life history is unknown.

Range: the La Hotte and Ennery regions of Haiti, 3000 to 4000 feet, and doubtless elsewhere in Hispaniola at similar altitudes.

Material examined: 4 specimens, including the holotype, in the Museum of Comparative Zoology.

12. *Calisto obscura* Michener

Calisto hysius: Butler, 1868: 97, misidentification.
Calisto hysius: Lathy, 1899: 226, pl. 4.
Calisto confusa, variety A: Bates, 1935: 240 (in part).
Calisto obscura Michener, 1943: 2, 5, f. 2 (genitalia).
Calisto obscura: Clench, 1943a: 115.

This species approaches subgroup C both in pattern and in the elongation of the valves and uncus. Although it is common in Hispaniola its life history has not been described.

Range: Hispaniola, sea level to at least 3000 feet.

Material examined: 29 specimens, in the Museum of Comparative Zoology, the American Museum of Natural History, the Carnegie Museum, and Cornell University, including portions of the type series.

13. *Calisto lyceius* Bates

Calisto lyceius Bates, 1935: 240.

This and the following form are easily recognized by the general wine red flush of the under surface. The life history is unknown.

Range: Hispaniola; described from Saona Island, but also known from the northern portion of the Dominican Republic.

Material examined: 14 specimens, including the type series, in the Museum of Comparative Zoology, the American Museum of Natural History, and the Cornell University collection. The American Museum series has not been available for reexamination, and it is possible that the following form may be represented in it.

13A. *Calisto,* unclassified form no. 1.

Two females in the Museum of Comparative Zoology differ from typical *lyceius* in being larger, and in having the middle two preocellar white spots on the under side of the hind wing greatly reduced or absent, instead of having all four of equal size. It is possible that these specimens represent a distinct species, but in the absence of males a definite conclusion does not seem warranted.

subgroup C

Uncus four to six times as long as deep, and valve correspondingly elongate; otherwise similar to subgroup B.

The two Cuban species are very closely related, and have undoubtedly been derived from some form resembling *Calisto obscura.* On zoogeographic grounds Bates associated the Bahaman *C. sibylla,* known from a single female, with *herophile* and *smintheus;* I follow his arrangement here, but there is nothing which would exclude the species from subgroup B.

14. *Calisto herophile* Hübner

Calisto herophile Hübner, 1823, 2: 16.

Two hardly distinguishable subspecies are recognized here; *C. herophile parsonsi* Clench is discussed separately below.

a. *C. herophile apollinis* Bates

Calisto herophile apollinis Bates, 1934: 136.

Differs from material from eastern Cuba in having the transverse bands of the under side on the average less distinctly bordered by pale shades. It is hardly distinguishable from the western Cuban form.

Range: Bahamas (New Providence; Long I.; Cat. I).

Material examined: 13 specimens (including type series), in the Museum of Comparative Zoology.

b. *Calisto herophile herophile* Hübner

Calisto herophile Hübner, 1823, 2: 16.
Satyrus herophile: Poey, 1847: 179.
Calisto herophile: Gundlach, 1881: 111.
Calisto herophile: Lathy, 1899: 223, pl. 4.
Calisto herophile herophile: Bates, 1935: 242, f. 6 (genitalia).
Calisto herophile: Dethier, 1940: 14.

The Cuban subspecies differs from that of the Bahamas in having the pale markings of the under side better developed. There is, however, considerable variation, both individual and regional, in this respect. Material from central and western Cuba contains a much smaller proportion of conspicuously pale-shaded individuals than does that from Oriente Province. In all areas, however, every transition may be found between the most contrastingly marked and the most obscure forms; the difference between the populations is one of distribution, rather than range, of variation, and is not sufficiently striking or definite to justify the separation of subspecies. The life history has been described by Dethier; the larva feeds on a variety of grasses.

Range: throughout Cuba and the Isle of Pines, at altitudes up to 3000 feet; abundant.

Material examined: 110 specimens in the Museum of Comparative Zoology, the American Museum of Natural History, and the Cornell University collection.

15. *Calisto smintheus* Bates

Calisto smintheus Bates, 1935: 242.

This interesting species closely resembles *herophile,* differing in the much richer and darker ground color, and in the palpi and male genitalia, both of which are longer in proportion to their breadth than the corresponding organs in *herophile.* Unlike *herophile, smintheus* is a mountain species, although the two overlap in the zone from 2500 to 3000 feet. Even here, however, they are said to be separated to some extent by a difference in environmental preference, *smintheus* being an inhabitant of dense forest, while *herophile* is found in shrubby or partly cleared terrain. Although *herophile* and *smintheus* seem abundantly distinct at first sight, the situation is complicated by the presence of intermediates, described as unclassified forms nos. 2 and 3, below.

The distribution of mountain ranges in Cuba divides the habitat of *C. smintheus* into three well separated segments, in each of which a characteristic subspecies is found.

a. *C. smintheus smintheus* Bates

Calisto smintheus Bates, 1935: 242, f. 9 (genitalia).
Calisto delos Bates, 1935: 243. New synonymy.
Calisto smintheus smintheus: Michener, 1943: 1, 6.

This subspecies is known only from the Sierra Maestra, although it may prove to have a wider distribution in Oriente Province. More extensive material shows that *delos* Bates represents simply one extreme of the normal range of variation of *smintheus*. In twenty-four specimens from Loma del Gato, the type locality of *smintheus,* three were as dark as the holotype of *delos,* while several others were intermediate to typical *smintheus,* being about as dark as the paratype of *delos*. The life history is unknown.

Range: Oriente Province of Cuba, from 3000 to 6000 feet.

Material examined: 26 specimens, including the type series of *smintheus* and *delos,* in the Museum of Comparative Zoology, the American Museum of Natural History, and the Cornell University collection.

b. *C. smintheus muripetens* Bates

Calisto smintheus muripetens Bates, 1939: 3.

This subspecies is similar in general aspect to typical *smintheus*. The red cellular patch on the under side of the fore wing is larger, and is not delimited distally by a brown line. The life history is unknown.

Range: Buenos Aires, Trinidad Mts., central Cuba.

Material examined: 2 specimens (types) in the Museum of Comparative Zoology.

c. *C. smintheus bradleyi,* new subspecies

Male: Wings slightly narrower than in typical *smintheus.* Upper side with a less pronounced brownish tinge and with the terminal and apical areas of the fore wing paler, so that the androconial patch stands out more prominently. Beneath, the wings, especially in the terminal area, are paler and more olivaceous than in the typical subspecies. All the transverse dark lines are better developed, but the pale shades which border them tend to be suppressed. On the fore wing the postmedial and first subterminal lines are conspicuous, though posteriorly somewhat diffuse; the red cellular patch is better developed than in *smintheus smintheus,* while the ocellus has the posterior of the two blue pupils strongly displaced basad. On the hind wing below, the postmedial violet shading is greatly reduced; there is only one white spot visible of the preocellar row. The first subterminal line is crenate, but not strongly offset on the veins as in typical *smintheus;* the second subterminal line is distinct.

The female and early stages are unknown.

Holotype, male, from Rio Tacoluco, Sierra Rangel, Pinar del Rio Province, Cuba, collected by Dr. J. C. Bradley on March 3, 1939. The altitude at which the specimen was captured is not recorded.

One would ordinarily hesitate to describe a subspecies from a single specimen; the unique holotype of *bradleyi,* however, although clearly a geographical representative of *smintheus,* falls entirely outside the conceivable range of individual variation of either of the previously known subspecies; it is in fact considerably more distinct from either of them than they are from each other. The Sierra Rangel is isolated by a broad tract of lowlying land from the other known habitats of the species, and one might *a priori* expect its population to be subspecifically distinct. I think there is no reason to doubt that, with the discovery of further material, *bradleyi* will stand as a valid subspecies.

15A. *Calisto*, unclassified form no. 2.

Among a mixed series of *Calisto smintheus* and *herophile* from Loma del Gato, collected by my correspondent Brother Clement at an altitude of about 850 metres, several specimens appeared which, although having the coloration of *herophile*, were of slightly larger size and showed the principal pattern characters of *smintheus*, the course of the postmedial line and the extensive blue postmedial scaling on the under side of the hind wing being suggestive of that species. On close examination the series stood out quite distinctly from the normal *herophile*, and very distinctly from the much larger, chocolate brown *smintheus*. Anatomical investigation revealed the surprising fact that these specimens had palpi and genitalia of the *smintheus*, rather than of the *herophile*, type.

Considering the fact that this material appears to have come from a zone where the ranges of *smintheus* and *herophile* overlap, three possible interpretations suggest themselves: either (1) there is in this zone a third species, intermediate in characters between the other two; (2) *smintheus* and *herophile* are not really distinct, but are simply altitudinal (and ecological) races connected by a series of intermediates of which these specimens represent one stage; or (3) they are specimens of a natural F_1 hybrid of frequent occurrence but low fertility. Interpretation (1) seems intrinsically unlikely. Interpretation (2) not only fails to explain the fact that seven almost identical specimens of one stage in the hypothetical series of intermediates are available, whereas no other intermediates, at any rate to the *smintheus* side, have been found, but also involves the rather difficult corollary assumption that three altitudinal subspecies (*smintheus*, *bradleyi*, and *muripetens*), agreeing in the important characters of size, general coloration, and genitalic structure, but differing recognizably in other characters, have evolved independently in the three principal mountainous regions of Cuba, from the almost homogeneous *herophile* population of the lowlands. Interpretation (3), on the other hand, does not involve objectionable corollary assumptions. Frequent natural hybridization between closely related species is well known in certain genera of Lepidoptera (see, for instance, Sweadner's account of the genus

Platysamia); a high degree of hybrid sterility would be a sufficient explanation of the constancy of the intermediate form, or, to look at it another way, would provide the barrier necessary to prevent the complete intermingling of *herophile* and *smintheus*. It is very possible that further investigation will show that this interpretation is the true one.[1]

Material examined: 7 specimens, in the Cornell University collection and the American Museum of Natural History.

15B. *Calisto,* unclassified form no. 3.

Calisto herophile parsonsi Clench, 1943: 26.

Although I have not seen the genitalia, superficial examination of the type material of this subspecies suggests to me that it occupies the same position with respect to *smintheus muripetens* as does form no. 2 with respect to *smintheus smintheus*. Form no. 3 also occupies a zone of overlap between *smintheus* and *herophile;* again the coloration is that of *herophile,* the size is slightly larger, while the pattern, as Clench notes, shows features reminiscent of *smintheus*.

Material examined: 15 specimens, in the Museum of Comparative Zoology and the collection of Cornell University. I am not quite confident as to the placing of all these specimens, and it is possible that a re-examination will show that some of them are true *herophile*.

16. *Calisto sibylla* Bates

Calisto sibylla Bates, 1934: 136.
Calisto sibylla: Bates, 1935: 342.

The original spelling of this name appears to have been the correct one, and the 1935 modification a lapse, rather than an emendation. The unique female holotype has been seriously damaged in an accident since the species was described. There is nothing in the available characters which would indicate with certainty whether the species really belongs to this or to the preceding subgroup; in the absence of a male specimen a definite

[1] Interested students should compare Michener's description of *Calisto bruneri* (Am. Mus. Novitates, no. 1391), which appeared while this paper was in press.

decision is probably impossible. It is likely that Bates adopted the present grouping on zoogeographic grounds; I see no reason to disturb his arrangement. The type was collected by Maynard in 1897; as the species has not been encountered subsequently it may now be extinct. The fauna of the Bahamas, however, has not been adequately studied, and *C. sibylla* should still be looked for by collectors.

Distribution: New Providence, Bahamas.

Material examined: 1 female (type), in the Museum of Comparative Zoology.

eleleus group

No definite androconial patch on the fore wing. Male genitalia with tegumen inflated, uncus finger-like and slightly decurved, juxta small, ædœagus slightly sinuate, valve with tip recurved and boot-shaped.

This is the first of four monotypical groups, each with conspicuously modified and strikingly different genitalia. All four appear to have been derived from subgroup B of the *hysius* group, having the juxta small, the ædœagus at most slightly sinuate, and the ocellus of the hind wing beneath strongly unsymmetrical. It is possible that the four groups are more closely related to one another than the large superficial differences in the genitalia would suggest. All of the species are of large size and of somewhat similar facies. Even in the genitalia there is a certain vague similarity: in all the species the tegumen is inflated, and in three of the four the uncus has a finger-like, instead of the normal beak-like, shape. *C. eleleus,* the least similar to *pulchella* in external appearance, is the most similar in genitalic structure.

17. *Calisto eleleus* Bates

Calisto eleleus Bates, 1935: 245, fig. 5 (genitalia).

Evidently scarce. The life history is unknown.

Range: Port-au-Prince region of Haiti, 2000–5000 feet.

Material examined: 5 specimens, in the Museum of Comparative Zoology, the Carnegie Museum, and the Cornell University collection; (including the type series).

zangis group

Androconial patch large and target-shaped; genitalia recognizably similar to those of *hysius* and its allies, differing in the inflated tegumen and the dentate dorsal margin of the valve. The single species is confined to Jamaica, where it is the sole representative of the genus.

18. *Calisto zangis* (Fabricius)

Papilio zangis Fabricius, 1775: 486.
Papilio agnes Cramer, 1782, 4: 73, pl. 325.
Hipparchia zangis: Hübner, 1816: 57.
Satyrus zangis: Godart, 1823: 525.
Calisto zangis: Westwood and Hewitson, 1851, 2: 399.
Calisto zangis: Möschler, 1886: 27.
Calisto zangis: Lathy, 1899: 222, pl. 4.
Calisto zangis: Robinson, 1903: 19.
Calisto zangis: Bates, 1935: 245, fig. 4, venation 7, genitalia.

As it is the only one which occurs in Jamaica, this species is not likely to be confused; the male is easily recognized by the conspicuous roundel of androconia on the upper side of the fore wing.

Distribution: throughout Jamaica, sea level to 6000 feet.

Material examined: 172 specimens, in the American Museum of Natural History, the Carnegie Museum, the Museum of Comparative Zoology, and the Cornell University collection.

pulchella group

The single species comes from Hispaniola. In external appearance *C. pulchella* closely approaches the following species, although the males may be distinguished by having a recognizable androconial patch. The male genitalia, however, are strikingly different, the tegumen being greatly inflated, the uncus long, finger-like, and decurved, the ædœagus long and slender, and the valve short and truncate.

19. *Calisto pulchella* Lathy

Calisto pulchella Lathy, 1899: 223, pl. 4.

A large and conspicuous species. Two subspecies are known, both from Hispaniola. According to Wolcott the larva is a pest of cane.

a. *C. pulchella pulchella* Lathy

Calisto pulchella Lathy, 1899: 223, pl. 4.
Calisto pulchella f. *tenebrosa* Lathy, 1899: 225, pl. 4.
Calisto pulchella: Bates, 1935: 246, fig. 8, genitalia.
Calisto pulchella pulchella: Clench, 1943: 29.

In the typical subspecies the fulvous markings of the under side are less extensive than in the northern one.

Distribution: southern Haiti, including Port-au-Prince, sea level to at least 2500 feet.

Material examined: 15 specimens, in the American Museum of Natural History, the Carnegie Museum, the Museum of Comparative Zoology, and the Cornell University collection.

b. *C. pulchella darlingtoni* Clench

Calisto pulchella: Bates, 1939a: 50.
Calisto pulchella darlingtoni Clench, 1943: 28.

If the rather small type series is representative, the northern population is certainly distinct from that of the southern peninsula.

Distribution: Cordillera Central of the Dominican Republic, 3000–4000 feet.

Material examined: 4 specimens (type series), in the Museum of Comparative Zoology.

nubila group

Fore wing of male without androconial patch; genitalia with tegumen inflated, expanded posteriorly beneath the short, finger-like uncus; ædœagus short, valve slender and tapering.

20. *Calisto nubila* Lathy

Calisto zangis: Dewitz, 1877: 241.
Calisto zangis: Möschler, 1889: 99.
Calisto zangis: Gundlach, 1891: 132.
Calisto nubila Lathy, 1899: 223, pl. 4.
Calisto nubila: Bates, 1935: 247.
Calisto nubila: Comstock, 1944: 479, pl. 8, text fig. 10.

The only species recorded from Puerto Rico. It is evidently common in suitable localities, but is by no means as generally distributed as the *Calisto* species of the other islands. The life history is unknown.

Distribution: various localities in Puerto Rico, from sea level up to 2000 feet.

Material examined: 41 specimens, in the American Museum of Natural History, the Carnegie Museum, the Museum of Comparative Zoology, and the Cornell University collection.

ZOOGEOGRAPHIC AND EVOLUTIONARY CONSIDERATIONS

Zoogeographically, the genus *Calisto* is unique in the Antillean butterfly fauna in two respects: it is the only genus in which we can clearly demonstrate a history of autochthonous speciation within single islands, and it is likewise the only genus in which pairs or sets of geographical races or vicarious species occur on the same island. The distribution pattern of *Calisto* thus parallels on a small scale that of the terrestrial molluscs (see, for instance, Cooke, 1895, Simpson, 1895), whereas the distribution of the remaining butterflies resembles more closely that of the birds (see Bond, 1934, 1936).

Before inquiring into the possible reasons for this phenomenon, it will be profitable to discuss the distribution of *Calisto* in somewhat greater detail. The twenty clearly defined species of the genus are divided among the principal island groups as follows:

Islands	Species	Subgroups	Groups	Sections
Puerto Rico	1	1	1	1
Jamaica	1	1	1	1
Hispaniola	15	6	5	2
Cuba and Bahamas	3	1	1	1

The fifteen Hispaniolan species, as I have tried to show in the systematic section of this paper, appear to represent the terminal branches of a native and apparently continuous phylogenetic development. The first impression therefore is that Hispaniola has been enormously prolific in the development of species, as compared with the other islands. A consideration of the relationships of the species of the other islands shows, however, that this first impression is to some extent exaggerated, for all of these species appear to have been derived from the Hispaniolan stock at a point not lower than the base of subgroup B of the *hysius* group. The more primitive subgroup A of the *hysius* group and the still more primitive groups of Section I cannot fairly, therefore, be taken into account in assessing the numerical development of the Hispaniolan fauna, because some, and conceivably all, of their species must have been in existence before the colonization of the remaining islands by the stocks which now inhabit them.

Considering, then, only those species which appear to have evolved contemporaneously with the independent history of the groups of the other islands, i.e., eliminating Section I and subgroup A of the *hysius* group, the Hispaniolan fauna is reduced as follows:

Species	Subgroups	Groups	Sections
7	3	3	1

Even after this drastic reduction, the preponderance of the Hispaniolan fauna is marked, the number of species being greater than that of all the remaining islands combined.

To what are we to attribute this numerical superiority of the Hispaniolan fauna? Is it perhaps due to some inherent plasticity of the Hispaniolan stock, which has been lost in the colonists to other islands? This can hardly be the case, for both the Jamaican and the Puerto Rican species show modifications as extreme as can be found in any from Hispaniola, while the Cuban *smintheus* has undergone marked subspeciation which must, as we shall see, have been of very recent origin. Rather we must suppose that essential conditions have differed among the islands, in such a way as to favor the development and preservation of a relatively large number of species in Hispaniola.

It is agreed by the majority of recent students that speciation in animals most frequently proceeds through the slow genetic divergence of originally similar populations which are physically isolated from one another. Often this isolation is geographical, suitable habitats being separated by ecologically unfavorable barriers which the animals cannot or will not cross. Other types of isolation are, however, conceivable, depending on differences in habitat preferences, differences in almost specific host requirements, differences in annual breeding rhythms, etc. The evidence in favor of these non-geographic methods of speciation is not as clear-cut as could be wished, and their importance is accordingly minimized by several authoritative writers.

In *Calisto* there are several pairs or sets of subspecies or of species so closely related that we might reasonably expect them to show some evidence of the isolating mechanisms responsible for their formation. These may be tabulated as follows:

SERIES OF SPECIES OF SUBSPECIES	APPARENT EXTRINSIC ISOLATING MECHANISM
C. loxias and *C. archebates*	Geographic separation
C. hysius batesi and *C. h. hysius*	Geographic separation
C. confusa, C. debarriera, and *C. obscura*	None
C. herophile apollinis and *C. h. herophile*	Geographic separation
C. smintheus smintheus, C. s. muripetens, and *C. s. bradleyi*	Geographic separation
C. herophile and *C. smintheus*	Different habitat preference
C. pulchella pulchella and *C. p. darlingtoni*	Geographic separation

The series *C. zangis, C. pulchella,* and *C. nubila,* in which the separation is also geographic, must be omitted, as the evidence for the direct relationship of these forms is not conclusive. Summarizing, however, the cases of authenticated relationship, we see that in five out of seven series, with a degree of differentiation ranging from barely distinguishable subspecies (*C. herophile*) to somewhat doubtfully distinct species (*C. loxias* and *archebates*), the cleavage falls clearly along geographic lines. The various *smintheus* subspecies are separated from *herophile herophile* by a difference in habitat preference: mountain forests against somewhat open lowlands. We have seen, however, that there is circumstantial evidence of rather frequent hybridization between the two species along their zones of contact; we can hardly, therefore, suppose that the habitat difference would by itself be sufficient to keep the *herophile* and *smintheus* populations isolated. In the case of *C. obscura, C. confusa,* and the rather less certainly distinct *C. debarriera,* we have no evidence as to the mechanism of speciation. Summing up, then, while it would be rash to say that all speciation in the genus *Calisto* has been geographic, we can safely claim that geographic isolation has been a major factor in the differentiation of populations to form species.

This at once provides an explanation of the dominant position of Hispaniola in the evolutionary history of the genus, for in Hispaniola alone is the topography sufficiently elevated and complex to provide frequent opportunities for the geographic isolation of populations. It is true that there are high mountains in the other large islands, but in Puerto Rico and Jamaica they are concentrated in single, essentially continuous chains, providing little effective separation for either lowland or high altitude forms. In Cuba there are three well separated mountainous zones, but the only really high elevations are found in the topographically simple Sierra Maestra; the remaining mountains would rank as mere foothills in Hispaniola. It may be noted that even this relatively small array of mountainous habitats has permitted the differentiation of subspecies in *Calisto smintheus.*

In Hispaniola, on the other hand, there are three major mountain chains, each reaching imposing altitudes, and separated from one another by valleys hardly raised above sea level. Within each chain there are separate minor massifs and ranges, which permit the isolation of populations of species which are restricted to the higher altitudes. Ecological barriers of arid or subarid land, unsuitable for the life of *Calisto,* are also present. At various times in the past, including the warmer stages of the Pleistocene, the valley barriers are known to have been made even more complete by inundation with the rising waters of the sea. In the Plaine Cul-de-Sac, which separates the Southern from the Central Cordillera, forests of branching coral are said to be still standing in the open air, while remnants of the former sea connection exist in the form of salt lakes which have shrunk in size within the memory of living man. The importance of the Plaine Cul-de-Sac barrier is seen in the fact that two pairs of subspecies (in *C. hysius* and *C. pulchella*) are still separated by it, while a number of other species are confined to one side or the other of the valley. It is evidently, however, no longer a barrier to species such as *confusa* and *obscura* which are tolerant of more or less open-country conditions, as these occur indiscriminately on both the northern and southern sides.

In the development of a rich fauna, conditions governing not only the formation, but also the preservation, of species must be considered. Thus, in Hispaniola we have a whole series of primitive species (eight species in Section I and in the *hysius* group, subgroup A), which are not represented in the other islands. Two hypotheses are possible: either *Calisto* was endemic in Hispaniola until a relatively late stage in its development, and the more primitive forms have accordingly never reached the other Antilles; or conditions have favored the survival of primitive forms on Hispaniola, while they have become extinct elsewhere.

In my opinion, the latter view is preferable. In the first place, we can hardly doubt that the original immigrant ancestor of the group came from some place on the American continent, where apparently related forms exist as the "Andean" group of Satyrids—*Steroma* and other genera, represented as far north as the United States by *Gyrocheilus*. This immigrant must have come either from the west, through Cuba or Jamaica, or, less probably, from the north, where the Florida peninsula was not yet long enough to provide a very close approach to Cuba, or from the South, across the numerous water gaps of the Lesser Antilles. In any event, the line of immigration must have passed through at least one of the other islands, unless we are prepared to accept the very improbable alternative of a direct jump over a sea barrier of several hundred miles width, from northern Florida, Venezuela, or some other remote point. In the second place, even conservative students such as Matthew (1939) think that the Greater Antilles were united in an essentially single land mass until the late Miocene or early Pliocene, when block faulting and possibly other movements caused its fragmentation. If, as in view of its extensive autochthonous development seems at least possible, *Calisto* had already arrived in the West Indies before this time, the earlier forms must have been represented in all parts of the present Greater Antillean area, and have become regionally extinct at a subsequent period.

The problem then is, why has the survival of species been favored on Hispaniola as compared with the other islands? The answer appears to me to be twofold, and to be related to the same conditions which have favored prolific speciation in Hispaniola, namely, the high altitude and complex relief of a relatively large part of the island. These factors have acted first in minimizing the reducing effect of epeirogenic sinking and eustatic rise of sea level on the land area of the island, whereas in Cuba, the only other island of comparable size, there has been widespread inundation at various times since the Miocene (Schuchert, 1935). As I have tried to show in a paper now in press, the land area of an island has an important effect on the preservation of an abundant fauna; Hispaniola has had a larger continuous land area than any of the other Antilles, and would thus have been able to retain a larger proportion of its early fauna. A second important effect has been the possibility of isolation of populations already discussed in connection with speciation. The ecological zonation associated with the many different mountain masses has allowed species to escape competition, and thus to reduce the danger of extinction, by (a) differential survival in different isolated regions of similar habitat type, and (b) invasion of alpine regions where many other species are unable to follow. It is significant that of the eight primitive species known from Hispaniola not one, if we except Hall's record of *C. archebates* from Puerto Plata, which may well refer to mountains behind that city, has been taken at sea level. Six of the eight are confined to altitudes above 4000 feet, and of these same six none occurs in more than one Cordillera, four being confined to the Central, two to the Southern, Range.

We are now in a position to offer a reasonable explanation of the distributional parallelism which exists on the one hand between *Calisto* and the terrestrial molluscs, and on the other hand between the remaining butterflies and the birds. Topographic barriers are sufficient to isolate in *Calisto,* as in the molluscs, different populations within the confines of a single island, permitting autochthonous geographic speciation on Hispaniola, and to a lesser extent on Cuba. In all the remaining butterflies there is not one single case known of two geographic races being confined to different parts of the same island: the phenomenon of occasional immigrants of an extraneous subspecies being found among a resident population (*Danaus, Phœbis*) is quite different. The same thing is true, according to Bond, of birds, single resident subspecies being found on each island. Such geographic speciation as may occur accordingly takes place between, rather than within, islands, and species groups tend to be represented in several islands, rather than characteristic of a single one.

The primary difference between molluscs and birds from the distributional standpoint is one of mobility, and such a difference exists in a lesser degree between *Calisto* and the majority of other West Indian butterflies. The Satyrids in general are weakly-flying, shade-loving insects, and many of the tropical species are actually confined to the deep shadow of rain forests. As a group they tend, particularly in the tropics, to be sedentary and to have a very low capacity for crossing water barriers. There are, of course, other groups of butterflies which have these characteristics, but they have for the most part not succeeded in reaching the West Indies, or have not become very firmly established (Ithomiinæ, Erycinidæ). It seems safe to conclude that this low mobility, coupled with an early arrival and an adaptability to local conditions, has been responsible for the present diversity and anomalous distribution of the genus.

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REPORT UPON SPECIMENS OF *DIATRÆA* GUILDING (LEPIDOPTERA, PYRALIDÆ) IN THE CORNELL UNIVERSITY COLLECTION

By Harold E. Box
Maracay, Venezuela

I am greatly obliged to Professor W. T. M. Forbes for giving me the opportunity to examine the various specimens of *Diatræa* in the collection of Cornell University, which he has kindly sent to me on loan for study. The collection has proved to be of unusual interest, and I therefore have pleasure in submitting the following report, which Professor Forbes has asked to have published.

Among the fifty-seven specimens examined, which represent the whole range of the genus from the United States of America to Argentina, fourteen species are recognized.

The arrangement of species in the following list is chronological. References are given to the original description, and to the first transfer to *Diatræa* where transference has occurred; synonyms and other references are given only where considered necessary.

LEPIDOPTERA

Fam. Pyralidæ

Subfam. Crambinæ

Diatræa Guild.

Diatræa Guilding 1828, Trans. Soc. Encour. Arts, etc., **xlvi**: 148.

1. *Diatræa saccharalis* (Fabr.)

Phalæna saccharalis Fabricius 1794, Skrift. af Naturh.-Selsk., **iii(2)**: 64, pl. vii, fig. 1 (Danish West Indies).

Diatræa saccharalis (Fabr.) Comstock 1881, U. S. Dept. Agr. Ent. Rept. 1880: 240. (Not *D. saccharalis* (?) (Fabr.) Comstock, l.c.: 243, = *D. crambidoides* (Grt.)).

Sugar Cane Moth Borer.

U. S. A., TEXAS: Brownsville, Oct. 1938 (C. G. Anderson), 1 ♀. PUERTO RICO: Cayey, Nov. 1947 (J. P. & L. G. Huntoon), 1 ♀. TRINIDAD: Fyzabad, Feb. 1928 (N. A. W. via Parish), 1 ♀. SURINAM: Moengo, Boven Cottica R., May 1927 (Forbes), 1 ♀. VENEZUELA, DISTRITO FEDERAL: El Valle, "pupa an caña de azúcar," Feb. & Apr. 1945 (F. Gomez Alvarez), 1 ♂, 1 ♀. BRAZIL, MINAS GERAES: Viçosa, Mar. 1932 (E. J. Hambleton), 1 ♂, 1 ♀; RIO GRANDE DO SUL: Pelotas (C. M. de Biezanko), 1 ♂, 3 ♀♀. ARGENTINA, SANTA FE: Feb. 1920 (Cornell University Expedition), 1 ♀; San Cristobal, Feb. 1920 (Cornell University Expedition), 1 ♀; CORDOBA: Cruz del Eje, Sierra de Córdoba, Mar. 1920 (Cornell University Expedition), 1 ♀.

2. *Diatræa lineolata* (Walk.)

Leucania lineolata Walker 1856, List Lep. Ins. Brit. Mus., **ix**: 100 (Venezuela).

Diatræa lineolata (Walk.) Hampson 1895, Proc. Zool. Soc. Lond. 1895: 953. Neotropical Cornstalk Borer.

CUBA: Finca San Francisco, Caraballo, "larva criada del tallo del maiz," Aug. 1938 (D.G.; Universidad de Habana, Esc. I. Agronómica, Cát. "g"), 1 ♂. COLOMBIA: Juntas del Rio Tamana y Rio San Juan, 405 ft., Feb. 1909 (W. F. H. Rosenberg), 1 ♀. ECUADOR: Quevedo (Rosenberg), 1 ♀.

3. *Diatræa impersonatella* (Walk.)

Crambus impersonatellus Walker 1863, List Lep. Ins. Brit. Mus., **xxvii**: 163 (Venezuela; Santarem).

Diatræa impersonatella (Walk.) Box 1931, Bull. Ent. Res. **xxii**: 41, pl. iii, figs. 2, 3.

TRINIDAD: Fyzabad, Feb. 1928 (N. A. W. via Parish), 1 ♂, 2 ♀♀. VENEZUELA, TERRITORIO FEDERAL AMAZONAS: Sanariapo (S. of Puerto Ayacucho, Rio Orinoco), Sept. 1946 (R. Lichy), 1 ♂.

4. *Diatræa crambidoides* (Grt.)

Chilo crambidoides Grote 1880, Canad. Ent., **xii**: 15 (Kansas).

Diarœtria (*sic*) *crambidoides* (Grt.) Grote 1882, New Check List N. Amer. Moths: 56.

Diatræa zeacolella Dyar 1911, Ent. News, **xxii**: 203 (North Carolina). Larger Cornstalk Borer.

U. S. A., NEW YORK: Long Island: Orient, Southold, E. Marion, Greenport, Shelter Is., various dates June 1934 to Aug. 1946 (R. Latham), 5 ♂♂, 2 ♀♀; Eastport, Aug. 1941 (D. Raynor), 1 ♂; VIRGINIA: Petersburg, June 1917 (Bradley), 2 ♂♂; GEORGIA: May 1927 (Addison Ellsworth coll.), 1 ♂; Clarke Co., Aug. 1928 (Richards), 2 ♀♀; FLORIDA: Royal Palm State Park, Mar. 1939 (J. C. Bradley), 1 ♂; Florida City, Mar. 1936 (J. C. Franclemont), 1 ♀.

The above records from New York State appear to indicate the most northerly part of the range of this species. The male from Royal Palm State Park, Fla., is unusually small (expanse 22.5 mm.).

5. *Diatræa canella* Hamps.

Diatræa canella Hampson 1895, Ann. Mag. Nat. Hist. (6) **xvi**: 349 (Grenada).

SURINAM: Moengo, Boven Cottica R., May 1927 (Forbes), 1 ♂.

6. *Diatræa minimifacta* Dyar

Diatræa minimifacta Dyar 1911, Ent. News, **xxii**: 202 (Trinidad); Box 1931, Bull. Ent. Res., **xxii**: 21.

Trinidadia minimifacta (Dyar) Dyar & Heinrich 1927, Proc. U. S. Nat. Mus., **lxxi**, no. 2691: 6, figs. 29, 48.

TRINIDAD: Fyzabad, Feb. 1928 (N. A. M. via Parish), 1 ♀. The hind wing has veins 4 and 5 united, but not stalked, otherwise the venation appears to be normal.[1]

7. *Diatræa grandiosella* Dyar

Diatræa grandiosella Dyar 1911, Ent. News, **xxii**: 203 (Mexico). Southwestern Cornstalk Borer.

U. S. A., ARIZONA: Tucson, Oct. 1939 (Crandall), 1 ♀. MEXICO: Guerrero (———), 2 ♀♀.

[1] The stalking of veins 4 and 5 was one of the characters on which Dyar and Heinrich based their genus *Trinidadia*, to accommodate this species. This question was discussed by me in some detail (*op. cit.*: 10, 21), and my conclusions led me to sink *Trinidadia* into *Diatræa*.—H.E.B.

8. *Diatræa angustella* Dyar

Diatræa angustella Dyar 1911, Ent. News, **xxii**: 205 (Brazil).

BRAZIL, MINAS GERAES: Viçosa, Oct.–Nov. 1930 (E. J. Hambleton), 1 ♂.

9. *Diatræa bellifactella* Dyar

Diatræa bellifactella Dyar 1911, Ent. News, **xxii**: 205 (Brazil).

TRINIDAD: Fyzabad, Feb. 1928 (N. A. W. via Parish), 1 ♂. BRAZIL, SANTA CATHERINA: Nova Teutonia (27° 11′, 52° 23′), Oct. 1939 (F. Plaumann), 1 ♂).

10. *Diatræa evanescens* Dyar

Diatræa evanescens Dyar 1917, Insec. Insc. Mens., **v**: 84 (Louisiana); Forbes 1920, Jour. N. Y. Ent. Soc., **xxviii**: 224; Dyar & Heinrich 1927, Proc. U. S. Nat. Mus., **lxxi**, no. 2691: 18, figs. 10, 57; Box 1931, Bull. Ent. Res., **xxii**: 40.

U. S. A., NORTH CAROLINA: Polloksville, Sept. 1931 (Bradley & Knorr), 1 ♂; GEORGIA: Clarke Co., Aug. 1928 (Richards), 1 ♂; TEXAS: Corpus Christi, June 1943, "at light" (W. M. Gordon), 1 ♂, 2 ♀♀.

The above records extend considerably the known range of this species, previously listed from Texas, Louisiana, Mississippi and Missouri in the U. S. A.,[2] and (as *sobrinalis* Schs.) from Guatemala. According to Dyar and Heinrich, *evanescens* is extremely variable in size: "Male, 11–20 mm., female, 21–30 mm.". The present specimens from North Carolina and Texas are all small (males, 14–17.5 mm., females 14.5–15 mm.). The single male from Georgia (which has already been identified by Professor Forbes), is much larger (21 mm.).

11. *Diatræa indigenella* Dyar & Heinr.

Diatræa indigenella Dyar & Heinrich 1927, Proc. U. S. Nat. Mus., **lxxi**, no. 2691: 13, fig. 51 (Colombia).

COLOMBIA: Slopes of Pueblo Rico, San Juan, Choco, 5,200 ft., Aug. 1909 (W. F. H. Rosenberg), 2 ♀♀.

[2] In 1935, Mr. O. L. Cartwright kindly gave me one male: SOUTH CAROLINA: Florence, Aug. 1931, collected by himself; it has since been presented to the British Museum.

12. *Diatræa brunnescens* Box

Diatræa brunnescens Box 1931, Bull. Ent. Res., **xxii**: 29, pl. v, fig. 1 (Venezuela); 1935, **xxvi**: 326.
Diatræa incertella Box 1931, op. cit.: 30, pl. i, figs. 16, 17 (Brazil).

BRAZIL, MINAS GERAES: Viçosa (E. J. Hambleton), 1 ♂.

Previously known from Brazil (Rio de Janeiro) only by the unique male type of *incertella.*

13. *Diatræa busckella rosa* Heinr.

Diatræa busckella var. *rosa* Heinrich 1931, Proc. U. S. Nat. Mus., **lxxix**, no. 2879: 4 (Venezuela).
Diatræa busckella subsp. *rosa* (Heinr.) Box 1948, Bol. Entom. Venez., Caracas, **vii**: 39.

VENEZUELA: ———; Maracay, 1945 (F. Gomez Alvarez), 2 ♂♂, 1 ♀.

Two of these specimens (1 ♂, 1 ♀) are without locality labels, but they carry the collector's ms. numbers, which enable their provenience to be established as Venezuela.

14. *Diatræa savannarum* Box

Diatræa savannarum Box 1935, Bull. Ent. Res., **xxvi**: 332, pl. xii, figs. 3, 4. (British Guiana).

VENEZUELA, TERRITORIO FEDERAL AMAZONAS: Sanariapo (South of Puerto Ayacucho, Rio Orinoco), Oct. 6, 1946 (R. Lichy), 1 ♂.

This specimen is rather damaged, but is seen to be darker in color and much smaller (expanse 11.5 mm.) than any of the four males in the type series (16–20 mm.), so much so that it was at first believed to represent a new species. The genitalia, however, leave little doubt as to its identity.[3]

[3] It is to be noted that Mr. Tans' photograph of the male genitalia accompanying the original description, and the slide of Dr. Lichy's specimen in the Cornell collection, both show the arms of the anellus to be crossed, whereas in the preparation before mounting they are seen to be quite free from each other.

LEPIDOPTERISTS' SOCIETY MEETS

The Lepidopterists' Society held its first annual meeting December 29–30, 1950, at the American Museum of Natural History, New York City. The two-day program included a general paper reading session, a symposium on "Geographic subspeciation in the Lepidoptera", and an illustrations session, followed by a business meeting. There was a display of Lepidoptera, equipment, and photographs furnished by the members. At the business meeting presided over by Mr. A. H. Clark in place of Dr. McDunnough, who was unable to attend, the Society was formally organized with the adoption of a constitution and bylaws. The following men were elected for office:

President	J. H. McDunnough
Senior Vice-President	A. H. Clark
Vice-Presidents	W. Forster, K. J. Hayward
Secretary	F. H. Rindge
Treasurer	J. B. Ziegler

Members of the Executive Committee: H. Stempffer, T. N. Freeman, L. M. Martin, N. D. Riley, T. Shirozu, and J. C. Franclemont.

The symposium was in charge of Dr. C. L. Remington, and the following talks were given: Dr. E. G. Munroe, "Geographic races in Microlepidoptera"; Dr. A. B. Klotz, "Geographic subspeciation in Holarctic butterflies"; Mrs. M. M. Cary, "Subspeciation in Sphingid moths of the West Indies and adjacent continental areas", Mr. B. P. Beirne, "Lepidoptera races in Europe"; and Mr. L. P. Grey, "Subspeciation in *Speyeria atlantis*".— F. H. RINDGE.

CORRECTION

In Vol. LVIII, No. 4, Sept. 1950, the following should be substituted for line 1, p. 153—

Cicindela tranquebarica—gregarious and solitary—taken in

SOME INSECTS ASSOCIATED WITH NESTS OF DIANTHIDIUM DUBIUM DILECTUM TIMBERLAKE, WITH A LIST OF THE RECORDED PARASITES AND INQUILINES OF DIANTHIDIUM IN NORTH AMERICA

By P. D. Hurd, Jr., and E. G. Linsley
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The purpose of this paper is to assemble the records of the various insects which have been reared from the nests of the Megachilid genus *Dianthidium* Cockerell as a basis for further studies. The opportunity is also taken to present the results obtained from rearing the inhabitants of several nests of *Dianthidium dubium dilectum* Timberlake. It now appears that partial host relationships have been established for five determined *Dianthidium* species or subspecies and additional information is also available for several undetermined forms.

The new records here reported were obtained from a series of nests of *Dianthidium dubium dilectum* Timberlake[1] collected from exposed clay shales along Upper Sulphur Creek, Santa Clara County, California on September 14, 1948. The nests were brought back to the laboratory for rearing and in the succeeding spring the following associated species emerged: *Amobia* (*Pachyophthalmus*) *floridensis* (Townsend),[2] *Chrysis* (*Chrysis*) *cœrulans* Fabricius, *Sapyga nevadica* Cresson,[3] *Stenodynerus cochisensis* (Viereck),[3] and *Toxophora pellucida* Coquillett.[4]

Summarized in the accompanying table are all the nest inhabitants now known to the writers for the North American species of *Dianthidium.* These records have been listed under the trivial names in current use, regardless of how they were reported originally.

It may be seen that the known insects associated with the nests of *Dianthidium* represent three orders, the Coleoptera, Diptera,

1 Determined by P. H. Timberlake, Citrus Experiment Station, Riverside, California.

2 Determined by H. J. Reinhard, Texas A & M, College Station, Texas.

3 Determined by R. M. Bohart, University of California, Davis.

4 Determined by F. R. Cole, Redlands, California.

SUMMARY OF THE KNOWN ENTOMOPHAGOUS AND INQUILINE INSECTS ASSOCIATED WITH NESTS OF THE GENUS *Dianthidium*

Dianthidium species	Associate	Locality	Authority
[species?]	*Nemognatha nigripennis* LeConte	Arizona	Schwarz, 1903
	Trichodes ornatus Say	California	Essig, 1934
	Monodontomerus dianthidii Gahan	California	Gahan, 1941
dubium dilectum Timberlake	*Amobia (Pachyophthalmus) floridensis* (Townsend)	California	
	Chrysis (Chrysis) cœrulans Fabricius	California	
	Sapyga nevadica Cresson	California	New records
	Stenodynerus cochisensis (Viereck)	California	
	Toxophora pellucida Coquillett	California	
pudicum consimile (Ashmead)	*Alcidamea producta* Cresson	California	Davidson, 1896
	Monodontomerus montivagus Ashmead	California	Davidson, 1896
	Leucospis affinis Say	California	Davidson, 1896
	Torymus anthidii Ashmead	California	
	Trichodes ornatus tenellus LeConte	California	Davidson, 1896 Davidson, 1896
	Eusapyga verticalis (Cresson)	California	Hicks, 1934
	Sapyga minor Roberts	California	Hicks, 1934
	Trichodes ornatus ornatus Say	California	Linsley & MacSwain, 1942
pudicum decorum Timberlake	*Odynerus (Stenodynerus)* sp.	Colorado	Hicks, 1927
	Monodontomerus montivagus Ashmead	Colorado	Hicks, 1927
	Eusapyga proxima (Cresson)	Colorado	Hicks, 1927, 1934
	Eusapyga rubripes (Cresson)	Nebraska Colorado	Roberts, 1933 Hicks, 1934
	Sapyga sp.	Colorado	Hicks, 1934

Dianthidium species	Associate	Locality	Authority
macswaini Timberlake	*Trichodes ornatus ornatus* Say	California	Linsley & MacSwain, 1943
sayi Cockerell	*Spogostylum daphne* (Osten Sacken)	Colorado	Hicks, 1926; Custer, 1928
	Dasymutilla asopus (Cresson) or *D. hector* (Blake)	Colorado	Hicks, 1926; Mickel, 1928

and Hymenoptera. The seven families of Hymenoptera and their respective numbers of species are as follows: Callimomidæ (3), Chrysididæ (1), Leucospididæ (1), Megachilidæ (1), Mutillidæ (1), Sapygidæ (6), and Vespidæ (2). The Diptera are represented by two families, the Bombyliidæ with two species, and the Sarcophagidæ with one species. The only Coleoptera in the list are the Cleridæ and the Meloidæ, each with one species. Undoubtedly further collecting will greatly increase these records and also clarify the ecological relationships of the species involved.

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DAVIDSON, A., 1896. On the nesting habits of Anthidium consimile. *Ent. News,* **7**: 22–26, 3 figs. [*Alcidamea producta, Monodontomerus montivagus, Leucospis affinis, Torymus anthidii,* and *Trichodes ornatus,* var. *tenellus* recorded as associated with nests of *Anthidium consimile;* note, *A. consimile = Dianthidium pudicum consimile* (Timberlake, 1948: 152).]

ESSIG, E. O., 1934. *Trichodes ornatus* (Say). *Journ. Econ. Ent.,* **27**: 724. [Reared from cell of "mason bee" = *Dianthidium* sp., *teste* Linsley & MacSwain, 1943: 597.]

GAHAN, A. B., 1941. A revision of the chalcid-flies of the genus Monodontomerus in the United States National Museum. *Proc. U. S. Nat. Mus.,* **90**: 461–482. [*Monodontomerus dianthidii* reported as reared from a cell of *Dianthidium* sp. on oak.]

HICKS, CHARLES H., 1926. Nesting habits and parasites of certain bees of Boulder County, Colorado. *Univ. Colorado Studies,* **15**: 217–252. [*Dasymutilla asopus* (or *D. hector*) and *Villa* (*Anthrax*) sp., (= *Spo-*

gostylum daphne, teste Custer, 1928: 123) reared from nests of *Dianthidium sayi.*]

———, 1927. Parasites and habits of *Dianthidium pudicum* Cresson. *Psyche,* 34: 193–198. [*Eusapyga proxima, Odynerus* (*Stenodynerus*) n. sp., and *Monodontomerus montivagus* recorded as reared from nests of *D. pudicum* (probably = *pudicum decorum* Timberlake, *teste* Linsley, 1944: 54).]

———, 1934. Some reared insect parasites and their hosts. *Univ. Colorado Studies,* **21**: 265–271, 3 figs. [*Eusapyga proxima, E. rubripes,* and *Sapyga* sp. recorded as parasites of *Dianthidium pudicum* (probably = *pudicum decorum* Timberlake, *teste* Linsley, 1944: 54; *Eusapyga verticalis* and *Sapyga minor* reported as reared from *Dianthidium pudicum consimile.*]

LINSLEY, E. GORTON, 1942. Notes on the habits of some beetles from the vicinity of Yosemite National Park. *Bull. So. Cal. Acad. Sci.,* **41**: 164–166, plate 30. [*Trichodes ornatus* Say recorded from cell of *Dianthidium pudicum provancheri* (= *D. pudicum consimile*).]

———, 1944. Host relationships of some Sapygid wasps. (*Hymenoptera, Sapygidæ.*) *Bull. Brooklyn Ent. Soc.,* **39**: 54–55. [Review of published North American records with new host data.]

LINSLEY, E. G., AND J. W. MACSWAIN, 1943. Observations on the life history of *Trichodes ornatus* (Coleoptera, Cleridæ), a larval predator in the nests of bees and wasps. *Ann. Ent. Soc. Amer.,* **36**: 589–601, 2 plates, 1 text figure. [*T. ornatus* reported as a predator in nests of *Dianthidium pudicum provancheri* (= *D. pudicum consimile*), and *D. macswaini.*]

MICKEL, CLARENCE E., 1928. Biological and taxonomic investigations on the Mutillid wasps. *Bull. U. S. Nat. Mus.,* **143**: ix + 351, 28 text-figures, 5 plates. [*Dasymutilla asopus* (or possibly *D. hector*) reported as parasitic on *Dianthidium* species (= *Dianthidium sayi, teste* Hicks, 1926: 249).]

PATE, V. S. L., 1947. Neotropical Sapygidæ, with a conspectus of the family (Hymenoptera: Aculeata). *Acta Zool. Lilloana,* 4: 393–426, 1 table. [Tabular summary of the known host relationships of the sapygine wasps.]

ROBERTS, RAYMOND, 1933. Two new species of Vespoidea (Hymenoptera), with notes on a previously named species. *Journ. Kansas Ent. Soc.,* **6**: 91–98. [*Eusapyga rubripes* reported "at hole of *Anthidium* sp." in Nebraska (referred by Pate, 1947: 407 to *Dianthidium pudicum decorum* Timberlake).]

SCHWARZ, E. A., 1903. [Breeding habit of Nemognatha nigripennis.] *Proc. Ent. Soc. Wash.,* **5**: 137–138. [*N. nigripennis* reared from nest of *Anthidium* (= apparently, *Dianthidium*).]

TIMBERLAKE, P. H., 1948. Additions and corrections to the list of Nearctic species of Dianthidium (Hymenoptera, Apoidea). *Journ. N. Y. Ent. Soc.,* **56**: 149–153. [Nomenclatural changes: *D. pudicum provancheri of* Timberlake, 1943, *nec* Titus = *D. pudicum consimile* (Ashmead).]

THE OLD WORLD MEMBRACIDÆ

BY FREDERIC W. GODING

(Concluded from Vol. LVIII, p. 129)

Eutryonia

Goding, Mon. Aust. Memb. p. 34. (1903); *Gelastorrhachis* Kirkaldy, Rept. Exp. St. Haw. S. P. Assoc. ix, p. 372. (1906).

KEY TO SPECIES

1(2). Black, knees and tarsi tawny, white tomentose oblique stripe each side; front process short, lateral spines slender nearly as long as the body, posterior process nearly straight; tegmina black, opaque; 12 × 8 mm. .... **formidenda**

2(1). Piceous or black, yellow pubescent, posterior process except apex, and legs yellowish; front process slender, altitude about equal to length of the body, hind margin sinuate, lateral spines three or four times longer than their basal width, tips abruptly acute; posterior process sinuate, apical area decurved; tegmina ochraceous, base and costal margin piceous; 6 × 3 mm. .... **gracilis**

LIST OF SPECIES

formidenda Walker, Jour. Linn. Soc. i, p. 94, pl. 3, fig. 2. (1856); Buckton, Mon. Memb. p. 213, pl. 47, fig. 6. (1903). Sarawak, Borneo. Singapore.

gracilis Goding, Jour. N. Y. Ent. Soc. xxxiv, p. 243. (1926). Kuranda, Queensland, Australia.

Leptobelus

Stål, Hemip. Afric. iv, p. 86. (1866).

KEY TO SPECIES

1(12). Posterior process emitted from summit of front pronotal process.

2(9). Posterior process descending obliquely downward to or nearly to margins of tegmina; front pronotal process long.

3(8). Apex of scutellum more or less obtuse and notched.

4(7). Base of posterior process level with bases of lateral spines, the latter slightly decurved and recurved; tegmina with two discoidal cells.

5(6). Entirely black, tegmina yellowish brown; scutellum long as broad, deeply notched at apex; posterior process almost as long as the tegmina; 10 × 9 mm. .... **sauteri**

6(5). Dark brown, metopidium paler, abdomen black, tegmina smoky hyaline, base brown; scutellum longer than broad, apex slightly notched; posterior process almost black, apex lightly decurved, slightly passing apex of clavus; 9 × 6.6 mm. .... **decurvatus**

7(4). Base of posterior process distinctly higher than bases of lateral spines, obliquely straight, lateral spines slightly elevated and recurved; scutellum triangular, broader than long, apex broadly notched; black, tegmina smoky hyaline, base black, three discoidal cells; 6.8 × 4.5 mm. .... **nigris**

8(3). Apex of scutellum acute, longer than broad; lateral spines straight, tips lightly deflexed, posterior process slightly undulate, passing apex of clavus; black, tegmina pale bronze; 9.5 × 5 mm. ..... **dama**

9(2). Posterior process horizontal, distant from the body and tegmina; front process short, not much longer than broad.

10(11). Blue black, legs brown, tegmina brownish ochraceous hyaline, base black; lateral spines substraight, recurved, posterior process straight; scutellum longer than broad, acute; 8–10 × 6 mm. **gazella**

11(10). Black, tegmina brownish ochraceous; front process conical, lateral spines broad, horizontal, slightly decurved, twice as long as the intervening space, posterior process subarcuate, slightly decurved, passing apex of clavus; 12 mm. .... **alticeps**

12(1). Posterior process emitted from the middle of the posterior margin of the front process, obliquely descending and passing apex of clavus; scutellum longer than broad, apex acute; black.

13(14). Front pronotal process very high, slightly inclined forwardly, lateral spines subhorizontal, very slightly decurved and recurved, about as long as width of metopidium; black, shining, body beneath brownish black, tarsi flavous, tegmina smoky or colorless hyaline, base black; 7.6 × 3.8 mm. .... **elevatus**

14(13). Front pronotal process not highly elevated, rather short, erect, lateral spines some longer than width of metopidium, subarcuate; tegmina brownish ochraceous hyaline; 8 × 5 mm. .... **metuenda**

List of Species

sauteri Schumacher, Suppl. Ent. viii, p. 114. (1915). Taihorin, Hoozan, Formosa Is.

decurvatus Funkhouser, Bul. Brook. Ent. Soc. xvi, p. 43, figs. 1, 2. (1921). Dikhim, India. Kiautschau, Kinkiang, China.

nigris Funkhouser, Jour. Fed. Malay Sts. Mus. xiv, p. 473, figs. 5, 6. (1929). Sandaken, Bettotan, Borneo.

dama Germar, Rev. Ent. Silb. iii, p. 258. (1835); Fairmaire, Rev. Memb. p. 510, pl. 3, fig. 14. (1846); Distant, Faun. Brit. Ind. iv, p. 15, fig. 11. (1908); Funkhouser, Phil. Jour. Sci. x, pl. 1, fig. 4. (1915). East Indies. Java. Palawan, Puerta Princesa, Philippines.

gazella Fairmaire, Rev. Memb. p. 510. (1846); Buckton, Mon. Memb. p. 235, pl. 53, fig. 5. (1903); Distant, Faun. Brit. Ind. iv, p. 16, fig. 12. (1908). Sidjoendjoeng, Moeara Laboe, Padang Sidempoean, Serdang, Tandjong Morawa, Sumatra. Depok, Java. N. China. Assam, Naga Hills, India. Ruby Mines, Pusa, Burma.

alticeps Walker, Jour. Linn. Soc. x, p. 183. (1868). Aru Is., near New Guinea.

elevatus Funkhouser, Phil. Jour. Sci. xviii, p. 685, pl. 1, figs. 8, 9. (1921). Palawan, Puerta Princesa, Philippines. Kinabalu, Borneo.

metuenda Walker, Jour. Linn. Soc. i, p. 164 (1857). Sarawak, Borneo. Malacca. Java.

macularum Buckton, Mon. Memb. p. 214, pl. 47, fig. 7. (1903). Perak, Malacca, Borneo.

Elaphiceps

Buckton, Mon. Memb. p. 217. (1903). (Synonym of *Leptobelus* ?)

KEY TO SPECIES

One pale fuscous species with front pronotal horn shining black, narrowed upwardly; posterior process emitted from summit of front process, obliquely curved to margins of tegmina far beyond apex of clavus; tegmina fuscous; 12 × 7 mm. .... **cervus**

LIST OF SPECIES

cervus Buckton, Mon. Memb. p. 217, pl. 48, fig. 4. (1903); Lingn. Sci. Jour. vii, p. 477, pl. 14, fig. 2. (1829). China; Horischa, Formosa.

Hypsauchenini

Hypsauchenia

Germar, Rev. Ent. Silb. iii, p. 230. (1835).

KEY TO SPECIES

1(2). Apical folioles of front pronotal process broad, wrinkled, broadly separated at bases forming a circular space; tegmina brown; 7–8 mm. .... **hardwicki**

2(1). Apical folioles of front pronotal process narrow, elongate, space between ovate not circular; tegmina brown, white fascia across the disk; 7–8 mm. .... **subfusca**

LIST OF SPECIES

hardwicki Kirby, Mag. Nat. Hist. ii, p. 21, fig. 5b. (1929); Buckton, Mon. Memb. p. 210, pl. 46, fig. 3. (1903); Distant, Faun. Brit. Ind. iv, p. 11, fig. 6. (1908). Assam, Darjiling, Berge, Nepaul, Sikhim, Naga Hills, Khasi Hills, India. Todano, Celebes Is.

balista Germar, Rev. Ent. Silb. iii, p. 231. (1835). ? Demarara.

floralis Buckton, Mon. Memb. p. 210. (1903). Pegu, Burma.

pygmæa Buckton, Mon. Memb. p. 211, pl. 47, fig. 1. (1903). Darjiling, Assam, India.

subfusca Buckton, Mon. Memb. p. 211, pl. 46, fig. 5. (1903). Assam, Sikhim, India.

hardwicki Fairmaire, Rev. Memb. p. 520, pl. 3, figs. 20, 21. (1846). Nepaul, Tukyar, Darjiling, India.

Pyrgauchenia

Breddin, Abh. Nat. Ges. Halle, Stutt. xxiv, p. 126. (1901); *Pyrgophyllium* Breddin, Soc. Ent. xvii, p. 91. (1902); *Pyrgolyrium* Breddin, Soc. Ent. xvii, p. 92. (1902); *Hypsophyllium* Schmidt, Soc. Ent. xli, p. 22. (1926).

Key to Species

1(8). Apical area of front pronotal process not dilated and divided into two foliaceous branches; dorsal node of posterior process strongly elevated, semicircular; tegmina more or less opaque.

2(7). Front process erect, apical area slender and abruptly bent backwardly.

3(6). Apical area of front process ending in a horizontal plate its hind margin emarginate, centrally carinate.

4(5). Entirely immaculate pale stramineous; front process erect, apical plate very small slightly broader than its petiole; apex of posterior process reaching apex of clavus; base of head with two small subacute horns; long. 6, alt. 3 mm. .... **cornuta**

5(4). Black or dark brown, ridges, basal margin, basal area of posterior process, pale yellow, legs brown; front process lightly inclined forwardly, apical plate distinctly broader than its petiole; apex of posterior process passing apex of clavus near which is a small hyaline spot; base of head with two small tubercles; long. 5.5, alt. 3.75 mm. .... **wallacei**

6(3). Apical area of front process subacutely produced inwardly, the process narrowed upwardly, lightly inclined forwardly; posterior process weakly convexly gibbous, apex passing apex of clavus; black or brown, ridges and basal area of posterior process pale yellow, legs darker, small hyaline spot near apex of clavus; long. 6, alt. 5 mm. .... **kinabalense**

7(2). Front process roundly recurved, apical area foliaceously expanded its hind margin excised even with middle of scutellum; small hyaline spot near apex of clavus, head black; long. 5.5–6 mm. **fulmeki**

8(1). Front pronotal process strongly recurved, apical area expanded forming two foliaceous lobes.

9(14). Tips of folioles of front process even with or passing beyond apex of posterior process.

10(13). Dorsal node of posterior process conically elevated at least twice higher than broad at base; basal margin and ridges of pronotum, basal area of posterior process and legs pale yellow, hyaline spot near apex of clavus, else blackish or ferruginous.

11(12). Large; tip of front process even with tips of tegmina, median carina of posterior process serrate; row of white spots on apical area of tegmina; long. 9.5–10.5 mm. .... **sarasinorum**

12(11). Smaller; extreme tip of front process even with apex of posterior process whose median carina is smooth; tegmina unspotted on apical area; long. 5.5–6.5 mm. .... **fœrsteri**

13(10). Large; brown, ridges, base of posterior process and legs pale yellow, hyaline spot near apex of clavus; dorsal node of posterior process much wider at base than high; 8–9, alt. 8mm. **jugulata**

14(9). Tips of folioles of front process not extended beyond dorsal node of posterior process the latter strongly conically elevated at least twice higher than width at base.

15(18). Brown, not pubescent, small hyaline spot near apex of clavus.

16(17). Larger; dull bronze brown, basal pronotal ridges and legs yellow; front process suberect; long. 9 mm. .... **suberecta**

17(16). Smaller; dark brown, ridges and basal area of posterior process yellow, legs pale brown; front process strongly recurved; long. 7 mm. .... **recurva**

18(15). Black, thickly pubescent, ridges, costal margin and claval area of tegmina, and legs yellowish brown, row of white spots on apical area of tegmina; long. 6.5 mm. .... **colorata**

List of Species

cornuta Goding, Am. Mus. Novitt. No. 421, p. 26. (1930). Banguey, Borneo.

wallacei Breddin, Soc. Ent. xvii, p. 91. (1902). Borneo.

kinabalense Breddin, Soc. Ent. xvii, p. 91. (1902). Mt. Kinabalu, Borneo. Swlak Daras, Korinchi, Sumatra.

fulmeki Schmidt. Soc. Ent. xli, p. 22. (1926). Brestagi, Sumatra.

sarasinorum Breddin, Abb. Nat. Ges. Halle, xxiv, p. 127. (1901). Todano, Berge, Tomohon, Karookaraeng, Bua-Kroeng, Celebes Is.

fœrsteri Breddin, Soc. Ent. xvii, p. 91. (1902). Wonosobo, Java.

fulva Schmidt, Stet. Ent. Zeit. lxvii, p. 371. (1906). Java.

jugulata Buckton, Tr. Linn. Soc. Lond. Zool. ix, p. 332, pl. 21, fig. 12. (1905). Swlak, Korinchi, Sumatra.

breddini Schmidt, Stet. Ent. Zeit. lxvii, p. 370. (1906). Bekantiang, Sumatra.

suberecta Distant, Ann. Mag. N. H. xvi, p. 325. (1915). Bua-Kræng, Celebes Is.

recurva Funkhouser, Phil. Jour. Sci. xl, p. 112, pl. 1, fig. 2. (1929). Roban, Java.

colorata Distant, Ann. Mag. N. H. xvi, p. 326. (1915). Mt. Kinabalu, Borneo.

Gigantorhabdus

Schmidt, Stet. Ent. Zeit. lxvii, p. 372. (1906).

KEY TO SPECIES

One species, the head black, pronotum ivory white, spot above each humeral, spot behind each eye, larger part of basal half and apical area of posterior process, and spot on abdomen black; tegmina with base black, spot in corium and subapical band ivory white, body and legs brown; long. 15, to tip of forks 23, alt. 13 mm. .... **enderleini**

LIST OF SPECIES

enderleini Schmidt, Stet. Ent. Zeit. lxvii, p. 372. (1906). Waterstradt, Borneo.

Hypsolyrium

Schmidt, Soc. Ent. xli, p. 22. (1926).

KEY TO SPECIES

1(6). Front pronotal process with summit produced posteriorly in a short spur a small node just beneath it, or summit oblique not acute.

2(5). Summit of front process acute posteriorly.

3(4). Ferruginous, pubescent; front process lightly inclined forwardly shorter than posterior process the latter slightly elevated behind middle; 8 mm. .... **uncinata**

4(3). Black; front process longer, erect, posterior process abruptly elevated behind middle, median carina serrate, basal area and legs pale red; central marginal space to tegmina pale red, small white spot near clavus; 8 mm. .... **kempi**

5(2). Black, legs yellowish; front process shorter, broader, more outwardly curved apically than *kempi*, its summit oblique, not acute; 7 mm. **manni**

6(1). Reddish brown, apical area of tegmina white spotted; front process slightly inclined forwardly its summit ending in two very short narrow recurved lobes almost contiguous at tips; posterior process slender, strongly serrate, subapical node large, broadly conical, reticulate; 7 mm. .... **gibbosa**

LIST OF SPECIES

uncinata Stål, Bid. Memb. K. p. 283. (1869); Distant, Faun. Brit. Ind. iv, p. 12, fig. 8. (1908). Pussumbing, Nepaul, Nagorkote, Darjiling, India.

kempi Distant, Faun. Brit. Ind. vi, App., p. 148, fig. 107. (1916). Sadon, Upper Burma. Cherrapungi, Assam, India.

manni Distant, Faun. Brit. Ind. App. vi, p. 149. (1916). Pussumbing, Darjiling, India.

gibbosa Distant, Faun. Brit. Ind. iv, p. 12. (1908). Ruby Mines, Burma.

Pyrgonota

Stål, Hemip. Philip. p. 730. (1870); *Hybanda* Distant, Faun. Brit. Ind. iv, p. 13. (1908); *Funkhouserella* Schmidt, Soc. Ent. xli, p. 22. (1926).

Key to Species

1(10). Summit of front pronotal process forked or bilobed.

2(5). Front process with a bulb at middle, posterior process unicarinate; legs simple; brown.

3(4). Front process contorted above the bulb, median carina of posterior process dentate; tegmina opaque brown, pilose, apical third hyaline, brown spot at apical angle; 8 mm. .... **bulbicornis**

4(3). Front process sinuate above bulb, median carina smooth; tegmina infuscate bronze, veins indistinct; 10 mm. .... **bulbosa**

5(2). Front process gradually narrowed upwardly, not bulbous.

6(13). Front process porrect or strongly inclined forwardly.

7(12). Posterior process unicarinate.

8(11). Front process porrect, apical branches of fork very short.

9(10). Summit of front process with two branches; tegmina opaque brown; long. 9, alt. 11 mm. .... **brevifurca**

10(9). Summit of front process with two branches the tip of each branch briefly bifurcate; tegmina opaque brown, small hyaline spot near apex of clavus; long. 9.5, alt. 12 mm. .... **sinuata**

11(8). Front process inclined forwardly, not porrect, the apical branches long, strongly diverging a ridge between their bases, foliaceous behind middle, tips truncate; median carina of posterior process dentate posteriorly; tegmina opaque brown, transverse central band and spot near apex clavus hyaline; long 6–6.5, alt. 7.5 mm. **fenestrata**

12(7). Posterior process tricarinate, tectiform, median carina spinulose; apical branches of front process divaricate, broadened behind middle; tegmina opaque piceous, hyaline spot near apex of clavus; long. 7.5 mm. .... **bifurca**

13(6). Front pronotal process not porrect or inclined forwardly.

14(19). Front process erect, apical branches long, foliaceous and bent backwardly.

15(18). Posterior process tricarinate, legs foliaceous.

16(17). Apical folioles of front process oblique, parallel, gibbous between their bases; brown, dorsum of posterior process with yellow basal vitta its median carina denticulate; tegmina opaque black or brown pale spot near apex of clavus, three discoidal cells; long. 7, alt. 10 mm. .... **funkhouseri**

17(16). Apical folioles of front process strongly divaricate, no gibba between bases; dark brown, basal area of posterior process pale; tegmina entirely piceous; 7 mm. .... **semperi**

18(15). Posterior process unicarinate, median carina serrate, middle of dorsum yellow; folioles of front process suberect, parallel, no gibba between bases; brown, including tegmina opaque; long. 6–7, alt. 10 mm. .... **bifoliata**

19(14). Front process strongly recurved, apical folioles broad, parallel, tips even with or behind tips of tegmina; median carina of posterior process serrate, legs simple; yellowish brown including tegmina; long. 8, alt. 8 mm. .... **anodonta**

20(1). Summit of front pronotal process swollen or bulbous, not forked, posterior process unicarinate.

21(30). Front process porrect or strongly inclined forwardly.

22(29). Summit of front process moderately swollen.

23(28). Pronotum with a median and sometimes lateral carinæ on the front process.

24(27). Front process inclined forwardly, not porrect, gradually narrowed upwardly.

25(26). Black, tegmina with pale spot near apex of clavus, legs yellowish, simple; front process laterally tricarinate, median carina denticulate posteriorly; long. 8 mm.

a. Apical area of front process distinctly thickened, posterior process gradually slender, subdepressed behind middle ...... ♂ **tumida**

aa. Apical area of front process slightly recurved, moderately swollen, truncate, posterior process acutely tectiform, subcompressed .... ♀ **tumida**

26(25). Ferruginous, tegmina entirely opaque; apical area of front process abruptly bent backwardly expanded in a plate, not laterally carinate; tibiæ flattened; long. 7, alt. 8 mm. .... **longiturris**

27(24). Front process porrect, apical area swollen two prominent nodes on hind margin and short ridges, median carina of posterior process dentate, apex reddish; yellow, tegmina yellow hyaline, apical veins irregular; legs foliaceous; long. 5.6, alt. 6 mm. **nodituris**

28(23). Front process destitute of median and lateral carinæ, inclined forwardly not porrect, cylindrical, summit swollen, rounded, slight tubercle each side; median carina of posterior process roughly defined; brown, tegmina opaque; tibiæ foliaceous; long. 6.5, alt. 4 mm. .... **pinguiturris**

29(22). Front process broad, laterally carinate, the summit a very large hemispherical reticulate bulb with a blunt spine each side of median line and one each side posteriorly, median carina dentate posteriorly; brown, legs yellow, simple; tegmina brown, hyaline spot near apex of clavus; long. 7, lat. of bulb 5.5 mm. **bulbiturris**

30(21). Front process erect, slender, sides ridged, slightly recurved, apical area expanded in a reticulate swelling seen from side ovoid, seen from front constricted at middle to form two subhemispherical nodes, the upper node with a sharp tooth each side; brown, legs yellow, flattened, tegmina vinaceous translucent; long. 8, alt. 12 mm. .... **binodis**

LIST OF SPECIES

bulbicornis Funkhouser, Jou. Fed. Malay Sts. Mus. xiii, pl. 1, fig. 1. (1927). Bukit Kutu, Salangor, Sumatra.

bulbosa Buckton, Mon. Memb. p. 211, pl. 46, fig. 4. (1903). Perak, Malacca.

brevifurca Funkhouser, Phil. Jour. Sci. xxxiii, p. 110, pl. 2, fig. 5, 6. (1927). Baguio, Benguet, Luzon, Philippines.

sinuata Funkhouser, Phil. Jour. Sci. xl, p. 111, pl. 1, fig. 1. (1929). Ripang, Luzon, Philippines.

fenestrata Bergroth, Noct. Ent. v, p. 105. (1925). Surigao, Mindanao, Philippines.

bifurca Stål, Hemip. Phil. p. 731. (1870). Baguio, Banquet, Luzon, Philippines.

funkhouseri Bergroth, Noct. Ent. v, p. 106. (1925). nom. nov.

semperi Funkhouser, Phil. Jour. Sci. xv, p. 17, pl. 1, figs. 2, 3. (1919). Panay, Culasi, Antique, Philippines.

semperi Stål, Hemip. Phil. p. 731. (1870). Philippines.

bifoliata Westwood, Proc. Zool. Soc. Lond. p. 130. (1837); id. Guer. Mag. Zool. iii, p. 3, pl. 83. (1841); Funkhouser, Jour. Ent. Zool. vi, p. 67, fig. 1, (1914); id. Phil. Jour. Sci. x, p. 372, pl. 1, fig. 2. (1915). Los Baños, Luzon, Philippines.

westwoodi Fairmaire, Rev. Memb. p. 521, pl. 7, figs. 6–8. (1846); Buckton, Mon. Memb. p. 211, pl. 46, fig. 6. (1903). Philippines.

bifasciata Walker, List Hom. B. M. p. 631. (1851). Philippines.

anodonta Buckton, Mon. Memb. p. 212, pl. 47, fig. 2. (1903); Distant, Faun. Brit. Ind. iv, p. 13, fig. 9. (1908). Assam, India. Perak, Malacca.

tumida Stål, (♂), Hemip. Phil. p. 730. (1870). Philippines.

philippina Stål, (♀), Hemip. Phil. p. 730. (1870). Philippines.

longiturris Funkhouser, Phil. Jour. Sci. xiii, p. 23, pl. 1, figs. 1, 2. (1918). Mt. Maquiling, Luzon, Philippines.

nodituris Funkhouser, Phil. Jour. Sci. xviii, p. 684, pl. 1, fig. 7. (1921). Surigao, Mindanao, Philippines.

pinguiturris Funkhouser, Phil. Jour. Sci. x, p. 374, pl. 1, fig. 3. (1915). Mt. Maquiling, Luzon, Philippines.

bulbiturris Funkhouser, Phil. Jour. Sci. xxxiii, p. 109, pl. 1, figs. 1, 2. (1927). Kavignian, Luzon, Philippines.

binodis Funkhouser, Phil. Jour. Sci. xxxiii, p. 110, pl. 1, figs. 3, 4. (1927). Isabela, San Marino, Mt. Banahao, Luzon, Philippines.

Hybandoides

Distant, Ann. Mag. N. H. xvi, p. 327. (1915); *Platyceras* Schmidt, Soc. Ent. p. 21 (1926).

KEY TO SPECIES

1(8). Summit of front process broad, rounded or truncate, upper margin slightly convex, lower margin straight; brown, densely pilose.

2(7). Tegmina brown and white mottled; brown.
3(4). Basal margin of pronotum distinctly produced forwardly, front process subhorizontal; head to tips teg. 6.5 mm. .... **sumatrensis**
4(3). Basal margin of pronotum not produced forwardly.
5(6). Front process horizontal, summit slightly recurved roundly truncate, not expanded, length variable; 8.6 mm. .... **horizontalis**
6(5). Front process granulate, oblique, summit slightly expanded, angularly rounded not recurved; veins of tegmina granulate; head to tips teg. 5.5, incl. corn. 8 mm. .... **laticornis**
7(2). Tegmina brown, not mottled, apical area yellowish; blackish; head to tips teg. 5.5, incl. corn. 7.5 mm. .... **borneensis**
8(1). Summit of front process acute, horizontal, margins converging; reddish brown, tegmina brown and yellow mottled; head to tips teg. 5–5.5, incl. corn. 6–7 mm. .... **acuticornis**

LIST OF SPECIES

sumatrensis Funkhouser, Suppl. Ent. xv, p. 26. (1927). Ft. de Kock, Anei Kloof, Sumatra.

horizontalis Distant, Ann. Mag. N. H. xvi, p. 327. (1915). Mt. Kinabalu, Borneo.

laticornis Schmidt, Soc. Ent. p. 21. (1926). Mentawei Is., Sumatra.

borneensis Schmidt, Soc. Ent. p. 21. (1926). North Borneo.

acuticornis Schmidt, Soc. Ent. p. 21. (1926). West coast of Sumatra.

Centrocharesini

Centrochares

Stål, Hemip. Afric. iv, p. 86. (1866).

KEY TO SPECIES

1(6). Surface densely spinulose, suprahumerals obliquely erect tips more or less swollen, posterior process moderately elevated above the scutellum long as tegmina; brown or black.
2(5). Suprahumerals robust, apical area moderately swollen.
3(4). Suprahumerals with sides parallel to apical swelling, subapical node of posterior process twice higher than breadth of base; tegmina opaque ferruginous, tips darker, (pale subapical pale spot in ♂); legs brown; long. ♂ 3.5–5 × 3.5, ♀ 5–6 × 4–5 mm. .... **horrificus**
4(3). Suprahumerals gradually broadened from slender base to foliate tips, subapical node of posterior process semicircular; high as width of base; tegmina hyaline, base, spot on clavus and subapical transverse fascia brown; legs yellow, front and middle tibiæ flattened; 4.8 × 3.7 mm. .... **spiniferus**
5(2). Suprahumerals slender, apical half broadly foliaceous, tips quadrate abruptly acute; subapical node of posterior process trilobate, convex, high as broad at base, legs foliaceous; black, tegmina opaque, interior apical margin brown; 5.4 × 5 mm. **foliatus**

6(1). Surface covered with scattering tubercles, not spinulose; suprahumerals oblique, moderately broadened and flattened, posterior process slightly elevated above the scutellum long as tegmina, median carina and lateral margins serrate; legs brown, dilated.

7(8). Suprahumerals obliquely inclined forwardly, margins serrate, tips spatulate, truncate exteriorly, subapical node of posterior process narrow, erect; brown; 4 mm. .... **ridleyanus**

8(7). Suprahumerals obliquely erect, tips rounded in front, subapical node of posterior process robust, trilobed; testaceous, tegmina yellowish, base and costal margin brown; 4.5 × 4 mm. .... **borneensis**

LIST OF SPECIES

horrificus Westwood, Proc. Zool. Soc. Lond. p. 130. (1837); Guerin, Mag. Zool. iii, pl. 82. (1841); Walker, List Hom. B. M. p. 500, pl. 4, figs. 4, 5. (1851); Buckton, Mon. Memb. p. 73, pl. 12, fig. 5. (1903); Funkhouser, Phil. Jour. Sci. x, p. 370, pl. 1, fig. 1. (1915); id. Phil. Jour. Sci. xv, p. 15, pl. 1, fig. 1. (1919). Los Baños, Mt. Banahao, Panay, Culasi, Antique, Luzon, Philippines.

posticus Buckton, Mon. Memb. p. 70, pl. 11, figs. 4, 5. (1903). Culasi, Philippines.

spinula Buckton, Mon. Memb. p. 72, pl. 12, fig. 4. (1903). Luzon, Philippines.

bucktoni Distant, Ann. Mag. N. H. xvii, p. 314. (1916). nom. nov.

spiniferus Funkhouser, Suppl. Ent. xv, p. 19, fig. 29. (1927). Anei Kloof, Sumatra.

foliatus Funkhouser, Phil. Jour. Sci. xl, p. 113, pl. 1, fig. 3. (1929). Mowong, Borneo.

ridleyanus Distant, Ann. Mag. N. H. xvi, p. 328. (1915). Singapore, Malacca.

borneensis Distant, Ann. Mag. N. H. xvii, p. 314. (1916). Kuching, Sandakan, Borneo.

Sinenodus

Goding, Jour. N. Y. Ent. Soc. xxxix, p. 311. (1931).

KEY TO SPECIES

1(2). Suprahumerals three times as long as width at base, robust, porrect, quadrangular, several carinæ on front surface, tips slightly dilated, truncate; posterior process far passing tips of tegmina, slender, sinuate, apical area elevated; tegmina colorless hyaline, extreme tips piceous brown; reddish brown, legs moderately dilated; 7.5, incl. corn. 9 × 3.5 mm. .... **gracilis**

2(1). Suprahumerals robust, long as width at base, slightly inclined forwardly, upper surface carinate, tips rounded somewhat deflexed; posterior process some shorter than tegmina, substraight, tip deflected; tegmina opaque reddish brown; blackish brown, very pubescent, legs dark brown; 8 × 4 mm. .... **orientalis**

LIST OF SPECIES

gracilis Goding, Mon. Aust. Memb. p. 33. (1903). Beverly, West Australia.
orientalis Funkhouser, Jour. Sts. Br. Roy. Asiat. Soc. (79), p. 1, (1918). Singapore, Malacca.

MEMBRACINÆ

Bolbauchenini

Bolbauchenia

Schumacher, Sup. Ent. iii, p. 115. (1915); *Clonauchenia* Funkhouser, Phil. Jour. Sci. xviii, p. 679. (1921).

KEY TO SPECIES

1(2). Front pronotal process inclined forwardly, summit not produced posteriorly or outwardly in acute tips; posterior process with basal half tectiformly elevated; brown, posterior process paler, tegmina hyaline; long. 10, lat. 2, alt. 5 mm. .... **taiwanensis**

2(1). Front process erect, summit produced posteriorly in a large protuberance and exteriorly in acute tips each side; posterior process with basal two-thirds triangularly elevated in a large compressed plate its apex acute almost touching hind lobe of front process; tegmina dark brown, basal two-thirds of broad costal margin opaque, apical half semiopaque, venation irregular; dark brown; long. 8, lat. 2.6, alt. corn. 6.8 mm. .... **mirabilis**

LIST OF SPECIES

taiwanensis Schumacher, Suppl. Ent. iii, p. 115. (1915). Kankau, Koshun, Formosa Is.
mirabilis Funkhouser, Phil. Jour. Sci. xviii, p. 680, pl. 1, figs. 1, 2. (1921). Surogao, Mindanao, Philippines.

Xiphistesini

Xiphistes

Stål, Hemip. Afric. iv, p. 85. (1866).

KEY TO SPECIES

1(2). Suprahumerals obliquely porrect, conical, tips subacute, posterior process tricarinate, shorter than tegmina, dorsal line straight; piceous, legs ferruginous, tegmina colorless hyaline; long. incl. corn. 10 mm. .... **unicolor**

2(1). Suprahumerals strongly inclined forwardly, triquetrous, tips truncate inwardly rounded, dorsal weakly concave, posterior process just passing apex of clavus; ochraceous, pilose, tegmina clear hyaline, base ochraceous; 7 × 3 mm. .... **neglectus**

LIST OF SPECIES

unicolor Walker, List Hom. B. M. p. 509. (1851); Distant, Faun. Brit. Ind. iv, p. 9, fig. 5. (1908). East Indies.

neglectus Buckton, Mon. Memb. p. 224, pl. 49, fig. 5. (1903). South Australia.

australasiæ Distant, Ann. Mag. N. H. xviii, p. 21. (1916). South Australia.

Goddefroyinella

Distant, Ann. Mag. N. H. xviii, p. 22. (1916).

KEY TO SPECIES

One piceous pilose species with testaceous legs; suprahumerals robust, compressed, porrect, slightly diverging, tips truncate, posterior process robust, convexly rounded, apical area narrowed, usually long as tegmina; tegmina subhyaline, base black, apical venation reticulate; 6–6.5 × 3–3.5 mm. .... **indicans**

LIST OF SPECIES

indicans Distant, Ann. Mag. N. H. xviii, p. 22. (1916). Gayndah, Queensland, Australia.

Oxyrhachisini

Oxyrhachidia

Melichar, Hom. Ceylon, p. 118. (1903).

KEY TO SPECIES

One ferruginous brown species, the median carina, middle of the posterior process, abdomen and legs yellowish; tegmina hyaline; pronotum convex, tricarinate anteriorly, posterior process narrowest near base, ampliate beneath and fuscous margined; 6.5–7.5 mm. .... **inermis**

LIST OF SPECIES

inermis Stål, Bid. Memb. K. p. 283. (1869); Distant, Faun. Brit. Ind. iv, p. 8, fig. 4. (1908). Peradeniya, Ceylon.

Oxyrhachis

Germar, Rev. Ent. Silb. iii, p. 232. (1835); *Polocentrus* Buckton, Mon. Memb. p. 253. (1903); *Ouranorthus* Buckton, Tr. Linn. Soc. Lond. Zool. ix, p. 333. (1905).

KEY TO SPECIES

1(10). Posterior process as long or slightly longer than tegmina.

2(5). Suprahumerals as long or slightly longer than space between bases, more or less obliquely elevated; inferior margin of apical area of posterior process serrate; tegmina hyaline.

3(4). Pronotum granulose, brownish ochraceous, basal half of median carina paler, apical half, two large spots and head black; narrow costal margin of tegmina brown, black spot behind clavus; 8–9.5 mm. .... **mangiferana**

4(3). Pronotum punctate, not granulate, fuscous or black, head piceous and yellow, apical half of posterior process blackish, median carina brown, legs ochraceous; narrow costal margin of tegmina ferruginous; 7–9 × 4–5.5 mm. .... **tarandus**

5(2). Suprahumerals horizontal, shorter than width between bases, inferior margin of posterior process not serrate.

6(7). Suprahumerals longer than half the width between bases; black, pubescent, median carina and posterior process ferruginous, legs reddish; tegmina tawny, brown spot near clavus; 8 mm. **subjecta**

7(6). Suprahumerals about one-fourth as long as space between bases, tips obtuse; brownish, tegmina hyaline.

8(9). Brownish ochraceous, median carina pale yellow, legs ochraceous; suprahumerals subhorizontal, margins ochraceous, pale stripe on outer side, tips slightly decurved; posterior process ochraceous, apical area slightly elevated; 7 × 3–3.5 mm. .... **uncatus**

9(8). Entirely fuscous brown; suprahumerals horizontal, straight, apical area of posterior process strongly elevated; 6–7 × 3–3.5 mm. **lefroyi**

10(1). Posterior process shorter than the tegmina.

11(18). Suprahumerals long as or slightly longer than space between bases.

12(17). Suprahumerals oblique, inferior margin of posterior process not serrate.

13(16). Pronotum more or less black, tegmina immaculate; tips suprahumerals acute.

14(15). Entirely black; suprahumerals slightly longer, more robust, distinctly carinate, posterior process compressed and broader beyond middle; 6.5 × 5.5 mm. .... **yerburyi**

15(14). Black, frontal area, basal margin, upper basal area, body, legs and base of tegmina ochraceous; suprahumerals medium, slightly shorter, ridges weak, and posterior process not distinctly broader beyond middle; 7 × 5.5 mm. .... **versicolor**

16(13). Pronotum dark brown, head purplish red with black suffusions; suprahumerals with hind margins above and central disk beneath black, tips broadly obtusely angulate; apical half of posterior process and spot near clavus black; 8.5 × 5 mm. .... **binsarus**

17(12). Suprahumerals horizontal, tips acute, posterior process gibbous at base, inferior margin weakly serrate; brown, median carina and ridges paler, legs testaceous; 7–7.5 × 3.5 mm. .... **rufescens**

18(11). Suprahumerals about as long as wide at bases, much shorter that space between bases, horizontal; posterior process moderately gibbous near base.

19(20). Inferior margin of posterior process serrate; pale brownish ochraceous, median carina paler, head partly, spot above each eye and apex of posterior process black, abdomen and legs ochraceous; 4.5–5.5 × 1.5–2 mm. .... **crinitus**

20(19). Inferior margin of posterior process not serrate.

21(22). Ferruginous brown, suprahumerals substraight, ridges pale, tips truncate; posterior process with dorsal black spot, apex obliquely truncate, black spot near apex of clavus; legs brown; 6–7.5 mm. **delalandei**

22(21). Entirely ochraceous, tegmina immaculate; suprahumerals distinctly decurved and recurved; 8 × 3 mm. .... **palus**

LIST OF SPECIES

mangiferana Distant, Faun. Brit. Ind. vi, App. p. 147. (1916). Dehra Dun, Duraj Bagh, Madras, India.

tarandus Fabricius, Ent. Syst. Suppl. p. 514. (1798); Fairmaire, Rev. Memb. p. 268, pl. 4, fig. 13. (1846); Distant, Faun. Brit. Ind. iv, p. 4, fig. 1. (1908); id. Ins. Transv. i, p. 209, pl. 21, fig. 11. (1909); Lefroy, Ins. Life, p. 730, pl. 78, figs. 1–7. (1909); Funkhouser, Biol. Memb. pl. 31, fig. 25, and pl. 36, figs. 7–9, 13–15. (1917). Calcutta, Bengal, Madras, Chatrapur, Ganganu, Bangalore, Karachi, India. Ceylon. Abyssinia, Egypt, Senegal, N. Africa; S. Africa.

rufus Buckton, Mon. Memb. p. 254, pl. 58, fig. 2. (1903). Mysore, India.

neuter Buckton, Mon. Memb. p. 254, pl. 58, fig. 3. (1903). Madras, India.

emyo Distant, Faun. Brit. Ind. iv, p. 5. (1908). nom. nud.

formidabilis Distant, Faun. Brit. Ind. vi, App. p. 146. (1916). Dehra Dun, Suraj Bagh, Athurkuppan, Salem, India.

subjecta Walker, List Hom. B. M. p. 504. (1851). East Indies.

uncatus Melichar, Hom. Ceylon, p. 108. (1903); Distant, Faun. Brit. Ind. iv, p. 6, fig. 2. (1908). Paradeniya, Trichinoply, Ceylon.

nectaris Buckton, Mon. Memb. p. 246, pl. 58, fig. 4. (1903). Peradeniya Ceylon.

lefroyi Distant, Faun. Brit. Ind. vi, App. p. 147, fig. 106. (1916). Pusa, India.

yerburyi Distant, Ann. Mag. N. H. xviii, p. 21. (1916). Aden, Arabia.

versicolor Distant, Ann. Mag. N. H. xvi, p. 322. (1915). Aden, Arabia.

binsarus Distant, Faun. Brit. Ind. vi, App. p. 148. (1916). Binsar, Humaon, India.

rufescens Walker, List Hom. B. M. p. 506. (1851). Calcutta, Mysore, Medha, Kajshaki, Yenna Valley, India.

rudis Walker, List Hom. B. M. p. 509. (1851). North Bengal, India.

crinitus Buckton, Mon. Memb. p. 247, pl. 60, fig. 5. (1903); Distant, Faun. Brit. Ind. iv, p. 7, fig. 3. (1908). Kaits, Ceylon.

delalandei Fairmaire, Rev. Memb. p. 268. (1846). Amacera, Dalmatia, Sicily, Europe. Jordan R., Syria, Asia. Tunis; Mariut, Egypt, North Africa; ? Natal, Cape, South Africa.

palus Buckton, Tr. Linn. Soc. Lond. Zool. ix, p. 333, pl. 22, fig. 1. (1905). Bangalore, Mysore, Coimbatore, India.

DARNINÆ

Darnini

Cryptaspidia

Stål, Hemip. Phil. p. 729. (1870).

KEY TO SPECIES

1(10). Median carina of pronotum absent on the metopidium; black.

2(7). Apex of posterior process passing apex of clavus; tegmina smoky hyaline with black or brown markings.

3(4). Apical area of posterior process strongly elevated, humerals prominent; ocelli nearer to the eyes; basal fourth of costal margin of tegmina black, faint central transverse fascia; finely pubescent, legs brown; 7 × 3.8 mm. .... **elevata**

4(3). Apex of posterior process not elevated; shining, not pubescent.

5(6). Tegmina with transverse fascia and subapical spot brown; humerals not prominent; ocelli equidistant; legs brown; 6.6 × 3.5 mm. **lustra**

6(5). Tegmina with basal third of costal margin black; ocelli nearer to the eyes; legs black, tarsi brown; 6 × 3 mm. .... **nigris**

7(2). Apex of posterior process not passing apex of clavus; ocelli nearer to the eyes; legs brown.

8(9). Tegmina immaculate except base; humerals very prominent; strongly pilose, shining; 4 × 2 mm. .... **pilosa**

9(8). Tegmina ferruginous, decolored behind middle and fasciate; humerals not prominent; slightly pubescent; 5.5 × 2.7 mm. ...... **pubera**

10(1). Median carina of pronotum percurrent, usually weak; ocelli nearer to the eyes.

11(14). Apex of posterior process passing apex of clavus, humerals very prominent; black, tegmina immaculate vinaceous hyaline.

12(13). Humerals produced in horns half as long as the space between bases, median carina faint; finely pubescent, legs dark brown; 7.5 mm. .... **auriculata**

13(12). Humerals very strong, not corniculiform, median carina almost obsolete on metopidium; legs black; 8 × 4.2 mm. .... **magna**

14(11). Apex of posterior process not passing apex of clavus, humerals not prominent; not or slightly pubescent.

15(20). Tegmina immaculate; median carina weak.

16(19). Small, short, length not exceeding 5 mm; brownish.

17(18). Entirely dark brown, slightly pubescent, tegmina hyaline; posterior process straight; 3 mm. .... **piceola**

18(17). Entirely ferruginous including tegmina, not pubescent; posterior process depressed at base then slightly arcuate; 3–3.5 mm. **ferrugata**

19(16). Large, elongate, posterior process straight apex not reaching apex of clavus; black, legs ferruginous; tegmina very long, far passing tip of abdomen; 8.2 × 3 mm. .... **longa**

20(15). Tegmina black and hyaline; black.

21(22). Tegmina black, opaque, tips hyaline, tarsi flavous; posterior process depressed at base then slightly arcuate, median carina distinct; 3.2 × 1.7 mm. .... **minuta**

22(21). Tegmina vinaceous hyaline, interrupted fascia and apical margin more or less broadly blackish, legs black; posterior process straight, sides impressed, median carina obsolete on metopidium; 6–7 × 3–3.5 mm. .... **impressa**

LIST OF SPECIES

elevata Funkhouser, Phil. Jour. Sci. xv, p. 26, pl. 1, fig. 7. (1919). Benguet, Bagnio, Luzon, Philippines.

lustra Funkhouser, Phil. Jour. Sci. xl, p. 114, pl. 1, fig. 6. (1929). Ripang, Luzon, Philippines.

nigris Funkhouser, Phil. Jour. Sci. xiii, p. 36, pl. 1, figs. 17, 18. (1918). Tayabes, Mt. Bonahao, Luzon, Philippines.

pilosa Funkhouser, Phil. Jour. Sci. xviii, p. 686, pl. 1, fig. 10. (1921). Basilan Is., Philippines.

pubera Stål, Hemip. Phil. p. 729. (1870); Funkhouser, Phil. Jour. Sci. x, p. 401, pl. 2, fig. 20. (1915). Los Baños, Mt. Maquiling, Luzon, Philippines.

tagalica Stål, Hemip. Phil. p. 729. (1870). Culasi, Antique, Panay, Basilan Is., Los Baños, Mt. Maquiling, Luzon, Philippines.

auriculata Funkhouser, Phil. Jour. Sci. xl, p. 114, pl. 1, figs. 4, 5. (1929). Ubi, Luzon, Philippines.

magna Funkhouser, Jour. Fed. Malay Sts. Mus. xiii, p. 2, fig. 2. (1927). Bukit Kutu, Salangor, Malacca.

piceola Melichar, Hom. Ceylon, p. 122. (1903). Paradeniya, Ceylon. Singapore, Penang, Sumatra. Sandakan, Borneo.

ferrugata Melichar, Hom. Ceylon, p. 123. (1903). Paradeniya, Weligama, Keshewa, Kandy, Ceylon.

longa Funkhouser, Phil. Jour. Sci. xv, p. 27, pl. 1, fig. 8. (1919). Banguet, Bagnio, Luzon, Philippines.

minuta Funkhouser, Phil. Jour. Sci. xxxiii, p. 118, pl. 4, fig. 22. (1927). Palawan, Philippines.

impressa Stål, Hemip. Phil. p. 730. (1870). Philippines.

obtusiceps Stål, Hemip. Phil. p. 730. (1870). Davao, Mindanao, Luzon, Philippines.

Anzac

Distant, Ann. Mag. N. H. xviii, p. 43. (1916).

KEY TO SPECIES

One yellowish gray (doubtless green when alive) species with two spots near base of tegmina and spot on interior vein of clavus black, the apical area reticulate with numerous cellules; body, legs and tegmina pale tawny brown; 5 × 2 mm. .... **bipunctatus**

LIST OF SPECIES

bipunctatus Fabricius, Syst. Ent. p. 677. (1775); Distant, Ann. Mag. N. H. xviii, p. 44, fig. on p. 45. (1916). Australia.

Mesocentrus

Funkhouser, Phil. Jour. Sci. xviii, p. 681. (1921).

KEY TO SPECIES

One brown pubescent species with faint median carina anteriorly; tegmina black at base, large bronze coriaceous central area, apical area fuscous hyaline; 7 × 3.3 mm. .... **pyramidatus**

LIST OF SPECIES

pyramidatus Funkhouser, Phil. Jour. Sci. xviii, p. 681, pl. 1, figs. 3, 4. (1921). Iligan, Mindanao, Philippines.

Hemikypthini

Cryptoparma

Goding, Jour. N. Y. Ent. Soc. xxxix, p. 313. (1931).

KEY TO SPECIES

One slender pubescent black species with ferruginous legs, and ferruginous hyaline tegmina; ocelli equidistant; suprahumerals short, slender, oblique, acute, posterior process slender, tricarinate, distinctly passing apex of clavus; 5 × 2.3 mm. .... **parva**

LIST OF SPECIES

parva Funkhouser, Rec. Ind. Mus. xxiv, p. 325, pl. 10, fig. 2. (1922). Taiping Hills, Perak, Malacca.

Megaloschema

Buckton, Mon. Memb. p. 231. (1903).

KEY TO SPECIES

One broad ochreous yellow species with suprahumerals broad, long, sides parallel, tips carinate and truncate; tegmina hyaline; 8 × 4 mm.
laticornis

LIST OF SPECIES

laticornis Buckton, Mon. Memb. p. 231, pl. 52, fig. 2. (1903). Sumatra.

THE TOXIC EFFECT OF BEAUVERIA BASSIANA (BALS.) VUILL, ON INSECTS

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The post-mortem symptoms of insects killed by exposure to *Beauveria bassiana* (Bals.) Vuill. spores described by Dresner (1949) were in contrast to those heretofore ascribed to fungus invasion. This paper is an attempt to explain that variance; the paralysis of insects by entomogenous fungi is caused by a fungus-produced toxin. This toxin is produced by the spores during germination and by the hyphæ during growth. Under certain conditions this paralysis is followed by bacterial histolysis of the insect tissues. When bacterial histolysis occurs, the production of conidia is rare.

REVIEW OF THE LITERATURE

Experiments have been recorded in the literature relating to the toxicology and histology of fungus infection. Wallengren and Johansson (1929), Pilat (1938), Baldacci (1939), Toumanoff (1931), and Burnside (1930) mention the secretion of enzymes by the growing fungus. Wallengren and Johannson (1929) state that the toxic enzyme secreted by *Metarrhizium anisopliæ* (Metsch.) Sor. appears to produce nervous disorders in the insects ending in complete loss of activity; this stage is followed by death of the insect. Burnside (1930) found that an extract of the toxin produced by fungi (*Aspergillus* and *Mucor*) was a stomach poison. Wallengren and Johansson (1929) found that the time of penetration of the cuticle by the hypha was usually about five days; Sawyer (1933) includes observations with *Entomophthora sphærosperma* Fres. penetrating the cuticle in two to twelve hours after germination of the spores; paralysis took place a few hours later. Whinfield (1946) showed that germinating conidia of *Penicillium notatum* Westl. produced penicillin.

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Florey and Jennings (1942) reported that high concentrations of penicillin in the blood of humans caused inhibition or death of the leucocytes. Masera (1934) reported that *B. bassiana* inhibited the growth in culture of *Serratia marcesens* Bizio (*Bacillus prodigiosus* Flugge); within the insect the bacteria inhibited the growth of the fungus.

EXPERIMENTAL METHODS AND RESULTS

The accompanying tables describe the experiments and data obtained on tests of *B. bassiana* spores on housefly adults (*Musca domestica* L.), potato tuber worm larvæ (*Phthorimœa operculella* Zeller), and dock beetle adults (*Gastroidea cyanea* Melsh.). These tests indicate that the insect is paralyzed on exposure to the germinating spores in much less time than has been determined histologically for the penetration of the hypha into the body cavity. In many of the experiments described here, paralysis occurred in two hours or less after exposure of the insect to the germinating spores.

Most of the tests were repeated with a spore dust made from a new culture of spores. This new culture was obtained from the American Type Culture Collection, Washington, D. C. about two years after the first culture (1947). These tests were repeated primarily to insure that the toxic effect of the first spore dust was not due to an undetected contaminant. The series of tests with both spore dusts indicated similar results.

The fungus can produce this same paralytic effect after it has been killed; this is shown by experiments in which the potato tuber worm larvæ are treated with copper sulphate solution at the end of a two hour exposure to the germinating spores, treatment of the germinating spores with copper sulphate before the introduction of the insect, and finally, autoclaving of the germinated spores before introduction of the test insects. After these fungicidal treatments, no mycelia were observed to grow during a one week observation period. The rate of occurrence of paralysis and mortality did not differ substantially in all the tests involving fungicidal treatment compared with no treatment.

Experiments with housefly adults and potato tuber worm larvæ show that the toxin acts as a contact poison. The test insects were ligatured at points as close as possible to the mouth. The results in these tests were comparable to those tests which did not include ligaturing of the insects.

The toxin can act through the alimentary tract; this was shown by the 100 percent mortality of housefly adults fed on milk which had been used as the medium for the culture of the fungus. In contrast, adult houseflies, fed spores which had not germinated, were not killed.

In these tests it was found that the germinating spores produce a toxin which is capable of causing paralysis of the insect. This paralysis is always evident in cases of fungus infection; with an invasion the spore germinates, the hypha penetrates the cuticle, and the toxin is produced in quantity within the host body. External sporulation usually follows. In the experiments reported here a very large number of spores was permitted to germinate on a filter paper, the toxin was produced in relatively great quantities, and the toxin was absorbed through the cuticle and acted as a contact poison.

Examination of the tuber worm larvæ a few hours after paralysis showed the body cavity to be filled with bacteria. This bacterial multiplication is thought to be due to the inhibition of the phagocytic cells of the insect by the fungus-produced toxin; this assumption is based on the observations of the effect of penicillin on human leucocytes (Florey and Jennings 1942). Tests to show the effect of the fungus toxin on bacteria were made. *Escherichia coli* (Migula) Castellani and Chalmers. *Staphylococcus aureus* Rosenbach, *Serratia marcesens* Bizio, and *Bacillus subtilis* (Ehrenberg) Cohn were tested. Inhibition of bacterial growth resulted only with *Serratia marcesens,* a confirmation of the finding of Masera (1934). These tests were made by the agar disc and strip methods of Wilkins and Harris (1944, a, b).

Paralysis did not occur within two hours of exposure to germinating spores in tests with the following insects: tussock moth larvæ (*Hemerocampa vetusta* Bdv.), Eastern tent caterpillar larvæ (*Malacosoma americana* Fabr.), German roach adults (*Blattella germanica* L.), Southern armyworm larvæ (*Prodenia eridania* Cram.), grasshoppers (Locustidæ), and housefly maggots (*Musca domestica* L.). All these forms are susceptible to the parasitic action of *B. bassiana* with paralysis occurring as the first stage of attack. It is thought that these negative results can be attributed to the small amount of insect body surface in contact with the toxin-bearing filter paper in proportion to the volume of the insect. This does not hold true for the housefly maggots; this form is extremely resistant to even parasitism by *B. bassiana.*

A solution of penicillin, 2500 units per ml. of water, was used as a medium for mosquito larvæ, *Anopheles quadrimaculatus* Say. This treatment resulted in mortality of 14 of the 17 test insects; there was no death in the checks. Exposure was for 24 hours. A dust made up of 95,000 units of penicillin in two grams of wheat flour dusted on Petri dishes as described in Table I, produced no kill of housefly adults in 24 hour exposures.

In these tests 9.0 cm. Petri dishes were used. Almost one-eighth gram of spore dust was put on each wet filter paper. From these tests it is concluded that germination takes place only in the presence of a droplet of water, 90 percent relative humidity is not sufficient.

The variations in the quantitative results reported here can be attributed to a few causes. These include: experimental error; insufficient replication; variations in the virulence of the spores, they were not of a monosporous culture nor at the time of testing, of the same age; variations in the ability of the insects to withstand the experimental conditions, note the variations in check mortalities.

A possible explanation of why the bacterial type death in fungus attacked insects has not heretofore been mentioned in the literature, includes variation in method of experimentation and in size of test insects. In these tests the spores were permitted to germinate on a filter paper before exposure of the insect, in contrast to most other tests where the insect was dusted and germination was sporadic or limited. Also, early bacterial type death was noted only in tests with small insects, in contrast to many of the previously reported tests using corn borer larvæ and other large insects.

TABLE I

Tests were made of the effect of *Beauvaria bassiana* on housefly adults in laboratory tests. The procedure for each test is listed. Alive refers to those able to walk; Dead includes those paralyzed, or unable to walk.

PROCEDURE		Alive	Dead
About 200 chilled houseflies were liberated in a moist chamber with a wet filter paper on the bottom. The chamber was dusted with 1.0 g. of 0.5 percent *B. bassiana* spores in wheat flour. The count was made after a three hours exposure.	Ck T	95% 5%	5% 95%
The above test was repeated in a moist chamber with 70 to 80 percent relative humidity with no wet filter paper in the chamber. The count was made after a 24 hour exposure.	Ck T	95% 95%	5% 5%
Ten flies were liberated in a moist chamber with a wet filter paper on the bottom and the humidity at condensation point. One percent *B. bassiana* spores had settled and germinated one half hour, before the flies were put in. Counts were made one hour and 21 hours after the flies were put in.	 Ck T Ck T	1 hour 10 10 21 hours 10 0	 0 0 0 10
This test was similar to those listed above. The check chamber was washed out with $CuSO_4$ solution, five percent, before the flies were put in. The flies were in flying condition, not previously chilled as in the above tests. The spores were allowed one hour to germinate before the flies were put in. Counts were made at the end of two and 24 hours of exposure.	 Ck T Ck T	2 hours 7 3 24 hours 7 0	 0 4 0 7
In all tests after this, Petri dishes were substituted for a moist chamber. Wet filter paper was placed on the bottom of each dish. The spores were allowed one hour to germinate before the flies were put in. Ten flies were put into each dish. The count was made at the end of three hours of exposure.	Ck T	64 11	16 69
This was a test of newly prepared two percent *B. bassiana* spore dust. The spores were produced from a new culture obtained from the American Type Culture Collection, Washington,	Ck–1 –2 T–1	40 36 0	12 12 36

TABLE I (CONTINUED)

PROCEDURE		Alive	Dead
D. C. The test was made as described before except many chilled flies were placed in each dish. Counts were made at the end of a 12 hour exposure period.	–2	0	36
This test contrasts the effectiveness of old spore dust (18 months) and new dust. The test was made in Petri dishes; ten flies were put in each dish. The counts were made at the end of a 12 hour exposure period.		Old spores	
	Ck	14	6
	T	3	17
		New spores	
	Ck	16	14
	T	3	27
The effect of ingestion of spores which had not germinated was investigated in this test. Flies were separately mounted on paraffin blocks and fed individually. The flies were fed at 12 hour intervals after a 24 hour conditioning period. The flies were fed three times each during the test. The count was made 24 hours after the last feeding.	Ck	7	3
	T	9	1
This test was the same as the above test. The duration of the test was five feedings. After 48 hours on the block, sucrose was added to the water containing spores which had not germinated. The count was made 24 hours after the last feeding.	Ck	6	4
	T	6	4
About 250 flies in insectary type cages were fed milk which had been dusted with 0.25 g. one percent *B. bassiana* spores. At the end of 24 hours milk was added to the dusted feeding dish. Counts were made at 24 and 48 hours after the initial dusting and feeding. The check cage was kept in another room in the building.		24 hours	
	Ck	98%	2%
	T	63%	37%
		48 hours	
	Ck	95%	5%
	T	0%	100%
This test was similar to the above test except the feeding dish had a much lighter inoculation of *B. bassiana* spores; it was air contaminated in the laboratory. At the end of 48 hours mycelia, later identified as *B. bassiana*, were seen in the milk dish. Counts were made at the end of 24 and 48 hours. Check cage was same as that listed above.		24 hours	
	Ck	98%	2%
	T	89%	11%
		48 hours	
	Ck	95%	5%
	T	0%	100%

TABLE I (CONTINUED)

PROCEDURE		Alive	Dead
Petri dishes were prepared with wet filter papers and with spores which had settled and germinated. Twelve or 20 flies were placed in each dish. A thread ligatured the cervix of the flies preventing feeding. The count was made at the end of a 48 hour exposure.	Ck T	24 0	8 32
This test shows the effect of the fungus is not solely due to parasitic action. Petri dishes were prepared with a wet filter paper and the spores were allowed 12 hours to germinate. The plates were then autoclaved at 20 lbs. for 30 minutes. When the plates had cooled, ten flies were placed in each dish. Counts were made at the end of a 48 hour exposure.	Ck T T	9 Old spores 5 New spores 5	1 5 5

TABLE II

Tests were made of the effect of *Beauvaria bassiana* on potato tuber worm larvæ. All tests listed were in Petri dishes prepared with a wet filter paper on the bottom. The procedure for each test is described. Alive refers to alive, able at least to move; Dead includes those dead or paralyzed, all unable to move.

PROCEDURE		Alive	Dead
Petri dishes were prepared with one percent *B. bassiana* spores. The spores were allowed at least one half hour to germinate before the larvæ were put in. After a two hours exposure, the larvæ were dipped in a one percent $CuSO_4$ solution. The count was made 22 hours after dipping. There were about 20 larvæ in each dish. No fungus growth was noted on the dead larvæ, one week after dipping.	Ck T	64 22	14 56
The above test was repeated with only one hour exposure of the larvæ to the spores. The count was made at the end of the one hour exposure; no $CuSO_4$ dip was included. Each dish contained 15 larvæ.	Ck T	13 6	2 9

TABLE II (CONTINUED)

PROCEDURE		Alive	Dead
Petri dishes were prepared as above. The spores were allowed a two hour germination period; the dish was then flooded with $CuSO_4$ solution. Larvæ were placed on the plate and counted at the end of a 22 hour exposure. There were 18 larvæ in each dish.	Ck T	13 0	5 18
Petri dishes were prepared in the usual manner. Ligatures were tied in the prothoracic region of the larvæ. A one and one half hour exposure of the larvæ was followed by a $CuSO_4$ dip. The count was made at the end of the 24 hour period after dipping.	Ck T	5 3	0 2
Petri dishes were prepared as above. The larvæ were ligatured in the prothoracic region and were exposed for 24 hours. The count was made at the end of the 24 hour exposure period.	Ck T	12 3	2 11
Petri dishes were prepared as above; the spores were allowed 12 hours to germinate. The plates were then autoclaved at 15 lbs. for 20 minutes. The larvæ were left on the plate 72 hours before counting.	Ck T	8 2	2 8
The preceding test was repeated with the exposure period of the larvæ reduced to 48 hours before the count was made. Autoclaved plates were compared with non-autoclaved. Twenty larvæ were in each Petri dish. Checks 1 and 2 are No Flour and Plus Flour respectively; Checks 1 and 2 and Test 1 were not autoclaved. Check 3 was Plus Flour; Check 3 and Test 2 were autoclaved (15 lbs., 20 min.).	Ck–1 –2 –3 T–1 –2	6 8 6 0 1	14 12 14 20 39
The above test was repeated with a 22 hour exposure of the larvæ to the autoclaved plate. Checks 1 and 2 were Plus Flour; Check 1 and Test 1 were not autoclaved. Check 2 and Test 2 (both three plates each) were autoclaved. The high mortality in Check 1 was thought to be due to an excess of water in the plate.	Ck–1 –2 T–1 –2	6 44 0 18	14 16 20 42

TABLE III

Tests were made of the effect of *Beauveria bassiana* on dock beetle adults in Petri dishes in the laboratory The procedure for each test is described. Alive refers to alive, able at least to move; Dead includes dead or paralyzed, all unable to move.

PROCEDURE		Alive	Dead
Petri dishes were prepared with wet filter papers and dusted with one percent *B. bassiana* spores. The spores were allowed at least one half hour to germinate before the beetles were put in. Ten dock beetle adults, equal numbers of males and females, were placed in each dish. The first count was made at the end of two hours; the beetles were dipped in $CuSO_4$ and counted again 22 hours later. At the end of 24 hours all Test insects were dead; at the previous count some were only paralyzed.		2 hours	
	Ck	10	0
	T	0	10
		22 hours	
	Ck	10	0
	T	0	10
This test included a twelve hour exposure of the beetles to the spores. There was no $CuSO_4$ treatment. The count was made at the end of the exposure period.	Ck	6	4
	T	1	9
The above test was repeated with the new spore dust. The previous test had been made with dust about one year old.	Ck	6	4
	T	1	9
Petri dishes were prepared in the usual manner. The spores were allowed a 12 hour germination period. The plates were then autoclaved at 20 lbs. for 30 minutes. The beetles were exposed for 48 hours before the count was made.	Ck	4	1
	T	2	3

CONCLUSIONS

The germinating spores of *Beauveria bassiana* produce a toxin which is a contact poison. This toxin may cause paralysis of the insect even in advance of hyphal invasion. In addition, it is concluded that the poison is toxic to the phagocytic cells of the insect, since, in laboratory tests histolysis by intestinal bacteria usually follows paralysis. The toxin has the same effect when ingested.

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Generic names begin with capital letters. New genera, subgenera, species, varieties and new names are printed in italics.

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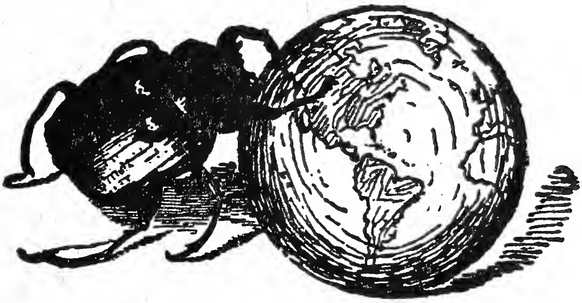

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A REVISION OF THE GENUS EPHUTA (MUTILLIDÆ) IN AMERICA NORTH OF MEXICO[1]

By R. M. Schuster
University of Mississippi

The genus *Ephuta* Say, together with the only other nearly related nearctic genus, *Timulla* Ashmead, includes some of the most polymorphic and difficult species complexes in the family Mutillidæ. The use of the term species in these two groups, often requires a great deal of courage and no end of imagination, since we have not yet arrived at the stage where quantitative study of large masses of material results in clear definition of what is a species, and what is a subspecies or merely individual variation.

The superficial uniformity of most of the species in both of these genera, both in vestiture and pigmentation, as well as in general body form, is coupled with a great deal of morphological variation in the males. To this must be added the baffling conservatism of the females, as regards evolution of specific characteristics that can be used to differentiate them. We thus are faced with a situation in which the considerable variation of the males leaves one in doubt where to draw the line between individual variation and geographic race, and between geographic race and species, while the superficial uniformity of the females prohibits their organization into definable taxonomic segregates

[1] Due to the length of this revision, it will appear in a number of separate sections, in this journal. The present part carries the paper through the keys to species. New binomials and trinomials will be properly validated by descriptions in succeeding parts of this work. The illustrations for the paper appear at the end of the present part; these also serve to illustrate subsequent portions of the work.

analogous to those evident in the male sex. In the only previous study of the nearctic species of the genus (Bradley, 1916) a single species was recognized in the female sex (though a second described species was unfortunately overlooked), and nine species were recognized in the male sex (while the tenth described species of male was also overlooked.) This very great difference in ratio between number of species known in the male sex, and number known in the female sex results from the interoperation of two factors: 1) the characters separating the female sex into species and races have not been adequately appreciated, 2) the females sometimes cannot be separated into morphological species. Actually, a number of clearcut characters exist by which several species groups can be recognized in the female sex, while a number of additional characters are used tentatively here to separate several species and subspecies. There still exists a considerable discrepancy in the numbers of species and subspecies known in the male and female sex, though that numerical ratio has been considerably reduced by the present study. It is certain, however, that critical study of larger series of females than have been available to the author will result in more adequate diagnosis of some of the species than is now possible, and perhaps in further breaking up of the specific groups here recognized. It is felt, however, that with the present amount of date it would be scarcely justifiable to break up the female sex into a greater number of species, especially since the characters used for specific diagnosis are often so slight and subtle.

Some of the problems and lacunæ in the study of this genus that have either not been adequately treated, or which it has been impossible to touch upon with our present knowledge of the group are: (1) the relationships of the males and females; we have been able to correlate definitely the sexes of only one species with any certainty, (2) the exact range of many of the species and races, and the variation that is to be encountered from one end of the range of the form to the opposite end, (3) the amount of heterogonic growth involved, or where differences between individuals of different sizes is the result of some genetic, hence taxonomic, difference, (4) the lack of data on the ecology of the group, (5) inability to judge with certainty what is heterogonic variation and what is geographical, or racial, variation.

The accumulation of data pointing toward a solution of all of these problems must certainly be regarded as forming the basis on which a sound taxonomic treatment of the group should be founded. Without at least some data of the above nature further, taxonomic study in the genus will be relatively sterile in results. The present treatment, in many ways merely an effort at pigeon-holing the various forms, can certainly be interpreted only as preparing the way for a more thorough study of the genus, based on some consideration of the above problems.

The species of nearctic *Ephuta* are perhaps less numerous in collections than those of any other moderate or large-sized Mutillid genus of the nearctic region. This relative scarcity has also been noted by Mickel for *Timulla* Ashmead. Both of these genera appear to be more fully represented in species and numbers in the neotropical region, though it must be stressed that the members of the Mutillinæ[2] are relatively poorly represented in the whole New World, compared with the Old World.

This scarcity of material in collections is the chief reason why problems two, three and five have been treated only in the case of the *battlei-copano-sabaliana-spinifera-pauxilla* complex of species and races. Of most of the species and lesser segregates we have seen less than a dozen individuals; of several of the forms only the holotype is known. This scarcity of material is chiefly responsible for the disposition as "species" of some segregates that possibly represent merely distinct races, or the separation as "subspecies" of forms that may indubitably be good species. It has been felt desirable to limit the term species to such forms as could be demonstrated in the present study to represent discrete entities differing in several major morphologigcal characteristics from all of the closely related forms. In the female sex, unfortunately, major morphological differences scarcely exist, and some of the species there are to be interpreted as tentative only. The systematist in working on this genus is faced with the choice

[2] Used here in the restricted sense (See Schuster, 1946, 1949) for those genera with large, conchiform tegulæ, reniform facetted eyes with a sharp inner emargination, and with the stigmatic cell poorly developed or absent, and not uniformly sclerotized and pigmented.

of calling the more or less discrete morphological segregates of the several ''Artenkreise'' of males species, and to leaving the plethora as inseparable on non-morphological characters, or calling the males involved a single polymorphic species, consisting of many races (some of which would have to exist side by side, yet inexplicably remain distinct from each other), while the female is presumed to be uniform and not capable of separation into analogous subspecies. This latter solution, in some ways, is the easy way out of the difficulty. Yet it leaves one in the position of having to explain the occurrence together of three or four of these ''subspecies'' of males in the same locality. For instance, forms of *battlei, pauxilla,* and *spinifera,* occur side by side, in northern Virginia (and are represented in the type series of *pauxilla* Bradley), together with the certainly distinct *E. scrupea.* Yet the females of these four distinct species of males have not been previously separated and have been simply called *''puteola''* Blake. Employing characters the author does not regard as above suspicion, he has been able to separate the females of *scrupea, pauxilla* and *spinifera* from each other. At the same time, the occurrence of these discrete forms of males in the same locality indicates that they in all probability are not subspecies of each other, and that their individuals must be able to tell the difference between the females of the three forms involved. Therefore, the author prefers to believe that the first of the above alternatives proposed is the more probable one, and has been guided by that precept in the present study. (Since this was written a certain amount of corroboratory data have accumulated in favor of such a viewpoint).

Although, before this study, only a single female was recognized for the United States (Bradley, 1916), the author has been able to increase this to sixteen species, and four additional varieties or subspecies. Using various standard techniques, he has been able to correlate six of these females to species of males, and able to suggest several more probable correlations. One species (*E. margueritæ*) was correlated on the basis of material of both sexes bred from the same group of cocoons of the same host, hence probable progeny of a single female. A second species (*E. argenticeps*) was correlated on the basis of exclusion of all other males and females, since the male and female assigned to it are the only ones known to occur in California. A third species (*E. spinifera*) was correlated on the basis of a male and female taken in copula by Mr. D. Shappirio, while several more males and females were taken at the same locality and time. Two other species ("*puteola*" portion and *scrupea*) were associated with their males on the basis of coincident distribution, and collections of the respective males and females at the same time and place, as well as differences in total range of the respective males and respective females. The sixth species (*E. conchate*) was associated with a female because of a suggestively similar east-west distribution in the Transition Zone of the eastern half of the United States, not matched by any other known male or female.

Study of mass collections made by Mr. D. Shappirio around Washington D. C. also made possible more clear-cut separation of the females of the *puteola-spinifera-scrupea* group. The long series made possible the analysis of the variation in each species of female, and the formation of some idea as to what represented merely vicarious modification within each species, and what represented valid taxonomic characters for species separation.[3]

Finally, it must be stressed that much more detailed study of larger series, with the ocular micrometer, must be undertaken,

[3] It must be stressed that reduction of the females has been so extreme that recourse must be had to characteristics of extreme subtlety (such as slight differences in puncturation), that possess an inherent amplitude of variation within the species (especially correlated with size differences) often much greater than the gap between two species. The utilization of such characters is therefore extremely unsatisfactory. Therefore, study of long series from a restricted area and comparison of these individuals with those of other populations are alone able to provide an answer as to whether such minor characters are valid taxonomic characters, or merely part of the inherent variability of a more broadly conceived species.

Since the hundred-odd females sent for study by Mr. Shappirio all could be placed definitely by means of the included key, it was concluded that the separating characters had the necessary validity, however great their nicety. This material therefore served as a welcome test of the specific concepts arrived at on the basis of isolated individuals. Whether the species can be separated readily without comparative material, remains another question, since the differences are scarcely subject to exact definition in a key (although enough to lend a distinctive facies to the species).

and some effort made to critically define the limits of variation of the species and races. It is evident that there is in the males a great deal of variation in the degree of development of the ocelli and eyes, of the humeral prothoracic angles, of the transverse propodeal ridge, of the sculpture of the thorax and of the tegulæ, and in the type and degree of pigmentation of the hypopygium, as well as in the amount and type of vestiture. Large ocelli, strongly developed humeral angles, coarse sculpture, dense sericeous vestiture, are all derivative characters usually developed to their greatest degree in large individuals of any one species, and to a lesser degree in abnormally small individuals.[4] When very small series, or only isolated, extreme individuals are at hand, interpretation of such possibly largely heterogonic variation as genetic variation may occur. Mickel (1924) has shown that differences on a nutritional level can result in a bimodal curve, as regards variation in size. If there is a corresponding distribution of degree of development of the specific characters, interpretation of each of the two main size groups as a distinct species may occur. Cautious interpretation of data derived from size of ocelli, and the spatial arrangement of the ocelli, of the relative widths of head and thorax, of the degree of development of the humeri, of the relative coarseness of the sculpture and density of vestiture is therefore a primary requisite of sound systematic work in this genus. It is quite possible, therefore, that abnormally small, and "underdeveloped" individuals of a specialized species could be confused with large, normally developed individuals of a less derivative species. This, in no way invalidates the two species as discrete entities, since all kinds of intergradation must occur between the large and small individuals of the one species, while there must exist some gap, however small, between the extreme individuals of the two species, that is not bridged by annectant forms. The distinction between species and subspecies in the following keys are drawn from normal, well-developed individuals. Therefore, when the statement "humeri strongly produced" is made, allowance must be made for the fact that abnormally small individuals may have them relatively weakly developed. Some knowledge of the variation in size of the species is thus necessary.

[4] See tables at the end of this revision.

In this preliminary monograph of the nearctic members of the genus thirty-two new species and subspecies and varieties have been described. This, together with the ten species treated by Bradley (1916), together with *E. rufisquamis* André, and *E. sudatrix* Melander (which were omitted by Bradley), and *E. conchate* Mickel (described subsequently), while subtracting *E. susura* (Melander) which is subsequently synonymized, results in forty-four nearctic forms. There are probably at least four times as many species of this entirely New World genus in the neotropical region. The species from Mexico, Central America, and the West Indies, which connect our forms with the more strictly tropical species, have been recently treated by the writer (Schuster, 1945). Study of the much more highly specialized tropical forms indicates the genus is conceivably a relatively recent invasion of the nearctic region, with the less specialized species being "forced" northward, to the periphery of distribution of the genus much as propounded by Matthews for the distribution of vertebrates.

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Genus *Ephuta* Say

Mutilla, auctorum.
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Mutilla, subgenus *Sphœropthalma* (Division I, subdivision II, in part) Blake, idem, pp. 232, 246.
Ephuta Ashmead, Jour. N. Y. Ent. Soc., **7**: p. 57, 1899.
Ronisia Ashmead (not Costa), idem. p. 58. (acc. André).
Mutilla, group *scrupea* Fox, Trans. Amer. Ent. Soc., **25,** p. 272, 1899.
Rhoptromutilla André, Gen. Insectorum, fasc. 11, p. 43, 1903.
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Ephuta Mickel, 19th Rep. State Ent. Minn., p. 111, 1923.
Ephuta Schuster, Rev. Ent. (Rio), **16,** pp. 187–204, 1945.
Ephuta Schuster, Annals Ent. Soc. Amer., **39,** p. 703, 1946.

Genotype:—*Ephuta scrupea* Say (Ashmead, Journ. N. Y. Ent. Soc., **7**, p. 57, 1899). Say in 1836 described the genus *Ephuta* as a subgeneric segregate from *Mutilla* L. and included three species in it, *erythrina, gibbosa* and *scrupea.* His description applies only to the first two, since it reads "Eyes entire or emargination obsolete." Ashmead, no doubt through some oversight, selected the last species as the genotype thus giving the genus an entirely different meaning from that intended by Say. André (1903) did not accept Ashmead's unfortunate type designation and described *Rhoptromutilla,* with *M. chrysodora* Perty as type, to include what we now call *Ephuta.* André used *Ephuta* in the sense indicated by Say's diagnosis, and his *Ephuta* therefore is largely synonomous with *Dasymutilla* Ashmead. Ashmead's type designation was valid under the International Rules of Nomenclature and *Ephuta* therefore stands as limited by him.

Ashmead (1904) made *Ephuta* the type genus of his tribe *Ephutini*. This latter group was an artificial pigeon-hole that has not found any acceptance. In 1945, the writer re-evaluated the characters of the group and came to the conclusion that *Ephutopsis* Ashmead, the only other generic segregate that could clearly be included in the *Ephutini*, was not generically distinct from *Ephuta*. In 1946, the writer rescued the name *Ephutini* from oblivion, and diagnosed it briefly, placing it as a tribe of Mutillinæ, with the genus *Ephuta* as type genus. The latter is the only included genus. This use of the tribal name *Ephutini* is not at all equivalent to the sense in which it was employed by Ashmead. The tribe as emended includes only the neogæic forms of the genus *Ephuta*, and the tribal characters may be briefly stated as follows:

Tribe EPHUTINI Ashmead (1904), emend. Schuster (1946)

MALES.—Tegulæ large, conchiform; (Fig. 37) eyes reniform, facetted distinctly, deeply emarginate within (Fig. 37); mandibles normally 2-dentate distally, ventrally devoid of all trace of teeth, or of emargination (Fig. 10, 24); mesopleura lacking the oblique sulcus (Fig. 37), evenly convex (except in a few, relatively generalized, neotropical species); propodeum areolate, frequently variously armed. Wings lacking a stigma; cells R_4 and M_2 indicated by color lines or delicate veins (Fig. 1). Abdomen with petiole extremely narrow, subterete, cylindrical, usually equally or subequally wide basally and distally (Fig. 37), very short and transverse to elongate; second segment lacking felt lines; tergites 5–7 (and usually 3–4) with a longitudinal median carina; second and distal sternites devoid of all trace of lateral or median processes, tubercles, or carinæ.

FEMALES.—Eyes ovate, silvery, strongly facetted (Figs. 38, 39); supraclypeal ridge quadridentate normally (Figs. 38, 39); mandibles entire below, falcate, slender. (Figs. 38–41); hypostomal ridge running back from mandibular posterior condyle angulate or dentiform produced (Figs. 40–41); alitrunk highly reduced, elliptical or ovate, with pleura punctate throughout and rounded gradually into notum (Fig. 25); lateral sutures entirely lost on pleuræ, including the pronotal-mesopleural suture. Gaster with petiole as in male, (Fig. 25); second segment with felt lines absent or represented by foveate pits or grooves; distal tergites not carinate as in male (Fig. 25); pygidium undefined or delicately delimited distally by faint carinæ, usually polished and very small (Figs. 25–26, 31, 34, 35); hypopgium usually with a pair of basal, lateral tubercles, often connected by a transverse ridge (Figs. 27–30, 32–33, 36).

The Tribe *Ephutini* may be contrasted to the *Mutillini* (in which, tentatively at least, the writer would include all the other genera of Mutillinæ), as follows:

Both sexes with petiole gradually dilated, broad, evenly and fully continuous and sessile with second tergite; felt lines present on second tergite (and often second sternite), except in *Areotilla* Bisch. Male with abdominal distal tergites not longitudinally carinate medially; mandibles usually with at least a trace of ventral excision and a ventral tooth; wings with a small to distinct stigmatic cell usually retained (distance between origin of M. on R + M and apex of stigma usually varying from 0.7–1.2 the length of marginal cell on costa); origin of r–m + R_s on M midway between origin of m–cu and M_{3+4}, or nearer M_{3+4}. Female with alitrunk with the pleura at a distinct angle to the notum, largely or entirely devoid of coarser sculpture, generally with retention of traces of sutures, the dorsal outline varying generally from rectangular to hour-glass shaped: never strongly narrowed both anteriorly and posteriorly. TRIBE MUTILLINI.

Both sexes with petiole nearly or quite parallel-sided, narrow, not dilated distally, sharply separated dorsally from the second tergite; felt lines absent on both tergite and sternite (at most analogous pit- or groove-like structures on the second tergite of the ♀). Male with distal abdominal tergites longitudinally carinate; mandibles entire below; wings with stigmatic cell obsolete (Fig. 1) (distance between origin of M on R + M and apex of stigma 0.3–0.5 the length of marginal cell on costa); origin of r–m + R_s much nearer origin of m–cu than of M_{3+4}. Female with alitrunk with pleura evenly continuous with notum, sculptured like notum and totally devoid of all traces of sutures, the dorsal outline narrowly ovoid of elliptical. TRIBE EPHUTINI

DIAGNOSTIC CHARACTERS OF GENUS

MALES.—Eyes large, reniform-ovate, deeply and sharply excised on the upper portions of the inner orbits, very distinctly facetted (Figs. 10, 11, 24, 37). Antennæ short, robust, with the second flagellar segment transverse, wider than long (Fig. 37), little longer than the first (rarely elongate); the pedicel short, sub-globular; the scape bicarinate, the carinæ meeting in a loop distally (occasionally with one of the carinæ obsolete, and the enclosed face little defined) (Figs. 10–11). Clypeal area usually defined by a pair of prominent, more or less diverging subantennal carinæ (Figs. 2–10), that are usually dentiform produced at a variable distance down towards the anterior clypeal margin (Fig. 3d), and which may have the carinæ dorsad of that angulation fused into a single median carina; the clypeal basin (Fig. 2b) (and the subantennal (Fig. 2a), when not obliterated) entirely or virtually devoid of setigerous punctures, more or less polished. Antennal scrobes with a distinct, transversely oblique, truncate tooth dorsally (Figs. 10–11); antennal tubercules approximate, more or less sculptured. Mandibles bidentate (Figs. 10, 24), occasionally with a larger, third, dorsal, molar tooth developed (Fig. 11) usually falcate and always simple, unexcised ventrally. Clypeus rounded anteriorly, not bidentate (Fig. 2c).

Thorax with pronotum short medially, the humeri often more or less produced and carinate (Fig. 37); mesonotum with parapsidal furrows totally absent, occasionally weakly indicated (in some neotropical forms doubtfully indicated by broad, polished gutters); mesopleura evenly swollen, lacking the oblique sulcus and pit, (Fig. 37), occasionally (neotropical forms) spinose-produced above; mesosternum (in nearctic forms) never produced as gibbosities, carinæ, or teeth; scutellum flatly swollen to gibbous (Fig. 37), occasionally (in neotropical forms) carinate medially or sulcate medially, and with the posterior angles dentiform produced. Tegulæ large, strongly convex, conchiform with the posterior margin not reflexed, hiding the auxillary wing sclerites beneath them (Fig. 37). Propodeum often variously armed medially or laterally, often with a transverse ridge, always coarsely reticulate-areolate (Fig. 37), and with a median basal areole or areoles. Legs with small, unproduced trochanters; posterior coxæ normal or armed; calcaria 1–2–2. Wings with stigma absent, cells R_4 and 1st M_2 more or less distinct, indicated at least by color lines; hind wings with basal part of Sc + R + M heavily sclerotized, the distal half or more, much less so; cell R_5 very elongate (Fig. 1).

Abdomen with petiole always very slender (Fig. 37), its width usually less than one-third that of second tergite, nearly parallel-sided in dorsal profile, with the form varying from short and transverse (all nearctic forms) to elongate and slender (many neotropical forms), in section subterete, with a low, sometimes anteriorly produced sternal carina (Fig. 37). Second segment with felt lines of the sternite always lacking, and absent on the tergite as well. Tergites 5–7 (and usually 3 and 4 as well) with a distinct median, delicate, longitudinal carinule. Vestiture of simple hairs throughout, lacking all types of specialized setæ or plumose hairs. Sternite two, and all distal sternites simple, lacking lateral carinæ or teeth; hypopygium simple, unarmed. Genitalia with the parameres ventrally decurved.

FEMALES.—Eyes large, ovate, entire, facetted, usually silvery (Figs. 38, 39); head transversely oval, with the eyes scarcely protruding (Fig. 25). Supraclypeal ridge or flange with several (usually four) distinct coarse teeth (Figs. 38–39); mandibles slender, distally bidentate, ventrally unarmed (Figs. 38–41). Antennal scrobes unarmed, lacking dorsal carinæ (Figs. 38, 39).

Alitrunk elliptical or oval, elongate, not more contracted anteriorly than posteriorly (Fig. 25), with the dorsum evenly, uniformly, closely punctured, the dorsum gradually rounded into the evenly convex pleura that are also evenly continuous with the posterior propodeal face, only the two pairs of spiracles protruding; all dorsal and lateral sutures lacking and the alitrunk much more highly reduced and simplified than in *Timulla* (and lacking trace of metanotal (''scutellar'') scales and ridges) as well as the suture separating the lateral pronotal faces from the mesopleura.

Gaster with petiole similar to that of male, short and transverse, parallel-sided (Fig. 25). Second segment, as in male, without felt lines (or, in some neotropical species, with modified grooves or pit-like ones of the second tergite); disk of tergite usually with two rounded or oval spots of silvery vestiture (often reduced or absent) and usually a distal band of similar hairs, more or less notched or emarginate in the middle) (Fig. 25). Distal segments not carinate as in male. Hypopygium more or less armed with a pair of basal lateral tubercles, often connected by a slight ridge (Figs. 27–30, 32, 36); distally the hypopygium may be entire (Figs. 27, 32–33) or weakly quadrilobed (Figs. 28–30). Pygidium with a distal, small, faintly defined area (Figs. 26, 31, 35), or virtually no area at all (Figs. 25, 34), the lateral carinules delicate, or virtually absent; the more or less defined small pygidial area is more or less convex, and usually polished (Fig. 26), at most slightly granulose or obscurely punctate-granulose (Fig. 31).

The males generally are black pigmented throughout, but may have the gaster iridescent and violaceous, or may have it more or less ferruginous. Rarely the ferruginous pigmentation extends over the whole body. The females are usually entirely ferruginous (occasionally, in tropical forms, with the head, or thorax, or head and abdomen more or less black). Both sexes have a more or less distinct band of silvery, dense, sericeous vestiture at the apex of the petiole, and a similar band at the apex of tergite two (Fig. 25) (except a few neotropical forms).

RELATIONSHIPS

The genus *Ephuta* is one of the most sharply and distinctly isolated of the genera of Mutillidæ. The form of the tegulæ, lack of a sclerotized stigmatic cell, the generally strongly decurved distal segments of the gaster, the nature of the eyes, and the distally decurved (rather than upcurved) parameres place it as a member of the Mutillinæ. It differs at once from all other genera of that subfamily in that the petiole is slender (Figs. 25, 37), and exhibits a constriction between it and the second tergite. In the linear or parallel-sided form of the petiole the genus, indeed, differs at once from all other Mutillid genera. The modification or loss of the felt lines also separates it at once from all other Mutillidæ, except those of the unrelated genus *Rhopalomutilla.* The ventrally uniformly simple mandibles, of both sexes, and the areolate propodeum of the male, as well as presence of median carinæ of the distal tergites of the males are other characters not generally found in other genera of Mutillinæ. In the female sex, the petiole form, as well as the highly modified and simplified form (Fig. 25) of the alitrunk (which is contracted evenly in front and back, and lacks all the primitive features of the pleura found in other genera), and the raised, transverse, more or less quadridentate supraclypeal ridge or arch (Figs. 38–39) are quite characteristic. The total loss in the female of the sutures separating the lateral pronotal faces from the mesopleura (below the prothoracic spiracular openings) separates the genus from almost all other Mutillid genera of which I have had available material in the female sex. The lack of felt lines is another highly important differentiating character, as well as the relatively poorly developed pygidium of the female which is polished or only very obscurely sculptured. The form of the hypopygium (always simple in the males; generally bituberculate at base in the female) is also diagnostic, as is the form of the clypeal region, and its configuration, in the male sex.

ECOLOGY

The ecology of the genus is virtually uninvestigated. We know very little regarding any phase of the biology of the genus, and nothing has been heretofore published. Certain observations, based both on field experience and study of the males, indicate that the various species do not prefer sandy regions, as do most of our other Mutillidæ. The absence of, or poorly developed pygidium of the females indicates that they are not adapted for digging; the lack of development of a comb of the anterior tarsi is further circumstantial proof that the various species are not fossorial.

The writer has observed the females at several times in the field, and finds that they occur most generally in areas overgrown by grasses and sedges, in which the bees of the genus *Halictus* and similar bees nest. A single female, of *E. puteola,* was observed in June, 1941, in Putnam County, New York, crawling among the clipped grass at the edge of a path, where *Pseudomethoca frigida* (Smith) and *Myrmosa* occurred. The species here appeared to be parasitic upon *Halictus,* among the tunnels of which it was found. A female observed in June 1946 on a small, low-lying island in Beebe Lake, Ithaca, New York, also occurred in open grassy land, crawling on moist, alluvial, pebbly soil. No possible hosts were observed here.

C. N. Ainslie has taken a series of males on the flowers of

Solidago, at Beach, North Dakota. These males, of *Ephuta grisea* Bradley, apparently were feeding on pollen. Harvey I. Scudder has taken the male *E. conchate* Mickel at Breesport, New York, feeding on the honey-dew of *Myzus ribis,* occurring on currant. Mr. Nathan Banks has also taken *Ephuta* (of the species *pauxilla, scrupea,* and *spinifera*), on the honey-dew of aphids on *Liriodendron,* the tulip tree. Although several species of the related genus *Timulla* have been reared from various hosts (*Tiphia, Eumenes,* and *Odynerus,* as well as the Dynastine beetle, *Ligyrus gibbosus*), there exist no previous records of any hosts of the genus *Ephuta.*

A male of *Ephuta scrupea* Say, from Enola, Pennsylvania has been examined bearing the following data: "Reared from cocoons of *Pseudagenia bombycina*" (collected by Kirk and Champlain). Three males and a single female of *E. margueritæ xanthocephala* sp. et subsp. n. have also been examined that were bred from "Hymenoptera —cocoons under stones — Rockville, Dauphin County, Pennsylvania." These had been collected May 1, 1910, by H. B. Kirk, and emerged May 23, 1910.[5]

Another clue to a possible host species is given by a male of *Ephuta pauxilla,* collected by P. W. Fattig, which was taken with *Tiphia transversa.*

No other data on the ecology and biology of the genus is available at this time.[6]

DISTRIBUTION

The genus *Ephuta* is entirely New World in distribution. It is developed to its greatest degree in the tropical regions of Central and South America. The known distribution, as well as absence of a tarsal comb and a large, sculptured pygidial area of the female, indicates the genus is quite or nearly absent from true desert regions. The small ocelli of most of the males also

[5] An inquiry adressed to Dr. Champlain was made regarding possible data regarding the host. Unfortunately no exact data on the host species involved were available.

[6] It should also be stressed that there is good evidence that the species of the genus overwinter in the north as adults. At least the fertilized females must pass the winter, since collections made of females (at St. Clair, Ill.) in January indicate this. Whether any of the species pass the winter in the egg, larval or pupal stages is unknown.

substantiate this. Furthermore, the distribution of the group is nearly complementary to that of the Sphæropthalmine wasps, which are nocturnal, decidedly xeromorphic forms. *Ephuta* is nearly absent from the region from New Mexico westward, only three rare species occurring in Arizona, and a single species in California. In the east the genus occurs north to Maine and Michigan, virtually into the Canadian zone of evergreen forests; in the west it occurs north into Alberta, Canada. It has, so far, not been found on the west coast of North America, except for a single species from California.

The relatively large fauna of this genus developed in the neotropical region, together with the development of many relatively highly specialized forms in that area, indicate that *Ephuta* is to be regarded as a relatively recent invasion of most of North America. Certainly, the imperfect speciation of many of the "Artenkreise" in North America indicates that there has been time only for racial evolution or only for imperfect species development. The relatively peripheral position of the North American fauna of this genus, together with the relatively generalized form of the species, can be interpreted as illustrating the theory of the peripheral distribution of the generalized, or primitive forms of a group.

INTRAGENERIC PHYLOGENY AND CLASSIFICATION

For present purposes, the relationship of only the nearctic forms need be treated. These forms are clearly divisable into three groups on the basis of the males, as follows:

1. Subantennal carinæ dentate about half-way or more their distance down to the anterior clypeal margin, (Fig. 3d), thus with a subantennal basin (Fig. 2a) subequal in height to the clypeal basin (Fig. 2b); genæ never distinctly carinate behind; mandibles slender, lacking a dorsal molar surface (Fig. 10); malar space insignificant.
   Species Group GRISEA
1. Subantennal carinæ dentate considerably less than half their distance down to anterior clypeal margin (Figs. 7–9, 11, 24), thus with the subantennal basin reduced (Fig. 5a) pit-like (often declivous into the large clypeal basin, and appearing obsolete); genæ more or less strongly carinate or crenulate-ridged behind, in forms with dilated mandibles the carina absent or weak 2
2. Mandibles slender, normal, lacking a dorsal molar surface (Fig. 24); malar space short; genæ distinctly carinate behind.
   Species Group PAUXILLA

2. Mandibles stout, dilated, with a broad molar surface, obliquely truncate apically (Fig. 11); malar space large, nearly twice as long as in above groups; genæ not or scarcely carinate.
Species Group EURYGNATHUS

An analogous division of the females into groups has been attempted, without success. The females can be divided into species groups as follows:

1. Hypopygium armed with an elevated V-shaped process; pygidial area setigerously punctured, defined by lateral carinules; hypostomal-subgenal carinules complete .... *E. tumacacori* Complex
(*E. tumacacori*)

1. Hypopygium nearly flat, and without a prominent elevated V-shaped process; pygidial area (if distinct) glabrous and impunctate 2
   2. Pygidial area distinct, defined by lateral carinules 3
      3. Hypostomal-subgenal carinules complete 4
         4. Head densely sericeous pubescent (in addition to the sparse erect vestiture); disk of second tergite with maculæ of similar hairs (except *E. baboquivari*) .... *E. albiceps* Complex
         (*E. albiceps, auricapitis, baboquivari*)
         4. Head lacking decumbent sericeous vestiture on vertex, with sparse erect hairs only; disk of second tergite lacking maculæ.
         E. scrupea Complex
         (*E. tentativa, E. scrupea, E. minuta*)
      3. Hypostomal-subgenal carinules incomplete 5
         5. Head with a slight to distinct sericeous pubescence (in addition to the sparse erect vestiture); disk of second tergite with maculae of similar hairs (except *E. dietrichi*).
         E. grisea Complex
         (*E. argenticeps, E. coloradella, E. conchate, E. floridana*)
         5. Head nearly bare, except for sparse erect vestiture of vertex; disk of second tergite lacking maculae .... *E. puteola* Complex
         (*E. puteola, E. slossonæ*)
   2. Pygidial area vestigial or absent; hypostomal-subgenal carinules complete; head densely sericeous pubescent; second tergite maculate .... *E. sudatrix* Complex
   (*E. puteola, E. margueritæ*)

It will be seen that females belonging to three of these complexes (*Scrupea, Grisea, Sudatrix* Complexes) have males in Species group *Grisea*. A wholesale correlation of males and females is therefore made virtually impossible. Parallel reduction in the female sex may be a contributing factor to the difficulty in correlating the "Arten-Kreise" or "Species Groups" existing in the male and female sexes. For the present, the division based on male characters is followed, since it appears based on sounder and more reliable characters. (The Species Group Grisea will probably be found to be divisible into several discrete groups of males).

The Groups Pauxilla and Eurygnathus are endemic in the nearctic region, although the former extends southward at least into Mexico. The first group, Species Group Grisea has a much more extended distribution; it serves to connect the two other groups with the vast neotropical fauna, in most of which the clypeal type described for Species Group GRISEA exists, with various minor modifications. It is therefore believed that this type is the generalized, ''primitive'' type.

There are, in addition, a large number of neotropical groups, with specialized morphological features in the male sex, such as armed mesopleura, armed scutelli, armed propodea, elongate petioles, and other characteristics. These groups are only very distantly related to the nearctic species that typify *Ephuta,* as delimited by Ashmead.

All of the nearctic forms, in the male sex, may be further diagnosed as follows. This diagnosis is purely negative, and will serve to separate them from a large number of neotropical species groups:

Mesopleura never tuberculiform or spiniform produced, never divided by an oblique sulcus; petiole always short, transverse in dorsal profile; propodeum never armed laterally; subantennal carina never fused into a median carina above; gaster always rather strongly punctured; the second segment never merely punctulate; body and wings never violaceous or metallic; tergites 3 and 4 always distinctly longitudinally carinate, like the distal tergites; vestiture of gaster never exceedingly dense.

It is thus apparent that the nearctic species, excepting the two forms with modified mandibles, belong to the least specialized and derivative members of the genus.

In an ascending series, the nearctic forms can be arranged in a series as above; from the relatively unspecialized members of group GRISEA, which are annectant to the least derivative neotropical forms, on one hand, and to the nearctic group PAUXILLA on the other hand. The small, but distinctive group EURYGNATHUS, in turn, is to be derived from near group PAUXILLA.

CHARACTERS USED IN GROUP AND SPECIES DIAGNOSIS

Males

In *Ephuta,* as in most other genera of Mutillidæ, the males retain many more differential characters than the females; hence they can express species differences in a more varied and in a greater number of ways. The taxonomy of the genus, thus, must be largely based on a consideration of the male sex. The fundamental characters of the males allow a separation into three groups of species, founded on the following characters:

The head, below and between the antennal fossæ, bears two more or less diverging clypeal carinæ that run down towards the anterior clypeal margin. These carinæ are usually more or less dentiform produced between one-fifth and three-fifths of their distance down to the clypeal margin (Fig. 3d), and often have a more or less transverse ridge or convexity connecting these two dentiform or angulate protrusions (Fig. 5e). There are, therefore, generally two basins or areas defined, one directly below the antennæ (hereafter referred to as the subantennal basin or pit (Figs. 2a, 5a), depending on its size), the other directly below that, i.e., below the transverse convexity or ridge connecting the angulations or protrusions of the subantennal ridges (this is referred to as the clypeal basin) (Figs. 2b, 5b). In the Species Groups PAUXILLA and EURYGNATHUS the subantennal pit is greatly reduced by the encroachment of the clypeal basin (Figs. 11, 24), and may be virtually absent; it is frequently not separated by a transverse ridge from the clypeal, and then is spoken of as ''declivent evenly into the clypeal basin'' (Figs. 11, 12). In both these groups, the subantennal carinæ are angulate or dentiform at from one-fifth to two-fifths of their distance to the anterior clypeal margin. In the third group, Species Group GRISEA, the carinæ are dentiform produced half or more their distance to the anterior clypeal margin, and the subantennal basin is therefore more or less elongate, and not pit-like (Figs. 2–4, 10). In the Species Group PAUXILLA (and to a lesser degree, in Group EURYGNATHUS) the genæ are coarsely sculptured and separated by a distinct ridge on each side from the unsculptured, smooth, hypostomal region of the head (Fig. 37); in Group GRISEA the genal ridge is entirely lacking (faintly indicated in *tegulicia* Bdly.), and the genæ are evenly rounded into the posterior portions of the head. Group GRISEA always has the malar region very short (Fig. 10), and the mandibles slender and falcate, not produced into a dorsal molariform, rounded tooth. In this character Group GRISEA agrees with Group PAUXILLA (Fig. 24); the third group, Group EURYGNATHUS, however, has a larger malar distance and has large, dilated mandibles, bearing a dorsal flattened molar tooth (Fig. 11).

A number of other characters are used in diagnosing the various species in each of these main evolutionary lines. The size of the ocelli, and the form of the subantennal carinæ, with the resulting configuration of the subantennal basins and clypeal basins is (within certain limits) a valuable species character. The degree of development of the sculpture, and development or absence of a sericeous, decumbent vestiture are also important species characters. The humeral prothoracic angles may be strongly or weakly developed and bear a ventrally descending carina (Fig. 37) that bifurcates (with one branch continuing ventrad, and a second, the oblique lateral pronotal carina, cutting the lateral pronotal faces obliquely and more or less bisecting them). The degree of development of the humeri (within certain limits)[7] and of the oblique carina are important species characters. The form and sculpture of the tegulæ, and degree of development of the carina that traverses the base (and sometimes the whole tegula) is specific for the various species. The presence of a distinct separation, or transverse ridge, cutting the propodeum into a dorsal and into a posterior face (Fig. 37) is an important species character; in some species this ridge may be strongly produced as a median tooth; in some tropical forms the middle or sides, or both, of the propodeum may be armed with spines, tubercles, or ridges. The mesopleura of the nearctic species are uniform and offer few species characters, except as regards the density of the decumbent vestiture; in tropical forms they may be armed with a spinose process above. The scutellum

[7] In abnormally small individuals the humeral angles are occasionally very poorly developed, compared with the normal condition for the species.

may be nearly flat, or it may be gibbous, or it may be sulcate medially, and may have each side produced into a posterior spine. The form of the petiole is uniform in our species; some tropical forms, however, have it elongate and cylindrical; the ventral carina of the petiole is sometimes constant in its degree and type of development. The sculpture of the second tergite is often of specific importance. The color of the hypopygium is nearly always of specific importance, or rather, is correlated with other characters of specific importance; in some species it may be a yellowish white, in others virtually concolorous with the pygidium and rest of the body.

Finally, the pigmentation of the integument and nature and pigmentation of the vestiture may be of specific importance, though more often only of racial importance (as in most other aculeate Hymenoptera). In some species the second segment of the abdomen may be erythrisized, in others, the whole gaster; in another form the thorax may in addition be largely ferruginous; in three species the whole body is ferruginous; a single species has only the appendages (and tegulæ) more or less completely ferruginous. With these exceptions the body and appendages of these wasps are entirely black in the nearctic forms; in no species of the nearctic fauna is there any trace of iridescence. The predominant color of the integument is then black, of the gaster as well as head and alitrunk.

This contrasts the genus with *Timulla,* and the two other neogæic genera of Mutillinæ, *Chœtotilla* Schuster and *Physetopoda* Schuster, in which the predominant color is ferruginous or orange on the gaster (there never entirely black), and largely or entirely black on head and alitrunk. The vestiture, furthermore, differs from these three genera in being nearly uniformly pale (white or silvery), with only localized development of fuscous vestiture on the vertex, mesonotum, second and distal abdominal tergites; its degree of development, as well as absence of vestiture other than white pubescence, is specific in nature. To some degree the development of the distal sericeous band of hairs of tergite two (characteristic, on the whole, as a generic feature) is of specific importance, as well as the presence or absence of similar (less dense) vestiture on the dorsum of the propodeum and the distal abdominal tergites.[8]

FEMALES

In *Ephuta* the extreme reduction of the females results in a correlated "conservatism" as regards evolution of morphological species that is scarcely matched in any other Mutillid genus. The loss (in nearctic species) of the scutellar scale, and the extreme uniformity of the thoracic shape (Fig. 25), both of which afford excellent characteristics for separating species in the related genus *Timulla,* as well as the evolution of only two types of pigmentation and pubescence pattern (in the North American forms) result in a uniformity of form and livery that makes study of the females at once monotonous and challenging, from the taxonomic point of view. In the North American literature there is but one species of female listed, *puteola* Blake. Melander (1903) described a second species, as *Mutilla sudatrix,* which has remained unrecognized until the present. Brimley (1938, p. 438) indeed went so far as to state that *puteola* is "the only species of the genus known of the female sex," totally disregarding the considerable number of species of *Ephuta* described in the female sex from the neotropical realm.

Consideration of the rather large number of males that are known, and which differ in important morphological characteristics from each other, hence must be recognized as morphological species, leads to the conclusion that there must be more than two species of females in our region. Critical study of over 150 specimens of the female sex, at first revealed but few characteristics on which to base species, and most of these so trivial and difficultly perceptible that the description of species based on such characters would be assailable from the "practical" taxonomic point of view. On the other hand, these trivial characteristics appeared, on further study, to be constant and valid for species differentiation.

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[8] In several species where series have been examined it was found, however, that there was a decided correlation between large size and development of such vestiture, on dorsum of propodeum, apex of tergite two, and on the distal abdominal tergites, and between small size, and the lack of development of such vestiture. The density of the pubescence is therefore at least in some species correlated with size differences and is therefore not of any great importance as a species character.

Head: The size of the eyes is rather variable, and to some degree useful in distinguishing species (Figs. 38–39). In the PAUXILLA complex, preliminary work indicates it may serve to separate the female sex of the large-eyed *E. battlei* Bradley from the small-eyed *E. pauxilla*. The eye-size is to be recorded as related to the frontal distance between the eyes. The supraclypeal arched, transverse, normally quadridentate ridge, though very variable, seems to vary so much intraspecifically, that its use for species discrimination is very limited, when at all feasible. The venter of the head, bearing a pair of initially convergent, then subparallel carinæ (Figs. 40–41), or faint carinules (homologous, for at least part of their distance, with the hypostomal ridges) offers significant differences, but the degree of development of the carinules, and especially of the erect teeth near their anterior ends, is quite variable in at least some of the species. These carinæ may become obsolete before the occipital carina is attained (Fig. 40), or may end in the occipital carina (Fig. 41); with some limits these two conditions are valid for separating species. The degree of development of the occipital carina may also be specific in nature; it is so difficult to perceive that it has not been extensively used here. The antennæ are rather uniform, but there is considerable variation in the length of the first flagellar segment, as related to its width, and to the length of the pedicel and second flagellar segment; to a limited degree differences in this regard are to be considered of specific importance. Finally, the vestiture of the head (whether limited to the sparse, erect hairs issuing from the macropunctures of the frons or vertex, or whether with an additional vestiture, issuing from micropunctures, of short, sericeous, curly, silvery or golden hairs; also the density of this sericeous vestiture) is of obvious importance taxonomically. The sculpture (coarseness, depth, and density) varies widely, but must be used with caution, since small individuals always are more finely punctured than large individuals; for this reason sculpture has been avoided in the keys when possible.

Thorax: The thoracic shape is subject to variation within rather narrow limits; this variation, if sometimes specific in nature, is so intangible that it has had to be avoided as a species or descriptive characteristic. The nature of the erect vestiture, and its pigmentation, also vary so widely that specific differentiation based on them does not seem warranted. The presence of a median propodeal line of sericeous curly hairs, however, appears to be correlated with other characters of specific importance. The color of the legs varies from ferruginous to black or almost black; this variation, which may be the sum total expression of a single gene factor, could not by itself be considered as specific or varietal in value.

Abdomen: The presence of maculæ of the second tergite (Fig. 25), and whether these are large and obvious, or consist merely of a limited number of inconspicuous hairs, appears decidedly of specific value in segregating species, and is always correlated with other characteristics of specific importance. The form of the fascia of silvery sericeous hairs of the apex of tergite two also, within limits, appears taxonomically significant. The pigmentation, and livery, of segments 3–5 dorsally are, within limits, of great value in differentiating species; in the *puteola* complex, unfortunately, there is little significant variation in this characteristic. The pygidial region offers characteristics of prime taxonomic significance; the pygidium may be virtually undefined (as in the *sudatrix* complex, Fig. 34) or may be distinctly delimited by fine ridges on the apical fourth or fifth of the ultimate tergites (Fig. 26, 31); the pygidial region may be impunctate and glabrous (Fig. 26), or (as in the *tumacacori* complex) may bear conspicuous appressed pubescence, arising from distinct pygidial punctures; the pygidial area, if glabrous, may be very narrow (as in *minuta*, Fig. 31), and less than one-fifth to one-sixth the width of the frontal interocular distance of the head, or it may be wide (and over one-fourth that width, Fig. 26); the pygidial area may be virtually polished and smooth (Fig. 26), or may be quite granulose (Fig. 31). The hypopygium also offers excellent specific characters; the sculptured hypopygial region may be slender and longer than wide at base (as in the *sudatrix* complex, Fig. 33), or may be as wide as long (Figs. 29, 30, 32); at its base the hpopygium usually bears a pair of glabrous, shining tubercles (near the basal, lateral corner of each side) (Figs. 29–30), which may be connected by a prominent ridge (Fig. 36); in a few species these tubercles are absent. The form of the apex of the hypopygium is also of some significance, though often nearly indeterminable; in some species the apex is truncate or nearly so, and the sides do not bear projections (Figs. 27, 32); in other cases the tip is retuse or emarginate, and the sides before the apex each bear a distinct tooth or tubercle, the apical portion of the hypopygium thus appearing quadridentate (Figs. 28–30, 36). This dentition is often very difficult to observe; in a number of individuals it could not be determined, without doubt, whether teeth were present or absent, but in most cases the character is easily observable, even from above. When the lateral teeth or tubercles are well-developed, they appear to be bent dorsad, and seem to function as guides for the pygidial plate, which they tend to keep in a position of strict opposition to the hypopygial plate. It may be possible that these teeth, in old individuals, may be nearly worn away, and misdeterminations may be made on that account; this does not invalidate the characteristic. In doubtful cases the hypopygium has to be dissected away, and can then be studied on a slide, and mounted on a small triangular point beneath the insect.

It can thus be seen that the specific characteristics of the females are few indeed, and not very satisfactory at best. Statistical study of the variation in the head capsule and thoracic shape may yet result in clearer definition of the species, especially if possible heterogonic variation is taken into account.[9]

[9] It should also be stressed that a division of the females, on morphological grounds, into species groups is very difficult. It has been impossible to divide them into groups even approximately analogous to the three major groups recognized in the male sex (see p. 15).

KEY TO MALES

1. Subantennal basin subequal in height to clypeal basin (Figs. 2–4, 10), the subantennal carinæ dentiform produced or angulate about half their distance from anterior clypeal margin (or not dentiform at all); genæ evenly rounded into postgenal regions, not separated from them by genal ridges; antennal scrobes lacking distinct ridges running up them and obliquely outward (Fig. 10); mandibles slender, not dilated. Species Group GRISEA 2

1. Subantennal basin small or obsolete, pit-like if at all separated from the very large clypeal basin (Figs. 5, 7–9, 11–13, 24); the subantennal carinæ dentiform or angulate about one-fourth their distance from their dorsal origins; genæ separated by slight to distinct ridges from the postgenal regions (Fig. 37); antennal scrobes usually with indications of ridges running up and outward from them (Fig. 24) 16

2. Head not conically produced in ocellar region (the frontal profile with the vertex evenly arched in outline, as in Fig. 24); interocellar distance relatively small, 0.5–0.7 the ocellocular distance 3

2. Head with vertex conically produced in ocellar region (the frontal profile with the vertex evidently angulate in outline), the prominence of vertex terminating in a more or less distinct tubercle (Fig. 10); wings hyaline; ocelli minute, the ocellocular distance nearly or quite three times the ocellar length; interocellar distance very great, more than 0.8 the ocellocular distance; tegulæ smooth and polished; vestiture totally silvery; hypopygium buff to castaneous .... **E. cephalotes** n. sp.

3. Bicolorous, the reddish legs, tegulæ and antennal scapes sharply contrasted to the black body; ocelli very large, the ocellocular distance about one- and two-thirds, the interocellar distance about equal to the ocellar length; tegulæ polished; subantennal basin high, narrow, gutter-like (Fig. 19) .... *E. rufisquamis* André

3. Unicolorous, either entirely black or entirely ferruginous. (Other characters in different combination) 4

4. Hypopygium white or yellowish (occasionally buff on distal fourth); propodeal ridge often dentiform medially; tegulæ sometimes coarsely punctured, never carinate; lateral pronotal oblique ridge weak, obsolete 5

4. Hypopygium uniformly black or dark castaneous (at most yellow-buff on basal fourth); tegulæ smooth and polished, sometimes carinate medially; transverse propodeal ridge weak or absent (if medially dentiform the tegulæ are carinate) 12

5. Entire tegulæ (except for occasional narrow margin) coarsely and contiguously punctured and hirsute (as in Fig. 37); dorsal and posterior propodeal faces arched into each other with only a suggestion of a transverse ridge, lacking median tooth; dorsal propodeal face not densely sericeous pubescent 6

5. Tegulæ smooth throughout, polished; dorsal and posterior propodeal faces more or less distinctly separated by a transverse ridge, more or less dentiform produced medially; dorsal propodeal face with sparse to dense sericeous vestiture.[10] 7
6. Totally black (except for hypopygium); mesopleura densely silvery hirsute; tergites 3–5 silvery pubescent; yellow hypopygial pigmentation more or less extended on to pygidium.......... *E. scrupea* Say
6. Totally ferruginous (except for hypopygium); mesopleura very sparsely and obscurely pubescent; tergites 3–5 largely fuscous pubescent; yellow hypopygial color not extending on to pygidium.
E. floridana n. sp.
7. Ocelli large; interocellar distance subequal to ocellar length; ocellocular distance 1.6—1.7 the ocellar length; subantennal basin narrow, gutter-like, 3–4 times as high as wide, less than one-third the width of the clypeal basin (Fig. 18); transverse propodeal ridge strongly dentiform medially, with the dorsal face sparsely sericeous.......... **E. psephenophila** n. sp.
7. Ocelli small or moderate in size; interocellar distance 1.5–1.9 the ocellar length; ocellocular distance 1.9–3.1 the ocellar length; subantennal basin broader, about twice as high as wide, at least half the clypeal basin in width (Figs. 17, 22).......... 8
8. Subantennal basin little narrower than clypeal, the subantennal ridges merely undulate, not dentiform produced half their distance to anterior clypeal margin; clypeal and subantennal basins confluent, merely separated by a broad convexity (Fig. 17); transverse propodeal carina strongly dentiform produced medially as an erect tooth; humeri of prothorax weakly developed (less than 0.85 width of head); ocellocular distance three times the ocellar length; legs and antennæ concolorous, black like body.......... 9
8. Subantennal basin much narrower than clypeal, the subantennal ridges strongly dentiform produced at the angulate or carinate junction of the subantennal and clypeal basins (Fig. 22); transverse propodeal carina moderately or not dentiform produced medially; ocellocular distance 1.9–3.5 the ocellar length; legs and antennæ more or less castaneous, paler than body.......... 10
9. Propodeum dorsally very densely pubescent, forming a sericeous mat obscuring the areolation; wings moderately infuscated.
E. margueritæ subsp. **margueritæ** n. sp. and subsp.
9. Propodeum dorsally rather sparsely sericeous pubescent, not obscuring the areolation; wings subhyaline.
E. margueritæ subsp. **xanthocephala** n. sp. and subsp.
10. Ocelli quite small, the ocellocular distance 3.4–3.5 the ocellar length,

[10] *E. californica* may be sought here, since its hypopygium is buff or yellow-buff throughout. It differs from all of the species falling in this couplet by the infuscated vestiture of the mesonotum, disk of second abdominal tergite, and of the distal abdominal segments.

the interocellar distance 2.3–2.4 the ocellar length; dorsal propodeal face devoid of dense sericeous vestiture; dorsum of pronotum not rounded into the anterior, polished face.

E. ecarinata subsp. **neomexicana** n. sp. and subsp.

10. Ocelli, moderate, the ocellocular distance 1.8–2.7 the ocellar length, the interocellar distance 1.5–1.8 the ocellar length; dorsum of pronotum rounded into the anterior face, which only gradually becomes impunctate. 11

11. Dorsal propodeal face rather densely white sericeous, the pubescence obscuring the areolation; ocelli moderate in size, the ocellocular distance 2.1–2.7 the ocellar length; transverse propodeal carina relatively distinct, medially produced into an erect tooth usually. Texas to Mexico....... **E. ecarinata** subsp. **ecarinata** n. sp. and subsp.

11. Dorsal propodeal face sparsely sericeous, the vestiture not obscuring the areolation; ocelli large, the ocellocular distance 1.8–2.1 the ocellar length; transverse propodeal carina obsolete, medially not at all dentiform produced. Arizona.

E. ecarinata subsp. **pima** n. sp. and subsp.

12. Tegulæ strongly longitudinally carinate, roof-like; humeri strongly produced, sharp and acute, but with the oblique ridges of the lateral pronotal faces low and weakly developed; hypopygium black; dorsal propodeal face densely sericeous, separated from posterior face by a weak transverse ridge that is dentiform medially.

E. tegulicia Bdly.

12. Tegulæ evenly convex, at most obtusely ridged on basal fourth, never roof-like; if humeri strongly produced, the lateral pronotal oblique ridges are sharp and high; dorsal propodeal face obscurely or not sericeous pubescent, not with a median erect tooth 13

13. Lateral pronotal faces with the oblique ridges running back from below the humeral angles weak or vestigial, obscured by fine sericeous vestiture, humeri little produced, not acute or dentiform 14

13. Lateral pronotal faces with the oblique ridges sharp, acute, distinct, not obscured by fine decumbent vestiture; humeri rather strongly produced, acute, subdentiform, ocelli moderately small, the interocellar distance about 2.0 times the ocellar length; the ocellocular distance about 2.75 the ocellar length; distal tergites silvery pubescent .... *E. conchate* Mickel

14. Ocelli large, the length of the ocellocular distance less than 2.0 their length; eyes large, the eye-length distinctly greater than their distance apart below inner excision, their distance apart above the inner excision 1.3 the eye-length; tegulæ small, with rather strong, obscure sculpture; abdominal segments 3–7 dorsally, and hypopygium fuscous pubescent; hypopygium buff-yellow, or light fuscous .... **E. argenticeps** n. sp.

14. Ocelli small or minute, the ocellocular distânce 3.1–5.0 times the ocellar length; eyes smaller, length distinctly less than distance apart

below excision, their distance apart above excision 1.5–1.6 the eye-length; tegulæ larger, smoother; segments 3–7 and hypopygium silvery pubescent; hypopygium black or nearly 15

15. Ocelli minute, the ocellocular distance 4.5–5.0 their length; subantennal carinæ "each with a weak median tooth," the subantennal and clypeal basins not sharply separated (Fig. 22). Colorado. *E. grisea* subsp. *grisea* Bdly.

15. Ocelli small, the ocellocular distance 3.0–4.1 their length; subantennal carinæ with a strong median tooth on each side, connected by a high sharp ridge (the portions of the subantennal carina dorsad of the lateral teeth often obsolete) (Figs. 14–15). Utah and Montana eastward and northward.........*E. grisea* subsp. **fuscosericea** n. subsp.

16. Mandibles normal, slender, lacking a dorsal molar region, bidentate distally (Fig. 24); mandibular maximum width distinctly less than height of clypeal basin; malar space obsolete. Species Group PAUXILLA 17

16. Mandibles stout, dilated, with a dorsal, rounded molar tooth, thus tridentate-truncate at apex (Fig. 11); mandibular maximum width greater than height of clypeal basin; malar spaee moderately long; hypopygium pale yellow; genal carinæ weak. Species Group EURYGNATHUS 28

17. Gaster orange throughout, contrasted to the entirely black head and alitrunk; hypopygium fuscous; clypeal basin separated from subantennal pit by a transverse high carina (Fig. 9); tegulæ polished, smooth, with few, scattered, coarse, punctures ...... *E. copano* (Blake)

17. Gaster not unicolorous ferruginous or orange (or head and alitrunk also largely reddish) 18

18. Posterior coxæ spinose-dentiform produced on their inner sides; hypopygium pale; tegulæ with only few, scattered moderate punctures; propodeum obscurely transversely divided; integument black throughout .... **E. spinifera** n. sp.

18. Posterior coxæ simple, normal, unarmed 19

19. Hypopygium fuscous or black (at base occasionally merely a light buff); humeri usually strongly produced (0.9 or more the head width); sculpture usually very coarse; tegulæ not coarsely punctured throughout 20

19. Hypopygium ivory-white throughout (at most buff on distal fourth); humeri usually weakly produced; suprascrobal ridges weak; ocelli small or moderate, the ocellocular distance 3.5–2.2 the ocellar length, the interocellar distance 2.0–1.4 the ocellar length; tegulæ coarsely sculptured throughout, usually confluently so (except for narrow lateral margins) (Fig. 37); sculpture moderate, that of second tergite of distinct, sharp, close punctures; genal carinæ moderate, with the submandibular, transverse prolongation weak normally; entirely black, with black legs 27

20. Largely or entirely ferruginous; base of antennal tubercles each with

a sharp dorsal ridge that runs out obliquely to the eyes; ocelli small. Florida 21

20. Totally black (at most second abdominal segment reddish or orange); suprascrobal ridges running up and out from antennal tubercles weak or moderate (Fig. 24) 22

21. Head and alitrunk totally ferruginous. Central and southern Florida peninsula ...... **E. stenognatha** subsp. **stenognatha** n. sp. and subsp.

21. Head and alitrunk largely or entirely black (only the mesonotum and pronotum ferruginous throughout). Northern Florida.
E. stenognatha subsp. **psephenophora** n. subsp.

22. Ocelli minute, length of ocellocular distance 3.0–3.1 the ocellar length (Figs. 24, 37); eyes small, not broadly impinging on frons (eye-length 0.9–1.0 their distance apart below emargination) (Fig. 24); hypopygium black; body totally black; subantennal pit evenly declivous into the clypeal, without a transverse carina bounding it below (Fig. 24); tegulæ rather strongly but obtusely ridged for most of their length; legs black 23

22. Ocelli large, length of ocellocular distance 1.6–2.2 the ocellar length; eyes larger, impinging on frons (eye-length 1.1–1.2 the interocular distance below eye-emargination); hypopygium castaneous or buff; second segment frequently reddish; subantennal pit more or less distinctly separated by a low or high transverse carina from the clypeal basin (Fig. 5); tegulæ nearly evenly convex; legs castaneous 24

23. Petiole with dorsal and anterior faces at an obtuse angle, not separated by a sharp, erect, crenulate ridge (as in Fig. 37); mesopleura sparsely silvery sericeous; second tergite of abdomen with punctures sharp and very coarse; tegulæ weakly to moderately ridged or folded, not strongly roof-like. Florida.
E. sabaliana subsp. **sabaliana** n. sp. and subsp.

23. Petiole with dorsal and anterior faces sharply separated by a distinct crenulate ridge; mesopleura rather densely sericeous; second tergite with punctures extraordinarily coarse, rather ill-defined and shallow; tegulæ very strongly, acutely folded nearly their entire length. Georgia ....*E. sabaliana* subsp. **fattigi** n. subsp.

24. Second abdominal tergite with small, distant punctures, with wide polished intervals separating them; transverse ridge separating subantennal pit and clypeal basin low or vestigial; ocelli small, the ocellocular distance 2.2–2.9 the ocellar length; totally black (except for castaneous legs); distal silvery fringe of tergite two very sparse, inconspicuous; humeri moderate (width 0.77–0.83 head). Transition-Upper Austral.
E. battlei subsp. **transitionalis** n. subsp.

24. Second abdominal tergite with coarse, more close punctures, with narrower polished intervals; transverse ridge separating subantennal and clypeal basins high and erect; second segment fre-

quently partly or entirely red; distal fringe of tergite two moderate to full; humeri strongly produced (width 0.85–0.95 head width). Lower Austral-Sabalian 25

25. Ocelli small, length of ocellocular distance 2.5–2.6 the ocellar length; second segment ferruginous on sides; Northern Coastal Plain. *E. battlei* subsp. **microcellaria** n. subsp.
25. Ocelli large, length of ocellocular distance 1.4–2.3 the ocellar length. Lower Austral and Sabalian 26
26. Second segment ferruginous entirely or largely. Coastal Plain. *E. battlei* subsp. *battlei* Bdly.
26. Second segment black pigmented like rest of gaster. Piedmont. *E. battlei* subsp. **confusa** n. subsp.
27. Humeri weakly developed, the thorax at humeri 0.76–0.86 the head width; humeral prothoracic width 0.74–0.82 the tegular prothoracic width; ocelli smaller, the ocellocular distance 3.45–2.50 the ocellar length; transverse subantennal carina totally absent (Fig. 12). North and east of Texas..... *E. pauxilla* subsp. *pauxilla* Bdly.
27. Humeri more strongly developed, the thorax at humeri 0.86–1.02 the head width; humeral prothoracic width 0.82–0.87 the tegular prothoracic width; ocelli larger, the ocellocular distance 2.2–2.5 the ocellar length; transverse subantennal carina often weakly developed (Fig. 13). Texas .... *E. pauxilla* subsp. **texanella** n. subsp.
28. Totally black; propodeum strongly divided into a dorsal and posterior face by a transverse ridge; mandible with molar region very broadly dilated, wider than the rest of mandible (Fig. 11); clypeal basin transversely oval, depressed (Fig. 11); entirely silvery pubescent .... **E. eurygnathus** n. sp.
28. Totally ferruginous (except for appendages); propodeum weakly or moderately divided by a transverse ridge; mandible with a moderately developed molar region, not wider than the lower half of mandible; clypeal basin triangular, not depressed; malar space shorter; vertex and thoracic dorsum largely fuscous pubescent. *E. slossonæ* (Fox)

KEY TO FEMALES[11]

1. Hypopygium armed with an elevated V-shaped, biramose process sharply defined by carinæ; pygidial area setigerously punctured throughout, obscured by dense decumbent silvery vestiture, laterally

[11] Since the females in most cases have not been correlated with the males, they form a separate and discrete taxonomic problem, hence are treated as a unit here. The females of the species that are known, are described together with their males, but are keyed out here. It is to be noted that it has not been possible to divide the females into complexes clearly corresponding to those set up for the males, and therefore a different set of "species complexes" are set up for them.

defined by carinules; hypostomal-postgenal carinules connecting the hypostomal teeth with the occipital carina complete, dilated to form low lamellæ near the occipital carina; tergites 2–5 with broad, dense bands of silvery sericeous vestiture, interrupted medially by dark hairs .... **E. tumacacori** n. sp.

1. Disk of hypopygium lacking an obvious V-shaped elevation (Figs. 27–39, 32–33); pygidial area impunctate, nitid or weakly granulose-punctate (Figs. 26, 31); postgenal carinules not dilated above, if complete (Figs. 40–41); abdominal tergite two at apex with a wide silvery sericeous interrupted band, but no such bands on subsequent tergites 2

2. Pygidial area obsolete or undefined, evenly declivous laterally, (Fig 34), nitid (at most with an inconspicuous delicate carinule on each side on the distal 1/12 of the tergite); front and vertex conspicuously pale golden pubescent (Fig. 25); second tergite with a pair of similar (sometimes obsolete) distal maculæ (Fig. 25); hypopygium subentire to more or less tridentate at apex (Fig. 33); hypostomal-postgenal ridges complete, attaining the occipital carina on either side; disk of abdominal tergite two excessively closely, deeply, sharply punctured, the transverse intervals obsolete and the punctures subconfluent 3

2. Pygidial area clearly defined by lateral carinules for $\frac{1}{3}$–$\frac{1}{5}$ the length of the last tergite (Figs. 26, 31, 35); hypopygium broader, more or less truncate at apex, or bidentate-emarginate at tip (Fig. 27–30, 32, 36); disk of tergite two with slight to obvious intervals 4

3. Head a brilliant golden pubescent, even on lower front; sericeous decumbent vestiture of abdominal terga 3–5 uniformly fuscous, dark: lacking white patches near center of segment; maculæ of abdominal tergum two, obvious. Texas .... *E. sudatrix* (Mel.)

3. Head dull pubescent; either ivory yellow or fuscous, the lower front yellowish to white pubescent; sericeous decumbent vestiture of terga 3–5 fuscous, except for a small (rarely obscure) spot on each side of midline, of silvery hairs; maculæ of tergum two of abdomen small, obscure. Florida to Pennsylvania. (*E. margueritæ*) 3a

3a. Head with front and vertex with fuscous to burnt-golden erect stiff, and decumbent, sericeous hairs; maculæ of tergum two of abdomen dull golden; erect hairs of terga 3–5 entirely fuscous (except for a few hairs of extreme lateral margins, which are silvery). Florida. **E. margueritæ** subsp. **margueritæ** n. sp. and subsp.

3a. Head with front and vertex with pale yellowish white to ivory colored, erect stiff, and decumbent, sericeous pubescence; maculæ of second abdominal segment whitish; erect hairs of terga 3–6 largely or entirely whitish (or partly pale golden). South Carolina to Pennsylvania........ **E. margueritæ** subsp. **xanthocephala** n. sp. and subsp.

4. Front and vertex with short, curly, fine sericeous hairs (usually obvious

and rather dense), arising from punctulations interspersed among the intervals between the normal, coarser punctures; disk of second abdominal tergite usually with a pair of maculæ (as in Fig. 25) of similar hairs (these often vestigial, occasionally lacking); tergites 3–5 of abdomen, and propodeum, frequently with a longitudinal median line of silvery, decumbent, brilliant hairs; apical border of tergite two of abdomen sometimes undulate and very unequally wide 5

4. Front and vertex with only the coarse setigerous punctures, from each of which arises a suberect long hair, the intervals virtually or quite devoid of punctulations giving rise to decumbent, fine sericeous hairs; disk of tergite two usually quite lacking all trace of maculæ; propodeum and distal abdominal tergites never with a median line of silvery hairs........ 13

5. Postgenal carinules complete, extending upward unbroken from the teeth opposite the base of the mentum (Fig. 41); eyes relatively large, the interocular minimum distance of front 1.0–1.2 (1.3) the eye-length; head with a dense vestiture of golden or whitish hairs 6

5. Postgenal carinules extending only a short distance upward from the teeth at their lower ends, then becoming obsolete (the genæ and postgenæ thus evenly continuous, usually broadly so); eyes smaller, the interocular distance 1.32–1.60 the eye-length 9

6. Maculæ of disk of second abdominal tergite large, obvious (as in Fig. 25); propodeum with three narrow, obscure longitudinal lines of silvery hairs; terga 3–5 of abdomen with a similar median line of silvery hairs; eyes large, the minimal interocular frontal distance 1.0–1.2 the eye-length; basal hypopygial tubercles or transverse ridge obscure or lacking 8

6. Maculæ of disk absent; propodeum not trilineate with pale hairs; distal terga of abdomen lacking a median line of silvery hairs; basal hypopygial tubercles connected by an obvious, glabrous transverse carinule (Fig. 36) 7

7. Head with a dense vestiture of sericeous, glittering yellowish or golden hairs and front and vertex ....**E. baboquivari** n. sp.

7. Head with a sparse vestiture of decumbent hairs, silvery on front and lower vertex, fuscous posteriorly on vertex, the sparse erect hairs fuscous to blackish ....*E. yucatana* (Blake)

8. Head golden or golden-yellow pubescent; front closely contiguously punctured; hypopygium distinctly quadridentate, the distal half closely, confluently punctured ....**E. auricapitis** n. sp.

8. Head white or ivory-white pubescent; front not contiguously punctured; hypopygium not distinctly quadridentate, the disk with somewhat separated, rather coarse punctures ....**E. albiceps** n. sp.

9. Hypopygial basal tubercles not connected by a sharp transverse ridge, the base of the hypopygium thus only obscurely bituberculate (as

in Figs. 29–30); second tergite with a pair of obsolete maculæ; tergites 3–5 entirely fuscous pubescent; New York to Illinois s. to Colorado 10

9. Hypopygial basal tubercles connected by a welt-like glabrous transverse ridge (thus appearing carinate but not bituberculate) (Fig. 36) (California e. to Florida) 11

10. Vertex and front with the erect and decumbent vestiture fuscous, obscure; disk of second tergite of abdomen with punctures close; broad apical margin of second abdominal tergite with integument concolorous with that of disk of tergite; N. Y. to Illinois and westward .... *E. conchate* Mickel.

10. Vertex and front with entirely white vestiture, rather brilliant but thin; disk of second tergite with punctures well separated; integument of broad apical margin of second tergite, beneath distal pale band, pale testaceous, not concolorous with that of disk of tergites.
E. coloradella n. sp.

11. Head brilliant silvery pubescent; second tergite with similar, vestigial maculæ, with the apical sericeous band very unequally wide,strongly undulate. California .... **E. argenticeps** n. sp.

11. Head fuscous to golden pubescent; second tergite, except for the median interruption, with the distal sericeous band subequally wide, not undulate; disk of second tergite quite immaculate. Eastern 12

12. Head with decumbent microsetigerous vestiture dull, more or less fuscous or griseous-fuscous. Florida.
E. floridana subsp. **floridana** n. sp. and subsp.

12. Head with decumbent microsetigerous vestiture yellowish-tinged, relatively brilliant. Alabama-Mississippi.
E. floridana subsp. **dietrichi** n. sp. and subsp.

13. Pygidial area very narrow, elongate oval, distinctly granulose, dull, 1/7–1/9 the width of the front between the eyes (Fig. 31); tergites 3–5 infuscated pubescent (except for the extreme lateral margins), only the pygidial tergite silvery pubescent; genal-postgenal carinules complete, discrete (as in Fig. 41); front 1.36–1.48 the eye length; puncturation of head, alitrunk and disk of tergite two not contiguo-confluent 14

13. Pygidial area relatively broadly U-shaped, smooth and more or less nitid, $\frac{1}{3}$–$\frac{1}{6}$ the width of the front (Fig. 26); puncturation of head, alitrunk and disk of tergite two moderate contiguo-confluent (except in unusually small individuals) 15

14. Pleura of alitrunk contiguously, coarsely punctured (the punctures much closer than on genæ); apex of second abdominal tergum with the sericeous band of decumbent hairs vestigial, except near lateral margins. Arizona.
E. minuta subsp. **modesta** n. sp. and subsp.

14. Pleura medially with the very coarse punctures slightly separated (little closer than on genæ); apex of tergum two with a distinct,

wide, dense silvery sericeous band, interrupted narrowly in the middle. Texas .... *E. minuta* subsp. **minuta** n. subsp.

15. Genal-postgenal carinules complete (Fig. 41), not disappearing above the high, lamellate hypostomal ridges, nor reduced to obscure vestiges (the genæ and subgenæ thus sharply separated from each other, with the puncturation of the genæ never extending onto the postgenæ); disk of tergum two with relatively fine, very regular, extremely close, contiguo-confluent puncturation, the vestigial intervals between punctures sharp and blade-like: the punctures not or scarcely coarser than those of head, as close as those of dorsum of alitrunk; abdominal terga 3–5 largely or entirely fuscous pubescent 20

15. Genal-postgenal carinules incomplete (Fig. 40), disappearing shortly above the angulations of the hypostomal ridges, or continued above as obscure, obsolete vestiges (the genæ and postgenæ thus at least narrowly continuous, with the puncturation of the genæ more or less extended onto lateral margins of postgenæ); disk of tergum two of abdomen with relatively coarse, distinct punctures: the punctures separated by discrete, flat-topped, nitid intervals (at most with transverse interval-sectors reduced and punctures more or less contiguous longitudinally), the punctures normally coarser than those of vertex, about as coarse as those of alitrunk (but much less close); abdominal terga 4–5 or 3–5 largely silvery pubescent (rarely 4–5 fuscous pubescent) 16

16. Eyes small: the front between them 1.30–1.60 the eye-length (Fig. 38); eye-length 1.3–1.8 the malar distance; head-width normally 1.64–1.79 the frontal distance between eyes 17

16. Eyes large, silvery, the front between them 1.17–1.21 the eye-length (as in Fig. 39); eye-length 1.9–2.1 the malar distance; puncturation very coarse, especially of disk of tergum two of abdomen 19

17. Disk of second tergum of abdomen with coarse, longitudinally contiguous or locally contiguo-confluent punctures: the punctures somewhat elongate; terga 3–6 with integument castaneous or infuscated, with the dark pigmentation more or less extended over segment two (at least the lateral and distal portions of tergum two castaneous to piceous, often the entire tergum concolorous with distal segments); lateral portions of pygidial tergum with close, but narrowly separated setigerous punctures, the intervals discrete; head often piceous .... *E. puteola* (Blake)[12]

17. Disk of tergum two with circular, distinctly separated punctures (longi-

[12] I have recently been able to study the type (December, 1949), but was unable to compare it with other specimens. The head is mounted separated from the body and is partly obscured by glue: hence no accurate cephalic measurements could be made; in all other characters the type agrees perfectly with the above characteristics. This represents, almost without question, the female sex of *pauxilla* Bdly.

tudinal intervals never obsolete), the punctures usually moderate in size; entire second abdominal segment bright orange-ferruginous and quite concolorous with alitrunk: never showing any trace of infuscation, even posteriorly; lateral portions of pygidial tergum largely contiguously punctured, dull 18

18. Segments 3–6 of abdomen fuscous: contrasted to the second segments; head with punctures slightly separated, even on front; terga 3–4 of abdomen with largely fuscous vestiture; head generally deep ferruginous. N. J. to Ga. .... **E. spinifera** n. sp.

18. Segments 3–6 of abdomen with integument orange-ferruginous, quite concolorous with second segment and with alitrunk; head with punctures contiguous, at least on front; terga 3–4 with vestiture silvery to golden; head orange-ferruginous. Texas. *E. copano* (Blake)

19. Integument ferruginous to deep ferruginous throughout, the antennæ and legs (and sometimes apical abdominal segments) often somewhat deeper pigmented; vertex and occiput with more or less fuscous, erect vestiture; pygidial area polished, virtually smooth. Florida .... *E. slossonæ* subsp. *slossonæ*

19. Integument yellowish-testaceous, the antennæ, legs and distal abdominal segments no darker; vertex and occiput with golden erect hairs; pygidium weakly, obscurely shagreened or granulose-punctate. Texas .... *E. slossonæ* subsp. **monochroa** n. subsp.

20. Eyes large: the front between the eyes only 1.17–1.21 the eye-length (as in Fig. 39); malar length 0.4–0.45 the eye-length. **E. tentativa** n. sp.

20. Eyes smaller, the front 1.33–1.50 the eye-length (as in Fig. 38); malar distance 0.58–0.64 the eye-length .... *E. scrupea* Say

PLATE I.

Figure 1. Wings of *Ephuta pauxilla,* with wing venation according to the Comstock-Needham System.

Figure 2. Subantennal carinæ of *Ephuta scrupea* Say (common, generalized type).

Figure 3. Subantennal carinæ of *Ephuta scrupea* Say (common, slightly derivative type).

Figure 4. Subantennal carinæ of *Ephuta scrupea* Say (rarer, highly derivative type).

Figure 5. Subantennal carinæ of *Ephuta battlei* subsp. *battlei* Bradley.

Figure 6. Subantennal carinæ of *Ephuta tegulicia* Bradley.

Figure 7. Subantennal carinæ of *Ephuta stenognatha* n. sp.

Figure 8. Subantennal carinæ of *Ephuta stenognatha* n. sp. (variant).

Figure 9. Subantennal carinæ of *Ephuta copano* (Blake).

Figure 10. Frontal view of head of *Ephuta cephalotes* n. sp.

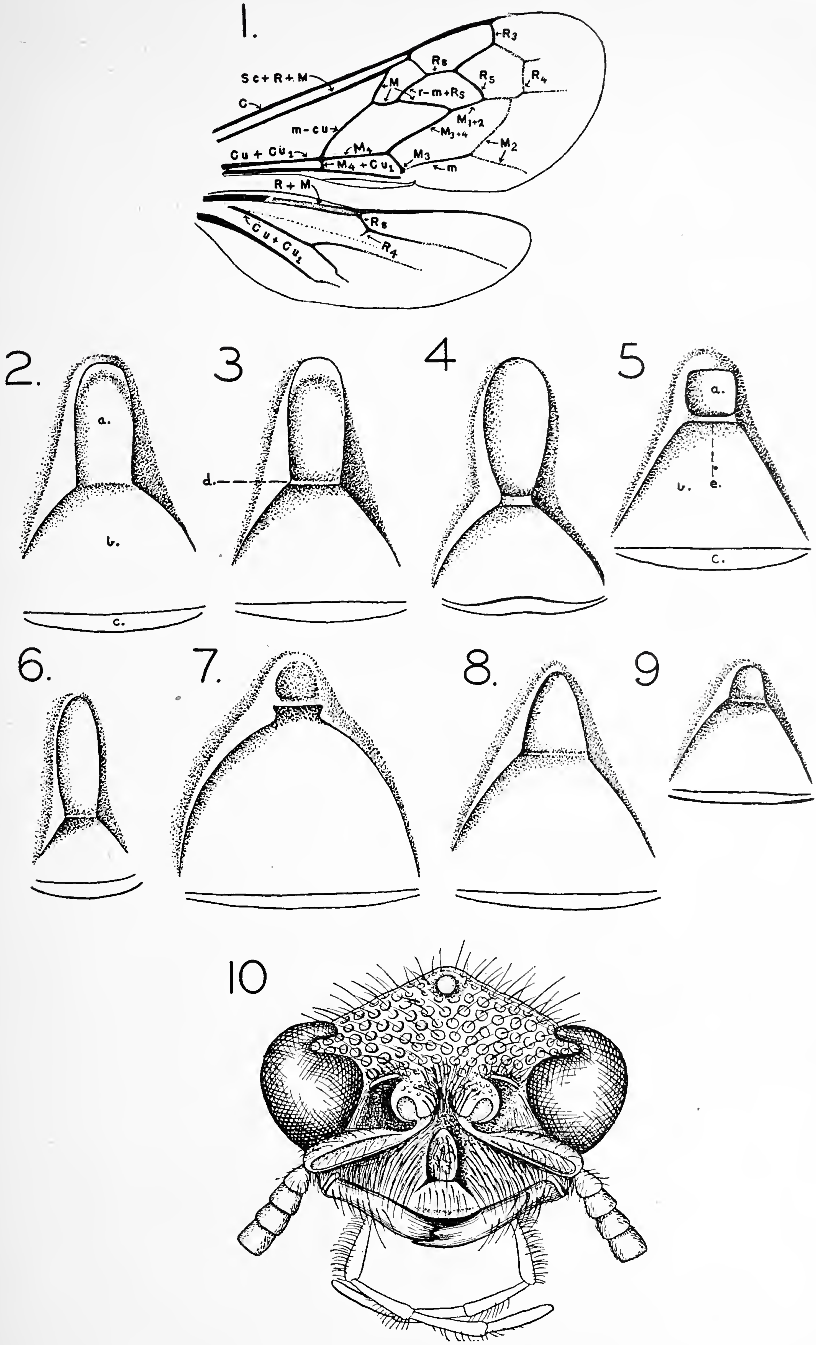
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PLATE II.

Figure 11. Frontal view of head of *Ephuta eurygnathus* n. sp.

Figure 12. Subantennal carinæ of *Ephuta pauxilla* subsp. *pauxilla* Bradley.

Figure 13. Subantennal carinæ of *Ephuta pauxilla* subsp. *texanella* n. subsp. (extreme form).

Figure 14. Subantennal carinæ of *Ephuta grisea* subsp. *fuscosericea* n. subsp. (generalized type).

Figure 15. Subantennal carinæ of *Ephuta grisea* subsp. *fuscosericea* n. subsp. (derivative type).

Figure 16. Subantennal carinæ of *Ephuta conchate* Mickel n. subsp.

Figure 17. Subantennal carinæ of *Ephuta margueritæ* n. sp.

Figure 18. Subantennal carinæ of *Ephuta ocellaria* n. sp.

Figure 19. Subantennal carinæ of *Ephuta rufisquamis* André.

Figure 20. Subantennal carinæ of *Ephuta cephalotes* n. sp.

Figure 21. Subantennal carinæ of *Ephuta grisea* subsp. *grisea* Bradley.

Figure 22. Subantennal carinæ of *Ephuta ecarinata* subsp. *ecarinata* n. sp. and subsp.

Figure 23. Subantennal carinæ of *Ephuta tegulicia* Bradley.

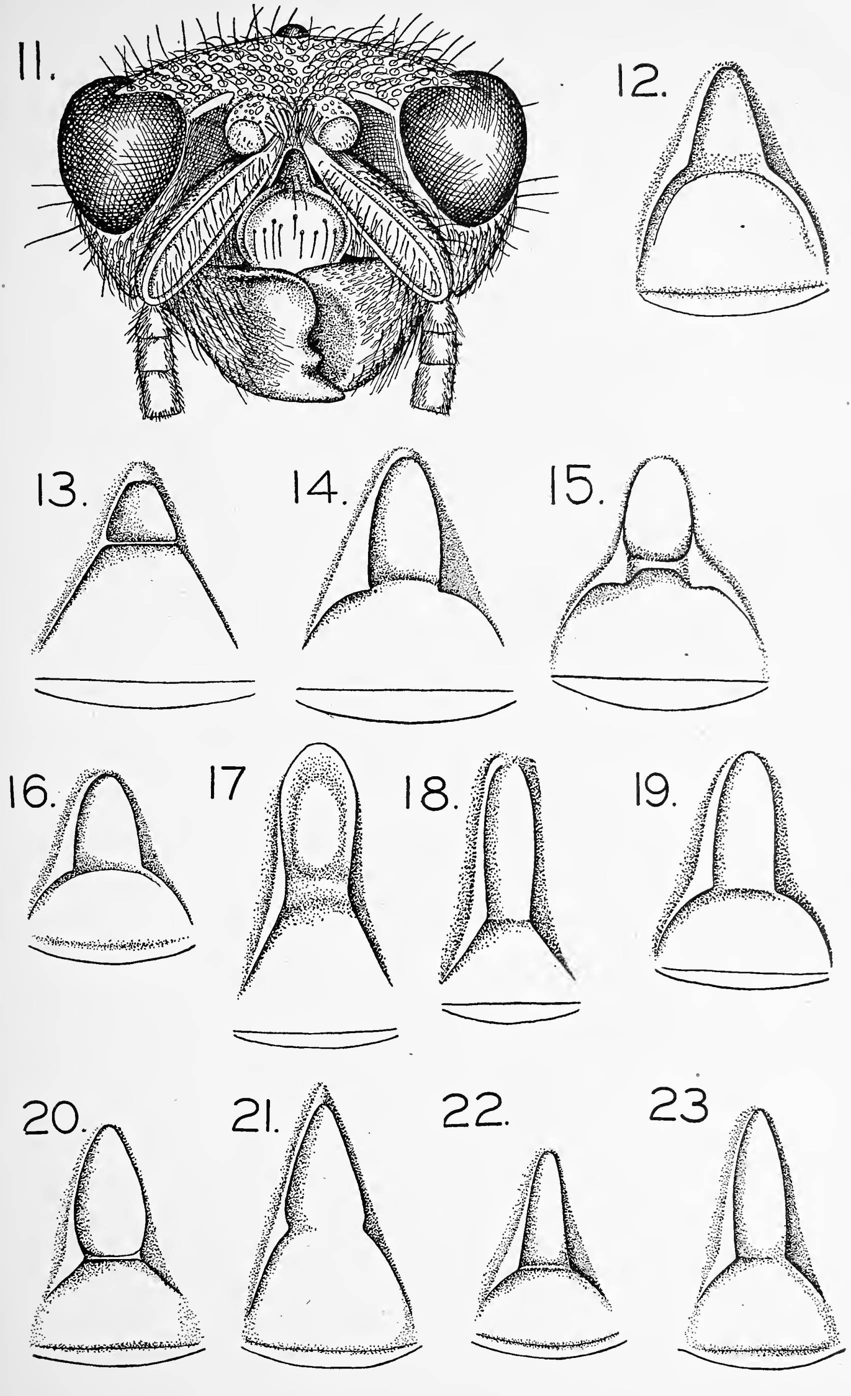
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PLATE III.

Figure 24. Head (frontal view) of *Ephuta sabaliana* subsp. *sabaliana* n. sp. and subsp.

Figure 25. Dorsum of *Ephuta margueritæ* subsp. *xanthocephala* n. sp. and subsp.

Figure 26. Pygidial tergite of *Ephuta puteola* (Blake) (form b).

Figure 27. Ventral view of last sternite of *Ephuta scrupea* Say (form b).

Figure 28. Dorsal aspect of hypopygial sternite of *Ephuta scrupea* Say (form a).

Figure 29. Ventral aspect of hypopygial sternite of *Ephuta scrupea* Say (form a).

Figure 30. Ventral aspect of hypopygial sternite of *Ephuta scrupea* Say (form a).

Figure 31. Pygidial tergite of *Ephuta minuta* subsp. *modesta* n. sp. and subsp.

Figure 32. Hypopygial sternite of *Ephuta minuta* subsp. *modesta* n. sp. and subsp.

Figure 33. Hypopygial sternite of *Ephuta sudatrix* (Melander).

Figure 34. Pygidial tergite of *Ephuta sudatrix* (Melander).

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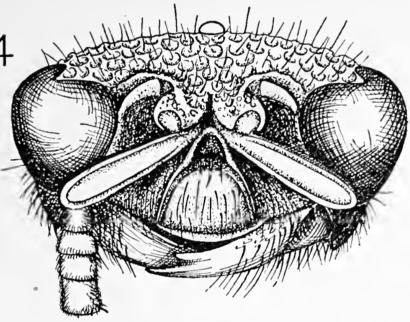

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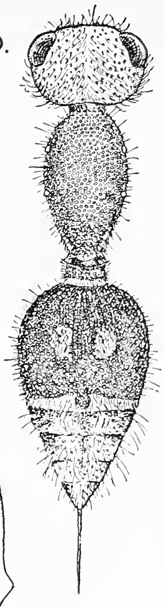

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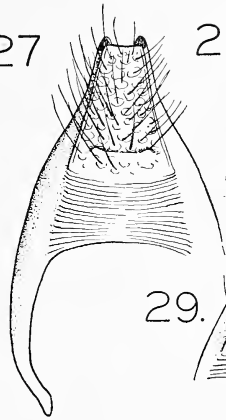

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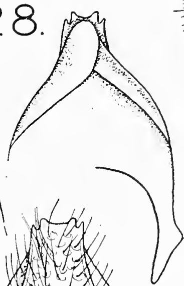

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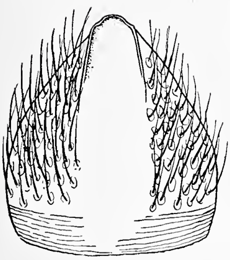

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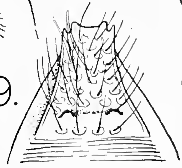

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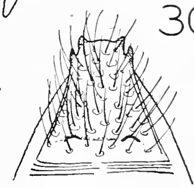

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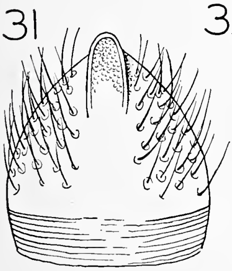

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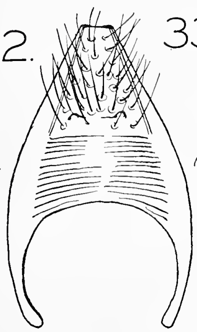

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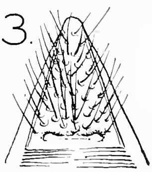

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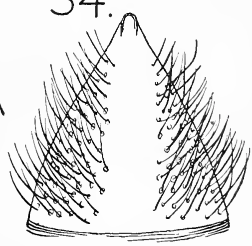

PLATE IV.

Figure 35. Pygidial tergite of *Ephuta floridana dietrichi* n. sp. and subsp.

Figure 36. Hypopygial sternite of *Ephuta floridana dietrichi* n. sp. and subsp.

Figure 37. Lateral view of male *Ephuta pauxilla* subsp. *pauxilla* Bradley.

Figure 38. Frontal view of head of *Ephuta puteola* (Blake).

Figure 39. Frontal view of head of *Ephuta baboquivari* n. sp.

Figure 40. Ventral view of head of *Ephuta puteola* (Blake).

Figure 41. Ventral view of head of *Ephuta baboquivari* n. sp.

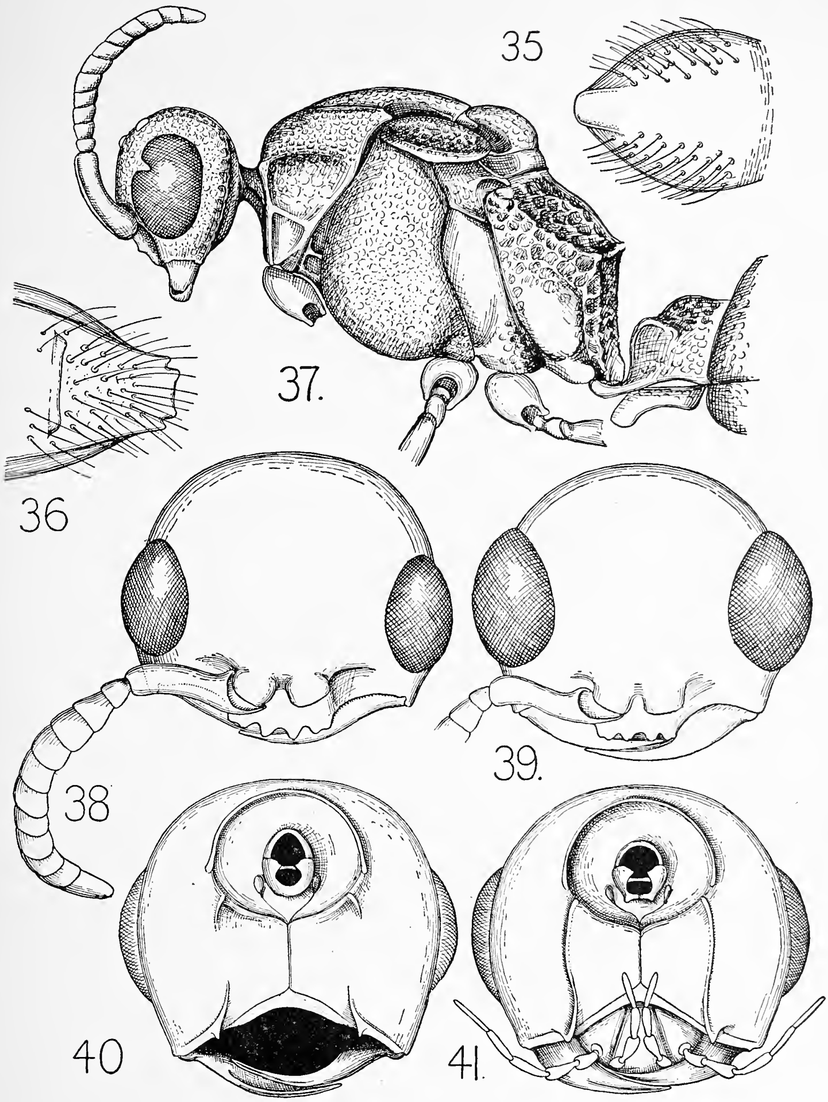
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PLATE V.

DISTRIBUTION MAPS

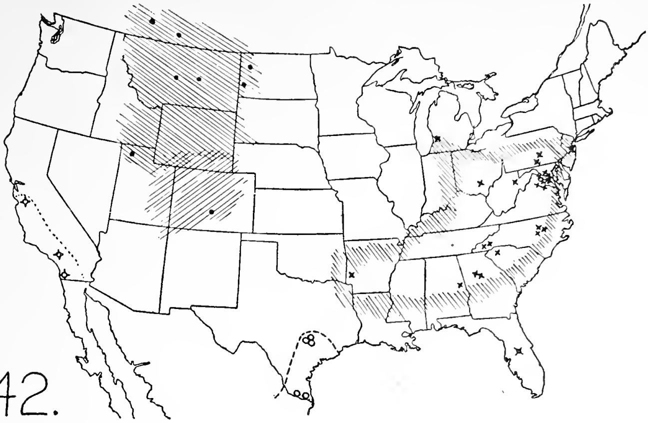
Figure 42. Range of *E. grisea*
(subsp. *grisea:* diagonal lines; northeast to southwest).
(subsp. *fuscosericea:* diagonal lines; northwest to southeast).
Range of *E. scrupea* (males): plain crosses.
Range of *E. floridana:* crosses with solid centers.
Range of *E. tegulicia:* plain circles.
Range of *E. argenticeps:* four-armed circles.

Figure 43. Range of *E. pauxilla* (males)
(subsp. *pauxilla:* diagonal lines; northeast to southwest, with solid dots).
(subsp. *texanella:* diagonal lines; northeast to southeast, with solid center crosses).

Figure 44. Range of *E. battlei*
(subsp. *transitionalis:* horizontal lines; plain crosses).
(subsp. *microcellaria:* horizontal lines; solid center crosses).
(subsp. *confusa:* vertical lines; plain circles).
(intergrades between *battlei* and *confusa:* circles with solid centers).
(subsp. *battlei:* diagonal lines; northwest to southeast, with dots).
Range of *E. sabaliana:*
(subsp. *sabaliana:* plus signs).
(subsp. *fattigi:* quartered square).

Figure 45. Range of *E. spinifera:* circles.
Range of *E. stenognatha*
(subsp. *stenognatha:* solid dots).
(subsp. *psephenophora:* crosses).

Figure 46. Range of *E. cephalotes:* diagonal lines; northwest to southeast, with circles.
Range of *E. margueritæ:* horizontal lines; crosses.
(subsp. *margueritæ:* vertical lines; crosses).
(subsp. *xanthocephala:* solid center; crosses).
Range of *E. conchate* (males): diagonal lines; northeast to southwest, with dots.



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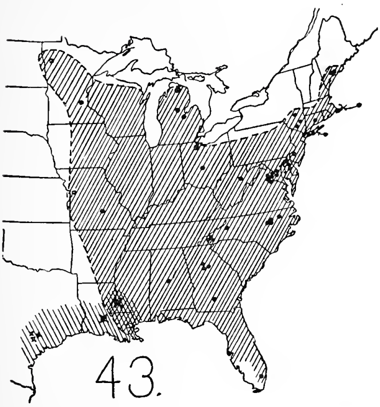

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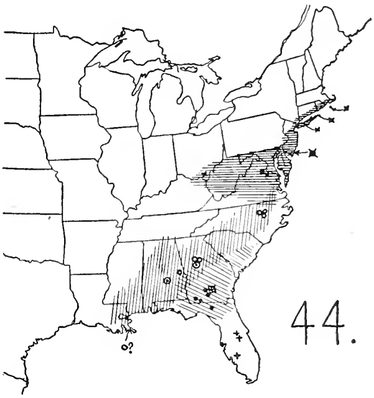

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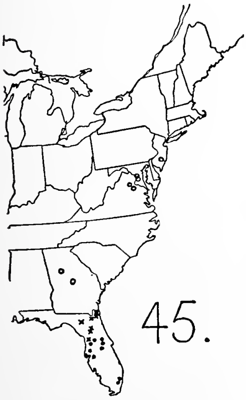

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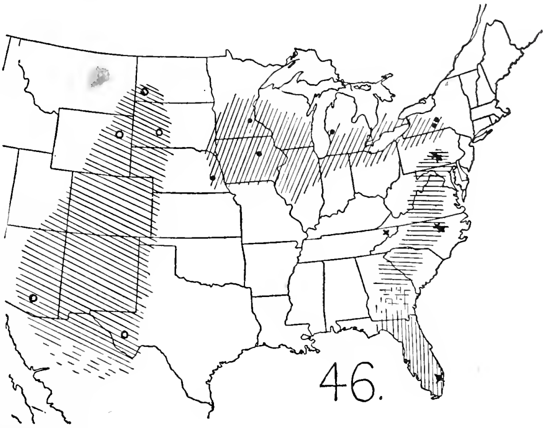

46.

BOOK NOTICE

INSECTS IN YOUR LIFE. By C. H. Curran. Sheridan House, New York, 1951. 316 p., 16 plates, $3.50.

This book is a collection of short essays on various insects and near relatives of popular interest. Fleas, clothes moths, carpet beetles, termites, butterflies and ticks all receive a bit of attention. One chapter, of 14 short pages (Insects About the House), covers house centipedes, measuring works, cluster flies, spider beetles, springtails and snowfleas, lady beetles, silverfish, elm leaf beetles and fall webworm. Yet, in this small space the author succeeds in answering, conversationally, many of the questions commonly asked by the housewife. Another chapter of 14 pages "On Eating Insects" will, no doubt, cause the housewife to add to the list of questions commonly asked of the entomologist. The European Hornet, *Vespa crabro,* is treated as "the Rival of the Japanese Beetle" in another short chapter. Some 12 pages are spent on woolly bear caterpillar exploration, conducted in cahoots with a newspaperman, while "How Flies Fly" consumes 33 pages and explains the interest of the Sperry Gyroscope Company in matters dipterological.

Along with facts, some new, some recent and some fabled, Dr. Curran's opinions are given on some highly controversial subjects. This book was certainly written for popular consumption, and if it causes the lay reader to take an interest in the subject matter and to pursue the subject further, it will probably have served its purpose.—F. A. S.

THE SECOND ANNUAL EXHIBIT OF THE NEW YORK ENTOMOLOGICAL SOCIETY

The second annual exhibit of the New York Entomological Society was held in the American Museum of Natural History, New York City, from May 16th through June 16th, 1950. It was arranged in the 77th Street Foyer of the Museum and represented material from twenty-three contributors.

As the visitor entered the Foyer his attention was commanded by a five-panel display explaining the newly recognized disease RICKETTSIALPOX. This material was shown for the first time in New York City by courtesy of the National Institutes of Health, Bethesda, Maryland and emphasized the fact that Rickettsialpox is an arthropod-borne disease.

Immediately behind these panels were three cases of exhibits designed by Miss Alice Gray. In the first case INSECT PAPER-DOLLS depicted greatly enlarged and simplified insect figures of colored paper. These ''Insect Dolls,'' including spider beetles, dermestids, and differentiating characteristics of ants and termites, were used recently as teaching aids during a pest control conference at the Museum. Some excellent paintings of Saturnid moths by Marjorie Statham were also in this case.

The second case contained material prepared by Dr. Mont Cazier and dealt with the distribution, subspeciation, and hybridization of the tiger beetle, *Cicindela scutellaris.* Watercolor paintings, illustrating hybrids between the various species, were prepared by Miss Statham. A necktie with a tiger beetle motif, designed by Miss Gray, completed the case.

The last case of this group contained entomological collecting, spreading, and mounting equipment. Pamphlets written by Miss Gray on the various aspects of insect collection techniques formed an integral part of the case material.

The photographs, paintings, charts, and drawings of the exhibit were arranged on ten Museum Beneker blocks and two cases around the far wall of the Foyer. One case showed the instruments used by Mr. A. T. Gaul in his investigations of hornet activities. These instruments included a frequency meter which is used with a microphone at the hornet nest entrance to measure wing vibration rate, an electronic counter to automatically count the hornets entering and leaving the nest, and an amplifier unit built into the counter which relays the hornet's wing vibrations to the recording machine for later analysis. The other case was used to display the books and articles written by the following Society members: L. W. Clausen, W. S. Creighton, C. H. Curran, A. T. Gaul, W. J. Gertsch, T. C. Schneirla, H. F. Schwarz, R. B. Swain, and E. W. Teale.

The following is a list of the photographs, paintings, charts, and drawings:

By G. Becker—sixteen photographs showing some of the activities of the inspectors and some of the pests which are intercepted on material coming through the Hoboken, N. J., Inspection House of the Bureau of Entomology and Plant Quarantine;

By J. Cody—six water-color paintings of moths and butterflies;

By J. Forbes, J. Tafuri, and R. Vishniac—photographs of insect anatomy;

By W. J. Gertsch—black and white plates of spider drawings and the printed plate for comparison;

By H. R. Hagan—six photographs and drawings illustrating the anatomy of viviparous insects;

By A. B. Klots—seven photographs which show various phases of research projects dealing with aircraft spraying of DDT and other insecticides sponsored by the U. S. Army during 1945–46;

By C. E. Olsen—three photographs of a plastic model of a house-fly made by him for the Boston Museum of Science;

By C. Pomerantz—a group of photographs and articles showing some of the steps taken by Dr. Jellison, Dr. Heubner, and Mr. Pomerantz in running down the causative agent and the vector of the Rickettsialpox disease epidemic in Queens, New York City, during the summer of 1946;

By T. C. Schneirla—photographs of Army ants which appeared in a recent issue of LIFE magazine;

By R. B. Swain—two large wall charts, one depicting the life history of ants and the other the life history of the honey bee, and a series of six tempera and water-color paintings used to illustrate his book THE INSECT GUIDE. These paintings and charts were executed by SuZan N. Swain;

By E. W. Teale—ten photographic studies of insects;

By R. Vishniac—six photographs of insects and insect anatomy, two of which were taken with polarized light.

Dr. Lucy W. Clausen was in charge of receiving the material and planning the exhibit. She was ably assisted by Messrs. A. Roensch, A. T. Gaul, J. Cody, and Doctors R. Vishniac and R. B. Swain. The large amount of fine material submitted by members and the very fine arrangement achieved by the committee resulted in an exhibit which was highly praised by Society members, visitors, and various Museum personnel.—J. Forbes.

CRÈVECOEUR'S FIREFLIES

In the Everyman's Library edition of "Letters From an American Farmer" by J. Hector St. John de Crèvecoeur, mention is made in the "Notes," of Crèvecoeur's three volume work "Voyage dans la Haute Pennsylvanie (sic) et dans l'Etat de New York," that was published in Paris in 1801, in which Crèvecoeur gives the following "astonishing information" about *mouches luisantes,* or fireflies. "They much resemble bees in color and size: like scarabs, they have two pairs of wings . . . when they fly, they develop a third set whence issue rays of light, which give to the lower and posterior part of their bodies the appearance of a lighted coal. . . . They do no harm and never rise to more than six feet above the ground. One can catch them easily and make use of them as a reading light." Warren Barton Blake who wrote the Introduction and probably the "Notes," in the Everyman's edition, believed that such "astonishing information" deserved perpetuation.

I am sure that, even as early as 1801, in Paris, no such belief was ever held by French entomologists, as to the source of the fire fly's light.—H. B. W.

BOOK NOTICE

A Field Guide to the Butterflies of North America, East of the Great Plains. By Alexander B. Klots. Houghton Mifflin Company, Boston, 1951. $7\frac{1}{4} \times 4\frac{1}{2}$ inches. XVI + 349 p., 40 pl., 9 line cuts, green cloth binding, $3.75.

This book, one of The Peterson Field Guide Series, by Dr. Alexander B. Klots, a skilled lepidopterist, who teaches biology in the College of the City of New York and who has long been a student of the taxonomy of Lepidoptera, is the most complete and exhaustive guide that has ever appeared.

Part 1 (pages 3–60) covers collecting, preservation, faunal regions, habitats, variations, predators, parasites, protective form and coloration, behavior, life histories, habits, structures, and classification.

Part 2 (pages 63–289) deals with resident butterflies and skippers. For every species known to breed in Eastern North America, there are given, brief larval descriptions, food plants of larvæ, the range of the species, dates, a description of the species, notes on similar species and subspecies, together with common and scientific names. Every important species is excellently illustrated, 247 of them in color.

Part 3 (pages 293–328) includes and principles of taxonomy, references to the literature and collections, and a checklist of butterflies and skippers. And in addition there are indices to general subjects and technical terms to larval food plants, and to the butterflies and skippers.

This brief summary does not by any means convey the sense of satisfaction and adequacy that comes from a close examination of Dr. Klots' book, which is an authentic presentation in compact form of innumerable facts about butterflies—all of interest, not only to beginners but to older students. With it, one can identify practically every butterfly in Eastern North America.

In this world, the skill, patience and knowledge of a few, contribute greatly to the comfort and happiness of many. In this particular instance the skill and knowledge of Dr. Klots will make the road easier and more attractive for students and teachers. His book is both readable and scientifically accurate, and it has been needed for many years.—H. B. W.

HANDY INSECT-VECTOR CAGE

BY KARL MARAMOROSCH
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During the past year a small insect-vector cage, having some advantages over cages previously described for use in plant virus transmissions, was developed. It was based on the principle described by Sikora (6) and later perfected by Weigl (7) in experiments with typhus transmitted by lice feeding through a screen. The cage was made of celluloid, like one recently described by Costa and Bennett (1) as a modification of a cage developed by Giddings (2). It employed a binder clip for suspension, like cages used by Hutchinson (3).

The cage (Fig. 1) was made from pieces of translucent Lusteroid centrifuge tubes of desired diameter and cut by a circular saw to a suitable length. One piece was cut lengthwise and glued with acetone along the cut edges so as to fit telescopically into the other one. Holes were cut with a paper punch in both parts, the end of the outer tube being covered with a round piece of screen, fixed with Duco cement. It was found (5) that a plastic screen of Lumite (produced by the Chicopee Manufacturing Corporation) allowed greater light transmission than cheesecloth or wire, was acid resistant and would not corrode. A mesh 60×60 per inch, woven from 0.005″ diameter translucent amber-colored saran monofilament, was small enough to prevent the escape of the smallest insects used in the experiments and still allowed their feeding through the screen. Two strips of cellulose nitrate, 0.02″ in thickness, were connected with a shoe eyelet at one end. Cellulose nitrate was used exclusively because cellulose acetate proved toxic for plants (4). In the upper strip a hole was cut of a diameter somewhat smaller than that of the tubing used, and covered from below with a circular piece of Lumite screen, fastened tightly with Duco cement. The lower strip was made slightly longer than the upper to simplify manipulation of the cage. The shoe eyelet connection permitted the scissor-like opening of the two parts, between which the leaf to be exposed was inserted. It also proved useful in suspending the cage on a piece of heavy wire, bent at one end, and in facilitating the cleaning of the screen.

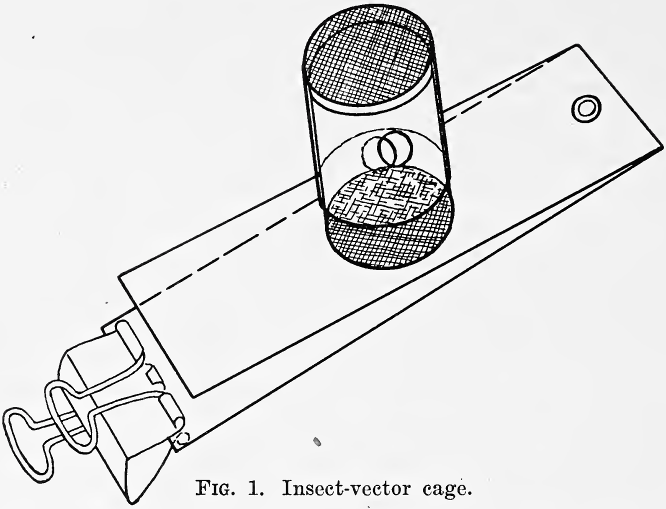

FIG. 1. Insect-vector cage.

At the opposite end the two celluloid strips were clamped together by a binder clip No. 2 to hold the cage in place on a leaf. Smaller cages adhered adequately to a leaf without a clip. After insects were inserted through the matching holes, the outer part was turned, thus closing the cage. The device permitted rapid transfer of insects from plant to plant without the necessity of catching or harming them in any way. The smallest cage, used without a clip, weighed 1.5 g (diameter 1.2 cm, height 1.8 cm); the largest (2.7 cm × 3.5 cm) weighed 11 g, clip included. For permanent numbering of cages India ink was used. Numbers were covered with a celluloid-acetone glue to prevent smearing.

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NEW SPECIES OF ANTHOPHORA FROM THE WESTERN UNITED STATES (HYMENOPTERA, APOIDEA)[1]

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The genus *Anthophora* has a world-wide distribution and is composed mostly of large, swift-flying bees that have a very long tongue. The species inhabiting North America, north of Mexico, may be separated into four groups that seem to be quite natural but certainly are not more than subgeneric in value, excepting the group called *Clisodon* by Patton. This group consists of a single holarctic species, *C. furcatus* (Panzer), which has become differentiated into several local races in both the Old and the New World. It differs from other *Anthophora* not only in habits, but also in structure of the mandibles of both sexes and in the tibial plate of the female; and in the male it lacks the apico-dorsal, strap-shaped, semimembranous appendage of the stipites, which is found in all true *Anthophora.*

The second group, called *Micranthophora* by Cockerell in 1906, embraces the smaller species that have well-developed white or yellow face-marks in both sexes.

In the past, several names have been applied to the third group, although not collectively to the whole group as distinguished here. The name *Amegilla* was adopted by Robertson in 1905 for two of our species having apical white tegumentary bands on the abdomen. *Amegilla* Friese (1897), with *Anthophora quadrifasciata* (Villers) as type, is a very different Old World group, however, lacking tarsal arolia, and in the male lacking also the stipital appendage. Its species are very numerous and have short appressed hair on the abdomen, this hair sometimes covering nearly the whole surface, but frequently forming apical bands. The clypeus of the female is usually yellow, with two large basal black marks. *Amegilla* is essen-

[1] Paper No. 669, University of California Citrus Experiment Station, Riverside, California.

tially the same as *Asaropoda*[2] Cockerell, and in my opinion should have full generic standing. In 1903 the name *Anthophoroides* was proposed by Dr. and Mrs. Cockerell for *Anthophora vallorum* (Cockerell) because of the five-jointed maxillary palpi, but this species is closely allied to other species of the group, and, presumably, the number of palpal joints may vary from five to six, as in the California species *Anthophora linsleyi* Timberlake. In 1905 Robertson proposed the generic name *Anthemoessa* for *Anthophora abrupta* Say, using the greater breadth of the third submarginal cell as the principal key character for the female, and the strongly toothed hind basitarsus for the male. The name *Anthemoessa,* strangely enough, had been used previously by Agassiz as an emendation for a Lepidopteran genus; hence, the new name *Melea* was proposed by Sandhouse in 1943. The name *Anthophoroides* Cockerell & Cockerell is available, however, and is, I believe, applicable to the whole group. The characters and constituents of this group will be discussed more fully in a subsequent paper.

The fourth group is composed of those species that are most closely allied to the type species of *Anthophora,* the *A. acervorum* (Linnæus) of Europe. With the addition of many species unknown to Robertson, the character of the breadth of the third submarginal cell proves to be valueless in distinguishing *Anthophora* (s. str.) from *Anthophoroides.* In the female the great length of the third antennal joint (at least equal to the next four and sometimes the next five or six joints combined), and the greater development of the malar space, are the two most valuable characters. These two characters usually are developed concurrently, although one or the other is sometimes more pronounced. In the male the above characters also hold, as well as certain others that are sex-limited. The legs, compared with those of typical *Anthophoroides,* are always slender, with the hind pair little modified. In one species, only, is the hind basitarsus armed with a small tooth. The middle tarsi are usually

[2] *Asaropoda* Cockerell bears the same relationships to *Amegilla* that *Saropoda* does to *Anthophora.* The two small apical joints of the labial palpi are obsolete or absent in both. It seems best to consider these subgenera, although *Saropoda* has a little more validity than *Asaropoda,* as it has the additional character of four-jointed maxillary palpi.

strongly fringed or provided with long, dense hair, and the apical joint often is ciliated on each side. It should be understood, however, that the male characters here described apply principally to the North American species, as the Old World species have various other modifications which we do not see exemplified in our species.

In this paper five new species of the typical subgenus of *Anthophora* are described from Arizona and southern California, and notes on other species of the group are included as space permits. The material here recorded is in the collection of the Citrus Experiment Station at Riverside, except as otherwise noted.

Synopsis of Species

Males

1. Apical joint of middle tarsi densely ciliated on each side with long black hair, these fringes, taken together, more or less circular and remarkably fanlike 2
   Apical joint of middle tarsi having the lateral fringes, when present, either too short or too loose to resemble a fan 4
2. Mandibles normal 3
   Mandibles cut away on each side of a rather conical apical tooth, the inferior surface near the truncation densely clothed with a tuft of short black hair .... **coptognatha** n. sp.
3. Mandibles long and black; labrum apically compressed and narrowed; pubescense white, intermixed with black on mesonotum. **vannigera** n. sp.
   Mandibles yellow except at apex; labrum broadly rounded at apex, not compressed; pubescence fulvous, or fox-red, not mixed with black on thorax .... *crotchii* Cresson
4. Apical joint of middle tarsi with a definite, although sometimes very short, fringe on each side 5
   Apical joint of middle tarsi not fringed laterally 12
5. Middle tarsi clothed on outer side with ferruginous hair, the hairs more or less flattened and clavate 6
   Middle tarsi either with a conspicuous fringe of long hair behind, or with only a few bristling hairs on outer surface; this hair never ferruginous 7
6. Face-marks white; dense ferruginous hair present at apex of middle tibiæ in front, as well as on the tarsus .... *dammersi* Timberlake
   Face-marks yellow; middle tarsi only thinly clothed with ferruginous hair on outer side .... *ursina* Cresson
7. Middle tarsi conspicuously fringed with long hair 8

Middle tarsi not fringed with long hair 10

8. Fringe of middle tarsi very long and loose 9

Fringe of middle tarsi comparatively dense, black or blackish brown, with some white hair on basitarsus; pubescence fulvo-ochreous, not mixed with black on mesonotum .... *fedorica* Cockerell

9. Fringe of middle tarsi blackish; the ciliation on each side of the apical joint long, loose, and supplemented with dorsal hairs; labrum normal, broadly rounded at apex .... *porteræ* Cockerell

Fringe of middle tarsi white, with a few black hairs on basitarsus; fringes of apical joint short, with black and white hairs intermingled; labrum with a somewhat concave, porrect, and narrowed apical part .... **pernicis** n. sp.

10. Lateral fringes of apical joint of middle tarsi short, their length not exceeding greatest width of the joint 11

Lateral fringes of apical joint of middle tarsi more than twice as long as width of joint, but loose; clypeus polished, impunctate; abdomen subfasciate .... *forbesi* Cockerell

11. Fringes of apical joint of middle tarsi equalling width of joint; pubescence ochreous to fulvous, not mixed with black on thorax; abdomen subfasciate; mandibles black .... **fulvicollis** n. sp.

Fringes of apical joint of middle tarsi shorter than width of joint; pubescence fulvo-ochreous, slightly intermixed with black on vertex and mesonotum; abdomen not at all fasciate; mandibles with a yellow spot .... **platti** n. sp.

12. Middle tarsi not fringed 13

Middle tarsi with a long, loose white fringe behind, becoming partly black on basitarsus .... *pacifica* Cresson

13. Hind basitarsi simple; tibial spurs almost straight; face-marks creamy white .... *neglecta* Timberlake and Cockerell

Hind basitarsi armed with a tooth on anterior margin; face-marks bright yellow .... *edwardsii* Cresson

Anthophora coptognatha, new species

The male of *coptognatha* is easily recognized by the unique peculiarity of the apex of the mandibles, which appears to be cut away nearly squarely on each side of a median tooth. The female resembles *A. porteræ* Ckll., but is significantly smaller and has the mesoscutum much less opaque.

MALE.—Black, the tegulæ and small joints of tarsi a little reddened. Labrum, except narrow apical margin and broader lateral margins, clypeus, large lateral face-marks, supraclypeal band, and stripe on under side of scapes, bright yellow. Apical margin of tergites 1 to 6 slightly decolored. Wings slightly dusky, with blackish stigma and nervures. Hair of head and thorax white, sparsely intermixed with black on vertex and mesonotum, moderately dense, and longest and most dense on the cheeks beneath. Long hair of supraclypeal area medially parted and extending a little obliquely outward on each side over the clypeus, which also is clothed with long hair on lateral margins. Hair of basal tergite of abdomen moderately long and white; that of following segments short and erect, white on base of tergite 2, more or less black on apical half of 2, black on tergites 3 to 5, and on base of 6, and white and appressed on apex of 6 and on 7, with the long scattered hairs of apical segments mostly light. A thin fringe of short white hair on apical margin of tergites 2 and 3, but apparent only in fresh specimens. Hair of venter and legs mostly white, but black on inner side of middle and hind tibiæ and hind femora, and the sparse hair on anterior side of front and middle femora also dark. Hair on inner side of tarsi reddish brown, but black on each margin of the basitarsi. Mandible fringed beneath with long white hair and having a tuft of very short black hair on lower side just before the truncation. Antennal joint 3 longer than the scape and nearly as long as joints 4 to 7 together, the fourth joint much shorter than the fifth. Clypeus moderately bulging and slightly dullish. Thorax dull, the mesoscutum with dense shallow punctures except for two small, nearly impunctate areas on posterior middle. Tergite 7 with a raised, projecting, nude pygidiform area, which extends nearly to the base and is narrowed and truncate at the apex. Legs normal, the apical joint of middle tarsi fringed with black hair, but the hair only slightly longer than greatest width of joint. Length, 11–12 mm.; anterior wing, 9–9.5 mm.

FEMALE.—Like the male, but face entirely dark. Hair of first two tergites white, long on tergite 1, short and with a slight admixture of black preapically on tergite 2. Tergites 3 and 4 with short black hair, and the broad apical tuft of tergite 5 and hair on each side of pygidium also black. The scattered long hair of apical segments mostly white, becoming abundant at sides of tergite 5. Hair on apical margin of tergites 1 to 4 depressed and white, forming a narrow band, but more evanescent and interrupted medially on 3 and 4. Hair of venter black, but with much white along the lateral margins. Hair of legs as in male, but hair on outer side of front basitarsi blackish and forming a rather long fringe. Antennal joint 3 a little longer than the next four joints combined. Tibial spurs of middle and hind legs gently recurved at apex. Labrum coarsely rugose in a large triangular area on disk, the apex of the triangle forming a raised point a little above the rounded apical margin. Clypeus with fine dense punctures. The two nearly or quite impunctate areas on posterior middle of mesoscutum are separated by a densely punctate line and are minutely tessellate and dull in the Arizona types and more shining in California specimens. Length, 12–13 mm.; anterior wing, 10 mm.

Holotype, male and allotype, Buckeye, Arizona, on *Lycium torreyi,* March 28, 1934 (Timberlake). Also the following paratypes: 5 males, 2 females, Buckeye, March 28–30, 1934; 2 males, Riverside, California, on *Lantana* flowers, March 3 and 12, 1936 (F. R. Platt); 1 female, near Victorville, California, on *Dalea fremontii* var. *saundersii,* May 17, 1930 (Timberlake); and 1 female, Adelanto, California, April 11, 1935 (C. M. Dammers).

In the collection of the University of California at Berkeley are four female paratypes: one, Searles Station, Kern County, California, April 25, 1949 (Linsley, MacSwain, and R. F. Smith); one, Scotty's Castle, Death Valley, March 23, 1940; one, Furnace Creek, Death Valley, on *Prosopis,* April 8, 1939 (Linsley); and one, 30 miles south of Needles, San Bernardino County, March 6, 1947 (Linsley).

Anthophora vannigera, new species.

This is similar to *A. lesquerellæ* (Cockerell) and may possibly prove to be a race of that species. It differs from the description of that species, as follows: the clypeus is broadly black on lateral margins, and a yellow supraclypeal band is present (clypeus yellow, except anterior margin, in *lesquerellæ,* and no supraclypeal mark recorded). The labrum has no median notch at apex (a small round notch in *lesquerellæ*) and is peculiarly compressed and narrowed on the apical half.

MALE.—Black, the three intermediate joints of tarsi and the tegulæ somewhat reddened. Apical margin of tergites 1 to 6 glassy hyaline. Labrum, except narrow apical margin and the usual pair of blisterlike spots, clypeus, except narrow apical margin and broad black band above on each side, supraclypeal band, large lateral marks notched above, and scapes broadly beneath, bright yellow. The black bands on clypeus slightly widened above and there separated by an interval about equal to their own width. Supraclypeal band continuous at each end with the inner fork of the lateral marks. Hair of head, thorax, and first tergite long, rather dense, and white, intermixed with black on vertex and mesonotum. Hair of tergites 2 to 5 short, erect, and black, sparsely intermixed with longer, mostly light hairs, especially on 4 and 5, but hair on tergite 2 mainly white (some black hair subapically, or hair sometimes nearly all black on apical half). Hair of tergite 6 black on basal half; otherwise, moderately long, rather sparse, and whitish, like that of tergite 7. Hair of legs white, that of middle legs very long, but hair of hind femora almost entirely, and the long hair on under margin of hind tibiæ and anterior edge of the hind basitarsi, black; some black hairs intermingled on middle femora, tibiæ, and basitarsi. The long posterior fringe on front and middle tibiæ and basitarsi mainly light. Hair on inner side of tarsi ferruginous, and the very short hair on posterior surface of hind tibiæ black, with a slight brown tinge. Apical joint of middle tarsi with a broad, dense fan of black hair. Mandibles long and crossing when closed, the apex acuminate, with the inner tooth well developed and about one third of the length of the mandible from apex. Malar space very short and transverse. Antennal joint 3 equal to the next four joints combined, and joint 4 shorter than 5. Tergite 7 obtusely angled on each side toward base and provided with a nude, elevated, and shortly projecting pygidial area which is about twice as long as wide and slightly notched at apex. Wings faintly dusky, the stigma and nervures nearly black. Length, about 12 mm.; anterior wing, 9.5 mm.

Described from 7 males (holotype and paratypes) from southern California and Arizona, as follows: Holotype, Palm Springs, California, on *Phacelia distans,* March 22, 1932 (Timberlake); one from the so-called "fish-traps" near Oasis, on *Lycium fremontii,* Feb. 18, 1928 (Timberlake); one from Rock Corral, San Bernardino County, on *Isomeris arborea,* March 29, 1933 (C. M. Dammers); one from Needles, Dec. 4, 1921 (J. A. Kusche); two from Borego, Feb. 25 and 28, 1950 (J. L. Sperry); and one from Buckeye, Arizona, on *Lycium torreyi,* March 28, 1934 (Timberlake).

The paratype from Needles is in the collection of the California Academy of Sciences.

Anthophora ursina Cresson

This species has three well-marked races, as follows: *A. ursina ursina* Cresson, of the eastern states; *A. ursina simillima* Cresson, widely distributed in the western states; and *A. ursina californiensis* Michener, known only from the coastal region of northern California. The ferruginous hair on the middle tarsi of the male of this species becomes more or less black in *californiensis.*

A. pyralitarsis Dours, described from a male from New York, is evidently the same as *ursina.* Both names were published in 1869, and I do not know which has priority, but I prefer to retain the name *ursina* unless it can be shown that *pyralitarsis* has clear priority.

Anthophora porteræ Cockerell

Cockerell described this in 1900 from a male from Romeroville, New Mexico, and a female from the Mohave Desert, California. It is a rather common species in the West, flies early in the spring, and is particularly addicted to visiting the flowers of various species of *Astragalus.* It was described as having black hair intermixed with the light on the mesonotum, but not infrequently there are specimens in which this black hair is very sparse or absent. Such specimens would agree well with the characters of *A. affabilis* Cresson (female), but the characters of the male *affabilis,* as given by Cresson, disagree with those of *porteræ.* *A. affabilis* was described from Bosque County, Texas

(Belfrage) and is not well known. The record of it by Cockerell, from Engle, Mesilla Valley, New Mexico, could well have had reference to a specimen of *porteræ,* lacking the usual black hair on mesonotum.

Anthophora pernicis, new species

A. pernicis[3] is allied to *A. porteræ* Cockerell, but the male differs in having the long fringe of middle tarsi mainly white, the clypeus more shining and sparsely punctured, and the labrum and pygidial area distinctively peculiar.

MALE.—Black, the small intermediate joints of tarsi ferruginous, the apex of mandibles and the tegulæ a little reddened. Apex of tergites 1 to 6 decolored, somewhat hyaline. Labrum, except narrow margins and basal spots, clypeus, except very narrow apical margin and a short black streak on each lateral margin above, lateral marks notched above, narrow supraclypeal band, and scapes broadly beneath, bright yellow. Pubescence white, intermixed with black on vertex and mesonotum, and the hair on cheeks, thorax, and first tergite long and dense. Hair of tergite 2 somewhat shorter and white; that on following three tergites black, with a few of the longer hairs white, especially those along lateral margins. Hair of tergite 6 black, but the longer depressed hair, except narrowly in middle, is white. Hair of tergite 7 black, but that in notch on each side of pygidial area partly white. Hair of legs white, especially the long fringes on front legs, middle tibiæ, and tarsi, as well as that on outer side of hind tibiæ and tarsi. Hair of hind femora, that on posterior side and inferior margin of hind tibiæ, the sparse short hair on anterior side of middle femora, the short dense hair on under side of front tibiæ, and the much longer hair on under side of middle tibiæ, black. A few black hairs intermixed in the very long posterior fringe of middle basitarsi. Hair on inner side of all basitarsi ferruginous by reflected light. Apical joint of middle tarsi with a short fringe on each side, the hair black, overlaid with white, a little longer than width of the joint but not spreading out like a fan. Labrum somewhat concave beyond the middle, so that the apex becomes porrect, with the margin rounded and minutely notched at middle (notched lacking in paratype). Malar space developed but transverse. Antennal joint 3 as long as the next four joints combined, the fourth shorter than fifth. Mandibles stout but rather long, the inner margin dilated from the middle to the inner tooth, which is about one sixth of the length of mandible from apex. Labrum, clypeus, and yellow lateral areas of face shining, thinly hairy, and sparsely and minutely punctate. Thorax minutely tessellate, dull, the shallow punctures of mesoscutum dense and fine but absent in a small area on each side of median line on the posterior middle of disk. Pygidiform area of tergite 7 nude, reddened, about twice as long as wide, somewhat oval, but truncate at apex; this area prominent and projecting, being set off by a strong emargination on each side, the notch also helping to form a subacute tooth

[3] Feminine gender of *pernix* (swift); accent on second syllable.

on each lateral margin. Wings somewhat dusky hyaline, the stigma and nervures nearly black. Length, about 14 mm.; anterior wing, 11 mm.

Holotype, male, Chiricahua Mountains, Cochise County, Arizona, March 26, 1917 (V. W. Owen), in collection of the California Academy of Sciences. Another much-worn male (paratype) from Kyle Canyon, 7500 feet, Charleston Mountains, Nevada, on *Ribes cereum,* June 5, 1941 (Timberlake).

Anthophora forbesi Cockerell

A. forbesi was described from Maricopa, Arizona. It occurs along the eastern border of California, and I have seen specimens from Yermo, San Bernardino County, March 31, 1941 (Lindsley, MacSwain, and Bohart) and from Death Valley, Inyo County, March 13, 1941 (T. H. G. Aitken). It also occurs in Baja California, as is evidenced by a female from 35 miles north of Rosario, March 22, 1935 (C. F. Harbison). This female has brighter ferruginous hair on front tarsi than females from Arizona. The maxillary palpi are five-jointed in both sexes of this species.

MALE.—Similar to female, but hair of thorax above uniformly light. Spot on base of mandibles, labrum, almost entire face below antennæ, and scapes beneath, bright yellow. Apex of tergites 1 to 6 broadly hyaline. Hair of head, thorax, and abdomen entirely whitish, rather long and dense; that on tergites 2 to 7 shorter, mostly erect, but becoming somewhat depressed and bandlike at apex of tergites 2 to 5. Hair of legs white, becoming short and dark on posterior side of hind femora and tibiæ, and mostly black on under side of middle and hind basitarsi. Hair on inner side of front basitarsi ferruginous. Middle and hind basitarsi with a thin, not very long, fringe of white hair behind. Apical joint of middle tarsi fringed on each side with long black hair, but the hair too loose to form a perfect fan. Mandibles rather short, with a small inner tooth. Labrum normal, broadly rounded at apex. Antennal joint 3 about equal to next three joints combined. Tergite 7 with a rather broad projecting lobe at middle of apex, which is slightly emarginate, but disk of segment without a pygidiform area. Face below antennæ and the labrum polished, minutely and sparsely punctate, and thinly hairy. Thorax dull, the mesoscutum densely punctate except in a slightly shining area on each side of the median line on posterior middle of disk. Length, about 13 mm.; anterior wing, 10.5 mm.

Anthophora fulvicollis, new species

This and *A. platti* have the sex-limited peculiarities of the legs of the male reduced nearly to a minimum. Both have the apical joint of the middle tarsi fringed on each side with black hair, but the hair is much too short to resemble a fan. *A. fulvicollis* has the abdomen subfasciate, the mandibles entirely black, and the genitalia of the type seen in *A. fedorica*

Cockerell, *A. pernicis* Timberlake, *A. porteræ* Cockerell, *A. pacifica* Cresson, etc.

MALE.—Black, the four apical tarsal joints and base of claws dull ferruginous. Tegulæ slightly reddened. Labrum, except marginal black line and basal spots, clypeus, except a small spot on suture on each side above, large lateral marks extended slightly upward on orbits and continuous within with a supraclypeal band, and scapes beneath, rather pale yellow. Apical margin of tergites 1 to 6 narrowly decolored. Pubescence rather bright fulvous (but pale ochreous in paratype, which is otherwise similar), without admixture of black on thorax and with only very inconspicuous black hair on vertex. Hair of tergite 1 long, dense, and tinged with fulvous; that on following segment short, depressed, mostly light on tergite 2 (except a black patch on each side before the apex), and black on disk of 3 and 4. Apical margin of tergites 2 to 4 with a narrow band of depressed white hair, thinner and obsolescent on 4. Three apical segments with pale ochreous hair, except some black at base of tergites 5 and 6. Venter with an apical fringe of light hair on segments 1 to 6, and short, fine black hair on disk of each segment except the first two. Hair of legs pale ochreous, becoming black on under side of hind femora and on under side and posterior face of hind tibiæ. Hair on inner side of basitarsi black, but with a ferruginous tinge by reflected light. Apical joint of middle tarsi with a fringe each side of blackish hair, overlaid with light hair, these fringes about equalling the greatest width of the joint. Mandibles rather short, with a small inner tooth close to apex. Clypeus very convex and bulging, the labrum large and quadrate. Malar space transverse. Antennal joint 3 as long as the next three joints combined, and joint 4 one-fourth shorter than 5. Tergite 7 somewhat broadly ridged in middle, with this part shortly produced and truncate at apex and the lateral margins strongly emarginate between the medio-apical lobe and a short, blunt subbasal angle. Disk of segment covered with hair, except extreme apex of median lobe. Wings slightly dusky, the stigma and nervures nearly black. Length, about 14.5 mm.; anterior wing, 10.5 mm.

Holotype, male, Needles, California, Dec. 4, 1921 (J. A. Kusche), in collection of the California Academy of Sciences. One paratype, male, Douglas, Arizona, April 6, 1933 (W. W. Jones).

Anthophora platti, new species

The male of this species is similar to that of *A. fulvicollis*, but has a yellow spot on base of mandibles, and more than apical half of abdomen is uniformly black. Apex of the stipites of the genitalia bispinose, as in *A. edwardsii* Cresson, *A. forbesi* Cockerell, and *A. vannigera* Timberlake. The female of *platti* is distinguishable from similar species by the medially ridged pygidium, the feebly curved spurs of middle and hind tibiæ, the black integument of abdomen, and the fulvo-ochreous color of the dorsal pubescence.

MALE.—Black, the tegulæ and small joints of tarsi slightly reddened. Spot on base of mandibles, labrum, except margins and basal spots, clypeus, except exterior corners and narrow lateral margins, large lateral marks, shallowly emarginate above, supraclypeal band, and scapes in front, bright yellow. Pubescence ochreous to rather bright fulvous above and whitish on under side of head and thorax; it is long and dense on cheeks and thorax, but rather thin on face; on sides of face, middle of face between antennæ, and on vertex and mesonotum, it is intermixed with numerous black hairs; a trace of black is also found on posterior orbits. Hair of first tergite very long and tinged with ochreous or fulvous; that on second shorter and whiter, with some black hairs along the apical margin except at sides; following segments with hair rather short, erect, and black, intermixed with numerous long black hairs and a few whitish ones along lateral margins. Hair of venter nearly all white. Hair of legs white, becoming black on inner side of hind tibiæ and ferruginous brown on inner side of basitarsi. Apical joint of middle tarsi fringed on each side with blackish hair, which is shorter than width of joint. Mandibles short, with well-developed inner tooth close to apex. Malar space linear but evident. Clypeus moderately convexly protuberant, the labrum rounded at apex. Antennal joint 3 about equal to the next three joints combined, the fourth considerably shorter than the fifth. Tergite 7 slightly produced medially and narrowly truncate, the truncation a little emarginate, so that the apex is slightly bidentate, but this structure well concealed by dense black pubescence. Lateral margins of this segment broadly emarginate and not toothed subbasally. Hind basitarsi about six times longer than wide and longer than following joints combined. Length, about 12 mm.; anterior wing, 9.5 mm.

FEMALE.—Similar to male, but face dark. Pubescence of vertex, thoracic notum, and first tergite, fulvo-ochreous, with black hairs intermixed on sides of face, between antennæ, and on vertex and mesonotum. Hair of face otherwise, and of cheeks and under parts of thorax, whitish. Hair of second tergite white, short, and erect, with a few inconspicuous black hairs along the apical margin. Hair of remainder of tergum black, with long black hairs intermixed and some white ones on lateral margins of tergites 4 and 5. Hair of venter black, but with an apical white fringe on segments 2 and 3 and laterally on 4. Hair of legs whitish, but black on anterior side of middle tibiæ and posterior side of hind tibiæ, and a little black hair on under side of hind femora. Hair on under side of tarsi ferruginous brown, margined with black on the basitarsi. Front basitarsi with a blackish fringe behind. Labrum medially rugose on disk, rounded at apex. Antennal joint 3 somewhat longer than next four joints combined. Malar space well developed but transverse. Pygidial plate grooved laterally, with a rounded ridge down the middle. Clypeus densely and finely punctured. Thorax dull, the close shallow punctures of mesoscutum becoming sparser on posterior middle. Length, 13 mm.; anterior wing, 10 mm.

Described from 7 specimens, all collected in southern California in March and April, 1936: 5 males (holotype and paratypes), Riverside, at flowers of *Lantana sellowiana,* March 12, 13, 18 and 21 (F. R. Platt, Timberlake, and Linsley); 1 male (paratype), Acton, Los Angeles County, at flowers of *Salix,* March 15 (Linsley); and 1 female (allotype), Palmdale, April 11 (G. E. and R. M. Bohart).

Two males are in the collection of the University of California at Berkeley.

Anthophora neglecta Timberlake and Cockerell

The male of *neglecta* is similar to that of *A. edwardsii* Cresson, but lacks the tooth on the hind basitarsi and has creamy-white face-marks. The genitalia are of the type found in *A. pacifica* Cresson, but the apical process of stipites are longer than wide. The female is so like *edwardsii* in size and general appearance that it is difficult to distinguish it. I depend upon the black color of the abdominal integument (bluish in *edwardsii*) and the gently curved apices of the spurs of middle and hind legs to distinguish it from that species.

Anthophora edwardsii Cresson

This species was described from California and Nevada. The similar *A. gohrmanæ* Cockerell, which was described from Las Vegas, New Mexico, and differs only in having a yellow spot on base of mandibles and little or no black hair intermixed on the mesonotum, is merely a local race of *edwardsii* and should be cited as *A. edwardsii gohrmanæ* Cockerell. It is true that *edwardsii* as found in California also may have a yellow spot on mandibles, but such specimens have much black hair intermixed on the thorax. It was probably such specimens that formed the basis of Cockerell's record (1905) of *gohrmanæ* from Los Angeles. *A. gohrmanæ coloradensis* Michener apparently differs too slightly from *gohrmanæ* to form a good subspecies.

Anthophora pacifica Cresson

This species has a sex-limited, all-black form in the female, which was described as *A. carbonaria* Cresson and renamed *A. infernalis* by Dalla Torre. This melanic female is widely distributed, having been recorded from Nevada (type locality), Utah, and northern California. In southern California it is the only form of female that is found; hence, for that part of its range it deserves to be cited as a subspecies, *A. pacifica infernalis* (Dalla Torre).

A CHANGE IN SYNONYMY IN DREPANULATRIX (LEPIDOPTERA, GEOMETRIDÆ)

BY FREDERICK H. RINDGE
AMERICAN MUSEUM OF NATURAL HISTORY

Drepanulatrix bifilata ella (Hulst), new combination

Diastictis ella Hulst, 1896, Trans. Amer. Ent. Soc., vol. 23, p. 332. Barnes and McDunnough, Contributions to the natural history of the Lepidoptera of North America, vol. 3, p. 182.

Cymatophora ella, Dyar, 1902, Bull. U. S. Natl. Mus., vol. 52, p. 213; 1904, Proc. Ent. Soc. Washington, vol. 6, p. 224.

Drepanulatrix ella, Barnes and McDunnough, 1917, Check list, p. 112. Rindge, 1949, Bull. Amer. Mus. Nat. Hist., vol. 94, p. 253.

When the unique female type of this moth was first examined in the summer of 1948, it was not feasible to make a genitalic preparation. Since then, through the courtesy and cooperation of Dr. Pepper and Dr. Schmitt of the Department of Entomology at Rutgers University, a genitalic slide has been prepared of this type specimen. This shows that the author was incorrect in placing *ella* as a synonym of *Drepanulatrix unicalcararia* (Guenée); instead, it should be associated with the widespread and variable *D. bifilata* (Hulst). If the locality is correctly given for this specimen ("Was. T.") it had best be tentatively placed as a northern subspecies of *bifilata,* although no other specimens of this species are known from that far to the north (see Rindge, *loc. cit.,* p. 261, fig. 4).

As it is obviously impossible to characterize a subspecies from a single specimen, particularly in a group showing as much varability as the speces of *Drepanulatrx,* it will not be done here. The type specimen has the forewings above an immaculate orange, with a small and faint dark discal dot and with a very few darker scales in cell M_3 where the t. p. line normally runs; there is no trace of the two, usually prominent, dark spots on the costa marking the inception of the cross lines; hind wings above dull yellowish or cream colored; under surfaces of both wings a unicolorous pale yellow white. The genitalia of the type specimen are apparently indistinguishable from those of *bifilata bifilata* (Hulst) and *bifilata ruthiaria* Sperry.

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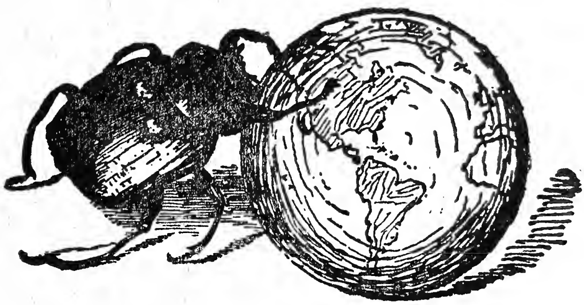

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SOME NEW SPECIES OF SYRPHID FLIES

By F. M. Hull

University, Mississippi

Some unidentified species of Syrphid flies have appeared in recent collections. These species are described in this paper.

Quichuana montana new species.

Distinguished by the broad front and the very large, light brown spots, on either side of the second, third and fourth abdominal segments. Not closely related to other species. Length 11.5 mm.

Male. Head: the face, front and cheeks are shining black; the area immediately below and on either side of the antennæ is yellowish brown. The sides of the face and the posterior portion of the cheeks are thickly yellow pubescent and there is a little yellow pollen below the antennæ and on the eye margins opposite the antennæ. The pile of the front is long, erect and black and abundant with a single row of golden hairs along the eye margin; the pile of the face is likewise abundant, long and golden. There is a low elevation on the lower part of the front above the pre-antennal callus. The first antennal segment is dark brown, the second lighter, the third reddish brown on the ventral half, blackish above, broadly rounded apically and but little longer than wide. The arista is entirely pale yellowish brown. Antennal pile black. Vertex shining black with black pile and a band of yellow pubescence immediately in front of the ocelli. The occiput is black, densely yellow pollinose with thick bright yellow pile and a few black hairs at the extreme upper occiput. Eyes with sparse, scattered, shining yellow pile on the lower half posteriorly, replaced by dense pale brown to yellow pile anteriorly which becomes still more dense and longer and dark brown on the upper half of the eyes.

Thorax: the mesonotum is dully shining black with a pair of broad, sub-medial, dark brown pollinose vittæ which are evanescent before they reach the scutellum. Scutellum blackish in the corners, but otherwise light reddish brown, of a pale coffee color. Humeri black. The pile of the mesonotum is dense, erect and shining yellow with a conspicuous, triangular tuft of opaque, bright yellow tomentum on the notopleura at the base of the transverse suture such as is seen in *Meromacrus*. It is connected with an equally large, longer tuft of the same deep sulphur yellow tomentum on the upper mesopleura. Squamæ pale brown basally, dark brown on the border with brownish yellow fringe. Scutellar pile yellow. Pleura feebly shining black, all of their pile yellow.

Legs: anterior and middle femora black with the apical fifth of the former and the apical third of the latter brownish orange. The hind femora are a little thickened and entirely black except for an apical, lateral, brown, diffuse streak. The pile of the hind femora is yellow and long dorsally, short and black laterally and also black dorsally at the apex. The ventral pile is short and yellow except upon the outer two-fifths where it is black setate. There are also about fourteen quite long golden ventral hairs. The middle tibiæ and their tarsi, all of the front tibiæ, except a blackish, preapical, incomplete band, all of their tarsi and the hind tarsi except the last two segments are light reddish brown or orange-brown, with reddish-golden pile. Hind tibiæ widely black beyond the middle except at the apex. The pile of the black area black, elsewhere reddish yellow. Base of hind tibiæ with a serrosetate knife-edge and short black pile.

Wings: nearly hyaline except the costal cell, the basal half of the stigmal area, the first basal cell, and the base of the marginal and submarginal cell, all of which are pale brown. Stigmal cross vein in the form of a small thickened brown triangle. Loop of third vein without spur. The marginal cell is opened.

Abdomen: broad as in *Meromacrus* with similar, opaque, bright yellow tomentum, abundant on each side of the black, first abdominal segment. The second abdominal segment has the middle third dully shining black, or perhaps subopaque; it is slightly expanded at the posterior margin and widely expanded to form a basal fascia, which however, does not reach the sides. The remainder of this segment is light coffee brown. The sides of the second segment are densely yellow pilose, long basally, short posteriorly where it becomes black in the corners; central pile of this segment long, erect, shining yellow, narrowly black in the middle posteriorly. Third segment quite similar to the second though shorter and distinctly narrowed posteriorly and the medial black band somewhat more narrow with parallel sides, not widened at the base and only obscurely expanded posteriorly. The postero-lateral half of the segment is somewhat darker brown but the remainder is of the same clear light brown. Fifth segment similar to the third, but the brown area is now restricted to an obscure, large baso-lateral triangle reaching the end of the segment laterally. Second to fourth segments with dense postmarginal appressed fringe of long, shining yellow pile. Hypopygium black.

Female. Similar to the male, the front with an obscure, slender, medial, opaque black line. Scutellum dark reddish sepia. Hind femora equally as thick as in the male and the hind tibiæ black nearly to the base; only the immediate base being obscurely, diffusely reddish brown. The second abdominal segment has the medial black stripe equally wide and posteriorly it is narrowly expanded to the lateral margin. Lateral margins narrowly blackish, almost to the base. The third segment has the baso-lateral brown spots much reduced and the sides of this segment black. The fourth segment is entirely black with a broad band of opaque black occupying the basal three-fifths of the segment, somewhat receding medially behind and not reaching the sides.

Holotype, male, Chanchamayo, Peru, May 17, 1948, 1100 meters. Allotype, female, July 26, 1948, J. Schunke. In the author's collection.

Quichuana hermosa new species.

Related to *montana* n. sp. The pile of the thorax and abdomen where yellow has been replaced by white; the upper third of the front has a distinct reddish brown triangle below the ocelli. The brown vittæ of the mesonotum are replaced by grey. Length 11 mm.

FEMALE. Head: shining black, the upper part of the front with reddish sepia pollen; viewed anteriorly and obliquely the front has a wide band of such reddish pollen enclosing the anterior ocellus and extended forward as a pointed, sharply demarcated, triangle which is linearly cleft in the middle. The pile of the front is black; of face and occiput white; face with a thick, white, diagonal band of pollen from epistoma to eye margin and fine whitish pollen beneath the antennæ. Antennæ black, the arista dark brown basally and yellowish brown upon the remainder. Third segment broadly rounded, scarcely longer than wide. The ocular pile is shining on the whole lower half, posteriorly and anteriorly, and is whitish in color. The upper ocular pile is brown. Occipital pile shining whitish with a few black hairs mixed with the white ones above.

Thorax: the mesonotum is black, with a pair of broad, submedial grey vittæ which, while they have a faint brownish tinge, are not reddish as in *montana;* between and on either side of these vittæ the mesonotum has a bluish green reflection. The conspicuous tufts of opaque tomentum on the notopleura, upper mesopleura and postcalli are white. Scutellum very dark sepia brown with long yellowish white pile. The mesonotal pile is dense and very pale yellow; it is almost white in places. Squamæ pale brownish yellow, the border blackish sepia, the fringe golden on the lower squamæ but sepia on the upper squamæ. The pleura are thickly greyish white or greyish yellow pollinose on the mesopleura, sternopleura and anterior hypopleura; their pile whitish.

Legs: similar in color to *montana,* the hind femora of about the same thickness, the pile of the legs tends to be paler and on the hind femora whitish.

Wings: similar to *montana*, the loop of the third vein a little more pointed and without spur.

Abdomen: similar to the female of *montana* except that the basal, light brown spots of the third segment are more distinct, rectangular and the opaque and shining pile of the abdomen and the post marginal fringes are white or nearly white in color instead of golden yellow.

Holotype, female, Chanchamayo, Peru, August 19, 1948, 1100 meters, J. Schunke. In the author's collection.

Eristalis pusioides new species.

Related to *urotænia* Curran. The eyes are distinctly brownish red pilose; the cheeks are quite black, the sides of the second abdominal segment are entirely yellow pilose. The posterior tibiæ are distinctly black, very narrow yellow at the base. Length 10 mm.

MALE. Head: the face is light brown with a bare middle stripe covering the tubercle and narrowing to a point a short distance below the antennæ; the cheeks are jet black. The sides of the face are densely pale yellow pubescent with pile which is yellowish white. The front is light brownish-yellow pollenose except in front of the preantennal callus. And the pile along the sides is light yellow with a few black hairs below the junction of the eyes and most of the pile in the center of the front above the antennæ is black. First two segments of antennæ pale reddish-brown; third missing. The vertex is opaque, light yellowish brown pollinose, occupying an almost exactly equilateral triangle; the pile is yellow behind, black between the ocelli. Occiput black, yellowish white pollinose below, yellowish brown above. The pile of the occiput is almost entirely pale yellow with a few scattered black hairs above. Ocular pile very dense and distinctly reddish brown.

Thorax: mesonotum opaque, ochraceous grey in front of the suture with a prominent, transverse, slightly arched, opaque black fascia stretching from humerus to humerus. The anterior margin of the mesonotum is more of a dark olive grey. The entire region of the mesonotum behind the transverse suture is opaque velvety black without any shining areas, and its pile everywhere long, abundant and black. Pile upon the mesonotum anterior to the suture long and yellow and there are a few yellow hairs immediately behind the suture. Pleura opaque blackish with dense yellowish grey pollen, all of its pile yellow. The entire scutellum is opaque light sulphur yellow, its pile entirely long and golden yellow except for about six scattered fine black hairs. Ventral fringe yellow. Squamæ entirely very dark sepia brown. Halteres yellow. Squamal fringe golden.

Legs: the femora are shining black, the narrow apices of the first and middle pairs only yellowish. Anterior tibiæ reddish yellow, the apical fourth blackish. Middle tibiæ similar, the apex only reddish brown. Hind tibiæ entirely shining black, except the extreme base which is yellowish. First two segments of anterior and middle tarsi light yellowish brown, the first segment of the hind tarsi dark reddish brown. Remaining tarsal segments blackish.

Wings: quite hyaline, without villi, the marginal cell closed, with a short stalk and slightly widened. The dark brown stigmal cross vein is wide and thick.

Abdomen: the first segment is yellow, narrowly blackish along the posterior margin for a little less than half the width of the second segment. The second segment is opaque, pale sulphur yellow, with a large, acute, opaque black triangle which rests on the posterior margin and is narrowly connected with the blackish band of the first segment. The third segment has a similar, wider, opaque triangle resting on the posterior margin, narrowly touching the base of the segment; lying in the middle of each anterior side of the triangle there is a small round shining spot which is the only shining area upon the segment. Remainder of this segment pale yellow. The fourth segment is entirely shining black, except for a very narrow, basal yellowish band toward the sides of the segment, occupying less than one-third the width of the segment. The anterior portion of the black part of this segment has a slender, medially interrupted, metallic black fascia slightly expanding on the lateral margin. Hypopygium shining black; apical margins of segments two, three and four linearly pale yellow. Pile of first and second and third segments entirely pale yellow except for the pile upon the medial black triangles. Pile of fourth segment black except upon the sides. Hypopygial pile yellow. Venter entirely pale yellow with yellow pile. The last sternite, however, is black.

Holotype, male, Chanchamayo, Peru, August 19, 1948, 1100 meters. J. Schunke. In the author's collection.

Mesogramma harlequina new species.

Related to *hieroglyphica* Schiner. The abdomen is shining black except for narrow, lateral, wedge-like vittæ and opaque black spots centrally. Length 5.5 mm.

FEMALE. Head: the face is short and pale yellow with the tubercle brownish. Cheeks black, the front polished black, non-striate, the sides sharply yellow to within a short distance of the ocelli. The antennæ are brownish yellow on the first and second segment, reddish brown on the third. The arista is reddish at the base, blackish apically. Vertex black, reddish violet behind, the pile blackish. Sides of face narrowly above but more widely below white pubescent, the short scanty pile white. The pile of the front is scanty and whitish. The occiput is black, faintly brassy, pale brownish yellow pillinose, the lateral pile yellowish white and flattened, the upper pile also yellow.

Thorax: the mesonotum is black with violaceous reflections submedially and the black central area brownish pollinose, except for the medial blue grey lines and, except that the outermost portion of the black area is bare and metallic black. Lateral margins of mesonotum dark brownish-yellow and this color is submarginal upon the notopleura. The humeri are light yellow; scutellum shining black, the margin rather widely yellow, but the yellow color does not quite reach the base. The mesonotal pile and scutellar pile is pale yellow, the latter has four or five long, slender, fine, marginal black hairs. The pleura are shining black, only the narrow posterior border of the mesopleura and a large spot on the upper sternopleura pale yellow. Squamæ pale yellow, the halteres reddish.

Legs: anterior femora dark brown dorsally except narrowly at base and apex, their tibiæ yellow, their tarsi light brown. Middle legs similar except that the still darker dorsal band of brown upon the femora encircles the femora subbasally. The hind femora are brownish black except narrowly at the base and apex where they are yellow. The hind tibiæ are widely dark brown in the middle, the basal fourth pale yellow, the apex light brown. Hind tibiæ brown.

Wings: not quite hyaline, the faint yellowish cast may be due to the color of the villi. Pterostigma brownish yellow. Alulæ slightly wider than the basal section of the costal cell.

Abdomen: oval, wider than the thorax, the first segment black with brassy reflections and its anterior margin narrowly yellow. The second segment is polished shining brassy black with only the middle portion of the lateral margin narrowly light yellow and with a wide, subapical, opaque black band slightly expanded medially and anteriorly and attenuate laterally. This band ends a short distance from the lateral margins. The third segment is similarly shining black with a narrow yellow basal triangle lying upon the lateral marging and with a medial opaque black vitta which does not quite reach the posterior margin and is expanded into a rounded spot subbasally so that the medial figure resembles the shape of a key-hole. On either side between the medial vitta and the lateral margin is an acute, wedge-like triangle of opaque black, the pointed end of the spot touching the base of the segment. This segment ends one-fourth the length of the segment from the posterior margin. Fourth segment similar to the third in every respect. Fifth segment similar except that the opaque black spots consist of three posteriorly rounded, nearly parallel-sided vittæ, the outer pair a little wider.

Holotype, female, Sao Paulo, Brazil, J. Lane collector. In the collection of J. Lane.

ANATOMY AND MORPHOLOGY

BY R. E. SNODGRASS

COLLABORATOR, U. S. BUREAU OF ENTOMOLOGY

In the vocabulary of zoologists, particularly of entomologists, the words "anatomy" and "morphology" seem to have become synonymous, or nearly so, as applied to animal structure, except that "morphology" appears to be preferred probably as having a more impressive sound. In ordinary English, words mean what the speaker intends them to mean and the hearer understands; many, probably most, of our everyday words now mean something quite different from what they originally did, just because we have come to use them as we do. Humpty Dumpty said to Alice, "When I use a word it means just what I choose it to mean," and he had linguistic sanction on his side. "Anatomy" and "morphology," however, are not ordinary English words, and the question is: can usage establish the meaning of scientific terms? Technical words must have a definite meaning, they must be capable of specific definition, and they can be given a precise meaning only on a basis of their Latin and Greek origins.

The term anatomy is formed of two Greek words that together mean "cutting up." In its original sense "anatomy" is thus the same as the Latin "dissection." As with many other words, however, "anatomy" has expanded until its origin has been forgotten, so that with us it now stands for the facts we learn by cutting up the animal, or also it designates the structure or even the tissue of the animal itself, whether dissected or not. "Anatomy" in its evolved sense is comparable to "venison." VENATOR is the hunter, VENATIO is first the hunting of game, then the game animal itself, and finally, the flesh of the game becomes VENISON. "Game" has a similar transference from the sport of hunting to the animal hunted. So we may concede that "anatomy" has acquired its present meaning by perfectly legitimate processes of word evolution. "Dissection," on the other hand, is a conservative word that still means just what it did when first coined, the cutting-apart of an animal for the study of its structure. Two words for the same thing being unnecessary, "anatomy" has been promoted to fill a vacancy.

The term MORPHOLOGY, according to its derivation, cannot possibly be made synonymous with "anatomy." MORPHÉ is Greek for form, and as applied to an animal it refers to its structure, or anatomy, but the LOGY part of the word gives the term an abstract philosophical meaning . LÓGOS is Greek for "word," or a discourse in words, but words are expressions of ideas, and ideas may be right or they may be wrong. In either case, zoological morphology is simply what we think about the facts of anatomy; it is our philosophy about the form of animals. By contrast, anatomy is the concrete facts of structure.

The difference between anatomy and morphology will be clearly perceived by listening to two anatomists or two morphologists discuss their respective subjects. The anatomists may disagree, but they have only to get a specimen and look at it until they both see it alike. Anatomy, in other wards, is capable of demonstration. The morphologists, however, can argue interminably over theories and never, or hardly ever, come to the same conclusion. Of course, there is some chance that some morphological ideas may conform with something true in the present or past of nature, but since most of them involve evolution concepts, there is no way of putting them to a practical test. The very fact that our morphology can and does change with each generation of morphologists, while the anatomy of animals has not perceptibly changed during the memory of man is sufficient to show that the term "morphology" cannot be substituted for "anatomy."

We may now look at some of the literary results of confusing morphology with anatomy. We often see entomological papers entitled "The External Morphology," or "The Internal Morphology" of some insect. Even if such papers contain some morphological ideas, how can there be either an "external philosophy" or an "internal philosophy" of form? The philosophy is in the mind of the author, not in the insect under discussion. Such papers might correctly be entitled, "Morphology of the External Structure," or "Morphology of the Internal

Structure'' of the insect, if they are truly morphological, but their contents often reveal that the subject matter is purely anatomical.

In conclusion, for definitions the writer would submit to entomologists the following:

DISSECTION (L. DIS, apart; SECTUM, cut).—The cutting-apart of the animal to determine the facts of its structure.

ANATOMY (Gr. ANÁ, up; TÓMOS, cut).—The demonstrable facts of animal structure, or also, by transference to the object, the structure or even the tissue of the animal itself.

MORPHOLOGY (Gr. MORPHÉ, form; LÓGOS, word or discourse).—Our philosophy or science of animal form, a mental concept derived from evidence based on anatomy and embryogeny, usually incapable of proof, attempting to discover structural homologies and to explain how animal organization has come to be as it is.

No suggestion is here offered as to what can be done about ''physiology,'' which should mean the science of functional facts, but has to do duty also for the facts themselves. ''Embryology'' is more fortunate, since there is ''embryogeny'' or ''embryogenesis'' to express the concrete facts of development; but again, microanatomy is commonly called the ''histology'' of the animal or its organs. However, because some words, for the lack of a complementary term, have to serve in two capacities is no excuse for confusing ''morphology'' with ''anatomy.''

FORMATION OF THE ENTOMOLOGICAL SOCIETY OF CANADA

At the eighty-seventh annual meeting of the Entomological Society of Ontario, held at Guelph on November 1–3, 1950, it was decided to form a national society, to be called the Entomological Society of Canada. The new society will serve as a link between the various regional societies, namely, the Acadian Entomological Society, the Entomological Society of Ontario, the Entomological Society of Manitoba, the Entomological Society of British Columbia, the proposed entomological society of Quebec, and others that may be established. THE CANADIAN ENTOMOLOGIST will be published jointly by the Ontario and the national societies, Dr. W. R. Thompson continuing as Editor, with Dr. G. C. Ullyett as Associate Editor.

W. A. Ross, Division of Entomology, Ottawa, was elected President and Professor A. W. Baker, Ontario Agricultural College, Guelph, Vice-President. R. H. Wigmore and A. B. Baird, Division of Entomology, Ottawa, have been named Secretary and Treasurer respectively. The Directors comprise the presidents of the regional societies, namely, D. D. Pond, Fredericton, N.B.; W. N. Keenan, Ottawa, Ont.; C. A. Smith, Winnipeg, Man.; and Prof. G. J. Spencer, Vancouver, B.C.; as well as Father O. Fournier, President, Montreal Branch of the Entomological Society of Ontario; Dr. C. W. Farstad, Dominion Entomological Laboratory, Lethbridge, Alta.; and Dr. A. S. West, Queen's University, Kingston, Ont.

The annual meeting of the national society will always be held jointly with the annual meeting of one of the regional societies. In 1951, the combined meetings will be held at Ottawa.—W. A. Ross.

THE GENUS EREMOMYIA STEIN IN NORTH AMERICA, WITH DESCRIPTIONS OF NEW SPECIES. (MUSCIDÆ: DIPTERA)

BY H. C. HUCKETT
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The genus Eremomyia was erected by Stein (1898)[1] for the reception of four newly described North American species, the first named, *humeralis,* being designated the genotype by Coquillett (1901). Later Stein (1919) added a fifth species to the group, namely *Pegomyia setosa* Stein. Séguy (1937) in GENERA INSECTORUM listed nine nominal species in the genus, of which two were recorded from Europe. Concerning these species it may be mentioned that *E. setosa* (Stein) was placed by Malloch[2] in Eremomyioides, along with *Eremomyia cylindrica* Stein; the species *E. apicalis* Stein, *E. incompleta* Stein, *E. major* Malloch have been included by Huckett[3] in the genus Pegomyia *sens. lat.;* the species *E. depressa* Malloch,[4] described from Idaho, the type of which has recently been reexamined, is I consider the same species as *Leucophora* (= *Hammomyia*) *sociata* (Meigen). Thus in my opinion there remains only two North American species in Séguy's list that may properly be regarded as belonging to the genus Eremomyia, namely *Eremomyia humeralis* Stein and *Eremomyia pilimana* (Ringdahl), the latter being identical with *E. vernalis* Huckett.

In the present review of the genus ten species are recorded from North America, eight of which are described as new.

The genus Eremomyia may be linked to Eremomyioides and the *major*-group in Pegomyia owing to the similar appearance

[1] Figures in parentheses refer to literature cited in synonymies as indicated by date of publication.

[2] Malloch, J. R. 1918. Notes and descriptions of some anthomyid genera. Proc. Biol. Soc. Wash., XXXI: 67–68.

[3] Huckett, H. C. 1941. A revision of the North American species belonging to the genus Pegomyia. (Diptera: Muscidæ). Mem. Amer. Ent. Soc. No. 10, p. 14.

[4] Malloch, J. R. 1918. Diptera from the Southwestern United States. Trans. Amer. Ent. Soc., XLIV: 304.

and structure of the hypopygium and copulatory appendages in the male. The ninth tergum (anal sclerite) is rounded dorsad, the gonostyli (inferior forceps) are styliform, cleft at apex on inner margin, and bear spinules, the processes of fifth abdominal sternum are subcylindrical with bristles on outer surface increasing in length distad, the processes also have a series of incurving weak bristles on distal half of inner border (figs. 1–3). In the female of Eremomyia and Eremomyioides the abdomen is depressed and broadly suboval in outline when viewed from above, being widest prebasad; the fifth abdominal tergum has slender semierect bristlelike setæ similar to those on ventral aspect of terga, and which are dissimilar to the short decumbent setulæ on dorsum of preceding terga. All the species in Eremomyia have bare eyes and arista, long prealar bristle, one mid posterodorsal bristle on mid tibia, and subequal squamal scales; the lower or second posthumeral bristle is invariably well developed in male and in female of certain species, but in others it is a variable character.

The genus Eremomyia differs from Eremomyioides in the absence of fine setulæ on propleura, pteropleura, hypopleura and sterna of thorax, and from the *major*-group of Pegomyia by the presence of more than two posterodorsal bristles on hind tibia, and by the absence of mesopleural setulæ on the declivity dorsad of mesothoracic spiracle. The species may invariably be distinguished from those of Hylemyia *sens. lat.* by the absence of cruciate bristles and by the setulose character of the under surface of costa; further in the male by the absence of semierect posteroventral setulæ on hind tibia, and by the weakened development of caudal pair of acrostical bristles.

The species belonging to the genus may be grouped according to their habitus as exemplified in *E. humeralis* Stein and *E. pilimana* (Ringdahl) respectively. In the *humeralis* complex the species are more robust and the males are more setulose, notably on the lower occipital region of head, at base of stigmatal bristles situated below the mesothoracic spiracle, on the scutellum, and on the first three abdominal sterna; in both sexes the notopleural callosities have setulæ, the three apical bristles on dorsal aspect of hind tibia are robust, *m-cu* cross vein is oblique and sinuate;

in males the abdomen is conical, and when viewed from behind the sclerites caudad of fifth tergum present a normal symmetrical pattern (fig. 4), the prebasal plate of hypopygium (tergum 6 of Crampton)[5] is setulose; in females, the mid tibia has a mid antero-ventral bristle and fore tarsal segments 3 and 4 are broadened in three of four species included in the group.

In the *pilimana* complex the species are comparatively smaller and in the male tend to be less notably setulose, there being but few if any setulæ at base of stigmatal bristles; in both sexes the notopleural callosity is usually devoid of setulæ, the three apical bristles on dorsal aspect of hind tibia are variable in development, *m-cu* cross vein is semierect and less sinuate; in the male the abdomen is depressed, sides subparallel, and when viewed from behind the sclerites caudad of fifth tergum present an asymmetrical design owing to the emergence of the seventh sternum laterad (fig. 5),[5] the prebasal plate of hypopygium is usually bare: in female the mid tibia lacks a mid anteroventral bristle and fore tarsal segments 3 and 4 are not broadened.

Apparently little is known concerning the habits of the different species. Adults occur commonly in the woods in spring and are conspicuous by their absence for the remainder of the season. Stein[6] has recorded that the larvæ of the European species *Eremomyia triticiperda* (Stein) were noticed in grains of wheat during threshing. He also mentions their unusual structure and that of the pupæ.

The genus is evidently distributed throughout a larger part of the northern and temperate regions of North America, the records ranging from Alaska to California and again from Quebec to northern Georgia.

Genus *Eremomyia* Stein

Eremomyia Stein, 1898. Berl. Ent. Zeitschr., (1897) 42 (3–4): 223. Coquillett, 1901. Jour. N. Y. Ent. Soc., 9 (3): 137. Aldrich, 1905. Misc. Coll. Smithsn. Inst., 46: 554. Coquil-

[5] Crampton, G. C. 1944. A comparative morphological study of the terminalia of male calypterate cyclorrhaphous Diptera and their acalypterate relatives. Bull. Brooklyn Ent. Soc., XXXIX (1): 11–13, figs. 23–34.

[6] Stein, P. 1900. Einige neue Anthomyiden. Entomologische Nachrichten, XXVI (20): 319.

lett. 1910. Proc. U. S. Nat. Mus., 37: 539. Stein, 1919. Arch. f. Naturgesch., (1917) 83 A (1): 153. Stein, 1920. Arch. f. Naturgesch., (1918) 84 A (9): 73. Huckett, 1924. Mem. 77 N. Y. (Cornell) Agr. Exp. Sta., (1923) p. 10. Séguy, 1937. Gen. Insect., Fasc. 205 p. 121.

Hylemyia (Eremomyia) Ringdahl, 1933. Ent. Tidskr., 54 (1): 30.

Genotype: *Eremomyia humeralis* Stein (by designation of Coquillett, 1901).

KEY TO SPECIES

Males

1. Anteroventral region of mesopleura and dorsal region of hypopleura polished 2
   Mesopleura and hypopleura without such surface marking 3
2. Shortest distance across frons greater than half distance between first pair of dorsocentral bristles; hind tibia usually reddish. **medicaginis** n. sp.
   Shortest distance across frons slightly less than half distance between first pair of dorsocentral bristles; hind tibia usually black. *humeralis* Stein
3. Shortest distance across frons greater than width of third antennal segment; frons densely whitish pruinose; mesonotum whitish gray. **albidosa** n. sp.
   Shortest distance across frons not greater than width of third antennal segment 4
4. Abdomen conical, caudal sclerites viewed from behind symmetrical in appearance (fig. 4); notopleural callosity and prebasal plate of hypopygium setulose; *m-cu* cross vein oblique .... **impolita** n. sp.
   Abdomen depressed, caudal sclerites viewed from behind asymmetrical in design owing to emergence of seventh sternum laterad (fig. 5); notopleural callosity and prebasal plate of hypopygium seldom with setulæ; *m-cu* cross vein semierect 5
5. Wings intensively infuscated on anterior and basal regions and notably tinged throughout membrane; cross veins not clouded; calyptræ yellowish brown; abdomen lustrous .... **fumipennis** n. sp.
   Not all characters present 6
6. Lateral margins of face polished and blackish, not conclorous with face; processes each fully as long as half length of hind tibia. **parafacialis** n. sp.
   Lateral margins of face grayish pruinescent, concolorous with face 7
7. Vibrissal angle with several short coarse setulæ; second antennal segment shining black; halteres purplish .... **obversa** n. sp.
   Not all characters present 8
8. Mesonotum and scutellum viewed from in front blackish and unmarked;

second antennal segment partly shining black; abdominal pruinescence smooth and silky .... **lucescens** n. sp.
Mesonotum and scutellum viewed from in front pale grayish with usually a brownish postsutural dorsocentral vitta, and with or without brownish infuscation caudad; second antennal segment opaque, subshining 9
9. Shortest distance between eyes about equal to diameter of anterior ocellus; cheeks not as high as width of third antennal segment; ventral aspect of occiput bordering oral cavity not polished. *pilimana* (Ringd.)
Shortest distance between eyes equal to distance between posterior ocelli; cheeks as high as width of third antennal segment; ventral aspect of occiput bordering oral cavity polished and glossy. **turbida** n. sp.

Females

1. Fore tarsal segments 3 and 4 broadened, distinctly wider than segment 5 2
Fore tarsal segments 3 and 4 not broadened, not wider than segment 5 4
2. Anteroventral region of mesopleura, dorsal region of hypopleura, and caudal sclerite of hind coxa polished 3
Mesopleura, hypopleura and hind coxa not so marked .... **impolita** n. sp.
3. Mid and hind tibiæ blackish .... *humeralis* Stein
Mid and hind tibiæ reddish yellow .... **medicaginis** n. sp.
4. Tibiæ reddish yellow; mid tibia with a mid anteroventral bristle; narrowest width of parafacials greater than breadth of third antennal segment .... **albidosa** n. sp.
Tibiæ black; mid tibia without mid anteroventral bristle; narrowest width of parafacials less than breadth of third antennal segment. 5
5. Halteres dark purplish; second antennal segment shining black; mid tibia with a mid anterior bristle; anterior surface of fore femur with a median series of semierect setulæ 6
Halteres yellowish or occasionally reddish tinged; second antennal segment not shining black; mid tibia without a mid anterior bristle; anterior surface of fore femur without a median series of semierect setulæ 7
6. Lateral margins of face polished, not concolorous with face. **parafacialis** n. sp.
Lateral margins of face grayish pruinescent, concolorous with face. **obversa** n. sp.
7. Height of cheek one fourth that of eye; parafacials at narrowest width exceeding half its breadth at base of antennæ, width at base of antennæ about half diameter of eye measured immediately caudad...8
Height of cheek less than one fourth that of eye; parafacials at narrowest about half its breadth at base of antennæ, width at base of antennæ less than half diameter of eye measured immediately caudad. *pilimana* (Ringd.)

8. Grayish black species; abdominal pruinescence with smooth silky sheen. **lucescens** n. sp.
Species with brownish pruinescence; abdomen not lustrous. **turbida** n. sp.

Eremomyia humeralis Stein

Eremomyia humeralis Stein, 1898. Berl. Ent. Zeitschr., (1897) 42 (3–4) : 224. Coquillett, 1901. Jour. N. Y. Ent. Soc., 9: 137. Aldrich, 1905. Misc. Coll. Smithsn. Inst., 46: 554. Coquillett, 1910. Proc. U. S. Nat. Mus., 37: 539. Stein, 1919. Arch. f. Naturgesch., (1917) 83 A (1) : 153. Stein, 1920. Arch. f. Naturgesch., (1918) 84 A (9) : 73. Séguy, 1937. Gen. Insect., Fasc. 205 p. 122.

The species *humeralis* has erroneously been reported by me (1924) from New York.[7] Stein (1898) mentions the species as occurring in Illinois, a record I have been unable to verify from an examination of material in the collections at Berlin and Chicago. All specimens of *humeralis* that I have seen were collected in the western states and provinces. The species most closely resembles *impolita,* differing essentially in that the mesopleura and hypopleura are partly polished.

British Columbia: 39 ♂, 3 ♀, Cranbrook, May 4–16, 1922 (C. B. D. Garrett), 2 ♀, Robson, April 6–21, 1947 (H. R. Foxlee) [C. N. C.].

Idaho: 2 ♀, Moscow, cotypes [Z. M. U. B., C. N. H. M.].* ♀, Juliaetta, April 2, 1899 (J. M. Aldrich) [U. S. N. M.].

Montana: ♂, ♀, Blackfoot Valley, 16 mi. up Missoula County, April 20, 1938.

Oregon: 2 ♂, Florence, April 5, 1915, ♂, ♀, Forest Grove, March 12, 1919, 3 ♂, 3 ♀, Mt. Angel, [U. S. N. M.].

Utah: ♂, Spanish Fork Canyon, alt. 6500 ft., Febr. 22, 1936, 3 ♂ Provo, alt. 6500 ft., Febr. 1936 (D. E. Hardy).

Washington: ♂, Pullman, March 17, 1909 (W. M. Mason), ♀, same locality, 1909 [Z. M. U. B.]. 2 ♂, Kamiak Butte, Whitman County, March 16, 1941, ♀, Wawawai, May 17.

[7] Leonard, M. D. 1928. A list of the insects of New York. Mem. 101 N. Y. (Cornell) Agric. Exp. Sta., (1926) p. 837.

* Zoological Museum of the University of Berlin, Chicago Natural History Museum.

Eremomyia impolita new species

Male. Black subshining, with bluish gray pruinescence; antennæ black, second segment shining; palpi black, rufous basad; frons, parafacials and cheeks whitish pruinescent; mesonotum with three vittæ and blackish marking along declivities, mesopleura and hypopleura not partly polished; abdomen with dorsocentral vitta, hypopygium shining. Legs blackish, hind tibiæ more or less reddish tinged, pulvilli brownish; wings faintly tinged or largely clear, fuscous tinged basad, cross veins clouded; halteres deep purple, calyptræ and calyptral hairs whitish, calyptral margin yellowish. Habitus of *humeralis,* shortest distance between eyes slightly less than width of third antennal segment, interfrontalia uninterrupted, much narrower caudad; narrowest width of parafacials about equal to breadth of third antennal segment; cheeks slightly restricted caudad by the course of occipitogenal margin, vibrissal angle densely and coarsely setulose. Thorax with three pairs of presutural acrostical bristles, of which the middle pair is much the stronger. Abdomen conical, anal cleft on ninth tergum restricted to region of cerci.

Fore femur with a distinct series of semierect setulæ on median plane of anterior surface; fore tibia with 1 or 2 posteroventral bristles; mid tibia with 1 anterodorsal, 1 posterodorsal, 2 posterior bristles; hind femur with 10 to 12 anteroventral, and 2 to 4 weaker posteroventral bristles on proximal half, the distal half being finely setulose; hind tibia with 2 or 3 anteroventral, 3 or 4 anterodorsal and posterodorsal bristles respectively, no bristle on distal half of anterior surface: costal thorn short and well developed, about half length of *r-m* cross vein.

Female. Slightly paler than male; ocellar triangle with a small polished area in front on anterior ocellus; mid tibiæ blackish to reddish yellow, hind tibiæ rufous to reddish yellow; caudal pair of ocellar bristles longish and directed outward, marginal bristles of tergum 4 slightly weaker than those of terga 1 + 2, and 3. Anterior surface of fore femur with a median series of semierect setulæ; anteroventral surface of mid femur with one or more longish bristles on proximal half, mid tibia with a mid anteroventral bristle, otherwise tibial bristling as in male. Fore tarsal segments 3 and 4 broadened, the second partly so; pulvilli whitish. Costal thorn variable in length, slightly longer than in male.

Length 10–10.5 mm.

Holotype and allotype: ♂, ♀, Rainier, Oregon, March 3, 1930 (R. E. Dimick) [U. S. N. M.].

The species *impolita* is closely related to *humeralis,* from which it differs in having the mesopleura, hypopleura and caudal sclerite of hind coxæ wholly unpolished. Within the species there appears to be a variation in the color of the female mid and hind tibiæ from fuscous to reddish yellow. In female specimens from Utah the pruinescence of abdomen is notably paler.

British Columbia: ♂, Copper Mtn., April 8, 1928 (G. Stace Smith) [C. N. C.].

California: ♀, San Mateo County, Febr. 22, 1920 (L. A. Whitney).

Oregon: ♂, Kiger's Island, April 12, 1930 (J. Wilcox). ♀, Rock Creek, 10 mi. West of Corvallis, March 30, 1941 (Fred Glover), ♀, Corvallis, Febr. 22, 1932 (J. Schuh), ♂, Parkdale, March 31, 1938, ♂, ♀, Vernonia, March 30–April 1, 1938 (K. Gray, J. Schuh) [Ore. State Col.]. ♂, Forest Grove, March 14, 1919 (F. R. Cole), 2 ♂, 2 ♀, Rainier, March 3, 1930 (J. Wilcox, R. E. Dimick).

Utah: ♂, Dry Canyon, Logan, March 29, 1942 (J. R. Fowler), ♀, Logan Canyon, March 24, 1940, ♂, Farmington, March 26 (K. M. Pack), 2 ♀, Provo, (Lowell Miller), ♀, Scipio, April 9, 1938.

Eremomyia medicaginis new species

Male. Black with seal brown pruinescence, parafacials and cheeks occasionally rufous tinged; second antennal segment shining black; mesonotum slightly grayish, paler than pleura, with trace of three vittæ; mesopleura polished on anteroventral region, hypopleura extensively so and caudal sclerite of hind coxæ entirely so. Abdomen subshining, pale grayish pruinescent, blackish dorsocentral vitta, basal plate of hypopygium shining. All femora entirely blackish, fore tibia entirely fuscous or blackish, mid and hind tibiæ more or less reddish tinged or reddish yellow, pulvilli brownish. Wings largely clear, tinged basad; *r–m* cross veins faintly clouded, *m–cu* cross veins clear or faintly tinged; calyptræ whitish with outer basal hairs brownish tinged; halteres purplish.

Habitus of *humeralis,* shortest distance between eyes equal to length of third antennal segment, interfrontalia broadly maintained caudad; parafacials and cheeks slightly wider and higher respectively than breadth of third antennal segment, cheeks broadly maintained caudad, vibrissal angle densely and coarsely setulose. Mesonotum with a robust median pair of presutural acrostical bristles and a weaker pair: abdomen conical, not longer than thorax.

Fore tibial bristles fine and slender, with 2 posteroventral bristles; mid tibia with a weak mid anteroventral, an anterior and 2 or 3 fine posterior bristles, 1 stronger anterodorsal and posterodorsal bristle respectively; hind femur and hind tibia bristled as in *impolita.* Costal thorn well developed.

Female. Head and thorax more densely seal brown pruinescent; mesopleura, hypopleura and coxæ marked as in male; abdomen more densely grayish drab, with or without a dorsocentral marking; mid and hind tibiæ largely reddish yellow, pulvilli whitish; parafacials narrower at middle and cheeks higher than in male; femoral and tibial bristling stronger, otherwise similar to male. Fore tarsal segments 3 and 4 broadened.

Length 8 mm.

Holotype: ♂, Medicine Hat, Alberta, April 2, 1921: Allotype, ♀, same locality, March 20, 1926 (F. S. Carr) [C. N. C.].

The species *medicaginis* has the mesopleura partly and the hypopleura and caudal sclerite of hind coxæ extensively polished. The male may be distinguished from its congeners by the notably broad frons. Except for the male specimen recorded below as captured on March 30, and which is in a teneral condition, the hind tibiæ being blackish, all other specimens of both sexes have at least the hind tibiæ reddish translucent or even reddish yellow.

Alberta: ♂, ♀, Medicine Hat, April 3–23, 1927 (F. S. Carr), ♂, same locality, March 30, 1940 (J. L. Carr) [C. N. C.].

Eremomyia albidosa new species

Male. Black; frons with whitish dust, parafacials and parafrontals with silvery pruinescence, cheeks opaque black; second antennal segment not shining; mesonotum and scutellum from in front whitish pollinose with faint trace of vittæ, pleura darker and subshining; abdominal terga whitish gray pruinescent and with an ill defined linear dorsocentral marking, hypopygium blackish and subshining. All femora narrowly reddish at apex; fore, mid and hind tibiæ successively more distinctly reddish tinged, pulvilli brownish. Wings clear or faintly and uniformly tinged; cross veins not clouded; calyptræ hyaline, halteres purplish.

Head, thorax, abdomen and femora not so densely nor so profusely setulose as in *humeralis;* narrowest distance between eyes about equal to length of third antennal segment, interfrontalia broad throughout its length; inner pair of vertical bristles erect and longish, caudal pair of ocellar bristles long and directed outward, parafrontal series of bristles continued caudad to nearly a level with anterior ocellus; parafacials and cheeks at shortest dimensions greater than breadth of third antennal segment, cheeks broadly maintained caudad; third antennal segment twice as long as second; proboscis polished, palpi sparsely setose. Mesonotum with a robust median and two weaker pairs of presutural acrostical bristles; lower posthumeral bristle weakly developed in type; stigmatal bristles devoid of accessory setulæ at base; sternopleural bristles arranged 2: 2, the lower anterior bristle finely developed. Abdomen conical as in *impolita,* with stronger marginal bristles on terga, and more bristlelike setæ on hypopygium, prebasal plate sparsely setulose.

Fore tibia with 2 posteroventral bristles; mid femur with 4 or 5 long anteroventral bristles on proximal three fifths, and 4 to 6 shorter posteroventral bristles on proximal half, scarcely longer than height of femur, mid tibia with 1 anterodorsal, 1 posterodorsal and 2 shorter posterior bristles; hind femur with 8 or 9 anteroventral, and 4 to 6 shorter posteroventral bristles on proximal three fifths, hind tibia with 2 or 3 anteroventral, 3 or 4 anterodorsal, 3 or 4 posterodorsal bristles, tarsi slender and attenuated. Wings with costal thorn as long as or longer than humeral cross vein, costal setulæ semierect, several being twice as long as diameter of costa.

Female. Head with brownish pruinescence, frontal vitta and cheeks rufous, mesonotum with seal brown pruinescence; abdomen subshining, pale drab gray, unmarked; tibiæ reddish yellow: marginal bristles on abdominal tergum 4 robust and as long as those on tergum 3; mid tibia with 1 or 2 anteroventral bristles, mid and hind femora with slightly longer bristles on posteroventral surface, otherwise bristling of legs as in male. Fore tarsal segments 3 and 4 not broadened.

Length 8–8.5 mm.

Holotype and allotype: ♂, ♀, Manhattan, Kansas, March 25–27, 1932 (C. W. Sabrosky) [U. S. N. M.].

The species *albidosa* may be readily distinguished in the male sex by the more widely separated eyes caudad, and by the dense white pruinescence on the frons; in both sexes the narrowest width of parafacials is much greater than breadth of third antennal segment and all the tarsi are slender and attenuated. In the female the mid and hind tibiæ are reddish yellow.

Colorado: ♂, Sandhills N. of Roggen, April 8, 1933 (H. G. Rodeck).

Iowa: ♀, Iowa City, April 15, 1917.

Kansas: ♂, Douglas County, March 18, 1919 (Wm. E. Hoffmann), ♂, Riley County, March 19 (R. C. Smith) [Univ. Kans.].

Eremomyia pilimana (Ringdahl)

Chortophila pilimana Ringdahl, 1918. Ent. Tidskr., 39: 190.

Eremomyia vernalis Huckett, 1924. Mem. 77 N. Y. (Cornell) Agr. Exp. Sta., (1923) p. 11. Leonard, 1928. Mem. 101 N. Y. (Cornell) Agr. Exp. Sta., (1926) p. 837. Séguy, 1937. Gen. Insect., Fasc. 205 p. 122.

Hylemyia (Eremomyia) pilimana Ringdahl, 1933. Ent. Tidskr., 54: 30. Tiensuu, 1941. Enum. Insect. Fenn., VI Diptera p. 33. Ringdahl, 1943. Tromsø Museums Årshefter, (1942) 65 (2): 9.

Eremomyia pilimana Séguy, 1937. Gen. Insect., Fasc. 205 p. 122. Tiensuu, 1941. Ann. Entom. Fenn., (1940) 6 (4): 155.

The species *pilimana* and *turbida* have yellowish halteres and differ from *fumipennis* and *lucescens* in the lustreless or less shiny appearance of the abdomen. In males of *pilimana* the parafrontals are contiguous and in both sexes the cheeks and parafacials are narrower than width of third antennal segment, whereas in male of *turbida* the parafrontals are narrowly separated throughout their length and in both sexes the cheeks and parafacials are equal to width of third antennal segment.

Georgia: 65 ♂, Clayton, April 15–22, 1940.

New Hampshire: ♀, Durham, May 18, 1907.

New York: 2 ♂, 2 ♀, Ithaca, April 18, 1920 (R. C. Shannon), 4 ♀, Coy Glen, near Ithaca, May 22, 1922, ♂, Ringwood, near Ithaca, May 3, 1922, 6 ♂, 2 ♀, Aurora, May 16, 1920, ♂, Cayuta Lake, May 8, 1935.

Nova Scotia: 2 ♀, Kentville, May 24, 1923 (R. P. Gorham).

Ontario: 10 ♂, 4 ♀, Niagara Glen, June 1–15, 1926 (G. S. Walley), ♂, Nettleby, May 17, 1925 (N. K. Bigelow) [C. N. C.].

Pennsylvania: ♂, Maryville, April 28, 1909 (E. Daecke) [U. S. N. M.].

Quebec: ♂, Aylmer, June 13, 1926 (C. H. Curran), ♀, Laniel, June 7, 1931 (H. S. Fleming), 2 ♀, Old Chelsea, May 3, 1939 (G. E. Shewell), ♂, Queens Park, Alymer, May 6, 1924 (C. B. Hutchings), ♂, Quyan, April 28, 1925 (G. H. Hammond) [C. N. C.].

Virginia: ♂, Dead Run, Fairfax County, March 24, 1925 (R. C. Shannon) [U. S. N. M.].

Wisconsin: ♂, ♀, Devils Lake, May 7, 1937 (F. M. Snyder).

Eremomyia obversa new species

Male. Grayish black, subshining; parafrontals, parafacials and cheeks whitish pruinescent; second antennal segment shining; proboscis pruinescent; mesonotum with pale brownish pruinescence and darker vittæ and markings along declivities; abdomen grayish pruinescent with dorsocentral vitta; legs brownish black, caudal sclerite of hind coxæ shining, pulvilli tinged; wings faintly brownish tinged, denser basad, and cross veins faintly clouded, or wings and cross veins clear in teneral or less matured specimens; calyptræ whitish, halteres purplish.

Shortest distance between eyes about equal to diameter of anterior ocellus, parafrontals contiguous caudad; parafacials at base of antennæ nearly as wide as breadth of third antennal segment, at narrowest less than half width of third antennal segment; cheeks not as high as width of third antennal segment, gradually narrowed caudad; vibrissal angle with several short coarse setulæ; lower region of occiput with dense slender setulæ, postocular series slender. Mesonotum with a robust median and a second weaker pair of presutural acrostical bristles, stigmatal bristles with a few setulæ at base. Abdomen as in *pilimana*, depressed; processes as long as hind metatarsus, inner border fringed with fine setulæ, apical region with several longer slender bristles curving mesad.

Fore femur without a median series of semierect setulæ on anterior surface, fore tibia with a slender posteroventral bristle; mid femur with a dense series of slender setæ and occasionally one slender bristle on proximal half of anteroventral surface, and an entire series of setæ and 4 or 5 slender proximal bristles on posteroventral surface, mid tibia with 1 anterodorsal, 1 posterodorsal and 2 posterior bristles; hind femur with 8 or 9 longish anteroventral, and 4 or 5 slender bristles on proximal three fifths of posteroventral surface, hind tibia with 2 or 3 anteroventral, 2 longer and 2 shorter anterodorsal, 3 longer and 2 or 3 shorter posterodorsal bristles, apical posterodorsal slender and varying in length. Costal thorn fine and short.

Female with pale brownish pruinescence, abdomen more densely gray pruinescent, with or without a dorsocentral marking; caudal pair of ocellar bristles erect and directed outwards; fore femur with a median series of semierect setulæ on anterior surface; mid femur with 1 to 3 longish anteroventral, and 3 to 5 longish posteroventral bristles on proximal half, mid tibia with 1 mid anterior, 1 robust anterodorsal and occasionally a second weak bristle, bristling on posterior aspect as in male; hind tibia with apical posterodorsal bristle short; fore tarsal segments 3 and 4 not broadened.

Length 5.5 mm.

Holotype and allotype: ♂, ♀, Ithaca, New York, March 25, 1917 (R. C. Shannon) [U. S. N. M.].

The species *obversa* closely resembles *parafacialis*, from which it differs essentially in not having the lateral margins of face polished and black. The species has been mistakenly recorded by me from New York under the name *humeralis*.[7]

Connecticut: ♂, Redding, April 1931 (A. L. Melander).

New York: 9 ♂, 8 ♀, Ithaca, March 25, 1917 (R. C. Shannon, S. H. Emerson), 3♂, 3 ♀, Coy Glen, near Ithaca, May 22, 1922, ♀, Lake Ridge, May 6, 1922.

Ontario: 2 ♂, ♀, Arnprior, March 14, 1926 (C. Macnamara), *ex* ground hog hole.

Quebec: ♀, Old Chelsea, May 3, 1939 (G. E. Shewell).

Eremomyia parafacialis new species

Similar in habitus to *obversa*, differing essentially in both sexes by having the lateral margins of face polished and black in contrast to the grayish pruinescence on the remainder of the face; cross veins clouded, notably so in female.

Male. Parafacials at base of antennæ and cheeks at shortest dimension about as wide as breadth of third antennal segment, vibrissal angle with setulæ more slender than in *obversa;* processes of fifth abdominal sternum about as long as half length of hind tibia, with nearly as long bristles at apex that are directed ventrad and mesad; fore femur with a median series of semierect setulæ on anterior surface, mid femur more sparsely setulose on anteroventral and posteroventral surfaces than in *obversa,* hind tibia in type with 1 anteroventral, 2 anterodorsal, 2 longer and 3 shorter posterodorsal bristles, apical posterodorsal weak; costal thorn nearly twice as long as diameter of costa. Length 5 mm.

Female. Wings more densely infuscated and cross veins more densely clouded than in male, lower posthumeral bristle well developed; mid tibia with a mid anterior bristle, fore tarsal segments 3 and 4 not broadened; costal thorn as long as humeral cross vein, costal setulæ in a well defined semierect series. Length 7 mm.

Holotype: ♂, Katmai, Alaska, June 1917 (J. S. Hine). Allotype: ♀, Banff, Alberta, July 18, 1922 (C. B. D. Garrett) [C. N. C.].

The species *parafacialis* and *obversa* are closely related, the former occurring in Alaska, British Columbia and Alberta, and the latter in the eastern states and provinces. The species *parafacialis* may be separated from *obversa* by the shining black appearance of lateral margins of face.

Alberta: 8 ♀, Banff, July 12–20, 1922 (C. B. D. Garrett) [C. N. C.].

British Columbia: ♀, Hedley, July 20, 1923 (C. B. D. Garrett).

Eremomyia fumipennis new species

Male. Brownish black, subshining; parafacials and parafrontals with seal brown pruinescence; second antennal segment shiny, proboscis polished; mesonotum and scutellum from in front blackish, with little trace of markings, when viewed from behind with a black dorsocentral vitta and sublaterals that are decidedly broader on presutural region than on postsutural; abdomen lustrous, hypopygium shiny. Wings extensively brownish tinged, and more intensively on anterior and basal regions, cross veins not clouded; calyptræ yellowish brown including marginal hairs, halteres largely yellow, stalk being purplish tinged. Legs brownish black, subshining, pulvilli fuscous.

Habitus of *pilimana,* narrowest distance between eyes about equal to diameter of anterior ocellus; parafrontals contiguous at middle of frons, parafacials at base of antennæ and cheeks at shortest dimension less than width of third antennal segment, the former at narrowest about equal to one fourth width of third antennal segment, cheeks gradually narrowed caudad, third antennal segment 1.75 times as long as second. Mesonotum with 3 pairs of presutural acrostical bristles, lower posthumeral bristle well developed, sternopleural bristles arranged 1: 3, the lower caudal bristle being slender and weak. Abdomen as in *pilimana*.

Fore femur with no trace of median series of semierect setulæ on anterior surface, fore tibia with 2 posteroventral bristles; mid femur with a dense series of slender setulæ on proximal two thirds of anteroventral and along entire length of posteroventral surface, and with 3 proximal posteroventral bristles, mid tibia with 1 anterodorsal, 1 posterodorsal and 3 posterior bristles; hind femur with 8 or 9 bristles on distal three fifths of anteroventral surface, and with 2 or 3 short bristles on median third of posteroventral surface, hind tibia with 2 anteroventral, 2 long and 2 short anterodorsal, 3 longer and 3 shorter posterodorsal bristles, apical posterodorsal weak; costal thorn short and inconspicuous. Length 6.5 mm.

Holotype: ♂, Tacoma, Washington, April 12, 1913 (J. M. Aldrich) [U. S. N. M.]

The males of *fumipennis* have the wings and calyptræ extensively yellowish brown and the abdomen lustrous, thereby distinguishing them from those of related species.

Oregon: ♂, Forest Grove, March 28, 1919 (F. R. Cole).

Eremomyia lucescens new species

Male related to *fumipennis*, differing in that the parafrontals, parafacials and cheeks are whitish pruinescent; second antennal segment shiny and mesonotum blackish as in *fumipennis;* abdomen with distinct sheen and more grayish pruinescent; wings faintly tinged, largely clear, calyptræ whitish, halteres dull yellowish brown with trace of purple tinge.

Female paler than male, subshining; second antennal segment not shiny, mesonotum with a brownish dorsocentral vitta; abdominal terga highly shiny, with scant silky pruinescence and trace of dorsocentral marking. Wings yellowish brown tinged, denser basad, cross veins unclouded, calyptræ yellowish. Parafacials at base of antennæ and cheeks at shortest dimension equal to breadth of third antennal segment; presutural acrostical bristles varying in development, absent in allotype, lower posthumeral bristle weakly developed or absent, stigmatal bristles with a few accessory setulæ at base.

Fore femur without median series of semierect setulæ on anterior surface, fore tibia differing from male in having an apical posterodorsal bristle; mid femur with anteroventral surface bristleless or with one prebasal bristle, and with 2 or 3 proximal posteroventral bristles, mid tibia with 1 anterodorsal and 1 posterodorsal bristle, 1 or 2 posterior bristles, and in occasional specimens a second weak posterodorsal; hind femur with 6 to 8 anteroventral bristles, and 2 or 3 on median third of posteroventral surface, hind tibia with 2 anteroventral, 2 longer and occasionally 1 or 2 shorter anterodorsal bristles, 2 longer and 2 to 4 shorter posterodorsal, apical posterodorsal bristle weak. Costal thorn finely developed, varying in length.

Length 5.75 mm.

Holotype: ♂, Banff, Alberta, alt. 7600 ft., June 13, 1922 (C. B. D. Garrett). Allotype: ♀, same locality, August 2, 1922. [C. N. C.].

The species *lucescens* has the abdomen notably shiny, but not so lustrous as in the male of *fumipennis*. Neither are the wings of the male of *lucescens* as strongly tinged as in the male of the latter species.

Alberta: 9 ♀, Banff, July 19, 1915 (N. B. Sanson), 2 ♀, same locality, alt. 7600–8000 ft., August 2–3, 1922 (C. B. D. Garrett) [C. N. C.].

British Columbia: 2 ♀, Hedley, July 19–20, 1923 (C. B. D. Garrett) [C. N. C.].

Washington: ♀, Mt. Baker, July 29, 1931 (R. H. Beamer) [Univ. Kans.].

Eremomyia turbida new species

Essentially resembling *pilimana*, but the eyes are more widely separated in the male, the interfrontalia in the type being uninterrupted caudad and hence the parafrontals are not contiguous at middle. In both sexes the parafacials and cheeks are wider, and the ventral surface of head bordering oral cavity is largely polished black.

In the male type the lower posthumeral bristle is weakly developed, setose; the prebasal plate of hypopygium has several setulæ; abdominal sterna 1 and 2 shining and glossy, and sternum 3 partly so; caudal sclerite of hind coxæ polished. Fore tibia with 2 posteroventral bristles. Wings yellowish tinged, calyptræ whitish, halteres yellow, the knobs pinkish tinged.

Female, parafrontals and parafacials with brownish pruinescence, mesonotum suffused with brownish infuscation, abdomen yellowish gray pruinescent; presutural pair of acrostical bristles lacking; hind tibia in allotype with 2 anterodorsal bristles, fore tarsal segments slender; wings more yellowish than in male, calyptræ yellowish tinged; costal thorns as long as humeral cross vein.

Holotype and allotype: ♂, ♀, Baker Lake, North West Territories, July 12–20, 1947 (T. N. Freeman) [C. N. C.].

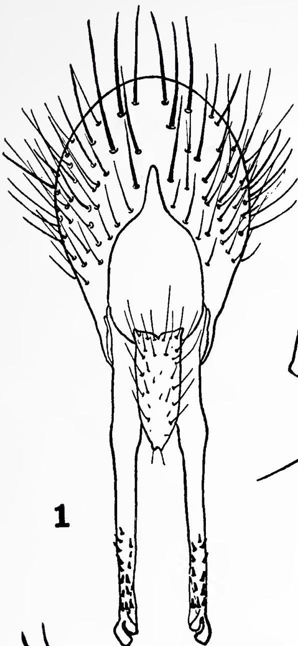
The species *turbida* largely resembles *pilimana*, from which it differs in having wider cheeks and parafacials, and in the male in having the eyes more widely separated across the frons.

PLATE VI

Figures 1 to 3. Male copulatory appendages of *Eremomyia humeralis* Stein, showing caudal or dorsal and lateral aspects of tergum 9, ventral aspect of sternum 5.

Figures 4 and 5. Semidiagrammatic drawings of the caudal aspect of male terminal abdominal sclerites in *Eremomyia humeralis* Stein (fig. 4), and in *Eremomyia pilimana* (Ringdahl) (fig. 5).

5 T = tergum 5
6 T = tergum 6, ''prebasal plate of hypopygium.''
9 T = tergum 9, ''anal sclerite.''
7 S = sternum 7
8 S = sternum 8, ''basal plate of hypopygium.''



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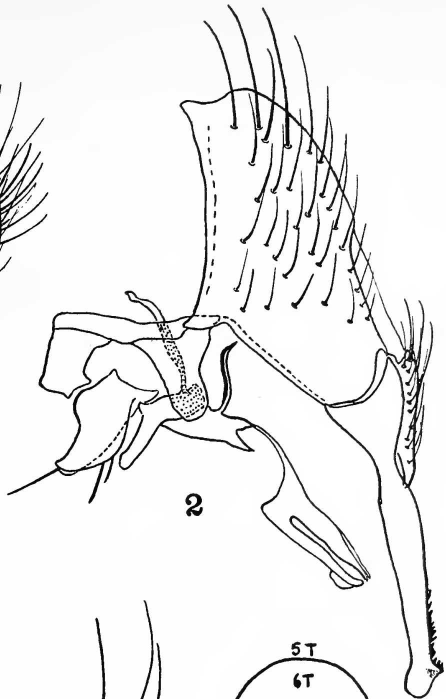

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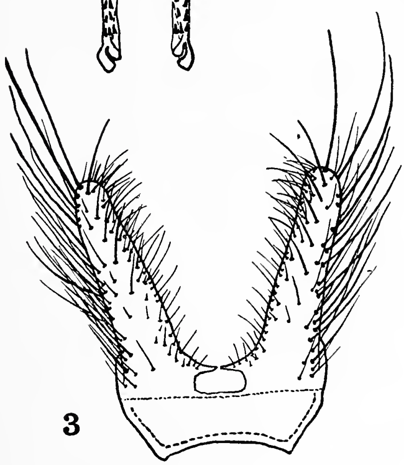

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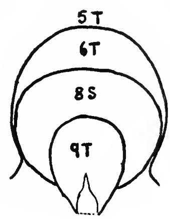

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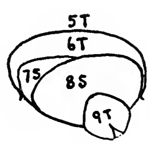

5

HOW SCOGIN SOLD POWDER TO KILL FLEAS

"Scogin divers times did lacke money, and could not tell what shift to make. At last, he thought to play the physician, and did fill a box full of the powder of a rotten post; and on a Sunday he went to a Parish Church, and told the wives that hee had a powder to kill up all the fleas in the country, and every wife bought a pennyworth; and Scogin went his way, ere Masse was done. The wives went home, and cast the powder into their beds and in their chambers, and fleas continued still. On a time, Scogin came to the same Church on a Sunday, and when the wives had espied him, the one said to the other; this is he that deceived us with the powder to kill fleas; see, said the one to the other, this is the selfe-same person. When Masse was done, the wives gathered about Scogin, and said: you be an honest man to deceive us with the powder to kill fleas. Why, said Scogin, are not your fleas all dead? We have more now (said they) than ever we had. I marvell of that, said Scogin, I am sure you did not use the medicine as you should have done. They said: wee did cast it in our beds and in our chambers. Said he, there be a sort of foole that will buy a thing, and will not aske what they should doe with it. I tell you all, that you should have taken every flea by the neck, and then they would gape; and then you should have cast a little of the powder into every flea's mouth, and so you should have killed them all. Then, said the wives: we have not onely lost our money, but we are mocked for our labour." The above is one of the stories in "Scogins Jests," London, 1626. An earlier edition was published in 1565–6. The collection of jests was "Full of Witty Mirth and Pleasant Shifts" and was a "Preservative against Melancholy" according to the title page.—H. B. W.

RODRIGUES OTTOLENGUI, 1861–1937

Upon consulting Mathilde M. Carpenter's "Bibliography of Biographies of Entomologists," and finding that, except for a brief anonymous statement in a German entomological periodical in 1937, no adequate biography of Dr. Ottolengui had ever been published in an American entomological journal, no other course was open except to prepare one of this distinguished former member of the New York Entomological Society.

Apparently his first entomological paper was a note on his capture of a single male specimen of the geometrid moth *Brotis vulneraria* in Prospect Park, Brooklyn. This appeared in the Journal of the New York Entomological Society, volume 1, page 91, 1893. At this time Dr. Ottolengui was vice-president of the Society and also a member of the executive committee and the committee on admissions. He continued as a member of the executive committee until 1895 inclusive and again in 1898 and 1900 he was a member of that committee. His next entomological paper appeared in 1902 in the Journal of the New York Entomological Society, volume 10, p. 57–77. This was entitled "Plusia and Allied Genera with Descriptions of New Species." In this paper twelve new species were described and fifty-eight species were illustrated on four plates. In the same issue of that journal, this paper was followed by another by Dr. Ottolengui, on "Notes on Calocampa With a Description of a New Species" p. 77—79, with one plate. Apparently nothing entomological came from him again until seventeen years later when he again published in the Journal of the New York Entomological Society, volume 27, p. 117–126, 1919 "Notes on the Plusiinæ With Descriptions of New Species and Races." This included six new species and races and was illustrated by one plate. In this paper Dr. Ottolengui referred to his 1902 paper and stated that he was working on the data and illustrations for a new complete monograh. For this he had obtained, through the courtesy of Sir George Hampson of the British Museum and with the help of Hampson's artist, drawings in color of the thirty-six types in the British Museum. He also had other color drawings made for him by Mrs. William Beutenmüller. It was his intention to publish these, but estimates on the cost of reproduction by the 4-color process were prohibitive and so the matter was postponed.

Dr. Ottolengui's active interest in descriptive entomology lasted at least for twenty-six years beginning probably around 1893 when he was thirty-two years old and continuing until 1919 when he was fifty-eight. Twelve years later or in 1931 he gave his "very excellent collection" of Phytometrinæ to the American Museum of Natural History in New York City. At the December 15, 1931 meeting of the New York Entomological Society, a statement by Frank E. Watson, in charge of the Museum's collection of Lepidoptera, was read in which it was said that the collection of Phytometrinæ (subfamily of the Noctuidæ), in which Dr. Ottolengui had specialized for so many years, was very complete and world-wide in scope. It contained some 3,300 specimens representing nearly 450 species, including types, paratypes, metatypes and homotypes. A large part of the material was "fresh and beautiful." Accompanying the collection was an album containing 171 hand-colored sketches of types and other rare species. These were the colored drawings, made by Sir George Hampson's artist, and by Mrs. Beutenmüller, to which Dr. Ottolengui had referred in his 1919 paper on the Plusiinæ.

William Beutenmüller (1864–1934), husband of Mrs. Beutenmüller, named a new genus Ottolenguia in a paper entitled "Description of a New Moth" (Jour. N. Y. Ent. Soc., vol. 4, p. 146, 1896). He also described a new species from Florida in the new genus calling it *Ottolenguia reticulina* Beut., (Family Thyrididæ). Unfortunately Beutenmüller's new genus and species turned out to be a synonym of *Hexeris enhydris* Grt., according to J. McDunnough's "Check List of the Lepidoptera of Canada and the United States of America, Part II, Microlepidoptera" (Mem. So. Calif. Acad. Sci., vol. 2, No. 1, 1939) and Beutenmüller's effort to honor his friend was invalidated. However *Autographa arctica* Ottolengui was renamed *Autographa ottolenguii* by Dyar. Of some eighteen new species and varieties described by Ottolengui, fifteen are valid to-day.

Between the ages of thirty-one and thirty-seven, or from 1892 to 1898, Dr. Ottolengui wrote five mystery detective novels. These were all published by G. P. Putnam's Sons of New York City. The first was "An Artist in Crime," 1892. This was followed by "A Conflict of Evidence" in 1893 (347 p.); "A Modern Wizard," 1894 (434 p.); "The Crime of the Century" in 1896 (349 p.), and "Final Proof, or the Value of Evidence" in 1898, (390 p.).* It has been recorded that "An Artist in Crime" was translated into French, German and Polish. According to the Union Catalogue "An Artist in Crime" was translated into Icelandic by Sigtryggur Jonasson and published in Winnipeg in 1900, under the title "Leikinn Glaepamaour." And in 1901 "The Crime of the Century" was also translated by the same person into Icelandic, and published at Winnipeg as "Höfuo-Glaepurinn, Saga."

Dr. Ottolengui's life-long interest however was the practice of dentistry. He was born March 15, 1861 in Charleston, South Carolina. His grandfather Dr. B. A. Rodrigues was a dentist who had studied under Dr. C. Starr Brewster, also of Charleston. His father was Daniel Ottolengui, a newspaper man and playwright and his mother Mrs. Helen Rosalie Rodrigues Ottolengui, was an author. In 1885 when Rodrigues Ottolengui was 24 years old, the degree Master of Dental Surgery was conferred upon him by the University of the State of New York. He studied dentistry under Dr. Norman W. Kingsley of New York City and became his assistant. And early in his career he attracted the attention of Dr. W. A. Atkinson, once the dean of the dental profession. Dr. Kingsley who was a prominent orthodontist and the originator of the best method of treating cleft palates, exacted a promise from Dr. Ottolengui that in return for the methods and techniques taught by Dr. Kingsley, he (Dr. Ottolengui) was to give the treatment to any patient requiring it

* In "Queen's Quorum" (p. 227–288 of "Twentieth Century Detective Stories," ed. by "Ellery Queen," New York. The World Publishing Company, 1948), Ottolengui's "Final Proof" is recorded as one of "the 101 most important books of detective-crime short stories." Mr. "Queen" refers to Dr. Ottolengui as one of the most neglected authors in the history of the detective story and as being unappreciated even in his own time.

regardless of any fee. This was because the majority of the cleft palate patients had little or no money but were worthy of receiving service. Dr. W. A. Atkinson to whom the young Ottolengui sometimes brought his patients for help and advice and whose office was always open for such a purpose, also exacted a promise that as Ottolengui became older he should give his help freely to younger practitioners. Dr. Ottolengui practiced his profession successfully in New York City for fifty years and had an office at 80 West Fortieth Street. He was among the first to sponsor dental research and did much to advance the dental profession. He specialized in several branches especially orthodontia and was among the first to use the X-ray in the dental field. He also made important contributions to pulp canal therapy and cleft palate restorations. In addition dental literature was enriched by his contributions.

In August, 1896 Dr. Ottolengui became editor of ''Items of Interest'' later changed to ''Dental Items of Interest.'' He continued to edit that journal with distinction and ability for forty-one years, or until the time of his death. Many honors came to him. He was a past president of the Dental Society of the State of New York, of the original Brooklyn Dental Society, of the Second District Dental Society and of the American Society of Orthodontists. He was honored by the Odontographic Society of France and by the Dental Society of Denmark. In 1909 the honorary degree of Doctor of Dental Surgery was conferred upon him by Creighton University (Omaha, Nebraska) and in 1907 Valparaiso University (Valparaiso, Indiana) made him an LL.D., in recognition of his extracurricular activities. In addition he was a Fellow of the American College of Dentists and a past Supreme Grand Master of Delta Sigma Delta.

For twenty-three years Dr. Ottolengui conducted the ''round-table'' in ''Dental Items of Interest,'' a popular and famous feature of that journal. His last contribution of that sort appeared in the August, 1937 issue (volume 59, No. 8, p. 797–802). In this feature of the journal the leaders of the dentistry profession discussed problems under the able guidance of Dr. Ottolengui. In 1892 his work ''Looking Forward (in Dentistry)'' was published in Chicago. In 1892, the S. S. White Dental

Manufacturing Company of Philadelphia brought out his "Methods of Filling Teeth: An Exposition of Practical Methods" (200 p. illus.). A second edition was published by White and also by Claudius Ath and Sons, London, in 1899. In 1928 the Dental Items of Interest Publishing Company of Brooklyn, published his "Table Talks on Dentistry" a work of 488 pages with illustrations. During his early years Dr. Ottolengui was active in dental politics. Being a fluent speaker and having a legal type of mind, together with ample courage, his influence in the old National Dental Association was undisputed.

About 1933 Dr. Ottolengui retired from dental practice, but continued to edit "Dental Items of Interest." At the Twentieth Anniversary of the Kings County Dental Society celebrated in 1932 he was acclaimed as an individual "possessing great intellectual attainments, keen and alert to the requirements of organized dentistry," who "through his deliberations and writings dispelled the fears, complexes and misunderstandings with which our profession has been so frequently confronted." In 1935 the Ottolengui Testimonial Committee was organized to elicit a response from the profession in honor of his seventy-fifth birthday. To this, an overwhelming number of congratulatory expressions poured in.

Dr. Ottolengui died on Sunday, July 11, 1937 at his home 175 West Seventy-second Street, New York, of a heart ailment and a stroke after a long illness. According to the obituary in "The New York Times" of July 13, 1937 he was a cousin of the late Count Aguilar, dentist to former King Alfonso of Spain, and of Octavus Roy Cohen, American novelist, short story writer, and author of detective stories. Dr. Ottolengui's wife, Mrs. May Hall Ottolengui had died on July 10, 1936. At the time of his death he was survived by a sister Mrs. Helen Hirsch and a brother Lee Ottolengui, a retired theatrical manager, both of Brooklyn.

In addition to what has been noted, Dr. Ottolengui was an amateur taxidermist, a sculptor, and a photographer of ability. He was a member of the New York Camera Club and won a prize at one of their exhibitions. In an editorial in the "International Journal of Orthodontia and Oral Surgery" for September, 1937,

H. C. P. referred to this gifted and versatile man as "one of those intrepid, enthusiastic, brilliant, personable and outstanding individuals who not only have helped carve out the destiny of American dentistry, but have contributed in no small way to the growth of the lusty infant, orthodontia."

For help received in the preparation of this biography, I wish to express my thanks and appreciation to Mrs. Elise C. Ottolengui of Brooklyn, N. Y., sister-in-law of the late Dr. Ottolengui; Dr. Irving Kraut, Trenton, N. J.; Joseph S. Wade, Washington, D. C., and Lewis M. Stark, The New York Public Library. For the information about Dr. Ottolengui's professional accomplishments, I have drawn freely from H. C. P. author of the editorial in the "International Journal of Orthodontia and Oral Surgery" for September, 1937; and from the accounts by Dr. J. R. Schwartz and Dr. Robert H. Lieberthal, that were published in "Dental Items of Interest" for August, 1937.—HARRY B. WEISS.

PRESERVATION OF FUNGI FOR LABORATORY USE

While making a study of the insect inhabitants of the bracket fungus Polyporus betulinus, it was necessary to bring some of the fungi into the laboratory. Here, however, a problem confronted the experimenter. For rearing the insects, it was necessary to keep the fungi in a fleshy condition and yet avoid the mold which developed if they were kept too moist. The problem was solved by placing the fungi in small plastic bags, such as are used for food storage and home freezing, closed by elastic bands or clamps. Molding was prevented by opening the bags once or twice a week for a few hours. By this method of preservation, fungi can be kept in a good condition for indefinite periods.—EDITH L. MINCH, Graduate student, New York State College for Teachers, Albany, N. Y.

RECORDS AND DESCRIPTIONS OF NEOTROPICAL CRANE-FLIES (TIPULIDÆ, DIPTERA), XXV

By Charles P. Alexander
Amherst, Massachusetts

The preceding article under this general title was published in the Journal of the New York Entomological Society, **57**: 253–265; 1949. The novelties herein described are from Guatemala, British Guiana, Brazil and Peru, where they were collected by Messrs. Thomas H. Farr, Neal R. Weber, the late Mr. J. F. Zikán, and Mr. José M. Schunke, respectively. Except where indicated to the contrary, the types of the new species are preserved in my personal collection of these flies.

Genus *Limonia* Meigen

Limonia (Limonia) imperturbata new species

Belongs to the *insularis* group; size very large (wing, male, 16 mm.); general coloration black, more or less pruinose; femora brownish yellow, darker before the tips which are narrowly yellow; tibiæ brownish black, the narrow base and broader tip yellow; basitarsus brownish black, the tip and succeeding segments yellow, the outer segments darkened on lower surface; wings very obtuse at apex, dusky, weakly patterned with darker; free tip of Sc_2 and R_2 subequal, vein R_{1+2} projecting beyond them as a spur; outer end of vein R_3 deflected very strongly caudad, of vein R_{4-5} less so; male hypopygium with the spines of the rostral prolongation very small and inconspicuous, placed on the proximal half of the compressed-flattened blade; gonapophysis with mesal-apical lobe a blackened spine.

Male. Length about 13 mm.; wing 16 mm.; antenna about 3.1 mm.

Rostrum and palpi black. Antennæ black throughout; flagellar segments passing through oval to elongate, with short apical necks, these becoming longer and narrower on the outer segments; longest verticils unilaterally arranged, about one-half longer than the segments; terminal segment elongate, about one-half longer than the penultimate. Head black, sparsely pruinose, more heavily so on the genæ and on the sides of the posterior vertex; anterior vertex behind the antennal bases silvery white; narrowest point of anterior vertex about one-half the diameter of scape.

Pronotum black, sparsely pruinose. Mesonotal præscutum black, sparsely pruinose, more conspicuously so on the sides; posterior sclerites of notum pruinose. Pleura black, the dorsopleural membrane darkened. Halteres brown, knobs blackened. Legs with the coxæ black; trochanters brownish yellow; femora obscure brownish yellow, before the tips passing into black, forming a more or less distinct ring, the actual tip narrowly yellow; tibiæ brownish black, the base narrowly yellow, less than the femoral apex, the tips more broadly yellow; basitarsi brownish black, the tips and succeeding segments paling to yellow, the outer segments infuscated on lower surface; claws (male) long and slender, with a strong spine at near the basal third. Wings with a strong dusky tinge, the prearcular and costal fields a trifle more yellowish brown; wing apex in outer radial field more heavily but narrowly darkened; *Rs* and cord less evidently seamed with pale brown; veins brown, *Sc* more yellowed. Wing apex very obtuse to nearly truncate. Venation: Sc_1 ending shortly before the fork of *Rs*, Sc_2 a little shorter than Sc_1; *Rs* subperpendicular at origin; free tip of Sc_2 and R_2 subequal, both shorter than vein R_1 lying between them; a spur of R_{1+2} about equal in length to R_2; veins R_3 and R_{4+5}, especially the former, deflected very strongly caudad to end at and beyond the wing tip; cell *1st* M_2 a little longer than vein M_4; *m–cu* close to the fork of *M*, shorter than the distal section of Cu_1; vein *2nd A* only gently arcuated.

Abdomen, including hypopygium, brownish black. Male hypopygium with the ninth tergite large, the caudal border narrowly but deeply divided medially, the low lobes with conspicuous black setæ. Basistyle with ventromesal lobe conspicuously setiferous on outer end. Dorsal dististyle sinuously curved, the outer surface scabrous, as in the group. Ventral dististyle subequal in area to the basistyle; rostral prolongation yellow, appearing as a compressed cleaver-like blade; spines very pale and difficult to see, placed in large pale depressions on basal half of blade. Gonapophysis with mesal-apical lobe a blackened curved spine that narrows to the acute tip.

Habitat. Guatemala.

Holotype, ♂, Chicacao, altitude 3,300 feet, August 8, 1949 (T. H. Farr).

From the other members of the *insularis* group of outstanding size, including *Limonia* (*Limonia*) *felix* Alexander, *L.* (*L.*) *ingens* Alexander, and *L.* (*L.*) *pernobilis* Alexander, the present fly is readily told by pattern of the legs and wings.

Limonia (Limonia) scænalis new species

Mesonotal præscutum yellowish brown, clearer laterally, with a broad brown central stripe; antennæ black, the flagellar segments with short apical necks; legs black; wings with a strong blackish tinge, the stigma scarcely differentiated; male hypopygium unusually complex in structure, particularly the basistyle and dististyle.

Male. Length about 6.5 mm.; wing 6.9 mm.

Rostrum brown; palpi black. Antennæ brownish black, relatively long, if bent backward extending nearly to the root of the halteres; flagellar segments well separated by short apical necks, the swollen bases of the more proximal segments subcordate, of the outer segments narrower and more oval. Head gray.

Pronotum brownish yellow. Mesonotum yellowish brown, the præscutum clearer yellow laterally, with a broad black central stripe, more intense in front, behind confluent with the shorter lateral stripes, the whole forming a blackened discal shield; scutal lobes infuscated. Pleura weakly infuscated above, brighter ventrally. Halteres brownish black, the base of stem narrowly yellow. Legs with the coxæ and trochanters yellow; remainder of legs black; claws long and slender, with a long basal spine and a smaller very acute spine on upper face at near two-thirds the length. Wings with a strong blackish tinge, the stigma scarcely differentiated; veins dark brown. Venation: Sc_1 ending shortly before the fork of *Rs*, Sc_2 near its tip and subequal in length; *Rs* long, arcuated, more than twice the basal section of R_{4+5}; free tip of Sc_2 and R_2 both pale and in transverse alignment; cell *1st* M_2 a little longer than vein M_4; *m–cu* at or just beyond the fork of *M*; vein *2nd A* virtually straight for most of its length.

Abdominal tergites dark brown, sternites yellow; hypopygium brownish yellow. Male hypopygium unusually complex in structure. Ninth tergite transverse, its caudal margin very gently emarginate, scarcely forming lobes; a transverse row of setæ across the posterior third, four or five near the outer end of the row very long, approximately equal to the transverse diameter of the sclerite, the central setæ shorter and stouter. Basistyle very complex, the outer end of mesal face produced into a stout lobe that bears abundant setæ from conspicuous basal tubercles, these more concentrated at tip; on mesal face of style with a further very low lobe tipped with a few long setæ and two glabrous blackened blades or plates; still more basad on face of style with a circular darkened area provided with long strong setæ. Dististyle complex, including three major blackened structures, the more dorsal one shorter, its lower margin with numerous long setæ; the two longer rods lie superimposed in the slide mount of the type, the upper one forking into two points at tip, the lower a simple slightly decurved hook. Gonapophysis stout, especially the mesal-apical lobe which is narrowly blackened at tip and directed slightly laterad. Aedeagus very slender, bilobed at apex.

Habitat. Peru.

Holotype, ♂, Chanchamayo, Junin, altitude 1,100 meters, February 12, 1949 (J. M. Schunke).

This very distinct fly requires no comparison with other described forms. In some respects it suggests *Limonia* (*Limonia*) *somnifica* Alexander, but the relationship is not close.

Genus *Epiphragma* Osten Sacken

Epiphragma (Epiphragma) farri new species

Thorax above polished black, the præscutum with four yellow stripes, the anterior portions of the scutal lobes similarly yellow; scutellum yellow, the posterior border black; postnotum and pleura chiefly yellow; femora yellow, each with two narrow pale brown rings; wings pale brown, restrictedly patterned with darker brown, the markings not at all ocelliform; a broad, bright yellow longitudinal stripe in the subcostal and cephalic radial fields, reaching the wing tip in cell R_4.

Male. Length about 12 mm.; wing 11 mm.; antenna about 2.2 mm.

Female. Length about 14 mm.; wing 12 mm.; antenna about 2 mm.

Rostrum light brownish yellow; palpi black. Antennæ relatively short in both sexes; scape brown, pedicel black; fusion-segment of flagellum yellow, the outer end and remainder of flagellum black; flagellar segments long-cylindrical, with elongate verticils that exceed the segments. Head above chestnut brown.

Pronotum brown, the scutellum and pretergites more yellowed. Mesonotal præscutum polished black, handsomely patterned with yellow, the latter including four stripes and an isolated circular area in the humeral field; intermediate stripes separated by a capillary black line that is widest at its anterior end; lateral stripes crossing the suture and covering the anterior parts of the scutum, the posterior borders and lateral margin black; scutellum and parascutella obscure yellow, the posterior border of the former broadly brownish black; postnotum brownish yellow. Pleura yellow or weakly brownish yellow, the pteropleurite and meral region somewhat paler yellow; dorsopleural region more or less spotted with brown, especially on the propleura and before the wing root. Halteres infuscated. Legs with the coxæ yellow, the fore pair a trifle darker; trochanters yellow; femora yellow, each with two narrow and relatively indistinct pale brown rings that are scarcely half as wide as the broad pale apex or interspace; remainder of legs yellow. Wings with the ground color pale brown, restrictedly patterned with darker brown; a very conspicuous bright yellow longitudinal stripe in the subcostal and cephalic radial field, extending from the prearcular area to the wing tip in outer end of cell R_4; the darker areas appear as spots above and below the yellow stripe, near arculus, origin of *Rs* and at tip of *Sc;* more evident seams in outer radial and medial fields, the longest extending obliquely from cell R_5 to the margin at end of vein M_3; small to scarcely apparent clouds on *m–cu* and at or near ends of veins M_4, Cu_1, *1st A* and *2nd A;* extreme outer radial field dusky, appearing as a narrow band lying outside the yellow stripe, ending at wing tip in cell R_5; no evidence of an ocelliform pattern, as common in the genus; veins brown, those in the centers of the yellow stripe a trifle paler. Venation: Supernumerary crossvein in cell *C* erect; *Rs* square and short-spurred at origin; R_{2+3+4} longer than basal section of R_5; cell M_1 a trifle longer than its petiole; *m–cu* at near one-third the length of cell *1st* M_2.

Abdominal tergites dark brown; basal sternites yellow, the outer segments more darkened; hypopygium brownish yellow, the tips of the basistyles paling to yellow. Male hypopygium with the tergal lobes small, separated by a small V-shaped notch. Outer dististyle terminating in a simple decurved point, shorter than the inner style. Interbase appearing as an erect slender rod, the tip recurved into an acute point.

Habitat. Guatemala.

Holotype, ♂, El Naranjo, Chicacao, altitude 5,000 feet, July 11, 1949 (T. H. Farr). Allotopotype, ♀, altitude 5,200 feet, July 11, 1949 (T. H. Farr).

This crane-fly is named in honor of Mr. Thomas Howard Farr, to whom I am indebted for several unusually interesting Tipulidæ from Guatemala. The species is entirely distinct, with no close relative so far described. The still poorly known *Epiphragma* (*Epiphragma*) *nebulosa* (Bellardi), of Mexico, is much larger and has all details of coloration distinct. The very striking wing pattern of the present fly strongly suggests that found in various species of the Pediciine genus *Nipponomyia* Alexander, occurring in eastern and southern Asia.

Genus *Hexatoma* Latreille

Hexatoma (Eriocera) weberi new species

Size medium (wing, female, 8.5 mm.); general coloration of thorax almost uniform reddish brown, the surface sparsely pruinose; mouthparts greatly reduced, rostrum lacking; antennæ dark brown, 7-segmented in female; wings with a weak brownish tinge, the costal border somewhat darker; vein R_1 lying very close to costa, cell R_1 thus very narrow in the stigmal region; R_{1+2} appearing as a very short element, vein R_2 bent backward, long and arcuated; *r–m* nearly its own length before the fork of *Rs;* cell M_2 open by atrophy of *m; m-cu* at fork of *M*, subequal in length to distal section of vein Cu_1; abdomen obscure yellow, the posterior borders of the segments narrowly brown; ovipositor with elongate valves.

Female. Length about 11.5 mm.; wing 8.5 mm.; antenna about 1.7 mm.

Mouthparts greatly reduced, appearing as small yellow palpi, the entire face on a vertical plane, with no indication of a rostrum. Antennæ (female) 7-segmented, dark brown throughout; flagellar segments with abundant relatively short setæ; first flagellar segment more than twice the length of the second. Head below the mouthparts silvery gray pruinose; strip of the front between the mouthparts and antennæ brownish testaceous, relatively narrow, sub-equal in width to the diameter of scape; head above light gray pruinose; vertical tubercle high and conspicuous, entire.

Thorax almost uniformly reddish brown, the surface sparsely pruinose; præscutum with a very delicate capillary gray vitta; a narrow furrow extends from the humeral region diagonally inward toward the midline. Pleura obscure yellowish brown, the ventral sternopleurite clearer yellow. Halteres dusky, the base of stem yellow, the knob weakly darkened. Legs with the coxæ brownish yellow, the fore pair somewhat darker; trochanters testaceous yellow; remainder of legs brown; tibial spurs apparently lacking. Wings with a weak brownish tinge, the costal border somewhat darker; veins pale brown. Veins beyond cord with abundant macrotrichia; basad of cord with trichia over most of *Rs* and outer end of vein *M*. Venation: Sc_1 ending about opposite *r–m*, the latter nearly its own length before the fork of *Rs;* vein R_1 lying close to costa, greatly narrowing the costal cell in the stigmal area; R_{1+2} appearing as a very short oblique element, R_2 long, bent backward, somewhat as in the genus *Trentepohlia;* R_{2+3} very short to punctiform; *Rs* relatively short; cell M_2 open by the atrophy of *m;* cell M_3 shorter than its petiole; *m–cu* at fork of *M*, subequal to distal section of Cu_1; cell *2nd A* relatively broad.

Abdomen obscure yellow, the posterior borders of the segments narrowly brown to produce a weak banded appearance. Ovipositor with the cerci long and slender, nearly straight, the tips gently upcurved.

Habitat. British Guiana.

Holotype, ♀, Waricabra Falls, Courantyne River, July 10, 1936 (Neal R. Weber); University of Michigan No. 553.

The species is named for Dr. Neal R. Weber, distinguished ant specialist. This small fly shows several features of unusual interest in the genus. The loss of the rostrum is very noteworthy. Similarly, the venation shows some features that are unique in the genus, as far as known, particularly in the radial field. Here the venation simulates that of the genus *Lechria* Skuse (tribe Lechriini) in a surprising manner yet it is believed that the end result in these two flies has been derived in two entirely different ways, the last vein of the radial field in *Lechria* being R_{4+5} whereas in the present fly it is R_5 alone. The only other regional *Hexatoma* with cell M_2 open is *Hexatoma (Eriocera) patens* Alexander, where this cell is open by the atrophy of the basal section of vein M_3 rather than by the loss of *m*, as in the present fly.

Hexatoma (Eriocera) opulenta new species

Mesonotum dark liver-brown, including the confluent præscutal stripes; head deep orange; femora yellow, with two dark brown rings, the outer segments darkened; wings obscure brownish yellow, variegated with clearer yellow markings and with brown washes and seams; veins virtually glabrous; abdomen dark brown above, the incisures more reddened.

Female. Length about 27 mm.; wing 20 mm.; antenna about 3.2 mm.

Rostrum and palpi dark brown. Antennæ (female) 9-segmented; scape dark above, obscure yellow beneath; pedicel reddish brown; flagellar segments dark brown, the first paler, the segments cylindrical, gradually decreasing in length and thickness outwardly, the terminal segment about one-third longer than the penultimate. Head deep orange; vertical tubercle bilobed.

Pronotum dark brown, more pruinose on the sides. Mesonotum chiefly dark liver-brown, including the confluent præscutal stripes; humeral and lateral regions of præscutum broadly yellow pollinose; median region of scutum dusted with more brownish pollen. Pleura dark liver-brown, conspicuously variegated with gray, including the dorsal sternopleurite and adjacent parts of the pteropleurite and anepisternum; a more yellowed spot on cephalic part of the anepisternum; dorsopleural membrane dark brown. Halteres with stem obscure yellow, knob dark brown. Legs with all coxæ and trochanters dark brown, pruinose; femora yellow, with two dark brown rings, the broad basal one at near midlength, exceeding the yellow subterminal ring on the fore and middle legs, subequal to this ring on the posterior femora; remainder of legs brown to dark brown; tarsi passing into black. Wings with the restricted ground obscure brownish yellow, the cephalic interspaces, especially the broad area above the fork of *Rs* and before the stigma clearer yellow; ill-defined darker brown washes and seams include the stigma, origin of *Rs*, vein R_5, with still more extensive clouds at bases of cells *M* and *Cu* and in the Anal field; veins brown, yellowed in the more brightened portions. Veins beyond cord virtually glabrous. Venation: Sc_1 ending nearly opposite midlength of R_{2+3+4}, Sc_2 scarcely one-third to one-fourth as long as Sc_1; R_{2+3} nearly equal to R_2 and a little shorter than R_{1+2}; cell *1st* M_2 rectangular, about twice as long as wide, with *m–cu* just before one-third the length.

Basal abdominal tergites chiefly dark brown, the outer ones variegated with reddish, especially at the incisures; sternites almost uniformly reddened, sparsely pruinose, particularly on lateral portions and on the subterminal segments. Ovipositor with long slender valves.

Habitat. Brazil.

Holotype, ♀, Campo Bello, Rio de Janeiro, altitude 407 meters, January 28, 1942 (J. F. Zikán). A further specimen from the type locality, taken December 7, 1940, by Zikán, may be conspecific.

The most similar species is *Hexatoma* (*Eriocera*) *gomesiana* Alexander, which differs in the coloration of the body, legs and wings, and in the details of venation.

Hexatoma (Eriocera) pullatipes new species

General coloration of mesonotum dark gray, the præscutum with three brownish black stripes; head above obscure orange, more pruinose on sides; antennæ with scape and pedicel yellow, flagellum black; legs black, the femoral bases yellow; wings with a strong brownish tinge, the costal border darker; macrotrichia on outer radial veins; vein Sc_1 weak, Sc_2 correspondingly enlarged; *m–cu* a short distance beyond the fork of *M*; abdomen with basal four segments orange-yellow, segments five to eight, inclusive, dark brown; hypopygium orange.

Male. Length about 11 mm.; wing 10.3 mm.; antenna about 2.5 mm. Rostrum obscure yellow; palpi black. Antennæ (male) 7-segmented; scape and pedicel yellow, flagellum black, the extreme base of the first segment yellowed; flagellar segments gradually decreasing in length outwardly, segments two and three subequal; vestiture of segments consisting of coarse black setæ. Head above obscure orange, the genæ light gray pruinose; vertical tubercle weakly emarginate, with a pair of brown spots on anterior face.

Pronotum dark brown; anterior pretergites obscure reddish orange. Mesonotal præscutum with the ground yellow pollinose, with three brownish black stripes, the median one very vaguely divided by a pale line on about the posterior half; lateral borders broadly paler brown, the humeral region brownish black; posterior sclerites of notum gray, the centers of the scutal lobes extensively dark brown; posterior portions of mediotergite paling to brown. Pleura and pleurotergite brownish black, heavily gray pruinose; dorsopleural membrane brownish yellow. Halteres brownish black, the base of stem yellow. Legs with the coxæ black, pruinose; trochanters obscure brownish yellow; remainder of legs black, the femoral bases yellow, including about the proximal fourth of segment; posterior tibæ more brownish black. Wings with a strong brownish tinge, cells *C* and *Sc* still darker; stigma vaguely darker than the ground; veins brown. Macrotrichia on outer radial veins, including complete series on veins R_3 and R_4, on vein R_5 more restricted to the outer end. Venation: Sc_2 ending nearly opposite the fork of *Rs*, vein Sc_1 weak and perpendicular; R_{1+2} nearly three times R_2; R_{2+3} about one-third R_2; *m-cu* about one-fourth its length beyond the fork of *M*, subequal to or longer than the distal section of Cu_1.

Abdomen with basal four segments clear orange-yellow, unpatterned; segments five to eight dark brown, the extreme base of the fifth brightened; hypopygium orange-yellow, the color involving part of the eighth sternite.

Habitat. Peru.

Holotype, ♂, Fundo Sinchono, Cordillera Azul, Huanuco, altitude 1,500 meters, August 8, 1947 (J. M. Schunke).

The most similar allied species include *Hexatoma* (*Eriocera*) *cornigera* (Alexander), *H.* (*E.*) *interlineata* Alexander, *H.* (*E.*) *zonata* (Osten Sacken), and others, all of which have the legs chiefly yellow, and with the other details of coloration distinct.

Hexatoma (Eriocera) perfestiva new species

General coloration black, gray pruinose; antennæ with basal segments yellow, the outer ones dark brown; head orange yellow; femora yellow, each with two black rings; wings crossbanded with light yellow and medium brown; veins virtually glabrous; vein R_2 before the fork of the cell, producing a short element R_{3+4}, cell R_3 short; *m–cu* before the fork of *M;* abdomen variegated with black and yellow.

Female. Length about 15 mm.; wing 11.5 mm.; antenna about 3 mm. Rostrum yellow, pruinose; palpi with basal segment yellow, the outer ones dark brown. Antennæ (female) 11-segmented; basal four segments yellow, the outer ones dark brown; segments gradually decreasing in size outwardly; verticils shorter than the segments. Head orange-yellow; verticle tubercle bulbous, especially on sides, the central part more depressed, with two weak parallel impressions.

Pronotum black, pruinose. Mesonotum almost uniformly black, the surface pruinose, the sides of the præscutum and the pleura more heavily so. Halteres black. Legs with the coxæ black, pruinose; trochanters dark brown; femora yellow, each with two conspicuous black rings, one terminal, the other broader, at near midlength and subbasal in position; in what appears to be the detached posterior femur, the yellow subterminal ring is broadest, exceeding the darkened apex; tibiæ brown, the tips narrowly blackened; tarsi black. Wings variegated light yellow and medium brown, appearing as alternating, almost parallel bands; apical dark band extending basad to outer end of cell *1st* M_2; central dark band before the cord, its outer end at midlength of *Rs* and almost touching the distal section of Cu_1; further darkenings on outer half of cell *2nd A* and a very small postarcular spot in cell *R;* dark central band virtually equal in extent to the yellow band beyond it; cell *C* chiefly yellow, narrowly darkened at midlength along costa; veins brown, clear yellow in the flavous parts. Veins beyond cord virtually glabrous, with scattered trichia on outer half of distal section of R_5. Venation: Sc_1 ending nearly opposite the fork of *Rs*, Sc_1 alone about equal to *m;* cell R_3 short, outer end of vein R_3 curved slightly cephalad; R_{3+4} about one-half R_2, the latter slightly more than one-half R_{1+2}; *m–cu* a short distance before the fork of *M*, slightly exceeding the distal section of Cu_1; vein *2nd A* very gently to scarcely sinuous.

First abdominal segment black; tergites two and three, together with most of four yellow, the succeeding segments black, their lateral margins yellow, narrower on the fourth and fifth tergites, broader on the sixth; succeeding segments, including the genital shield, orange; basal sternite black, succeeding three segments yellow, the outer ones almost if not quite black, without the yellow lateral borders. Ovipositor with the cerci slender, nearly straight, yellow, their bases, together with the hypovalvæ, dark chestnut brown.

Habitat. Peru.

Holotype, ♀, Chanchamayo, Junin, altitude 1,200 meters, December 19, 1948 (J. M. Schunke).

This most attractive species is generally similar to forms such as *Hexatoma* (*Eriocera*) *aglaia* Alexander and *H.* (*E.*) *magistra* Alexander, differing in all details of coloration of the body, legs and wings, and in the details of venation.

Genus *Gnophomyia* Osten Sacken

Gnophomyia (Eugnophomyia) excordis new species

Size small (wing, male, 5.4 mm.); general coloration of head and thorax dark plumbeous gray, the pretergites obscure orange; pleura with an extensive more whitened longitudinal stripe; legs brownish black, the femoral tips darker, more narrowly and abruptly on the posterior legs, tarsi dark; wings with a strong brownish tinge, the narrow stigma darker brown; abundant macrotrichia in the cells beyond the cord; *Sc* relatively long, Sc_1 ending only a short distance before fork of *Rs;* a short element R_{3+4} present; male hypopygium with the apex of basistyle produced; both dististyles glabrous; phallosome a broadly flattened plate, the gonapophyses separate, at tips narrowed into slender rods.

Male. Length about 5.5 mm.; wing 5.4 mm.; antenna about 1.5 mm. Rostrum brown; palpi black. Antennæ black, scape pruinose; flagellar segments oval, shorter than the verticils. Head dark gray.

Thorax dark plumbeous gray, the pretergites obscure orange. Pleura dorsally dark gray, the ventral region chiefly much paler, forming a broad longitudinal stripe, ventral sternopleurite slightly darkened, dorsopleural membrane buffy. Halteres with stem infuscated, narrowly yellow at base, knob brownish black. Legs with coxæ gray pruinose; trochanters light brown; fore and middle legs chiefly brownish black, the femoral bases vaguely paler; posterior femora brown, the tips more narrowly blackened; tibiæ and tarsi brown. Wings with a strong brownish tinge, the narrow stigma darker brown; veins brown. Abundant macrotrichia in centers of cells beyond cord. Venation: *Sc* relatively long, Sc_1 ending only a short distance before the fork of *Rs*, Sc_2 a short distance from its tip; vein R_2 oblique, about three-fifths as long as R_{2+3+4}; R_{3+4} present, slightly more than one-third vein R_2; cell *1st* M_2 about equal in length to vein M_4; *m–cu* more than one-half its length beyond the fork of *M*.

Abdomen dark brown, the basistyles brownish black. Male hypopygium with the apex of basistyle prolonged into a lobe, the tip subacute; surface of style with numerous pale punctures bearing long erect yellow setæ; at apex of lobe with a few stout retrorse spinous setæ. Two dististyles, both glabrous, the outer shorter and more slender, its apex obliquely truncate; inner dististyle broad on basal half, thence more narrowed, the lower edge of outer portion with a short flange. Phallosome a broadly flattened plate, the apex of the ædeagus curved. Gonapophyses broad-based, the outer third narrowed into a slender rod.

Habitat. Guatemala.

Holotype, ♂, El Naranjo, Chicacao, altitude 4,100 feet, July 12, 1949 (T. H. Farr).

From other generally similar small species of the subgenus, as *Gnophomyia* (*Eugnophomyia*) *juniniana* new species and

G. (*E.*) *posticata* Alexander, the present fly differs in the details of coloration and venation, as well as in the degree of development of wing trichia. The male hypopygium of such allied forms is still unavailable for comparisons.

Gnophomyia (Eugnophomyia) juniniana new species

General coloration of thorax almost uniformly dark gray; antennæ, halteres and legs black; wings with a brownish tinge, the costal field not further darkened; macrotrichia in wing cells unusually abundant, including the outer ends of the basal cells, as well as those beyond the cord; Sc_1 relatively long, subequal to *r–m*.

Female. Length about 5 mm.; wing 5.5 mm.

Rostrum and palpi black. Antennæ black, scape more pruinose; flagellar segments long-oval, shorter than the verticils. Head dark plumbeous gray, more pruinose with light gray on front and anterior vertex.

Thoracic notum almost uniformly dark gray, the lateral borders more blackened. Pleura chiefly light gray, the dorsal anepisternum and pteropleurite more blackened; dorsopleural region dark. Halteres uniformly black. Legs with the coxæ gray pruinose; trochanters brownish black; remainder of legs black. Wings with a brownish tinge, the prearcular and costal fields not more darkened; a vague to scarcely evident darkening in the region of the stigma; veins and macrotrichia dark brown. Abundant macrotrichia in cells beyond cord and also in most of cell R_1, outer fourth of *R*, all of cell *M* except the base, and in outer ends of cells *Cu*, *1st A* and *2nd A*. Venation: Sc_1 ending about opposite five-sixth *Rs*, Sc_2 some distance from its tip, Sc_1 alone subequal in length to *r–m*; R_2 more than twice R_{2+3}; *m–cu* just beyond the fork of *M*, close to the inner end of cell *1st* M_2, the latter about three-fifths as long as the distal section of vein M_3; cell *2nd A* broad.

Abdomen brownish black; cerci long and slender, very gently upcurved.

Habitat. Peru.

Holotype, ♀, Chanchamayo, Junin, altitude 1,100 meters, January 20, 1949 (J. M. Schunke).

Most similar to the other small species of the subgenus discussed at the end of the account of the preceding fly. All three are distinguished among themselves by relatively slight differences in coloration, venation and wing-trichiation.

Gnophomyia (Gnophomyia) sagittoides new species

General coloration brownish black, the anterior pretergites conspicuously whitened; wings with a grayish tinge; vein R_2 very faint to subatrophied; male hypopygium with the caudal margin of the ninth tergite produced caudad into a depressed-spatulate blade, the apex truncate; outer dististyle expanded on basal three-fifths, the outer portion suddenly narrowed, the entire surface smooth; phallosome consisting of a massive central plate, its truncated apex blackened.

Male. Length about 5.5 mm.; wing 5.5 mm.

Head missing. Pronotum brownish black; anterior pretergites conspicuously whitened. Mesonotal præscutum and scutum brownish black, the lateral border of the præscutum very narrowly more reddened, more or less pruinose; posterior sclerites of notum more brownish. Pleura dark plumbeous gray, the meral region abruptly whitened, this color also involving the posterior coxæ; dorsopleural membrane dusky. Halteres with stem pale, the knobs broken. Legs brown, the fore coxæ light brown, mid-coxæ small, pale, hind coxæ whitened, as described. Wings with a grayish tinge; stigma pale brown, very restricted, virtually limited to the space beyond vein *Sc* and cephalad of R_1; veins delicate, dark brown. Venation: Sc_1 ending about opposite two-thirds the length of R_{2+3+4}; *Rs* in longitudinal alignment with R_5; R_{2+3+4} only moderately arcuated; vein R_2 very faint to subatrophied; *m–cu* more than its own length beyond the fork of *M*.

Abdomen, including hypopygium, dark brown; basal sternites paler. Male hypopygium with the caudal margin of tergite extended into a depressed-spatulate blade, its apex truncate, at the widest part of the blade with darkened lateral margins; on either side before apex with a pair of small setæ. Outer dististyle somewhat as in *sagitta,* the basal three-fifths expanded, the outer part suddenly narrowed, the entire surface glabrous and without ridges or corrugations. Phallosome consisting of a massive central plate, the truncated apex blackened, the tip of the ædeagus projecting caudad beyond its tip.

Habitat. Peru.

Holotype, ♂, Fundo Sinchono, Cordillera Azul, Huanuco, altitude 1,500 meters, August 4, 1947 (J. M. Schunke).

The most similar described species is *Gnophomyia* (*Gnophomyia*) *sagitta* Alexander, which differs in all details of the male hypopygium, including the lobe of the ninth tergite, dististyles, and phallosome.

NOTES ON THE DISTRIBUTION AND HABITS OF THE TWO SPECIES OF ARPHIA (ORTHOPTERA, ACRIDIDÆ) THAT OCCUR IN NEW YORK AND NEW JERSEY

By Dwight C. Hageman

Arphia sulphurea (Burm.), and *Arphia xanthoptera* (Fab.), the only two species of this genus that occur in New York or New Jersey, are rather large, compressed species. *A. sulphurea* is the smaller of the two, although I have noticed intergradations of size in the same locality. On the average, the size of the body of *xanthoptera* is as follows: ♂ 21–27 mm., ♀ 28–34 mm. *Sulphurea,* the smaller, runs as follows: ♂ 17–22 mm., ♀ 26–30 mm.

Arphia sulphurea appears earlier in the season than *xanthoptera,* passing the winter as a nymph. It begins to reach maturity about May 1, making it one of the earliest locusts to make its appearance in these states. Throughout June it is extremely abundant, but about July 15, it begins to be replaced by *xanthoptera.* At Tuxedo Pk., New York, in the Ramapo Mts., I have noticed that about July 20, *A. sulphurea* begins to diminish in numbers, while on or about July 31, *xanthoptera* begins to appear in increasing numbers throughout August, until as late as November 1. *Arphia xanthoptera* does not pass the winter in the nymphal stage as does *sulphurea,* but appears from eggs hatched in the spring; reaching its full growth on or about July 25 in most localities. However, *xanthoptera* occurs as late as November 1, while *sulphurea* may occur until September 10, but I have not found such specimens common.

The general range of *xanthoptera* as given by W. S. Blatchley (1920) is from "southern New England, west to Minnesota and western Nebraska, and south and southwest to central Florida, Oklahoma and northern Texas." Of *sulphurea* he says: "New England and Ontario, west to Minnesota and eastern Nebraska, and south and southwest to northern Florida, Oklahoma and Texas." Morse (1919), "List of the Orthoptera of New England," states that *sulphurea* probably occurs throughout

New England, though not as yet recorded from north of Deering and Norway, Maine; Berlin Falls and Hanover, New Hampshire.

Both *xanthoptera* and *sulphurea* are very common species, occurring in almost identical habitat. They both frequent the stubble of wheat, clover, and timothy fields, preferably in dry upland situations. *Arphia sulphurea* seems to me to show a more woodland choice of habitat than does *xanthoptera.* The former likes its fields bordering on woods if possible, although both species frequent the edges of fields, roads, and the sides of railway embankments. *Sulphurea* also shows a preference for gravelly and rocky slopes. Some of the nymphs and a few of the adults observed at Tuxedo Pk., New York, early in the season, had the pronotum and hind femora tinged with greenish coloration. This coloration seemed to be such that it harmonized with the lichens that occurred on the rocks in that vicinity. The young nymphs of *sulphurea* can be found during the winter, when on warmer days they come out of hiding to sun themselves. In Bronxville, New York, I have found the nymphs in numbers about March 25 on a small hill having a sunny southern exposure. The nymphs would crawl about, their antennæ twitching nervously most of the time. They seemed to be fairly gregarious at this stage.

The flight habits of both *sulphurea* and *xanthoptera* are more or less similar; however, I have noticed some differences between the two. The stridulation of the male *sulphurea* is to be heard continuously once the insect has spread its wings. The female of this species does not make any audible sound, but flies in a straight line for about ten to thirty feet, whence she drops quickly to the ground, as do almost all *sulphurea,* in dead leaves, showing a definite preference for them. The male, however, stridulates when flushed to or three times, then usually ceases upon being flushed again. The male *xanthoptera* stridulates when it rises from the ground, and at every turn in its course of flight. The sound thus produced is much louder and more prolonged than that of *sulphurea.* The flight of this species is also more prolonged, ranging from ten to fifty feet. When the two locusts are in company with each other, it is usually possible to differentiate the males of the two species by their respective stridulations. The females of both species are silent, and not as willing to take to the wing as are the males.

Both *Arphia sulphurea* and *xanthoptera* are to be found generally throughout New York and New Jersey; providing, of course, that the habitat and the date are suitable to the species. However, some records might prove helpful to the collector, as follows:

In the collection of the American Museum of Natural History in New York City, *Arphia sulphurea* is recorded from: West Farms, N. Y. C. (Angus, coll.), New York, N. Y., Rahway, N. J. (May 30), Hugenot Sta., N. Y. C. (June 26), Guymard, N. J. (June 9), Bear Swamp, N. J. (July 10), Carmel, N. Y., (Aug. 12), Lakehurst, N. J. (July 4, Olsen coll.), Plainfield, N. J. (June 2), Ramsey, N. J. (May 21), Crugers, N. Y. (July 10, 1912), Englewood, N. J. (June 28, Mitchner coll.), Ft. Lee, N. J. (June 28), Paterson, N. J. (June 17).

In the same collection, *xanthoptera* is recorded from: Lakehurst, N. J. (Sept.), Bronxville, N. Y. (Sept.), Ft. Lee, N. J. (Sept. 20), Baldwin, N. Y. (Aug. 18), West Farms, N. Y. C. (Aug. 20), Hartsdale, N. Y. (Aug. 26), Toms River, N. J. (Aug. 18), Ramsey, N. J. (Sept. 28), Nyack, N. J. (Sept.), Ellenville, N. Y. (Aug. 15).

J. B. Smith (1909), "Insects of New Jersey," lists the distribution of *sulphurea* as being: "throughout the state, commoner south of Piedmont Plain (Apr.–July)," found in "waste places along the edge of woods and about cranberry bogs."

The same author speaks of *xanthoptera* as being: "common south of Piedmont Plain (August–October)," inhabiting "waste grassy and sandy fields, woodland roads, and along the edges of woods." He further states that: "North of that point (Piedmont Plain) it occurs at Ft. Lee, Orange Mts., Middlesex County, and Staten Island (Aug.–Oct.)."

In "A List of the Insects of New York," edited by M. D. Leonard (1928), *sulphurea* are reported as occurring in:

New York: White Plains, Ft. Montgomery, West Point, Croton, Oliverea, Elmira, Ithaca, Conensus Lake, Rochester, and the Ramapo Mts., all May–July.

Staten Island: "Generally distributed. Reaches maturity about May 15, from overwintering nymphs. A few survive until Aug. 1, or later.''

Long Island: Central Pk., Massapequa, West Hills, Half Way Hollow Hills, Nissequoque, Kings Park, Yaphank (Sept. 3 latest date), Riverhead, and Wading River, all from May–July.

The same list records *xanthoptera* as follows:

New York: Bronxville, Nyack, and the Ramapo Mts., (August–October).

Staten Island: ''Generally distributed from St. George to Tottenville, August–October.''

Long Island: Maspeth, Central Pk., Cold Sp., Smithtown, Selden, Coram, Yaphank, Southold, Orient, Amagansett, Montauk, and Gardiners Island, during the months of August and October.

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A SHORT-WINGED FORM OF ONCOPELTUS FASCIATUS DAL.

BY NEELY TURNER

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION
NEW HAVEN, CONN.

A colony of the larger milkweed bug (*Oncopeltus fasciatus* Dal.) has been maintained for the past five years for insecticide studies. Early in 1950 a few short-winged individuals appeared in the colony. The wings were shorter than the abdomen rather than extending two or three millimeters beyond it as in normal individuals. When these short-winged individuals were mated, they produced short-winged offspring. After a suitable stock had been developed, crosses were made with normal bugs. The F_1 generation was normal. The F_2 generation was as follows:

	Normal wings			Short wings		
	♀	♂	Total	♀	♂	Total
F_2 N♀ × SW♂	140	150	290	38	43	81
F_2 SW♀ × N♂	219	221	440	63	76	139

The deviation from 3:1 ratio was not significant statistically.

Back crosses of the F_1 hybrids produced the following results:

	Normal wings			Short wings		
	♀	♂	Total	♀	♂	Total
SW♀ × (SW♀ × N♂)♂	78	76	154	88	64	152
(SW♀ × N♂) × SW♂	17	20	37	10	15	25
(N♀ × SW♂)♀ × SW♂	40	38	78	35	49	84
SW♀ × (N♀ × SW♂)♂	33	35	68	30	24	54

This approximates a 1:1 ratio especially in the two cases in which there were relatively large numbers. These results indicate that the short-winged character is recessive and is inherited as such.

This short-winged character is being used as a marker in studies of inheritance of resistance to poisons. It is available to entomologists, physiologists or geneticists who may be interested in using it.

THE "KNOCKER" AND THE "GROUND-ASS"

These insects, among others, are described as follows in Griffith Hughes' generally worthless book "The Natural History of Barbados," published in London in 1750 by the author, on a subscription basis.

THE KNOCKER

"This Fly is somewhat larger and blacker than a Cock-Roch: and derives its Name from the tinkling Noise it makes. The Head and Back are hard and shining; the former divided by the latter by a broad close joint. As it bends its Head backward, the upper Joint falls as a regular Spring into the socket of the lower; and, when it bows its head forward, it opens with a sharp tinkling Note, as the Spring of the outward Case of a Watch, when pressed."

THE GROUND-ASS

"This is of the Colour of an Hog-Louse; in length about a Quarter of an Inch. The Back is convex, not ill resembling the Back of a Tortoise in Miniature; but somewhat longer in proportion. The Head is small and long, when compared to the Bulk of the Body. This is supported by Six Legs, the Pair next the Shoulder being the longest. What is most remarkable in this Animal, is its Motion, which is always retrograde; and this not by walking, but by quick Starts, springing back. These generally live in very loose Dust or Sand, under Logs of Wood of such Coverings: In these Places they artfully make a circular Hole of about an Inch Diameter, a Funnel-shape; in the Centre of which this Creature lies unseen, watchfully waiting for his Prey."

In spite of the peculiar names and the crude descriptions, one recognizes the insects as click beetles and ant-lions.—H. B. W.

PROCEEDINGS OF THE NEW YORK ENTOMOLOGICAL SOCIETY

MEETING OF OCTOBER 4, 1949

A regular meeting of the Society was held October 4, 1949, at the American Museum of Natural History, at 8: 15. In the absence of the president, the vice-president, Dr. Forbes, presided. About 15 persons were present.

It was announced that the new room, 129, would be used in the future, unless it should prove too small.

The treasurer, Mr. Bigelow, read the financial report for January 1, 1949–October 1, 1949.

Dr. Forbes announced the committee for the May exhibit which included, as chairman, Dr. L. Clausen, as members, Mr. A. Roensch, Mr. A. Gaul, Dr. R. Vishniac, Miss A. Gray, and Dr. Forbes. It was suggested that Mr. Ugo Mochi, an artist specializing in cut-outs, also be contacted to serve on the committee.

Mr. Teale reported on the August field trip, held at the Boyce Thompson Institute at Yonkers. Dr. Forbes said that the president was going to write a note of appreciation to the head of the institute, Dr. Hartsell.

Two new members were proposed, Professor Merle W. Wing of North Carolina State College, Raleigh, and Mr. Gilbert C. Wood, Technical Service Dept., John Powell & Co., 1 Park Ave., New York 16, N. Y. Mr. Louis S. Marks, 821 Argyle Road, Brooklyn, N. Y., who had to drop his membership in 1942, was, at his request, reinstated.

A letter was read from the Zoological Society of London, asking for help from the Society for the Zoological Record.

Summer collecting activities of members: Dr. M. Cazier gave an account of the activities of the Department of Insects and Spiders of the Museum for the past two years and of the various collectors for the Museum in Central and South America; Mrs. P. Vaurie spoke on collecting tiger beetles in north central United States for the Museum; Mr. E. Teale showed some photographs of insects taken in the summer; Mr. R. Vishniac reported on photography and insects in the south of France; Dr. R. Swain told of the new set-up of post-entry quarantine for plants.

Mr. Cody, who had studied art at the Johns Hopkins Medical School, exhibited some of his insect paintings to the members.

PATRICIA VAURIE, *Asst. Sec'y.*

MEETING OF OCTOBER 18, 1949

A regular meeting of the Society was held October 18, 1949 in the American Museum of Natural History. There were 13 members and 11 guests present. In the absence of the president, the vice-president, Dr. James Forbes called the meeting to order at 8: 00 P. M. The minutes of the previous meeting were approved as read.

Prof. Merle W. Wing of North Carolina State College and Mr. Gilbert C. Wood, 1 Park Ave., New York City, were elected to membership.

Announcement was made of the action taken by the executive committee of the Society in the price of available back numbers of the JOURNAL at $1.50 per copy.

It was also announced that Mr. E. W. Teale would exhibit some of his insect photographs starting mid-November, at the Museum.

The membership was advised of the serious illness of our esteemed member Mr. John D. Sherman, Jr., and the secretary was directed to send regrets.

The speaker of the evening, Dr. Heber Donohoe was then introduced. He talked on his recent experience in teaching Entomology to seventh grade children. He enrolled for a years work at the Trenton State Teachers College in New Jersey, and praised the course of instruction. He felt that modern teaching methods were excellent, generally, but did not feel that enough attention is given to the natural sciences, generally, and entomology, specifically, in the lower grades. In the practice teaching phase of his course, he taught a seventh grade class, in a very short period, to appreciate insects for their beauty. His class made a collection, many specimens being taken with homemade nets on one field trip. The collection was labeled to orders, boxed and presented to the school.

Doctor Donohoe believes the text book material for such teaching is very poor because it has been written by educators, rather than entomologists. He expects to write a book which will meet the need. The enthusiasm with which a smattering of entomology was received by these youngsters, leads Doctor Donohoe to believe that the teacher would be well rewarded for his effort in presenting the subject of entomology to children in the lower school grades. He proposed that entomologists might promote interest in the schools by presenting collections to them.

The topic aroused much interest, and many questions were asked of the speaker.

FRANK A. SORACI, *Secretary.*

MEETING OF NOVEMBER 1, 1949

A regular meeting of the Society was held November 1, 1949 in the American Museum of Natural History. Vice-President Dr. Forbes presided. There were 15 members and 11 guests present. A report of the November 1, 1949 meeting of the executive committee was read. The resignation of the treasurer, Mr. David Bigelow, was announced. Mr. John C. Pallister was appointed to finish out his term.

Mr. John Cody, 1665 Marine Parkway, Brooklyn, New York was proposed for active membership in the Society.

By motion, the Society expressed its gratitude to Mr. Bigelow for his fine job as treasurer, and wished him well in his new position as naturalist at the Fort Worth Children's Museum in Texas.

The speaker of the evening, Miss Jocelyn Crane, was then introduced by Dr. Forbes. Her topic was "Observations on the Jumping Spiders." She spoke of her collection and observations of the Salticidæ in Venezuela. She was interested in the meaning of ornamentation, and in the odd movements of the spiders. Definite courtship and threat displays were recognized and studied. Some excellent colored slides and movies were shown. Miss Crane was hopeful that students of the Salticidæ in the north might observe, and report more fully on the behavior of these spiders.

Frank A. Soraci, *Secretary.*

Meeting of November 15, 1949

A regular meeting of the Society was held November 15, 1949 at the American Museum of Natural History. The vice-president, Dr. Forbes, presided. There were 16 members and 24 visitors present. The minutes of the previous meeting were approved as read.

The auditing committee was appointed, consisting of Dr. W. J. Gertsch, Dr. Lucy Clausen and H. F. Schwarz.

Dr. Forbes spoke on the recent appeal of the Zoological Record for financial assistance. He urged the membership to give every possible support to the publication.

Mr. John Cody, 1665 Marine Avenue, Brooklyn 34, N. Y., was elected to active membership. Mr. Harry Chapman, 176-34, 132 Avenue, Springfield Gardens, N. Y., was proposed for active membership.

The speaker of the evening, Mr. Stephen Easter, Entomologist for Food and Agriculture Organization (FAO) of the United Nations, was then introduced by Dr. Ralph Swain. Mr. Easter spoke on his topic of worldwide losses due to insects in stored foods. It is roughly estimated that 10 per cent of stored foods is lost annually through insect depredations. Mr. Easter has been working on the problem for FAO for about two and one-half years. In early 1948 he surveyed grain storage in Egypt. He found most of the grain bagged and stored in the open. The lack of rain there made such storage feasible. The work has carried him to Italy, where he found excellent rodent-proof farm storages, and to Latin America where he found poor storages with losses ranging as high as 50 per cent. Mr. Easter feels that in temperate countries generally, the problem of grain storage has been solved, but that a great deal of work remains to be done in tropical and subtropical lands. The talk was illustrated with some exceptionally fine photographs of general interest.

Frank A. Soraci, *Secretary.*

Meeting of December 6, 1949

A regular meeting of the Society was held December 6, 1949 at the American Museum of Natural History. The vice-president, Dr. James Forbes, called the meeting to order at 8: 10 P. M. There were 11 members and five guests present. The minutes of the previous meeting were approved as read.

Mr. Harry Chapman, 176-34, 132 Avenue, Springfield Garden 13, New York was elected to active membership.

Mr. Teale showed a copy of the book by Mabel Abbott on the life of William T. Davis. He recommended it as an especially fine Christmas gift.

Doctor Forbes brought to the attention of the membership Mr. Teale's photographic exhibit at the museum, and congratulated Mr. Teale in behalf of the Society on his recent election to an Associateship in the Royal Photographic Society of London.

There being no further business, the speaker of the evening, Mr. John Cody, proceeded with his talk on ''Entomological Illustrations and Techniques.'' He spoke of his early interest and practice in painting; his training in zoology, with emphasis on Entomology; his pre-medicine work at Johns Hopkins, and his training there in medical art. The course at Johns Hopkins was founded by Max Brödel, who died in 1942.

Mr. Cody is of the opinion that the medical art background is ideally suited for the artist who is interested in entomological illustration. In illustrating an operative technique, for instance, the medical artist is required to work very rapidly, depending upon working over and filling in his basic sketches to produce the finished illustration. The artist's ability to work under these conditions is most useful in reproducing insect life in its true natural state. In this point he mentioned that the artist should be able to derive his bread and butter from medical subjects, and his pleasure from the entomological.

A number of water colors of medical and entomological subjects were shown. Mr. Cody mentioned that he favors the William Black technique in depicting entomological subjects.

Mr. Cody expressed his ambition to journey to East Africa so that he might paint the native lepidoptera and food plants.

FRANK A. SORACI, *Secretary.*

MEETING OF DECEMBER 20, 1949

A regular meeting of the Society was held December 20, 1949 at the American Museum of Natural History. The vice-president, Dr. James Forbes, called the meeting to order at 8:00 P. M. There were 11 members and eight guests present. The minutes of the previous meeting were approved as read.

It was announced that a nominating committee had been appointed for the annual meeting, January 3, 1950. The committee was composed of Dr. A. B. Klotz, chairman, Dr. Mont A. Cazier and Dr. Roman Vishniac.

Mr. Harry B. Weiss was proposed for honorary membership. It was announced that member, Dr. Harold Hagan, had been awarded the Cressy Morrison prize for his paper on ''Embryology of Viviparous Insects.'' Mr. Teale passed around a twig on which egg masses of *Tenodera angustipennis* and *T. sinensis* had been attached, side by side.

Dr. Vishniac reported recently observing a large population of tussock moths in the vicinity of Nyack, New York. He thought these might be third generation.

The speaker of the evening, Mr. Albro T. Gaul, was then introduced. He spoke on "Hornet Activity and Sounds." Through his talk he gave his answers to the following five problems:

1. Why do these wasps wake up in the morning?
2. What are the quantitative activities of labor in the nest?
3. What factors attract the wasps to their food?
4. Are there specific differences in nest structure?
5. What factors cause cannibalism in wasps?

The first problem, that of awakening, was studied with the aid of a G. E. light meter, with foot candle readings, and thermometers. Mr. Gaul found that, with his instruments a combination of 8.5° C. of temperature and .5 F.C. of light provided a double threshold of stimulus for awakening of *Vespula*. A colony was considered awake when two flights per minute were established and sustained. He found that the thresholds of awakening for *Dolichovespula* were lower. He found that *Vespula* flights are at their peak about 8: 30 A. M., but that they quickly drop to the daily level, which is maintained until sunset. As the light drops to the 2.5 foot candle level, there is a sudden surge of homecomers. At .5 F.C., activity ceases. So long as the temperature remained above the flight threshold, the wasps would become active if light was provided. When the temperature was below the flight threshold, light would have no effect on the wasps.

Mr. Gaul estimates that a wasp makes 3,436 round trips from its nest, for a total of 884 miles of flight in its six weeks of active life.

On the subject of attraction of wasps to their food, it was found that wasps generally recognize a feeding area by sight, but that the exact spot is found through smell. It was found that the workers were able to remember a feeding area for at least nine days.

Mr. Gaul found that there are specific differences in nest structure, on the basis of which an accurate key could be evolved identifying the species responsible for the making of a nest. Some characters which would be used in such a key would be; presence or absence of lignin in the structure; brood cell diameter; nest envelope thickness; length of chewed fibers of structure; tensile strength and tearing point of the nest, and presence or absence of grease.

With regard to cannibalism in wasps, Mr. Gaul stresses the importance of glucose in the blood. Wasps must maintain a certain minimum glucose level in the blood to permit flight. When the wasps are forced to remain in the nest because of weather or for other reasons, they use up their own sugar reserves and that obtained from the larvæ through trophollaxis. The larvæ are eaten in a final effort to maintain the necessary glucose level.

FRANK A. SORACI, *Secretary.*

MEETING OF JANUARY 3, 1950

The annual meeting of the Society was held January 3, 1950 at the American Museum of Natural History. The president, Dr. Schneirla called the meeting to order at 8: 00 P. M. There were 15 members and 57 guests present. The minutes of the previous meeting were approved as read. Dr. Schneirla reported briefly on the accomplishments of the Society during 1949, and mentioned the present needs. He thanked the vice-president, treasurer, secretary, editor, and the members of the various committees for their aid during his term of office.

The treasurer gave his report on the financial status of the society.

Mr. Comstock gave his report as delegate to the New York Academy of Sciences.

Mr. Harry B. Weiss was elected to honorary membership in the Society. A tribute, prepared by Mr. Herbert F. Schwarz, honoring Mr. Weiss for his outstanding and long service to the Society as editor of the Journal, was read and ordered published in the March, 1950 issue of the JOURNAL.

The nominating committee proposed the following slate of officers for 1950, which was duly elected:

President, Dr. James Forbes
Vice-President, Albro T. Gaul
Secretary, Sam Harriott
Treasurer, John Pallister
Assistant Treasurer, Mrs. Patricia Vaurie
Editor, Frank A. Soraci
Associate Editor, Herbert F. Schwarz

Trustees

Dr. Harold R. Hagan, Dr. Mont Cazier, Dr. T. F. Schneirla, Mr. E. W. Teale, Mr. E. I. Huntington

Mr. Nicholas Gillham, 4 Washington Square North, New York City, was proposed for membership.

There being no further business, Dr. Carl Von Frisch's film "Language of the Bees" was shown. Dr. Schneirla provided an interesting commentary. The film was concerned primarily with the various dances of the bees, apparently used in guiding the colony to food sources.

FRANK A. SORACI, *Secretary.*

MEETING OF JANUARY 17, 1950

A regular meeting of the Society was held January 17, 1950, in the American Museum of Natural History; president Dr. Forbes in the chair. There were 11 members and 8 guests present.

The President appointed an exhibit committee of Dr. Lucy Clausen, chairman; Miss Alice Gray, Mr. Arthur Roensch, and Dr. Roman Vishniac. Appointment of the program and field committees was postponed until a later meeting.

Mr. Nicholas Gillham of 4 Washington Square North, New York 3, N. Y. was elected to active membership.

Mr. Soraci reported for the Treasurer, Mr. Pallister, that a total of fifty dollars had been collected from the members as a contribution to the "Zoological Record'' and that this donation would soon be sent to the Zoological Society of London.

Dr. Swain introduced the speaker of the evening, Mr. E. Kostal of the Hoboken Inspection House, U. S. Bureau of Entomology and Plant Quarantine. Mr. Kostal spoke on the ''Relationship of Insects to Plant Disease from the Plant-Protection Viewpoint.''

He pointed out that insects were formerly considered unimportant in spreading plant diseases. More recently, however, studies by plant pathologists and entomologists have shown that their importance as disease vectors often rivals in importance the damage caused by their direct feeding.

Mr. Kostal discussed the various types of plant diseases, bacterial, virus and fungus, giving numerous examples of the diseases and their vectors. Some examples were the Dutch elm disease fungus spread by two species of *Scolytus* beetles, fire blight of apple and pear carried by aphids, cucurbit wilt disease spread by the striped cucumber beetle and curly-top of sugar beets spread by a leaf hopper.

The speaker also mentioned the difficulty of discovering and diagnosing many plant diseases in the field and spoke of the new program of growing limited quantities of plants in quarantine as the most practical method of handling and preventing the possible spread of new introductions. Considerable discussion followed Mr. Kostal's paper.

Dr. Vishniac questioned the interpretation of some of the behavior of the hive bees pictured in Dr. Von Frisch's film which had been presented with a running commentary by Dr. Schneirla at the annual meeting of the Society on January 3.

Samuel C. Harriot, *Secretary.*

Meeting of February 7, 1950

A regular meeting of the Society was held February 7, 1950 in the American Museum of Natural History; president Dr. Forbes in the chair. There were 11 members and 30 visitors present.

Dr. Forbes reported that a meeting of the executive committee had been held that afternoon. In recognition of his long services to the Society, Mr. Harry B. Weiss, former editor of the Journal, was appointed editor emeritus. The executive committee also appointed the publication committee as follows: Mr. Frank A. Soraci, chairman; Mr. Herbert F. Schwarz, Mr. E. W. Teale, and Mr. John D. Sherman, Jr.

Mr. Pallister reported the death of Mr. Alan S. Nicolay on January 30. Mr. Nicolay was a member of long standing in the Society. Flowers were sent in the name of the Society.

Dr. Frederick H. Rindge, Department of Insects and Spiders, American Museum of Natural History, was proposed for membership by Mr. Comstock. Mr. Soraci proposed for membership, Mr. Richard C. Froeschner, 712 Crawford Avenue, Ames, Iowa.

Mr. Pallister made a motion that the by-laws be suspended and that Dr. Rindge and Mr. Froeschner be elected to active membership at this meeting. The motion was carried and Dr. Rindge and Mr. Froeschner were elected.

There being no further business, Mr. E. Irving Huntington showed some of his excellent Agfa colored slides of Zion Canyon and Bryce Canyon, Utah. Mr. Huntington prefaced the showing of his pictures by a short summary of the geology of the region.

SAMUEL C. HARRIOT, *Secretary.*

MEETING OF FEBRUARY 21, 1950

A regular meeting of the Society was held February 21, 1950, in the American Museum of Natural History; President Dr. Forbes in the chair. The minutes of the February 7 meeting were read and accepted. Dr. Forbes announced the resignation of the Secretary, Mr. Samuel Harriot. The resignation was accepted with regret.

The following appointments were then announced: For Secretary, Mr. Louis S. Marks; for Assistant Secretary, Mr. Leon Siroto; for the Program Committee, Dr. Lucy Clausen, Dr. Roman Vishniac and Dr. Ralph B. Swain, Chairman; for the Field Committee, Mr. Arthur Roensch and Mr. Samuel Harriot, Chairman; for Delegate to the New York Academy of Sciences, Mr. William P. Comstock.

Dr. Forbes suggested a procedure for field trips. Any member about to take a field trip would announce it at the meeting, so that he could be joined by interested members. The result of the activities of this field trip would then be reported at a subsequent meeting. This would eventually lead to a compilation of local faunal records.

Mr. Schwarz proposed Dr. Jose T. Acosta, Calle K no. 418, Vedado, Habana, Cuba, for active membership. The nomination was seconded by Mr. Comstock. A motion was made and seconded that the by-laws be suspended and that Dr. Acosta be immediately elected to active membership in the Society. The motion was carried without opposition and Dr. Acosta was elected.

Mr. Teale showed the members a new British insect guide, "A Pocket Book of British Insects."

There being no further business, the paper of the evening was given by Dr. George W. Rawson of Ciba Pharmaceutical Company, and an amateur lepidopterist, on "Biology of the Butterflies, Chiefly of the Michigan Region." The talk was illustrated with Kodachrome slides. One of the interesting and amusing sidelights of Dr. Rawson's talk was a set of slides depicting the cartoonists' idea of the entomologist.

A discussion followed, which emphasized the sense organs of the Lepidoptera, particularly the sense of smell. Dr. Vishniac raised the point that the males find the females in spite of intense distracting odors. Mr. Teale, Dr. Hagen, Dr. Rawson and Mr. Soraci cited experiments designed to prove the existence of this faculty. Mr. Comstock referred to the classic work of Fritz Muller on the subject.

LOUIS S. MARKS, *Secretary.*

Meeting of March 7, 1950

A regular meeting of the Society was held March 7, 1950, at the American Museum of Natural History; president Dr. Forbes in the chair. The meeting opened with nine members and seven guests present. The minutes of the February 21 meeting were read and accepted. This was followed by a reading of the minutes of the Executive Committee meeting of February 7.

Dr. Forbes asked the membership to keep the date of April 15 in mind. This is the deadline for submission of material to the Exhibit Committee. Attention was called to Dr. Vishniac's photographic exhibit and to the write-up in the New York Times.

Dr. Forbes announced that Dr. Schnierla, our past president, had been invited to participate in a Symposium on "The Structure and Physiology of Animal Societies," to be held in Paris, France, March 19th to 29th. The organizers of this Conference are Professor Grasse and his students, entomologists at the University of Paris. Dr. Schneirla will report to the Society on this Symposium upon his return.

Dr. Forbes commented that entomologists in general have taken the lead in investigations concerned with social grouping and organization. They have found that in wasps and some ants which have a primitvie society, such as Ponerines, or a loose social organization, individuals, provided they are fed and watered properly, survive quite well as individuals. In Formicine and Myrmicine species, the individuals do better in groups; two better than one; three better than two; large groups better than smaller groups.

The Secretary then read the following proposed change in the by-laws, which will be voted on at the April 4th meeting:

> Article I., Section 2 as amended: Life members shall be active members who have reached the age of 45 years, and who shall pay the sum of $100 at any one time in lieu of further annual dues. They shall be entitled to vote and hold office.

Dr. Forbes introduced Professor Dobzhansky, the speaker of the evening, who spoke on "Ecological Observations of Drosophila in Brazil." Professor Dobzhansky pointed out that although Drosophila has been exhaustively studied for thirty years, its ecology has been neglected. He began by studying the western species, *D. pseudoobscura*, in 1933. With this he contrasted his recent tropical investigations. His chief conclusions were:

1. That diversity within a group of organisms is in response to and proportional to the diversity of habitats.
2. In the Temperate Zone, physical factors such as temperature, humidity, are the important factors in species variability.
3. In the tropical rain forest, however, the organic environment, i.e., competition of species, is the chief factor.

After a brief discussion period, the meeting was adjourned.

Louis S. Marks, *Secretary.*

MEETING OF MARCH 21, 1950

A regular meeting of the Society was held March 21, 1950, at the American Museum of Natural History; president Dr. Forbes in the chair. There were twelve members and twenty guests present. The minutes of the Executive Committee meeting of March 7 were read.

Dr. Forbes called attention to the fact that the proposed change in the by-laws would be voted on at the April 4 meeting.

Mr. Sam Harriot reported for the Field Committee.

Dr. Harold Hagen then proposed the following motion:

> ''That no nomination for membership of any person be considered in order except that, at the same time, the presiding officer be presented with a written statement in duplicate to include the name, address, and JOURNAL option of said nominee.''

The motion was seconded by Dr. Swain and passed unanimously.

Dr. Forbes then introduced the speaker of the evening, Mr. Charles Pomerantz, who spoke on ''Mites, Mice and Men.'' This talk covered his pioneer work with the new disease RICKETTSIALPOX. He spoke from an outline, proceeding in orderly fashion with a discussion of the mite vector, outdoor and indoor surveys, considerations for control, medical considerations, cooperative arrangements with interested workers in the U. S. Department of Agriculture and the U. S. Public Health Service and laboratory procedures. An interesting discussion of the various phases of his work followed.

LOUIS S. MARKS, *Secretary.*

BOOK NOTICE

Rocky Mountain Naturalists. By Joseph Ewan. The University of Denver Press, Denver, 10, Colorado. 1950. 9 × 6 inches. XVI + 358 p. 9 port. $5.00

This attractively printed volume, with its interesting end-papers, is an indication of the slowly developing appreciation of this country's naturalists. Such books are comparatively few and far between and many naturalists do not appear to be aware of the background of their science.

The author, a well-known botanist, bibliographer, and historian, on the faculty of Tulane University, has gathered together seven of his previously published papers on the botanical explorers of Colorado and to these has added additional essays, explanatory notes, bibliography, and an extensive roster of natural history collectors that occupies 206 of the book's 358 pages. Although eight of Mr. Ewan's pen portraits describe botanical explorers, the ninth is a tribute to the memory of that well-known versatile entomologist, Professor T. D. A. Cockerell. I suppose this latter essay will be of most interest to entomologists, but on the other hand, there is no reason why entomologists should not enjoy reading about pioneer botanists, especially when the accounts are well-written.

The author's extensive roster (1682–1932) of natural history collectors is both biographical and bibliographical. It identifies hundreds of ornithologists, foresters, botanists, horticulturists, zoologists, mammalogists, mycologists, biologists, etc., professionals and amateurs, including 70 entomologists, who collected in the Rocky Mountain region. While the accounts are of necessity brief, enough information is given to satisfy most taxonomists and references are cited for the benefit of those needing more information. As time goes on, this roster will be more and more appreciated and used by future students and historians.

Rocky Mountain Naturalists is a noteworthy and satisfying book. I have only one criticism. The roster fails to give any account of one Rocky Mountain naturalist who should not have been overlooked, this being Joseph Ewan.—HARRY B. WEISS

BOOK NOTICE

Larvæ of Insects. Coleoptera, Diptera, Neuroptera, Siphonaptera, Mecoptera, Trichoptera. Part II. By Alvah Peterson. Edwards Brothers, Inc. Ann Arbor, Mich. Lithoprinted, $8\frac{1}{4} \times 10\frac{3}{4}$ inches. 416 pp. 104 pl.

Notice of the publication of *Part I* of this important entomological work was given in this Journal, vol. 57, June 1949 by M. W. Sanderson. The present volume concludes Doctor Peterson's first edition of "Larvæ of Insects". The Coleoptera and Diptera are treated rather fully, while the remaining four orders of *Part II* are treated in a more abbreviated manner. Fifty-eight plates illustrate the Coleoptera alone, and most of the plates are composed of ten or more figures. As explained for *Part I,* there are keys, illustrations and selected bibliographies for each order treated. There is a good working glossary of terms used, food, host or habitat indices for the Coleoptera and the Diptera and a general index of the common and scientific names of the insects treated.

By means of this prodigious work, Doctor Peterson has provided a real aid for the student interested in the immature stages of insects, and a short cut for the entomologist attempting to answer the proverbial, "What is it?"

In his preface, Doctor Peterson states that he hopes to add to this edition by revisions or supplements. They will help to make his "Larvæ of Insects" one of the most valuable references on the entomologists book shelf.—F. A. S.

The
New York Entomological Society

Organized June 29, 1892—Incorporated February 25, 1893

Reincorporated February 17, 1943

The meetings of the Society are held on the first and third Tuesday of each month (except June, July, August and September) at 8 P. M., in the AMERICAN MUSEUM OF NATURAL HISTORY, 79th St., & Central Park W., New York 24, N. Y.

Annual dues for Active Members, $4.00; including subscription to the Journal, $6.00.

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Officers for the Year 1951

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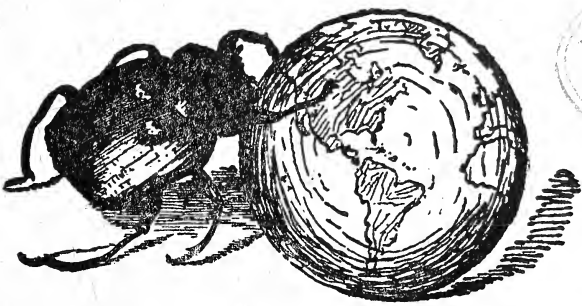

Edited by FRANK A. SORACI

Publication Committee

FRANK A. SORACI — JOHN D. SHERMAN, Jr.
E. W. TEALE — HERBERT F. SCHWARZ

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THE ENTOMOLOGICAL REMINISCENCES OF WILLIAM HENRY EDWARDS

With an Introduction and Annotations by
Cyril F. dos Passos

INTRODUCTION

It is safe to say that the name of William Henry Edwards (1822–1909) is known to most entomologists, and to all lepidopterists. As the author of that exquisite three volume work entitled "The Butterflies of North America" (1868–1897) and the writer of about two hundred and sixty-five scientific papers, mostly on RHOPALOCERA, wherein he proposed some three hundred and fifty-six names for Nearctic butterflies as well as for some moths, he carved for himself a high niche in the annals of lepidopterology that few of his generation equalled or excelled. Edwards' pre-eminent position was recognized by his fellow entomologists at the second meeting of the Entomological Society of America (1907) when, for the first time, Honorary Fellows were elected, he was one of seven so honored.

In the seventy-ninth year of his life at Coalburg, West Virginia, where he had made his home since 1869, Edwards sat down to write his autobiography. When about half way through that enterprise, his old love for the butterflies took hold of him again and he set aside the work at hand to write the "Entomological Reminiscences" that follows. That completed, he returned to his autobiography which he finished three months before his eightieth birthday.

It was my good fortune to visit Coalburg in the spring of 1949 in circumstances more fully related in "A visit to the home of the late William Henry Edwards at Coalburg, West Virginia" (1949, The Lepidopterists' News, vol. 3, pp. 61–62) and to make the acquaintance of Mrs. John Augustine Willis and her family. Mrs. Willis is a granddaughter of Edwards. While there, Mrs. Willis showed me, among other personal belongings of her grandfather, the first part of the autobiography—the second had not then been found—and the Entomological Reminiscences. Realizing the importance of these manuscripts I prevailed upon Mrs. Willis to entrust them to me with a view to their eventual publication. Thus, two highly interesting and valuable manuscripts commenced their journey to the public, to delight and instruct lepidopterists in the ways and works of a man who was a pioneer in the art of rearing butterflies, and the contemporary and correspondent of Boisduval, Henry Edwards, Strecker and Scudder, to mention only a few of the illustrious lepidopterists of that day

John Abbot appears to have been the first American entomologist to observe some of the preparatory stages of Lepidoptera and figure them in their natural colors. However, on none of his plates, with which I am familiar, did he figure the ova or any instar of the larva, except the last. Apparently Abbot collected the larvæ at random, raised them on the food plants upon which they were found, and thus observed some stages of their metamorphoses. Edwards went one step further. He discovered a simple method of obtaining eggs from gravid females confined over their food plants and thus was able to figure the entire life history of many species of butterflies. The Reminiscences are devoted mostly to describing this type of work, some of which is already scattered through the literature.

Edwards was a prodigious worker and a most meticulous observer and recorder of facts. Beginning in 1862, he kept a diary covering his entomological experiences and filled about twenty-six volumes with detailed notes to which he prepared two indices. Most of these books are now in the possession of the Document Section of the Department of Archives and History in the Library of the State Capitol Building, Charleston, West Virginia, having been given to the Library by Edwards' only son, the late William Seymour Edwards.

In preparing the Entomological Reminiscences for publication, very few changes have been made. These are placed in brackets unless obviously corrections of typographical errors. It has been thought advisable to bring all scientific names used by Edwards up to date, retaining, however, the names he used, since they occur throughout his writings. This has been done by placing the present name in brackets after the old name, where that is first used in the text. Thereafter Edwards' usage is followed.

Three manuscripts were available in preparing the Reminiscences, one of sixty-three pages in Edwards' handwriting and the other two typewritten. The second draft, probably copied from the handwritten one, being incomplete, consists of thirty-seven pages only, and the third draft of fifty-seven pages. Edwards' handwriting is extremely difficult to decipher and some errors were doubtless made in copying the original by one probably not familiar with the subject matter. When this seemed probable, recourse was had to the original manuscript.

Biographical notes have been added concerning a number of the individuals mentioned by Edwards. In preparing these notes valuable assistance has been rendered by many friends and correspondents, especially the following, to all of whom I desire to express my thanks: Mr. Milt Andrus, Manager, Chamber of Commerce, Pueblo, Colorado; Mr. Nathan Banks, Holliston, Massachusetts; Mr. Harold C. Bauer, Superintendent, Fond du Lac Public Schools, Fond du Lac, Wisconsin; Mr. Henry Bird, Rye, New York; Mrs. Ethel Rowley Brown, Orlando, Florida; Mr. F. Martin Brown, Colorado Springs, Colorado; Mrs. Marshall Robert Bruce, Brockport, New York; Dr. G. Clifford Carl, Director of the Provincial Museum, Victoria, British Columbia; Miss Mathilde M. Carpenter, Washington, D. C.; Miss Emma Clune, Galena, Illinois; Dr. Spright Dowell, President, Mercer University, Macon, Georgia; Prof. John H. Gerould, Dartmouth College, Hanover, New Hampshire; Mr. Hamilton Gordon, Secretary-Manager, Miles City Chamber of Commerce, Miles City, Montana; Mr. Frank Morton Jones, Wilmington, Delaware; Prof. Alexander Barrett Klots, The City College of New York, New York; Prof. Frank H. Lathrop, Entomologist, University of Maine, Orono, Maine; Mr. J. R. Morrison, City Editor, Press Journal, Louisiana, Missouri; Dr. Eugene S. Richardson, Jr., Curator of Fossil Invertebrates, Chicago Natural History Museum, Chicago, Illinois; Mr. George F. Schlosser, President, Brockport Civic Association, Brockport, New York; Mr. W. H. T. Tams, Department of Entomology, British Museum (Natural History), London, England; Mrs. John Augustine Willis, Coalburg, West Virginia; Mr. J. W. Winson, Huntingdon, British Columbia, Canada. If anyone who has furnished information has not been mentioned, I trust that my oversight will be forgiven. To Miss Carpenter I am especially indebted. She not only searched her card index for information secured since the publication of her ''Bibliography of Biographies of Entomologists'' (1945, American Midland Naturalist, vol. 33, pp. 1–116), but was kind enough to make a number of independent investigations for me. I cannot thank her enough for all the time and trouble she devoted to running down my many inquiries. Finally, I must thank many others who have been kind enough to answer my inquiries and often furnished leads that resulted in uncovering valuable facts. The ''Pioneer Century of American Entomology'' (1936) by Dr. Harry B. Weiss, and other of his papers, have also been consulted and proved of assistance. Reference has been made to ''Rocky Mountain Naturalists'' (1950) by Joseph Ewan, and ''A Century of Entomology in the Pacific Northwest'' (1949) by Melville H. Hatch.

Appended to the Entomological Reminiscences was a list of the papers published by Edwards in entomological magazines and elsewhere. It has not been deemed necessary to incorporate this list, because a partial list will be found in ''Butterflies and Moths of North America'' (1878, pp. 221–224) by Herman Strecker, and a nearly complete list in ''Illustrations of Diurnal Lepidoptera with Descriptions'' (1911, pp.[9–18]) by Andrew Gray Weeks, Jr. These lists have been compared with Edwards' manuscript list and it has been found that both are somewhat incomplete. The papers omitted from the two aforementioned lists will be found in the bibliography at the end of the Reminiscences. Neither has it been deemed necessary to mention any biographical material published prior to 1945 concerning Edwards. Those that appeared in entomological publications are listed by Miss Carpenter in the paper already referred to. A few later ones have been added in an endeavor to bring this subject up to date.

And now I leave the reader to the perusal of the Entomological Reminiscences, lingering only to express on behalf of all lepidopterists our sincere appreciation to Mrs. Willis, to whom we are so deeply indebted for having carefully preserved Edwards' manuscripts through these many years, and for now placing it in the hands of entomologists for our instruction and enjoyment.

Cyril F. dos Passos.

ENTOMOLOGICAL REMINISCENCES

My first studies in natural history were in ornithology, though I had made collections of minerals and shells at one time or other. But from the time when I began to preserve the skins and to mount them, which was in my sophomore year at Williams College in 1839 and 1840, till after my return from the Amazon in 1846, I worked hard at the birds. I made a pretty complete local collection at Williamstown, [Massachusetts], and another at Hunter, [Greene County, New York], in the Catskills, my native place, and another at Princeton, New Jersey, where I spent the summers of 1844 and 1845 and reached the point where collecting birds involved much travel and much expense. I had made a small collection of miscellaneous insects at Williamstown, and another at Pompton, New Jersey in the summer of 1843, but I had no one to show me how to preserve the insects in my boxes, and all were destroyed. When I returned from Brazil in 1846 I made the acquaintance of John Akhurst[1] of Brooklyn, New York, (who is still living at a great age[2]), a professional taxidermist, who was also a collector of Coleoptera and Lepidoptera for his own amusement. I got from him, as I needed, cork and pins, and learned from him how to store the insects which I took and how to preserve them against other destructive insects. Akhurst was skillful in rearing the larvæ of butterflies and moths, and I soon caught on.

The summer which my wife and myself spent at New Hamburg, New York, where our house was in a bit of wood, started me on the butterfly path. I found many sorts of caterpillars and Mrs. Edwards made colored portraits of them. The next summer, 1857, we were at Lenox, Massachusetts, and I used the net to great advantage. In 1858 at Hunter, I had a fine field, especially in Stony Clove, where I took several species unknown in the lowlands. In 1859 we removed to Newburgh, New York,

[1] John Akhurst (1816–1902). Dealer in entomological supplies and inventor of the Akhurst pinning forceps.

[2] [Edwards' note.] He died January, 1902.

where we lived the next ten years. There my collection increased largely and I got in the way of rearing such larvæ as I found. I made the acquaintance of other lepidopterists, as Edward Norton[3] of Farmington, Connecticut, who visited me at Newburgh, and Samuel H. Scudder[4] of Cambridge, Massachusetts, who also came to see me. Akhurst came on one occasion and we spent a pleasant day in searching for larvæ of SPHINGIDÆ. I made the acquaintance of Augustus R. Grote,[5] who was devoted to the Heterocera, (the moths). I visited Dr. Brackenridge Clemens,[6] a zealous lepidopterist living at Easton, Pennsylvania, and author of a valuable work on the SPHINGIDÆ. In Philadelphia I got to know William Newman[7] and James Ridings,[8] veteran collectors and full of butterfly lore. Also of Ezra T. Cresson,[9] soon after Curator of the newly organized Entomological Society [of Philadelphia, 1859. The name was changed in 1867 to the American Entomological Society]. In Baltimore I made friends of Philip R. Uhler,[10] afterwards Librarian of the Peabody Institute of that city, and of Dr. John G. Morris,[11] who in

[3] Edward Norton (1823–1894). For many years Secretary of the American Guernsey Cattle Club, and an authority in Hymenoptera.

[4] Samuel Hubbard Scudder (1837–1911). Celebrated zoologist and author of ''The Butterflies of the Eastern United States and Canada with Special Reference to New England'' (1889), and numerous papers on Lepidoptera, Orthoptera, and other subjects.

[5] Augustus Radcliffe Grote (1841–1903). Well known for his systematic work on North American NOCTUIDÆ and author of many articles on Lepidoptera.

[6] James Brackenridge Clemens (1829–1867). Author of ''Synopsis of the North American SPHINGIDÆ'' (1859), and other papers.

[7] William Newman (–). One of the founders of the Entomological Society of Philadelphia.

[8] James Ridings (1803–1880). One of the founders of the Entomological Society of Philadelphia.

[9] Ezra Townsend Cresson, Sr. (1838–1926). Well-known author of numerous papers on Hymenoptera, and one of the founders of the Entomological Society of Philadelphia, which he served in various capacities.

[10] Philip Reese Uhler (1835–1913). Author of papers on entomology, geology, etc., and one of the founders of the Entomological Society of Washington.

[11] John [?Johann] Goodlove [Gottlieb] Morris [Moritz] (1803–1895). Author of ''Synopsis of the Described Lepidoptera of North America'' (1862), which followed his ''Catalogue of the Described Lepidoptera of North America'' (1860), and other articles.

1862 through the Smithsonian published a book containing all the hitherto printed descriptions of the American butterflies and moths, translating from other languages where necessary. This gave a start to American collectors, and the work of describing new species went on briskly. Before, it had been impossible to tell what had been described and what not. I had made the acquaintance of Professor Spencer F. Baird[12] soon after I came home from Brazil, and now found him greatly interested in my studies of the Lepidoptera. Our friendship continued till his death, and I received from him all the butterflies that came from any part of the United States to the Smithsonian.

My first descriptions of new species were printed in the Proceedings of the Academy of Natural Sciences of Philadelphia. I see that the date of this paper is July, 1861. In that and the following year there followed two other such papers. In 1863 the recently founded Entomological Society commenced publishing its Proceedings, and I contributed a paper in March on new species, mostly from the collection of Mr. Newman. He was an interesting old man, an Englishman by birth, and a house painter by trade. He and his old wife lived in a little house on South Street, in front of which was a small yard containing shrubs and plants on which caterpillars would feed. The couple had no children, and seemed equally devoted to entomology. Mr. Ridings was a builder by trade, and built the house which was used free of rent by the Society for several years. These two men were in the habit of making frequent excursions to the environs of Philadelphia, and into New Jersey in search of insects. As occasions arose, Professor Baird suggested my contributing money in aid of a collector going to an unexplored or distant region. The first such application was in favor of Mr. C. Drexler,[13] a taxidermist employed at the Smithsonian, who went overland from Quebec to the region south of Hudson Bay. He brought back some valuable butterflies, among which were *Papilio machaon* var. *aliaska* Scudder, and *Chionobas* [*Oeneis*

[12] Spencer Fullerton Baird (1823–1887). Zoologist and at one time Secretary of the Smithsonian Institution.

[13] Constantin "Charles" Drexler (–). Hospital steward employed at one time in the Smithsonian Institution.

chryxus] *calais* Scudder. Robert W. Kennicott[14] of Illinois, an ardent naturalist, at about the same time, in the employment of the Siberian Overland Telegraph Company, went through British America to Fort Simpson on the Mackenzie River, and thence down the Yukon. At Simpson he interested Mrs. Christina Ross, wife of Bernard G. Ross, the Hudson Bay factor at that post, in collecting butterflies, and left her a net and pins. In due time I received thence quite a large number of butterflies, among which was the new and beautiful species, [subsequently named] *Colias christina* Edwards. Part of these butterflies were described in the Proceedings of the Entomological Society of Philadelphia, July, 1863. I first met Kennicott at the Smithsonian and he took me to Mr. Titian Peale,[15] who had quite a collection of Lepidoptera set in boxes, the fronts and backs of which were of glass.[16] I afterwards arranged my own collection in similar boxes bound like books. Apart from the security against depredators it was an advantage to be able to see the upper or the under side of many specimens at one glance, rendering it easy to perceive resemblances or differences.

About this time I made the acquaintance of Charles Wilt[17] of Philadelphia, another enthusiastic collector of butterflies, and as long as he lived I called on him whenever I was in the city. He lived on South Street.

The first Californian butterflies I received came by way of St.

[14] Robert W[—] Kennicott (1835–1866). Naturalist, explorer who made many collecting trips in northwestern United States and Canada, and author of several reports concerning his expeditions. Founder of the Chicago Academy of Sciences, Chicago, Illinois (1856). The Kennicott Club, located in the Chicago Academy of Sciences, was named in his honor.

[15] Titian Ramsey Peale (1800–1885). Curator of The Philadelphia Museum, which was founded by his father Charles Willson Peale (1741–1827), as Peale's Museum, a private enterprise, and entirely distinct from the Academy of Natural Sciences of Philadelphia. Author of "Lepidoptera Americana" (1833), the first American publication on Lepidoptera and probably the inspiration for the "Butterflies of North America." Peale's work was not a success; only one number was published.

[16] This collection, still in its original boxes, is in the Academy of Natural Sciences of Philadelphia.

[17] Charles Wilt (1821–1886). Organization member of the Entomological Society of Philadelphia.

Petersburg, Russia. Mr. Ménétriés,[18] Curator of the Museum there, had asked Baron Osten Sacken,[19] their Consul General in the United States, to arrange an exchange of insects, and he applied to me. I wanted Californian butterflies and would exchange American species for those. I forwarded a large box to Mr. Ménétriés and in return received many Californian species which had reached Russia through Dr. Boisduval,[20] the great French lepidopterist, who employed collectors in California. At about the same time I entered into correspondence with Dr. Herman Behr[21] of San Francisco, who had for years taken butterflies throughout California. In this way I received many species, and in after years valuable information respecting their localities and habits. A few years later I corresponded actively with the late Henry Edwards[22] of San Francisco, and after of New York. My friendship and intimacy with him continued till his death in 1891.

Some time before 1860 I made the acquaintance of Professor Julius Meyer[23] of Brooklyn, a teacher of music, an enthusiastic lepidopterist, and an expert at breeding larvæ.

It was in 1863 that Edward Norton, then living in New York, received from a Frenchman to whom he had done some service a large collection of European butterflies, sphinges, and moths in

[18] Edouard Ménétriés (1802–1861). Celebrated entomologist and author of several papers on Siberian and North American Lepidoptera.

[19] Karl Robert Romanovich, Baron von der Osten Sacken (1828–1906). Known among entomologists as C. R. Osten-Sacken. Eminent dipterist.

[20] Jean Baptiste Alphonse Déchauffour de Boisduval (1799–1879). Author of "Lépidopterès de la Californie" (1852 and 1869), and many other valuable works (see page 140).

[21] Hans Herman Behr (1818–1904). At one time Vice President and Curator of the Academy of Sciences of San Francisco, and author of many papers on Californian Lepidoptera.

[22] Henry Edwards (1830–1891). Celebrated actor and author of many entomological papers, especially on Pacific Coast Lepidoptera. He formed one of the largest, world-wide collections of his period. He was not related to William Henry Edwards.

[23] Julius E[—] Meyer (–). One of the early members of the New York Entomological Club, professor of the pianoforte and of singing, and at one time a teacher at Miss Porter's School at Farmington, Connecticut.

neat wooden boxes, glass topped, every specimen labelled with its name. Norton gave me the butterflies and they were useful in comparing with American species. But my collection of Americans grew rapidly and I finally gave to Meyer all these Europeans, and confined myself to the butterflies of America north of Mexico. But in 1863 I was much interested in sphinges and the *Catocala* moths. I had it in mind to some day publish a work on the Catocalas.

John W. Weidemeyer[24] and Stephen Calverley[25] of Brooklyn in 1863 began to issue a series of colored plates of North American SPHINGIDÆ, drawn and colored by a German, one [Ch-] Walo. I was permitted to join these gentlemen with their issue of No. 2. Each of us had one set colored by Walo, and fifty plain plates. The work went on as far as No. 28 under Mr. Weidemeyer's supervision and then suddenly stopped. Weidemeyer sold his whole collection of insects in Europe and gave up the study entirely; probably it interfered with his business which was that of a broker in hides. No text was issued with the plates of sphinges. I have recently sold my set of colored plates and all my plain plates to the Academy of Natural Sciences of Philadelphia.

Another entomologist whose acquaintance I made about this time was Benjamin D. Walsh[26] of Rock Island, Illinois, most able and industrious. We corresponded for some years, compared notes, and exchanged specimens. He lost his life by being run down by an engine as he was walking on the track near his home, while intent on a letter he was reading.

In 1864 Mr. Ridings made an overland trip to Colorado, then an unexplored region entomologically. He brought home several new species of butterflies, some of which I described in the Proceedings of the Entomological Society of Philadelphia, March, 1865.

In August, 1864 I went to the Kanawha Valley in West Virginia in connection with the coal company that was building the

[24] John William Weidemeyer (1819–). Author of "Catalogue of North American Butterflies" (1864).

[25] Stephen H[—] Calverley (–).

[26] Benjamin Dann Walsh (1808–1869). Well-known entomologist who at the time of his death was State Entomologist of Illinois.

town of Coalburg, on the Kanawha River, twenty miles above Charleston. On the twentieth I was staying at Mr. Felix Hansford's at the mouth of Paint Creek (five miles above Coalburg), and that afternoon was walking along the Creek and saw fly past the first example I had ever seen of the butterfly *Argynnis* [*Speyeria* (*Semnopsyche*)] *diana,* a male. Up to that day this was the rarest American species in collections. None of my correspondents had seen it except Mr. Walsh, who possessed a battered male which had been taken in southern Illinois. Cramer,[27] 1779 to 1782, had figured the male *diana*[28] and gave Virginia as its habitat. Boisduval and Leconte[29] in their Lepidoptera of North America, 1833,[30] copied Cramer's figure and drew their description from it, never having seen the species in life. The female was entirely unknown. A few days later near the same spot in a thicket of ironweed (*Vernonia noveboracènsis*) I came suddenly on a large black butterfly, having a broad band of metallic blue across the hind wings. It was feeding so quietly on the ironweed flowers as to allow me to watch it for some seconds. It seemed to be a species of *Limenitis,* so much did it resemble *L.* [*arthemis*] *ursula* [= *astyanax*] in the color and the markings of the upper side. But on taking it I saw that it was an *Argynnis* female, and the pattern of the under side left no doubt of its relationship to the male *diana.* The delight of that moment has never again been experienced by me. Naturalists will understand that. My attention once attracted to this species I found that both sexes were not uncommon, and in the course of a few days I took a number of examples. Shortly after, on an excursion up Elk River, a northern branch of the Kanawha, I found *diana* as plentiful as the other large *Argynnis* [*Speyeria* (*Semnopsyche*) *cybele*] *cybele* and [*Speyeria* (*Semnopsyche*) *aphrodite*] *aphrodite.* I published an account of my capture on

27 Pierre Cramer (–1779). With Caspar Stoll (–1795) in part, author of Papillons exotiques de trois parties du monde l'Asie, l'Afrique et l'Amerique ([1775]–1791).

28 [1777].

29 John Eatton Leconte (1784–1860). Father of John Lawrence Leconte, the distinguished coleopterist.

30 Histoire générale et iconographie des Lépidoptères et des chenilles de l'Amérique Septentrionale [1829–1837].

Paint Creek in the Proceedings of the Entomological Society of Philadelphia for November, 1864. In both sexes *diana* is one of the grandest butterflies belonging to the American fauna. In after years it has been found plentifully in Fayette County, West Virginia, also in southern Indiana. In 1866 Mr. Ridings took three fresh males in Georgia, and it has been reported in both the Carolinas. All which makes it the more remarkable that that conspicuous female was not reported before I took the example at Paint Creek.

Eager to take *diana,* both Mr. Ridings and Mr. Meyer came to Coalburg in 1865 and stayed with me some weeks. In all they took about one hundred dianas, and the species has been scarce in this vicinity ever since. Mr. Ridings made another visit to Coalburg in 1867.

About this time I made the acquaintance of Mr. William Saunders[31] of London, Ontario, who was interested especially in insects injurious to vegetation, and the Reverend Charles J. S. Bethune[32] of Toronto, soon after Head of the public school at Port Hope, Ontario, and the first Editor of the magazine, The Canadian Entomologist, the first number of which was issued August, 1868. This magazine has reached its thirty-fourth volume and is still under the supervision of Dr. Bethune. It has been of the greatest assistance to the entomologists both of Canada and the United States. Long may it flourish, and that under the present Editorship ![33]

A species of butterfly which had much exercised the lepidopterists of Canada and the northern United States was *Melitœa* [*Euphydryas*] *phœton.* It was seen in many localities, almost always in the vicinity of swampy ground, but there was no

31 William Saunders (1835–1914). One of the founders of the Entomological Society of Ontario, Editor of The Canadian Entomologist from 1874 to 1886, and author of ''Insects Injurious To Fruits'' (1883).

32 Charles James Stewart Bethune (1838–1932). One of the organizers of the Entomological Society of Ontario, author of many articles on systematic and economic entomology, and a number of bulletins on injurious insects.

33 Since the death of Bethune, The Canadian Entomologist has been under the able Editorships of Dr. E. M. Walker through 1920, Dr. James H. McDunnough through 1938, Mr. W. J. Brown to June, 1947, and is edited presently by Dr. W. R. Thompson.

knowledge of its preparatory stages or of the food plant. In The Canadian Entomologist for June, 1869 appeared this notice: "Mr. W. H. Edwards, of Coalburgh, West Va., writes us that he has obtained the larvæ of *M. phæton,* feeding, May 20, on the leaves of *Chelone glàbra,* L., (the plant was determined by Mr. B. Billings, of Ottawa, Ont)." In The Canadian Entomologist for November, 1869, I communicated the discovery of the larvæ of *phæton* and their food plant: "I am glad to be able to inform you that I have a brood of *M. phæton* feeding. They were found by Mr. J. [T.] L. Mead,[34] of New York, who has spent some time here this season. He found them within close webs which were attached to *Chelone glàbra,* and sometimes to other plants, as iron-weed [*Vernonia*] and a *Solidàgo.* In one instance a web was attached to the two last named. The larvæ which I have feed on *Chelone;* they appear to feed at night, and during the day collect in dense clusters in the corner of the box in which they live. . . ." *Chelone* is a swamp plant. The stems grow in a clump, to the height of four feet or so, and early in the spring they may be seen black with these larvæ. The leaves and stems are eaten nearly to the ground, and the larvæ emigrate to another plant. When ready to pupate they scatter, and we found them abundant along the lower edges of fence rails near our swamp, and chrysalids suspended from the rails. The eggs are laid in clusters on the leaves of the plant.

Mr. Theodore L. Mead, then a young and ardent collector of butterflies, wrote me in the early summer of 1869 asking if I could direct him to a good region for butterflies within five hundred miles of New York. I replied that the Kanawha Valley was exactly the place he wanted and invited him to come and see. He came in July, and repeated his visits for years, and was of the greatest assistance to me in the matter of both butterflies and larvæ. He discovered several species of larvæ which had not been observed before, and the food plants of several species. The discovery of the dianas, and about the same time of *Argynnis* [*Speyeria* (*Speyeria*) *nokomis*] *nokomis* Edwards, a large and

[34] Theodore Luqueer Mead (1852–1936). In later years Mead became interested in orchids. His collection is now at the Mead Botanical Garden, Winter Park, Florida.

beautiful species, a single male of which I found at the Smithsonian in a glass jar amid some cotton wool from south[ern] Utah, or southeastern California,[35] led me to wish that such fine things might be figured and published. I talked it over with Mr. Cresson and he knew a lithograph artist, Mr. [D-] Wiest, who would draw a plate on trial. So I gave Wiest a pair of dianas to copy. He made a fair plate, but the figures were smaller than life and the legs and other small organs were not correctly copied. We tried Wiest further on *nokomis* and *cybele* and *aphrodite,* with the same results. I then consulted Mr. John Cassin of the lithograph house of Bowen & Co., of Philadelphia. I had been helped by Mr. Cassin years before at the Academy to determine my South American birds. I proposed his making a trial plate and gave him specimens of *Argynnis* [*Speyeria* (*Speyeria*) *atlantis*] *atlantis* Edwards. He put them in the hands of one of his men and the outcome was fair. I now had five plates drawn and it was agreed with Mr. Cresson that these should constitute the first part of the Butterflies of North America. Cresson undertook to print the text on a hand press that was in the Entomological Society's room, and with the help of some of the members of the Society the thing was done. Part One was issued in June, 1868. It was noticed in The Canadian Entomologist for October, 1868 thus: "The Butterflies of North America: with colored drawings and descriptions. By W. H. Edwards. Philadelphia: the American Entomological Society. Part I, April, 1868. Price $2. It would be difficult indeed to produce anything more beautiful or true to nature than these exquisite drawings of butterflies; they vie in excellence with any European work that we have seen. . . ." Although Part One was surpassed by most of its successors in the execution of the plates, it was well received by the lepidopterists of the United States and Canada, and met a want. Therefore, I was encouraged to venture, but had no idea how far I should go or where the work would stop. Mr. Cassin had no artist who had drawn insects, or who knew anything about insects. But he said he had a skill-

[35] This insect was described by Edwards from the "Rocky Mountains, and Mountains of California" ("1862" [1863], Proc. Acad. Nat. Sci. Philadelphia, vol. 14, p. 221).

ful young lady to whom he would give the next plate. Accordingly, Miss Mary Peart drew the sixth plate, *Argynnis* [*Speyeria* (*Speyeria*) *callippe*] *callippe*, and thereafter drew every plate in volume one, besides redrawing three of Wiest's plates.[36] Also, she drew all the plates of volume two. The plates of volume one and also of two were colored by Mrs. Lydia Bowen and her sister, Mrs. P. D. Leslie. These ladies had formerly worked on the plates of Audubon's birds, the quarto edition, and were experts. So long as they lived they continued to work on my books. Mr. Cassin died, and Mrs. Bowen took Mr. Edward Turnbull as partner. He was an ornithologist, and a man of very poor business capacity and of objectionable habits. My arrangement with Mr. Cassin had been that a part of five plates should issue each three months. But under Turnbull the delays were constant and unreasonable. I had not been in direct communication with Miss Peart. On November 29, 1870, she wrote Mr. Cresson thus: "I was almost ready to enter a protest against receiving any more work at the hands of Bowen & Co. Calling this morning, I learned that Mrs. Bowen had seen you, and that you know that Mr. Edwards' work is sadly neglected. I have not commenced on stone the plates of part 8, and will do nothing further till I see you or hear from you, except preparatory work on paper. But I trust some other arrangement can be made for the future." This led us to propose to Miss Peart that we should treat with her alone for the drawing of the plates, while the printing of them and the coloring should still be done by the house. The proposal was accepted, and Miss Peart (afterwards Mrs. Peart)

[36] It is believed that Edwards was in error in stating that "three" of Wiest's plates were redrawn. Plates *Argynnis* 1 *diana* and *Argynnis* 4 *nokomis* were certainly redrawn, but no evidence has been found showing that either plates *Argynnis* 2 *cybele* or *Argynnis* 3 *aphrodite* were redrawn. Plate *Argynnis* 5 *atlantis* does not appear to have been drawn by Wiest, but "by one of his [Cassin's] men." Edwards' error may be due to the fact that Mary Peart redrew one of her own plates, *Argynnis* 10 *leto*, or at least it was recolored. There can be no doubt concerning the publication of the original plates *Argynnis* 1 and 4. They are to be found bound in various copies of Edwards' work—sometimes accompanied by the redrawn plates. In a copy in my personal library they are included in the original cover as issued, which is inscribed "With compliments of W. H. Edwards" in his handwriting.

worked on my plates many years to the satisfaction of myself and my subscribers. At the beginning she knew nothing of the structure of butterflies. I called her attention to the peculiarities of the small organs, the legs, the antennæ, and palpi, and gave her a net with which to take live butterflies in order to make sketches of these organs. These were rendered faithfully, and added greatly to the value and beauty of the plates.

The phenomena of dimorphism and polymorphism among the butterflies interested me very early. *Papilio ajax* [= *marcellus* = *walshii*], a common species in the Kanawha Valley, seemed to manifest itself in three forms: 1. *walshii* [= *marcellus*], so named by me, the small form which appears in early spring.[37] 2. *telamonides* Felder [and Felder], seen later in spring and in early summer. 3. [?]*marcellus* Boisduval [and Leconte][38] [*gen. æst. lecontei*], the only form flying in the latter part of summer. Another such species is *Papilio* [*glaucus* form] *turnus,* [being] yellow in both sexes [in the north (= female form *turnus*)] but in the south having a second female, black, and the more common of the two.

So *Grapta* [*Polygonia*] *interrogationis* showed itself in two forms, as also does *Grapta* [*Polygonia*] *comma,* both common species. From 1864 I had tried to separate the forms of [*Papilio*] *ajax,* but was baffled by one form overlapping another, or two of them flying at the same time. It was easy to find both eggs and caterpillars on the leaves of the papaw (*Asímina tríloba*), but it was rarely possible to discover which form laid a particular egg, and quite impossible to tell which a caterpillar came from. In 1870 it occurred to me to try confining the female *ajax* to the food plant, and on May 16 I enclosed in a wooden powder keg, from which both heads had been removed, a female of the form *telamonides.* The upper end of the keg had been covered by a net, and it was placed over a small papaw. During that day the butterfly laid several eggs on the leaves, and from these I raised six larvæ which, between June 20 and 24, gave six butterflies of

[37] In Florida the very early spring form is *floridensis* Holland, but that name seems hardly applicable to specimens from West Virginia.

[38] *P. marcellus* Boisduval and Leconte is a misdetermination of *marcellus* Cramer.

the summer form *marcellus*. On June 1, I shut in three female *telamonides* from which resulted in July twenty-three *marcellus* and one chrysalid went over the winter to produce *telamonides* on April 19, 1871.

These experiments were continued during 1871 and the result of the whole was that *walshii* from over-wintering chrysalids produced *telamonides* and *marcellus* the same season, and occasionally its own form. [*Papilio*] *telamonides* produced *telamonides* the same season, and *telamonides* in the spring, and *marcellus* produced successive broods of *marcellus* the same season, and occasionally a *telamonides*, and the last brood of *marcellus* produced *walshii* and *telamonides* in the spring. *Papilio ajax*, therefore, was subject to seasonal polymorphism.

As to *Grapta interrogationis*, of which there are two forms, a red and a black, on June 4, 1870 I captured two females of the dark form, *umbrosa* [= *interrogationis*] Lintner, and enclosed them over a spray of the hop vine. A large number of eggs were laid, from which I got eighteen chrysalids. These produced on July 3 and subsequent days eleven butterflies of the form *umbrosa*, and six *fabricii* Edwards, the red form. On July 20 and the days following to August 5, I took eleven females of *umbrosa*, no *fabricii* being seen, and from them obtained twenty-nine *umbrosa* butterflies and twenty *fabricii*. [*Polygonia*] *interrogationis* is, therefore, subject to simple dimorphism, but as the early examples of the year are nearly all of the form *fabricii*, while nearly all those seen in the fall are *umbrosa*, the species is subject to seasonal dimorphism more or less completely. The same is true of *Grapta comma*, *G. harrisii* [= *comma*] being the spring form and *G. dryas* the summer.

The three forms of [*Papilio*] *ajax*, and the two of [*Polygonia*] *interrogationis* made up my part nine, which was issued in January, 1873, and attracted great interest among naturalists.

The mode of getting eggs, practiced by me, has since come into general use, and has revolutionized the study of Lepidoptera particularly. It was soon found by me that the females of any species of butterfly might be enclosed in a bag over a growing stem of its food plant, or over a plant rooted in a pot, and thenceforth it became easy to get eggs from any part of the United States and from much of Canada, and even France and England.

Mr. Charles Darwin[39] wrote me on April 22, 1872: "I am very much obliged to you for your kindness in having sent me Part 9 of your Butterflies, which is one of the most beautiful works I have seen. Your careful observations of the dimorphism, or rather the trimorphism, of *Papilio ajax* strikes me as most remarkable and interesting."

Mr. Alfred Russel Wallace[40] had treated of polymorphism of Malayan butterflies in a paper published in the Transactions of the Linnean Society, volume 30, and reprinted in "Some Contributions to the Theory of Natural Selection," London and New York, 1870. He wrote me: "Your Part 9 is an exceedingly interesting number, and goes far, I think, to elucidate one mode at least, in which species are found. The varieties of *Grapta interrogationis* are even more interesting than those of *P. ajax,* as they are most easily recognized and, as they are of a character very common among NYMPHALIDÆ, they will no doubt lead to many more cases being discovered."

Mr. Henry W. Bates[41] wrote: "Having reflected on the bearing of these extraordinary facts of variation on the great question of the origin of species, they appear to me to open up a long vista of consequences. They do not, strictly speaking, form a case of alternation of generations, they rather point to variation under changed conditions; i.e., conditions of accelerated or retarded growth; and of growth taking place in different seasons, and under different states of temperature."

My acquaintance with both Mr. Wallace and Mr. Bates began in 1848. My Voyage up the River Amazon (1846) was published by the Appletons in New York, and by John Murray in London, the next year. I spent most of the year 1848 in London. One morning I was called on by two young men who introduced

[39] Charles Robert Darwin (1808–1882). Celebrated naturalist, author, and co-discoverer of the theory of natural selection.

[40] Alfred Russel Wallace (1823–1913). Celebrated naturalist, author, and co-discoverer of the theory of natural selection.

[41] Henry Walter Bates (1825–1892). Contributed to the theory of mimicry, author of "The Naturalist on the River Amazon" (1863), assisted with publication of three parts of Coleoptera in "Biologia Centrali-Americana. Zoology-Coleoptera" (1881–1899), and published many other articles.

themselves as Messrs. Wallace and Bates. They had read my book and it had decided them to go to the Amazon to collect birds and insects. They wanted information in regard to the country and the way of moving about. I talked over the matter some time, and gave them letters to friends at Pará who might help them. They soon departed and remained on the Amazon for many years, and did grand work. In 1887 Mr. Wallace visited me at Coalburg.

At about the time that part nine was issued I received a letter from Professor Louis Agassiz,[42] part of which reads as follows: "Without knowing more of your doings than appears on the face of your publications, I was so much struck by the beauty and thoroughness of your Lepidoptera that I requested Dr. Hagen[43] to write to you and offer you anything from our collections[44] that might be desirable in the progress of your work."

In the course of the years following, by breeding the butterflies from eggs obtained from the females in captivity, I made clear many other cases of polymorphism among the North American butterflies. Of these some of the most conspicuous examples were *Colias eurytheme,* which I worked out in connection with Mr. G. M. Dodge[45] of Nebraska. In this species three distinct forms combine to form one species. *Limenitis* [*arthemis*] *arthemis* and *L.* [*a.* form] *proserpina* proved to be one, and in the genus *Melitœa* [?*Phyciodes*] there were several like cases.

So, *Lycœna* [*Lycœnopsis pseudargiolus*] *pseudargiolus* is made up of the winter form *lucia,* which itself splits into three subforms, the other two being *marginata* and *violacea* [= *pseudargiolus*], the last named having also a black [?brown] female [or black aberrational male] in addition to its normal blue one. Be-

[42] Jean Louis Rodolphe Agassiz (1807–1873). Noted biologist, teacher, author of voluminous publications, and founder of the Museum of Comparative Zoölogy, Cambridge, Massachusetts.

[43] Hermann August Hagen (1817–1893). Professor of Entomology at Harvard University, one of the most distinguished entomologists of the century, and author of "Bibliotheca Entomologica" (1862–1863) as well as many other publications.

[44] Collection of the Museum of Comparative Zoölogy, Cambridge, Massachusetts.

[45] George M[—] Dodge (—). Brother of Edgar A. Dodge and author of many articles published in Psyche.

sides this winter form there is a spring one, *pseudargiolus,* and a summer form *neglecta.* The caterpillars in spring feed on the flowers of the dogwood; those of the later spring and early summer on the rattleweed (*Cimicífuga racemòsa*), and those of the late summer on flowers of *Actinómeris squarrosa* and other plants. This remarkable species is treated of at length and exhibited on two plates crowded with figures in my second volume. In the same volume are given *Colias eurytheme, Limenitis arthemis,* and *Melitæa* [*Phyciodes tharos*] *tharos,* all polymorphic species.

In 1868 when the first part [of the Butterflies of North America] appeared, my place of residence in West Virginia was inaccessible from the east, except by stage road over the Virginias, and the time to Philadelphia was four days at the quickest, so that it was next to impossible to get the caterpillars of butterflies to the artist. But the opening of the Chesapeake and Ohio Railway, which took place in 1870, changed all this, and in the course of the next year all places which could be reached by rail, such as Florida, Texas, Arizona, California, and Colorado, as well as much of British America, were in my reach. Correspondents in all these regions were instructed how to obtain eggs of butterflies, and eggs were sent me through the mails. I reared the larvæ at Coalburg and sent the different stages of them, as well as eggs and chrysalids, to Miss Peart. She became quite as expert as I was in rearing the caterpillars. When volume one began, nothing to speak of was known by myself, or anyone else, of these stages of butterflies. As an egg or a caterpillar, when found, could rarely be traced to a particular butterfly, it was not possible that much knowledge could be gained of the life histories of the species. Scarcely any advance had been made in this line since the time of Abbot[46] about 1800, and Abbot in his two great volumes on the insects of Georgia gave no stages of the larvæ but the mature one, and nothing of the egg. Mr. Titian Peale, who knew Abbot, told me in 1864 that caterpillars of all sorts were

[46] John Abbot (1751–1840). The date of Abbot's birth is usually given as 1750, but in a detailed account of the first part of Abbot's life, handwritten by himself, discovered recently (1948, Lep. News, vol. 2, p. 28) Abbot wrote that he was born in 1751. Abbot's minute observations and drawings appear in the splendid work "The Natural History of the Rarer Lepidopterous Insects of Georgia" (1797) by James Edward Smith.

brought in by negro boys in Savannah, and he generally only learned what species they belonged to when the butterfly or moth came from the chrysalid or pupa.

So it was that my experiments in 1870 and 1871 revolutionized the study of the Lepidoptera. In volume one of the Butterflies of North America there are few caterpillars represented on the plates; in volume two there are several, but in volume three thirty-four out of the fifty-one plates give the preparatory stages, generally the eggs, all the moults of the larvæ, and the chrysalids.

In May, 1871 Mr. Mead went on a collecting tour to Colorado[47] and thence to southern California, stopping at Coalburg on the way. It was arranged that he should mail the Colorado butterflies in papers to me, and that I might describe and figure any species. No such expert collector had before worked in that region, and he mailed multitudes of specimens, many of them hitherto unknown. Of these were *Colias* [*meadii*] *meadii, Argynnis* [*Speyeria* (*Speyeria*) *callippe*] *meadii,* and *Satyrus* [*Minois*] *meadii,* so named and figured in the course of my volumes.

In 1872 Mr. Mead came to Coalburg in April. I recorded in my diary that up to the twenty-ninth he had taken sixty-three [*Papilio*] *ajax walshii,* and but one *telamonides,* which agreed with what we had observed, and what I had learned by rearing from the egg in previous years that *walshii* was the winter form of the species.

In July came Julius Meyer, by way of stage over the mountain, stopping off at Frank Tyree's on Big Sewell Mountain, sixty miles east of Coalburg. From Tyree's he walked, net in hand, and had the good luck to take a dozen fresh and perfect male dianas, which he counted as worth all the expense of his trip. That summer, 1872, Mr. William D. Scott,[48] an ornithologist from Cambridge, Massachusetts, spent several weeks with us collecting birds. He and my son, William Seymour Edwards[49] were out on the hills every day, and spent the afternoons in taking off and preserving the skins of what they brought in. When Scott

[47] For information concerning Mead's collecting in Colorado see "The Localities of T. L. Mead's Collection of Butterflies from Colorado in 1871" by F. Martin Brown (1934, Jour. New York Ent. Soc., vol. 42, pp. 155–162).

[48] ? William Earl Dodge Scott (1852–1910).

[49] William Seymour Edwards (1856–1915).

had obtained eight hundred skins he went home. My son continued to collect birds, and in a year or two had fully one thousand skins. Scott found that the northern and southern species met in this valley, and that it was a most interesting field for ornithologists.

In January, 1873, volume one of the Butterflies was finished. It was begun in 1868. Nature, London, for March 27, 1873, said of it: ". . . No American work of the kind has ever been printed containing in its pages so satisfactory illustrations of the various species. . . ." The Entomologist's Monthly Magazine (London) for August, 1868 said: ". . . , it is not too much to say that they [the figures] will bear comparison with the best that have ever been given in iconographical works. . . . The letter-press accompaniment to the plates is also remarkably well done. . . ."

The American Entomological Society of Philadelphia just then moved its collections and library to the Academy of Natural Sciences of Philadelphia, and Mr. Cresson was connected with the publication of my books no more. I made arrangements with Houghton, Mifflin, and Company of Boston and Cambridge to publish a second volume. The first part of volume two was issued July, 1874, and the last in November, 1884. Professor Baird, in Harpers Weekly for July 18, 1874 wrote: "The second series of this superb work on the Butterflies of North America has just commenced with the appearance of Part One, and with the promise of even greater beauty and excellence than the one recently ended."

In August, 1873 Mr. Mead came. Whenever he appeared entomological work went on finely. He was in the fields and woods all the day long, and never returned without trophies of his net, and without discoveries in the matter of caterpillars or food plants. On August 25 he went to Fayette County after the female dianas, and returned on the thirtieth, bringing sixty of them alive. These were set for eggs on violet plants under gauze bags, and by September 7 they had laid swarms of eggs on the plants and on the nets. These eggs hatched in twenty or twenty-one days. I had not then learned how to carry the newly hatched larvæ of any species of *Argynnis* through the winter, and at a venture left these on the violets in the greenhouse. In nature such larvæ live within the dead leaves on the ground in a torpid state, and as spring comes on they become active and search for young leaves of violet. The greenhouse treatment was not very successful, but one larva was carried to maturity, several through one, two or three moults, the rest dying off rapidly. This one pupated on May 19 and the female butterfly came out on June 9, the outcome of hundreds of eggs. Moult by moult Mrs. Peart had followed these larvæ with the drawings, and the stages complete were depicted in volume two on plate seven of *Argynnis.*

In 1874 Mr. Meyer came again to Coalburg and stayed nearly a month. As with Mr. Mead, things were lively when the Professor was on hand. He filled his collecting box every time he went out.

In July, 1875 I went to Hunter, New York, in the heart of the Catskills—my native place—and spent some weeks there. Mr. Mead came there also and we made many excursions to Stony Clove and other points where good collecting was to be had. We had wanted to know the food plant of *Phyciodes tharos,* a butterfly common in many parts of the country, and had experimented with various plants at Coalburg in former years, but to no purpose. This butterfly varied much, seasonally and otherwise, and eggs were needed in order to ascertain the nature and limits of the variation. On July 27 Mr. Mead brought in hundreds of eggs, laid on a species of wild aster. He had planted in a large box all the *Compositæ* he could find and turned in several females of *tharos.* Next day, on examining the plants, the eggs were found on aster, and that alone.

In Stony Clove, and at the head of the mountain on the Platter Kill road, were always to be found *Argynnis atlantis,* and *Grapta* [*Polygonia*] *faunus,* fine mountain species, also, the dimorphic *Limenitis arthemis.*

Dr. August Weismann[50] about this time had published his observations and experiments on dimorphism, Studien zur Descendenz-Theorie (Studies in the Theory of Descent), [1875–1876], and they led me to experiment on the effect of cold applied to

[50] Friedrich Leopold August Weismann (1834–1914). Eminent biologist and author of articles on the theory of evolution and its correlations.

chrysalids of *Papilio ajax* in 1875 and the year after. In June, one hundred and twenty-two chrysalids were obtained from the eggs laid by the spring form of this species, *telamonides,* late in May. These, as fast as formed, were placed on ice in the refrigerator within a wooden box, and kept there till July 20 when I went to Hunter. I sent the box to the icehouse with directions to place it on the surface of the ice. I returned on August 20 and learned that the ice had just failed. The chrysalids had been subject to a low degree of temperature in the refrigerator for three or four weeks, and in the icehouse to a lesser degree which must have been daily diminishing. That the severity of the cold had not been sufficient to prevent the emerging of the butterflies was apparent when I opened the box, for there were discovered a number of dead ones which had just vitality enough to break through the shells. The wings of these were wholly unexpanded. But one butterfly was still alive, just emerged, and it proved to be a typical *telamonides.* By September 4 fourteen examples of the same form had come forth. In all fifty butterflies emerged between August 20 and October 16. Of these twenty-two were typical *telamonides,* one was between *telamonides* and *walshii,* seven were between *telamonides* and *marcellus* (winter form) but nearer the former, nine were between *telamonides* and *marcellus* but nearer the latter, and eleven were typical *marcellus.* Most of the chrysalids which had not given butterflies by October died during the winter, and there was but one emergence the next spring, a male *walshii* on March 2.

It seemed a proper conclusion from this experiment that the butterflies which emerged from the chrysalids subjected to cold would have done so in their natural state, and that the effect of the cold was not to precipitate the emerging of any which would have slept till spring. And, as all which would naturally have emerged the first season would have taken the form *marcellus,* the summer form, the effect of the cold had been to change them to *telamonides,* the spring form. The intermediate examples were probably from chrysalids which had experienced a lesser degree of cold, and several experienced cold enough to retard their emergence, though not to change the form. In his book, Dr. Weismann gave my experiments in full.

I made further experiments with *ajax* in subsequent years. In May, 1878, I placed many chrysalids from eggs laid by the form *walshii* in the icebox, temperature about 33° Fahrenheit. The youngest were but ten to fifteen minutes from pupation and some of these were still soft; others were added at intervals up to twenty-four hours from pupation; others at two and three days, and so up to eight days. (The chrysalid in this species becomes hard in about twelve hours from pupation.) All the chrysalids were removed from the box at the same time. The exposure had been from five to nineteen days. I wished to determine whether, in order to effect any change, it was necessary that cold should be applied immediately after pupation, or if one or several days might intervene between pupation and icing. Inasmuch as no color begins to show itself in any butterfly till within a few hours of emergence from the chrysalid, I thought it possible that cold applied shortly before that time might be as effective as if applied earlier. The result was that more than half the younger chrysalids died. On the other hand, one which had been exposed but ten minutes, and another two hours, gave butterflies. On the fourteenth day after removing the chrysalids a *telamonides* came from the chrysalid placed in the icebox three days after pupation and exposed sixteen days.

On the nineteenth day emerged a *telamonides* near to *walshii* from a chrysalid placed in the box twelve hours from pupation and kept there eleven days. On the same day also emerged a *walshii* from a chrysalid on the ice at two hours old and kept there eleven days. All the rest of the butterflies emerged unchanged *marcellus,* but at periods prolonged in a surprising way from forty-six days after removal from the ice to ninety-six days. The normal length of the chrysalid period in *ajax* is about eleven days. These experiments and others on *ajax* are detailed at length in volume three of the Butterflies of North America under the head of *Papilio* 5. They were also given in the appendix to Mr. Raphael Meldola's translation of Dr. Weismann's book, London, 1880 [1882].

In 1875 and 1876 I subjected the polymorphic species, *Phyciodes tharos,* to experiments with cold. These are related in volume two of the Butterflies of North America; also in volume three are given my experiments with *Grapta interrogationis.* These things bore upon the question of the origin of species and were noticed by biologists in both Europe and America. In the two species last named several of the butterflies showed suffusion of colors to a marked degree.

In the fall of 1876 I was at Hunter and obtained eggs of *Limenitis arthemis* and its coform, *L. proserpina,* by confining the female over small aspen trees. I reared the larvæ to chrysalids and butterflies, and proved that both were forms of one species, as I had concluded was the case from observations in the field.

In 1878 and for two or three years preceding, I had been engaged in working out the life history of *Lycæna pseudargiolus,* and a very curious one it is. The larva of this species, when on its food plant, is attended by ants. I noticed that in summer when the larvæ were on rattleweed the ants were always present on the plant and were attracted by the larvæ; they caressed the larvæ with their antennæ, and ran up and down their backs. The larvæ manifested no annoyance at such familiarity. The ants seemed to linger about the last segments of the larvæ. Not having a sufficiently powerful glass, I sent some of the larvæ to Dr. Hagen at Cambridge, and he soon replied: "On the penultimate segment, are found, outside and behind the stigmata, two large white spots, each of which evaginates a white membranous tube, just like the finger of a glove, the top of which is not entirely drawn out. I have seen the tube frequently. On the antepenultimate segment is a larger and transversal opening, behind and between the stigmata, near the apical border. It looks like a closed mouth with its lips, etc." I pursued the matter further. The caressing of the ants is to persuade the larvæ to emit a drop of fluid from the transversal opening spoken of. The fluid is clear and green, and flows in tiny drops, which the ants drink greedily. They lick up the last trace, and stroke the back of the segment, waiting to see if their coaxing avails anything. If not, they run about, but presently return, and the manipulations go on as before. The tubes, when fully evaginated, emit a crown of fleshy tubercles, which move freely at the will of the larvæ, and are withdrawn separately or altogether, as are the tubes. My observations led me to think that the tubes served as signals for the ants to come to segment 11. Now what was the object of this complicated apparatus? Dr. Weismann wrote me: "You should try and observe what enemies these larvæ have. It is conceivable that there are enemies that are afraid of ants." I set myself to find any such enemies. On June 20 when in the woods I saw a mature larva on rattleweed, and on its back, facing to the tail, stood a large ant. At less than two inches behind the larva on the stem was an ichneumon fly, watching its chance to thrust its ovipositor into the larva. The fly crept a little nearer, and again nearer, the ant standing motionless but plainly alert and knowing of the danger. After several advances the fly turned its abdomen under and forward, thrust out its long ovipositor, and strained to the utmost to reach the prey. Just as it seemed about to succeed the ant made a dash at the fly, which flew away, and so long as I stayed did not return. The larva, which all the time had been quiet, its head completely buried in a flower bud, suddenly seemed to have become aware of the peril and thrashed the end of its body about in alarm, as all lepidopterous larvæ will do when one of these flies comes near. The ant saved the larva (for the sting of an ichneumon fly means sure death). These larvæ attract and reward the ants, and the ants protect the larvæ from enemies whose sole business in life is to deposit their eggs in the bodies of any species of caterpillars. The larvæ of the fly hatch within the caterpillar, and avoiding vital parts feed till maturity on the substance of the caterpillar, then eat their way out; meanwhile the caterpillar has been reduced to a mere shell. All this and my further observations on *Lycæna pseudargiolus* are told in volume two. Similar organs are found in many other species of *Lycæna* [LYCÆNIDÆ], but in *L.* [*Everes*] *amyntula,* a Californian species whose larvæ live wholly within closed pods of *Astrágalus,* and therefore are not exposed to the ichneumons, there are no such organs as I have described. Mr. Scudder wrote me on June 27, 1884: "Thanks for what you have done for *pseudargiolus.* It is noble, superb."

In July, 1877 my family were for some weeks at Oak Bluffs, Martha's Vineyard, Massachusetts. I joined them on the twentieth for a few days. There I found several butterflies not seen in West Virginia, especially *Argynnis* [*Speyeria* (*Speyeria*)] *idalia,* and *Satyrus* [*Minois*] *nephele* [*pegala*] var. *maritima,* both of which were plentiful in the open fields.

In the summer of 1878 Mr. Mead went west, and collected in Nevada and in the Yosemite region. He sent me many eggs and butterflies. One of the latter was *Chionobas* [*Oeneis*] *ivallda,* a species discovered by him. He also found the hitherto rare *Argynnis* [*Speyeria* (*Semnopsyche*) *cybele*] *leto,* which was just emerging from chrysalid, in a locality in Nevada.

In 1880 I began a correspondence with Dr. William Wittfeld[51] of Georgiana, Florida, on the Indian River, and for several years he sent me butterflies of that region, and often eggs. In this way I was able to rear at Coalburg the tropical species *Heliconius charitonius* [*tuckeri*], which is figured with all its preparatory stages in volume two. The curious life history of this species is given in full. The Doctor also sent eggs of the new species *Limenitis* [*archippus*] *eros* Edwards [= *floridensis*], and the Apaturas [*Asterocampa celtis*] *alicia* and [*A. clyton*] *flora,* all of which I figured with all their stages. On May 25 I received from Arizona, by mail, a single egg of *Lemonias* [*Apodemia*] *nais,* laid on the leaves of mesquite, and four caterpillars which had but just hatched. I tried the caterpillars with leaves of various plants, but they refused them and two died from starvation. At last I tried the wild plum, the tender terminal leaves, and it was accepted. I was able to rear two of these larvæ to pupation, and to get the several stages drawn by Mrs. Peart. The species is figured in volume two. Mr. Scudder wrote me: "You have filled one of the greatest voids in our knowledge of the biology of butterflies by your studies of *Lemonias.*" This genus contains a vast number of species, but hitherto absolutely nothing had been known concerning the preparatory stages of any one of them.

On June 1, 1882 Theodore L. Mead married my eldest daughter, Edith Antill,[52] at Coalburg, West Virginia, and thenceforth they lived in Orange County, Florida, first at Eustis, then at Oviedo.

[51] William Wittfeld (–).

[52] Edith Edwards Mead (1852–1927).

In 1883 I began a correspondence with Mr. W. G. Wright[53] of San Bernardino, California, which has continued to this day. From him I received in 1883 eggs of *Papilio zelicaon,* and in 1884 eggs of *P.* [*rutulus*] *rutulus,* both of which species I was able to rear to the butterfly. They are given in all their stages in volume two. I sent Mr. Wright a copy of my Voyage up the Amazon, and he replied as follows: ''Your book has arrived, and I find at the first glance that it is one of two books which excited my boyish fancies, years ago. Every line is familiar, and when I begin to read a sentence, I can cover the page and finish the sentence, often verbatim. Yet it is so many years since I last saw the book. I would rather have it today than any newer one. To discover, after our rather extended correspondence, that you are really my favorite author of younger days, is a most delightful experience.'' Mr. Wright's letter was written nearly forty years after the book was published. In another letter Mr. Wright said that he was sixteen years old when he read the book, and he burned to go to Pará. He went to Salem, and tried to get passage to Pará, but the rate was more than he was able to pay, and he never saw the Amazon.

Among other eggs and larvæ sent me by Mr. Wright were those of the beautiful *Colias* [*Zerene*] *eurydice,* and with them came the plant of *Amórpha californica,* on which the larvæ feed. I succeeded in acclimatizing this plant, and for several years it stood in my garden. The butterfly in all its stages is figured in volume three.

In succeeding years Mr. Wright made many long and expensive journeys after butterflies, and always bore in mind my wants. He went a long way into the Mohave Desert, and as far east as Tucson, [Arizona]. He worked over the Yosemite region, and on Mt. Shasta in the north. Also, through Oregon and Washington, and Vancouver Island. He went along the Northern Pacific Railroad as far as Duluth, [Minnesota], stopping off at any point where he thought he could use the net to advantage. Of recent years I have been more beholden to Mr. Wright than

53 William Greenwood Wright (?1830–1912). Enthusiastic collector, author of ''The Butterflies of the West Coast of the United States'' (1905), and other articles.

to any other person, except Mr. David Bruce,[54] of whom I shall speak presently.

In May, 1885 I received thirteen eggs of *Cœnonympha* [*california* form] *gallactina* from Professor J. J. Rivers[55] of Berkeley, California. From these I raised larvæ to pupation and butterfly, and a fully illustrated plate was given in volume three. In June of the same year came twenty-five eggs of *Cœnonympha ampelos* [*insulana*], from Mr. James Fletcher[56] of Ottawa, but then at Victoria, British America. In this case also I was enabled to get the whole life history of the species, though I gave no plate of *ampelos*. The same year I received from Mr. McGlashan[57] of Truckee, California, fourteen eggs of *Satyrus* [*Minois œtus*] *œtus*, and thirty-one of *Argynnis* [*Speyeria* (*Speyeria*) *egleis*] *egleis*.

Volume two, which was begun in 1874, was completed in 1884. Science for October 9, 1885 said of this volume: ". . . As to the execution of the plates, no iconography of the present time excels them; in faithfulness and sobriety of color, in gracefulness of disposition upon the plates, in artistic execution and in faithful representation of the minutest details, they surpass anything that has been given to the world from the most famed *ateliers* of Europe. There is little inequality about them. They are uniformly exquisite, and lepidopterists the world over are indebted to Mr. Edwards for the faithfulness and luxury of his illustrations. . . ."

[54] David T[—] Bruce (1832–1903). Taxidermist and naturalist of Brockport, Munroe County, New York. A fresco painter and decorator by trade, who because of ill health spent many summers in Colorado. His locality labels were printed in bright red ink between two heavy horizontal lines and read merely "Colo/Bruce." For a time he dealt in new and second-hand natural history books. Probably one of the founders of the Brockport Natural History Club. Bruce was married twice and had several children.

[55] James John Rivers (1824–1913). Lepidopterist, coleopterist, and author of several papers. For some time Curator of Organic History at the University of California, and took an active interest in the California Academy of Sciences.

[56] James Fletcher (1852–1908). Economic entomologist and botanist, and author of many articles.

[57] Charles Fayette McGlashan (1847–1931). Well-known breeder and collector of Lepidoptera who settled in California in 1854.

In 1886 I began getting ready for part one, volume three. I wrote in my diary, April 8: "Today I have received the first proofs of two plates, *Argynnis* [*Speyeria* (*Speyeria*) *nokomis*] *nitocris* and *Argynnis* [*Speyeria* (*Speyeria*) *atlantis*] *lais*." These and the rest of that volume were drawn on the stone by Edward A. Ketterer of Philadelphia, excepting the plate of *Parnassius* which was drawn by Mrs. Peart. The lithographing printing was begun by E. Sinclair and Son of Philadelphia. Mrs. Peart undertook to make the drawings of the preparatory stages of the species as of old and to superintend the lithograph work. To publish volume three I sold my collection of butterflies to Dr. W. J. Holland[58] for the sum of Twenty-Five Hundred Dollars, to be applied to bills of the volume as called for. Part of the butterflies were delivered at once, namely; all the LYCÆNIDÆ and HESPERIIDÆ, the rest as I could spare them.

Part one was issued in January, 1887. Mr. Fletcher said of this part in The Canadian Entomologist for April, 1887: ". . . they [the plates] are exquisite, and are all equal to the very best in Vols. I and II. . . ." Mr. Scudder, in Science for February 4, 1887: ". . . Nothing has ever surpassed them; they are a perfect model for such work. . . ."

In August, 1886 I received by mail from Mr. P. Chrétien[59] of Paris, France, thirty eggs of the European butterfly, *Arge* [*Melanargia*] *galathea*, and was able to rear some of the larvæ to chrysalids and butterflies by June, 1887.

About this time I began to receive eggs and butterflies from Thomas E. Bean,[60] formerly of Galena, Illinois, but then at Laggan, Alberta, on the Canadian Pacific Railway. This was a new field, and many rare or new species of butterfly were found there.

[58] William Jacob Holland (1848–1932). Famous entomologist, author of "The Butterfly Book" (1898), and the revised edition of "The Butterfly Book" (1931), and many papers on Lepidoptera.

[59] Pierre Chrétien (?1846–1934). Microlepidopterist.

[60] Thomas Ebenezer Bean (1844–1931). Collector and author of several papers on the Lepidoptera of the Laggan, Alberta region. He was employed by the telegraph department of the Canadian Pacific Railway. His collecting in the Laggan region resulted in the discovery of several new species of Lepidoptera, and was of inestimable value to Edwards in the preparation of the third volume of the "Butterflies of North America."

Eggs of the boreal *Argynnis* [*Boloria*[61] *freija*] *freija* came from Mr. Bean on June 12, 1886. Ten eggs of *Chionobas* [*Oeneis*] *jutta* [*ridingiana*] came on July 7.

On April 26 of that year I received thirty-four eggs of *Lemonias* [*Apodemia mormo*] *virgulti* from Mr. Wright at San Bernardino. David Bruce of Brockport, New York began in 1886 to collect butterflies in Colorado, and thereafter spent several summers in that state. He sent eggs of the very rare species, *Neominois* [*Eumenis ridingsii*] *ridingsii* on June 16, obtained near Denver. From Denver he went to Hall Valley, near Mounts Hayden and Bullion, elevation 11,500 feet. From that place, July 18, came thirty-one eggs of *Chionobas* [*Oeneis uhleri*] *uhleri,* and on July 25 eggs of *Colias meadii.* On July 28 [came] eggs of *Erebia epipsodea;* on August 7 twenty-five eggs of *Satyrus meadii;* on August 12 eggs of *Argynnis* [*Speyeria* (*Speyeria*)] *edwardsii.*

Feniseca tarquinius is a small butterfly which is found in many of the eastern parts of the United States and Canada, always near the water, and where alder grows. Nothing had so far been known of its preparatory stages or of the plant the larvæ fed on. On August 15 I received from Miss Emily Morton[62] of Newburgh, New York, several eggs of this species which had been laid on stems of alder, directly among a lot of woolly aphides. She saw an egg laid as she was watching the butterfly. Miss Morton continued to send eggs and larvæ, and I reared some of them to chrysalids. I published our joint observations in The Canadian Entomologist for August, 1886. No other carnivorous butterfly larva is known to exist in the United States. The larvæ of *tarquinius* seem to eat nothing but aphides. The ants also are present with the aphides and show great excitement at the interference with their cows by the larvæ. They do their best to rout the enemy, but until nearly grown the larvæ lie concealed among the aphides covered by a web of their own

[61] *Argynnis,* as used in Edwards' day, comprised Nearctic species that were subsequently divided between *Argynnis* and *Brenthis.* In that fauna the former has now given way to *Speyeria,* and the latter to *Boloria,* which has been even further subdivided.

[62] Emily L[–] Morton (1841–1920).

spinning, so that the ants cannot well get at them. It is a very odd history altogether.

On August 18 I received from Mr. Bean twenty eggs of *Parnassius smintheus* [*sayii*], and the same day half a dozen young larvæ of *Colias* [*alexandra*] *alexandra* from Professor G. H. French[63] of Carbondale, Illinois, then at Central City, Colorado.

On April 18 Alfred Russel Wallace visited me, staying two days. I have before spoken of my first acquaintance with Mr. Wallace.

On May 18 I received several eggs of *Paphia* [*Anœa*] [?] *troglodyta* [*andria*] from Professor R. R. Rowley[64] of Curryville, Missouri. He sent with these a number of the food plant, *Cròton capitàtus.* The plants grew well in my garden, and I was so able to rear the larvæ. On July 2 came eggs of *Chionobas* [*Oeneis jutta*] *jutta* from the Reverend Thomas W. Fyles[65] of South Quebec. On the nineteenth of July eggs of *Erebia epipsodea* from Mr. Bruce at Hall Valley. Also eggs of that exceedingly rare species, *E. magdalena,* from high up on Bullion Mountain. On August 7 a cluster of eggs of *Phyciodes picta* from Mr. H. W. Nash[66] of Pueblo, Colorado. Also, on August 7 many eggs of *Argynnis* [*Speyeria* (*Speyeria*) *coronis*] *semiramis* from Mr. Wright at San Bernardino.

On April 10, 1888 Miss Annie Wittfeld[67] of Georgiana,

63 George Hazen French (1841–1935). Author of "The Butterflies of the Eastern United States" (1886), and numerous papers.

64 Robert Rossell Rowley (1854–1935). Teacher, High School Principal and later Superintendent of Schools and Science Teacher, Louisiana, Missouri. Member of the American Society for the Advancement of Science, American Paleontological Society, edited eight volumes of the Missouri State Geological Survey, and author of several articles on Lepidoptera. His two large collections of lepidopterous insects were sold to the University of Missouri, the last consisting of fifteen thousand butterflies and moths. His collection of fossils was sold to the University of Illinois.

65 Thomas W[–] Fyles (1832–1921). Author of many entomological papers, a number of which were published in the Annual Reports of the Entomological Society of Ontario, and in other journals.

66 Herman W[–] Nash (–). A reporter in the District Court at Pueblo, Colorado, and the first man to make a verbatim report in shorthand in the State of Colorado in 1881.

67 Annie M[–] Wittfeld (1865–1888). Daughter of Dr. William Wittfeld.

Florida, died, a great loss to lepidopterology, and particularly a loss to me. For several years she had been a correspondent of mine, and gave me intelligent aid in obtaining eggs and in making observations on the habits of butterflies. About the middle of the previous November Miss Wittfeld wrote me that she had seen a butterfly of a species she had not before known, while it was laying eggs on purslane. She caught the butterfly and confined it over this plant, and it laid seventy-four eggs. I wrote her that the species was possibly *Deidamia* [*Hypolimnas*] *misippus* of Linnæus, which I had read fed on purslane. Dr. Wittfeld had sent me formerly a single example of the butterfly. It turned out to be that species, and Mrs. Peart was able to make a set of portraits of all the preparatory stages. This butterfly is a cosmopolitan, being common in southeastern Asia and the West Indies, but had not been observed in the United States before Dr. Wittfeld took it.

On April 8, 1888 I received eggs of *Anthocaris* [(*Falcapica*)] *genutia* [= *midea*], the pretty little white, orange-tipped butterfly, which is seen in the middle and southern states in early spring. They were sent by Henry F. Schoenborn[68] of Washington, D. C., and with them came the plant on which he had found them, *Sisýmbrium thaliànum.* I recognized the plant as one growing on my lawn. It was therefore easy to raise the larvæ, and the result is to be seen on the beautiful plate given in volume three. Although there are several species of *Anthocaris* in Europe, no one seemed hitherto to have known the preparatory stages of any one of them. On May 2 one of the larvæ of *Erebia epipsodea* pupated, and thus we were enabled to complete the series of drawings of that species, and put them on a plate. Mr. Scudder said of that plate, in Science, February 21, 1890: "The third plate illustrates *Erebia epipsodea,* of the Rocky Mountains. Heretofore, our knowledge of the transformation of any species of this genus has been most meager, but here we are treated to a plate full of exquisite details, leaving nothing to be desired; and this when the insect had to be obtained from

68 Henry F[–] Schoenborn (1833–1896). Well-known collector and at the time of his death the possessor of the largest collection of Lepidoptera in that city.

points thousands of miles away, and sent five hundred miles again to the artist.''

On May 14 I received from C. F. McGlashan at Truckee, [California], eggs of the new species *Melitæa* [*Euphydryas chalcedona*] *mcglashanii;* June 8 young larvæ of *Pieris protodice* from Mr. T. D. Cockerell[69] at West Cliff, Colorado; June 10 eggs of *Chionobas* [*Oeneis chryxus*] *chryxus* from W. S. Foster[70] at Salida, Colorado; on June 19 eggs of *Neonympha* [*Megisto*] *rubricata* from Oscar T. Baron[71] at Pontano, Arizona; on June 23 eggs of *Cœnonympha* [*ochracea*] *ochracea* from Foster, and also of *Neominois ridingsii.*

On July 12 Mr. Scudder wrote from Nepigon, on the north side of Lake Superior, a station on the Canadian Pacific Railway, whither he had gone with Mr. Fletcher solely to get eggs of the recently described species, *Chionobas* [*Oeneis*] *macounii* Edwards, that they had obtained about one hundred eggs by bagging the females over grass. On the twenty-fifth there came a large lot of these eggs. In subsequent years Mr. Fletcher more than once got more of the same eggs, but none of us was ever able to carry one of the larvæ to a chrysalid. We got one or two to the last larval stage, but just then they died. I figured this species, excepting the chrysalid. With the eggs, spoken of from Nepigon, came also eggs of *Colias meadii* and *Argynnis* [*Speyeria* (*Speyeria*) *mormonia*] *eurynome.*[72]

On July 30 there came from Mr. Mead at Oviedo, Florida, two of the singular larvæ of *Pamphila* [*Calpodes*] *ethlius* which feed on species of *Canna.* On the same day eggs of *Colias* [*interior*] *interior* came from Mr. Fletcher. On August 8 from Foster at Salida came eggs of *Parnassius smintheus,* and young larvæ of *Colias* [*scudderii*] *scudderii.* On August 18 eggs of *Argynnis leto* came from Mr. Baron in California.

Mrs. Lydia Bowen died on August 8, 1888 in Philadelphia.

69 Theodore Dru Alison Cockerell (1866–1948). Naturalist and author of well-known text books and numerous entomological articles, also, ''Recollections of a Naturalist'' (1935–1939).

70 William S[–] Foster (1868–1889).

71 Oscar Theodor Baron (1847–1926).

72 Eggs of *C. meadii* and *S.* (*S.*) *m. eurynome* could hardly have come from Nepigon. They must have been received from some other source.

She had worked on my plates from the beginning in 1868 till quite recently, and I thenceforth missed her help greatly.

On April 24, 1889 there came from Mr. Wright at San Bernardino eggs of *Anthocaris* [*sara gen. vern.*] *reakirtii*. On June 1 eggs of *Chionobas uhleri* from Bruce, again at Hall Valley.

On June 10 eggs and young larvæ of *Argynnis freija* came from Mr. Bean; on June 14 eighteen eggs of *Cœnonympha* [*ampelos*] *elko* from Foster at Weber River, Colorado; on June 22 twenty-five eggs of *Chionobas uhleri* from Bruce; on June 27 from Bean eggs of *Erebia disa mancinus* and of *Chionobas jutta*. On June 28 from Foster at Salida came eggs of *Cœnonympha* [?] *pamphiloides;* on July 5 eggs of *Melitæa* [*Euphydryas anicia*] *anicia* from Bean; on July 12 from Professor I. N. Mitchell[73] of Vandalia, Michigan, sixteen eggs of the new species, *Neonympha* [*Megisto*] *mitchellii;* on July 18 from Mr. Mead at Oviedo, Florida, eggs of *Satyrus* [*Minois pegala*] *pegala;* on July 23 eggs of *Colias* [*meadii*] *elis* from Bean.

On July 25, 1889 I received from Bruce at Hall Valley three chrysalids of *Parnassius smintheus,* something never before seen. They were found in friable earth where *Sedum* grew on the summit of Mount Bullion, elevation 14,000 feet. On July 28 I received from Bruce eggs of *Erebia magdalena;* on July 26 thirty eggs of *Colias christina* from Bean; on August 8 eggs of *Argynnis* [*Boloria eunomia*] *triclaris* from Bean, and on August 3 eggs of *Colias nastes* [*streckeri*] and twelve eggs of *Erebia callias* from Bruce.

On August 13 came eggs of *Satyrus* [*Minois*] *charon* [= *œtus*] from Mr. Nash at Pueblo; on August 14 eggs of *Chionobas* [*Oeneis*] *œno*[74] from Bruce. The female that laid these was

[73] I[–] N[–] Mitchell (–). Superintendent of schools at Fond du Lac, Wisconsin from 1886 until 1892.

[74] In referring to species of *Oeneis* (*Chionobas*), Edwards employs the names *crambis* Freyer, *œno* Boisduval, and *bore* Schneider for, at that time, partly unnamed Coloradan species or subspecies. Some of these species were subsequently named *brucei* Edwards, *lucilla* Barnes and McDunnough, and *edwardsii* dos Passos. It is often impossible to tell with certainty to which species Edwards and his correspondents actually referred, but most likely they were one or the other of the species just named. We do know that *crambis* of the "Butterflies of North America" (vol. 3, pl. *Chionobas* 6, figs. 1–4) equals *brucei,* and that it does occur in Colorado (dos Passos,

taken on the top of Mount Hayden and was confined over grass at Hall Valley, 3000 feet lower. On August 14 also came eggs of *Satyrus* [*Minois*] *ariane* from Mr. Koebele[75] at Shasta, California; on August 16 from Salida eggs of *Colias scudderii;* on August 26 larvæ of *Heliconius charitonius* from Dr. Wittfeld, Florida; on August 30 eggs of *Argynnis* [*Speyeria* (*Speyeria*) *aphrodite*] *cypris* [= *ethne*] from Nash at Beulah, Colorado; on September 6 from Bruce eggs of *Parnassius smintheus* laid by a female confined on *Sedum,* and eggs of *Colias meadii;* on September 16 eggs of *Agraulis vanillæ* [*nigrior*] from Professor Joseph E. Willet[76] of Macon, Georgia.

William S. Foster died of typhoid fever at his home in Batavia, New York, on October 9, 1889. He had come from Colorado for a short visit, and was taken with the fever almost at once. He was a telegraph operator stationed at Salida. There he had met Mr. Bruce, who taught him how to take and care for butterflies, and to get eggs. He was an apt pupil. His death was a loss to me.

On April 5, 1890 I received from Mr. Wright, at San Bernardino, eggs of *Papilio zelicaon.* He soon after took a trip to the north, and on May 10 I received from him, in Oregon, eggs of *Pieris* [*napi gen. vern.*] *venosa.* On June 11 forty eggs of *Argynnis freija* came from Bean.

On July 6 I received from Bruce, at Hall Valley, three mature larvæ of *Parnassius smintheus,* and a chrysalid made on the way.

[75] Albert Koebele (1852–1924). One of the organizers of the New York Entomological Club, and a pioneer in the field of biological control. He collected specimens for the Department of Agriculture at Washington in various parts of the world.

[76] Joseph Edgerton Willet (1826–1897). Eminent scientist, retired in 1897 as Professor Emeritus of Mercer University, Macon, Georgia, and served as a specialist in Science at the University of Georgia Medical College, Augusta, Georgia, up to the time of his death. Willet Science Hall, Mercer University, named in his honor.

1949, Amer. Mus. Novitates, no. 1399, p. 19). Also, *œno* of the same volume (pl. *Chionobas* 7, figs. 1–6) equals *lucilla.* On the other hand, *bore* is not a Nearctic species. Its nearest relative on this continent is *taygete* Geyer, of which a subspecies occurs in Colorado, and has been named *edwardsii.*

On the same day from Mr. Wright, then at Maiden, Montana, came a mature larva of *Parnassius smintheus* var. *hermodur,* and at Spokane, Washington, he sent me a single egg of *Chionobas* [*Oeneis*] *californica* [=*nevadensis*], and several eggs of *Argynnis* [*Boloria*] *epithore.* Next day from Bean came eggs of *Argynnis* [*Boloria*] *frigga* [*saga*], and on July 13 eggs of *Cœnonympha* [?]*inornata* from Wright.

On July 14 I received from Bruce, at Hall Valley, eggs of the new species, *Chionobas* [*Oeneis brucei*] *brucei,* laid by females taken on the summit of Mount Bullion, and confined on grass at his stopping place; on July 18 from the same, eggs of *Erebia magdalena, Chionobas uhleri,* and *Cœnonympha ochracea;* on July 19 a single egg of *Colias* [*occidentalis*] *chrysomelas* from Koebele, at Spokane. He also sent a larva of *Papilio* [*bairdii*] *oregonia,* half grown. On July 21 came eggs of *Chionobas* [*Oeneis*] *bore*[74] from Bruce, and a good chrysalid of *Parnassius smintheus;* on July 24, from same, eggs of *Colias scudderii,* and twenty-nine eggs of *Erebia magdalena.*

On July 22 from Bean came eggs of *Colias elis,* and also eggs of *Colias christina;* on July 27 two eggs of the new species, *Chionobas* [*Oeneis alberta*] *alberta* from Bean. He had taken the female that laid these on the summit of one of the peaks near Laggan, elevation of about 9000 feet. He was the discoverer of this species. On August 9 I received from him fourteen eggs of *Argynnis* [*Boloria*] [?]*chariclea* [*titania ingens*].

On July 28 from Mr. Fletcher, again at Nepigon, came six eggs of *Chionobas macounii;* on August 8 eggs of *Colias meadii, C. alexandra, Argynnis* [*Speyeria* (*Speyeria*) *atlantis*] *electa* and of *A. leto* from Mr. Wright, at home. The butterfly, *leto,* was taken at Shasta and carried over eight hundred miles, being on the way five and a half days, and laid the eggs at San Bernardino. On August 17 I received from Mr. W. H. Danby[77] of Victoria, British Columbia, thirty young larvæ (hatched en route) of *Melitœa* [*Euphydryas editha*] *taylori.*

[77] William Hartley Danby (?1850–1920). Entomologist connected with the Provincial Museum, Victoria, British Columbia, and co-author with Charles de Blois Green of "Report on the Entomology of British Columbia" (1893).

I give an extract from one of Mr. Bruce's letters from Hall Valley, elevation 11,000 feet; the timber line is at 10,500 feet. His letter was written late in July, 1890. "Weather warm and pleasant every day now; but everything is frozen solid at night. Ice half inch thick at timber line, one quarter inch here; yet butterflies are abundant after nine or ten A.M. Several species have occurred to me that I have not seen in Colorado before; as *Colias* [*Zerene*] *cæsonia,* above timber line; *Terias* [*Eurema*] *nicippe* and *T.* [*E.*] *mexicana* not uncommon in Gibson Gulch. It is astonishing to see *Chrysophanus* [*Lycæna*] *helloides* and *C.* [*L.*] *sirius* on the flowers before the frost is off them in the morning. I see *Colias scudderii, C. alexandra, Parnassius smintheus, Argynnis cypris, A. electa, A. eurynome, A.* [*Boloria helena*] *helena, Grapta* [*Polygonia satyrus*] *satyrus, G.* [*P.*] *zephyrus, Limenitis* [*weidemeyerii*] *weidemeyerii, Vanessa* [*Nymphalis californica*] *californica, V.* [*antiopa*] *antiopa,* and several species of *Chrysophanus* and *Lycæna,* every day at the back of this house."

Mr. Bruce wrote again on September 7: "In August, as I went through the belt of timber, I saw a dark butterfly flying around, and alighting on the bark of a very large pine, six feet from the ground. As this was something new to me, I went cautiously to it and captured it. It was a very large *Erebia magdalena.* It was by the side of a very extensive rock slide, where detached and broken rocks had slid down into the dense timber for a quarter of a mile; and the insect had doubtless followed the rock into the timber, and had not found its way back."

On September 13 I received from Mr. Danby at Victoria twenty-five eggs of *Cænonympha ampelos.* On September 2 I received from Bruce several eggs of *Colias meadii,* "the last of the season." He wrote that it was bitter cold and the ground was covered with snow, yet noctuids and other moths came to the lamp as he was writing, in abundance.

Mrs. Peart had in charge an adult [*Erebia*] *magdalena* larva that we thought would go to chrysalid. She wrote me on September 29: "I could not find it for a time. When I did, its head and two or three segments were just visible above the earth. I could not think it had worked its way so far, and backward. I removed the earth carefully from each side, and laid the larva on a sheet of paper. The hindmost segments were covered with earth and slime. On tearing in bits the little sod, I found another sort of larva, about an inch long, smooth and yellow. This creature had been eating the *magdalena* alive.'' That was the end of several months' labor, and, moreover we never were able to get a chrysalid of this species.

On October 1, 1890 I received eggs of *Satyrus* [*Minois pegala*] *boopis* from Wright, at San Bernardino, and eggs of the new species, *Melitæa* [*Euphydryas editha*] *augusta;* on May 26 from Professor A. D. Hopkins[78] of West Virginia Agricultural Experiment Station four larvæ of *Lycæna* [*Glaucopsyche*] *lygdamus* [*nittanyensis*] (figured in volume one, Butterflies of North America) from eggs laid on *Vícia caroliniàna.* Before this nothing had been known of the life history of this species. On June 6 came eggs of *Anthocaris* [*Euchloe olympia*] *rosa,* and *Apatura* [*Asterocampa celtis*] *montis* from Bruce at Denver.

On June 9, 1891 Henry Edwards, the veteran actor and experienced entomologist, died in New York City, aged sixty-seven[79] years. He was a native of Wales. In 1867 he came from Australia to San Francisco, and in 1878 he came to Boston, and the next year to New York. He was connected with Wallack's stock company until its disruption in 1888. After this he acted with Mrs. Potter, and in the season of 1889 went to Australia where he presented the Earl Dorincourt in Little Lord Fauntleroy. I became a correspondent with him about 1872 and from that time till his death we frequently exchanged letters and butterflies. I first saw him in December, 1887 at his house in New York, when I spent the morning with him in his study. His death was a great loss to our science. His collection of insects (embracing many orders) was sold by Mrs. Edwards to the American Museum of Natural History. Mr. Edwards' last note to me was dated New York, May 15, 1891: ''I grieve to tell you I have been terribly ill. In fact, I am almost a broken down man.

78 Andrew Delmar Hopkins (1857–1948). Afterwards in charge of forest insect investigation, Bureau of Entomology, United States Department of Agriculture.

79 This seems to be an error for sixty-one, but since it persists through three copies of the manuscript I was loathe to change it. See footnote 22.

It will be many weeks before I am anything like myself again. I am going, as soon as the weather is a trifle warmer, I hope by the end of this week, up to Catskill for a change of air, and hope to be able to write to you from there, and to give you better news of myself. Ever yours, H. Edwards.''

On June 12, 1891 I received from Professor Carl Braun[80] of Bangor, Maine, twenty-four eggs of *Chionobas jutta.* On June 18 came forty-three eggs of the same species from the Reverend Thomas W. Fyles, South Quebec. This fine species in all its stages is figured in volume three. On July 3 came thirty-two eggs of *Neonympha mitchellii,* and on July 5 fifteen more of the same from Professor Mitchell at Vandalia, Michigan. Nevertheless, I was not able to rear this species, because the young larvæ died off at the moults. They were unable to cast off the shells from their faces and so were smothered[!].

On July 8 nineteen eggs of *Erebia disa* [*mancinus*] came from Mr. Bean at Laggan, and the next day thirty-six eggs of *Chionobas* [*Oeneis nevadensis*] *gigas* from Mr. Wright at Victoria, Vancouver Island. He had made this trip from San Bernardino for the sake of this grand butterfly, and I cannot do better than to give his own words as to his success: ''So far as is yet known, *gigas* is confined to this island.'' Mr. Wright wrote from Victoria on June 30, 1891: ''I have just come from Mount Finlayson, and mail you today about two dozen eggs of *gigas.* I got fifty-one of the butterflies, of which only two were females. [*Oeneis*] *gigas* flies at the very top of a bald, rocky knob, Mount Finlayson, the highest peak in this part of the island, elevation, I understand, about 4000 feet. The knob is almost solid rock, and is covered in part with lichens and mosses, brown and black with age and exposure. But large areas are of clean rock, wind-swept, and similar in color to the mosses. Upon the rock this butterfly rests, with closed wings, and it is wholly invisible when quiet.'' (The under side of the wings is brown and gray, and resembles both lichens and mosses.) ''So far as I saw, the males spend nearly all their time on the rocks. I never saw one on a

[80] Carl Braun (–). Teacher of modern languages in the Bangor public schools; naturalist and florist. Moved to New York around 1911.

flower, or alighted on anything but rock. Other butterflies also fly about and over the peaks,—*Papilio zelicaon, P. eurymedon, Argynnis* [*Speyeria* (*Speyeria*) *zerene*] *bremnerii,* etc. The [*Oeneis*] *gigas* take delight in rising up to chase any passing butterfly, follow it a little way, and then return to their own spots. If started up by myself, and not alarmed, they flew circling about for a few minutes, and then alighted, frequently at my feet. I found them therefore easy to take on the wing, and when alighting. By one or two o'clock the chill sea air begins to be felt, as it comes in from the Strait de Fuca, and at once not a *gigas* is to be seen. In the two days I spent on the mountain none were taken after 1:30 P.M. The female that laid the eggs I found upon the highest peak, fluttering gently along the base of a big rock, and ovipositing, either as she flew or alighting a moment for the purpose. After capturing her I sought a suitable place, sheltered and bagged her over or in a little clump of bunch grass, parting the grass and putting the bag in the opening, so I left her over the night. The knob is so small that it is incapable of accommodating any large number of these butterflies, and on the second day but one was taken after 11:30 A.M. I had gotten them all. The approach to Mount Finlayson from the railway station is through a dense forest, and over rough mountainside, say for three miles, one of which is along the cattle path, if you can find it, and the rest through thicket. Arriving at the base of the knob, one wonders how he can ascend it. But there are little shelves that zigzag this way and that, and the task is made possible.'' Nevertheless, with all this wealth of eggs of *gigas* I was unable to get the larvæ beyond their second moults. Naturally, larvæ of *Chionobas gigas* hatch from the eggs in about twenty days, and the young larvæ go into hibernation at once, or they pass the first or even the second moult and then hibernate. It depends upon the weather principally. When I had these eggs at Coalburg the larvæ went into hibernation after the second moult, and I could not get them alive through the winter, whether they were kept in a refrigerator or a snowbank. Therefore, my plate of *gigas* shows only the egg and young larva, and the first and second moults.

On July 14, 1891 I received from Professor A. P. Morse[81] a dozen *Chionobas* [*Oeneis melissa*] *semidea* taken on the summit of Mount Washington, New Hampshire, and sent through the mail in a pasteboard box. They had been sent alive, but half were dead, some of the rest nearly, while two were active and flew out as I opened the box. I bagged these over a tuft of blue-grass set in a flowerpot, and the next day found that seven eggs had been laid.

On July 22 there came from Bruce at Hall Valley, eggs of *Erebia magdalena*, also of *Chionobas brucei*, and *Chrysophanus* [*Lycæna*] *snowi*, the last a beautiful, small, copper colored butterfly; on July 29 from Bruce at Glenwood Springs, southwestern Colorado, seven eggs of *Neominois* [*Eumenis ridingsii*] *dionysus*, a species allied to *Chionobas*, and up to that time exceedingly rare in collections. Mr. Bruce found plenty at the Springs. On July 24 came twelve eggs of *Chionobas semidea* from Mr. Scudder at Mount Washington, and on August 3 fifty more eggs of the same species from Mr. H. H. Lyman[82] of Montreal, then at Mount Washington. On July 30 thirty-five eggs of *Argynnis chariclea* came from Bean at Laggan, and several young larvæ of *Colias christina* hatched in the mail. Also, I received from Mr. F. Merrifield[83] at Brighton, England, by mail, sixty eggs of the European species, *Hipparchia semele*, another ally of the *Chionobas*. On August 11 there came a score of young larvæ of *Papilio* [*bairdii*] *bairdii*, hatched en route, from Bruce at Glenwood Springs; on August 18 seven eggs of *Chionobas brucei* from Bruce at Hall Valley; on August 24 fifteen eggs of *Limenitis weidemeyerii* from the same.

On August 24, 1891 Mr. James Fletcher of Ottawa visited me,

81 Albert Pitts Morse (1863–1936). Student of Orthoptera and Odonata, member of the faculty of Wellesley College, later Curator of Natural History at the Peabody Museum, Salem, Massachusetts, contributed to "Biologia Centrali-Americana. Zoology-Orthoptera" (1893–1909), and author of "Manual of the Orthoptera of New England" (1920).

82 Henry Herbert Lyman (1854–1914). Lepidopterist and author of many papers, especially on the rearing of butterflies and moths.

83 Frederick Merrifield (1831–1924). Investigated the effect of temperature upon variation and the production of seasonal forms, also the action of their surroundings in determining the color of exposed pupæ.

and remained two days. He was desirous of seeing a living *Argynnis diana,* and I drove with him several miles to a locality where I used to find them. We passed a hospital, and Mr. Fletcher made a vow to give Five Dollars to the same provided he took a *diana.* Not one did we see, but on returning my friend took a female *diana* in my flower garden, and the hospital was richer by the contribution.

On September 24 Mr. Wright at Sisson, California sent eggs of *Neophasia* [*menapia*] *menapia.*

Mr. Bruce wrote of the eggs of *Limenitis weidemeyerii,* which he sent me: "I saw the female evidently trying to oviposit, and caught her and put her under a net tied to a small cottonwood close to my window (at Hall Valley). It remained so for three days. During this time she rested motionless on the under side of a leaf. By noon of the fourth day the weather turned fair and warm. On the fifth day she laid the eggs. I have confined females of this species several times before without effect, and now am not a little pleased at seeing these beautiful eggs."

On April 25, 1892 I received from Mr. Wright at San Bernardino eggs of *Limenitis* [*lorquini*] *lorquini,* which were laid on the tips of willow leaves. On June 28 from Mr. Wright at Mendocino, California came thirty-three eggs of *Chionobas* [*Oeneis nevadensis*] *iduna.* [*Oeneis*] *iduna, californica, gigas* and *macounii* form a group by themselves. They are separated in many particulars from all other of the species of the genus *Chionobas.* In fact, they should be placed in a new genus by themselves. Of *gigas,* as I have before said, I was unable to get the larvæ beyond second moult, but I got *iduna* and *californica* to the mature larvæ (after fifth moult). So *macounii* was brought by Mr. Fletcher to maturity of the larvæ, but in none of these was a chrysalid obtained. On June 28 I received from Bruce at Glenwood Springs fifty eggs of *Neominois dionysus.* I had exactly the same trouble with this species as with the *Chionobas* just spoken of. But in the case of the other American species of *Neominois,* i.e., *N. ridingsii,* we reached a chrysalid and figured the whole series of the preparatory stages. This chrysalid is formed under the surface of the ground, not a common thing in the SATYRIDÆ.

On July 13 I received from Mr. Scudder two females of *Chionobas semidea,* with a dozen eggs which had been laid on the way. Two days later a nearly mature larva of the same species was found feeding on sedge. Between help of this sort from Mr. Scudder and our own attempts to rear the larvæ, we got the whole life history of *semidea* and gave a plate of it in volume three.

On August 5 there came from Dr. Wittfeld of Florida eggs of *Apatura alicia,* and I was able to get all the stages of that species.

On August 11 I found attached to the leg of a dry female, *Chionobas* [*Oeneis*] *crambis*[74] [= *polixenes*], taken in Labrador years ago, an eggshell so perfect that Mrs. Peart could make a magnified drawing of it, and it appeared on one of our plates [vol. 3, pl. *Chionobas* 7, figs. a, a^2].

On May 10, 1893 Mrs. Peart wrote that a female *Papilio oregonia* had come out of a chrysalid bred from a larva sent by Bruce last year of *P. bairdii.* In fact two *P. oregonia* had come out of the same lot of caterpillars. This was the first intimation of the most remarkable instance of dimorphism in the North American butterfly fauna.[84] [*Papilio*] *oregonia* is a yellow and black (mostly yellow) species, belonging to the same subgroup with *P. machaon* of Europe, while *P. bairdii* is a black species of the same subgroup as *P. asterius* of America. [*Papilio*] *oregonia* hitherto had only been taken in Washington and Oregon, while *bairdii* had only been taken in Arizona and New Mexico. I shall have more to say of this matter presently.

On July 2, seven eggs of *Papilio* [*indra*] *indra* came from Bruce at Denver; on July 3, seven eggs of *Chionobas iduna* from Mr. Wright at Mendocino, and on July 15 from the same at Truckee, California, three eggs of *Ch. ivallda;* on August 9 from T. D. A. Cockerell at Las Cruces, New Mexico, eggs and larvæ of *Synchloe* [*Chlosyne lacinia*] *crocale.* These larvæ fed on sunflower, and on rearing them a surprising amount of variation was discovered in the resulting butterflies. Fully half a dozen species had been named and described by authors from the varieties of *crocale.*

[84] *Papilio bairdii, oregonia, brucei* and *hollandii* are now considered to be one species, having well-characterized subspecies and intermediate forms.

On August 4 I received eggs of *Chionobas gigas* from Charles de Blois Green[85] at Victoria; on August 11 eggs of *Argynnis* [*Speyeria* (*Semnopsyche*) *cybele*] *leto* [*letona*] from Professor A. J. Snyder,[86] then at Park City, Utah.

On September 8 came from Mrs. Peart a female *Papilio bairdii,* out of a chrysalid bred from an egg sent by Bruce as *bairdii;* on September 14 I myself had a male *bairdii* come from a chrysalid I had reared from an egg sent as that of *oregonia;* on September 20 came a female *bairdii* out of the same lot of *oregonia* eggs. On September 21 came a male *bairdii* from a chrysalid of *bairdii.* On June 1, 1894 Mr. F. H. Wolley Dod[87] at Calgary, Manitoba [Alberta] sent Mrs. Peart many eggs of *Chionobas alberta.* I was about to go to Colorado. Mrs. Peart had charge of the larvæ from these eggs and reared two of them to pupæ and butterflies. Contrary to the habit of other species of the genus we had dealt with, *alberta* pupated the same year in which the eggs were laid—in August and September. Several full-grown larvæ lingered through the fall, apparently ready to pupate, motionless, close to the earth on a small sod, but died in November.

In June of the same year Mr. Wolley Dod and Mr. Charles A. Wiley[88] of Miles City, Montana, sent eggs of *Chionobas* [*Oeneis uhleri*] *varuna* to Mrs. Peart. The females captured by Mr. Wiley came from about a hundred miles east of Miles City. Mrs. Peart reared the larvæ of both lots to pupation and discovered no difference between them at any stage. Both pupated in the

85 Charles de Blois Green (1863–1929). Land surveyor keenly interested in entomology, whose specimens are now in the Provincial Museum, Victoria, British Columbia. Later became an ardent ornithologist and collected on the islands of the British Columbia coast. Member of the Entomological Society of British Columbia, and Pacific Bird and Mammal Society, University of Washington, Seattle, Washington. Associated with W. H. Danby in entomological work, and co-author with him of "Report on the Entomology of British Columbia" (1893).

86 Arthur John Snyder (1867–). Well-known collector of Lepidoptera, author of "The Argynnids of North America" (1900), the first revision of that genus, and now living in retirement at Springfield, Idaho.

87 Frederic Hova Wolley Dod (1871–1919). Author of many papers on Canadian Lepidoptera, especially the NOCTUIDÆ.

88 Charles A[–] Wiley (–). Author of "Butterflies of Miles City, Montana" (1894). Evidently not a resident of Miles City but an itinerant.

same manner. The mode of pupation of these species differs from that of any species we have handled. Mrs. Peart wrote me on August 24: "Did I tell you that the larva had disappeared, and as I had made the ground (of the flowerpot) soft—it being sandy—I felt about carefully until I found the sand stuck together with a film. Moving this slightly caused something to wriggle, but I feared to disturb it, and so left it to another day. Then I gently raised a corner of the little lid, which was formed of sand caught together with silk, quite smooth on the under sides, and there lay a light-green and yellow-brown chrysalid in a very shallow hole in the sand." Four days later two pupæ were sent me and Mrs. Peart wrote: "These two pupæ formed just as the first one did, under the sandy coverlet." Another pupa was received on September 15 [and Mrs. Peart wrote]: "It formed just as did the other three sent you, weaving together some of the sand with silk. But there was a little depression in the sand just where the larva chose to make its bed, and in twisting about it got partly from under the cover, so that I saw it all the time. When the pupa formed it was partly uncovered. While the larva was resting—and it rested nearly two days—it looked as if it were sitting up." Mrs. Peart carried three of the larvæ through the winter, and in May I saw the three pupæ in Philadelphia. Mrs. Peart called my attention to the fact that the sand in the three coverlets was assorted, that in the middle being very fine, that about the edges coarser. The whole thing, as it was turned up by forceps, appeared to be a substantial coverlet. The particles of sand were held together by the finest silk. Both *varuna* and *alberta* were figured with all their stages.

On June 24, 1894 I went from Coalburg to Glenwood Springs, Colorado, via St. Louis and Denver. At St. Louis, Mr. Bruce met me, having come from his home at Brockport, New York. We were together nearly all the time till I came home. The principal object I had in mind was to breed from the egg both the *Papilio oregonia* and *P. bairdii*, and see what was the real relation between them. Glenwood Springs is on Grand River in southwestern Colorado. This river joins Green River in Utah, and the two form the Colorado River. On June 30 I walked up the river from the hotel with Mr. Bruce. Within a mile we saw

P. zelicaon, rutulus, daunus, and *eurymedon,* besides many smaller butterflies, all of which were new to me alive. Next day Bruce went alone in another direction and brought back three females of *Neominois dionysus,* four females of *Papilio bairdii,* one of *P. zelicaon,* and one of the rare species, *Satyrus* [*Minois silvestris*] *paulus* Edwards. All these we bagged on their several food plants, the [*Papilio*] *bairdii* on *Artemísia dracunculoïdes,* called sage plant [sagebrush]. On July 2 we went up the mountain road about three miles. Along the foot of the hill [*Eumenis*] *dionysus* was common, and two females were taken. At a spring by the side of the trail, elevation about 7000 feet (the hotel is about 5500 feet), and where a little water ran along the roadbed for a few rods, we took fifty or sixty butterflies of many species. *Pieris* [*occidentalis*] *occidentalis, P.* [*beckerii*] *beckerii, Colias alexandra, Argynnis* [*Speyeria* (*Speyeria*) *callippe*] *nevadensis, A.* [*S.* (*S.*) *zerene*] *behrensii,* a new species *A.* [*S.* (*S.*) *cybele*] *charlottii* Barnes, *Satyrus paulus, S.* [?]*ariane* [*damei*], *S. charon, Chionobas chryxus, Cœnonympha ochracea,* and a dozen smaller species. On July 3 Bruce brought in one female of [*Papilio*] *oregonia* and two females of [*P,*] *bairdii,* all of which were bagged.

On July 5 we found in the bags eighteen eggs of [*Eumenis*] *dionysus,* eighty of [*Papilio*] *oregonia* and twelve of [*Cœnonympha*] *ochracea.* On July 6 there were bagged two [*Papilio*] *bairdii,* and the next day one had laid one hundred and seventeen eggs, the other seventy-six.

On July 11 we had two lots of [*Papilio*] *oregonia* eggs, and four of [*P.*] *bairdii.* When the females of these *Papilio* were bagged, Mr. Bruce and I were in all cases together, and both examined the plants to see if perchance any *Papilio* egg might have been previously laid on them. When the bags were opened I attended to them myself, clipped off the leaves or stems which bore eggs, and put each lot in a box by itself. Thenceforth they were in my room at the hotel, and were attended by myself solely. The bits of stems and leaves were placed in glass tumblers and labelled. When the larvæ hatched, fresh stems were given. As the larvæ grew and required more room, they were shifted to tin cans which were covered by cloth and overlaid by squares of plate glass—to prevent escape as well as to afford light.

On July 15 Mr. Bruce left for Hall Valley and the high peaks, in the hope of getting eggs of *Chionobas œno,* the only species of the genus in the United States of which I had not before had eggs. I divided the six lots of *Papilio* eggs, giving Bruce one brood of *oregonia* and two of *bairdii.* Bruce returned to Glenwood [Springs], having obtained the [*Oeneis*] *œno* eggs. On August 10 we left the Springs for Denver and home. My larvæ were nearly full-grown, and a few had suspended for pupation. I put the three lots into three boxes, and in a large tin box carried a supply of fresh *Artemísia* for such larvæ as were still feeding. They reached Coalburg in good condition.

The butterflies began to come from the chrysalids at eleven and more days from pupation, but many hibernated, some to give butterflies in April, May and June, 1895, and several went over to 1896. The *Papilio* results in 1894 were:

1. From *oregonia* eggs, three *oregonia,* one male, two females; eight *bairdii,* seven males, one female.

2. From *bairdii* eggs, first lot, twenty *bairdii,* eighteen males, two females; (no *oregonia*).

3. From *bairdii* eggs, second lot, two *bairdii,* one male, one female; (no *oregonia*).

The results in the spring of 1895 were:

1. From *oregonia* eggs, five *oregonia,* three males, two females; four *bairdii,* two males, two females.

2. From *bairdii* eggs, first lot, eleven *bairdii,* eight males, three females; one *oregonia,* male.

3. From *bairdii* eggs, second lot, three *bairdii,* two males, one female; one *oregonia,* male.

The results in the spring of 1896 were:

1. From *bairdii* eggs, four *bairdii,* one male, three females.

Mr. Bruce sent me a statement of the outcome of his pupæ, thus:

From *oregonia* in 1894, five *bairdii,* four males, one female; two *oregonia,* one male, one female.

From *oregonia* in 1895, nine *bairdii,* six males, three females; seven *oregonia,* four males, three females.

From *bairdii* in 1894, first brood, seven *bairdii,* five males, two females; two *oregonia,* females.

From *bairdii* [in 1894], second brood, three *bairdii,* females; one *oregonia,* male.

From *bairdii* in 1895, first brood, eight *bairdii,* six males, two females; four *oregonia,* females.

From *bairdii* in 1895, second brood, five *bairdii,* three males, two females; four *oregonia,* two males, two females.

Thus it appeared that in nearly all cases each brood of either species [form] produced butterflies of the two species [forms]. Some of the butterflies taken by us at Glenwood Springs were typical *bairdii,* that is they could not be distinguished from the usual examples of *bairdii* taken in south[ern] Arizona where there are no *oregonia* and where, therefore, there can be no intermixture. But most differ in varying degrees from the type, no two being quite alike. They are grayer, especially on the under surface, than *bairdii,* running off to the form [*Papilio bairdii*] *hollandii* Edwards. In this, while the wings are *bairdii,* the body is marked and colored as in *oregonia.* The Glenwood [Springs] form of *bairdii* I distinguished as *Papilio* [*bairdii hollandii* form] *brucei.* The usual type of *oregonia* at Glenwood is not quite that of Oregon and Washington.

I know of no such hybridism among butterflies the world over, and to have worked it out gave Mr. Bruce and myself great pleasure. It pleased the lepidopterists also.

I spoke of Mr. Bruce going after eggs of *Chionobas œno* on July 15. To show what difficulties are sometimes encountered in obtaining butterfly eggs in almost inaccessible regions, and especially on high peaks, I will give extracts from Bruce's letters to me while he was in pursuit of these *œno* eggs.

"Hall Valley, August [July] 16. I reached Webster (the railroad station for the Valley, five miles away) at 2:15 P.M. Found that all the former inhabitants of Hall Valley had left, and all mines are closed, one family alone remaining at the Valley. I shouldered my wallet and walked off. It had rained every morning for two weeks, and everything is backward. On Mounts Bullion and Hayden there was more snow than I had ever seen before at this season of the year. A storm was coming and I hurried to make the Valley before it. It came, however, when I was half a mile from my goal—a grand display of electricity, rather too close to be pleasant, but awfully sublime—a constant crackling. And the lightning! Then came a big hailstorm, ending in rain. I reached Tracy's cabin at four o'clock, without a dry rag on me. This morning rheumatism is around a little. My old cabin on Bullion is there still. Mrs. Tracy will lend me two or three blankets, and I will take them and some grub this P.M., and go to the top where I will stay till I get what I want. I may be here a week—do not know till I have been on the top."

"July 17. I started early this morning intending to get to the top of the range before the daily storm set in. The sun was shining brightly, and I took many species of butterflies as I walked through the timber. Just before I reached the timber line, I found that the precipitation, which had been rain in the valley for the last week, had here been snow. By nine o'clock the sun became obscured, and I hurried over the immense snow fields that cover the north sides of these mountains to reach the cabin just in time. The mists gradually crept up from the valley, and vast clouds came rolling over the mountaintop, when suddenly came a dense storm of hail with a mighty wind. The temperature quickly dropped to the freezing point, but I lighted a good fire and was pretty comfortable. The cabin was substantial, built over the entrance to an old silver mine, and was about 13,000 feet above the sea level, the peak rising about a thousand feet higher."

"July 20. No change for the better; clear in the morning for about two hours but not warm enough for any butterfly to be on the wing. I have been on the top twice and have found several female *œno* in crevices of the rocks on the leeward side, but had to hurry down when the storm commenced, as the whole top was enveloped in clouds too dense to allow me to see more than two feet away."

"July 21. A cold, stormy night ushered in a miserable day, the sun not visible at all. Indeed, it snowed hard all day up to six o'clock. The mountain birds took shelter in the outer shed of my cabin; three white-taled ptarmigans were tame as chickens.

Pipits more shy and running about like mice. The beautiful rosy finches (*Leucosticte* [*tephrocotis*]) were very tame and hungry. And large numbers of Say's chipmunk or striped squirrel invaded my room, eating everything they could find. I turned the tables on these fellows, and by a dead fall baited with oatmeal I caught nineteen of them. I skinned and stewed the bodies, and found them an agreeable change from the salt ham I have been living on the last five days."

"Hall Valley, July 22. I came down from the top of the range last night, as it was useless staying any longer. Have taken a bad cold, for everything was wet and miserable. A long tramp yesterday gave me not even one [*Parnassius*] *smintheus,* or *Colias meadii,* or *Erebia callias,* where in ordinary years the three species abound. At two P.M. it began to rain; at four o'clock a furious snowstorm set in; at six it cleared up, and I started for the Valley, which I reached at dark. I have six females of [*Oeneis*] *œno* in bags, and I see a lot of eggs in one, and five or six in another."

Mr. Bruce told me when we next met that he took the [*Oeneis*] *œno* off the rocks with his fingers. When he brought them to Tracy's he bagged them over tin cans, in which tufts of grass had been planted. In his absence Mrs. Tracy kindly looked after them. The eggs obtained were mailed to Mrs. Peart in Philadelphia, and she reared the larvæ as before said.

By what I have written it is evident that a vast many eggs were sent me every year, and for several years. I omitted from the record a great many of the more common species. The waste of material was great, but the difficulties experienced in rearing larvæ of boreal species, and species from an entirely different climate in a different envorinment than nature had provided for them must be taken into consideration. The losses were constant, but success depended on keeping at it, getting fresh material year after year, and making renewed attempts to reach the chrysalid and butterfly, with every failure gaining a little knowledge. In most cases I eventually succeeded, as the plates in my volumes show. One of these plates in volume three [*Parnassius* 1] exhibits the complete life history of the beautiful alpine species, *Parnassius smintheus.* It took observations running along for twenty years to get the whole story. Mr. Mead in 1870 first obtained eggs as he worked in Colorado, and Mr. Bruce closed the history in 1889. The genus *Parnassius* comprises many species, mostly European and Asiatic, always dwelling in mountain districts like the Alps, and the mountains of Siberia. Yet, with the exception of the adult caterpillar and the chrysalid of *P. apollo,* nothing seems to have been published on the preparatory stages of any Parnassian. But the history of *smintheus* was not traced altogether by breeding from the egg. The larvæ died rapidly at every stage, but in successive years, partly by breeding and partly from the larvæ sent me by Bruce and Wright and Koebele, I saw every stage, and Mrs. Peart was able to make a complete set of drawings of them.

Mrs. P. D. Leslie, sister to Mrs. Bowen, who had colored plates for me since 1868, died in 1893, a most accomplished artist in her line. Thereafter I was aided by several ladies, students or graduates of the Art School in New York.

The last part of volume three appeared in 1897. I was urged to go on with a fourth volume for which I had on hand a great deal of material, both insects and drawings. But as I was well advanced in years, I felt that I had better stop now. In publishing volume three I was aided by a grant of Five Hundred Dollars from the National Academy of Science, unsolicited and unsuspected on my part, but suggested by Mr. Samuel H. Scudder who, from the beginning, had taken the greatest interest in my work. I also received two grants amounting in all to Three Hundred Dollars from the Trustees of the Elizabeth Thompson Fund of Boston. I was substantially aided in both volume two and three by the kindness of my publishers, Houghton, Mifflin and Company.

On the issue of part seventeen of volume three, The Entomologist's Monthly Magazine for April, 1897 said: ". . . We infer that this Part is not only practically the last of the Series, but also of the entire work. If so, it brings to a conclusion a monumental enterprise commenced by the author nearly thirty years ago (1868), and carried on with a singleness of purpose that is most commendable. . . . Of the work as a whole it may be said that it commenced at a time when the number of North American species was very uncertain, and of the transformations, distribution, and habits little was known. Thanks largely to the energy of Mr. Edwards the biology of American species is almost as well known as those of Europe, and in some respects better known, for there is probably no European work in which the larval details are delineated in the same minute manner. It is an *ouvrage de luxe*, but at the same time probably the most important faunistic work on Butterflies that has ever appeared.''

In the Atlantic Monthly for August, 1897 the Butterflies of North America was reviewed and treated of as follows by Mr. Samuel H. Scudder: ''In the early part of 1868 Mr. W. H. Edwards began the issue of an iconographic serial publication on North American butterflies. Planned as a quarterly but with no expectation of extending beyond a single volume, it has appeared at regular intervals up to the present time, when, having in twenty-nine years completed three quarto volumes, with fifty or more colored plates each, the veteran author lays down his pen, . . . It is the story of a remarkable achievement. The only previous attempt to issue such a work, by Titian Peale, had ended with a first number, and Peale was his own artist. Edwards, when he began, had been known but a few years as an Entomologist; he had to pay all the charges of printer, draughtsman, lithographer and colorist, and could hardly expect any adequate support from a limited and generally impoverished group of naturalists. . . . Nevertheless by great sacrifices he has given to the world . . . what is on the whole the finest series of illustrations of butterflies that has appeared in any country, and if we take into proper account the proportion and character of the figures which illustrate the history of butterflies, we may say, incomparably the most valuable. This is due in very large measure to his good fortune and good sense in securing the services of Miss (afterwards Mrs.) Mary Peart, who has not only drawn for him as needed all the illustrations of the early stages, first on paper, and afterward (excepting most of the third volume) on stone, but has also drawn on stone all the butterflies of the first two volumes, excepting five[89] plates of the initial part. No

[89] Edwards changed Scudder's ''five'' to ''three'' in his manuscript, but it has been thought best to quote Scudder accurately. See footnote 36.

drawings of butterflies, whether in their early stages or in the final stage, have ever been made which surpass these for faithful portrayal, delicate finish, and artistic arrangement, and they have seldom been equalled anywhere. . . . In his announcement, in the first part, Mr. Edwards said: 'It is a matter of regret that in so few instances I shall be able to say anything of the larvæ.' Until the seventh part of his work (1871), no figure of any of the early stages appeared on his plates; but since then only two parts have been issued (out of thirty-four) in which some early stages are not shown, and more than half of the plates are used to some extent for their illustration. The reason for this is largely a happy discovery by Mr. Edwards, in 1870, that by imprisoning gravid females alive over their food plant they could be persuaded to lay any number of eggs. This discovery has completely changed our mode of studying the life histories, and placed us in this country well in advance of our European brethren, who have been slow to adopt this facile method. By experiment he also proved that caterpillars can be reared to maturity under conditions very different from those natural to them, so that in his retired little corner in the Kanawha Valley in West Virginia he has been able to rear, and so to draw and study in every stage butterflies from such distant and varied points as the Rocky Mountains, California, British Columbia, Canada, and Texas, simply by having packages of fresh laid eggs sent him through the mail by collectors at these points. . . . To this discovery, and particularly to Mr. Edwards' persistence in carrying it out, we owe our present minute knowledge of a very large proportion of our butterflies. . . . No better illustration of this can be given than by citing *Chionobas* (the snow-rover, to translate the term), a genus of butterflies peculiar to very elevated regions and the far north. Up to the present time hardly a figure has been published of the early stages of any of the European species. On the other hand, Mr. Edwards has given a complete, or almost complete, series of figures, (amounting in all to two hundred and sixty), of twelve of our species, besides partial series of two others, and nearly every one of these is given by him for the first time. Yet not one of them has Mr. Edwards seen alive in its native haunts; each had to be specially sought for by some agent on high mountain top, or region distant—often very distant—from human habitation, and difficult of access. The agent had to remain on the inclement or wild spot long enough, often days, to secure eggs freely laid by an imprisoned female, whose moods are dependent on sunshine and a certain warmth. This is but one instance of our author's indomitable perseverance. . . . This wonderful picture-book of nature has done even more for us, for it has been the means the author has taken of depicting his highly interesting and important discoveries in dimorphism and polymorphism, the minutest details in proof of which are given in the text. These discoveries have been a fruitful stimulus to similar studies in all parts of the world. . . . Mr. Edwards' patient investigation, year after year, of *Papilio ajax, Grapta interrogationis, Grapta comma, Phyciodes tharos,* and *Lycæna pseudargiolus;* and his trip to Colorado, when past seventy years of age, for the purpose of working out on the spot the complicated story of *Papilio bairdii-oregonia,* can but elicit our warmest enthusiasm. . . .''

Since the year 1862 I have kept a diary, which embraces books numbered A to X, in which everything entomological that has occurred, butterflies captured or bred, observations made, eggs obtained in any manner, larvæ reared, and full descriptions of all the preparatory stages of each species that I have dealt with has been set down. My entomological correspondence has been very extensive. Besides this work, I have written for entomological magazines and publications a total of two hundred and sixty-five separate papers on lepidopterology, a list of which I shall append to these notes.

I have reached my eightieth birthday. My pursuits in natural history, first in ornithology, began when I was a sophomore at Williams College in 1839, and continued through 1846, next in lepidopterology, have contributed to make the years agreeable as they passed. I have been happy in my home life also. I should be willing to live over again, and I hope the next life, wherever it may be, may have pursuits as delightful as those which have occupied me here.

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SUPPLEMENTAL

In "Illustrations of Diurnal Lepidoptera with Descriptions" (1911, vol. 2, pp. [9–18]), by Andrew Gray Weeks, Jr., there is a list of the scientific writings of William Henry Edwards. This is the most complete bibliography published, but in that list Weeks overlooked the following papers:

1877. Lepidoptera of the Big Horn Mountains. Field and Forest, **3**: 48.

1880. Migration of Butterflies. Canadian Ent., **12**: 39.

1880. [Letter to Mr. Scudder read at the Cambridge Entomological Club on *Grapta faunus* from Oregon.] Psyche, **3**: 77.

1880. [Letter to Mr. Scudder on rearing larvæ read at the meeting of the Entomological Club of the American Association for the Advancement of Science.] *Ibid.*, **3**: 114.

1884. [Letter to the editor on a question of the priority of certain species names.] Papilio, **4**: 132–134.

1884–[1885]. [Note with statement of Miss Wittfeld on effects of lightning on certain larvæ.] Canadian Ent., **16**: 180.

1887. Report upon the diurnal Lepidoptera collected in Alaska by E. W. Nelson. *In* Nelson, Edward William, Report of the Natural History Collections Made in Alaska between . . . 1877 and 1881, pt. 4, Insects: 323–330.

In Weeks' list, item 5, Description of Certain Species of Diurnal Lepidoptera Found within the Limits of the United States and British America. Nos. 1–5 (1863–1866), it is stated that those five papers were published in the Transactions of the Entomological Society of Philadelphia (**2**: 14–22, 78–82, 501, 507; **4**: 201–204; **6**: 200–208). These papers were published in the Proceedings of the Entomological Society of Philadelphia and not in the Transactions. The references to years, volumes and pages are correct.

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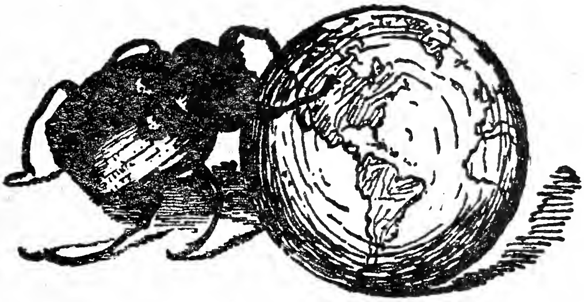

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THE NORTH AMERICAN SPECIES OF TETHINIDÆ (DIPTERA)*

By Axel Leonard Melander, Research Associate

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In 1913, in a paper dealing with the acalypterate flies related to the Agromyzidæ (Jour. New York Entomol. Soc. XXI: 219–300), I published a synopsis of the old group Geomyzinæ, as limited by Becker's catalog of palaearctic Diptera. Since that time the subfamily has been dismembered and the divisions have been elevated to family rank by Hendel, Czerny, Duda and other progressive dipterists. The genera that formerly comprised the Geomyzinæ are now apportioned to the Tethinidæ, Anthomyzidæ, Opomyzidæ, Trixoscelidæ, Chyromyiidæ and Diastatidæ, with *Scutops* and *Cyamops* going to the Periscelidæ and *Pseudodinia* to the Chamæmyiidæ. The distinctions between these groups are given in the Classification of Insects by Brues and Melander (1932), as well as by Hendel (1922 and 1928), Curran, in part (1934), Frey (1921) and Lindner (1933).

It will be observed that the original name based on *Geomyza* has been lost in these family designations. This has been caused by confusion in the application of *Geomyza* as a modern genus. It was generally accepted that Fallen (1823) proposed the genus for six European species. Of these, Rondani (1856) selected *obscurella* Fallen as the type for his genus *Trixoscelis*, overlook-

* Publication Number 700, Citrus Experiment Station, The University of California, Riverside, California.

ing that Westwood (1840) had already supposedly used the same species as the type for *Diastata* Meigen. Westwood's enumeration of a "typical species" for each genus has not been universally accepted as fixing genotypes. Coquillet (1910), in his monumental study of genotypes of Diptera, regarded Westwood's designations as valid and as determining priority, but Hendel (1911, p. 90 and 1923, p. 207) objected because they were published in a lengthy synoptic list, and Hopkins (1915, p. 115) rejected them as genotypes because all were restricted to the British fauna. It would seem that such objections are too personal to be seriously considered and that Westwood's citations are as cogent as the accepted selections of other early writers. In fact the International Commission on Zoological Nomenclature in Opinion 71 has ruled that Westwood's citation of "typical species" are to be accepted as definite designations of genotypes.

In 1864 Loew erected the genus *Balioptera,* which has been regarded as based on *combinata* Linnæus, one of the species included in *Geomyza* in Fallen's 1823 paper, and in 1865 Loew discussed the restricted use of *Geomyza* for the species around *obscurella* Fallen. After the publication of Becker's volume IV of the Katalog der paläarktischen Dipteren (1905) it was discovered that Fallen in 1810 had already created the genus *Geomyza* for *combinata* Linnæus, a species that occurs also in America. Therefore *Balioptera* Loew became a direct synonym of *Geomyza,* both having been based on the same genotype.

Perhaps partly because of the objection to Westwood's designation of *obscurella* Meigen as the genotype of *Diastata,* Hendel and others have accepted Fallen's *obscurella* as the type of *Trixoscelis* Rondani, as of date 1856, and hence arose the family name Trixoscelidæ (Frey 1921, p. 230). But more important, Loew (1864 and again in 1865) noted that Meigen's *obscurella* was not Fallen's species, and gave the name *vagans* to the form Meigen had described and figured. This species thus becomes the genotype of *Diastata* because Westwood designated the *obscurella* of Meigen instead of Fallen. *Diastata vagans* occurs both in Europe and America. Meigen (1830, p. 94) included sixteen species in his genus *Diastata.* Eliminating *obscurella, anus* (now placed in *Cyrtonotum*) and *leucopeza* (now in *Aulascigaster*) the other thirteen species are closely related and are now assigned to *Diastata* and *Tryptochæta* in the modern family Diastatidæ. Coquillett (1910), supposedly supporting Westwood, proposed the name *Calopterella,* with genotype *vagans,* for the European and American species that have been going by the name *Diastata* Loew. In view of Meigen's mistake in identifying Fallen's *obscurella* the new name is now considered unnecessary.

General usage has resulted in the selection of *Diastata* Meigen (synonym *Calopterella*) for the species around *vagans* Loew. *Geomyza* Fallen no longer is in doubt, its genotype being its single original species *combinata* Linnæus, the *Balioptera combinata* of Loew. *Trixoscelis* Rondani thus remains for the series of species that were listed as *Geomyza* Loew in the palæarctic catalog. Because Fallen's 1810 paper was overlooked his 1820 genus *Opomyza* was regarded as the earliest genus of the group and provided the name Opomyzidæ, thus resulting in the suppression of the term Geomyzidæ.

Since the publication of my paper on the Geomyzinæ (1913) I have collected some four thousand more specimens of this group, nearly all the flies so small as to require double mounting on minuten nadeln. Most of the flies belong to a few common species, such as *Pelomyia coronata, Rhicnoessa albula, Phycomyza milichioides* and *Trixoscelis frontalis,* which are widely distributed but which were saved for locality records. But here and there some rare and undescribed species have been discovered. Those belonging to the restricted Tethinidæ are herewith described.

The Tethinidæ include all acalypterate flies having the subcosta incomplete, a single costal break close to the end of the first vein, postvertical setulæ converging, upper fronto-orbitals directed outward or back, oral vibrissæ more or less distinct, one or two presutural dorsocentrals present and no preapical tibial bristles. The family is small. Aside from two monobasic genera from Formosa there are but six genera known (*Tethina* Haliday 1839, *Rhicnoessa* Loew 1862, *Pelomyia* Williston 1893, *Neopelomyia* Hendel 1917, *Pelomyiella* Hendel 1934, *Phycomyza,* n.gen.). *Neopelomyia* and *Phycomyza* are restricted to the Pacific coast of North America, the others are holarctic, with *Rhicnoessa* occurring also in the Orient. Although the oldest genus *Tethina* gives rise to the family name, most of the species belong to the dominant genus *Rhicnoessa.*

Geographically nearly all the species of Tethinidæ are confined to the sea coast, only *Pelomyia* and *Pelomyiella* occurring inland in America. Locally some species may be very abundant, and can be taken by sweeping beach grasses, sea plum or sand verbena along the dry sand area, or by collecting in salt marshes. *Neopelomyia rostrata* sometimes swarms in newly stranded algæ in association with *Phycomyza milichioides, Fucellia* and *Cœlopa.* Sometimes adjacent localities possess distinctive but different species. I have collected at two dozen places along the California coast between San Diego and San Francisco. *Phycomyza milichioides* was found at nearly all localities but *Rhicnoessa denudata* only at Carpenteria. At Pismo Beach *Rhicnoessa lavendula* was the only new species found, but at near-by Morro Dunes *Rhicnoessa angustipennis* seemed to be the predominating new species. *Rhicnoessa variseta* was taken at five places between Corona del Mar and Long Beach, a distance of twenty-five miles, but was found nowhere else. The Mexican *Rhicnoessa spinosula* Cole was found at only five places, between Laguna Beach and Palos Verdes, separated by about forty miles, but the closely allied *horripilans* occurs from San Francisco to the State of Washington, roughly a span of a thousand miles. The habitats of these interesting flies are rapidly being destroyed. Tramping by bathers and picnickers, industrial movements of soil, real estate expansion, and the in-washing of oil scum have recently altered the fauna of the sea beaches more than centuries of tempests and tides.

There has been considerable confusion in the application of generic and specific names in this group of flies in America, and in Europe as well. Hough, Aldrich and I identified a New England coastal form as Loew's *Rhicnoessa parvula* which we placed in the genus *Tethina,* and Hendel (1911, p. 43) reported the same species as occurring on the Pacific coast. Sturtevant (1923, p. 6) corrected the misidentifications, naming the eastern form *Pelomyia mallochi,* n. sp., and the western form *Pelomyia melanderi,* n. sp. Apparently the species identified by Malloch (1913, p. 197) as *Tethina parvula* is the form I described as *Tethina maritima* from Texas. The real *parvula* is the species

I described as *Rhicnoessa whitmani.* Hendel (1934, p. 53) extended the distribution of *mallochi,* which he placed in his new genus *Pelomyiella,* to Europe, where it had previously been known under the synonymous names *illota* Kuntze (not Haliday), *kuntzei* Czerny and *angustifacies* Meijere.

Sturtevant (1923) following Collin (1911) made *Rhicnoessa* a synonym of *Tethina,* transferring the American species of *Rhicnoessa* to *Tethina* and reviving *Pelomyia* Williston for *coronata* and its relatives, which previously had been called *Tethina.* Czerny (1928) adopted the same procedure for the European species. Hendel (1917) removed his species *rostrata* to a new genus *Neopelomyia,* and in 1934 he erected the genus *Pelomyiella* for *melanderi, mallochi* and two European species, at the same time differentiating *Rhicnoessa* from *Tethina* as valid genera. Although the separation of the last two genera is based on so tenuous a character as the presence or absence of the variable stigmatical setule, it has the advantage of retaining the well-known name *Rhicnoessa.* Malloch (1913, pp. 146, 147) has expressed the opinion that the resemblance of *Rhicnoessa* to *Pelomyia* is superficial, that *Rhicnoessa* belongs to the Milichiinæ and *Pelomyia* (his *Tethina*) to the Ephydridæ, a view similar to that of Williston (1909) and of Hendel (1902) in his first paper on *Rhicnoessa.* Later Malloch (1934) reversed his view, aligning the *Rhicnoessa* group with the Canaceidæ and the *Pelomyia* group with the Milichiidæ. Hennig (1936) separated all the Tethinidæ from the Milichiidæ on the arrangement of the sensory hairs of the pharnyx. On the basis of the structure of the fulcrum plate of the mouth, Hennig noticed a similarity between the Pelomyias and the Milichiidæ and between the Rhicnoessas and the Ephydrids. Attacking this problem of phylogeny from a different point of view, Hennig (1939) showed that the structure of the male genitalia of the Tethinidæ conforms to that of the Milichiidæ and not of the Canaceidæ. In view of such conflicting evidence the Tethinidæ may be regarded as a single comprehensive family.

It would seem that the absence of the humeral fracture of the costa fundamentally would exclude all the Tethinidæ from the Milichiidæ and Ephydridæ and link them phyletically together as a family older than either of the latter.

KEY TO THE AMERICAN GENERA OF TETHINIDÆ

1. Second basal cell fused with discal cell; cheeks with scattered fine hairs; acrostichal and interfrontal hairs absent or greatly reduced; lateral facial ridges not developed; one to three superior reclinate fronto-orbital bristles present, but no intermediate setulæ; front coxæ about two-thirds as long as their femora; middle tibiæ with apical spine, the spine of the hind tibiæ vestigial 2

   Second basal cell separated from discal cell; cheeks with only the peristomial row of out-bent setulæ; acrostichal and two rows of converging interfrontal hairs present; face with more or less evident central carina and lateral facial ridges; three to five backward- and outward-curved fronto-orbitals in addition to about five short and inclinate setulæ; front coxæ about half as long as femora; middle and hind tibiæ with apical spine 4

2. Vibrissal angle not projecting, the lower margin of head short and convex; face more than half as long as front, without nasute middle keel but with a median groove at oral margin; eyes rounded; one or two fronto-orbital bristles 3

   Vibrissal angle projecting, the under margin of head rather straight and long; eyes oblique; face half as long as front, with median keel; three fronto-orbitals .... *Neopelomyia* Hendel

3. A chitinous shining stripe along oral margin and facials; posterior ocelli near edge of the declivous occiput; anterior crossvein near middle of discal cell, last section of fifth vein subequal to posterior crossvein or less; a single large fronto-orbital near middle of front .... *Pelomyia* Williston

   Peristome and facials not marked by a shining chitinous stripe; posterior ocelli slightly more distant from rear of vertex which rounds into the occiput; anterior crossvein much beyond middle of discal cell, last section of fifth vein two or three times the length of the posterior crossvein; two fronto-orbitals on upper half of head. *Pelomyiella* Hendel

4. Antennæ never deeply sunken in a facial pit, face usually shallowly concave and vertical, distinctly more than one-third as long as the front; eyes usually rounded; front narrower than long, at least the upper fronto-orbitals long, ocellar bristles long, divergent and definitely proclinate. Seashore species from the dry sand zone 5

   Antennæ sunken, cheeks strongly projecting below, one-third the eye-height, face short, about one-third as long as the front, median carina strong, surpassing the antennæ, eyes large and oblique; front as wide as long, the fronto-orbitals shorter than the vertical bristles, ocellar bristles shorter than the distance between the ocelli and directed outward, frontal bristles and hairs short. Pacific coast species from the wet sand zone. **Phycomyza**, new genus

5. Stigmatical setule absent, only the propleural setule above the front coxæ .... *Tethina* Haliday
   Stigmatical setule present, i.e. two setulæ above the front coxæ. *Rhicnoessa* Loew

Pelomyia Williston

Williston, 1893, p. 258 (Ephydridæ). Becker, 1896. p. 274 (Ephydridæ). Williston, 1908, p. 295 (Ephydridæ), p. 307 (Agromyzidæ). Melander, 1913, p. 229. Hendel, 1917, p. 46. Sturtevant, 1923, p. 5. Czerny, 1928, p. 2. Hendel, 1934, p. 51.

Syn. *Tethina* (not Haliday). Kuntze, 1897, p. 20. Hendel, 1911, p. 41 (Milichiidæ). Melander, 1913, p. 297 (Geomyzinæ). Malloch, 1913, p. 146 (Ephydridæ).

Key to the Species of Pelomyia

1. Posterior coxæ blackish, front coxæ white, at least the femora blackish; wings hyaline, the crossveins not clouded, last section of fifth vein subequal to posterior crossvein; antennæ largely black 2
   All coxæ whitish yellow, hind legs pale yellow, the front femora somewhat darkened along middle, front tibiæ dark only toward apex; wings milky, both crossveins clouded, last section of fifth vein half as long as posterior crossvein; antennæ wholly yellow. (Cal.) **nubila**, new species
2. The fronto-orbital bristle placed before midddle of distance between inner vertical bristle and antennæ; hind tarsi reddish on basal half; mesonotum wholly dull; third vein nearly straight; male claspers slender, acute and crossed at rest. (Mo.) *cruciata* Hendel
   The fronto-orbital bristle located midway between the vertical bristle and the antennæ; hind legs usually black; mesonotum with somewhat translucent sheen; third vein arched; male claspers variable, ranging from wide and broadly forked apically to slender, acute and crossed. (Wide-spread, No. Am., Peru) .... *coronata* Loew

Pelomyia coronata Loew

Loew, 1865, Centuries VI, no. 98 (*Rhicnoessa*). Melander, 1913, p. 297 (*Tethina*). Malloch, 1913, p. 147 (*Tethina*). Sturtevant, 1923, p. 7 (*Pelomyia*). Hendel, 1934, p. 52 (*Pelomyia*). Hennig, 1939, p. 82, fig. 6 (*Pelomyia*).

Syn. *Pelomyia occidentalis* Williston

Williston, 1893, p. 258. Melander, 1913, p. 297 (synonymy). Sturtevant, 1923, p. 7 (synonymy). Curran, 1934, p. 330 (figure).

This species is most widely spread in America and usually is abundant. I have saved and mounted 600 specimens representing a large proportion of the collecting grounds I have visited through the South and West. Sturtevant listed sixteen States where the species occurs, in addition to Alaska, Mexico and Peru. To this record I can add New York, Montana, Arizona, Oregon and British Columbia. Except for the few specimens I caught in central New York State there are no records of the occurrence of this species in the entire northeastern portion of the United States. I have taken *coronata* at elevations between sea-level and the mountain-passes of the Rockies. I have encountered it in lush forests, meadowlands and in the deserts. It is not a halophile, thus differing from the other species of the family.

Pelomyia coronata is easily recognized by its orange colored front sharply delimited from the brown vertex-triangle and bearing a single large bristle at the middle of the frontal orbits. It is the only species having the front coxæ white pruinose and contrasting with the blackish femora (not excluding the following species for which the color of the legs has not been stated). There is some variability in the tone of the mesonotum and abdomen and in the amount of ruddiness in the tarsi and tibiæ, nothing however of specific importance. But if I have interpreted correctly that my aggregation of specimens belong to a single species, there is a great divergence in the formation of the male genitalia (figs. 1–4). With limited material the discovery of two extremes would seem a natural basis for differentiating species. Hendel assigned the name *coronata* to the form having stout male claspers tipped with a broadly U-shaped fork, and erected his species *cruciata* on specimens having slender, acutely pointed and crossed claspers. I have noticed a complete transition between these extremes, though not related to geographic occurrence of the specimens. Among those having broad claspers, both tines of the fork may be slender, or the anterior tine of the pendent valve may be reduced, or both tines may be entirely suppressed. In the slender valve the single apex is narrowly acute. This is the form most commonly encountered and agrees with Hendel's description of *cruciata*.

The size of the genitalia is variable as well as the general appearance. In the normal resting position the parts are folded against the underside of the abdomen and the shape of the apical parts of the claspers cannot be discerned. But when erected and opened, as happens in some males when captured, the parts are disclosed. Here comes the satisfaction of having saved representatives of a common species during fifty years of collecting. The crossing of the claspers noted by Hendel occurs in the normal resting position, but is possible only for the acute valves. The tines of the broader forked valves interlock when closed. The valves are powerful claspers and it is not unusual to find mating pairs still united after death in the killing bottle. When fully expanded the penis is a formidable structure terminating in a velvet-like sickle, but in the majority of males the penis is completely withdrawn into the abdomen.

Pelomyia cruciata Hendel

Hendel, 1934, p. 52.

The only distinctions for this species are those given in the key. While I have many specimens with the genitalic and some of the other characters of Hendel's Missouri specimens, in none are the frontal bristles placed before the middle of the orbits. It is impossible to pass on the validity of this species without access to the types.

Pelomyia nubila, new species

Length 2 mm. Head higher than long, eyes vertically oval, cheeks one-third the eye-height; front luteous merging with the yellowish cinereous ocellar triangle, orbit white, the single large fronto-orbital bristle slightly above the middle of the front, face and cheeks almost whitish, upper occiput light cinereous, the two cervical pruinose spots large, circular and almost touching; antennæ porrect, yellow, the arista brown; mouth-parts brownish, the palpi white. Mesonotum densely yellowish cinereous, grayer on pleuræ; abdomen blackish cinereous, the first two segments, extreme sides and incisures cinereous; hypopygium subshining blackish, the claspers nearly parallel-sided, ending in two tines the anterior of which is acute, the posterior blunt, with a broad U-shaped excision between them. Coxæ and posterior legs yellow, front femora darkened except at base and knee, front tibiæ yellow on basal half becoming darkened apically. Wings with slight milky tone, faintly infumated about the crossveins, veins brown but white at base, stronger than in *coronata*, anterior crossvein at three-fifths the discal cell, posterior crossvein twice the length of the last section of the fifth vein.

Three males, four females, San Clemente, California, October

18, 1944; one female, Corona del Mar, California, December 28, 1944. The species can be easily recognized by its pale colored legs, slight clouding about the crossveins and short last section of the fifth vein.

Pelomyiella Hendel

Hendel, 1934, p. 53.

KEY TO THE AMERICAN SPECIES OF PELOMYIELLA

1. Body largely dark olivaceous grayish pollinose; coxæ and legs mostly or wholly black; atnennæ mostly black 2
   Body pale yellowish cinereous pollinose; coxæ and legs mostly pale yellow; antennæ largely yellow. (Texas) .... *maritima* Melander
2. Anterior of the two fronto-orbitals much smaller than the posterior; hairs of cheeks and oral fringe pale; tibiæ usually brownish at each end. (North America and Europe) .... *mallochi* Sturtevant
   Anterior fronto-orbital nearly as long as the posterior; hairs of cheeks and oral fringe blackish; tibiæ wholly black. (Pacific coast) *melanderi* Sturtevant

Pelomyiella melanderi Sturtevant and *mallochi* Sturtevant

Pelomyiella melanderi Sturtevant, 1923, p. 7 (*Pelomyia*). Hendel, 1934, p. 53 (*Pelomyiella*).
Syn. *parvula* (not Loew). Hendel, 1911, p. 43, fig. 4 (*Tethina*). Melander, 1913, p. 297 (*Tethina*).

Pelomyiella mallochi Sturtevant, 1923, p. 7 (*Pelomyia*). Hendel, 1934, p. 53 (*Pelomyiella*).
Syn. *illota* (not Haliday). Kuntze, 1897, p. 20 (*Tethina*).
kuntzei Czerny, 1928, p. 3 (*Pelomyia*).
angustifacies Meijere, 1928, p. 76 (*Pelomyia*). Czerny, 1930, p. 450 (*Pelomyia*).

These two species are closely allied. The only noted differences are those given in the key. In general, *melanderi* is restricted to the Pacific slope and is primarily a salt marsh and coastal species, though it has been taken at various inland localities in California and Arizona. *Mallochi* is widely distributed, occurring along the Atlantic and Gulf coast and in Europe, and I have taken it in numerous inland localities in British Columbia, Washington, Oregon, California, Wyoming and Montana. On the Pacific coast I have failed to find *mallochi* in any seaside collecting, but have taken it around various inland alkali seeps, springs and lakes.

Though the differences between the two species may seem slight they are correlated enough to be of taxonomic value. In a given locality only one or the other species may be found. At only two places (on an alkali flat near Temecula, California, and in the Death Valley, also an alkaline region) have I taken both species together.

The distribution record of the three hundred specimens I have collected is of interest:

Melanderi. Coastal localities: British Columbia; Vancouver, Victoria, Cowichan Bay. Washington; Friday Harbor, Sequim, Blynn, Brinnon, Port Gamble, Puget, Mukilteo, Nahcotta. California; Monterey, Asilomar, Morro Bay, Carpenteria, Seal Beach, Huntington Beach, Corona del Mar, San Diego. Inland localities: California; Arvin, Atwood, Morongo, Temecula, Death Valley, Lovejoy Lake in the Mojave Desert, Oak Grove at base of Mount Palomar, Barton Flats in the San Bernardino Mountains, Cuyamaca Lake. Southernmost Arizona; Quitobaquito and Rincon Spring, which in flood time are connected through the Sonoyta River with the Gulf of Lower California.

Mallochi. Western localities: British Columbia; Osyoos. Washington; Mount Rainier, Yakima, Lowden, Kennewick, Pateros, Rock Lake, Soap Lake, Pullman. Oregan; Umapine. California; Riverside, Elsinore, Temecula, Death Valley, Victorville, Crestline. Colorado; Hartsel. Wyoming; Yellowstone Park at many stations, Thermopolis. Montana; Gardiner. Eastern localities: Maine; Trenton. Massachusetts; Provincetown, Yarmouth, Welfleet, Naushon Island, Woods Hole. Rhode Island; Watch Hill. Connecticut; Westport, South Norwalk. New York; Cold Spring Harbor, Oak Island.

Pelomyiella maritima Melander

Melander, 1913, p. 297 (*Tethina*). Sturtevant, 1923, p. 7 (*Pelomyia*). Hendel, 1934, p. 53 (*? Pelomyiella*).
Syn. *parvula* Malloch (not Loew), 1913, p. 147 (*Tethina*).

Hendel queried the absence of the postvertical bristles. They are present, but microscopically small and almost invisible, and are located immediately behind the posterior ocelli.

Malloch's identification of *Tethina parvula* as occurring at Galveston probably refers to this species, judging from the yellowish legs mentioned in his key.

Neopelomyia rostrata Hendel

Hendel, 1911, p. 41, fig. 3 (*Tethina*). Melander, 1913, p. 297 (*Tethina*). Malloch, 1913, p. 147, fig. 28 (*Tethina*). Hendel, 1917, p. 46 (*Neopelomyia*). Sturtevant, 1923, p. 7 (*Neopelomyia*). Hendel, 1934, p. 54 (*Neopelomyia*).

I have collected about one hundred fifty specimens of this halophilous species, at numerous oceanside stations between Vancouver Island and La Jolla, California. It is easily recognized by the protruding vibrissal angle of the shortened face, with the antennæ porrect. From *Phycomyza milichioides*, with which it associates, it differs in having the two strong ocellar bristles proclinate, the absence of interfrontal hairs and the notal setulæ sparse.

Phycomyza, new genus

In addition to the characters given in the key to genera the following distinctions may be included.

Front occupying more than one-third width of head, its length between ocellus and vertex about equal to its breadth at ocellus, five or six small reclinate fronto-orbitals placed next to eye-margin and decreasing in size anteriorly, the rear ones shorter than the verticals and equal to the strongly divaricate ocellars, five or six inclinate lesser fronto-orbitals, inner vertical bristle midway between the outer vertical and postvertical, the two rows of about five interfrontals diverging above so that the upper ones are twice as far apart as the lower ones are; eyes almost horizontally oval, one-half longer than deep, the uppper margin nearly straight by being parallel with the row of fronto-orbitals, the lower margin regularly curved, anterior facets enlarged, cheeks one-third the long diameter of the eye; antennæ unusually small, not as prominent as the median rostrum; proboscis nearly three times head-height, the three folds about equal. Thorax distinctly setulose, one presutural and three postsutural dorsocentrals of moderate length, four rows of acrostichals, lateral setulæ and some in dorsocentral rows strong, pleural setulæ and two above front coxæ distinct. Abdominal hairs small and not abundant, genitalia small, male valves cleaver-shaped. Legs sturdy, setose, femoral bristles as long as their diameter, hind femora bare and polished along inner face. Anal lobe of wing prominent, sections of fourth vein proportioned 1: 1: 2, of fifth vein 3: 1.

Genotype: *Rhicnoessa milichioides* Melander, the species following.

Phycomyza milichioides Melander

Melander, 1913, p. 299 (*Rhicnoessa*). Sturtevant, 1923, p. 6 (*Tethina*). Hendel, 1934, p. 48 (*Rhicnoessa*).

Body and legs dark cinereous, femora and tibiæ black, hind metatarsi white or yellow; antennæ blackish, front dull brownish (fig. 6).

This species is quite unlike the species of *Rhicnoessa.* By its shortened face and strongly protruding vibrissal angle it bears a similar relation to the Rhicnoessas that *Neopelomyia rostrata* does to the species of *Pelomyiella,* from which Hendel segregated it.

The species is restricted to the wet sand zone and is abundant on newly stranded seaweeds and even penetrates into the heaps of damp algæ. I have mounted nearly four hundred specimens taken in the many seaside collecting stations along the Washington, Oregon and California coast.

Tethina Haliday

Haliday, 1839, p. 188. Hendel, 1934, p. 39.

This controversial name has been shifted about. Haliday described one species, *illota,* which various dipterists thought to be linked with the species now placed in *Pelomyia* and *Pelomyiella,* and others wished to shift to it the large complex of species described under the genus name *Rhicnoessa.* Hendel (1934, p. 38) discovered that *T. illota* and another European species lack the usual bristle beneath the prothoracic spiracle and thus differ from the *Rhicnoessa* group with which they are most closely allied. Among the American species there is but one that does not have the stigmatical bristle, and it is here listed as a *Tethina* rather than in *Rhicnoessa,* though it is included in the key to the latter genus.

Tethina angustifrons, new species.

Length 2 mm. Cheeks about one-fourth the height of the obliquely rounded eyes, pale yellow, the vibrissal angle directly under base of antennæ, oral hairs pale; face pale yellow, concave in profile, the median keel visible; front scarcely wider than the eye, tapering anteriorly, the sides nearly straight, centrally luteous, orbits whitish, three widely separated fronto-orbitals, three minute intermediate hairs, six minute pale hairs in each of the two interfrontal rows; ocellar triangle and occiput cinereous, the two narrowly separated cervical oval spots scarcely silvery; antennæ and arista yellow; mouthparts light yellow. Thorax heavily cinereous, one presutural and three postsutural slender dorsocentrals, acrostichals and other hairs fine and sparse, mesopleural hairs sparse and minute, only one propleural hair above front coxa, the stigmatical absent. Abdomen cinereous, though less dense, incisures whitish, hairs sparse, small and blackish; genitalia yellowish below. Last tarsal joint scarcely darker. Wings nearly hyaline, all veins pale yellow, anterior crossvein at two-fifth discal cell, posterior crossvein three-fourths as long as last section of fifth vein.

Seventeen specimens; Asilomar, Morro Dunes, Pismo Beach, along the Southern California seacoast, various dates, July to October.

The absence of the stigmatical bristle over the front coxa places the species in the genus *Tethina,* as restricted by Hendel. The species agrees well with Williston's description of the West Indian *Anthomyza xanthopoda,* but cannot be the same because of the great difference in their habitats. Williston stated that in his species the hairs of the mesonotum are bristle-like. If this indicates a setose condition, such as in *horripilans* or *spinosula,* the two species are widely different.

Rhicnoessa Loew

Loew, 1862, p. 174; 1865, p. 34. Hendel, 1902, p. 261. Williston, 1908, p. 292, fig. 13. Hendel, 1911, p. 41; 1917, p. 46. Melander, 1913, p. 298. Malloch, 1913, p. 148, fig. 22. Meijere, 1928, p. 78. Curran, 1934, p. 331. Hendel, 1934, p. 46.

Syn. *Tethina* (not Haliday). Collin, 1911, p. 243. Hendel, 1917, p. 46; 1928, p. 108, fig, 179. Sturtevant, 1923, p. 5. Czerny, 1928, p. 3.

The species of *Rhicnoessa* are cinereous, mostly pale colored, often with milky wings, and are adapted for living on sand dunes and the dry beach sand zone. The many outward directed fronto-orbitals are distinctive. There are many species in Europe and North America, and the genus occurs also in South America, northern Africa, Asia Minor, Australia, Hawaii and the Orient. Probably careful collecting in other regions will disclose numerous additional species for the number of known species is related to the number of entomologists searching them, rather than a final accounting of the actual fauna.

KEY TO THE NORTH AMERICAN SPECIES OF RHICNOESSA

1. Cheeks broad, one-half to three-fourths as deep as eye-height, rarely two-fifths, slightly narrower in male than in female 2

Cheeks narrower, about one-third the eye-height, front narrow, orbits whitish, antennæ mostly yellow 13

2. All hairs of head, body, femora and tibiæ white (notal hairs of *willistoni* sometimes black) 3

All bristles and hairs of upper part of body black; three fronto-orbitals stronger than the lower ones and alone directed outward 7

3. All bristles of body and legs white as well as the hairs; five or six nearly uniform fronto-orbitals regularly decreasing anteriorly and all directed outward 4

At least apical scutellars black, some notal bristles sometimes black. 5

4. Coxæ and legs yellow; veins whitish. (Atlantic coast and Gulf of Mexico) .... *albula* Loew

Coxæ and femora blackish cinereous; veins brownish. (Bermuda) **bermudaensis,** new species

5. Width of front at ocelli three-fourths the length, the sides curving out; all bristles of head white 6

Width of front at ocelli about two-thirds the length, the sides nearly straight; fronto-orbitals reclinate, the upper two usually black. (Gulf of Lower California) .... **sonorensis,** new species

6. Coxæ and femora mostly blackish in ground color. (California) **variseta,** new species

Coxæ and legs yellow, femora sometimes slightly darker in part. (West Indies) .... *willistoni* Melander

7. Last section of fifth vein about three times posterior crossvein; abdominal hairs rather sparse; front coxæ with pale hairs or bare. 8

Last section of fifth vein about twice as long as posterior crossvein or less; hairs of coxæ black 10

8. Anterior crossvein at basal third of discal cell, wings smoky hyaline, widest just before end of fifth vein, veins strong and blackish; thorax testaceous, abdomen shining; two rows of acrostichals; legs yellow. (California) .... **angustipennis,** new species

Anterior crossvein at or beyond middle of discal cell; thorax pollinose; veins thin and pale 9

9. Coxæ and femora cinereous blackish; about four rows of acrostichals; wings rather milky, widest at end of first vein; body cinereous black; two presutural dorsocentrals. (Atlantic coast) .... *parvula* Loew

Coxæ and legs wholly yellow, not cinereous; two rows of acrostichals; wings yellowish hyaline, widest at posterior crossvein; one presutural dorsocentral; ground color of body rather rosaceous, abdomen subshining. (California) .... **lavendula,** new species

10. Wings widest at posterior crossvein; abdomen and femora subshining black; all hairs weak and sparse, acrostichals in two rows; the three fronto-orbitals widely spaced; female styles with

retrorse spinules. (California) .... **denudata**, new species

Wings widest at end of first vein; abdominal hairs strong; acrostichals in four rows; femora cinereous 11

11. Cheeks three-fourths as wide as eye-height; antennæ brown; coxæ and legs more or less black; abdomen black. (Pacific coast) **horripilans**, new species

Cheeks about half the eye-height; antennæ light brown 12

12. Middle keel of face not extending beyond third antennal joint; coxæ and legs usually pale, male femora swollen; abdomen more or less yellowish, female styles long, slender and pale yellow; notum sometimes with weak brown vittæ. (Baja California and California). (If hairs of coxæ are yellow, see *seriata*, couplet 15. If femora are largely darkened, see *texana*, couplet 13.) *spinosula* Cole

Middle keel of face extending beyond antennæ; legs black and brown, the metatarsi yellow; body cinereous on black ground; last segment of female abdomen studded with retrorse barbs replacing the paired styles. (California) ... **prognatha**, new species

13. Legs yellow; mesonotum with yellowish tone 14

Femora partly browned or blackened; mesonotum with brownish tone, six dorsocentrals; four irregular rows of acrostichals; eyes vertically long; second abdominal segment mostly yellow. (Texas). (If legs are principally black, see *prognatha*, couplet 12.) .... *texana* Malloch

14. Front luteous; hairs of sternopleura, coxæ and legs in part pale 15

Front with brownish anterior margin; last tarsal joint brown. (West Indies) .... *xanthopoda* Williston

15. Stigmatical bristle wanting; four dorsocentrals, two rows of acrostichals; interfrontals minute; last tarsal joint scarcely darker. (California .... **Tethina angustifrons**, new species

Stigmatical bristle present; six fine long dorsocentrals, four rows of acrostichals; interfrontal setulæ strong; last two tarsal joints brownish. (Florida) .... **seriata**, new species

Alphabetical Listing of the Species of *Rhicnoessa*

Rhicnoessa albula Loew

Loew, 1869, Cent. 8, no. 80 (*Rhicnoessa*). Melander, 1913, p. 298 (*Rhicnoessa*). Malloch, 1913, p. 147, fig. 22 (*Rhicnoessa*). Frey, 1918, p. 15 (*Rhicnoessa*). Sturtevant, 1923, p. 6 (*Tethina*). Curran, 1934, p. 330, fig. 2 (*Tethina*). Hendel, 1934, p. 46 (*Rhicnoessa*). Hennig, 1936, p. 140 (*Rhicnoessa*).

The most widely distributed and abundant species along the Atlantic and Gulf coast. I have mounted 330 specimens, representing seaside collecting from Cape Cod to Galveston, encountering the species in Massachusetts, Rhode Island, Connecticut, New York (Long Island), New Jersey, Delaware, Maryland, Virginia, North and South Carolina, Florida, Mississippi and Texas. Frey (1918) reported the species from Rio de Janeiro, Brazil, and Hennig (1936) from Argentine and Chile. Its light color, whitish vestiture and milky wings fit the insect to the dry sand zone.

Rhicnoessa angustipennis, new species

Length 1.5 mm. Head higher than long, eyes oblique, the long diameter one-fourth longer than the short diameter, cheeks almost one-half the eye-height; front luteous extending along each side of the yellowish gray ocellar triangle, the whitish orbits narrowing anteriorly; three fronto-orbitals and about three minor setulæ, two or three pairs of short interfrontal hairs; face shallowly concave, half as long as the front, whitish, the vibrissal angle directly under base of antennæ and rounding into the whitish satiny cheeks; lower half of occiput yellow, upper half yellowish gray, the cervical spots pyriform, almost touching and nearly reaching the vertex; antennæ slightly decumbent, pale yellow, arista brown; mouthparts wholly pale yellow. Mesonotum testaceous, not heavily pollinose, one presutural and three postsutural dorsocentrals, no hairs in dorsocentral rows, acrostichals sparse, in two irregular rows, lateral hairs very sparse; pleuræ light testaceous, almost shining, hairs weak. Abdomen shining, brownish, venter and the narrow incisures yellow, male genitalia polished, rufous, relatively large, the terminal cerci luteous, pale-hairy, the lateral claspers ending in a backward-curved luteous spatula as long as the base (fig. 5); cerci of female studded with retrorse spinules. Coxæ and legs wholly pale yellow, hairs sparse, pale toward base of legs, hairs elsewhere darkened except the glistening sole of the hind metatarsi. Wings peculiar for the genus, discal cell narrow, posterior crossvein about one-fourth as long as last section of fifth vein, anal angle reduced so that the wing is wider at middle than at end of first vein.

Two males and two females, on the dunes northwest of Morro Bay, California, June 17, 1947.

Rhicnoessa bermudaensis, new species

Length 2.5 mm. A hoary gray species with all bristles and hairs whitish, only the minute costal setulæ black. Closely related to *albula* but differing in that the veins of the wings are darker; the coxæ and femora blackish under the heavy white-cinereous coating, only the extremities of the femora yellowish; mesonotum showing a slight but evident brownish tone darker than on pleuræ; and third antennal joint somewhat brownish. In *albula* the thorax is uniformly whitish gray and the antennæ are wholly yellow.

Thirty specimens from a cove on Cooper Island and two from Castle Island, in the Bermudas, January 25, 1934.

Rhicnoessa denudata, new species

Length 1.5 mm. Front occupying about one-third the head, yellowish merging into the darker vertex, orbits scarcely lighter, three fronto-orbitals, the four or five intermediate hairs very minute, three pairs of small interfrontals; face about as long as the front, scarcely concave, vertical, vibrissal angle rounding, cheeks about two-fifths the eye-height, face, cheeks and lower occiput silky creamy, upper occiput brownish; antennæ and palpi pale yellow, geniculation of proboscis light brown. Mesonotum dark brownish, the pollen not dense, one presutural and three postsutural dorsocentrals, two irregular rows of acrostichals, the hairs of pleuræ very small and sparse. Abdomen dark brown, subshining, incisures linear, hypopygium shining, the claspers wide and ending in a large inflexed spatula, female cerci short and thick, only twice as long as wide and studded with retrorse barbs. Coxæ brown, femora piceous with the extremities narrowly paler, tibiæ and tarsi wholly yellow. Wings nearly hyaline with a yellow tinge, veins thin and yellowish brown, anterior crossvein at two-fifths the discal cell, last section of fifth vein slightly longer than posterior crossvein.

Seven males and eighteen females, all from the edge of the dunes at the seashore, Carpenteria, California, collected from sand verbena on three successive visits: August 28, 1945, October 8, 1946, and June 15, 1947.

The species is readily characterized by the small size, reduced hairs, barbed ovipositor and diminished anal angle of the wings.

Rhicnoessa horripilans, new species

Length 2.5 to 3 mm. Body black, heavily coated with cinereous, the abdomen with blue-gray tone, bristles and setulæ unusually strong. Head as long as high, the face concave and rounding into the cheeks, vibrissal angle under base of antennæ; eyes small and round, cheeks about as deep as eye-diameter; front occupying half of head, reddish merging into the cinereous vertex and into the unusually wide whitish orbits, usually four long fronto-orbitals, sometimes three, three pairs of long interfrontal setæ which are about twice the antennal length, ocellar bristles and two pairs of ocellar setæ long; face and cheeks pruinose yellow, upper occiput cinereous, cervical spots elongate; antennæ reddish brown, arista brown; proboscis fuscous, palpi luteous. Mesonotum pure gray, the vestiture coarse and long, two presutural and three postsutural dorsocentrals, four irregular rows of acrostichals, lateral bristles and setules strong, the hairs of meso- and sterno-pleura relatively long. Incisures of abdomen very narrowly whitish, abdominal pile long fine and black, genitalia small, reddish below. Coxæ and legs mostly cinereous blackish, hairs rather long, fine and black, knees, ends of tibiæ and the tarsi except last joint yellowish. Wings hyaline with slightly opalescent tinge, front and hind margins subparallel, veins yellow, costal setulæ strong and black, anterior crossvein at middle of discal cell, posterior crossvein almost as long as last section of fifth vein.

One hundred seventy specimens taken along the seashore. Types: Ilwaco, Washington, July, 1917. Other localities are: Washington; Copalis (August 14, 1921; September 5, 1934); Kaloloch (September 5, 1934); Long Beach (August 30, 1921). Oregon; Waldport, (September 13, 1934). California; San Francisco, Golden Gate Park (June 22, 1947). The vestiture of the female is not as coarse as that of the male. *Horripilans*, Latin, bristling with hairs on end.

Rhicnoessa lavendula, new species

Length 1.6 mm. Front, face, cheeks and lower occiput flavous, the frontal orbits yellowish white; three outward directed fronto-orbitals and about four minor hairs, three pairs of small interfrontal hairs; ocellar triangle scarcely darker, the small postvertical bristles twice as far apart as the ocellars; occiput cinereous, the cervical marks weak and separated; cheeks about half the height of the obliquely oval eyes whose longest diameter is but one-sixth greater than the shortest; antennæ and mouthparts wholly yellow. Mesonotum covered with yellowish gray pollen, the ground color reddish yellow, dorsocentrals long and slender, one presutural and three postsutural, acrostichals small and very sparse, irregularly biseriate. Abdomen lightly pollinose over a piceous ground color, the incisures narrowly yellow; genitalia small and shining. Hairs of lower occiput, coxæ and legs brownish. Anterior crossvein at middle of discal cell.

Two males, Huntington Beach, California, June 4, 1945; one female, Balboa, California, July 13, 1940. The combination of pollen and ground color gives the impression of a ruddy lavender tone; hence the specific name.

Rhicnoessa parvula Loew

Loew, 1869, Centuries 8: 81 (*Rhicnoessa*). Hendel, 1934, p. 48 (*Rhicnoessa*).

Syn. *whitmani* Melander, 1913, p. 298 (*Rhicnoessa*). Sturtevant, 1923, p. 6 (*Tethina*, syn.).

The species is common along the North Atlantic coast, occurring in association with *R. albula*. I have mounted 170 specimens in seaside collecting from Maine, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware and Maryland, but have not encountered it further south. The references to Pacific coast material in my 1913 paper were due to misidentification of *parvula* and refer to *Pelomyiella melanderi* and *mallochi*.

Hendel's *parvula* (1911) is *melanderi;* Malloch's *parvula* (1913) is *Pelomyiella maritima*. Coquillett's references to the occurrence of *parvula* in Alaska probably refer to *melanderi*.

Rhicnoessa prognatha, new species

Female. Length 3 mm. Body black, with cinereous coating, the bristles and hairs strong. Front one-third the head, luteous, the ocellar triangle darker, face and cheeks yellow, occiput cinereous piceous, cervical spots circular, almost touching; nine intermediate setulæ in frontal row, three pairs of interfrontals; eyes strongly oblique, cheeks nearly half the eye-height; antennæ rufous, the third joint darker above, base of arista black; mouthparts yellowish. Mesonotum with numerous setulæ, one presutural and three postsutural dorsocentrals, acrostichals in about four rows, hairs of pleuræ evident. Abdomen cinereous black, concolorous with thorax, the hairs coarse. Coxæ and femora cinereous black, hairs strong, tibiæ blackish brown, tarsi brown, hind metatarsi with golden pile. Wings pale smoky hyaline, the alula and anal angle somewhat whitish, veins light brown, pale basally, anterior crossvein at middle of discal cell, posterior crossvein three-fifths as long as last section of fifth vein.

Holotype: a single specimen collected September 6, 1945, on the dunes west of Morro Bay, California. The species is remarkable in the protruding face and in the unique spinose hemitubular eighth segment of the abdomen which shows no trace of division into the usual two slender styles. Often in other species of *Rhicnoessa* the two styles seem to be stuck together, but then show their paired nature by a small cleft at the apex.

Rhicnoessa seriata, new species

Length 2.2 mm. Cheeks one-third the eye-height, the eyes rotund and scarcely higher than broad, oral setulæ strong; face concave, the lower angle under base of antennæ, the middle carina narrow, the side ridges not attaining the vibrissæ; front one-third the width of the head, uniformly tapering, luteous, the orbits flavous, the lowest of the three strong fronto-orbitals closer to the uppermost than to the antennæ, five or six minor fronto-orbitals, three or four pairs of strong interfrontal setulæ, ocellar triangle and upper occiput gray, lower occiput and its hairs yellow, cervical spots ovular and separated, distance between postverticals twice that between ocellars; antennæ wholly yellow; mouthparts yellowish, the palpi paler. Mesonotum heavily cinereous with slight reddish yellow tone, bristles and hairs long, two presutural and four postsutural dorsocentrals, acrostichals rather sparse, in four rows; tip of scutellum reddish, pleuræ cinereous over a reddish ground color, hairs of lower sternopleura and coxæ yellow, both propleural bristles equally long. Abdomen blackish beneath the sericeous coating, incisures and last segments yellow, hairs coarse. Coxæ and legs flavous, the last two tarsal joints brownish, femoral hairs not strong. Wings nearly hyaline with milky tinge, widest at end of first vein, veins thin and pale yellow, anterior crossvein at middle of discal cell, posterior crossvein two-thirds as long as last section of fifth vein.

One male and three females, Miami, Florida, April 20, 1930; one female, Matecumba, in southern Florida, February 1, 1933; one male, Naples, on the Gulf coast of Florida, January 27, 1932. If the cheeks are regarded as more than one-third the eye-height the species keys to *spinosula,* from which it differs in having the hairs of the coxæ and sternopleura pale and the femora entirely light yellow.

Rhicnoessa sonorensis, new species

Length 2 mm. Thorax black, heavily coated with cinereous, a shining area above neck, abdomen less densely cinereous, the hind margins of the segments white, venter largely whitish, genitalia concolorous, cinereous above and whitish below, styles of female whitish. Head slightly higher than long, eyes round; front light yellow, a little darker in back on the cinereous ocellar triangle, five or six gradually decreasing pale fronto-orbitals which are bent back rather than outward, the upper two almost always black, three pairs of interfrontal whitish hairs; face concave, not protruding, but the median carina strong; antennæ yellow, arista light brownish; mouthparts pale yellow, the middle section of proboscis brown; cervical spots contiguous. One presutural and three postsutural dorsocentrals, acrostichals loosely in four rows, all hairs and nearly all bristles whitish, the scutellars black; abdominal hairs long and white. Coxæ, legs and hairs yellow, last tarsal joint slightly darker. Wings subhyaline, alulæ and posterior portion somewhat milky, veins light brownish becoming whitish at base, costal hairs black, anterior crossvein at middle of discal cell, posterior crossvein half as long as last section of fifth vein.

Twenty-four specimens, taken in a salt marsh at Rocky Point, at the head of the Gulf of Lower California, Sonora, Mexico, on April 21, 1947 and April 21, 1948. The species differs from *variseta* in having fewer notal hairs, there being about three irregular rows of hairs lateral to the dorsocentral row, whereas in *variseta* there are about four such rows.

Rhicnoessa spinulosa Cole

Cole, 1923, p. 478 (*Tethina*). Hendel, 1934, p. 41 (? *Tethina*).

Because the description states that one propleural bristle is present Hendel thought that the species should be assigned to *Tethina,* sensu stricto. I have collected a series of bristly flies from the Southern California coast that otherwise agree with the description, but which have two long bristles over the front coxæ. Through the courtesy of Dr. Frank R. Cole, and again of Drs. E. S. Ross and E. L. Kessel of the California Academy of Sciences, a set of the original paratypes of *spinulosa* has been sent to me. They prove to be the same as those I have collected, or a species so closely allied that the two are taxonomically incapable of separation. The species was originally described from the east shore of Baja California, so in terms of coastal mileage the species either has a wide range, like its counterpart, *horripilans,* to the North, or else two incipient species are involved.

Rhicnoessa spinulosa is well named. However, the specimens from the Gulf of Lower California consistently have finer bristles and setulæ than those from California. The coarseness of the vestiture is quite variable in the related *horripilans,* but nearly all the specimens of *spinulosa* I have collected are more heavily spinose than the Mexican specimens. The size of a hair is an elusive character to describe and can be appreciated only by direct comparison. The robust front and hind femora of the male are distinctive, the middle femora being lighter in color than the other pairs.

On various dates from July to October I have collected some forty specimens from the sea beach in Southern California, at Palos Verdes, Seal Beach, Balboa, Corona del Mar and Laguna Beach. I have also taken the species at Rocky Point on the Gulf of Lower California.

Rhicnoessa texana Malloch

Malloch, 1913, p. 148 (*Rhicnoessa*). Sturtevant, 1923, p. 7 (*Tethina*). Hendel, 1934, p. 50 (*Rhicnoessa*).

Eyes almost vertically oval, about one-third higher than long; antennæ brown, the base yellow; femora more or less blackened, tibiæ yellow; body dusted with pale gray, the mesonotum slightly brownish; abdominal incisures narrowly pale. (Diagnosis verified from the type in the National Museum).

The types from the Texas coast are the only recorded specimens.

Rhicnoessa variseta, new species

This Pacific coast species is very much like *albula,* its Atlantic coast counterpart, in structure, coloration and the covering of white hairs. It is distinct in that some of the bristles are black, at least the apical scutellars are always black, which is never the case in the large number of specimens of *albula* that I have collected all along the seacoast from Maine to Texas. There is variability in the number of black bristles, sometimes both pairs of scutellars, sometimes some of the dorsocentrals, or the supra-alar or postalar bristles are also black. The legs are darker than is usual in *albula,* the coxæ and femora being mostly blackish in ground color under the heavy cinereous coating. The base of the third antennal joint is brownish. The five or six fronto-orbitals are directed outward and are regularly decreasing in size anteriorly as in *albula.*

Nineteen specimens: Long Beach, Seal Beach, Huntington Beach, Balboa and Corona del Mar, all in Southern California, May to July. Because *variseta* and *albula* are separated by a continent the two forms are regarded as distinct species.

Rhicnoessa willistoni Melander

Melander, 1913, p. 298 (*Rhicnoessa*). Hendel, 1934, p. 51 (*Rhicnoessa*).

Syn. *Anthomyza cinerea* (not *Rhicnoessa cinerea* Loew, 1862) Williston, 1896, p. 444, fig. 170. Czerny, 1902, p. 256 (*Rhicnoessa*).

I have received two specimens from C. W. Johnson, collected in Jamaica, which he considered to be this species. They agree with the description except that all the setulæ are white. Williston stated that the notal hairs are black. This I interpret to be a locality variation rather than a species distinction, because the type specimens came from St. Vincent. The thoracic and scutellar bristles are black.

Rhicnoessa xanthopoda Williston

Williston, 1896, p. 445, fig. 170 (*Anthomyza*). Czerny, 1902, p. 256 (*Rhicnoessa*). Melander, 1913, p. 298 (*Rhicnoessa*). Hendel, 1934, p. 51 (*Rhicnoessa*).

I have not seen this species, but accept Czerny's opinion that it is a *Rhicnoessa*. Visualizing the description, it seems that the insect bears a resemblance to the Californian *Tethina angustifrons*.

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(JOUR. N. Y. ENT. SOC.), VOL. LIX (PLATE VII)

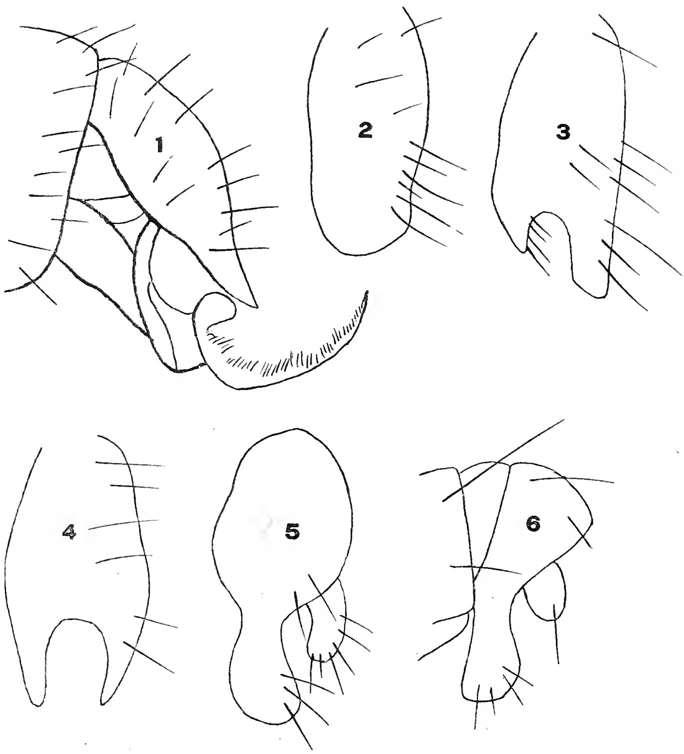

PLATE VII

Fig. 1, Pygidium of *Pelomyia coronata;* figs. 2, 3, 4, left valve. Fig. 5, left valve of *Rhicnoessa angustipennis.* Fig. 6, Pygidium of *Phycomyza milichioides.*

TEMPERATURE EFFECTS ON THE PREVALENCE OF MALE AND FEMALE DROSOPHILA MELANOGASTER MEIGEN[1]

By D. D. Williams
Department of Anatomy, Stanford University
Stanford, California

Introduction

Interest in the correlation between climatology and the occurrence of different species of *Drosophila* has been increasing during the past decade. However, most of the emphasis has been on systematics. An incredible number of *Drosophila* have been collected and classified, but the precise weather conditions at the time of collecting have often been only roughly estimated, if noted at all. In this study the emphasis was placed on the temperature at the time of collecting.

Materials and Methods

This study was begun in September of 1949 and continued until September of 1950. The paper cup type of traps were employed throughout. The size of the cups were $3\frac{3}{4}'' \times 3''$. Bananas and

TABLE I

The collection data for *Drosophila melanogaster.*

Temperature in degrees Fahrenheit	Total number of *melanogasters*	Per cent of total which are males	Per cent of total which are females	Number of collections	Average no. of *melanogasters* per collection	Number of paper cup type traps
50–60	1523	65.2	34.8	12	126.9	4
60–70	1876	61.1	38.9	10	187.6	4
70–80	3955	51.0	49.0	15	263.3	4
80–90	4882	31.5	68.5	14	348.7	4

[1] The author wishes to acknowledge his indebtedness to Dr. David D. Perkins of the Stanford University, Department of Biological Sciences for his constructive criticism and financial aid in this study.

yeast were used for bait. Traps with fresh bait were exchanged for the old traps every seven days. In this manner the condition of the bait was maintained quite constant, and the error due to the hatching of eggs in the food is eliminated. The funnel and jar type collector as described by Williams and Miller (3) was used to collect from the traps.

The traps were hung in wooded areas where the sun rays could not strike them directly. Temperature readings were recorded

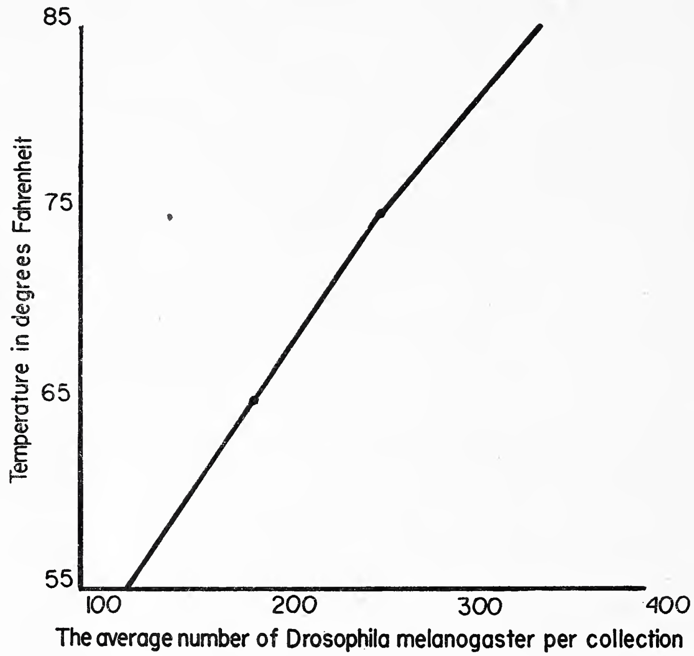

FIG. 1. This graph demonstrates that the prevalence of *Drosophila melanogaster* increases as the temperature increases.

at the site of the traps at the time of collecting. The specimens were etherized in the laboratory and identified as to species and sex.

FLUCTUATIONS OF THE MALE AND FEMALE POPULATION OF *Drosophila melanogaster*

After analysis of many collection records over a long period of time and over a great diversity of temperature changes in different parts of the Southwest, Patterson (1) came to the conclusion that *Drosophila melanogaster* was predominant over *Drosophila simulans* in the colder seasons or regions, whereas *simulans* was predominant in the warmer seasons or regions. Thus *melano-*

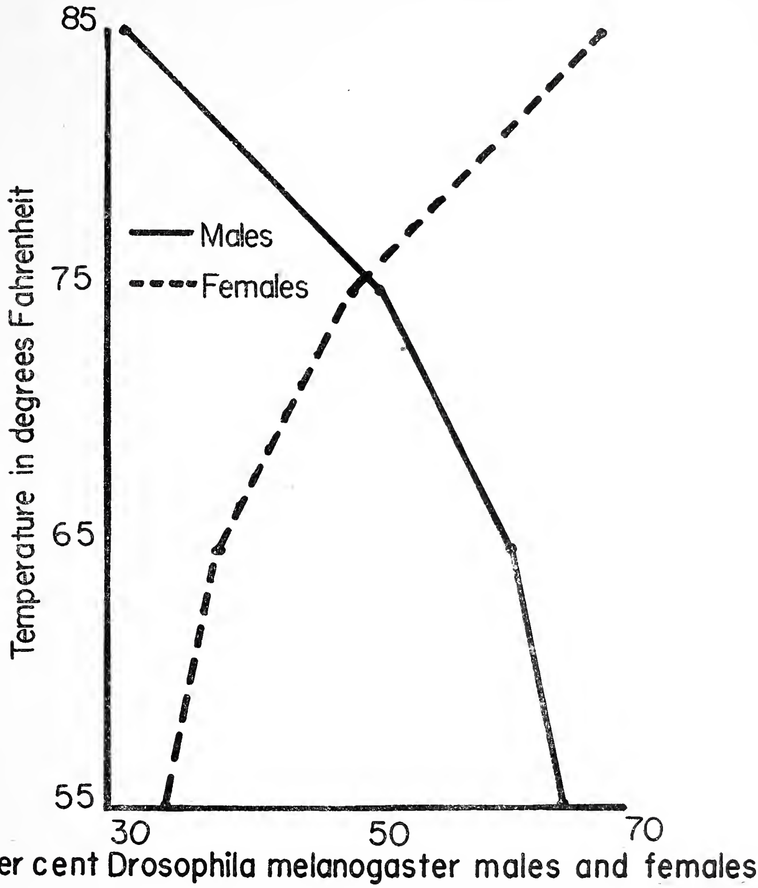

FIG. 2. This graph demonstrates that the percentage of *Drosophila melanogaster* females increases as the temperature increases.

gaster attained its population peak in the spring and *simulans* in the late summer or fall when the temperature was at its highest.

Williams and Miller (3) reported that *Drosophila melanogaster* reached its population peak in September when the temperature was at its highest. *Drosophila simulans* also attained its population peak in September, but at no time was *simulans* so numerous as *melanogaster*.

Spiess (2) also found that *melanogaster* reached its highest population peak in September, although the temperature was considerably higher in August. *Drosophila simulans* likewise attained its population peak in September, and its peak was higher than that for *melanogaster*.

In the present study *Drosophila melanogaster* appeared first in July and reached its population peak in the warmest month, September. The collection data for *melanogaster* are given in Table I. Figure 1 illustrates the increase in prevalence of *melanogaster* with temperature increases.

When collections were first begun for this study, it was noted that *Drosophila melanogaster* males were more numerous than the *melanogaster* females at a cooler temperature, but with a rise in temperature, the females increased greatly in numbers until they were predominant over the males. This relationship is illustrated graphically in Figure 2.

Other species of *Drosophila* collected during this study are *pseudoobscura, melanopalpa, hamatofila, immigrans,* and *busckii.*

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WILLIAM PROCTER, 1872–1951

William Procter died at Palm Beach, Florida on April 19, 1951. He was the grandson of a founder of the firm Procter and Gamble. According to S. J. Woolf, his grandfather borrowed one thousand pounds from Sir John Lubbock and came to this country to seek his fortune. He began as a candle maker, then switched to the manufacture of soap in a partnership with his brother-in-law, named Gamble. By the time William Procter was born at Cincinnati, on September 8, 1872, the loan had been repaid and the business was highly successful.

After graduating from Phillips Exeter, William Procter majored in chemistry as an undergraduate at Yale, obtaining his Ph.B. in the Sheffield Scientific School in 1894. Following this he spent three years in Europe with a year in the laboratory at the Sorbonne. For the next twenty-five years he was in the investment business and specialized in railroad securities. He organized the firm Procter and Borden in 1902, retiring from it in 1920. However, he still continued his business interest as a director in Procter and Gamble and was a regular attendant at board meetings. During his boyhood summers at Newtown, Connecticut, he became interested in biology, especially insects, and at the age of forty-five he enrolled as a graduate student in the department of zoology at Columbia University, where he studied from 1916 to 1920. At this time he was elected to Sigma Xi. A few years later he founded the Biological Survey of the Mount Desert Region, Inc., of which he was the director and president from 1928 on.

The New England Society of Natural History in connection with its work on the fauna of New England selected, in 1918, Mt. Desert Island as a place for part of its summer work, and Charles W. Johnson the curator and well-known dipterist spent ten days to two weeks collecting on the island each summer until 1926. Part I of the Survey was the result of their joint efforts, and it was devoted to the insect fauna. Parts II, III, IV and V were devoted to the marine fauna, etc. Part VI was a revision of Part I, and Part VII, which I think was the last to appear, was a revision of Parts I and VI with the addition of one thousand one hundred species. It is entitled ''Biological Survey of the Mount Desert Region, Inc., Part VII, The Insect Fauna'' by William Procter. It was published by The Wistar Institute of Anatomy and Biology, Philadelphia, 1946, and was privately printed and financed by Dr. Procter as were all his surveys of the Mt. Desert region. These faunal lists go far beyond being mere catalogues of names.

In 1936 the University of Montreal conferred the degree Sc.D. upon him. From 1928 to 1936 he was research associate of the Academy of Natural Sciences of Philadelphia. From 1929 to 1936 he was on the board of managers of the Wistar Institute. He was also connected with the Plymouth Marine Laboratory, England. In addition he served, from 1931 to 1951, as a trustee of the American Museum of Natural History, and as a member of the advisory board of the department of zoology of Columbia University. He belonged to the AAAS, the Entomological Society of America (of which he was a fellow), the Ornithological Union, The Scientific Research Society, the New York Entomological Society, the Brooklyn Entomological Society, the Southern California Academy of Science, the Royal Academy of Science of Canada, and the London Ray Society.

He was particularly interested in Sigma Xi and the recently organized Scientific Research Society of America. According to Dr. Donald B. Prentice, director of the latter, Dr. Procter's generous annual contributions to Resa permitted its establishment without financial assistance from Sigma Xi. His will provides generous bequests to both societies. In 1950 Dr. Procter established the William Procter Prize for Scientific Achievement. The first award of $1,000 was made to Dr. Karl T. Compton at Cleveland in December, 1950. Resa administers the award and provision was made by Dr. Procter for its continuance. During his lifetime Dr. Procter often made donations in support of other scientific endeavors. He designed the laboratory at the Wistar Biological Farm near Philadelphia in which the temperature is kept uniform throughout the year by the circulation of spring water around the walls.

Of late he spent his summers at Bar Harbor, Mount Desert

Island, Maine, and his winters at Florida. His wife's death preceded his by less than two years. A good likeness of Dr. Procter appeared in the American Scientist for October, 1947, this being a sketch from life together with an interview, both by S. J. Woolf. This present notice is based partly on S. J. Woolf's account, on the obituary of Dr. Procter by Donald B. Prentice in the American Scientist for July 1951 and on the facts in the eighth edition of American Men of Science. He had no children.

Because of Dr. William Procter's accomplishments in entomology and other branches of biology, his conscientious discharge of his many administrative responsibilities, his understanding aid to our own and other organizations of kindred objectives, and the stimulating qualities which he contributed to any gathering in which he participated, the New York Entomological Society records its profound regret at the passing of this valued member from our midst.—H. B. W.

THE NATURALISTS' DIRECTORY

The thirty-sixth edition of this directory was published in June, 1951. First published in 1878, it has appeared at two or three year intervals. The directory is useful in providing names and addresses and subjects of interest of naturalists. It also contains a list of Natural History Museums and Scientific Periodicals.

The Naturalists' Directory is published by Herman E. Cassino, Salem, Massachusetts and sells for $3.00.—F. A. S.

BOOK NOTICE

Horned Beetles, A Study of the Fantastic in Nature by Gilbert J. Arrow, edited by W. D. Hincks. Dr. W. Junk, The Hague. Netherlands. 1951. $8\frac{1}{4} \times 6$ inches. 154 pp. + 15 plates. Dutch Guild. 8.80.

This book brings together the thoughts of the late Gilbert J. Arrow of the British Museum on reason and purpose for the development of ''horns'' in Lamellicorns and other beetles, a subject which interested him and to which he devoted a great deal of study during his long life. An author's index, subject index and selected bibliography have been added, but otherwise the text remains as it was at the death of its author on October 5, 1948.

The book introduces the subject, then in the remaining eight chapters covers; horns and similar features in beetles; the habits of beetles; horns in male and female beetles; mandible-horns; outgrowth horns; comparison with higher animals; Darwin's theory of sexual selection, and the origin and significance of beetle horns.

This book is of importance to the coleopterist and the naturalist. It is shown that there is no quick, simple explanation of the significance of beetle horns. Many facts are given to show their lack of contribution to the welfare of either the male or female sex. Charles Darwin in his ''The Descent of Man'' concluded that insect horns might best be explained as ornaments serving to attract the opposite sex. But this is shown to be not true, since the female has little opportunity nor ability to exercise selection in the process of mating. It is concluded that beetle horns are, generally, quite useless and although Mr. Arrow has considered the evidence in support of all theories, he is unable to assign a real function to these interesting structures.

This is a well written and interesting book and is a valuable contribution to the study of the fantastic in nature.—F. A. S.

NOTE ON A GYNANDROMORPH IN AMBLYOPONE AUSTRALIS ERICHSON (HYMENOPTERA: FORMICIDÆ)

By Caryl P. Haskins

With the exception of Wheeler's report of an anterio-posterior gynandromorph in *Ponera coarctata pennsylvanica* Buckley (1931) and Tulloch's description of a gynergate in *Promyrmecia aberrans* Forel (1932) there have been relatively few cases reported of either sex or caste mosaics in Ponerine ants, despite the rather numerous cases of such mosaics reported in higher forms by Wheeler (1914, 1919, 1923, 1931, 1937) and others. The occurrence of a roughly bilateral queen-male gynandromorph in the archaic Australian Ponerine ant *Amblyopone australis* Erichson, therefore seems worth recording.

This individual was found in a group of cocoons and workers of *A. australis* which had been collected by Mr. John Clark at Ferntree Gully, near Melbourne in Victoria, and most kindly sent to the authors in a living condition. When received, on February 25, 1947, the majority of the cocoons had hatched, disclosing predominantly sexual adult forms, most of which were living. The gynandromorph was found dead among the debris of the nest, evidently having hatched during shipment and died very shortly before being found, since it was in perfect condition and the portions of female tissue still showed the rich red callow coloration characteristic of the species. It showed no evidence of having been molested by other adults. The fact that it had hatched successfully was rather remarkable, since, as one of the mandibles was of the short, slightly developed form characteristic of the male, while the other was of the huge, projecting structure characteristic of the female, it can hardly have emerged through its own efforts. This suggests that, although young imagoes of *Amblyopone australis* are fully capable of emerging from their cocoons without the assistance of adult nurses, they may receive such assistance under normal conditions.

This distribution of male and female tissue was roughly bilateral in the head and thorax of the gynandromorph, the right side being female, the left, male. The right antenna, eye, and mandible were typically female, the left antenna, eye, and mandible typically male. Three ocelli were present. There was some intrusion of male tissue to the right side of the median line near the posterior border of the head, and some intrusion of female tissue to the left side in the clypeal region. The pigmentation and sculpturing of both male and female tissue were typical of the species, thus presenting a decided contrast between the dense black of the male (which is fully pigmented on emergence) and the bright reddish brown of the female (which normally retains the callow coloration several days after hatching).

Although the thorax, like the head, showed a roughly bilateral distribution of male and female tissue, it was more nearly a mosaic, with about three-quarters of the area showing male form, pigmentation, and sculpturing. The left wings were male, and fully expanded. Wings were present on the right side, but imperfectly expanded. In each of the left legs, the femur resembled that of the typical male and was deeply pigmented. The tibia and tarsus were pigmented as in the female. Each of the right legs showed characteristic female pigmentation, except that the femur was a little darker than normal. The gaster was of female structure, sculpturing and pigmentation throughout.

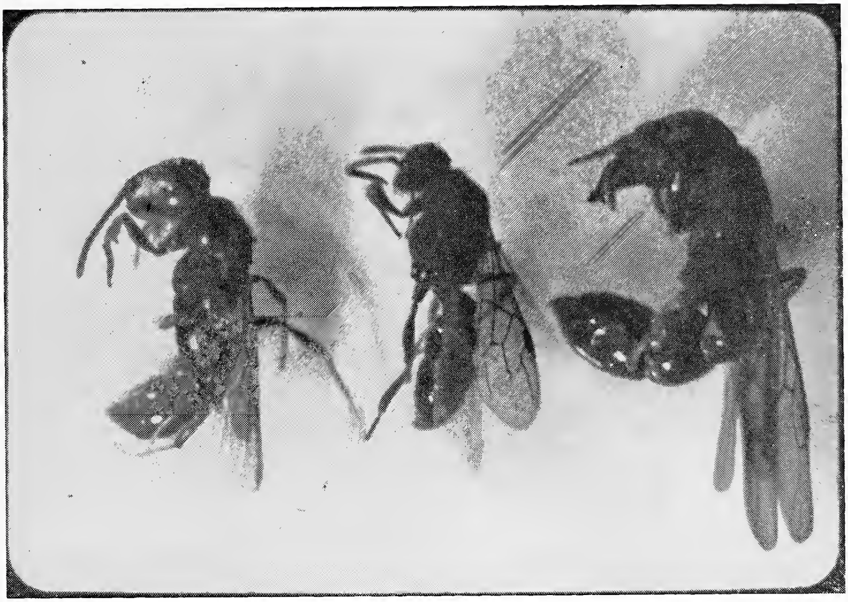
In stature and body measurements the gynandromorph was intermediate between the normal measurements for males and females of *A. australis*. Measurements for the width of the head, taken along the dorsal surface on a line passing through the centers of the compound eyes, and of the total body length, compared with similar measurements for a perfect female and male of the same brood, are given in Table I below.

TABLE I

	Head Width (mm.)	Total Body Length (mm.)
Perfect female	6.0	27.8
Perfect male	3.6	16.0
Gynandromorph	4.4	19.4

The general appearance of the individual, compared with a perfect female and male of its own brood, is shown in Plate VIII.

In its general habitus and in the distribution of male and



Gynandromorph of *Amblyopone australis* Erichson compared with Female and Male of Same Brood.

female tissue, this specimen is characteristic of many gynandromorphs of higher ants which have been described. It is suggestive that, whatever may be the mechanisms underlying sex determination in ants, they were clearly well established at a very archaic period in social development, if indeed (as seems most likely) they were already not well established among the solitary Aculeate progenitors of the ants long before the assumption of the social habit or the evolution of caste dimorphism in the female.

ACKNOWLEDGMENTS

We should like particularly to thank Mr. John Clark of Melbourne, Victoria for his kindness, among many others, in collecting this material and sending it to us for study.

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THE LARVAL STAGES AND THE BIOLOGY OF THE MOSQUITO, ORTHOPODOMYIA ALBA BAKER (DIPTERA: CULICIDÆ)[1]

By Orin P. Wilkins[2] and Osmond P. Breland[2]
The University of Texas

Introduction

The writers have been studying tree hole breeding mosquitoes for the past several years, and during this period hundreds of collections have been made from many localities in Texas. *Orthopodomyia alba* Baker is one of the most interesting of these tree hole species, since until recently it was considered to be rare. This species was described in 1936 from Ithaca, New York (Baker 1936) and since that time it has been collected at only a relatively few localities. In most areas, larval collections have usually yielded only a few specimens, but Ross (1947) reported a colony in Illinois that had persisted for several years. This same year, many larvæ were discovered near Austin, Texas (Breland, 1947a; 1947b), and since then numerous specimens have been collected here and at other localities of the state.

Jenkins and Carpenter (1946) have shown that no satisfactory features are known by which the adults of *O. alba* and *Orthopodomyia signifera* (Coq.) can be distinguished. Consequently, positive identification of *O. alba* should at present be based upon the larvæ which are distinct. This species, based upon larval determinations, is now known to occur in one or more localities in Alabama, Illinois, Kentucky, Louisiana, Mississippi, Missouri, New York, North Carolina and Texas (Jenkins and Carpenter 1946; Breland 1947a). The writers have collected *O. alba* near the following localities in Texas: Austin, Bartlett, Helotes, Junction, Marble Falls, San Antonio and Sheffield. All work to date indicates that although the species may be relatively common within a limited area, it is very sparsely distributed over its

[1] Supported by the University of Texas Research Institute.

[2] The writers wish to express appreciation to Miss Grace Hewitt who made the drawings.

range. Even in areas that have been searched intensively over a period of several years, larvæ have been recovered from only a small percentage of the tree holes investigated. Once a colony has become established, however, one may often recover larvæ repeatedly over a period of several years.

THE PRESENT STUDY

The objectives of the present study were to observe the reactions of *Orthopodomyia alba* under field and laboratory conditions, and to find features by which the various larval instars could be distinguished. During the course of the investigation hundreds of collections were made from tree holes. Many tree holes have been checked or collected from once to several times per week during all months of the year. Collections were made from tree holes containing rain water when these could be found, but during long dry spells, tree holes were filled with water from streams. The use of this type of water had no apparent effect upon the breeding habits of the mosquitoes, and this method was used to refill cavities after each collection, if all the water was removed.

Attempts to obtain egg deposition in the laboratory have so far been unsuccessful. This was tried on severol occasions at laboratory temperatures which averaged near 90° F., and in a constant temperature room, used for another purpose, which was kept at approximately 70° F. Humidity was maintained by the use of moist towels over the breeding cages, and tree hole water was supplied in various types of containers. It seems probable that the temperatures involved were either too high or too low, although factors other than temperatures may have been involved.

Larvæ which were used for the instar study were collected in various stages of development, and placed in individual staining dishes in the laboratory. Tree hole water was used which was diluted somewhat with pond water if it was too dark for good observation. It is well known that first instar mosquito larvæ can be distinguished by the presence of egg bursters on the head (EGB, Plate I, fig. 1). Many first instar larvæ of *O. alba* were recovered after it was discovered that this stage often occurs a few days after stream water was added to a dry cavity, or to one from which all the old water had been removed. The instars after the first were determined by the recovery of larval skins after ecdysis in the individual staining dishes.

Larval studies were made from living and freshly killed larvæ, larval skins, preserved and permanently mounted specimens. Examination of freshly killed larvæ of the first instar especially is important, since this stage often becomes distorted if placed on permanent slides. The conclusions to be presented relative to the larval instars are based upon an examination of more than 300 specimens. Most of the first three instars were collected in the region of Austin, Texas although a few specimens were procured from other localities. Many fourth instars were collected from other areas in Texas as noted above.

GENERAL BIOLOGY

Jenkins and Carpenter (1946) state that little is known of the biology of *O. alba*. The adults observed in the present study were not active in breeding cages, but tended to seek dark corners of the cages and to remain there even though attempts were made to dislodge them. On one occasion, several adults accidently escaped from a cage and instead of flying away, most of them alighted upon one of the writers and attempted to hide in folds of his clothing. The adults have been observed in the breeding cages apparently feeding on a sugar solution, but none attempted to bite the arms of the writers, although they were given optunity on numerous occasions.

No eggs of *O. alba* were recovered and consequently nothing is known regarding the egg deposition of this species. *O. signifera* has been reported to deposit its eggs in a cavity just above the water line (Howard, Dyar and Knab Vol. 4, 1917) and also upon the water surface itself (Horsfall 1937). The habits of *O. alba* may be similar.

In this area, most of the cavities in which tree hole mosquitoes normally breed may be dry for several weeks or months during the summer. Debris from these dry cavities was collected and flooded with water in an effort to determine whether or not eggs of *O. alba* were present under these conditions. More than one hundred such samples from several localities have been so treated. To date no *O. alba* have been found, although numerous larvæ of *Aedes triseriatus* Say and *Aedes zoosophus* D. & K. (formerly called *A. alleni* Turner) have been recovered in many samples. In many instances dry tree holes from which material had been taken were filled with stream water and then checked at intervals for young larvæ. In no case were *O. alba* larvæ found less than a week after the cavities had been filled. However, a week to ten days after such procedure, first instar larvæ of *O. alba* have been recovered in several instances. Such observations indicate that *O. alba* survives periods of drouth as adults.

Breeding Habitat and Associated Species: *Orthopodomyia alba* has been reported from several species of trees including "elm" (Baker, 1936), silver maple, pecan and sweet gum (Jenkins and Carpenter 1946). The writers collected the species from elm (*Ulmus crassifolia* Nutt.) and Texas oak (*Quercus texana* Buckl.), but never from artificial containers as has been reported previously (Jenkins and Carpenter 1946).

There is some evidence that *O. alba* in this area is more limited in the type of cavity in which it will normally breed than are some of the other species of tree hole mosquitoes. For several months, records were kept of the type of cavity from which this species was recovered, and there seems to be a definite tendency for the mosquito to deposit its eggs in holes with a relatively small external opening. Out of twenty-seven cavities in which larvæ occurred, twenty-one had an opening of 3 inches or less in diameter and many of these were barely large enough to insert the one-half inch rubber tube used in collecting the mosquitoes. The other openings were four to five inches in diameter with only a single one more than five inches wide. It may be that the size or nature of the available cavities is an important factor that limits the distribution of *O. alba* in a given area.

So far as could be determined there has never previously been a large series of pH readings made upon the water occurring in tree holes; although Seaman (1945) reports that the average pH of a few samples from sycamore trees in which he found *Aedes varipalpus* Coquillett in California was 8.04. A large series of samples in which *O. alba* was found and tested by the writers varied from 7.6 to 8.4.

Before 1947 *O. alba* had always been reported as being associated with *O. signifera* (Jenkins and Carpenter 1946). In 1947 one of the writers (Breland 1947a) noted some collections in the absence of *O. signifera.* Since that time the species has often been found in the absence of *O. signifera,* and in some cases *O. alba* has been the only species present at the time of the collection. At one time or another however, *O. alba* has been found associated with several other tree hole breeding species. These include *Orthopodomyia signifera, Aedes triseriatus, Aedes zoosophus* and *Toxorhynchites rutilis septentrionalis* (Dyar and Knab). This last mosquito, formerly designated as *Megarhinus septentrionalis* D & K, has recently had its name changed twice (Stone 1948; Jenkins 1949).

In view of the fact that the amount of water found in cavities is often limited, attempts were made to rear larvæ in other types of water. A sufficient number of experiments were not performed to allow positive conclusions, but indications are that tree hole water alone or pond water to which a few drops of tree hole water is added at intervals are the best rearing media. High mortality resulted from using only pond water plus small amounts of brewer's yeast.

RESISTANCE TO FREEZING AND DRYING: It is generally accepted that *O. alba* passes the winter as larvæ over a large part of its range (Baker 1936; Matheson 1944). There is considerable evidence, however, that in this area the mosquitoes survive the winter as adults. Although numerous collections have been made during the winter months, no larvæ have been found between November and April. Dry material collected during this period and flooded with water also failed to yield larvæ of this species.

Over fifty larvæ including second, third and fourth instars were used to determine the resistance of the larvæ to low temperatures. The specimens were frozen in a refrigerator in tree hole water and before thawing, were allowed to remain frozen for periods of from two hours to two days. No larvæ survived this treatment. These observations indicate that the larvæ here are physiologically different from those in the northern parts of their range, since Baker (1936) found that the second and third instar larvæ of *O. alba* survived after having been frozen in solid ice for a week.

Fourth instar larvæ were found to be quite resistant to low temperatures as long as the insects were not completely frozen. These included larvæ inside cubes of ice, the centers of which were still liquid, and some that were exposed to alternate periods of cold and laboratory temperatures. Low temperatures ranged from 32.5° F to 36° F. One group was kept in a refrigerator for two weeks at temperatures of from 32 to 33° F. When removed the insects pupated shortly and emerged with a mortality of only some 10 per cent.

It has been noted previously on the basis of limited observations (Breland 1947a) that the larvæ and pupæ of *O. alba* can survive for a time in the absence of free water. Large numbers of larvæ and pupæ were, on several occasions, placed in staining dishes on moist blotting paper upon which there was no free water. A drop or so of water was added at intervals to keep the paper moist. Larvæ died in less than forty-eight hours if the tops were left off the dishes even though the blotting paper was kept moist. When the dishes were kept covered, larvæ survived for as much as ninety-six hours. No larvæ were observed to shed their skins during the treatment. A single specimen pupated but died shortly thereafter. It seems probable that the relatively short survival time of the larvæ in the uncovered dishes was due to the drying of the integument on one side.

Pupæ demonstrated a surprising ability to attain the adult stage under these conditions. Percentage of emergence of a series of test groups varied from fifty to one hundred per cent.

LARVAL INSTARS

The descriptions of each larval instar, as previously indicated, are based upon a study of large numbers of permanently mounted, freshly killed larvæ and larval skins. There is considerable variation among the various instars in the number of branches of some of the hairs and in the number and arrangement of certain other structures. Often the number of structures or hair branches will be different on opposite sides of the body. However, those features present in the first instar are easily correlated with comparable structures in later instars. Most structures are labeled in the drawings of the first instar (Plate IX) while those that are added in later instars are labeled on the drawing of the first stage in which they appear. The comb scales increase in size in older stages although the drawings of these structures of different instars are not drawn to scale. Many of the head hairs increase in number of branches between the first and fourth instars as indicated in the illustrations. However, these changes are not sufficiently abrupt to be of diagnostic value in distinguishing between the various stages.

FIRST INSTAR LARVA: (Plate IX), Fourth instar larvæ of *O. alba* are well known for their hairy appearance and even in the first instar this condition is somewhat anticipated. Several hairs on the head and posterior abdominal segments are two to three branched and some of them have barbs distinguishable under high power (e.g. 880 ×). In all other species of first instar larvæ previously examined by the writers these hairs have been single. From dorsal view the egg burster appears as a transverse heavily chitinized bar or ridge slightly wider in the center (EGB, Fig. 1). It appears to lie in a partial depression the bounds of which are more evident posteriorly. From a lateral view it may be seen that the structure comes to a point near the center. No ventral brush occurs and the dorsal brush consists of two long hairs on each side. There is a single irregular row of comb scales (CS, Fig. 3). The individual comb scale is elongate with a series of teeth distally (Fig. 2). The dorsal plate or saddle (DP, Fig. 3) is represented by a small chitinized cap, while the siphon is chitinized distally. In general, the specimens examined conformed with the key features given by Dodge (1946) for the identification of first instar larvæ to genus.

Since no eggs were discovered, the exact length of the first instar could not be determined. However, on several occasions, eggs were apparently present in water when collected since first instar larvæ appeared later. The first instar stage of larvæ obtained in this way varied from two to four days.

SECOND INSTAR LARVA: (Plate X). A ventral brush appears in this stage with posterior hairs of two or three branches, (VB, Fig. 5), while the egg burster is absent. These features alone are sufficient to distinguish the second from the first instar. The dorsal brush now consists of a single lower caudal hair on each side (LC, Fig. 5) and an upper caudal hair on each side of four or five branches (UC, Fig. 5). The chitinized portion of the siphon has increased in extent and the subventral tuft is attached either just within the edge of the chitin or slightly proximal to it. The comb scales occur as overlapping rows; the individual scales vary in size and shape and are somewhat similar to those in later instars (Plate XIII, figs. 10 and 13).

Several hairs on the head have additional branches and most of them are barbed.

A few second instar larvæ stayed in this instar as long as five and one-half days, but most specimens under observation moulted within approximately three days.

Third Instar Larva: (Plate XI). The point of attachment of the subventral tuft is perhaps the easiest feature by which the third instar may be distinguished from the second. In the second instar this hair is attached to the distal edge of the chitinized area of the siphon or just distal to it (Plate X, Fig. 5). The siphon of the third instar is almost as completely chitinized as in the fourth stage and the subventral tuft is attached well within this chitinized portion (Plate XI, fig. 7). Additional branches have been added in the third stage to the upper caudal hair and to the individual hairs of the ventral brush. The former has seven to ten branches while the posterior ventral brush hairs have four to six. Representative comb scales are illustrated in Plate XIII, figures 11 and 14.

The length of the third instar varied from two to seven days for most specimens but a few remained in this stage for two to three weeks. Mortality was high in those larvæ that were third instar for more than seven days and it is thus believed that a period of more than a week for this stage is abnormal.

Fourth Instar Larva: (Plate XII). A chitinized lateral plate near the base of the anal segment appears for the first time in the fourth instar (LP, Plate XII, fig. 9). The presence of this plate alone is thus assurance that the stage is fourth instar. Each upper caudal hair is ten to fourteen-branched while the hairs of the posterior ventral brush have seven to twelve branches.

The dorsal plate or saddle of the larvæ of *O. alba* has previously been found to vary in specimens collected in the vicinity of Austin, Texas (Breland 1947b). In some of these larvæ the plate completely surrounded the anal segment while in others it was incomplete ventrally. This same situation has been found in other localities.

The lateral hair of the anal segment is usually attached just posterior to the dorsal plate or saddle, but is attached to the posterior edge of the plate in a few specimens. Comparatively speaking it is a more delicate hair, has fewer branches in general and is less conspicuously barbed than in younger instars. This is a rather unusual situation since other hairs noted by the writers become more conspicuous and/or add branches in older instars if they change to a noticeable degree.

The sutural and supraorbital hairs (SU and SO, Plate IX, fig. 1), are sparsely barbed in an occasional specimen, visible under high power.

The length of the fourth instar has been found to vary from four to twenty-three days. More than seventy per cent of the larvæ under observation pupated within seven days to two weeks after the fourth instar was attained. As was true for third instar larvæ, mortality was much greater in those larvæ with the longest developmental period. All that exceeded three weeks in this stage died without pupating or during the process. Pupation was a very critical process in the life cycle of the larvæ under observation and more than ninety per cent of fourth instar larval loss occurred at this time.

STATUS OF *O. Alba*

There has been considerable discussion relative to the status of *Orthopodomyia alba*. To date no constant differences have been noted between the adults and the suggestion has been made that *O. alba* may be simply a genetic variant of *O. signifera* (Jenkins and Carpenter 1946). This suggestion was apparently based principally upon the fact that up until that time *O. alba* had always been collected in association with *O. signifera*.

The writers however, believe that *O. alba* should continue to be given full specific rank. This conclusion is based upon several facts. First, larvæ of *O. alba* have often been collected in numbers not associated with *O. signifera*. Second, no larvæ intermediate between the two types have ever been seen out of hundreds of both species collected from several localities. All have been easy to distinguish, indicating that interbreeding in nature does not occur. Third, the larvæ of the two species may be distinguished beginning with the first instar. That the first instars are distinct has been indicated by Dodge (1946); the present study shows that second and third stages are also different. Fourth, *O. alba* seems to be more limited than *O. signifera* in its choice of breeding habitat suggesting different physiological reactions in the two groups. *O. signifera* may be found in almost any type of tree cavity that contains water, while *O. alba* seems to prefer a cavity with a small external opening.

Incomplete studies by the writers, of adults reared from known larvæ indicate that slight differences between the adults of *O. alba* and *O. signifera* do exist. The results of this work will be published later. However, even though constant adult differences are not found, this should not be sufficient reason to reduce *O. alba* to subspecific rank. The inheritance of an organism expressed in its immature stages should be given as much weight as adult features. This has long been recognized by many workers in mosquito taxonomy and today there are many species that can be more easily distinguished in the larval than in the adult stage. In addition there are others which are distinct as larvæ, but which to date cannot be distinguished as adult females (e.g. *Aedes tormentor* D & K and *Aedes atlanticus* D & K).

SUMMARY

1. The four larval instars of *Orthopodomyia alba* Baker have been described. Eggs have not been discovered.
2. Distinctions between the various stages were determined by rearing larvæ individually and by a study of freshly killed larvæ, larval skins and permanently mounted specimens.
3. The known biology of the species has been summarized.
4. The writers believe that *O. alba* should continue to be regarded as a distinct species rather than as a subspecies or variety. Reasons for this conclusion include the absence of intergrades in larvæ between this species and *O. signifera;* the fact that *O. alba* has often been collected alone; suggested differences

in selection of a breeding habitat and possible differences in the adults of the two groups.

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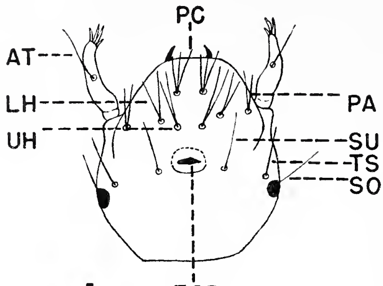

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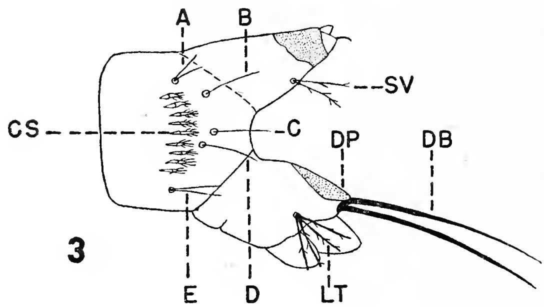

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Explanation of Plate IX

Orthopodomyia alba Baker, first instar larva. Fig. 1, Head. Fig. 2, Representative comb scale. Fig. 3, Posterior abdominal segments.

Abbreviations

A—hair A (Siphonal hair).
At—antennal hair.
B—hair B.
C—hair C (subsiphonal hair).
CS—comb scales.
D—hair D.
DB—dorsal brush.
DP—dorsal plate or saddle.
E—hair E (anal hair).
EGB—egg burster.
LH—lower head hair.
LT—lateral hair, anal segment.
PA—preantennal hair.
PC—postclypeal hair.
SO—supraorbital hair.
SU—sutural hair.
SV—Subventral tuft (siphonal hair).
TS—trans-sutural hair.
UH—upper head hair.

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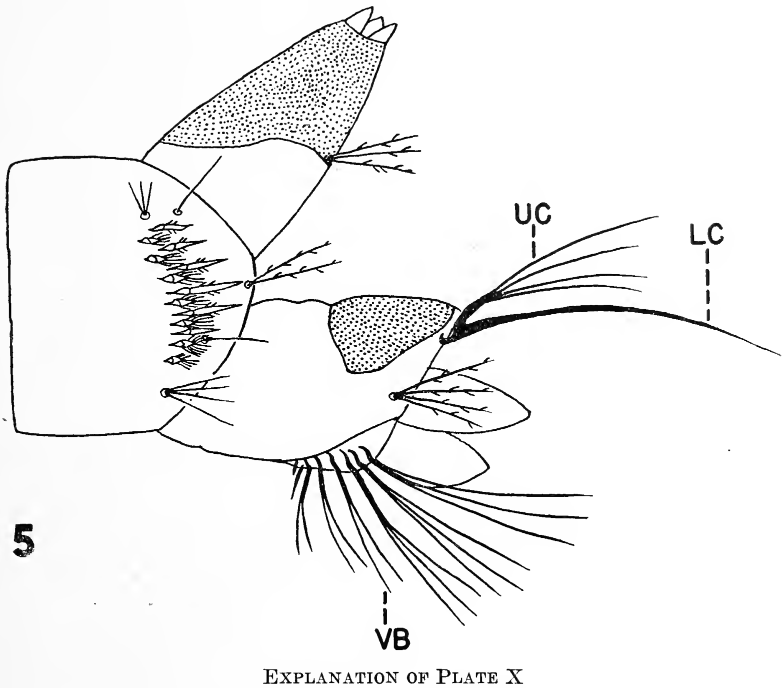

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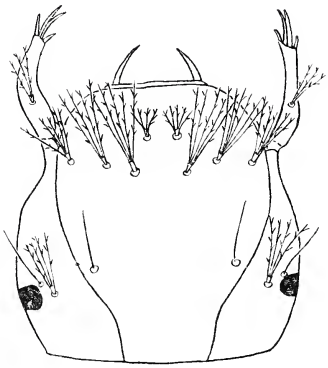
Explanation of Plate X

Orthopodomyia alba Baker, second instar larva. Fig. 4. Head. Fig. 5. Posterior abdominal segments.

Abbreviations

LC—lower caudal hair of dorsal brush.
UC—upper caudal hair of dorsal brush.
VB—ventral brush.



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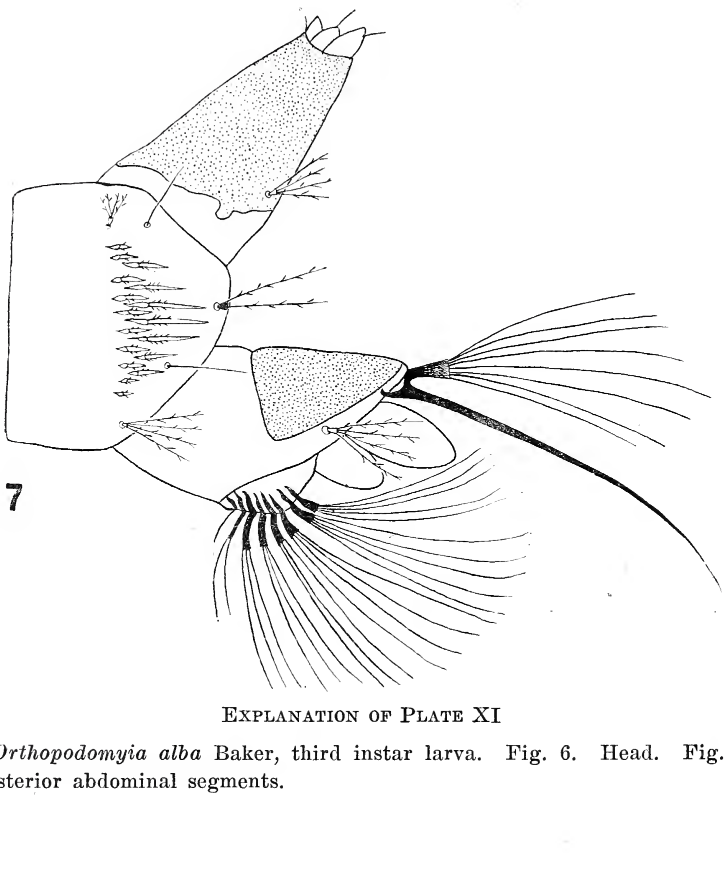

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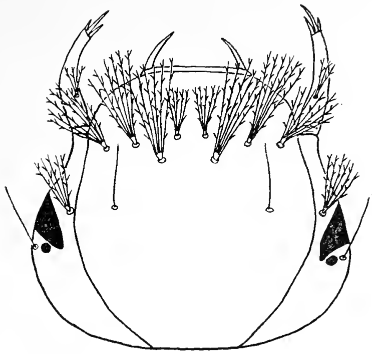
Explanation of Plate XI

Orthopodomyia alba Baker, third instar larva. Fig. 6. Head. Fig. 7. Posterior abdominal segments.



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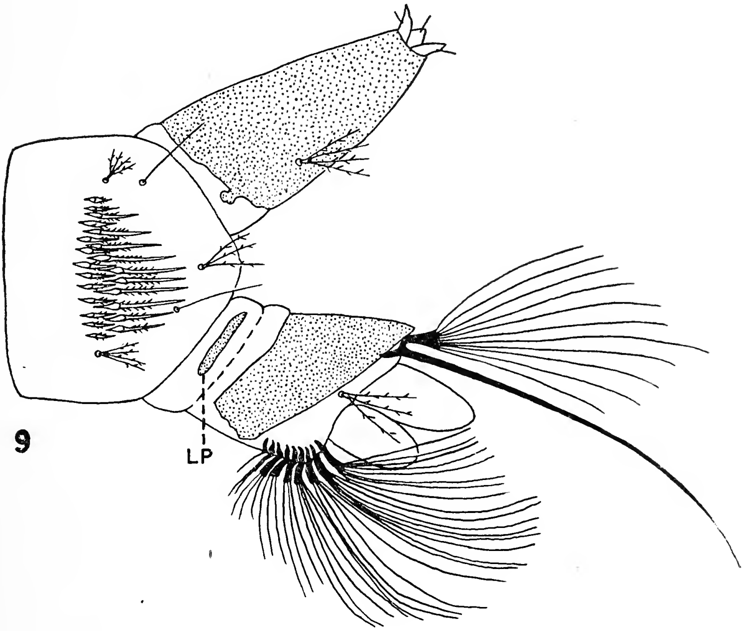

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Explanation of Plate XII

Orthopodomyia alba Baker, fourth instar larva. Fig. 8. Head. Fig. 9. Posterior abdominal segments.

Abbreviations

LP—lateral plate of the anal segment.

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EXPLANATION OF PLATE XIII

Representative comb scales of *Orthopodomyia alba* Baker. Top row. Comb scales from anterior rows. Bottom row. Comb scales from posterior rows. Drawings not made to scale.

Fig. 10. Comb scale from anterior row, second instar.
Fig. 11. Comb scale from anterior row, third instar.
Fig. 12. Comb scale from anterior row, fourth instar.
Fig. 13. Comb scale from posterior row, second instar.
Fig. 14. Comb scale from posterior row, third instar.
Fig. 15. Comb scale from posterior row, fourth instar.

THE EUROPEAN PINE SHOOT MOTH, RHYACIONIA BUOLIANA SCHIFF., ON AUSTRIAN PINE AT HAMILTON, ONTARIO

By W. W. Judd

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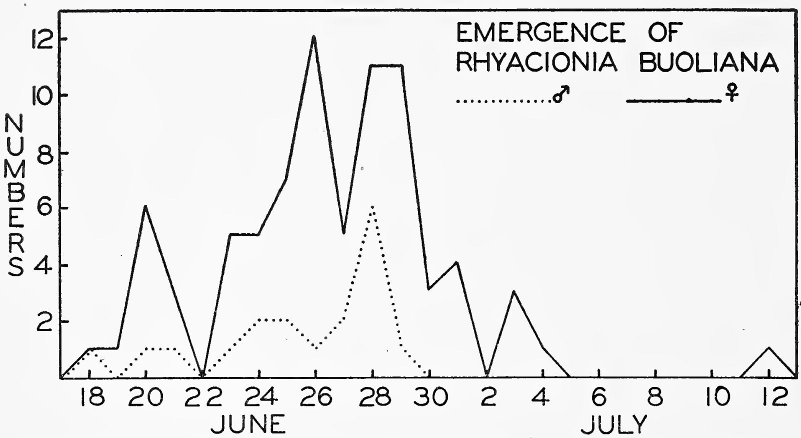
The distribution of the European Pine Shoot Moth has been studied in southern Ontario by the Forest Insect Survey of the Department of Agriculture of Canada, and the successive reports of the Survey record a gradual increase in the known range of this insect. Brown (1) reports it as being along the "shores of Lake Erie and of Lake Ontario as far as Whitby" in 1939 and records (2) that the "attack is now heavy at Hamilton and Toronto" in 1941. Watson and Raizenne (5) record a collection of the moth from Hamilton in 1947 and show (6) its northern limit of distribution in 1948 extending along a line from Owen Sound to Kingston. Hamilton lies approximately midway between the northern and southern limits of this distribution and an opportunity was taken, in the summer of 1950, to record the times of emergence of moths from shoots of Austrian pine on the campus of McMaster University at Hamilton. The occurrence of this insect on Austrian pine was recorded previously by Sheppard (4).

The type and extent of damage in the shoots varied with the amount of growth attained when the shoot was finally killed by the activity of the larva. Some unexpanded leaf buds had a short tunnel down their length, and remained as brown, conical buds one-half inch long with the leaf scales curled and dry. Other leaf buds had begun to expand and had produced shoots one to one and a half inches long before being killed. These remained as straight, brown shoots with the dead tips of the new needles showing beyond the dried leaf scales, and with a tunnel extending the length of the dead shoot. Some buds had produced shoots three to five inches long. The distal one or two inches were lopped over, forming an acute angle with the rest of the shoot. The shoot contained a tunnel extending from this angle to the base of the shoot. The whole shoot was withered, with dried needles as much as one inch long extending from its sides. Some shoots bearing female cones were tunnelled, causing an exudation of pitch and a contorted appearance of the cones, with wilting of the bracts. Several shoots supporting clusters of staminate cones were affected. The cones were dried and brown and produced no pollen when shaken, at a time when healthy cones produced a cloud of pollen when touched.

One hundred and twenty-seven infected shoots were collected from the Austrian pines between June 11 and June 18. Of nineteen shoots collected on June 11, twelve contained larvæ and seven contained pupæ, while thirty-three shoots collected on June 18 yielded five larvæ and twenty-eight pupæ, indicating that pupation of the population of larvæ in the shoots was well under way during that week. Each shoot was placed in a glass shell



vial (95 mm. × 25 mm.) and the mouth of the vial was closed by cheesecloth held in place by a rubber band. The vials were kept in flat trays and were examined daily. As moths emerged they were killed with cyanide and the sex of each specimen was recorded. During the period June 18 to July 12, ninety-seven of the shoots produced moths. In the remaining shoots the larvæ and pupæ died and became shrivelled and were discarded by Aug. 8. None of the shoots produced parasites. Of the ninety-seven moths reared from the shoots eighteen (18.6 per cent) were males and seventy-nine (81.4 per cent) were females. The periods of emergence of the males and females are plotted in Fig. 1: both males and females emerged first on June 18, the females reaching maximum emergence (twelve) on June 26 and the males (six) on June 28. These times of emergence are in accord with the findings of Friend (3) who reports of the European Pine Shoot Moth that "the adult moth flies in June and early in July."

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BOOK NOTICE

American Social Insects by Charles D. Michener and Mary H. Michener. D. Van Nostrand Company, Inc. Toronto, New York, London. October, 1951. xvi + 267 pp. 30 plates in color and 79 in gravure.

This book is the third in The New Illustrated Naturalist series. Like its predecessors it is of value to the professional worker as a reference; it is fascinating and well prepared, and could well serve to stimulate the uninitiated to further study of the subject.

The subject is covered in six parts, as follows: The Nature of Social Insects; The Hornets and Other Wasps; The Bees; The Ants; The Termites, and Societies and Their Parasites. There is also a short appendix giving some helpful basic information of structure and classification. A glossary of terms used and a bibliography add to the usefulness of the book. The illustrations are very well selected and the color work is thrilling.

There is no doubt that the Micheners enjoyed writing this book, introducing the reader to a field that has held their interest for many years. It cannot help but impart to the mind made receptive, a degree of their own enthusiasm in understanding the many complexities of the life that surround us. This book, lacking in drab accounts, is a real contribution to entomology and literature.—F. A. S.

THE DEATH FEINT OF DIPLOTAXUS LIBERTA GERM.

By Harry B. Weiss

The following notes relate to the death feint of *Diplotaxus liberta,* a small, oblong convex, photonegative, lamellicorn beetle found beneath stones, bark, logs, etc., usually in dry places. The death feints were induced by picking up the beetle and dropping it five or six inches or by touching its ventral thoracic surface with the point of a pencil. As a rule the antennæ and legs were not drawn close to the body during the death feint, but when specimens were roughly handled these appendages in some cases were withdrawn close to the ventral surface. Successive

TABLE I

Beetle	Temperature F.	Number of successive death feints.	Range in duration of death feints (seconds).
A	78°	62	1– 65
B	78°	49	5–135
C	78°	51	3– 75
D	78°	67	3– 70
E	88°	33	3– 85
F	88°	41	2– 75
G	88°	41	2– 12
H	88°	36	2– 56

stimuli were applied to four beetles at a temperature of 78° F., and to four other beetles at a temperature of 88° F., and their reactions noted. There was a great variation in the duration of the death feints probably due in part to the variations in the force of the stimulus. Manual stimulation is unsatisfactory in this respect. It is difficult to apply each stimulus with equal force. A puff of air which could be regulated mechanically would have been more satisfactory, but even under this condition there would be variations due to differences in the sensitivity and conductivity of the protoplasm of nerve tissue at different times. The results of these successive stimuli, therefore, should be considered as a sort of rough approximation of the behavior of the beetles.

As shown in Table I, although the range in the duration of the death feints was great whether the temperature was 78° F., or 88° F., the number of successive death feints that could be initiated at 88° F., was much smaller than when the temperature was 78° F. The number of successive death feints is equal to the number of stimuli, at the end of which the beetles failed to react.

The average duration of all successive death feints for each beetle is shown in Table II. The differences between the average duration periods at temperatures of 78° and 88° F., are not as significant as the differences between the total durations at 78° and 88° F. Nevertheless the averages at 78° F., are higher than at 88° F. As would be expected the total duration of the successive death feints was much greater at a temperature of 78° F.

TABLE II

Beetle	Temperature F.	Number of successive death feints.	Total duration of successive death feints (seconds).	Average duration of all successive death feints (seconds).
A	78°	62	1,017	16
B	78°	49	1,124	23
C	78°	51	595	12
D	78°	67	1,403	21
E	88°	33	301	9
F	88°	41	591	14
G	88°	41	281	7
H	88°	36	487	14

The average duration of each group of five successive death feints, in seconds, for each beetle at temperatures of 78° F., and 88° F., is found in Table III. The last figure in each column represents the average of a number slightly less than or slightly in excess of five. In all cases there is a more or less uneven decline in the average and at 88° F., as opposed to 78° F., the average at the end is smaller and is reached after a lesser number of death feints.

It is realized that the number of beetles tested was small, nevertheless the reactions of this small number indicate the ability of the insects to recover from fatigue each time, after a number of successive stimuli, much better at a temperature of 78° F., than

TABLE III

A 78° F.	B 78° F.	C 78° F.	D 78° F.	E 88° F.	F 88° F.	G 88° F.	H 88° F.
33	33	43	27	29	25	9	43
20	42	12	51	10	33	9	22
33	54	9	28	7	25	8	7
27	32	12	35	6	10	7	8
11	11	6	14	4	11	7	7
13	18	5	27	3	5	8	7
7	7	7	18		4	5	4
10	5	10	12		5	3	
13	14	6	11				
10	10	5	16				
11			14				
11			13				
			9				

at 88° F. After each stimulus the reaction of feigning death involves a destructive chemical action in the nerve tissue involved. The restoration of the discomposed substances took place more effectively or more slowly at 78° F., than at 88° F. At a temperature of 88° F., the beetles were more active, the average duration period of the death feint (recovery period) was smaller and the number and total duration of successive death feints declined. High temperatures hasten recovery but apparently the chemical processes necessary for a successively large number of recoveries are impaired. The insect becomes too excitable to react as it did under a lower temperature.

BOOK NOTICE

North With The Spring by Edwin Way Teale. Dodd, Mead and Company, New York. Nov. 5, 1951. xviii + 366 pages, 32 photographs. $5.00.

This is the book of a 17,000 mile automobile journey, recording the natural history of a season as it makes its way from south to north in the eastern United States. The trip consumed 130 days and carried into 32 states, and the account makes an excellent addition to Mr. Teale's list of nature volumes.

Spring for Mr. and Mrs. Teale started in the everglades of Florida and ended at the top of Mt. Washington in New Hampshire. They did not naturalize along main roads but rather took every opportunity to observe the impact of the season at points of natural interest. Plants, fish, birds, snakes, mammals and insects all attracted the attention of the voyagers and their responses to the new season are superbly reported.

This is a good book for the general reader, for the reader who appreciates good literature, for the young and the old and for the pleasure of us all. The reader cannot help but be amazed at the enormous volume of information presented. Yet the writing is leisurely and not crowded. The photographs are in keeping with the Teale tradition, i.e., they are incomparable.—F. A. S.

PROCEEDINGS OF THE NEW YORK ENTOMOLOGICAL SOCIETY

Meeting of April 4, 1950

A regular meeting of the Society was held at the American Museum of Natural History; President Dr. Forbes in the chair. There were fifteen members and eight guests present.

Dr. Forbes extended the deadline for exhibits until the meeting of April 18. The exhibit will be held in the 77th Street Foyer of the Museum and will open at the last meeting in May.

Dr. Forbes then announced that the required quorum being present, and that suitable notification having been given in accordance with Section X., the Society would vote on whether to amend Article I., Sec. IV. of the by-laws. The amended Section was passed unanimously.

Dr. Forbes then introduced the speaker of the evening, Dr. Herbert Ruckes, Professor of Biology at the College of the City of New York and Past President of the Society. Dr. Ruckes described his experiments on the amputation of antennæ in *Euschistis varialarius* (Hemiptera, Pentatomidæ). He divided his problem into three parts:

1. In the transformation of nymph to adult, how is the fifth antennal segment formed?
2. How does the amputation of an antenna effect the problem of Isometry?
3. What role does the hypodermis play in the role of regenerative growth?

His chief conclusions were:

1. The fifth adult antennal segment arises by division of the second nymphal.
2. The antennæ tend to grow to be equal in length, in short, there is an attempt to establish symetry.
3. That when certain hypodermis is excised, the remaining tissue can compensate for the injury and in so doing assume new values and functions.

A discussion followed on histological aspects.

Louis S. Marks, *Secretary.*

Meeting of April 18, 1950

A regular meeting of the Society was held in Room 129 of the American Museum of Natural History; President Dr. Forbes in the chair. There were fourteen members and eight guests present.

President Forbes then read the following letter from our new honorary member and Editor Emeritus, Mr. Weiss, thanking the Society for the bestowed honors:

19 North 7th Ave.
Highland Park, N. J.
April 8, 1950

Dear Doctor Forbes:

The announcement in the March issue of the Journal was the first official word I have had of my election to honorary membership in the New York

Entomological Society and also of my appointment as editor emeritus. And I wish to thank the Society for its action.

For the most part, editing the Journal for more than 25 years was a pleasure, and I deserve no special recognition. Nevertheless, I am human enough to be pleased by the Society's action and I am very grateful for the honor which they have bestowed upon me.

Sincerely yours,
(signed) Harry B. Weiss

Mr. Sam Harriot then announced the first Society field trip, to be held on Sunday, May 14. The group will meet at the end of the Pelham Bay Line. In case of rain the trip will be held Sunday, May 21. Mr. Harriot will meet the group. Members will bring lunch and collecting equipment.

Mr. Pohl announced that on his trip to Paris he had visited the new director of the Museum of Natural History.

Mr. Comstock announced that Bernard Lewis had been appointed Director of the Institute at Kingston, Jamaica, B. W. I.

Mr. Teale told the membership that the U. S. D. A. Yearbook for 1951 will be on insects.

The speaker of the evening, Dr. Stanley W. Bromley, Chief Entomologist, Bartlett Tree Research Laboratories, then gave the following paper:

TREES AND TREE INSECTS, WITH SPECIAL REFERENCE TO THE DUTCH ELM DISEASE

The message I bring is one of hope—new hope for our elms. Our elm trees can be saved,—we should never think of simply writing them off.

When the public asks a simple question they want a simple answer. When they asked the question "why are my elm trees dying?" they were given the simple answer "Dutch elm disease." Whether this answer was true or not was immaterial, irrelevant and inconsequential—that is, until the remedies began to fail. Then they asked the original question all over again. The trouble is that the answer is not so simple as all that. There are many things wrong with elm trees but that every one of them is Dutch elm disease is simply not true.

The average person thinks of the Dutch elm disease in terms of another tree disease—the chestnut blight or bark canker, that devastating fungus that killed out our native American chestnuts—but the two are entirely unlike. It is not the same problem at all.

To the popular mind the cause of all dying elm trees is the Dutch elm disease. In reality there are two problems of equal importance: (1) The bark beetle and (2) the fungus known as *Graphium ulmi* or *Ceratostomella ulmi*. Since there are two agents of destruction, so must the answer to them be twofold: First to control the bark beetles and second to control the fungus disease. I think we are well on the way toward the solution of both. You have to remember, however, that you cannot separate the two. You cannot expect to get satisfactory results by trying to control only one. Both problems are inextricably interwoven. Either the bark beetle or the fungus can kill an elm by itself but in the majority of cases it is the combination of the two that does the execution.

Healthy, vigorous, well-cared-for elms are least prone to attack by either the bark beetle or the fungus.

Let me tell you something about the history of elm troubles in Stamford, Connecticut, where we have had to live with the Dutch elm disease for almost twenty years. During the first onrush of both disease and beetle in the early thirties, treatment by sanitation was generally adopted. So effective was it that the *Scolytus* beetle actually became rare in certain localities.

Then came the war and a general letdown in tree care. Trees were neglected. They suffered from storms, drought, and cankerworm and elm leaf beetle defoliations. They became weakened; thus the stage was set for a great outbreak of bark beetles sweeping the fungus along with them.

What was the relative importance of factors bringing about the dying of elms in Stanford, to restrict the discussion to one particular area? Neglect or lack of care first of all. What next? Well, a recent survey of street and park trees came up with some very significant and startling figures. Here they are:

Of the elms that have died during the past twenty years in Stamford, 55 per cent (or more than half) were killed by what might be characterized as ''acts of man''—the actual agents being the axe, saw, steam shovel and bulldozer used in construction work, widening streets, installing sewers, sidewalks and the like. Indifference and carelessness in most cases.

About 15 per cent died by ''Acts of God''—such as hurricanes, ice storms and droughts.

About 30 per cent of the elm deaths could be allocated to Dutch elm disease in the broad or popular sense which includes bark beetle and other insect destroyers as well as the less common vascular diseases, *Cephalosporium* and *Verticillium*.

Indifference and neglect were the primary causes of mortality. Had those elms been kept healthy through a program of spraying, of feeding to promote tree vigor, and last but by no means least in importance, sanitation to remove the breeding places of the *Scolytus* beetle, and had man been kinder to them as he laid new roads and sidewalks and bulldozed areas for new houses many of those elms would be still standing.

During the past few years we at the Bartlett Tree Research Laboratories have been called upon for diagnosis of injuries to hundreds of elm trees. Of these all were more or less suspect of Dutch elm disease. Yet more than 50 per cent were found to be suffering from defoliation caused by either elm leaf beetle feeding or from the disastrous effects of the *Gnomonia* leaf spot fungus. About 25 per cent were killed by the combination of Dutch elm disease and *Scolytus* bettle, while 5 per cent were killed by the *Scolytus* alone, 10 per cent by the native elm bark beetle, 5 per cent by scale and the remaining 5 per cent showed *Cephalosporium* or *Verticillium* wilt (both vascular fungus diseases).

The European elm bark beetle or *Scolytus* has been relegated too long to a secondary role. It is a pest of primary importance in its own right.

As the forces of elm destruction gather momentum, the elm *Scolytus* is emerging as the No. 1 enemy of the elm both in our region and elsewhere. Even in Ohio, ''the battleground of the elms,'' it is a question as to whether more elms are being killed by *Scolytus* or by the virus of Phloem necrosis. In Columbus I have seen the ground underneath elm trees so littered by twigs and green leaves chewed off by *Scolytus* that it resembled the work of thousands of squirrels.

As is true of most bark beetles, *Scolytus* is a cambium feeder and must have living tissue on which to subsist. It attacks elms that are weakened by drought, by defoliation of other insects, by malnutrition and other causes.

When *Scolytus* attacks a tree it may do so in great numbers and so severe is the girdling of the cambium layer that it can readily kill an elm. It is a battle to the death. Either the tree kills the beetle or the beetle kills the tree.

Now about control. The Department of Agriculture scientists recommend two sprays of DDT for *Scolytus* beetle, one just before the leaves open and the second about ninety days later. We have found that a considerable measure of control may be obtained by spraying with arsenate of lead. Recent tests which I have conducted show that spraying with methoxychlor—the new insecticide which lacks many of the objectionable qualities of DDT, looks extremely promising for *Scolytus* control. Methoxychlor is effective on a greater number of insects than is DDT while it is less toxic to humans and warm-blooded animals as well as less injurious to foliage.

For combatting the Dutch elm fungus—once it has become established in a tree—chemotherapy—(the use of internal medication)—has opened up new avenues. Carolate, which has proven effective experimentally in suppressing and combatting the fungus when it has been detected in its early stages, holds great promise. However, no one medication can replace normal consistent tree care.

In the case of Stamford, as well as many other places, this is like the army demands during war. A thing had to be done not only now—immediately—but it had to be done yesterday.

LOUIS S. MARKS, *Secretary.*

MEETING OF MAY 2, 1950

A regular meeting of the Society was held in Room 129 of the American Museum of Natural History; President Dr. Forbes in the chair. There were fifteen members and eight guests present. The Executive Committee minutes of the meetings of April 4 and April 25 were read.

The resignation of the treasurer, Mr. John C. Pallister, and the appointment by the Executive Committee of a new treasurer, Mr. Arthur Roensch, were made known to the Society.

President Forbes then appointed an Auditing Committee to consist of: Dr. A. B. Klots, Mr. E. I. Huntington and Dr. Willis Gertsch.

Mr. Harriot reported for the Field Committee, that another trip will be held in June to the Boonton, New Jersey, area. The secretary will send notices to members in the New York area.

Dr. Lucy Clausen, Chairman, reported for the Exhibit Committee. The exhibit will open May 16. Fourteen contributions have been entered, including photographs, publications (popular and scientific) and drawings for taxonomic identification.

Dr. Creighton's book, "Ants of North America," being Vol. 104 of the Bulletin of the Museum of Comparative Zoology, was exhibited.

Mr. Teale showed the members the English edition of his "Dune Boy" which contains artists sketches of Mr. Teale as a boy.

Dr. Forbes announced the death of one of America's most famous entomologists, Dr. L. O. Howard, an honorary member of the New York Entomological Society. Cognizance of this will be taken in the Journal.

Dr. Forbes introduced the speaker of the evening, Dr. Caryl P. Haskins who spoke on "Problems of Sex and Caste Determinations in the Social Hymenoptera"

The president announced that there would be no formal meeting on May 16, but that the regular meeting time would be devoted to the viewing of the Society exhibits.

LOUIS S. MARKS, *Secretary.*

MEETING OF OCTOBER 3, 1950

A regular meeting of the Society was held in Room 129 of the American Museum of Natural History; President Dr. Forbes in the chair. There were twelve members and five guests present. The Executive Committee minutes of the September 12 meeting were read.

The president reported to the Society on the condition of Mr. Chris Olsen as of the 18th of September.

Mr. Roensch reported for the Field Committee. The official trip to Boonton was a success; five members and three guests were present.

Dr. Forbes reported for the Exhibit Committee. Our exhibit which was on display from May 16 to about June 16 filled the 77th Street foyer of the Museum. There has been some thought on the part of officers, trustees, members and the Committee as to whether a small foyer exhibit might not be more effective.

The following names were proposed for membership:

Mrs. Su Zan Swain, 406 Park Avenue, East Orange, New Jersey.

Dr. James A. Mullen, Biological Laboratory, Fordham University, New York 58, New York.

Mr. John T. Woodland, Harvard Biological Laboratories, Cambridge, Massachusetts.

Mr. Jacob Huberman, 1 East Fordham Road, The Bronx 58, New York.

The Secretary then read letters from N. D. Riley, Hon. Secretary, Royal Entomological Society and from the IX. International Congress of Entomology. A delegate will probably be named by the Executive Committee at the appropriate time.

Dr. Forbes then explained the Society will be permitted to meet in Room 129 until such time as the Civilian Emergency Committee needs the room. He further announced that the mailing and membership lists of the Society had been brought up to date. The September Journal will be out in mid-October, this with the new editor's apologies and regrets. The meetings of the Society will be announced in the Calendar of the Department of Education of the American Museum of Natural History.

The situation with regard to our current relationship with the New York Academy of Sciences was clarified in response to a question put by Dr. King.

The members then reported on their summer activities. Reports were made by Messrs. Teale, Gaul, Vishniac, Schneirla, Swain, and others.

Dr. Swain noted the death of Brayton Eddy, of the New York Zoological Park.

L. S. MARKS, *Secretary.*

MEETING OF OCTOBER 17, 1950

A regular meeting of the Society was held in Room 129 of the American Museum of Natural History; President Dr. Forbes in the chair. There were sixteen members and twelve guests present.

Dr. Forbes read a letter from Mr. Olsen in which he explained his forthcoming operation and his inability to be the speaker of the evening as originally planned.

Mr. Teale called attention to the latest published example of Mr. Olsen's art, notably the color plates in the new "Field Book of Sea Shore Life" by Miner.

Dr. Forbes announced that the September Journal had been mailed.

The following persons proposed at the October 3 meeting were then elected to active membership: Mrs. Su Zan Swain, Dr. James A Mullen, John T. Woodland and Jacob Huberman.

The President then inquired if any of the members were going to Europe this summer in connection with scientific meetings held abroad. Mr. Lucien Pohl announced that he might make such a trip.

Dr. Forbes then gave the paper of the evening on "Some Medical Entomological Problems in Korea". He showed, by means of slides, how the native Korean habits and customs gave rise to certain sanitary problems, some of them with a highly amusing aspect.

Several of the members and guests who had sojourned in the Orient in connection with the business of the last war then engaged in a general comparative discussion of Oriental sanitary problems.

LOUIS S. MARKS, *Secretary.*

Meeting of November 21, 1950

A regular meeting of the Society was held at the American Museum of Natural History, President Dr. Forbes in the chair. There were fifteen members and nine guests present.

Because the notice of meetings of the various allied societies is no longer sent out by the Academy, Dr. Forbes called on Mr. Teale for information about meetings of the Brooklyn Society. Mr. Teale announced that the speaker for the December meeting will be Mr. Gaul on Insect Flight. At the January meeting, Dr. Bequaert will talk on the Origin of the Hippoboscidæ. Mr. Teale then gave details as to the meeting place.

There was no new or old business.

Dr. Swain, Chairman of the Program Committee, introduced Dr. Leonard Goss of the New York Zoological Park. Dr. Goss is the veterinarian at the Bronx Zoo. Dr. Goss surprised most members of the Society when he stated that external insect parasites are not a problem at the zoo, contrary to popular belief. The talk was illustrated by a movie.

Dr. Forbes announced that the first December meeting will be a panel on the relatives of insects, conducted by Drs. Gertsch and Armstrong of the Museum. Audience participation and discussion is welcome at these panel meetings.

L. S. Marks, *Secretary.*

Meeting of December 5, 1950

A regular meeting of the Society was held at the American Museum of Natural History; President Dr. Forbes in the chair. There were seventeen members and fourteen guests present.

The president announced the appointment of a nominating committee composed of Drs. Schneirla and Spieth, with Dr. Spieth as Chairman.

The minutes of the Executive Committee meeting will be read at the December 19 meeting. Dr. Forbes parenthetically observed that we are not in bad shape financially.

There were two proposals for membership:

Senhor Paulo Nogueira-Neto, Av. Cidade Jardin, 264, São Paulo, Brazil, and Mr. Anthony R. Conte, Fordham University, New York 58, New York.

Dr. Donohoe then displayed some new paintings by Mr. John Cody.

Dr. Forbes reported on Mr. Huntington's telephone conversation with Mr. Comstock. Mr. Comstock is doing better.

The Society then proceeded with the paper of the evening, which was a panel discussion on Insect Relatives by Drs. Gertsch and Armstrong, both of the American Museum of Natural History. Many new, novel and interesting facts on Arachnids and Crustaceans were presented. There was a question and answer period following each discussion.

Dr. Forbes announced that the paper of the December 19 meeting would be on distribution and speciation in butterflies by Dr. A. B. Klots.

L. S. Marks, *Secretary.*

Meeting of December 19, 1950

A regular meeting of the Society was held at the American Museum of Natural History, President Dr. Forbes in the chair. There were sixteen members and five guests present.

The President announced the appointment of an Auditing Committee consisting of Mr. E. I. Huntington, Dr. James Forbes, and Dr. Harold R. Hagen, with Dr. Hagen as Chairman.

Senhor Paulo Nogueira-Neto and Mr. Anthony R. Conte were elected to membership.

Dr. Forbes announced that Dr. Vishniac had been awarded a First Prize by the Biologic Photographic Association.

It was suggested that the Annual Exhibit be held in conjunction with the second meeting in May. Members would bring in their current work and discuss it.

Dr. Klots informed the Society of the First Annual Meeting of the Lepidopterists Society, to be held the 29th and 30th of December in Room 419, American Museum of Natural History. There will be a symposium, papers and an extensive exhibit.

Dr. Swain then introduced the speaker of the evening, Dr. A. B. Klots, who spoke on ''Distribution and Speciation in North American Butterflies''.

For the past 27 years, Dr. Klots has been studying the distribution of the Alpine-Arctic butterfly fauna. The field work has involved 104 collections in 22 different mountain ranges. Dr. Klots pointed out that while the connection of the arctic fauna with that of the mountain tops has long been recognized, a third factor—the northern bogs—must be recognized as islands of arctic-alpine fauna. He then discussed the role of sub-speciation in the various areas of North America for certain genera. Using two species of *Boloria* as examples, he showed how one species is little changed in various parts of the world, whereas the other undergoes extensive subspeciation.

L. S. Marks, *Secretary*.

Meeting of January 2, 1951

The Annual Meeting of the Society was held January 3, 1951, at the American Museum of Natural History, President Dr. Forbes in the chair. There were 14 members and 10 guests present. The minutes of the Executive Committee meeting of December 5 were read.

The officers then gave their reports for the year to the Society.

The President thanked the other officers and the Executive, Field, Exhibit and Program committees for their cooperation. He noted the two field trips conducted by the Field Committee. The Exhibit Committee, headed by Dr. Clausen, is not contemplating the same type of exhibit we have had in the past because we cannot get the available space at the time we want it.

The President further reported that Mr. W. P. Comstock had asked to be relieved of his duties as Delegate to the New York Academy of Sciences.

The Secretary's report, and the Treasurer's report, approved by the Auditing Committee, were read and are appended to these minutes.

Dr. Spieth then reported for the Nominating Committee. The nominations follow:

President—Mr. Albro T. Gaul
Vice-President—Dr. Lucy Clausen
Secretary—Mr. Louis S. Marks
Assistant Secretary—Mr. Leon Siroto
Treasurer—Mr. Arthur Roensch
Assistant Treasurer—Mrs. Patricia Vaurie
The Executive Committee—Dr. Cazier
(amended)
Mr. Huntington
Mr. Teale
Dr. Hagen
Dr. Swain
Dr. Forbes
Editor of the Journal—Mr. Frank Soraci
Associate Editor—Mr. Herbert Schwarz
Editor Emeritus—Dr. Harry B. Weiss
Delegate to the New York Academy of Science—Mr. Herbert Schwarz

There being no further nominations, it was then moved by Mr. Harriot and seconded by Dr. Vishniac that the Secretary cast one ballot for the slate as amended.

In the absence of the new president, Dr. Forbes retained the chair.

Dr. Swain, chairman of the Program Committee, introduced the speaker of the evening, Dr. Roman Vishniac, who spoke on "Polarized Light and Entomology". By means of colored slides, Dr. Vishniac demonstrated the aid that polarized light could give the insect morphologist, particularly on the problem of sense organs in living insects.

L. S. Marks, *Secretary.*

Meeting of January 16, 1951

A regular meeting of the Society was held at the American Museum of Natural History, President Gaul in the chair. There were 13 members and 11 guests present.

The President appointed the following committees:

The Program Committee to consist of Doctors Vishniac, Swain and Spieth.

The Field Committee to consist of Mr. Harriot and Mr. Roensch.

The Publication Committee to consist of Messrs. Soraci, Schwarz, Teale and Sherman.

Dr. Forbes then read a letter he had sent to Mr. Comstock on the latter's resignation as Delegate to the New York Academy of Sciences.

There being no further business, the speaker of the evening was Dr. Gardner on "The Citrus Black Fly in Mexico." One of the high points of his talk which interested the members was the means used to ship live parasites halfway around the world. LOUIS S. MARKS, *Secretary.*

MEETING OF FEBRUARY 6, 1951

A regular meeting of the Society was held in the American Museum of Natural History, President Albro T. Gaul in the chair. Sixteen members and two guests were present.

Mr. Huntington reported that Mr. Comstock was critically ill.

Dr. Herman T. Spieth, the speaker of the evening, presented an interesting talk entitled "Mating Behavior and Breeding Site of *Drosophila virilis* and its Relatives." A detailed account of over 600 observations on the mating behavior of *Drosophila virilis, americana americana, americana texana, novamexicana, montana* and *lacicola* was given. Males are extremely aggressive and the females equally receptive. The geographical distribution of each species was described and the ecological relationships were pointed out. *Drosophila virilis* is a "domestic," rather numerous species found around human habitations such as produce houses, whereas the other species in the group are "wild" occurring only near the edges of bodies of water and never in large numbers.

Of particular interest was Dr. Spieth's account of his search in Minnesota for the breeding ground of *Drosophila lacicola.* Adults of this species were collected and eggs, larvæ and pupæ of what was presumed to be this species were discovered under the bark of decaying aspen logs close to the shore of a small pond. Adults reared from these eggs, larvæ and pupæ turned out to be morphologically very similar to *lacicola.* Upon further examination by a geneticist however, distinct chromosomal differences were found. It was decided that a new species of sympatric to *lacicola* was involved. Also of interest was a new species of Cloropid fly found by Dr. Spieth associated with the new species of *Drosophila* in the aspen logs.

The presence of full species, incipient species and subspecies in this group of *Drosophila* makes it one of great interest to the student of genetics and evolution.

Considerable discussion followed Dr. Spieth's talk.

S. C. HARRIOT, *Acting Secretary.*

MEETING OF FEBRUARY 20, 1951

A regular meeting of the Society was held in Room 129 of the American Museum of Natural History, President Gaul in the chair. There were eighteen members and six guests present.

Dr. Forbes proposed, on behalf of the Executive Committee, the name of Mr. Ernest L. Bell for Honorary membership in the New York Entomological Society. The motion was seconded by Mr. Marks, and passed by the Society. The Secretary will notify Mr. Bell of his election.

It was further announced that the Executive Committee has designated Mr. Cyril Dos Passos and Mr. Lucien L. Pohl as corepresentatives of the

the New York Entomological Society to the IX (Ninth) International Congress of Entomology to be held in Amsterdam, August 17–24, 1951.

The deaths of J. C. Crawford and S. A. Rohwer were noted.

The speaker of the evening, Mr. Richard H. Pough, Curator of Conservation, American Museum of Natural History, was introduced by Dr. Swain. The title of his talk was "Insect Conservation."

Mr. Pough spoke primarily of the work of the "Nature Conservancy" in its attempt to conserve typical ecological environments. This mission is not an easy one, as many of the primitive types have either disappeared or are rapidly disappearing before the onslaught of civilization. Contrary to popular opinion, the National Parks are not and cannot be made areas of this type because they are designed for recreation and scenic preservation only. The large Foundations are not interested in this idea because of the long-term aspect. An interesting discussion followed Mr. Pough's remarks.

LOUIS S. MARKS, *Secretary.*

MEETING OF MARCH 6, 1951

A regular meeting of the Society was held in Room 129 of the American Museum of Natural History, President Gaul in the chair. There were ten members and seven guests present.

The minutes of the Executive Committee meeting of February 20 were read.

There being no further business, the Society heard the paper of the evening, Mr. John Pallister on "Collecting Insects." With many personal anecdotes in illustration, Mr. Pallister detailed methods which he has found highly successful. He also exhibited various types of equipment that he has used. A general discussion followed on field preservation and shipment.

ANTHONY R. CONTE, *Acting Secretary.*

MEETING OF MARCH 20, 1951

A regular meeting of the Society was held in Room 129 of the American Museum of Natural History, President Gaul in the chair. There were thirteen members and three guests present.

The Secretary outlined what had been done in connection with the Ninth International Congress of Entomology. He then read the acceptance letter of Mr. Lucien Pohl, one of the co-delegates.

The Secretary, later in the meeting, read a note of appreciation from Mr. Ernest L. Bell on his election to the status of an honorary member.

Mrs. Alice W. Hopf, 136 West 16 Street, New York, New York, was proposed for membership.

The Society then heard the speaker of the evening, Mr. Stuart D. Whitlock of the Bureau of Entomology and Plant Quarantine, on "Plant Quarantine Problems of the Port of New York." Mr. Whitlock outlined ways that plant material entered the country. He then spoke of the duties of the

Bureau at the Port of New York. One of the major problems at present is to prevent the introduction of the Golden Nematode. In a series of colored lantern slides, Mr. Whitlock illustrated the diversity of crop pests that have been intercepted at New York Port.

Dr. Forbes called the attention of the members to Dr. Vishniac's exhibit of Photographs by Stroboscopic Light on exhibit at the Museum.

LOUIS S. MARKS, *Secretary.*

MEETING OF APRIL 3, 1951

A regular meeting of the Society was held in Room 129 of the American Museum of Natural History, President Gaul in the chair. There were twenty members and guests present.

Mrs. Alice W. Hopf, 136 West 16 Street, New York, New York, was elected to membership.

Mr. Herbert Schwarz reported on the condition of Mr. William P. Comstock. He had seen him on two occasions. Mr. Schwarz said Mr. Comstock would be happy to see friends, and noted that Mr. E. I. Huntington had been to see Mr. Comstock. Mr. Gaul thanked Mr. Schwarz for his report on behalf of the Society.

The Field Committee announced the first field trip is tentatively set for May 13.

Mr. Gaul announced that the Brooklyn Entomological Society had discussed means of improving the status of entomology as a popular hobby. The idea of cooperation between the two Societies was also discussed.

President Gaul then displayed some photographs of the wings of insects.

The President then introduced the speaker of the evening, Mr. Chris Olsen, who spoke on "A Giant House-Fly Cast in Polyester Resin." Mr. Olsen's first act was to disown a papier-mache mantid that was on the speaker's table. He then outlined the advantages of plastic models over the usual wax models. The plastic models can be easily assembled and disassembled, and can be shipped greater distances without fear of breakage. The greatest amount of time in the construction of a plastic model is in the making of suitable molds. Two types of molds are necessary—plaster and flexible plastic. Mr. Olsen explained the difficulties encountered at each step, and the ingenious means he devised to overcome them. The model is now in the Boston Museum of Science.

For a full account of the construction of this model see, GIANT MODEL OF A HOUSE-FLY CAST IN POLYESTER RESIN, in THE MUSEUM NEWS, Vol. 29, No. 8, October 15, 1951. American Association of Museums, Smithsonian Institution, Washington 25, D. C.

L. S. MARKS, *Secretary.*

INDEX TO NAMES OF INSECTS AND PLANTS IN VOLUME LIX

Generic names begin with capital letters. New genera, subgenera, species, varieties and new names are printed in italics.

The
New York Entomological Society

Organized June 29, 1892—Incorporated February 25, 1893

Reincorporated February 17, 1943

The meetings of the Society are held on the first and third Tuesday of each month (except June, July, August and September) at 8 P. M., in the AMERICAN MUSEUM OF NATURAL HISTORY, 79th St., & Central Park W., New York 24, N. Y.

Annual dues for Active Members, $4.00; including subscription to the Journal, $6.00.

Members of the Society will please remit their annual dues, payable in January, to the treasurer.

Officers for the Year 1951

President, ALBRO T. GAUL .... 401 Washington Ave., Brooklyn 5, N. Y.
Vice-President, DR. LUCY CLAUSEN .... American Museum of Natural History
Secretary, LOUIS S. MARKS .... 821 Argyle Road, Brooklyn, N. Y.
Assistant Secretary, LEON SIROTO .... 40–71 Elbertson St., Elmhurst, L. I., N. Y.
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