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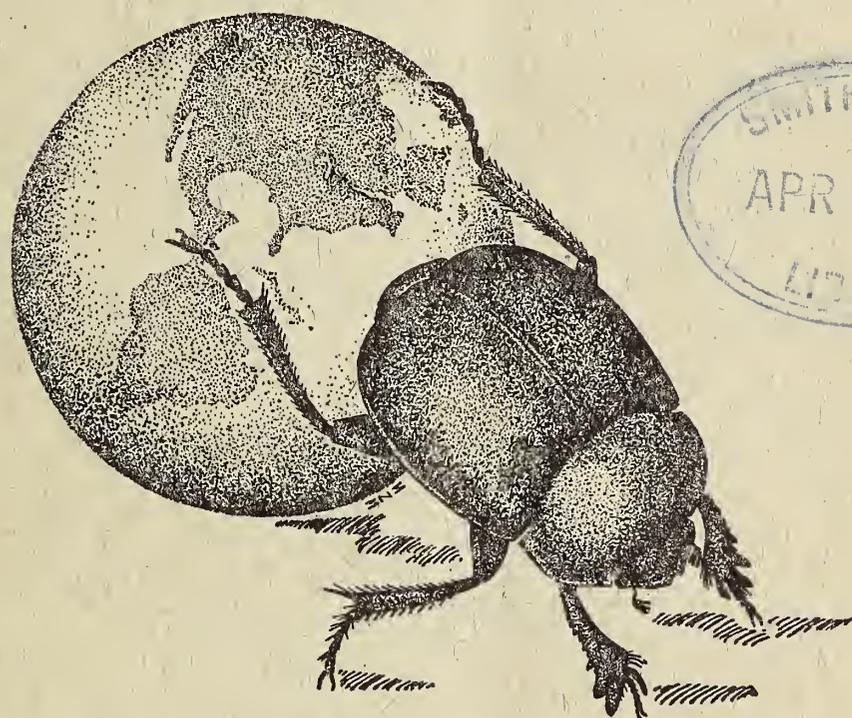
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VOL. LXV

MARCH, JUNE, 1957

Nos. 1, 2

NOTES ON THE ANATOMY OF THE FORMICIDAE I. STIGMATOMMA PALLIPES (HALDEMAN)

BY ROY M. WHELDEN

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During a prolonged study of the cytology of ants, it became evident that in several species there were many interesting anatomical details that seemed worthy of more extended examination. *Stigmatomma pallipes* was one of the first that was noted; and later studied in detail. This led to the collection and preparation of much additional material; eggs, larvae, pupae and adults.

Eventually, more than sixty nearly mature pupae, over one hundred and twenty adult workers, thirty young queens, some fertile, some still virgin, and several queens at least one year old, and also several males were used in this study. All were gathered from a small area near Schenectady. Material from other places was available for comparison with these, but is not included in the following notes. The collections were made at various times from May, 1945, to October, 1955, and included material taken in May, June, August, September and October, in about equal numbers.

Certain tissues are remarkably constant in appearance. For example, the muscles show only slight differences in the many specimens studied; excepting, of course, the differences that distinguished callows from adults of increasing age. In the callows, each muscle is composed of quite slender widely separated strands. In many cases, occasional fat cells occur in the spaces between the strands. In older individuals, the spaces become much smaller and soon disappear completely, the muscle then becoming a fairly solid mass. Another difference that was noted was in cross-stria-

tions of the muscle fibres: in some muscles, these are quite coarse, forming broad bands; in other muscles the bands are much narrower, and less conspicuous; in the flight muscles, the cross-striations are so very fine that the muscles often appear to lack them completely. But none of these is unusual. Nor is the disappearance of the flight-muscles, which in this ant seems to be completed sometime within the year after the nuptial flight, and probably in a much shorter period than that.

The nervous system likewise offers little that seems noteworthy. There are minor variations in the formation of the smaller nerves, in the sequence of their branching; and little more. Nor does the structure of the several ganglia show any conspicuous variation. One fact may be noted—that the nuclei of the cortical tissues of the ganglia do not show any very conspicuous difference in diameter. Seldom does the largest nucleus measure as much as twice that of the smallest one. Nor is the cortical tissue very thick; in many individuals, it is scarcely more than three to four times the diameter of the contained nuclei.

DIGESTIVE SYSTEM. Around the opening of the pocket and extending into the pocket for a short distance, the surface is marked with broad low mounds: across the surface of each mound, there is a row of 6–9 fine spines, progressively shorter from the center to each end of the row; and gradually decreasing in size and in number the farther into the pocket they are. Within, the wall is covered by rather uniformly hexagonal unarmed bosses, separated by shallow grooves. Rarely a specimen was found having the lumen of the pocket quite small. No individual was found with the infrabuccal pocket full. In most, there was a rather small quantity of material, mostly of indeterminate nature. Many individuals had completely empty pockets.

Around the opening of the pharynx, there are numerous densely massed, rather large, outwardly directed spines. Posteriorly, these spines decrease in size and in numbers, especially on the ventral surface, where they soon cease, to be replaced by low transverse ridges. From mid-pharynx posteriorly, the ventral wall is usually quite smooth. The dorsal wall is armed with much stouter spines than those of the ventral wall, and for a greater distance posteriorly. Then they, too, give way to ridges, but here the ridges are much closer together and broader. The ridges of the dorsal wall are 1.5–2 μ apart; those of the ventral

wall 3–4.5 μ apart. The lining of the oesophagus is entirely smooth, and the wall thin. Externally, there is a layer of longitudinal muscle fibres which are very thin and weak-looking. Surrounding these is an outer layer of circular muscles. The latter are very much coarser than the longitudinal muscles, but are still well separated in rather loose spirals. At times, these seem to be in two layers, one crossing the other in reversed spiral turns. The striations of these outer muscles are very prominent; those of the longitudinal fibres are either completely lacking or so very fine as to be discerned with difficulty. Pl. I, Fig. 2.

In nearly all individuals, the crop was nearly or completely empty, the wall being less than 0.5 μ thick and greatly wrinkled, and having many small ellipsoid nuclei measuring 1.5 \times 3.4 μ . Against the outer surface of this wall, there is usually a layer of rather strong widely separated muscle fibres very irregularly disposed. This muscle layer may decrease both in size and in amount until, in a few individuals, it seems to be completely lacking. This may be clearly seen only in those individuals having crops more or less distended. These muscle strands may measure as much as 2–3 \times 5–5.5 μ , in transverse section.

The proventriculus is short and rather featureless; the outer layer of circular muscular fibres is very thick, the inner layer of longitudinal muscle fibres is thin and weak. The chitin lining is thin and very irregularly wrinkled, and extends but a very short distance into the stomach.

The stomach wall is composed of columnar cells which in some individuals are quite conspicuously long, with relatively small nuclei. The muscle layers surrounding the stomach are rather thick, especially the outer layer.

There are 9–10 Malpighian tubules, usually about 22–23 μ in diameter in the queens, and 14–18 μ in the workers.

Little need be said of the intestine and rectum beyond noting that, in nearly all adults, there were little or no contents in the lumen of this part of the alimentary canal. Of 76 individuals noted, 69 had six rectal papillae and seven (two queens, two males, and three workers) had three each. The papillae varied greatly in shape, some being conspicuously rectangular, others uniformly rounded, and in size, the average being 76 μ long and 48 μ broad.

MANDIBULAR GLAND. Pl. I, Fig. 1. The secretory part of this gland is a small cushion of large cells pressed against the lateral wall of the head. It is separated from the chitin wall only by the cells of the hypodermis. In many specimens, this hypodermis is so thin that the gland cells seem adnate to the inner surface of the chitin wall. There is considerable variation in the number of cells forming the gland and in the size of these cells. One of the smallest found comprised only eight cells and measured about 110μ across and 34μ deep. More commonly, the gland comprises 10–18 cells and measures $85\text{--}140\mu$ in diameter and $40\text{--}62\mu$ thick. The component cells varied greatly in size and shape, those in the center of the gland being noticeably larger than the lateral cells.

From any point in the apical surface of each gland cell, a single duct extends for a short distance to end by opening through the wall of the gland reservoir. In many specimens, the several ducts come together so that all their openings are massed in a small area; in others, the duct openings are widely separated.

The reservoir of the gland is usually a rather narrow somewhat conical object bounded by a noticeably thick wall in which a few small, thin discoid nuclei occur. Only an occasional specimen shows any contents in the reservoir, and then not enough to reduce appreciably the numerous irregular wrinkles of the reservoir wall. Anteriorly, this part of the gland narrows very gradually until it passes into the base of the mandible, where it turns rather gradually, to end by opening through the wall of the mandible. Details as to the nature of the opening could not be determined, so thick and hard was the chitin.

MAXILLARY GLAND. Pl. I, Fig. 4. This gland seems to be rather small in *Stigmatomma*, and comprises a rather loose group of 8–20 cells near the lateral wall of the infra-buccal pocket. The cells are irregular in shape, but always with rounded outlines, and measure $24 \times 20\mu$ to $41 \times 35\mu$; occasionally, larger dimensions are found when the cells are more irregular. The single nucleus of each cell is spheroidal, less frequently rather irregular, and measures from $7 \times 14\mu$ to $15 \times 18\mu$. Each cell gives rise to a single duct, $0.7\text{--}1\mu$ in diameter. The several ducts of each gland join to form a loose irregular strand, and open in a compact group in the lateral wall of the pharynx near the mouth.

PHARYNGEAL GLAND. Pl. I, Fig. 5. This pair of glands, arising from the lateral walls of the posterior end of the pharynx into which it opens, has a quite typical structure. Each gland divides repeatedly to form many branches, some extending forward toward the mouth region, and others posteriorly both above and beside the brain. The latter are often quite long, at times reaching nearly to the posterior border of the brain. The diameter of the branches varies greatly, near its origin being $22-25\mu$, gradually increasing to $28-40\mu$ in the middle region, and then normally decreasing to a rounded apex where it is $20-24\mu$ in diameter. In an occasional individual, many or even all the branches gradually increase the diameter to the very broad blunt apex which may measure as much as 60μ across. The lumen of the branch varies from $2-5\mu$ in diameter, increase in branch diameter being increase in cell thickness. The lining of the central lumen is always quite smooth.

In nearly all individuals, the central canal appears to be completely empty. Only rarely is an individual found to have obvious secretion in the lumen, seldom enough to cause any evident distension. In only one case, a queen, was there an excessive quantity of secretion—in this queen, the diameter of the branches varied from $80-90\mu$, the wall thickness varying from $5-14\mu$. The abundant secretion within had a pale amber color (which may have been due to the stain).

In the workers, the pharyngeal gland normally forms a compact mass in front of the brain, with relatively few branches extending posteriorly above and beside the brain. In the queens, the gland varies more than in the workers, especially in the number of branches and their diameter. In the males, this gland normally has fewer branches, and they are shorter and rather coarse.

LABIAL (SALIVARY) GLANDS. Pl. II, Fig. 1. The secretory portion of this pair of glands occurs in the ventral part of the thorax. It consists of five to eight rather coarse sparingly forked branches which usually form a fairly compact group in the zone between the bases of the first and second pair of legs. One or two shorter branches extend anteriorly. When forking, one lobe of the branch is nearly always much shorter than is the other. The branches are formed of rather irregular, occasionally vacuolate

cells whose lateral walls are usually very vague. The diameter of the branches varies in different individuals from 38–44 μ , but is rather uniform in each individual. The central lumen has a diameter of 3–4 μ ; in rare cases, it may be as small as 2 μ .

The several branches of each gland join together very compactly to form the duct of this gland. The two ducts, one on each side, extend anteriorly for some distance and then gradually converge upward and inward near the anterior end of the thorax where they fuse to form a single duct that passes through the head to open in the labium.

This salivary duct (Pl. II, Figs. 1b, c, e) is a very interesting object, and a very variable one in the thoracic portion. It is composed of a central canal whose inner wall is reinforced by annular thickenings. Surrounding this central canal, there is a cellular sheath of varying and variable thickness. Considered externally, this salivary duct seems to be a fairly straight, quite coarse object. Its detailed appearance is quite otherwise, especially the central canal. Only in rare cases is this canal a simple, more or less straight tube. More often, it is thrown into long folds, turning back on itself for distances from one-third to three-quarters of its length. But in very many individuals, this central canal twists and turns in a most bewilderingly irregular manner so that its length becomes several times that of the distance it has to cover; all these convolutions occur within the outer sheath which externally shows none of this, except in its increased diameter. This diameter varies from 7–16 μ in the workers; in queens, it may be much larger, even approaching the diameter of the secretory portion in rare cases. The central canal is fairly constant in each individual, and varies from 2.5–7 μ , being larger in queens than in workers and males.

The tortuous nature of the central canal continues until the point of fusion of the two sides is reached. From that point on, the canal seems always to be quite straight.

METASTERAL GLANDS. Pl. II, Fig. 3. This pair of glands has a form apparently rather common in ants. A large somewhat irregular chamber occurs in the posterior portion of the thorax; the posterior and lateral (outer) portion of the wall of this chamber is pressed tightly against the adjacent wall of the thorax and may even be adnate thereto. From the ventral portion of the

chamber, a small somewhat irregular opening gives access to the outside. This opening is quite smooth, as is the entire inner wall of the chamber. The dimensions of the chamber are $120\text{--}180 \times 80\text{--}95\mu$.

The wall of the chamber is uniformly about 2μ thick over the greater part of its surface. The one area that is thinner is a small, rather irregular patch near the upper and anterior end, where it becomes less than 1μ thick. This is the area through which the many ducts of the secretory cells open into the chamber.

The secretory cells of this gland cover the dorsal surface of the chamber in a loose mass irregularly two to three cells thick; this mass extends down over the anterior and abaxial surface of the chamber to a point well below its mid-region. Near the margins and in the lower portions, this mass of cells is seldom more than a single cell thick.

The cells vary greatly in shape, though usually they are somewhat broadly ellipsoidal, and measure from $26 \times 24\mu$ to $32 \times 25\mu$. Cells near the bottom of the mass tend to be noticeably longer and may reach measurements up to $17 \times 42\mu$ to 50μ long. Each cell contains a single, nearly spherical nucleus $10\text{--}18\mu$ in diameter.

Each cell gives rise to a single duct which passes more or less parallel to the outer surface of the chamber. These ducts form a loose strand which ends in the sieve-like group of pores through the thin area. These ducts are very uniformly $0.8\text{--}1.2\mu$ in diameter.

The smallest number of secretory cells noted here was 33, found in a worker. Usually there are three to four times this number of cells. The largest number counted was over 150, in a mature queen.

Occasionally, an individual was found to have numerous very fine "hairs" projecting into the chamber. Evidently these were hardened secretions possibly forced from the ducts by the action of the fixative used.

GASTER GLANDS. Pl. II, Fig. 3. The secretory cells of this pair of glands form a rather irregular mass, sometimes being a single layer of cells just under the dorsal chitin of the fourth gastric segment, but more frequently forming an irregular mass, two to three cells thick. The number of cells varies greatly, being

usually from 25 to 40. Infrequently, individuals are found with only 8–14 cells in each of the glands. The cells vary from nearly spherical and $20\text{--}36\mu$ in diameter to slender, elongate cells measuring $36\text{--}45 \times 10\text{--}12\mu$. Each cell contains a single, usually spherical nucleus $12\text{--}15\mu$ in diameter.

From each cell, a duct $0.8\text{--}1.2\mu$ in diameter, passes posteriorly to end as a pore through the intersegmental membrane joining the fourth and fifth gastric segments. Each duct enlarges rather abruptly, just before opening through the membrane. These pores may be densely massed in a small area, or may be quite widely separated in a large area of the membrane.

Deeply embedded in the posterior part of the gaster, there is another pair of glands. These are found, one on each side of the sting as it normally rests in the gaster, but slightly dorsal to it and are always formed of a linear series of four to seven rather large rounded cells. From the lower part of each cell, a single duct extends. Each of the rather tortuous ducts pass down and inward, to open through a membrane which is above the sting. An average cell of this gland measures $25 \times 16\mu$; the diameter of the ducts is $0.8\text{--}1\mu$.

Between these glands and slightly anterior to them, there is a tiny structure of three to five minute cells which may be considered as glandular, or as vestiges of a gland. These cells measure $10\text{--}12 \times 3\text{--}4\mu$. (Pl. II, Fig. 6.)

POISON GLANDS. Pl. II, Fig. 5. The two poison glands are decidedly unequal in size, and in appearance. The larger gland extends diagonally upwards from the base of the sting until near the lower wall of the rectum, where it turns rather abruptly and extends forward to a point approximately above the last gastric ganglion. Throughout its length, there is a gradual increase in diameter until, near its anterior end, it attains a maximum diameter of perhaps 40μ , though in many cases the maximum is much less, even as small as 24μ . Throughout its entire length, this gland is formed of rather narrow columnar cells, each containing a single small spherical nucleus near its outer end. These nuclei vary from $2\text{--}3\mu$ in diameter, but are usually of rather uniform size in each individual, being smallest near the posterior end and larger toward the anterior end. The central lumen of this gland varies somewhat, being occasionally of quite uniform

though rather small diameter ($2-4\mu$): more frequently, it is of very irregular shape, due to the sharply conical inner ends of the wall cells. This gland extends into the base of the sting for some distance, becoming abruptly narrowed and flattened laterally near its end. The opening of this gland is a narrow, transversely elongate slit. Around the opening, the cells become small and very irregular.

In a large majority of the individuals studied, this describes the entire gland, the anterior end being definitely uniformly rounded. However, in some individuals, both workers and queens, two rather conspicuous branches arise from the anterior end. These usually extend forward from $200-400\mu$, then turn abruptly backward to reach as far back as their origin or even a bit more. Occasionally, there is a second turning so that the final portion extends forward. Now and then, these branches when present are very irregularly contorted, often seeming much entangled.

These branches are composed of large, rather irregular cells, each with a single, usually subspherical, nucleus, $8-11\mu$ in diameter. The diameter of the branches varies from $32-50\mu$, being usually larger in the queens than in the workers, and varying greatly in any one individual. Only rarely is there even a faint indication of any central lumen.

The second poison gland, the accessory gland, also turns dorsally just anterior to the sting, and then turns sharply toward the rear. It is much shorter than the other gland. The wall of this gland is invariably very irregularly wrinkled in transverse folds and seems to be non-cellular. Not a single nucleus was found in any part of it.

This gland varies greatly in size. In one individual, it ended very soon after its emergence from the base of the sting: in another, it was 220μ long and 14μ in maximum diameter, which is approximately its maximum size. This gland extends into the base of the sting, nearly as far as the first does, and also opens through a transversely elongate slit with closely appressed margins.

REPRODUCTIVE SYSTEM. In the queens, the number of ovarioles in each ovary varies from three to six, with the great majority having four or five in each ovary. In the workers, there are in-

variably either two, or usually three, ovarioles in each ovary. In nearly all the queens studied here, each ovariole contains a series of developing eggs, but the total number is never very large. In most cases, worker ovarioles contain only small egg cells, the largest seldom measuring more than 42μ long, and 28μ in diameter. The number of developing egg cells in workers is always less than that found in the queens. None the less, it would appear that many *Stigmatomma* workers are capable of and may lay small numbers of eggs.

The oviducts and uterus call for little comment, the former being straight thin-walled tubes in both queens and workers, as is also the uterus in many workers. In other workers, the uterus is more like that of the queen, a much wrinkled structure whose dorsal wall is increasingly thicker posteriorly, with the ventral and lateral wall uniformly thin.

The spermatheca of the virgin queen (Pl. II, Fig. 4) has a very constant structure, the wall showing two very distinct areas. In the anterior-dorsal region, there is a large irregularly circular area formed of columnar cells $18-30\mu$ long and about $2.5-3\mu$ in greatest breadth. Each of these cells has a small ellipsoidal nucleus near the outer wall: these nuclei are about 3μ long and $1.5-2.5\mu$ in diameter. The total extent of this part of the wall may be as small as about $1/10$ of the total spermathecal surface, but is usually greater than that and in occasional specimens may be about $1/5$ the entire surface. The remaining part of the wall is very much thinner and seems capable of considerable change in thickness. In virgin queens, this part is very greatly and irregularly wrinkled. In older queens, after fecundation, the spermatheca expands, the thin portion of the wall then being little or not at all wrinkled.

The spermatheca of the worker differs from that of the queen in having the thickened area very much less extensive, and the thin portion even more wrinkled.

The diameter of the spermatheca varies from 40μ in empty (virgin) queens and in workers, to about 100μ in fertile queens.

The spermathecal duct is rather short and thick-walled, though unequally so, the canal being excentric, the wall of the anterior side measuring $10-17\mu$ and that of the posterior side $3-7\mu$ thick. The canal of the duct is about 2μ in diameter.

The sperm mass seldom completely fills the spermathecal cavity. In it, the sperms are very loosely massed and often appear as if they had been in some sort of swirling movement. No worker has any sperms in the spermatheca.

The spermathecal glands of the queen are ellipsoidal bodies, 44–75 μ long and 16–30 μ in maximum diameter, rather gradually narrowing towards the posterior end and bluntly rounded at the other end. The wall of the spermatheca is composed mainly of large, irregularly polygonal cells, each with a large spheroidal nucleus 5–7 μ in greatest dimension. Toward the center and surrounding the lumen of the gland, there are many small cells with ill-defined walls and small spherical nuclei, 1.5–2.6 μ in diameter. In nearly all individuals studied here, the spermathecal glands are above the surface of the uterus, extending anteriorly from the spermatheca. Infrequently, an individual was found with the spermathecal gland extending posteriorly, being then near the upper wall of the spermatheca. The ducts of the spermathecal gland are short and thin-walled. They may pass through the lateral walls of the spermathecal duct to open on opposite sides near the entrance into the spermatheca. In many cases, the two spermathecal gland ducts are found to unite before reaching the spermathecal duct, the single, very short common duct then opening into the anterior wall of the spermathecal duct.

In the workers, the spermathecal glands seem often to be completely lacking; when present, they are much smaller than those in the queen. The spermathecal glands of the workers measure 30–44 μ long by 17–23 μ in diameter.

The copulatory pouch (Pl. II, Fig. 7) offers little of interest except to note the character of the dorsal wall. In the queens, the dorsal wall of the pouch is armed with uniformly separated, very even transverse rows of 10–18 fine bristles, 3–5 μ long in the center and gradually shorter laterally. These bristles are directed posteriorly. Where this wall turns upward, back of the spermatheca, the spines cease, the wall surface being then characterized by flat-topped, somewhat irregular hexagonal bosses, about 1 μ high. The opposite (ventral) wall of the pouch is quite smooth.

MANDIBLE. Four tissues pass from the head into the mandible: the ligaments of the rather large muscles that move the mandibles, one or two rather small trachea, two nerves and the now quite

narrow chamber of the mandibular gland. This chamber turns almost at once in the base of the mandible, upward and inward to open through an irregular pore in the mandible wall. The exact shape of this pore could not be determined. Of the two nerves, one is conspicuously larger than the other. This larger nerve passes along the lower part of the mandible, just above the hypodermal layer. From the large nerve, two types of branches occur. Most conspicuous are several quite large branches that pass to the upper surface of the mandible, where each branch passes into one of the several rather coarse teeth found there. Within these teeth, the nerve branches spread apart to form loose bundles of fine nerve fibres. These branches measure 35–80 μ in maximum breadth. The numerous nuclei occurring in these branches are always ellipsoidal and measure 2.5–4 μ in diameter, and 6–12 μ in length. Less conspicuous and more numerous are the many fine nerves that branch off from all sides to enter the fine canals through the chitin wall, and to pass into the bases of the smaller hairs that occur on the mandible surface. In addition to these nerve canals, the mandibular wall is traversed by numerous minute pores, 0.3–0.5 μ in diameter.

Fat cells and oenocytes are also present in the cavity of the mandible.

ANTENNAE. (Pl. I, Fig. 6.) *Stigmatomma pallipes* is not the most favorable ant to use for a study of the finer details of the antenna; for the chitin is not only heavily pigmented and thick, 12–15 μ , but also very brittle. Despite which, fairly satisfactory results were obtained in the course of this study.

The scape offers little difficulty, being of quite simple structure. Two slender muscles extend from near its base to the outer end, where they are modified to ligaments that extend into the pedicel. A small tracheal tube passes lengthwise through the scape as do two relatively large nerves. Infrequently, fine nerve fibres branch off from the nerves and pass diagonally to the hypodermal layer, and presently end at, or in the bases of the few slender hairs that occur on the scape. Occasional fat-cells appear here also.

The flagellum is much more interesting structurally. Two nerves pass through this structure, sending off several small branches in each joint. The trachea also extends throughout the length of the flagellum, with frequent irregular branches occurring in each segment.

The nerve branches pass laterally to be lost in masses of small spherical nuclei, $1-2\mu$ in diameter. From 30 to 60 of these occur in each of the many irregularly ellipsoidal masses that line the walls of the segments rather uniformly. Within or at the base of each of these groups, there are from 4–6 larger nuclei. From the outer end of each group, a slender bundle of fine nerve fibres passes diagonally toward the chitin wall, where it enters one of the many canals that pass outward toward the external surface. It was seldom possible to follow these fibres to their final end, but apparently this is in one of the many hairs that occur on the surface, or in the modified structures that are found there.

The surface of the antennae bears several types of hairs: some are coarse, straight and abruptly blunt-tipped; others are long, tapering slender hairs standing out from the surface; still others are abruptly angled at the base so that they are closely pressed against the surface; and finally, there are very fine pointed, slender hairs which are much shorter than any of the others. Arising from the groups of small nuclei, slender nerve fibres pass, each through a canal and into the base of one of the hairs. These hairs occur on all segments of the flagellum.

On the apical segment, two other structures occur. The first of these, styled champagne-cork organs by Forel, (Pl. I, Fig. 6d, e.) are contained within rather coarse canals through the wall. From an area about mid-way through the wall, a thin layer of chitin folds back a bit and then again outward, to end in three rather slender pointed teeth, entirely free from the wall of the canal. Across the base of this structure, a thin chitin film stretches, its center raised into a low, rather blunt, papilla. Three rather coarse groups of nerve fibres extend up to this surface: exactly how they end could not be determined in this study, perhaps because of the nature of the chitin surfaces involved.

Above this structure, the canal extends upward to the chitin surface, narrowing rather gradually, to form a very thin incomplete membrane—incomplete, because there is always a small circular opening in its center.

There are always 6–9 of these organs in the apical segment, most of them in the outer half. Those most distant from the apex of the segment differ slightly from the others, in having the thin apical surface sink abruptly inward to form a short cylindrical tube. The entire organ varies from $7-10\mu$ in its

maximum diameter. Two to four of these organs also occur in the subapical segment.

Yet another structure occurs in the apical segment, the flask-shaped organs, also named by Forel. (Pl. I, Fig. 6c.) In *Stigmatomma*, these are limited to the outer third of a rather narrow sector of this segment, and are about twelve in number. Each organ comprises a cylindrical base, 5–8 μ in diameter and 20–26 μ long, narrowing rather sharply at its conical upper end to a slender irregularly bent tube 0.7–1.1 μ in diameter. Each tube passes into the base of a canal through the chitin wall, and comes to an end near the mid-point of the canal. In some of these organs, the tube has a uniform diameter throughout its length; in others, that portion of the tube which is within the canal enlarges gradually to 3–4 times its average diameter. The basal portion of this organ usually has its rounded end at right angles to its length, but occasional examples are at a decided angle; some are even quite irregular. Extending the length of this basal portion, there is a central canal about 2 μ in diameter; this canal narrows gradually at the upper end of the basal portion of the organ and continues as an extremely fine canal through the entire length of the narrow portion.

The apex of the ultimate segment of the antenna gradually narrows to become a rather stout spine, the apical end of which is bluntly rounded. (Pl. I, Fig. 6g, h.) Cross sections show that four small canals extend through this spine; but these do not appear to open through the apex. Well below the base of this spine, a group of four to six relatively large nuclei occurs. From these nuclei, a narrowing bundle of nerve fibres extends up and into the base of these spines.

In addition to the canals associated with all these organs, the chitin wall of the joints of the flagellum is traversed by many irregularly distributed fine pores, scarcely 0.1 μ in diameter. (Some of these are shown in transverse section in Pl. I, Fig. 6d).

PUPAE. Many pupae were included in the collections on which these notes are based. Of these, over sixty were nearly mature, the wall formation of the adult form being well advanced, with head, thorax, and abdomen clearly distinct, and nearly all the internal organs well formed. These were examined in some detail. The most noticeable condition found was the occasional

occurrence of an individual with certain organs out of place. Most frequently noted were individuals having the crop entirely in the thorax, the proventriculus then extending from the posterior thorax through the isthmus and into the gaster. Less frequently noted were individuals having both crop and proventriculus in the thorax; two pupae studied had all three, crop, proventriculus, and stomach in the thorax; the intestine appeared to be tautly stretched and very narrow in one individual; the intestine and rectum shared equally in the tautness in the second case. The most extreme case noted was one with the crop and proventriculus in the head, the stomach partly in the head and partly in the anterior half of the thorax, and narrowly constricted where it passed through the neck; the intestine of this individual extended through the rest of the thorax and into the gaster, where the greatly narrowed rectum stretched nearly the full length of the gaster, the six rectal papillae occurring in the zone of the second gastric segment.

Similar to the foregoing were several individuals in which the reproductive organs were out of place. In several queen pupae, the ovaries were entirely in the thorax, usually in the posterior half. In two individuals, the ovaries were in the anterior end of the thorax, the oviduct then being a very slender tube reaching straight back to the posterior part of the gaster, where the spermatheca was found in its normal position.

Male pupae also shared in such abnormalities, several being observed to have the testes entirely in the thorax; and one extreme case showed a part of the testes in the head, where it was behind and above the brain.

Whether these displaced organs would have been eventually established in their proper positions is a question that cannot be answered here. Possibly many of those abnormal individuals would perish before eclosion. It would appear that not all suffer this fate, for several adults were found to have the entire crop or a considerable part of that organ in the thorax; one adult insect was noted to have the entire crop and much of the proventriculus in the thorax.

One further abnormality is to be noted: an adult queen having what can only be the larval silk gland still present in the head, where it occurred as a much contorted coarse unbranched tube, its lumen filled with yellowish secretion.

SUMMARY

Over one hundred and twenty workers, thirty young and some quite old queens, as well as sixty nearly mature pupae and a few males were studied in detail. The collections extended through ten years, covering the entire growing season. Attention is centered on variations within this ant, rather than in comparisons with other ants. Differences between callows and older workers are noted briefly, as well as differences between various muscles, including the flight muscles. The nervous system is quite constant, the cortex being very thin. The digestive system is described briefly, but shows no variations of particular note.

The several major glands are described in detail, with particular attention to the duct of the labial gland, it being very variable, and to the poison glands. In the latter, the larger gland is found to present two aspects, one characterized by having two quite long branches from the anterior end, the other lacking them completely. The significance of this could not be determined.

The reproductive system is described briefly, attention being centered on the spermatheca and its glands, since these varied slightly.

Extreme irregularity in pupation is described, it being found in many specimens that one or more of the parts of the digestive system are present in the developing thorax when they would normally appear in the gaster. Cases are also found with the ovaries in the thorax. A few adults are also noted to have some organs out of place.

DESCRIPTION OF FIGURES

All figures are drawn with the aid of a camera lucida. Two scales are given, the 25μ scale measures all detail figures, the 200μ scale measures the other figures. Plate II, Fig. 1 is an outline figure of a diagrammatical section through the thorax, the labial gland being shown at the left, and the metasternal at the right. This figure is at a much smaller scale than all the others.

Plate I. Fig. 1. The mandibular gland, showing chitin wall, hypodermis, the edge of secretory cells. *a.* Detail of secretory cells, one with duct, and above, detail of wall and hypodermis, and edge of secretory cells. *b.* Detail of wall of reservoir near its anterior end. *c.* Transverse section of part of reservoir wall. Fig. 2. Longitudinal sections of thoracic portion of oesophagus: right, tangential section showing large encircling muscles; left, slightly lower section, showing transverse sections of encircling muscles, and finer longitudinal muscles. Fig. 3. Hypodermis and chitin layer of callow adult (above) and old adult worker (below). Fig. 4. The maxillary gland, with outline of transverse section of half of pharynx and the infrabuccal pocket. *a.* Details of secretory cells and ducts. Fig. 5. Details of the pharyngeal gland, showing portions of gland near its opening, and an apical part of two ultimate branches of gland, one narrow, the other quite broad. Fig. 6. The antenna. *a.* Transverse section of the subapical segment, showing the chitin wall, the groups of small nuclei and the two nerves. Surface hairs are omitted. *b.* Longitudinal section of last two segments, showing these same parts, and also two of the flask-shaped organs. *c.* Detail of flask-shaped organ, with some of the surrounding nuclei, large ones above, and small ones beside it. *d.* Detail of transverse section of champagne-cork organ, together with some of the minute pores through the chitin wall. *e.* Details of longitudinal section of champagne-cork organs from base (above) and apex (below) of apical segment. The dark circles above the upper one are groups of small nuclei. *f.* Detail of transverse section through nuclei of nervous elements associated with large apical spine. *g.* Detail of longitudinal section of apical spine, and the large nuclei and nerve fibres associated with it. *h.* Details of sections through the large apical spine from base to apex.

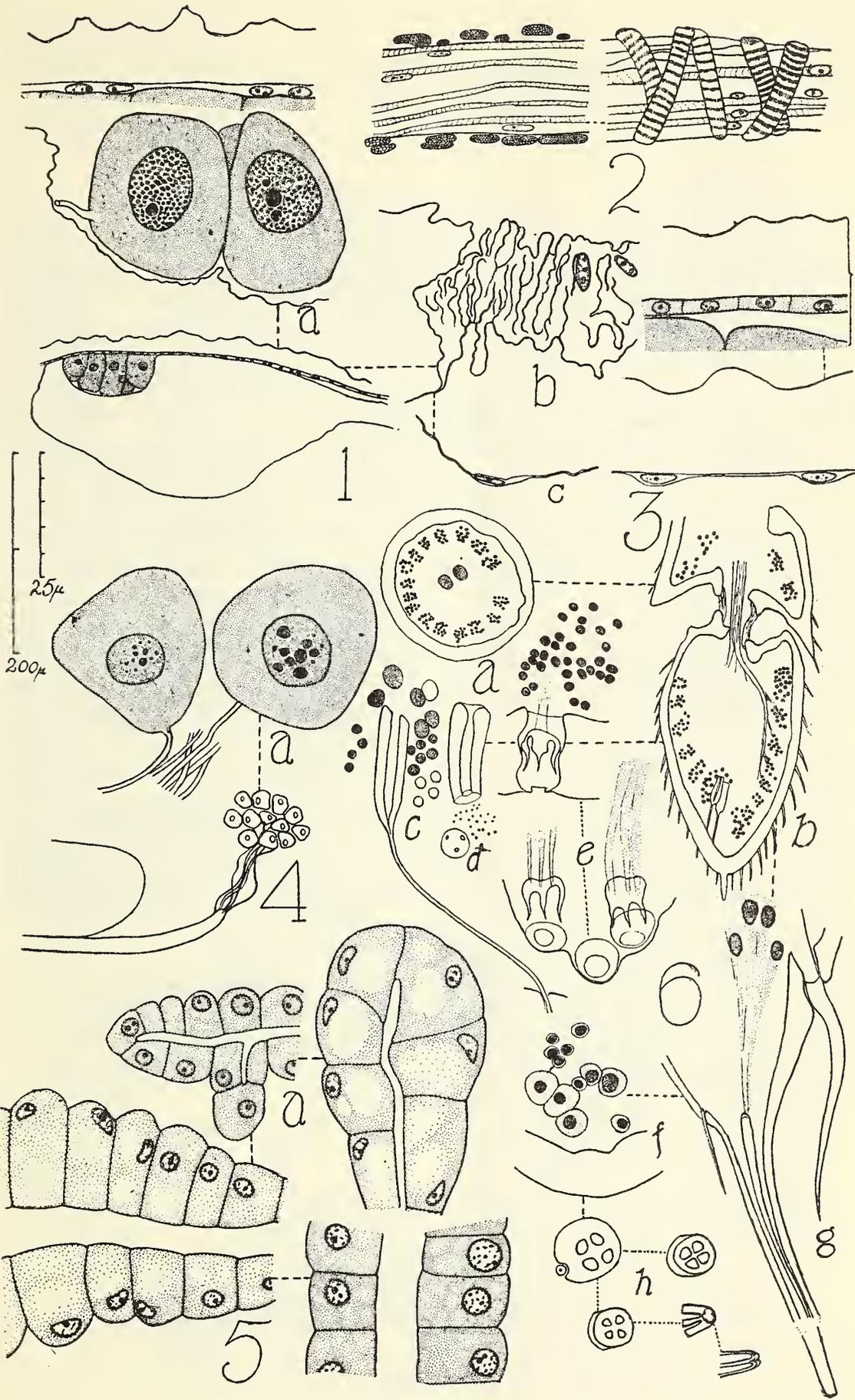
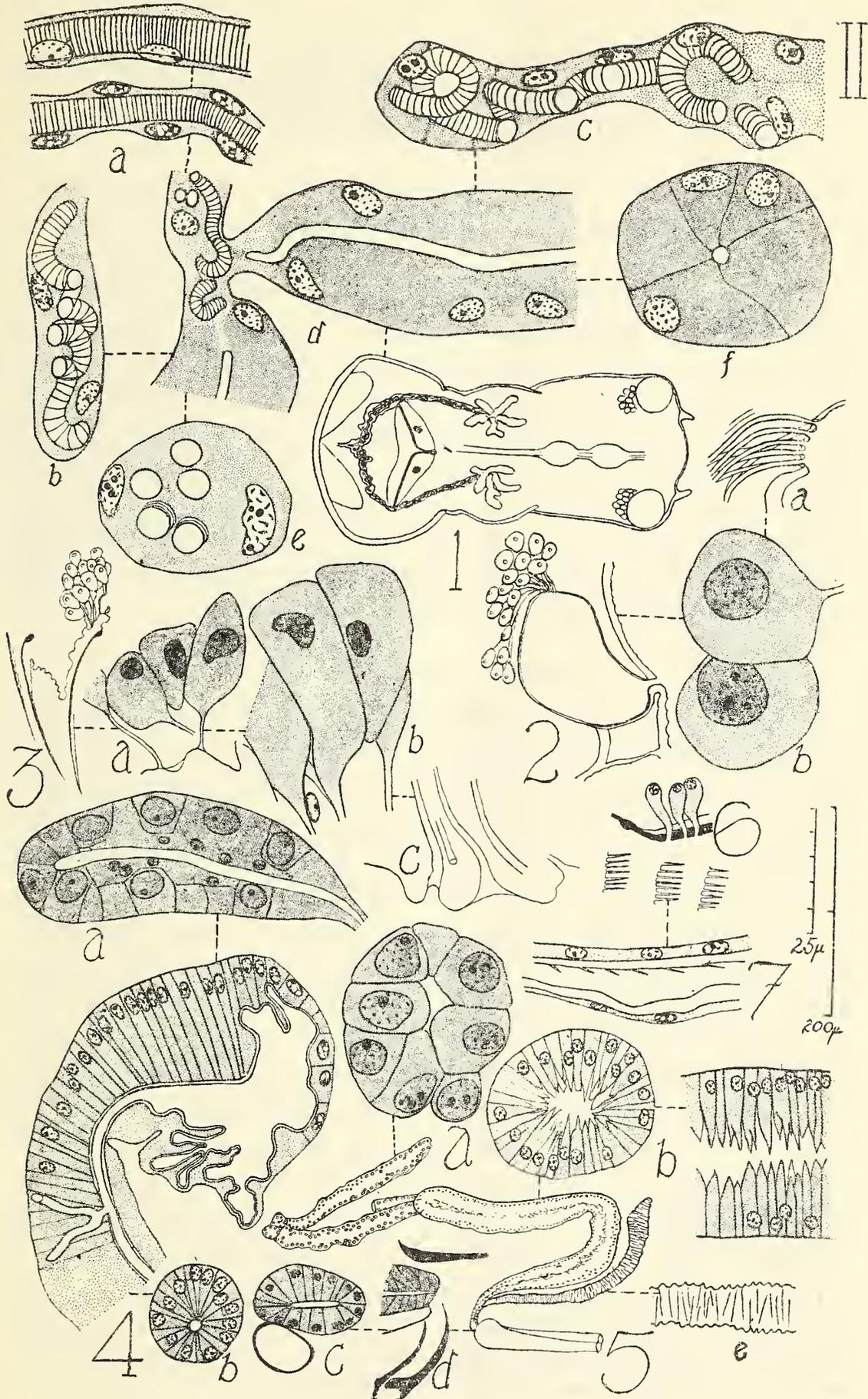


Plate II. Fig. 1. Diagrammatic section of thorax, showing labial gland at left and metasternal gland at right. *a.* Details of the labial gland duct in the head. *b.* Detail of duct in anterior thorax, near point of junction with that of the opposite side. *c.* Detail of duct near secretory portion, showing very irregular twisting of central canal. *d.* Detail of junction of duct with the bases of two of the secretory branches. *e.* Detail of transverse section of duct in thorax, showing sections of five loops of the canal. *f.* Detail of transverse section of secretory branch. Fig. 2. The metasternal gland, showing the irregular chamber and part of secretory portion. *a.* Detail of duct openings. *b.* Detail of secretory cells. Fig. 3. The gaster gland, showing intersegmental membrane between fourth and fifth gastric segments. *a.* Detail of secretory cells of an adult male. *b.* Detail of secretory cells of a queen. *c.* Detail of some of the duct openings of a queen. Fig. 4. The spermatheca, in longitudinal section, with part of its duct, and common opening of the spermathecal gland ducts. *a.* Detail of spermathecal gland showing two sets of nuclei and central lumen. *b.* Detail of transverse section of spermathecal duct, with excentric canal. Fig. 5. The poison glands, showing part of sting below, the two glands and one of apical branches sometimes present in this gland. *a.* Detail of transverse section of one of these apical branches. *b.* Detail of transverse (at left), and longitudinal (at right) sections of the same gland, showing irregular central lumen. *c.* Detail of transverse section of the two glands as they enter the base of the sting. *d.* Detail of longitudinal section of the ends of these glands in the sting. (The black outlines are parts of chitin of the sting.) *e.* Detail of a portion of the second (accessory) poison gland. Fig. 6. Minute gland in gaster. Fig. 7. Copulatory pouch, showing the spine-bearing dorsal surface with the adjoining hypodermal layer and the smooth ventral surface and its hypodermis. Above this is a detail of the rows of spines occurring on the dorsal surface.



EFFECTS OF SODIUM, POTASSIUM, AND CALCIUM IONS ON THE ISOLATED HEART OF THE MEALWORM, *TENEBRIO MOLITOR* L¹

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Insect tissue has great plasticity which enables it to maintain its activities in very abnormal media. The purpose of this investigation is to determine the tolerance of insects to different concentrations of sodium, potassium and calcium, as well as to changes in the osmotic pressure by the use of isolated heart preparations as indicators. Since no work is available on changes during metamorphosis of ion concentrations or tolerance to compositions of saline as it changes during metamorphosis these experiments were performed on a holometabolous insect, *Tenebrio molitor*, during the larval, pupal, and adult stages.

MATERIAL AND METHODS

The method for the preparation of glassware was that of Gese (1950) with the exception that no permanganate bath was used. Larvae of *Tenebrio molitor* were grown in chick growing mash dampened several times a week. Prepupae were collected daily and kept in beakers at 30°C. Each day, pupae were removed, placed in dated beakers and stored at 30° C. In this way the age of each pupa, within 24 hours, was obtained. Three-day pupae were used because at 30°C. this stage is the mid-point of the pupal period. Young adults from two to three weeks after emergence were used.

An analysis was made of the ion concentration and osmotic pressure of the blood of larvae, pupae, and adults. Blood was obtained from the larva and adult by removing a metathoracic leg with sharp scissors at the junction of the coxa and thorax. Blood was obtained from the pupa by cutting the tip of the abdomen with sharp scissors. In all cases, it was allowed to

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drip into a porcelain spot-plate, while pressure was exerted on the abdomen. Each analysis was made on 0.5 ml. of pooled blood using the Beckman flame photometer. For each stage, six determinations were made for ion concentration.

The osmotic pressures of the blood during larval, pupal, and adult stages were determined by Barger's vapor pressure method as used by Ludwig (1951). The molality and the osmotic pressures were calculated from the NaCl equivalence.

The effects of various solutions on the heart beats were determined by the following procedure. The hearts were prepared by the method of Yeager and Hager (1934). Since they were not clearly visible, several drops of 0.1 per cent neutral red were allowed to remain on the preparation for 30 seconds and then drained off. When the preparations were kept for 24 hours, neutral red was again added for better visibility. Aerated solutions at 25°C. were allowed to flow over the hearts. The apparatus used was a modification of that devised by Yeager and Hager (1934). A binocular dissecting microscope was used for observation and the time for ten beats was measured at 5 minute intervals over a three-hour period. The hearts which were beating at the end of this time were kept for 24 hours during which time the solution was allowed to drip more slowly on the preparation. For each solution tested, at least nine heart preparations were used. The solution was evaluated by the ability of the immersed hearts to beat at a uniform rate over a 3-hour and a 24-hour period.

The effects of osmotic pressure on the heart of the three stages were determined by taking a favorable isotonic solution and varying its osmotic pressure. Hypotonic solutions were prepared by diluting the isotonic, and hypertonic by adding a determined amount of the proper mixture of chloride salts.

OBSERVATIONS

The concentration of sodium, potassium, and calcium ions, as well as the osmotic pressure of the blood of the three stages are listed in Table I. The average concentration of inorganic cations in the larva, expressed as milligrams per cent, are sodium 177.7, potassium 128.3, and calcium 22.3; in the pupa they are 41.3, 74.0 and 7.8; and in the adult 83.5, 92.3, and 27.1, respectively.

The larval blood is isotonic to 0.37 molal NaCl (or KCl), and 0.26 molal CaCl₂; pupal blood to 0.40 molal NaCl and 0.28 molal CaCl₂; and adult blood to 0.2 molal NaCl, and 0.14 molal CaCl₂.

In isotonic NaCl the hearts beat at a moderate rate and the beating of the larval heart persisted for 44, the pupal heart for 53, and the adult heart for 32 minutes. Corresponding values for CaCl₂ were 38, 32, and 17 minutes, respectively. None of the

TABLE I
Na, K, AND Ca CONTENT AND OSMOTIC PRESSURE OF THE BLOOD.

Determination	Larva	Pupa	Adult
Composition			
	mg. per cent	mg. per cent	mg. per cent
Sodium			
Maximum	202.3	47.6	86.3
Minimum	142.4	38.2	80.1
Average	177.7	41.3	83.5
Potassium			
Maximum	146.7	86.1	97.4
Minimum	102.5	58.7	90.1
Average	128.3	74.0	92.3
Calcium			
Maximum	26.3	8.8	30.4
Minimum	18.4	6.5	25.0
Average	22.3	7.8	27.1
Osmotic Pressure			
NaCl equivalent, in per cent	2.14 (obs.)	2.40 (obs.)	1.45 (obs.)
Molality	0.37 (calc.)	0.40 (calc.)	0.20 (calc.)
Atmospheres	17.04 (calc.)	19.20 (calc.)	11.64 (calc.)

hearts beat in isotonic solutions of potassium chloride. The pupal heart beat in distilled water for 12 minutes. For each stage, sodium was found to be the least toxic, followed by calcium and then by potassium.

Table II shows the various ion ratios needed for maintaining the heart beat of the larva. The Na/K ratio could be varied from 1.4 to 22.4 without any appreciable toxic effects. When the ratio of K/Ca was 0.33 to 3, the resulting physiological solutions were excellent. However, when the potassium was increased so that the ratio was 4, irregularities were seen in the heart and the beating did not continue for 24 hours. Very slight irregulari-

TABLE II
MILLILITERS OF ISOTONIC SOLUTIONS AND ION RATIOS NEEDED FOR
MAINTAINING THE HEART BEAT OF THE LARVA.

NaCl	KCl	CaCl ₂	Ion ratios		Beats/min.	Period of activity (Hours)
			Na/K	K/Ca		
.....	100	24	0.00	1.00	18.5	3
256	100	24	1.40	1.00	12.5	24
512	100	24	2.80	1.00	17.8	24
1024	100	24	5.60	1.00	19.3	24
2048	100	24	11.20	1.00	18.0	24
4096	100	24	22.40	1.00	25.3	24
5120	100	24	28.00	1.00	34.6	3
256	100	12	1.40	2.00	22.9	24
256	100	9	1.40	3.00	19.5	24
256	100	6	1.40	4.00	18.7	3
256	100	48	1.40	0.50	17.7	24
256	100	72	1.40	0.33	16.9	24
256	100	96	1.40	0.25	11.5	3

ties were seen in the beats of hearts treated with solutions having a potassium to calcium ratio of 0.5 and 0.33, but the beating persisted for 24 hours. However, when this ratio was decreased to 0.25, the beats became very irregular and did not last for 24 hours.

Table III shows the various ion ratios needed for maintaining

TABLE III
MILLILITERS OF ISOTONIC SOLUTIONS AND ION RATIOS NEEDED FOR
MAINTAINING THE HEART BEAT OF THE PUPA.

NaCl	KCl	CaCl ₂	Ion ratios		Beats/min.	Period of activity (Hours)
			Na/K	K/Ca		
.....	179	26	0.00	1.00	10.3	0.3
165	179	26	0.60	1.00	23.9	1.5
330	179	26	1.10	1.00	11.7	2.5
660	179	26	2.20	1.00	29.9	24.0
1320	179	26	4.40	1.00	19.7	24.0
2640	179	26	8.80	1.00	15.9	24.0
3300	179	26	11.00	1.00	14.3	3.0
660	179	13	2.20	2.00	21.5	24.0
660	179	9	2.20	3.00	27.6	24.0
660	179	6	2.20	4.00	20.5	3.0
165	45	52	2.20	0.50	10.8	3.0

the heart beat of the pupa. The heart did not beat in a solution of the same ratio as found in the pupal blood, that is, where the Na/K ratio is 0.6. When the Na/K ratio was increased to 2.2, the resulting solution was satisfactory since the irregularities in beating decreased to a minimal value, and the beating continued for 24 hours. The Na/K ratio could vary from 2.2 to 8.8 without any appreciable toxic effects. The K/Ca ratio may vary from 1 to 3 without any effect on regularity. However, when the ratio was increased to 4 or decreased to 0.5, irregularities were observed and the beating lasted only 3 hours.

Table IV shows the various ion ratios needed for maintaining

TABLE IV
MILLILITERS OF ISOTONIC SOLUTIONS AND ION RATIOS NEEDED FOR
MAINTAINING THE HEART BEAT OF THE ADULT.

NaCl	KCl	CaCl ₂	Ion ratios		Beats/min.	Period of activity (Hours)
			Na/K	K/Ca		
.....	111	44	0.00	1.00	24.9	3
136	111	44	0.90	1.00	24.7	24
272	111	44	1.80	1.00	43.5	24
544	111	44	3.60	1.00	55.0	24
1088	111	44	7.20	1.00	51.7	24
2176	111	44	14.40	1.00	56.6	24
2720	111	44	18.00	1.00	42.1	3
136	111	22	0.90	2.00	23.1	24
136	111	17	0.90	3.00	19.7	24
136	111	11	0.90	4.00	21.8	12
136	111	88	0.90	0.50	23.2	24
136	111	132	0.90	0.33	26.3	12

the heart beat of the adult. When the Na/K ratio was the same as found in the blood of the adult, that is 0.9, the beats were regular and lasted 24 hours. When the ratio was increased, the beating became stronger and also continued for the 24-hour period. The Na/K ratio could vary from 0.9 to 14.4 without any appreciable effect. It was found that when the K/Ca ratio ranged from 0.5 to 3, the resulting physiological solutions were excellent. However, when the potassium was increased so that the ratio is 4, slight irregularities were seen and the hearts did not beat for 24 hours. Slight irregularities were also seen in the

beats of hearts treated with the solution having a K/Ca ratio of 0.5, although the beating persisted for 24 hours. However, when the ratio was decreased so that it was 0.33 or lower, the beats became irregular and did not persist for 24 hours.

Varying the osmotic pressure of the perfusion solution showed that when the osmotic pressure was decreased to below $\frac{1}{2}$ its isotonic value, the larval heart beat became faint and slightly irregular but lasted for 3 hours. Hearts in an isotonic solution (17.02 atmospheres), or in one $\frac{3}{4}$ of its isotonic value (12.77 atmospheres), beat regularly for 24 hours. However, when the osmotic pressure was $1\frac{1}{4}$ or more times its isotonic value, irregularities were seen and survival time was greatly reduced. With hypotonic solutions the beats were faint and irregular and with hypertonic solutions they were vigorous although infrequent. Solutions which were hypertonic seemed to be less toxic than hypotonic solutions since the immersed hearts beat for a longer time, although the beating was faint. When the osmotic pressure was decreased to below $\frac{1}{2}$ its isotonic value, the pupal heart beat became faint and slightly irregular but continued for 3 hours. Pupal hearts in an isotonic solution (19.20 atmospheres), or in one which is $\frac{3}{4}$ of its isotonic value (14.40 atmospheres), beat regularly for 24 hours. However, when the osmotic pressure was $1\frac{1}{4}$ or more times its isotonic value, irregularities were seen and survival time was greatly reduced. Solutions which are hypertonic seemed to be very toxic to the pupal heart, while those that are hypotonic seemed to be less toxic since the hearts beat for a longer time, although the beating was faint. When the osmotic pressure decreased below $\frac{3}{4}$ of the isotonic value, the heart beat of the adult did not persist for 24 hours. When the osmotic pressure of the solution was isotonic (11.64 atmospheres) or increased to $1\frac{1}{4}$ of the isotonic value (14.55 atmospheres), the solutions were good since the beats were regular and persisted for 24 hours. In solutions with the osmotic pressure $1\frac{1}{2}$ its isotonic value the beating did not last the 24-hour period although the beats were strong and regular. When the osmotic pressure was increased to twice its isotonic value, the beats became irregular but lasted over 3 hours. With very hypertonic solutions the beats were vigorous, although infrequent. Hypertonic solutions, in contrast to their effects on the larval and pupal hearts, appeared to be less toxic than the hypotonic to the hearts of the adults.

DISCUSSION

The ion concentrations found in the blood of the *Tenebrio molitor* larva, expressed as milliequivalents per liter (77.3 for sodium, 32.9 for potassium), agree with 77.0 and 32.0 obtained by Ramsay (1953) for the larva of this species. The calcium concentration of 11.2 agrees with values ranging from 10.9 to 46.4 milliequivalents per liter, found in various species of Coleoptera and tabulated by Duchâteau, Florkin, and Leclercq (1953). Blood of the pupa obtained from the hemocoel is milky and contains fatty granules. Ion concentrations of pupal blood, expressed in milliequivalents per liter (18.0 for sodium, 19.0 for potassium and 3.9 for calcium), showed a marked decrease during metamorphosis from larva to pupa and a shift from a high to a low sodium content. It was thought that the marked shift in the sodium to potassium ratio might be caused by a high potassium content of the granules. Samples of blood were centrifuged to remove the granules and readings were then made on the clear hemolymph; the results showed no change in sodium and calcium but a marked increase in potassium. This experiment indicates that the high potassium content is not due to the presence of granules in the blood. There was a slight increase in sodium during metamorphosis of the pupa to the adult. Further experiments on other holometabolous insects may help in the explanation of the sodium shift.

An explanation of the fact that the pupal blood has such a high osmotic pressure as compared with the larval and adult is that in insect blood, organic material is more effective osmotically than inorganic ions (Bishop, Briggs and Ronzoni, 1925; Ludwig, 1951), and so the greater amount of organic material added to the blood during metamorphosis due to the breakdown of larval tissues may therefore account for it.

Isotonic solutions with same ion ratios as found in the blood as well as modifications were prepared and used to determine the tolerance of the insect tissue using isolated heart preparations as indicators. A solution was satisfactory when hearts immersed in it could beat for 24 hours. The most satisfactory Na/K ratio was 5.6 in the larva, but it could be varied from 1.4 to 22.4 without any appreciable toxic effects. Comparable values for the

pupa were 4.4 with a range of 2.2 to 8.8; and for the adult, 7.1 and a range of 0.83 to 14.2. The most satisfactory K/Ca ratio for all three stages was 3, but it could be varied from 1 to 3. The present observations are in accord with the findings of Barsa (1954) and Ludwig, Tracey, and Burns (1957) that insect tissue is tolerant to a wide range in the ratio of Na/K, but is more sensitive to that of K/Ca. It is to be remembered that although there is a wide range in the ratios of Na/K, a difference in tolerance between stages is noticed.

Osmotic pressure is also an important factor in an insect saline solution. Drieux (1950) found that hypertonic solutions retard the frequency and increase the amplitude of heart beat of the bee moth, *Galleria mellonella*, and hypotonic solutions have an opposite effect. His results are similar to those of Barsa (1954) and those reported here. In the present experiments, hypertonic solutions were more toxic to the hearts of larvae and pupae than to those of the adults. This observation may result from the fact that the isotonic solution for both of these stages has a very high osmotic pressure. Barsa (1954) showed that, although the osmotic pressure of the blood of two insects she used (*C. viridifasciata* and *S. walkeri*) are very different, their hearts appear to be tolerant to solutions having approximately the same tonicity. It was noted, that the larval blood of *T. molitor* has an osmotic pressure of 17.02 atmospheres, and the hearts beat normally in solutions which varied from 12.77 to 17.02 atmospheres. On the other hand, the pupal blood has an osmotic pressure of 19.20 atmospheres and pupal hearts beat normally in solutions ranging from 14.40 to 19.20 atmospheres. Similar figures for the adult were 11.64 to 14.55 atmospheres. Therefore, the hearts of each stage appear to be tolerant to a solution with an osmotic pressure of approximately 14.5 atmospheres.

With this information a solution was allowed to be devised which contained 16.0 g. of NaCl, 1.4 g. of KCl, and 1.0 g. of CaCl₂ per liter. Although this solution was quite well tolerated by all stages it is clearly indicated that a physiological solution good for one stage might be wholly insufficient to another stage, because of difference in tolerance between different stages. Experimenters using physiological solutions should be aware of this.

SUMMARY

The blood of larvae, pupae, and adults of the mealworm was analyzed. The average concentrations of inorganic cations in the larva, expressed as milligrams per cent, are sodium 177.7, potassium 128.3, and calcium 22.3; in the pupa they are 14.3, 74.0, and 7.8, respectively; and in the adult, 83.5, 92.3, and 27.1. The osmotic pressures of the larval, pupal, and adult blood are 17.02, 19.20, and 11.64 atmospheres, respectively.

The effects of isotonic chloride solutions of sodium, potassium, calcium, and of distilled water on the heart beat of the larva, pupa, and the adult were determined. For all the stages, sodium was found to be the least toxic ion, followed by calcium and then by potassium. None of the hearts beat in isotonic solutions of potassium chloride.

The Na/K ratio for the larval heart could be varied from 1.4 to 22.4 without any appreciable toxic effects. The ratios of K/Ca necessary for maintaining the normal heart beat of the larva may vary from 0.33 to 3. The larval hearts beat normally in solutions having osmotic pressures from 12.77 to 17.02 atmospheres.

The heart of the pupa did not beat in a solution with the Na/K ratio the same as in the pupal blood (0.6). When the Na/K ratio was increased to 2.2, the resulting solution was satisfactory. The K/Ca ratio may vary from 1 to 3. The heart of the pupa beat normally in solutions having osmotic pressures from 14.4 to 19.0 atmospheres.

The Na/K ratio for the adult heart could be varied from 0.9 to 14.4. The ratio of K/Ca may vary from 1 to 3. The adult hearts beat normally in solutions having osmotic pressures of 11.64 to 14.55 atmospheres.

A solution in which the hearts of each stage will beat for at least 24 hours is composed of 16.0 g. of NaCl, 1.4 g. of KCl, and 1.0 g. of CaCl₂ per liter.

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PROCEEDINGS OF THE NEW YORK ENTOMOLOGICAL SOCIETY

MEETING OF JANUARY 17, 1956

A regular meeting of the Society was held at the American Museum of Natural History. President Vishniac was in the chair. The minutes of the previous meeting were approved as read. In view of the fact that there was no new business to come before the Society, the speaker of the evening, Miss Alice Gray of the Museum staff, in charge of entomological exhibits, was introduced and given additional time for her presentation.

Miss Gray spoke of the changes to be made in the various exhibits at the Museum. The plans for the new Insect Hall were described. The specialists of the Department of Insects and Spiders assisted in the preparation of a master outline for the Hall. The plan is now to design the exhibits and place them in such manner as will most effectively bring to the public the facts they want most to know about the various specimens. The exhibits would be designed to popularize the insects and spiders, to overcome the natural dislike of these forms of life and to impress upon the visitor the oneness of nature and the importance of careful study of lower forms of life.

The place of the insect world in relation to plants and invertebrates is one of the stories that will be repeated many times in the design of the various entomological exhibits. An important exhibit will deal with a clarification of what constitutes a species. Anatomy, physiology and development of insects will be presented in a variety of exhibits where oversimplification might be generally preferred to confusion. A valuable innovation will be the inclusion of a bibliography with each exhibit. Food, flight, reproduction, generally the habits and ways of the insects will receive careful attention. The struggle of the insects to compete with their surroundings will be illustrated as will their importance destructively and beneficially to these surroundings and particularly to man.

After an enthusiastic discussion, the meeting was adjourned at 9:25 P.M.

LOUIS S. MARKS, *Acting Secretary*

MEETING OF FEBRUARY 7, 1956

A regular meeting of the Society was held at the American Museum of Natural History, President Vishniac in the chair. Dr. Vishniac called attention to the fact that paper-making wasps had attacked his "summer White House", even making off with large pieces of metal. Wonder and sympathy regarding the occurrence were expressed by all the members, but possible combative measures were not forthcoming. The business part of the meeting was concluded with Dr. Mullen's proposal of Lieutenant Milton Tinker for membership in the Society.

The speaker of the evening, Dr. Berta Scharrer of the Albert Einstein

(Continued on page 40)

ON SOME PHYMATIDAE IN THE AMERICAN
MUSEUM OF NATURAL HISTORY
(HEMIPTERA, HETEROPTERA)

BY NICHOLAS A. KORMILEV¹

NEW YORK CITY, NEW YORK

The major portion of this collection consists of common North American species of the genus *Phymata* Latreille, which in some cases are represented by very large series. There are, however, numerous Central and South American specimens; among these are some very rare and little known species which are worth noting. In the genus *Macrocephalus* Swederus, one species apparently is new and is being described herewith.

Subfamily Phymatinae Laporte

Genus *Phymata* Latreille

Phymata producta Hoberlandt

Figure 1

Phymata producta Hoberlandt, 1944, Zbor. Ent. Odd. Zem. Mus., Praha, vol. 22, p. 123, fig. 1.

One male from Rio Natal, Santa Catharina, Brazil, collected by A. Maller, January, 1946, is in the American Museum of Natural History collection.

The description of this species was based on one male specimen from Sao Paulo, Brazil. This is the second known specimen and likewise a male. The drawing of Hoberlandt is good. However, in the American Museum's specimen, which I have examined, the proboscis, formed by the frontal plates, is more constricted before the apex and the postero-exterior angles of the connexiva III, IV, and V are more protruding and more rounded. Hoberlandt placed *P. producta* near the *longiceps* group to which it is not related. It stands distinctly isolated in the genus and would probably constitute a separate subgenus. The fused frontal processes, forming the long proboscis, taper from the base to the apex, but the tip itself is dilated and truncate—a unique condition in the genus; the ocella processes are lacking

¹ I wish to express my thanks to Dr. Herbert Ruckes, through whose cooperation I was given an opportunity to examine the collection of Phymatidae in the American Museum of Natural History.

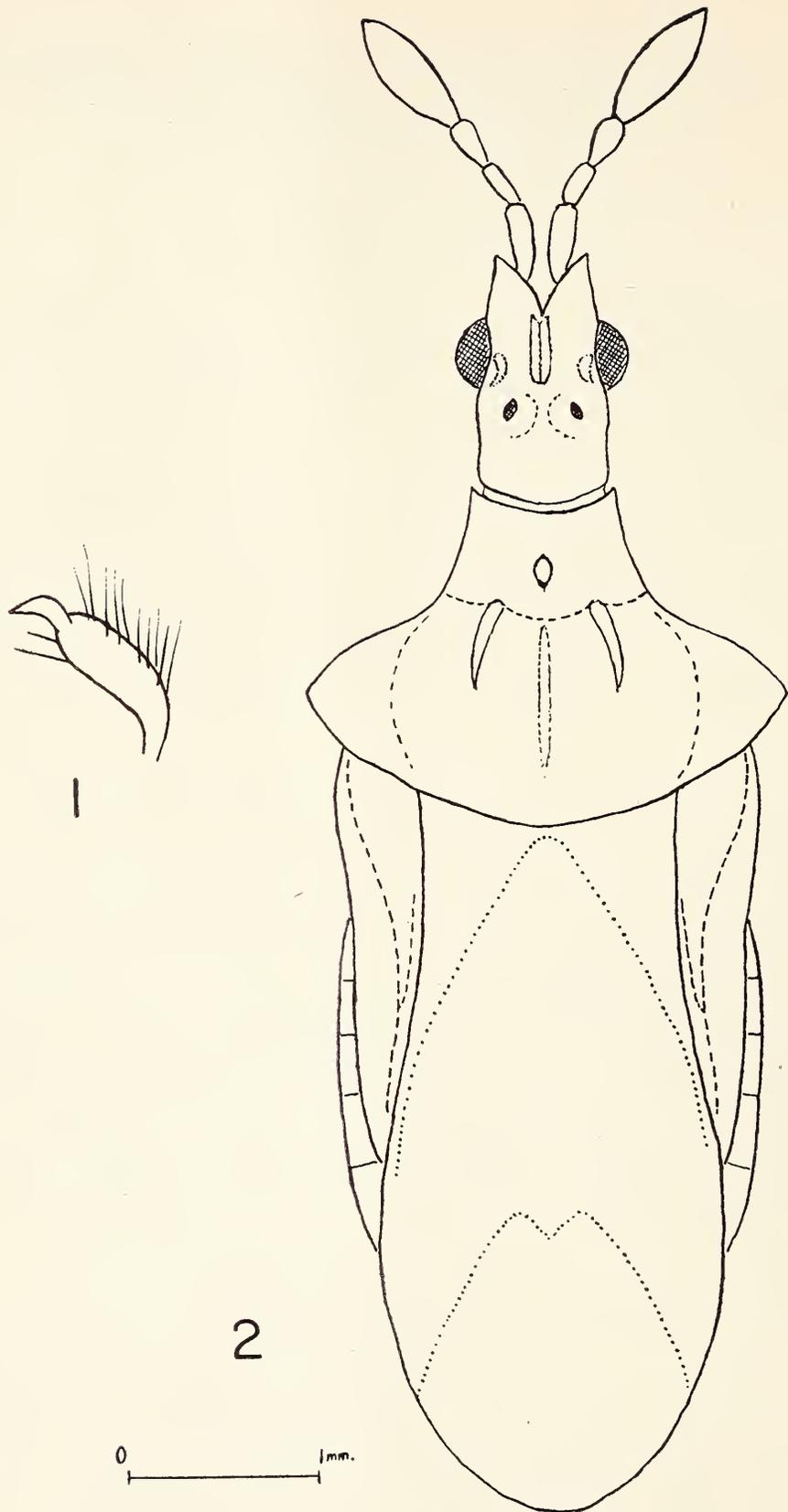


Fig. 1. *Phymata producta* Hoberlandt, male, right paramere.
Fig. 2 **Macrocephalus insignis**, new species, male.

and the ocelli are dorso-lateral in position, clearly visible from above; the posterior processes of the pronotum are also lacking; the median carina of the scutellum is vague, only at the base and apex is it visible as an obsolescent granulation; the scutellar disc is transversely rugose and the lateral borders rimmed, but without small teeth, the presence of which is so characteristic of the genus as a whole; the antennal excavation extends through the postero-lateral-posterior border (PLP-border); the postero-exterior angles of the connexiva protrude as rounded lobes, so that the entire abdominal border appears to be broadly and coarsely crenate. The parameres, although of the general *Phymata* type, are also distinctive and unlike those found in other groups of species of the genus.

Phymata acuta Stal

Phymata acuta Stal, 1860, Bidrag till Rio Janeiro trakt. Hem. fauna, vol. 1, p. 60.

One male from Chapada, Brazil.

In 1897 Handlirsch synonymized the Stal species *P. longiceps*, *P. simulans*, and *P. acuta* with *P. acutangula* Guérin, 1856, apparently not knowing the last. In 1930 Melin separated the species of Stal from *P. acutangula* Guerin, but left the two latter in synonymy with *P. longiceps* Stal. In 1951 I separated *P. simulans* Stal from *P. longiceps* Stal but, not knowing the types, left *P. acuta* as a synonym of *P. simulans* Stal. Later, through the kindness of Dr. René Malaise of the Stockholm Riksmuseum, I was privileged to see all types of Stal. They are quite distinct and each in its own right a valid species. The full synonymy and identity of these species is given in the author's "Revision of Phymatinae," still in press. All species of the *longiceps* group, to which *P. acuta* belongs, are characterized by the long head, which is at least one and a half times as long as wide across the eyes, and by a strongly dilated abdomen. *P. acuta* can be separated from *P. longiceps* and *P. simulans* by the absence of the lateral notch of the pronotum and by the evenly granulated body. From *P. peruensis* Melin, 1930, the most closely allied species, *P. acuta* can be separated by the smaller head, which is distinctly shorter than the pronotum. In *P. peruensis* the head is as long or almost as long as the pronotum.

Phymata rhynocerata Kormilev

Phymata rhynocerata Kormilev, 1957, Rev. Bras. Biol., vol. 17, p. 124, figs. 1-3.

In 1957, I described this species from one female specimen taken at Tuxtepec, Oaxaca, Mexico. The holotype is in the United States National Museum in Washington. The American Museum of Natural History has in its collection five specimens including two males, collected in the provinces of Vera Cruz and Jalisco, Mexico. One of these males I am designating as the allotype and give a short description of it below.

MALE. Slightly smaller than the female and darker in color: orange yellow; the hind disc of the pronotum, transverse band of the abdomen, meso- and meta-pleurae are chestnut brown; lateral bands of the pronotum testaceous; lateral notch of the pronotum whitish; legs greenish yellow; the tips of the lateral angles of the pronotum and abdomen are black.

Biometrical Measures. Head longer than wide across the eyes, 24/15; the proportions of the antennal segments (1-4) are 5/7/9/16; pronotum is shorter than wide across the lateral angles, 28/43; scutellum is shorter than wide at the base, 10/12; abdomen is shorter than wide across the lateral angles, 53/60; fore femora much longer than wide, 20/9.

Male. Total length 5.4 mm.; width of the pronotum 2.15 mm.; greatest width of the abdomen 3.0 mm.

Allotype, male, El Palomar, ten miles west of Tezonapa, Vera Cruz, Mexico, collected by Ray F. Smith, December 31, 1950; deposited in the American Museum of Natural History.

Specimens Examined. One male and two females from the same locality; one female, La Resolana, Jalisco, Mexico; in the same collection.

Phymata annulipes Stal

Phymata annulipes Stal, 1862, Stett. ent. Zeitg., vol. 23, p. 439.

One male, four miles southwest of Aguas Calientes, Aguas, Mexico, 6100 feet, collected by Ray Smith, October 24, 1950.

Phymata annulipes Stal is allied to *P. reticulata* Handlirsch, *P. venezuelana* Kormilev, *P. laciniata* Handlirsch, and more remotely *P. handlirschi* Champion, forming with them an "annulipes group." This group is characterized by the extreme development of connexivum IV (of the 5th abdominal segment), which has on the ventral side a longitudinal carina, separating the genuine connexivum from exterior portion, and which I propose to name *ultraconnexivum*. All these species are extremely rare and are known only as single or few specimens.

Phymata bipunctata Kormilev

Phymata bipunctata Kormilev, 1951, An. Soc. Cient. Arg., vol. 152, p. 174, fig. 3.

One female, Rio Vermelho, Santa Catharina, Brazil, collected by A. Maller, November, 1947.

This species was previously known from a single specimen, a female, collected in Bituruna, Parana, Brazil. The present specimen, also a female, is much darker than the holotype, having a coloration more comparable to a male: testaceous to reddish brown; the connexiva II and III with a black spot at the anterior angle; the median and hind tibiae each with two dark rings.

The systematic position of *P. bipunctata* is not very clear. It belongs to the species with very short head, and in the original description I related it with *P. andina* Melin, but it is perhaps more allied to *P. malaisei* Kormilev (in press), because it is matte, whereas *P. andina* belongs to the glossy species.

Subgenus *Phymatispa* Kormilev

Phymatispa Kormilev, 1951, Rev. Inst. Nac. Inv. Cien. Nat., Bs. As., vol. 2, p. 54.

Originally this subgenus was created for the reception of the "fortificata group" and consisted of three species: *P. fortificata* Herrich-Schaeffer, *P. argentina* Pennington, and *P. sanjuanensis* Kormilev. Later I added one more species, *Phymata (Phymatispa) paradoxa* Kormilev, 1952. The main character separating this subgenus from *Phymata* Latreille, *sensu stricto*, is found in the form of the parameres, which here are bifurcated, whereas in all other genera and subgenera of the subfamily Phymatinae they are uniramous.

Phymata (Phymatispa) paradoxa Kormilev

Phymata (Phymatispa) paradoxa Kormilev, 1952, Publ. Mision Estud. Pat. Reg. Arg., vol. 23, p. 126, fig. 2.

This striking species was described from two specimens, a male and a female, from Paraguay and Brazil, respectively. In the American Museum of Natural History is deposited a third specimen, also from Brazil.

One female, Rio Natal, Santa Catharina, Brazil, collected by A. Maller, February, 1945.

Subfamily Macrocephalinae Amyot and Serville
Genus *Macrocephalus* Swederus
Macrocephalus stali Handlirsch
(in Part.)

Macrocephalus lepidus Stal, 1862, Stett, ent. Zeitg., vol. 23, p. 440.

Macrocephalus stali Handlirsch, 1897, Ann. Naturh. Hofmus. Wien, vol. 12, p. 195.

One male from Chapulhuacan, Hidalgo, Mexico, collected by M. Cazier, W. Gertsch, and R. Schrammel, May 20, 1952. One female, ten miles from Villa Azueta, Oaxaca, Mexico, collected by R. Smith. One female from Tegucigalpa, Honduras, collected by F. J. Dyer, June 30, 1918.

This small species is distributed in Mexico and Central America. It is closely allied to *M. lepidus* Stal and belongs to the subgenus *Lophoscutus* Kormilev, 1951.

Macrocephalus pulchellus Westwood

Macrocephalus pulchellus Westwood, 1841, Trans. Ent. Soc., London, vol. 3, p. 25.

Syrtis (Macrocephalus) pulchella Guérin, 1856, in Sagra, Hist. de Cuba, p. 406.

One female from Vinales, Cuba, September 16-22, 1913.

This is one of the smallest species in the genus, restricted to Cuba. It also belongs to the subgenus *Lophoscutus* Kormilev.

Macrocephalus leucographus Westwood

Macrocephalus leucographus Westwood, 1841, Trans. Ent. Soc., London, vol. 3, p. 25.

One male from San Turce, Puerto Rico, December 6, 1918.

This species is restricted to the West Indies, being known from Haiti, San Domingo, and now from Puerto Rico. This species also belongs to the subgenus *Lophoscutus* Kormilev.

Macrocephalus asper Stal

Macrocephalus asper Stal, 1876, Enumeratio hemipterorum, pt. 5, p. 135.

One male from Rancho Grande, Venezuela, May 4, 1945.

This rare species is known only from Venezuela. It belongs to the subgenus *Lophoscutus* Kormilev.

Macrocephalus crassimanus (Fabricius)

Syrtis crassimana Fabricius, 1803, *Systema rhyngotorum*, p. 123.

Macrocephalus crassimanus St. Fargeau and Serville, 1825, *Encycl.*, vol. 10, p. 120.

One female from Ensenada, Puerto Rico, November 13, 1925.
One female from Charlotte Amelia, St. Thomas, June 2, 1911.
One male from Talboa near Ponce, Puerto Rico, no date.

This male is very small, only 6.5 mm., whereas Handlirsch indicates the size for the Westwood specimen, also male, 9.0 mm. I cannot separate this male from the females mentioned above. *Macrocephalus crassimanus* also belongs to the subgenus *Lophoscutus* Kormilev.

Macrocephalus insignis, new species

Figure 2

Male. Head relatively short (40/26); the anteocular part is narrower and almost half as long as the posterior; eyes large, semiglobose, protruding; ocelli placed nearer to the eyes than to each other (5/8); the superior and the lateral surfaces of the head covered with conspicuous, mostly black, granules; the lower border of the head behind the bucculae also granulated. Antennae relatively short; the proportion of the antennal segments (1-4) are 8(5)/6(5)/7 1/2(4)/23(8); the figures in brackets represent the maximal width of the segment; the first segment is subcylindrical, the second subglobose, the third tapering toward the base, the fourth^s robust, elongately ovate.

Pronotum shorter than wide across the humeri (47/75); the fore lobe is much shorter than the hind lobe (17/30), with dispersed, rounded granulation, black on the disc, and whitish at the borders. Foreborder deeply emarginate; anterior angles acute, dentiform, granulated and slightly divergent; lateral borders of the fore lobe slightly arcuate convex, crenulated; in the middle of the fore disc is situated a small but deep faceta. Hind disc with the antero- and postero-lateral borders slightly convex, but not crenulated; lateral angles not emarginate and forming a right angle; the disc is covered with coarse punctures but is almost without granules. (Two (1+1) short, robust, slightly divergent carinae running from the interlobal furrow to the middle of the disc, where they disappear; posterior border angularly protruding backward.

Scutellum large (105/55), reaching the tip of the abdomen, covering most of the abdomen and hemelytra, and at the base somewhat narrowed; the maximal width two-thirds of the distance from the base; the disc finely punctured, posteriorly with a sparse whitish granulation; the median carina narrow, rather obliterated, and only at the base slightly dilated and raised. The coloration of the scutellum is very characteristic, i.e., dark background with a wide, chevron-shaped, yellow, transverse band.

Hemelytra visible only as a narrow outer border of the corium.

Abdomen relatively narrow, longer than wide (85/65), slightly tapering from the base backward, and from above visible as a narrow margin. The posterior-exterior angles of the connexiva not protruding; venter with dispersed, somewhat obliterated, concolor granulation. Parameres of the *Lophoscutus* type, i.e., uniramous.

Pleurae with sparse rounded granulations; the foreborder of the propleuron crenulated.

Fore femora rather small and short (40/23), much narrowed at the base; disc convex, with dispersed dark granulations similar to those on the head and pronotum.

Coloration. Head, antennae, the hind lobe of the pronotum, chestnut brown; corium, the tip of the scutellum and the fore femora darker; the base of the scutellum fuscous; the transverse band of the scutellum, the entire ventral surface of the body (with the exception of the lateral angles of the propleurae, which are dark), the fore coxae, the median and hind legs, yellow; the fore lobe of the pronotum pale orange; tergum dark orange, almost red.

Male. Total length 6.5 mm.; width of the pronotum 2.5 mm.; width of the abdomen 2.25 mm.

Holotype, male, Rancho Grande, Venezuela, July 5, 1945; deposited in the American Museum of Natural History.

The new species belongs to the subgenus *Lophoscutus* Kormilev and is related to *Macrocephalus macilentus* Westwood. It is more robust, the lateral angles of the pronotum less acute; the lateral borders before and behind them more convex. The conspicuous black granulation of the head, pronotum, and fore femora, and the coloration of the body are also quite different.

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(Continued from page 32)

College of Medicine spoke on "Some new and some old research in insect endocrinology", during which she reviewed the various insect endocrine organs which have known functions.

The prothoracic glands of holometabolous insects have been shown to function during immature stages, producing a growth and differentiation hormone. It is this hormone which has recently been isolated in the laboratory of Adolf Butenandt, making this the only invertebrate hormone isolated in chemically pure form at the present time.

(Continued on page 78)

UNILATERALITY IN INFESTATIONS OF THE MOTH EAR MITE

BY ASHER E. TREAT*

THE CITY COLLEGE OF NEW YORK

The gamasine mite *Myrmonyssus phalaenodectes* Treat (1954) is a widely distributed parasite in the tympanic organs of noctuid moths, chiefly those of the genus *Leucania*. Its colonies, whether founded by a single female or by several, occupy and destroy the function of one but not both of the host's ears. Each female can produce from 80 to 100 eggs. The young develop to maturity on the original host and the fertile females then seek another moth on which to repeat the cycle. A large colony fills the three chambers of the ear to overflowing. As the maturing females leave the ear, they populate both sides of the head, neck, and prothorax of the host, whence they leave, a few at a time, to found colonies of their own. Regardless of the age, size, or condition of the colony, one ear is normally left unoccupied and undamaged. Left and right sided infestations are about equally common, and mites reared on one side of the original host may found colonies on the opposite side of its successor.

In the unilaterality of its colonies, the moth ear mite contrasts sharply with most insect-infesting mites, which tend to distribute themselves symmetrically on the host's body, often with astonishing precision (Cooper, 1955). In such relationships the equilibrium of the insect is undisturbed, while the damage to the host, if any, is not more severe for being equally distributed. The moth ear mites, on the other hand, make the moth "deaf in one ear," and were they to invade both sides they would leave their host unable to detect the high pitched sounds of bats and perhaps of other predators (Roeder and Treat, 1957). They might thus expose both their hosts and themselves to early extinction. Though it seems unlikely that the mites apprehend this danger, they nevertheless appear to avoid it quite systematically. How does this come about? Are bilateral colonies sometimes formed, only to be devoured by bats or to render the moths incapable of

* Special Research Fellow of the National Institute of Allergy and Infectious Diseases.

flight and therefore less likely to be taken by the collector? Is it physiologically impossible for the mites to use both ears? Are the moths somehow unsymmetrical in the attractiveness of their two sides, or are the mites congenitally right or left handed?

To most of these questions it is easy to show that the answer is No. That unilaterality is not required for the development of the colony is proved by the experiment of placing one or more gravid females in each of the two tympanic recesses of the same moth. The result is usually a colony on both sides. As long as the moth is sheltered in the laboratory it shows few ill effects (other than deafness) from its parasites, and the two colonies mature normally. A single ovipositing female transferred to the opposite ear will sometimes return to her brood, but she may instead continue egg laying in her new location, thus producing a bilateral colony all by herself. Except for such experiments, bilateral colonies are about as rare in the laboratory as they are in the field, where only two have been discovered among nearly 1,000 infestations.

Were every colony the work of a single female there would be no problem; her attraction to her brood, and later the gregariousness of her offspring would tend to localize the mites in whichever ear she chanced to occupy. But though such simple colonies are common, compound colonies with ovipositing females numbering eight or more are often seen, especially in midsummer when the incidence of infestation is at its peak. If, as is believed, the young females commonly leave their old hosts and find new ones while the insects are feeding on flowers, it must often happen that a single moth will take aboard several wanderers, one or a few at a time, from several sources. Indeed it is only in this way that cross-fertilization could be achieved, since the males do not wander, and the only males present in a colony are those that develop there. When several fertile female mites—say 8 or 10—are placed at random on both sides of a previously mite-free moth and the insect is then confined in a jar or cage, a typical unilateral compound colony usually develops. Similar results have been noted when mite-free moths are kept in closed jars with infested moths or with wandering female mites (Figure 1).

As far as one can tell, the mites are blind, deaf, and dumb. In glass containers they do not appear to follow trails, either

their own or others'. On a living moth held by upraised wings under an entomological microscope, they show no tendency to congregate, but push about slowly and singly, as though at random, among the hairs of the head and thorax. From two to several

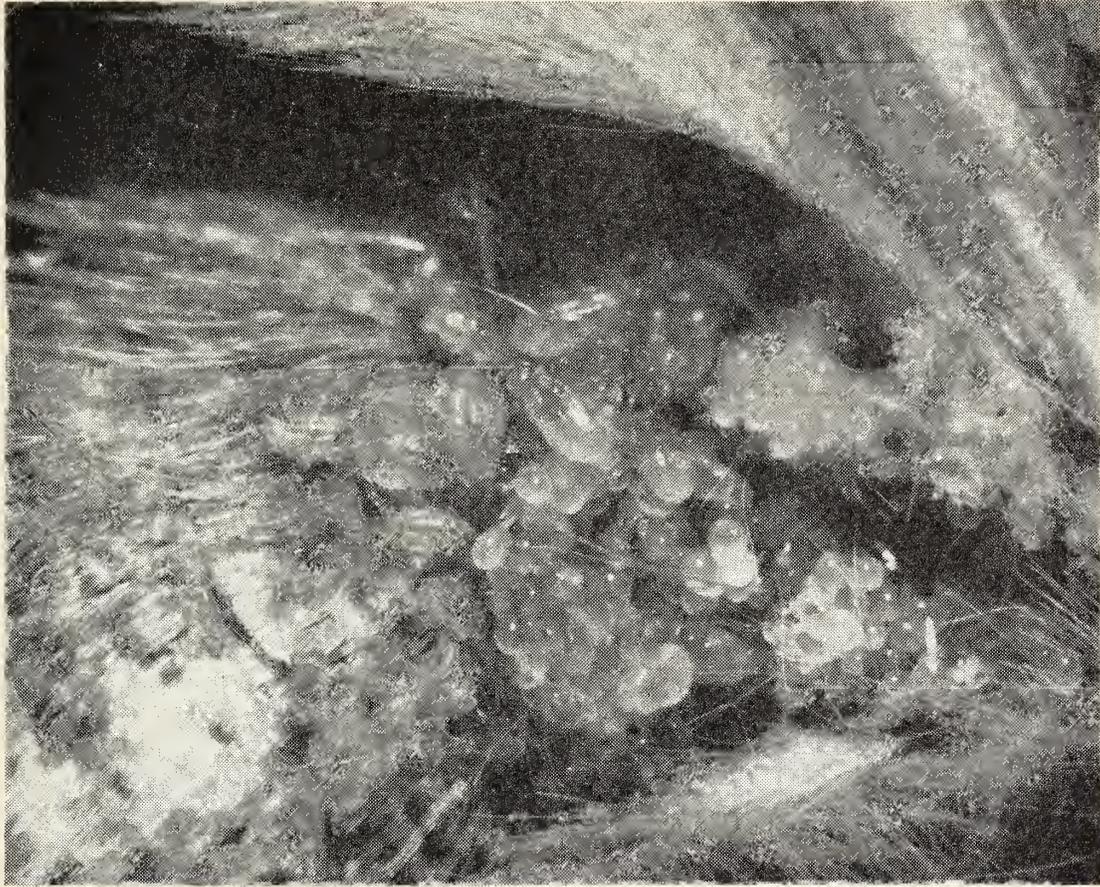


Figure 1. A living colony of moth ear mites in the right tympanic area of an armyworm moth, *Pseudaletia unipuncta*, ♀. The moth was taken, mite-free, on 21 September, 1957, and was confined in a glass jar for five days with an infested *Leucania phragmatidicola* ♂, taken at the same time in Tyringham, Massachusetts. Photographed 30 September, 1957, by Dr. A. B. Klots. Ten gravid female mites are visible, together with several larvae, three deutonymphs, and many eggs. Many more mites and eggs occupied the deeper parts of the tympanic recess and the internal parts of the ear. Wandering females of the second generation were found on the head and neck of this moth, but the left ear was unoccupied and undamaged. The moth was still alive when the photograph was taken, but died soon after—not necessarily from the effects of its parasites. Another moth of the same species survived a similar infestation for 16 days.

hours are required, with the moth unrestrained, for the mites to reach and perforate the tympanic and countertympanic membranes and to begin egg laying. It is during this time, of course,

that the "choice"¹ of ears is made. What goes on during this critical interval?

The possibilities appear to be limited: (a) the two ears are not equivalent, and each mite might find its way unaided to the more attractive or accessible one; (b) the mites might follow a leader whose choice could be random; (c) each might follow an innate behavior pattern dictating that it should seek the second ear unless it finds another mite in the first.² The actual solution of the problem, though differing from any of these conjectures, seems to partake somewhat of all three. The first mite may make a random choice, but does not normally visit both ears. Succeeding mites follow the same path as the first, but only from a critical point at which each arrives independently by an apparently innate routine.

The observations which led to this conclusion were delayed for several seasons by the mistaken assumption that one could not follow the movements of the mites on a free and unrestrained moth. Once it was realized that this is not true, it was but a short time before the assembly of the wanderers to form unilateral colonies had been observed repeatedly. Many moths after a few hours of evening activity settle down to a long rest which may last for the rest of the night and all the next day. At such times the moths are not too easily aroused and may be kept under the microscope without restraint for long periods. They are evidently not disturbed by the activities of the mites. For critical observations decapitated moths may be used. These stay indefinitely in a normal resting position, moving briefly only when touched. On resting normal or headless moths the mites, though often completely hidden in the vestiture, reveal their position at every movement by the displacement of the hairs, and can thus be followed quite readily.

Until shortly before they reach the ear, the mites seem to be guided by the moth's contours and by the distribution and orientation of its hairs and scales. Figure 2 is a dorsal view of *Pseudaletia* (= *Leucania* = *Cirphis* = *Heliophila*) *unipuncta* (Haworth), the armyworm moth, in the resting position, show-

¹ Lest the word "choice" be considered objectionable, it may be stated that no deliberative action is implied here or elsewhere in this paper.

² This amusing and ingenious suggestion was made by Dr. Horst Mittelstaedt.

ing the chief areas traversed by the mites and mentioned in the following account. The thoracic vestiture in this species is close and smooth. It consists of a mixture of simple, elongate,

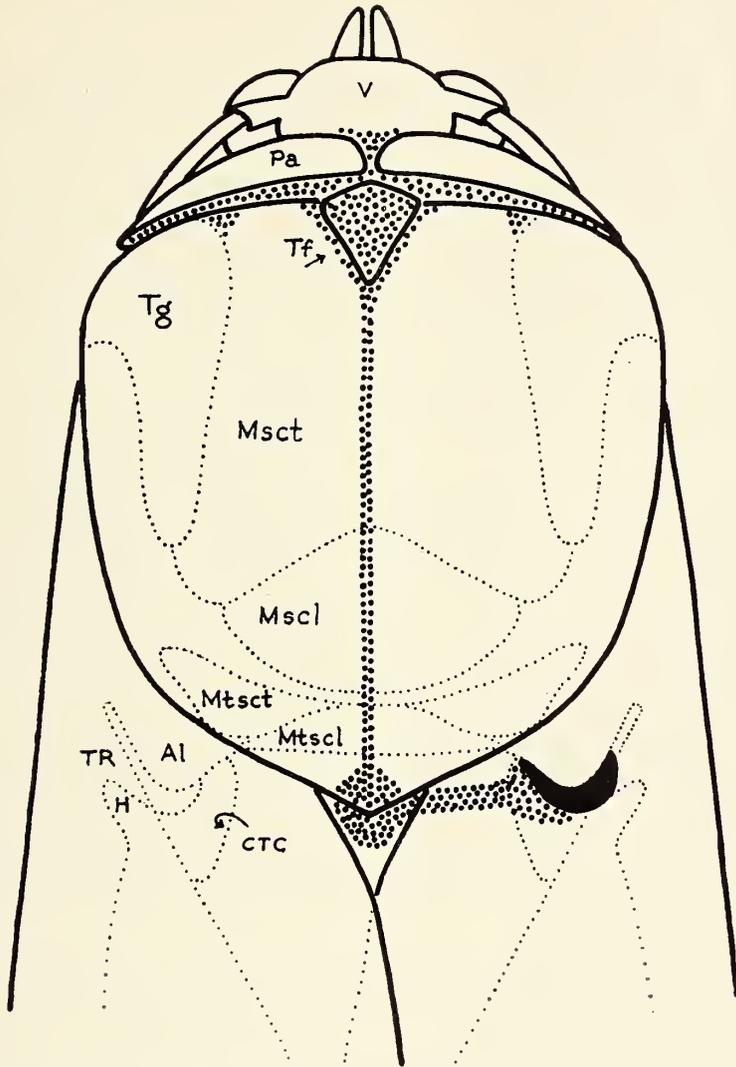


Figure 2. *Pseudaletia unipuncta*, semi-schematic dorsal view of anterior portions. Heavy lines indicate outlines of superficial features; light dotted lines, outlines of skeletal elements. Heavily dotted areas show the chief pathways traversed by the mites in reaching a colony site (shown in black) in the right tympanic recess. Al, alula of hind wing; CTC, orifice (shown by arrow) of countertympanic cavity; H, hood; Msc, mesoscutellum; Mset, mesoscutum; Mtsc, metascutellum; Mtset, metascutum; Pa, patagium; Tf, anterior mesothoracic tuft; Tg, tegula; TR, tympanic recess; V, vertex. The term "collar," as used in the text refers to the vestiture of the patagia; the term "disc" refers to the metascutum and metascutellum, collectively. Pathways of mites from the site of boarding to the collar region are not shown.

and spatulate scales overlain by simple, flattened, and spatulate hairs (cf. Forbes, 1954, p. 7-9). The distribution of these scale and hair types varies over different parts of the thoracic surface

Near the center of the disc, long, simple hairs predominate in the upper layers, and the convergence of the free tips of these hairs from the two sides marks the midline (an important part of the mites' path) from the anterior mesothoracic tuft to and slightly beyond the rear margin of the thorax. There the converging hairs form a little, pointed brush, meeting the first abdominal tuft between the inner margins of the folded forewings. The anterior thoracic tuft is a spray of long simple hairs on the anteromedial part of the mesonotal disc. Rimming and somewhat overlapping the disc anteriorly is the "collar" of mixed hair and scales that curve upward and rearward from the anterior surfaces and upper borders of the patagia.

Just behind the metascutellum, the surface of the first abdominal tergum dips downward slightly to form a shallow transverse trough or groove extending between the dorsal lips of the countertympanic cavities of either side. In a resting moth, this trough is roofed laterally by the forewings and medially by the projecting brush of thoracic hairs. It is bordered anteriorly by the metascutellum and posteriorly by the hair tufts of the first abdominal tergum. On its floor is a carpet of very small, closely appressed, simple scales, free from the admixture of hair. The transverse trough forms a natural external pathway between the two ears, quite concealed from view until the wings and overlying vestiture are removed.

When a fertile female mite is placed upon or allowed to board a resting moth she promptly buries herself among the hairs wherever she happens to be. She moves slowly among their bases in a hesitant, groping manner, punctuated by peculiar little jerks or darts which do not send her forward appreciably but which may serve to test the orientation of the hairs or to adjust her position among them. Her course, though irregular, is toward the collar or the neck, which she eventually reaches. The route depends partly, of course, upon the site of boarding, and does not appear to be fixed in any systematic way. Once arrived, the mite remains in the neck or collar area for some time. She may be quiet for long periods, occasionally rummaging about among the deep hairs or shuttling from one side to the other. There may be intermittent feeding through the soft membranes of these areas, and fecal droplets may be deposited among the hairs. One mite (on

a decapitate moth with loose collar vestiture) was seen to cross twice from a resting position at the left shoulder to right post-patagial region, each time leaving a fecal droplet in the same spot and returning immediately for another period of rest or feeding.

The time spent in the collar region seems to depend upon the alimentary or reproductive state of the mite rather than on the condition of the moth, the time of day, or other extrinsic factors. Some mites, perhaps unready for oviposition, remain there indefinitely after experimental transfer. Gravid females usually stay no longer than an hour or two. During this period there is no indication that the mite is seeking any other location. To all appearances she has made herself at home and is going to stay there.

The second phase of activity, which ends in the mite's arrival in the ear, is heralded by a rather sudden increase in the tempo of the movements in the collar region. Now the mite seems in a hurry, and her actions give the impression of impatient seeking for something. She approaches the anterior tuft and probes this way and that among the hairs at its base or sides. Soon the long hairs are parted like tall grass at a point near the midline. From the center of the "part" the mite emerges. She continues to push aside the hairs with her forelegs, making a broad path down the center of the disc. She creeps quickly along this path, extending it rearward as she goes, and pausing briefly now and then to lift or probe the scales that form its floor. There are no longer the jerky or darting movements that characterized her earlier actions, and there is no hesitation or turning aside until the brush at the posterior border of the thorax has been reached. This is the base of the triangle bordered by the forewings at the center of the transverse trough (Figure 2).

If the mite is already engorged she has some trouble in getting down among the tufted hairs of this region and into the trough itself, but she persists, and at last, within one or two minutes of the time her rearward march was started, she reaches the cross-road, midway between the two ears, where her final direction must be determined. Here she probes repeatedly in all directions, turning first one way and then another, making many tentative starts and returning to the midline after a step or two. Even-

tually the die is cast: she goes to one side and under the wing margin, raising it slightly as she disappears. She is now wholly concealed from observation or detection, but if the host is quickly anesthetized she is found in or just outside the tympanic recess of the side on which she was last seen.

This, it might be supposed, is the end of the journey; but it is not. Time after time, at intervals of about ten minutes for the next hour or more, she returns to the "crossroad," probes briefly in various directions as before, and then goes back to the ear first occupied. After seven or eight such visits, she finally settles down to the business of forming a colony. The third and last phase of her wandering is ended. But why the retracing of steps? Is it merely that she is still "undecided," or is this a functional part of her routine?

The problem of unilaterality in compound colonies is not solved, of course, by knowing the behavior of the first mite to arrive. It is the actions of the others that must tell the story. If a second mite is placed upon the moth, either at the same time as the first or later, it goes through the same general behavior pattern as the first, and in the initial phase quite independently of her predecessor's path. If the two mites meet in the collar region, their contact is brief; there is no obvious sign of recognition, no tendency to congregate or for either mite to follow the other's trail. The midline march of the second mite may begin at a different point from that of the first (for example, on the opposite side of the thoracic tuft) but is completed in the same way as if the moth had been previously unoccupied. It is only at the "crossroad" that the behavior of the second mite appears significantly different from that of the first. The newcomer shows less hesitation. After only brief probing, she goes to the occupied ear, from which she, in turn, may revisit the crossroad area, though as a rule not so often as the first arrival. A third mite, or a fourth, or a fifth will follow the same procedure but with less hesitation at the crossroad, each turning toward the occupied ear from this point as though following a well-marked trail. If one of these mites is later removed from the ear and transferred to the head of the same moth or of another, it proceeds as before except that the time in collar region may be somewhat shortened. A brood female removed from her eggs and transferred to the

head or thorax of a mite-free moth will not necessarily go to the same side as that of its former home, but may settle on the side opposite, showing that a given mite is not, either congenitally or by habituation, "right-" or "left-handed."

On resting moths with folded wings, the mites have never been seen to visit the unoccupied ear. If the forewings are removed, however, such visits sometimes occur, though no bilateral colonies have resulted from them. Moreover, when the moth's forewings are removed the first approach to the ear may be somewhat different from that described above. Only two such cases have been studied. In both, the mites wandered considerably on reaching the crossroad area and did not appear to find or recognize the transverse path immediately. One went as far rearward as the second segment of the abdomen, then turned obliquely forward and moved against the direction of the hair in this region until she reached the tympanic area. In one such moth the mites, having reached the ear, proceeded to distribute fecal droplets along the sides of the transverse path, and in this way made a mat of hairs which gradually converted the exposed passage into a thinly roofed tunnel extending clear across the dorsum. Such hair mats normally cover the external tympanic recess in mature colonies, but are not normally found on the dorsum. It was thought at one time that the slight symmetry of the overlapping forewings might guide all the mites to the same ear. Since in a given moth the wings do not always overlap in the same way, if at all, and since bilateral colonies have not been formed when the wings were removed, this idea was soon given up.

From the facts at hand, one may infer that until it is nearly ready to start egg laying and has reached the "crossroad" between the two ears, each mite obeys an innate behavior pattern for which the topography of the vestiture supplies the effective stimuli. At the crossroad, the choice of ears by the first mite could be at random, but succeeding mites are apparently influenced at this point by the previous behavior of the first. The nature of this influence remains unknown, but very likely it is concerned with the frequent retreading of the path between the chosen ear and the midline. It could be in the nature of a chemical trail, secreted, perhaps as a prelude to egg laying, after the colony site has finally been adopted. It is certainly not a simple

result of the perforation of the tympanic membrane by the first mite to arrive, for the experimental puncture of the membrane does not attract mites to the damaged ear. Many more observations are needed to clear up this and other puzzling points.

If the second mite does not arrive in the ear until after the first has produced an egg clutch, she may be greeted by a display of "hostility" that is offset only by persistent attempts to gain access to the tympanic air sac. This behavior has been described elsewhere (Treat, in press). It is remarkable that in the face of such a reception, the intruder does not seek the unoccupied ear. The fact that it does not do so testifies to the potency of the influences promoting unilaterality, and, no doubt, to the high selective value of that condition.

SUMMARY

When several fertile females of the moth ear mite board the same prospective host, they go at first to the collar region, from which, some time later, they proceed singly along the dorsal midline to a point midway between the two ears. Thence their course appears to be determined by the actions of the first mite to arrive, with the result that all the mites assemble in one ear to form a compound, unilateral colony.

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THE LIFE-HISTORY OF HISTIOSTOMA POLYPORI (OUD.) (ACARI: TYROGLYPHOIDEA)*

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INTRODUCTION

Specimens of the common European earwig, *Forficula auricularia* Linn., taken from the field in Edinburgh (Scotland) and reared on a medium of soil and vegetable food, often acquired heavy infections of the hypopi of the Tyroglyphoid mite *Histiostoma polypori* (Oud.). Apart from a casual reference to the mite and an insufficient description of the hypopus stage by Oudemans (1914) under the name of *Anoetus polypori*, nothing was practically known about the mite (Behura, 1950). The author (Behura, 1955) has dealt with the history and taxonomy of the mite and in this paper, endeavours to give an account of the life-history of the much obscure mite.

METHODS

The mites were reared in special cells designed, but with some modifications on the lines of those described by Robertson (1944). The cell consisted of a black perspex plate 4 cm. square and 0.3 cm. thick, having a central circular aperture with an inclined wall. A piece of black filter paper, fixed with a gum covered the space at its narrow diameter of 1.7 cm. and served as the porous base of the cell. The cell was completely closed by placing a coverglass, 3.5 cm. square, over the cell at its wider diameter of 2.4 cm. To prevent the escape of the minute larvae of a culture, the coverglass was sealed to the perspex plate with a thin smear of petroleum jelly.

A high moisture content, necessary for providing the most favorable conditions for culturing the mites was maintained by placing the filter paper base upon cotton wool, moistened with water, enclosed in a glass trough. The glass trough, containing the cells, could then be exposed to the required temperature. It

* This paper formed part of the thesis presented to the University of Edinburgh, Scotland, for the degree of Ph.D.

was found that the mites, including larvae introduced into the cells, moved slowly but quite easily over a filter paper base saturated with moisture.

The mites were literally submerged as they fed upon the liquefied decomposing food placed in the cell, e.g. small pieces of earwigs, decaying cabbage, dandelion floral parts, etc. Mites fed on horse flesh attained sizes about twice those of comparable stages of mites cultured on a diet of decomposing earwig remains.

Introduced mites will remain upon the decomposing food, either submerged and immobile, or slowly and laboriously moving to and fro in the liquefied mass. They will soon multiply, the eggs being usually laid in masses around the periphery of the food material, although they are also indiscriminately laid either singly or in small groups on the food itself or upon the filter paper at a relatively short distance from the food. The design of the cell made it very easy to observe the movements of a culture of mites under a binocular microscope. The moisture content of the cell was maintained by mounting the cell upon a solid watch glass containing moist cotton wool. Overhead or lateral illumination of the cell when viewed under the binocular microscope readily accentuated the contrast of the opaque mites against the black back-ground. The transparent nature of the cuticle also made observations of transition stages easy and it was possible to distinguish readily the newly forming stage within the cuticle of the preceding one. Immobilization of the mite was usually a prelude to the extensive histolytic processes which affected the soft organs and tissues of the body.

To follow in detail the stages of the life-cycle, a male and a female were transferred to a single cell. As the eggs were laid and when a sufficient number were counted, the adults were removed. In this way as many cells as could be examined by one observer were stocked with newly-laid eggs. As the larvae emerged they were transferred to separate cells and their progress of development to the adult stage carefully recorded. It was therefore possible to follow the life-cycle of separate individuals under standard conditions.

The cell design also made it very easy to expose the mites to varying humidities and different temperatures.

The laboratory cultures of *H. polyperi* if left unattended for

some time, occasionally became contaminated with the Tyroglyphoid mite *Tyroglyphus siro* Linne. *T. siro* requires less humidity than *H. polypori* for growth. As the moisture content decreased in the petri dish or bottle cultures, *T. siro* became dominant and the numbers of *H. polypori* gradually grew less. Some of the stock cultures in glass vials and petri dishes were ruined by heavy infection of *T. siro*.

A species of small fungus gnat also laid eggs in the stock cultures. Even when the large petri dishes are closed with glass covers, the slender dipterons find a way into the culture to lay eggs. The large elongate vermiform larvae with their black heads are voracious feeders and they will eat the *Forficula* remains, decaying vegetable matter, and even the filter paper. Mr. H. Oldroyd of the British Museum kindly identified the specimens as a species of *Sciara* of the family *Mycetophilidae*.

LIFE-HISTORY

Mating:

Mating in *H. polypori* is very peculiar. Active deutonymphs at an advanced stage of development are easily distinguishable as males or females. The "female" deutonymphs before passing to the resting stage carry adult males. The position of the male resembles that found in the insects, since it clasps the dorso-posterior part of the female's body. The well-developed legs of the male allow it to take a firm hold of the deutonymph. After a short period of activity, the deutonymph passes to the transition or resting stage. The male will remain attached to the resting "female deutonymph," while other males will attempt to dislodge it. The hold of the male is so firm that it will cling to the deutonymph even when both are rolled somewhat vigorously. Presumably, mating takes place immediately after the emergence of the female from the nymphal skin.

If for some reason or other, the "female" deutonymph does not hatch into the adult condition, but dies, even then the male remains clasping it for a considerable time. In one instance, the attachment lasted continuously for 11 days and discontinuously for another 3 days. This was more interesting from the fact that this male even when dislodged would mount on the "female" and attain the usual posture again.

It would therefore appear that the males have acquired the instinct of distinguishing an active or resting "female" deutonymph. I am not aware of this mating behaviour occurring among other members of the Tyroglyphoidea. Stolpe (1938), who worked on the life-history of *H. genetica* Stolpe, the hypopi of which heavily infest laboratory cultures of *Drosophila melanogaster*, recorded the mating behaviour of adults. Jary *et al* (1936), who studied the life-history of *H. rostro-serratum* Mégnin, apparently discovered no unusual mating behaviour.

Occasionally, however, males were found attached to resting

TABLE 1

PRE-OVIPOSITION PERIOD AND NUMBER OF EGGS LAID BY FERTILIZED AND PARTHENOGENETIC FEMALES OF *Histiostoma polyperi* AT LABORATORY TEMPERATURES AND 100% RH.

Serial No.	Date on which ♀ emerged	Fertilized (F) or unfertilized (UF)	Time in hours taken between maturity of ♀ and egg-laying	No. of days eggs laid continuously	Total No. of eggs laid
1	October 4, 1948	F	30	.....	50
2	Nov. 16, 1948	UF	90	.....	20
3	Nov. 12, 1948	F	.....	.....	89
4	Jan. 6, 1949	F	.....	6	80
5	Jan. 10, 1949	F	108	.....	.....
6	Jan. 11, 1949	UF	24	.....	.....
7	Jan. 11, 1949	UF	29	.....	36
8	Jan. 11, 1949	F	84	.....	.....
9	Jan. 11, 1949	F	40	.....	40

"male" deutonymphs. Sometimes they will apply themselves to gravid females which actively protest against the attachment and the male soon falls off. The observations imply that the male will assume attachment as an inherent response to the touch of a female mite's body, but the explanation could not account for males confining their attention only to "female" deutonymphs in readiness for the emerging female.

Oviposition:

At the laboratory temperatures in the month of January, 1949, eggs were laid 24 to 108 hours after mating. The average time taken was 57 hours. At a temperature of $26^{\circ} \text{C} \pm 1^{\circ} \text{C}$ and

100% RH, the fertilized female will lay from 40 to 110 eggs (Tables 1 and 2).

The eggs are very hygroscopic, transparent and not always easy to find even under the binocular microscope. In reflected light, however, the eggs impart a greenish tinge which makes their

TABLE 2

PRE-OVIPOSITION PERIOD AND NUMBER OF EGGS LAID BY FERTILIZED AND PARTHENOGENETIC FEMALES OF *Histiostoma polypori* AT 26° C ± 1° C., 100% RH.

Serial No.	Date on which ♀s emerged	Fertilized (F) or unfertilized (UF)	Time in hours taken between maturity of ♀ and laying of 1st batch of eggs	Number of days eggs laid continuously	Total number of eggs laid
1	March 30, 1949	F	18	5	40
2	April 1, 1949	UF	20	6	136
3*	April 7, 1949	UF	14	.....	9
4	April 5, 1949	UF	14	.....	50
5	April 6, 1949	UF	8	.....	30
6	April 6, 1949	UF	14	4	80
7	April 2, 1949	UF	10	4	70
8	April 6, 1949	UF	16	6	90
9*	April 23, 1949	UF	.....	.....	6
10	April 6, 1949	UF	18	6	110
11	April 30, 1949	UF	18	10	120
12	March 31, 1949	F	120	.....	110
(exception)					
13	April 11, 1949	UF	18	.....	50
14	April 1, 1949	UF	.....	.....	110
15	April 1, 1949	UF	16	7	95
Average			15		74

detection easier, but if the filter paper is too moist the eggs merge with the water film. When the excess moisture is allowed to evaporate, the eggs are contrasted against the black filter paper as well-defined oval bodies, partly opaque and partly transparent.

Oviposition lasts about 4 to 6 days but occasionally continues for about 10 days (Table 2).

Incubation :

At the laboratory temperature of January 1949, at 100% RH, the incubation period ranged from 28 to 110 hours with an average of 85 hours. In November, 1948, the period of incubation

was 28 to 96 hours with an average of 50 hours, owing to warmer temperatures, compared with those of January (Table 3). At a constant temperature of $26^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and 100% RH, the incubation period ranged from 13 to 40 hours with an average of 20.5 hours (Table 4).

The eggs, about $84\mu \times 59\mu$, are light and float in water. By the end of the incubation period the eggs owing to inhibition of water increase to about $126\mu \times 84\mu$. The first visible change in the egg was the appearance of the white material to one side of the egg. The transparent chorion of the egg allowed an examination of the developing larva to be made (Text-fig. 1). This was best seen

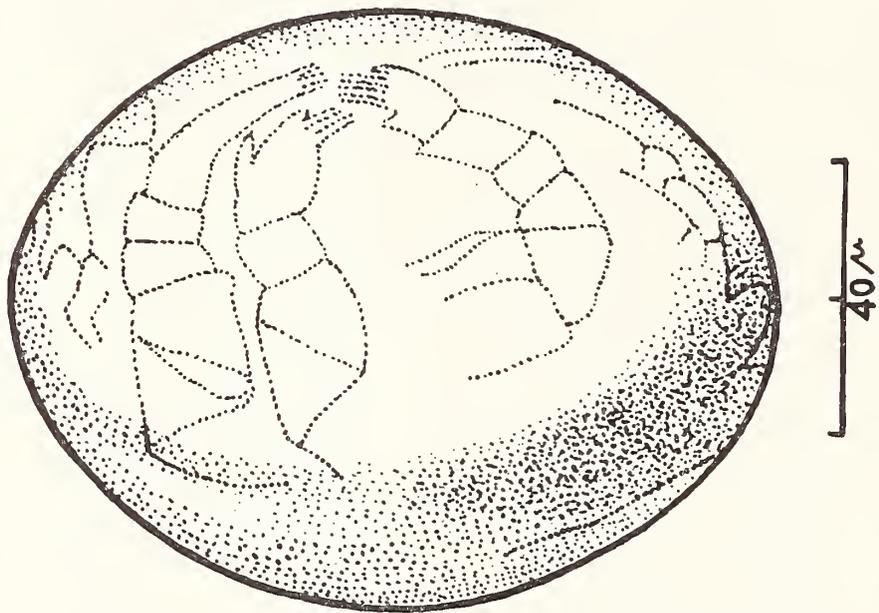


Fig. 1. *Histiostoma polypori*. Embryo as seen through the egg-case.

by mounting eggs in lactic acid or water or a preparation of Polyvinyl alcohol.

Emergence of Active Stages:

The actual emergence of the larva from the egg was never observed. However, the emergence of the nymph and adults and that of the specialized hypopus from the resting protonymphs were observed.

The emergence of the newly-formed nymph or adult from the cuticle of the preceding stage follows the same pattern. Before the preceding stage becomes immobile there are already signs of differentiation taking place. Thus the resting stage of the mite

TABLE 3

THE INCUBATION PERIODS OF FERTILIZED AND PARTHENOGENETIC EGGS
OF *Histiostoma polypori* AT THE LABORATORY
TEMPERATURE AND 100% RH.

Serial No.	Date on which eggs were laid	Fertilized (F) or un-fertilized (UF)	Duration of incubation in hours
1	November 16, '48	UF	96
2	November 16, '48	F	34
3	November 11, '48	F	28
4	November 11, '48	F	96
5	January 6, '49	F	28
6	January 10, '49	F	60
7	January 11, '49	F	100
8	January 11, '49	F	96
9	January 11, '49	F	110
10	January 15, '49	.....	96
11	January 15, '49	.....	108
12	January 20, '49	F	84
13	January 20, '49	F	84
Average (January, 1949)			85

TABLE 4

THE INCUBATION PERIODS OF FERTILIZED AND PARTHENOGENETIC EGGS OF
Histiostoma polypori AT 26° C ± 1° C, 100% RH.

Serial No.	Fertilized (F) or Un-fertilized (UF)	Duration of incubation in hours
1	F	18
2	F	24
3	F	24
4	UF	14
5	UF	10
6	UF	13
7	UF	17
8	UF	30
9	UF	20
10	UF	20
11	F	16
12	UF	40
Average		20½

is already recognized. The soft parts of the body retreat from the legs and the proterosoma, which become transparent. Histo-lytic processes are responsible for the breakdown of the organs and tissues, followed by a re-differentiation of the mass into organs of the next stage. The new stage forms at the posterior region, the legs are folded inside the old cuticle and do not protrude into the cuticle of the legs of the preceding stage. As a prelude to emergence, the newly formed stage becomes very active

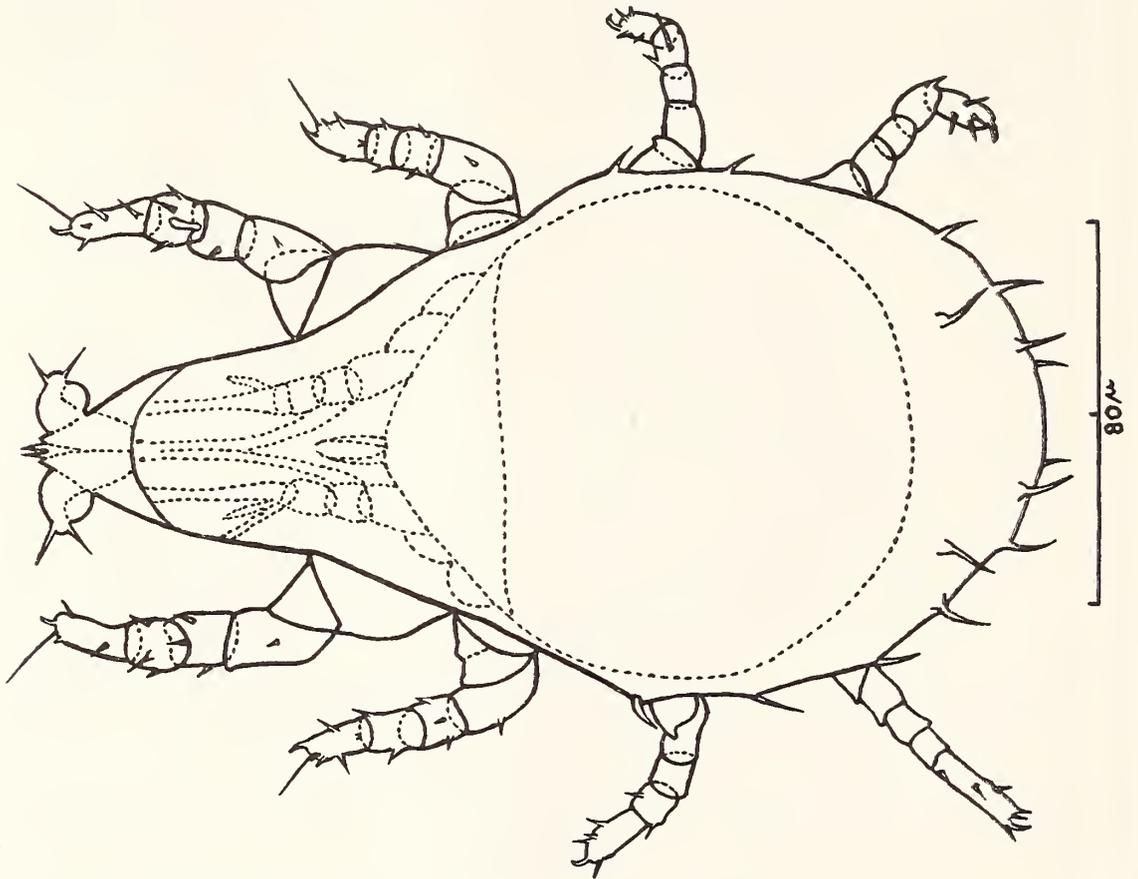


Fig. 2. Dorsal view showing the hypopus of *Histiostoma polyperi* developing inside the resting protonymph.

and there is considerable movement of the legs. The old cuticle splits across the line dividing the proterosoma and the hysterosoma and the new stage emerges through the transverse slit. The old cuticle is rejected and left as an exuvia. Usually the posterior part of the old cuticle remains attached for a short time to the newly emerged mite after the anterior part has been pushed away by the anterior legs.

The emergence of the hypopus from the cuticle of the resting protonymph differs from that of the normal nymphs and adults in many respects. The brown dorsal shield of the hypopus makes

it very easy to detect this stage inside the cuticle of the resting protonymph. The relatively long anterior legs are directed straight towards the gnathosoma of the old cuticle (Text-fig. 2). The period of activity is exceptionally short compared with that of the normal nymph or adult inside the old cuticle. The hypopus deftly emerges through the transverse slit without breaking the old cuticle and immediately moves away at an exceptionally quick pace. The shed cuticle is transparent, very delicate and collapses after the emergence. Unless the resting stage is transferred to a well moistened slide and the emergence observed under a binocu-

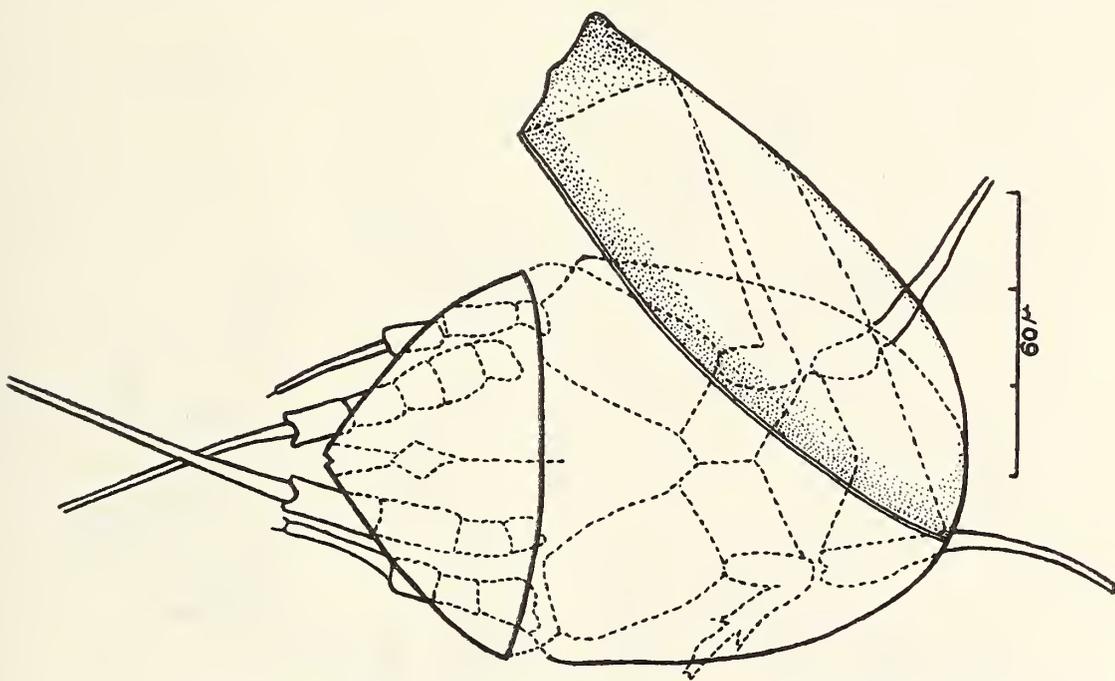


Fig. 3. The cuticle of the hypopus cast by the deutonymph of *Histiostoma polypori*.

lar microscope, it is easy to assume from mass observations of a culture in the cell that the old cuticle either disintegrates or is perhaps eaten by the newly emerged stage. My observations on the emergence of the hypopus from the cuticle of the preceding stage closely resemble those of Michael (1901), who studied *Tyroglyphus mycophagus* Mégnin.

The emergence of the deutonymph from the resting hypopus is preceded by the migration of tissues to the posterior region of the hysterosoma which is visible while the hypopus is still active. After the completion of de-differentiation of tissues, the cuticular shield splits along the line of division of the proterosoma and hysterosoma and emergence of the deutonymph as usually effected

by the cuticular shield of the hysterosoma also splitting along the left border and being pushed aside to lie slanting towards the right side, while still attached to the posterior end of the hysterosoma (Text-fig. 3). The shed cuticle of the deutonymph emerging from the resting hypopus is best seen when a thriving culture of mites in a petri dish is left to dry.

The Stages:

(a) The active larva:

The hexapod larva (Text-fig. 4), a characteristic stage in the life-cycle of members of the Acarina, soon after emergence from

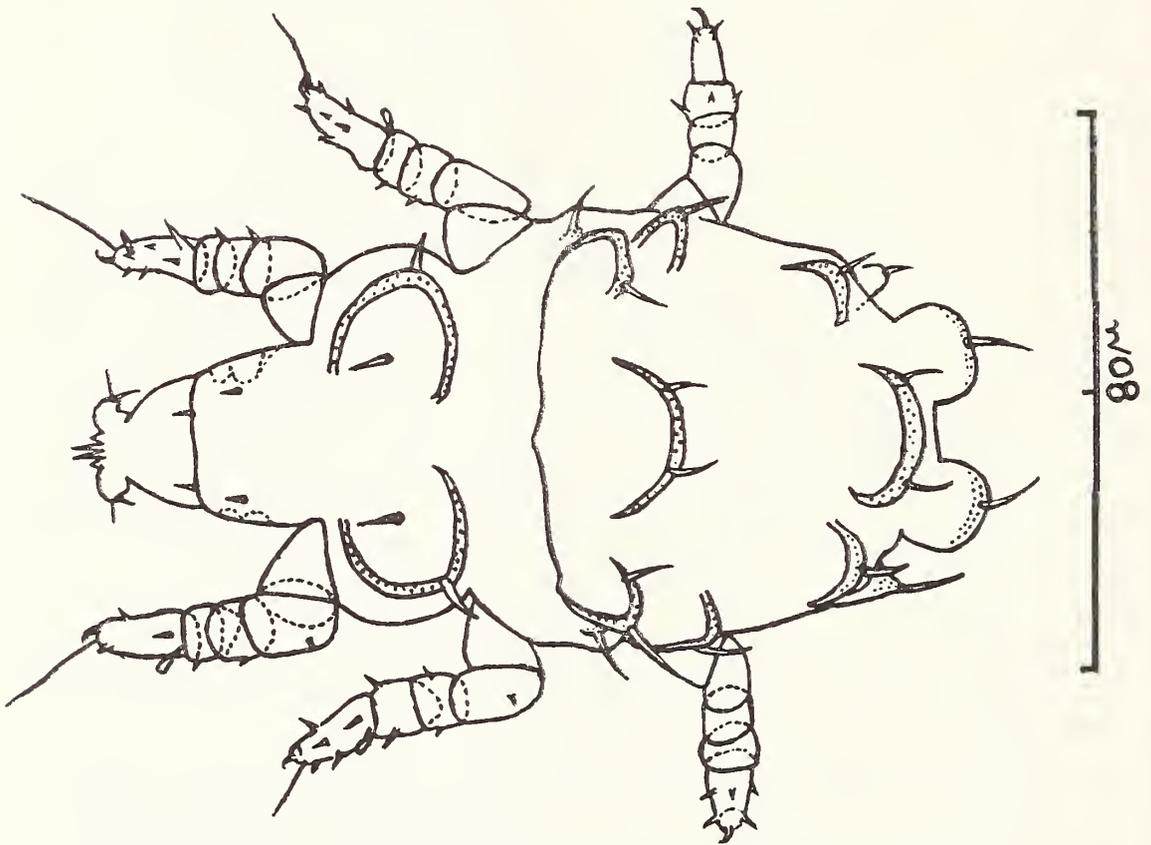


Fig. 4. *Histiostoma polypori*. Larva. Dorsal view.

the egg is hardly visible as it moves quickly over the moist filter paper. The fourth pair of legs is absent in the larval stage. The larva feeds continuously and as it increases in size the transparent nature of the body changes as the excreta, in the form of urates, are deposited as white masses in the body cavity. The deposition of urates is particularly heavy in the hysterosoma. When exposed to the temperatures of the laboratory, at 100% RH, in January 1949, the active larval phase lasted for a period

ranging from 24 hours to 84 hours with an average of 46.8 hours (Table 5). At a constant temperature of $26^{\circ}\text{C} \pm 1^{\circ}\text{C}$, 100% RH, the period of active larval life was greatly reduced with an average of 12.8 hours, although in some cases the larva was apparently unaffected by the warm conditions (Table 6).

TABLE 5

THE DURATION OF DIFFERENT STAGES OF *Histiostoma polypori* OBTAINED FROM FERTILIZED EGGS AND EXPOSED TO THE LABORATORY TEMPERATURES AND 100% RH.

Serial No.	Date of emergence of larval stage	Duration in hours					
		Larva		Protonymph		Deutonymph	
		Active	Resting	Active	Resting	Active	Resting
1	November 16, '48	19	17	22	22	30	20
2	January 15, '49	24	24	24	26	84	29
3	January 15, '49	24	24	24	26	84	29
4	January 18, '49	26	24	60	24	40	19
5	January 18, '49	.....	24	36	24	36	20
6	January 18, '49	24	24	36	36	.....	.....
7	January 20, '49	60	24	24	28	38	23
8	January 20, '49	84	23	24	24	45	24
9	January 20, '49	72	24	60	60	40	26
10	January 20, '49	60	24	24	40	42	22
Average January, 1949		46.8	24	34.7	32	51	24

(b) The resting larva:

The attempt by the larva to find a suitable shelter is a prelude to the resting stage. In the cell the mite will either submerge itself in the food or will retire under a piece of disintegrated earwig cuticle. It was noticeable that the pace of the active larva was reduced and already there were signs of changes taking place within the body. As the soft tissues retreat from the legs and migrate into the hysterosoma, the legs, now cuticular cells, remain attached to the old body cuticle. The resting stage, which is completely immobile, is thus easily detected by the transparent proterosoma and an opaque hysterosoma. It is clear that the process is gradual since the first sign of a migration of tissues are observed in the gnathosoma when the larva is still active. When a settled larva is disturbed, it will sometimes move from the site very slowly before resettling. When histolysis is ad-

vanced the larva is incapable of such movement. The opaque mass of material in the hysterosoma is gradually re-differentiated into the eight-legged protonymph. When the resting stages are mounted in polyvinyl alcohol, or even water, it is possible to observe the different stages in the growth of the new individual. As far as one could judge, the period of time required for the transition phase from the beginning of the resting stage to the

TABLE 6

THE DURATION OF DIFFERENT STAGES OF *Histiostoma polypori* AT
26° C ± 1° C AND 100% RH.

Serial No.	Young from Fertilized (F) or un- fertilized (UF) ♀	Duration in hours					
		Larva		Protonymph		Deutonymph	
		Active	Resting	Active	Resting	Active	Resting
1	UF	7	7	7	7	10	7
2	UF	48	14	16	6	8	6
	(exception)						
3	F	15	10	.....	10	8	12
4	F	21	9	9	10	10	9
5	F	21	9	9	10	10	9
6	F	8	8	10	6	8	6
7	F	9	7	8	6	8	6
8	F	9	8	8	10	14	10
9	F	.....	12	10	6	8	6
10	F	10	8	8	6	8	6
11	F	.....	7	7	7	10	7
12	F	9	8	8	8	14	8
13	F	.....	.....	12	12	14	10
Average (for young from fertilized eggs)		12.8	8.6	8.9	8.3	9.8	8.0

time the newly-formed individual emerged was about 23 to 24 hours at the laboratory winter temperature, at 100% RH (Table 5). At a constant temperature of 26° C ± 1° C and 100% RH, the time required was reduced to an average of 8.6 hours (Table 6).

(c) The active protonymph:

The eight legged protonymph (Text-fig. 5) on emergence from the larval cuticle is about the same size as the fully-grown larva. But it is more elongated and, although in miniature it resembles

the appearance of the adult, the cuticle is much less tuberculate than that of the larva of the deutonymph. However, as the nymph grows, deposits of urates accumulate in the body cavity. Like all stages the active protonymph feeds continuously and increases in length from about 179μ to 242μ . In the moist cell at the laboratory temperature of January, 1949, and 100% RH, the active protonymph stage lasts an average of 32 hours with a minimum of 24 hours and a maximum of 60 hours (Table 5);

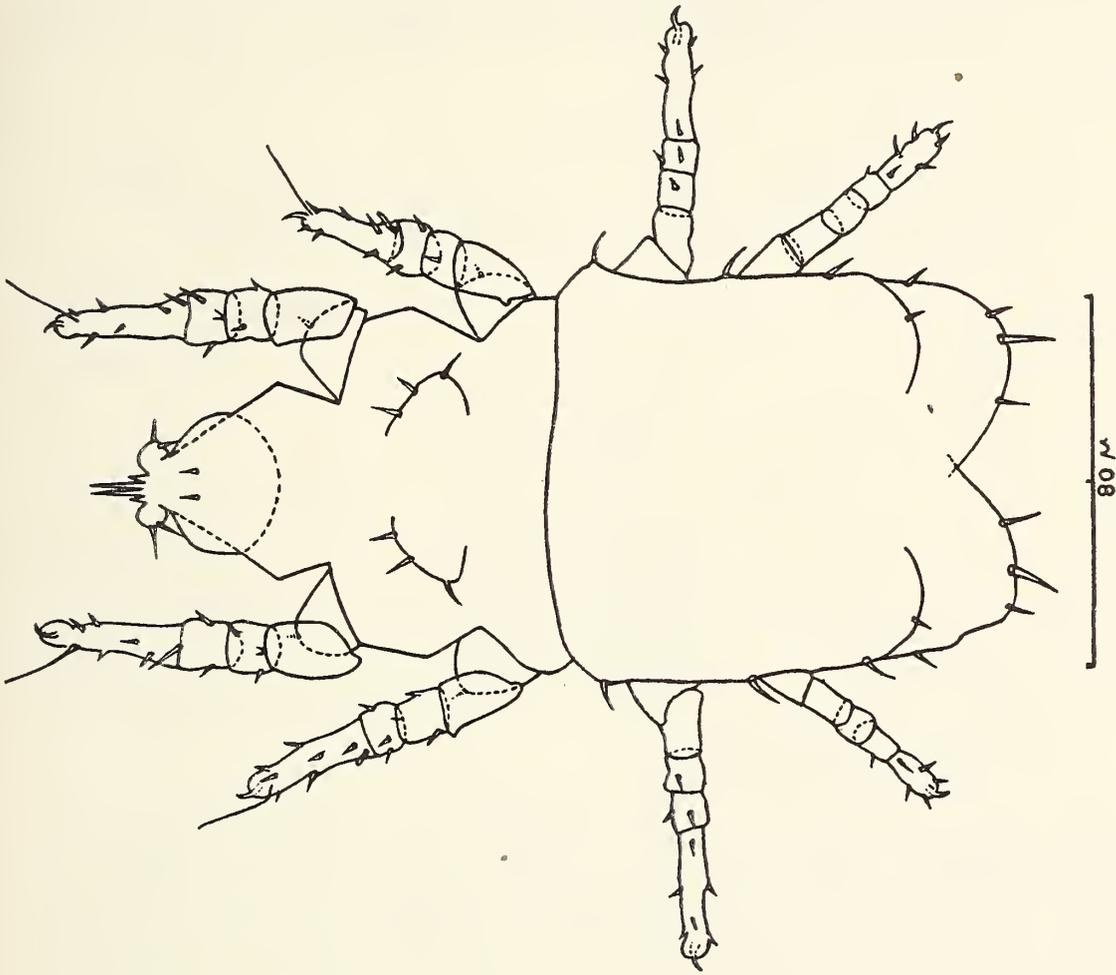


Fig. 5. *Histiostoma polypori*. Protonymph. Dorsal view.

but the time is greatly reduced at $26^{\circ}\text{C} \pm 1^{\circ}\text{C}$, 100% RH, to an average of 9 hours, with a minimum of 7 hours and a maximum of 16 hours (Table 6).

(d) The resting protonymph:

On approaching the resting conditions the behaviour of the active protonymph resembles that of the larva. The period of transition at the laboratory temperatures, at 100% RH lasts an average of 32 hours, with a minimum of 24 hours and a maximum

of 60 hours (Table 5). At $26^{\circ} \text{C} \pm 1^{\circ} \text{C}$, 100% RH, it only takes an average of 8.3 hours, with a minimum of 6 hours and a maximum of 12 hours (Table 6). Particularly characteristic of the later resting stages, including that of the protonymph, is the dull glassy appearance of the cuticle, resembling ground glass. The migration of tissue cells into the hysterosoma follows the same pattern, but the tissues may give rise either to the normal deutonymph or the extra-specialized hypopus. The production of the hypopus is indicated by a typically pointing and somewhat longer white proterosoma and later the rosy-brown colour of the dorsal shield.

TABLE 7

THE DURATION OF TRANSITION OF THE HYPOPI OF *Histiostoma polyperi*
EXPOSED TO THE LABORATORY TEMPERATURE AND 100% RH.

Serial No.	Date of resting of hypopus	Approximate duration in hours
1	October 2, '48	24
2	October 6, '48	23
3	October 6, '48	23
4	October 6, '48	26
5	November 16, '48	31
6	November 16, '48	33
7	November 16, '48	36
8	November 16, '48	48

(e) The resting hypopus:

On approaching the resting condition the behaviour of the active hypopus (Text-fig. 9) resembles that of other stages, e.g. larva, protonymph and deutonymph; the hypopus is very active and searches for a suitable place in which to settle. A feature of the resting position of the hypopus is the humped nature of the dorsal shield owing to a well marked curvature in the region of the anterior part of the hysterosoma. The anterior two pairs of legs are stretched closely forward, the first pairs usually crossing each other in front, and the posterior two pairs of legs are stretched outwards on the sides instead of being tucked underneath as is typical in the case of active hypopus attaching to the smooth surface of the host. As would be expected, the sucker apparatus of the hypopus is non-functional at the time of its rest-

ing and hence the resting hypopus can be easily removed from its resting place.

The period of transition at the laboratory temperatures of October and November 1948 and 100% RH lasts between 23 and 48 hours (Table 7). At $26^{\circ}\text{C} \pm 1^{\circ}\text{C}$, 100% RH, it only takes from 14 to 18 hours with an average of 16 hours (Table 8).

TABLE 8

THE DURATION OF TRANSITION OF THE HYPOPI OF *Histiostoma polyperi*
AT $26^{\circ}\text{C} \pm 1^{\circ}\text{C}$ AND 100% RH.

Serial No.	Approximate duration in hours
1	14
2	16
3	16
4	18
5	14
6	18
7	16
8	15
9	17
Average	16

The resting hypopus is recognized by the appearance of whitish areas, formed by the migration of tissue cells into the hysterosoma, which contrast against the transparent brown cuticle. The deutonymphal stage emerges from the resting hypopus.

(f) The active deutonymph:

Nymph II or the deutonymph (Text-fig. 6) will emerge either from the resting protonymph or the resting hypopus. This stage when fully grown closely resembles the adult (Text-figs. 7 and 8). It is distinguished from the protonymph by the stouter appearance of the legs and the pronounced tubercles of the cuticle, whereas it differs from the adult, apart from size, by the presence of only a trace of developing genitalia and in the position of the suckers. At the laboratory temperatures of January, 1949, and 100% RH, the deutonymph remains active for an average of 51 hours with a minimum of 36 hours and a maximum of 84 hours (Table 5). At $26^{\circ}\text{C} \pm 1^{\circ}\text{C}$, 100% RH, the average was 9.8 hours, with a minimum of 8 hours and a maximum of 14 hours (Table 6).

At a somewhat advanced state of the deutonymph, one can well

predict from the shape and size of the body whether it will be a male or a female.

(g) The resting deutonymph:

On approaching the resting conditions the behaviour of the deutonymph resembles that of the larva, protonymph and hypopus. The period of transition at the laboratory temperature of January 1949, at 100% RH, lasts an average of 24 hours, with a minimum of 19 hours and a maximum of 29 hours (Table 5).

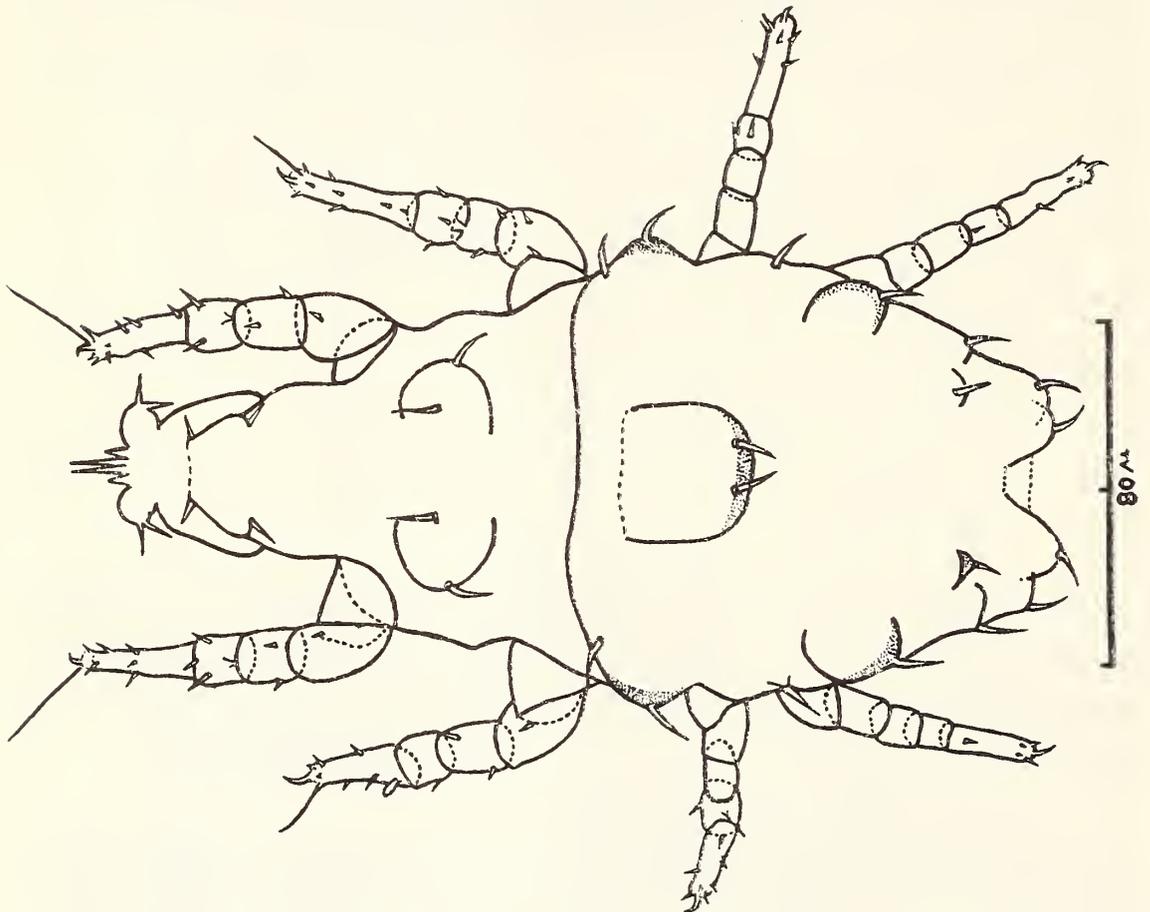


Fig. 6. *Histiostoma polypori*. Deutonymph. Dorsal view.

At $26^{\circ}\text{C} \pm 1^{\circ}\text{C}$, 100% RH, it only takes an average of 8 hours with a minimum of 6 hours and a maximum of 12 hours (Table 6). The migration of tissue into the hysterosoma follows the same pattern, but the redifferentiation of the tissues may give rise either to the male or the female adult, although of course, long before the transitional period, the shape of the active deutonymph indicates whether it will be a male or a female.

(h) The adult male:

The males which are about 263μ to 358μ are decidedly smaller than the females. The general shape of the body differs funda-

mentally from that of the female (Text-figs. 7 and 8). The tubercles of the body present a very rough surface. The stout nature of the legs is well pronounced compared with that of the female or deutonymph. The males are much more tenacious and long-lived than the females (Tables 9, 10 and 11). In the laboratory temperatures of January 1949 and 100% RH, the average length of life was 48 days, with a minimum of 26 days and a maximum of 63 days. No difference however was noticed in the survival periods of males derived from fertilized and unfertilized

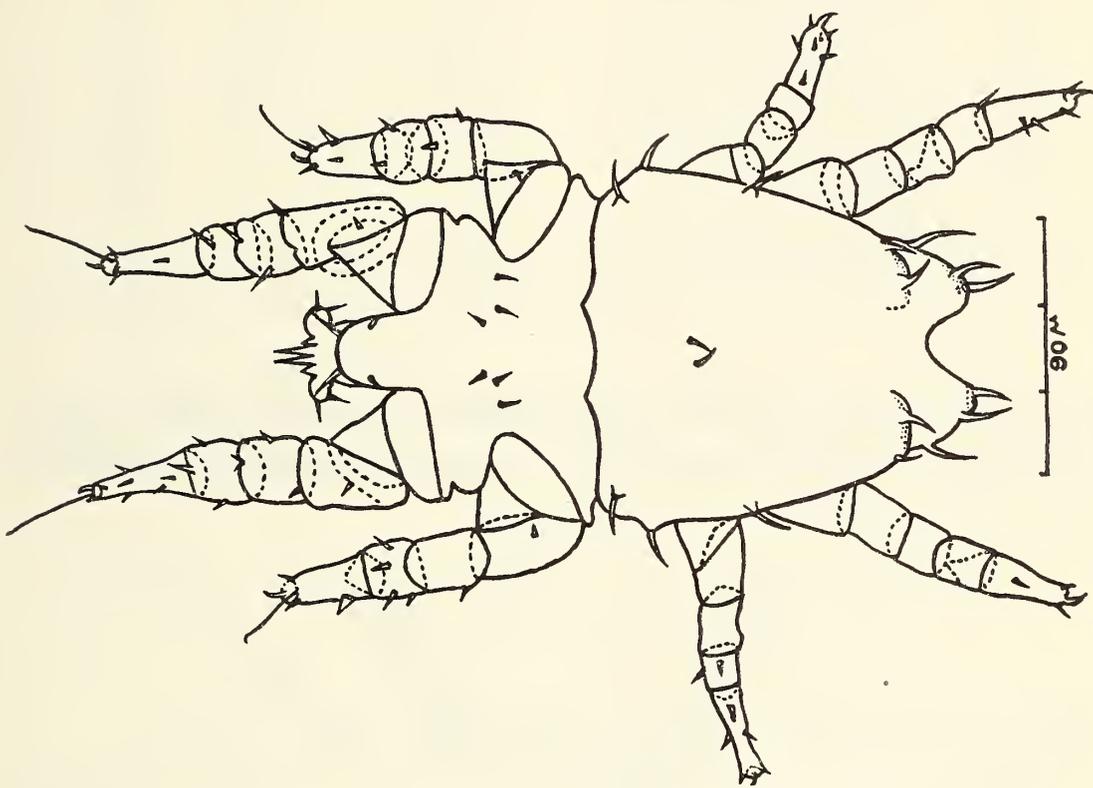


Fig. 7. *Histiostoma polyperi*. Male. Dorsal view.

eggs (Table 9). Even in food on which fungus is growing the males are able to thrive either on fungus spores or apparently without food. They can also live immersed under water for a considerable length of time.

The various stages practically pass their whole existence almost immersed in the fluid upon which they subsist. Hirst compared the moisture-loving Tyroglyphoid mites floating in the liquid with living plankton in the sea (Vitzthum, 1932). Vitzthum (1932) stated that they are supported by the surface film of the liquid mass, and the secretion of oily substances over their bodies protected them from too excessive a contact with the liquid. Be-

TABLE 9

SURVIVAL PERIODS OF MALE OF *Histiostoma polyperi* AT THE LABORATORY TEMPERATURES AND 100% RH.

Serial No.	Date of emergence of adult	Origin from fertilized (F) or un-fertilized (UF) egg	Length of life in days
1	November 18, '48	UF	39
2	November 24, '48	F	36
3	November 24, '48	F	51
4	November 26, '48	F	60
5	November 27, '48	F	61
6	December 14, '48	UF	46
7	December 15, '48	UF	55
8	December 16, '48	UF	39
9	January 11, '49	F	26
10	January 11, '49	F	32
11	January 15, '49	UF	52
12	January 18, '49	F	61
13	January 16, '49	F	63
Average			48

sides it appears, in the case of *H. polyperi*, that very little oxygen is required for their respiration or that they respire anaerobically, to some extent.

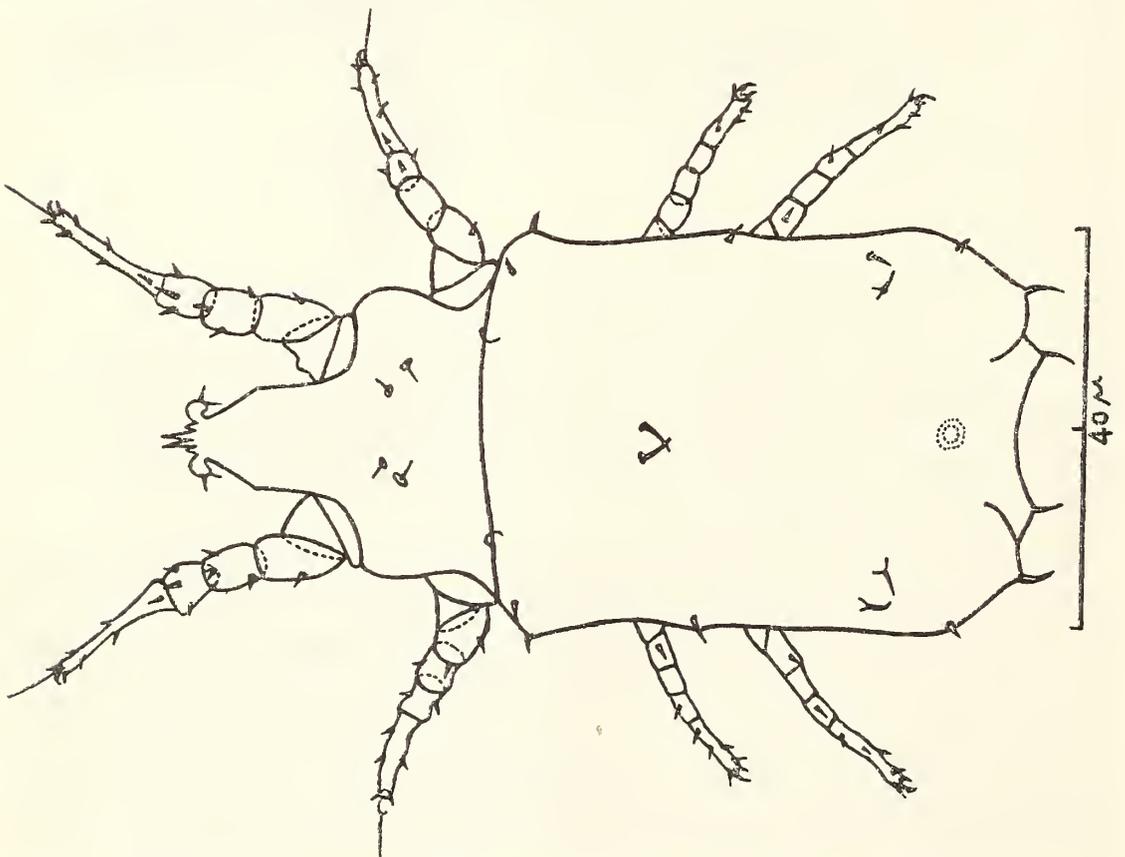


Fig. 8. *Histiostoma polyperi*. Female. Dorsal view.

TABLE 10

SURVIVAL PERIODS OF THE FEMALE OF *Histiostoma polypori* AT THE LABORATORY TEMPERATURE AND 100% RH.

Serial No.	Date of emergence of adult	Origin from fertilized egg (F) or hypopi (H)	Length of life in days
1	October 4, '48	F	17
2	November 18, '48	F	16
3	November 12, '48	F	12
4	November 21, '48	H	9
5	November 22, '48	H	14
6	January 6, '49	F	18
7	January 10, '49	F	16
8	January 11, '49	F	10
9	January 11, '49	F	19
Average			14.6

As the male grows old, it becomes less active and more white with a tinge of faint brown in color.

(i) The adult female:

The body length of the female varies from 410μ to 547μ and is decidedly larger than the male. The shape of the hysterosoma

TABLE 11

LENGTH OF LIFE OF THE FEMALE OF *Histiostoma polypori* AT $26^{\circ}\text{C} \pm 1^{\circ}\text{C}$, AND 100% RH.

Serial No.	Origin from fertilized (F) or unfertilized (UF) egg or hypopus (H)	Length of life in days
1	H	6
2	F	18
3	F	13
4	H	17
5	H	9
6	UF	7
7	F	9
8	UF	14
9	UF	6
10	F	16
11	F	4
12	UF	12
13	F	4
14	F	12
15	F	14
Average		10.7

of the female (Text-fig. 8) is rectangular, in contrast to the somewhat triangular and bi-fid shape of that of the male.

The female is less hardy and short lived than the male (Tables 10 and 11). At the laboratory temperature of October 1948 to January 1949 and 100% RH, the average length of life was 14.6 days, with a minimum of 9 days and a maximum of 19 days. This figure, when compared with the average survival period of the male of 48 days, with a minimum of 36 days and a maximum of 63 days, is much shorter. At $26^{\circ} \text{C} \pm 1^{\circ} \text{C}$ and 100% RH, the average length was 10.7 days, with a minimum of 4 days and a maximum of 18 days (Table 11).

The female cannot endure the growth of fungus in the cell in which it is reared, when compared with the high endurance of the

TABLE 12

DURATION OF THE LIFE-CYCLE OF *Histiostoma polypori* REARED IN THE LABORATORY AT DIFFERENT TIMES OF THE YEAR AT 100% RH.

Date on which eggs were laid	Condition of temperature	Number of days from egg to adult
Mid-November 1948	Laboratory temperature	9
Mid-January 1949	Laboratory temperature	13-16
Mid-April 1949	Laboratory temperature	6-8
.....	Constant temperature of $26^{\circ} \text{C} \pm 1^{\circ} \text{C}$.	3

male in such a situation. Food, especially fresh food, appeared to have a profound effect on the longevity and egg-laying of the female. If the female is kept in a moist cell without food, fungus soon grows on it and it succumbs to the infection; whereas, on the other hand, the male lives for a comparatively long time without food, even though fungus grows round about.

When the females are mature, eggs can well be seen through the transparent cuticle. However, they are sometimes confused with the uric acid crystals secreted into the body cavity. A maximum of three somewhat well-developed eggs have been seen inside the body of the individual female.

The female, as well as all stages of this species of mite, feign death when touched or disturbed.

Duration of Stages:

Since the duration of the different stages depends upon the temperature, it will vary according to the time of the year (Table 12).

The duration of the life-cycle as a whole will also vary in the same way (Table 13).

At the laboratory temperature of January, 1949 and 100% RH, the life-cycle was completed on the average in 14.5 days, with a minimum of 13 days and a maximum of 16 days, whereas at a constant temperature of $26^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and 100% RH, the average time was 3 days, with a minimum of 3 days and a maximum of 3.8 days (Table 13).

TABLE 13

THE DURATION OF THE LIFE-CYCLE (IN HOURS) INCLUDING THE DIFFERENT STAGES OF *Histiostoma polyperi* AT THE LABORATORY TEMPERATURE OF JANUARY, 1949 AND AT A CONSTANT TEMPERATURE OF $26^{\circ}\text{C} \pm 1^{\circ}\text{C}$ AND 100% RH.

	Laboratory temperature 100% RH.			Constant temperature, $26^{\circ}\text{C} \pm 1^{\circ}\text{C}$, 100% RH.		
	Aver- age	Mini- mum	Maxi- mum	Aver- age	Mini- mum	Maxi- mum
Incubation of egg	85	28	110	20.5	10	40
Active larva	46.8	24	84	12.8	9	21
Resting larva	24	23	24	8.6	7	12
Active protonymph	34.7	24	60	8.9	9	12
Resting protonymph	32	24	60	8.3	6	12
Active deutonymph	51	36	84	9.8	8	14
Resting deutonymph	24	19	29	8	6	12
Pre-oviposition period of ♀	57	24	108	15	8	20
Length of life of ♀ in days	14.6	10	19	10.7	4	18
Length of life of ♂ in days	48	26	63	.....	.....	.....
Complete life-cycle from egg to adult (egg-laying) in days	14.5	13	16	3	3	3.8

Note: The hypopus stage is not included since the actual phase of this stage fluctuates greatly in respect to environmental conditions. It will resist adverse conditions for long periods and will change to deutonymph quickly if conditions are favorable. For the length of time taken by the transitional stage of the hypopus see Tables 7 and 8.

The Hypopus Stage:

The hypopus stage is of great biological interest, in view of its hardiness and the role it plays in the distribution of the species.

The hypopus is interpolated between nymph I and nymph II, and after resting will give rise to the deutonymph. In the case of *H. polypori* the hypopus is an active, mobile form for migration and for surviving in unfavourable conditions.

The hypopus (Text-fig. 9) is somewhat shorter and broader

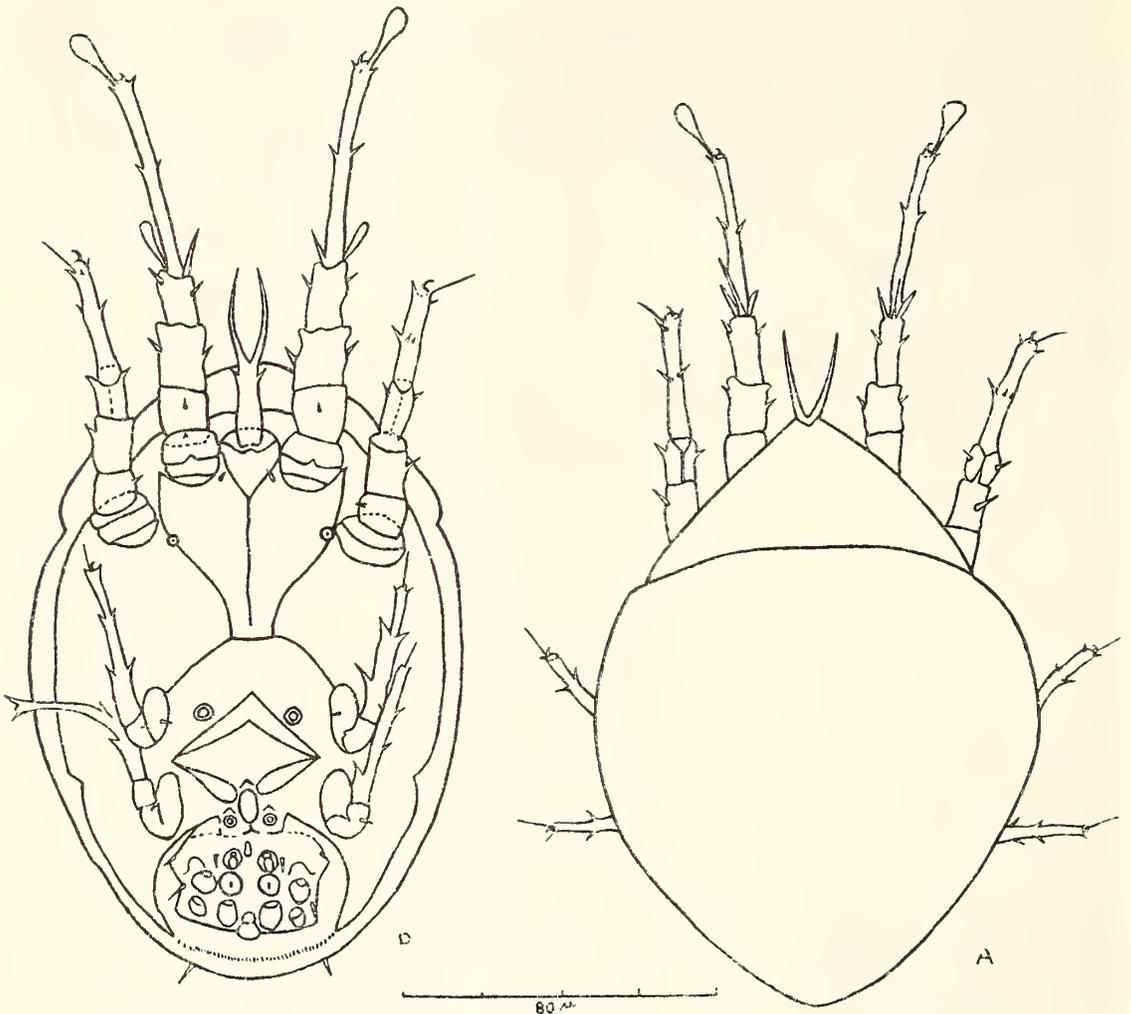


Fig. 9. *Histiostoma polypori*. Hypopus. A, Dorsal view; B, Ventral view.

than the protonymph, much more heavily chitinized and the dorsal surface covered by the carapace is usually of a reddish-brown color and shield-shaped. On the ventral surface of the body, near the posterior end, is a group of 10 suckers arranged in pairs upon a highly chitinized "sucker disc" or "plate," besides 6 more suckers arranged as shown in Text-fig. 9. These suckers are used by the hypopus in securing attachment to its "carrier host" for migratory purposes. The anterior two pairs of legs, especially their tarsi, are abnormally long and typically carried in front of the body. There are apparently no functional

mouthparts, this stage being an adaptation for the purpose of migration through attachment to *F. auricularia*. The length of time occupied by the hypopial instar varies considerably and the hypopi are able to withstand much more extreme conditions than any other stage. Normally, hypopi undergo ecdysis in about one or two days and the total length of the life-cycle may thus be increased by this amount.

When disturbed the hypopus retracts the third and fourth pair of legs and stretches the anterior two pairs of legs forwards and feigns death. They always occupy the upper portion of a container e.g. in a bottle, the underside of the cork in a glass dish, the underside of the glass cover.

When immersed under water, the hypopus is unable to retain its firm hold upon the host or a smooth glass surface with its "suckers" for any length of time. It soon releases its hold and will rise to the surface and float upside down.

The hypopus will often climb on to the dorsal shield of another and then actively wave its fore-legs.

Considerable variation of size exists in the hypopi obtained from the same culture. However, both small and large types of hypopi gave rise to deutonymphs which became either male or female adults. Evidence suggested that the size of the hypopi depended to some extent on the size of the preceding protonymphs as they passed into the resting stage.

Influence of Physical Factors on Hypopus Formation:

Solomon (1946) summarized our knowledge about the formation of hypopus as follows:

"The factors determining hypopus formation have been discovered only in part. In some cases it seems that intrinsic (probably genetic) factors predominate, in others extrinsic factors (e.g., lack of suitable food) seem to predominate. In fact, the position is far from clear, and appears to be different in different species, possibly in relation to the type of hypopus concerned."

In the case of *H. polypori*, lack of food appears to have profound effect on the formation of hypopus. When food was plentiful, not a single hypopus was formed. When food was scarce, some protonymphs instead of changing into deutonymphs formed hypopi. However, I do not consider food to be the only

factor controlling the formation of hypopus. Even when practically no food was given formation of hypopi as well as males and females was observed.

Humidity appeared to be the only factor responsible for stimulating the transformation of the hypopus to the deutonymph. If hypopi were kept at a high humidity but without food, they changed into deutonymphs. When kept immersed under water, the hypopi changed into deutonymphs, though not so quickly as they did when exposed to the moist conditions of the culture cell.

TABLE 14

MEASUREMENTS OF EGGS AND INCREASE IN SIZE IN DIFFERENT ACTIVE STAGES IN THE LIFE-CYCLE OF *Histiostoma polyperi* AT THE LABORATORY TEMPERATURE AT 100% RH (EXCEPT IN HYPOPI, THE LENGTH OF IDIOSOMA IS GIVEN).

Serial No.	Length of eggs when laid	Active larva	Active proto-nymph	Active deutonymph	Male	Female	Hypopus (total length)
1	84 μ	126 μ	147 μ	205 μ	210 μ	358 μ	158 μ
2	89 μ	126 μ	152 μ	210 μ	231 μ	358 μ	158 μ
3	89 μ	127 μ	152 μ	210 μ	258 μ	363 μ	162 μ
4	91 μ	128 μ	158 μ	215 μ	263 μ	373 μ	163 μ
5	94 μ	129 μ	158 μ	216 μ	263 μ	379 μ	163 μ
6	94 μ	137 μ	158 μ	220 μ	294 μ	386 μ	167 μ
7	94 μ	139 μ	159 μ	230 μ	300 μ	389 μ	168 μ
8	105 μ	142 μ	161 μ	233 μ	305 μ	433 μ	168 μ
9	105 μ	142 μ	179 μ	242 μ	305 μ	473 μ	179 μ
10	110 μ	147 μ	200 μ	242 μ	305 μ	477 μ	179 μ
Average	95.5 μ	134.3 μ	162.4 μ	222.3 μ	273.4 μ	398.9 μ	166.5 μ

Growth Rate:

The eggs when laid are about 89 μ long and 59 μ at their greatest width. Owing to the inhibition of water and the tension of the growing embryo, they are as large as the smallest larva—about 126 μ \times 84 μ at the end of the incubation period. The measurements of the different stages in the life cycle are given in Table 14. The variation of size is however primarily dependent on the supply of food.

PARTHENOGENESIS

There are few authentic records of the occurrence of parthenogenesis among members of the Acarina, especially, so far as the writer is aware, among those confined to the Tyroglyphoidea.

Jary and Stapley (1936) discovered parthenogenetic reproduction in *Histiostoma rostroratum* and Stolpe (1938), based on his studies of *H. genetica*, suspected the probability of parthenogenetic development, in mites.

Females originating from hypopi were segregated and given no opportunity of mating. These unfertilized females laid eggs which invariably produced adult males. The results resembled and recalled the phenomenon of the parthenogenetic eggs of Arthropods producing only males. Similar results were obtained by Jary *et al.* (1936) in their study of parthenogenesis in *H. rostroratum* and by Cooper (1937) in the grass mite *Pediculopsis graminum* (Reut.) (Tarsonemidae). Although artificially segregated females will produce eggs parthenogenetically, it is reasonable to suppose that the phenomenon will also occur in the natural environment. A female will normally begin laying within 48 hours after emerging from the resting deutonymph skin. So, should males not be available as the female emerges, unfertilized eggs will be laid within 48 hours. Should an egg-laying female become isolated in the field, it will live long enough possibly to be later fertilized by males of its own progeny. In the laboratory it was noticeable that unfertilized females occasionally laid fewer eggs (Table 2, items marked with *), but otherwise their appearance was normal. Of the batches of unfertilized eggs a great many did not survive even when they were exposed to favorable conditions of temperature and humidity. Occasionally an unfertilized female would lay no eggs at all.

SEX-RATIO

It was significant that the population of a thriving culture of mites was usually predominated by males. This suggested that a good many of the females had failed to mate and so gave rise to an all male parthenogenetic progeny, which accounted for an increase in the number of males in the culture. Occasionally the reverse was true because some colonies were predominated by females. This was more noticeable when stock cultures were examined.

The preponderance of males in a culture of *H. polyperi* may also originate from normally fertilized eggs. Of seven batches of fertilized eggs reared in the laboratory at 100% RH, the ratio obtained was 76% males and 24% females.

TABLE 15

THE NUMBER OF MALES AND FEMALES OF *Histiostoma polypori* OBTAINED FROM SEVEN BATCHES OF FERTILIZED EGGS REARED TO THE ADULT STAGE IN THE LABORATORY TEMPERATURE AT 100% RH.

Serial No.	Number of males	Number of females
1	9	9
2	20	14
3	14	2
4	6	1
5	2	3
6	64	32
7	87	4
Total	202	65

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SUMMARY

The mites, *Histiostoma polypori* (Oud.) were reared in special perspex cells 4 cm. square and 0.3 cm. deep. The actual rearing chamber was a central bevelled hole 1.7 cm. in diameter enclosed by black filter paper on one side and a coverglass on the other. The mites were kept at 100% RH and either at the laboratory temperature or a constant temperature of $26^{\circ} \text{C} \pm 1^{\circ} \text{C}$. The decomposing remains of earwigs and horse flesh provided an admirable rearing diet. Colonies or individuals in the cells were easily examined under the binocular microscope. The different stages as required were mounted in water, lactic acid or polyvinyl alcohol.

The male will clasp the female deutonymph in the active and resting phases and will mate with the adult female immediately after it emerges.

The eggs were laid within 24 to 108 hours, with an average of 57 hours, after mating. At $26^{\circ} \text{C} \pm 1^{\circ} \text{C}$, 100% RH, a single female will lay 40 to 110 eggs. The eggs are laid singly or in groups of two or three but in a large colony the eggs are found aggregated in masses, either upon or around the food. The chorion is transparent and the eggs are opaque in appearance.

The incubation period varies according to the time of the year. At $26^{\circ} \text{C} \pm 1^{\circ} \text{C}$, 100% RH, the period ranges from 13 to 40 hours, the average being 20.5 hours.

The new stage is formed within the cuticle of the preceding stage. Histolysis is followed by de-differentiation. The old cuticle splits transversely between the proterosoma and the hysterosoma to allow the emergence of the new stage. The old cuticle remains as an exuviae. The hypopus deftly emerges through the transverse slit and the process is a short one. On emerging from the hypopial cuticle the deutonymph will climb out of the hard cuticular case—the dorsal shield which is pushed aside after splitting along the line of the division of the proterosoma and hysterosoma and along the lateral borders.

The egg and larval stages are followed by two nymphal stages leading to the adult. The specialized extra nymph or hypopus occurs spasmodically between the two normal nymphal stages.

The duration of the stages depends primarily on the temperature. The life-cycle varies according to the time of the year. At a constant temperature of $26^{\circ} \text{C} \pm 1^{\circ} \text{C}$, 100% RH, it takes 3 to 4 days. At the laboratory temperatures during the winter months it takes about 2 weeks.

The duration of the hypopus stage varies considerably. When exposed to the favorable conditions of a culture cell the hypopi will soon pass into the transition stage but they will also remain as typical hardy hypopi indefinitely, should unfavorable conditions be prolonged. Both small and large hypopi will change into deutonymphs.

Scarcity of food and dry conditions will accelerate the formation of hypopi whereas a high humidity will cause hypopi to pass into the resting stage.

The variation of size of the different stages depends primarily on the temperature and the availability of food.

H. polypori will produce parthenogenetic eggs which will give rise to male individuals.

Cell cultures predominated by males whereas occasionally the reverse was true of stock cultures. More males will be produced because the females of a colony are not always fertilized. But it was also shown that males will predominate by 76:24 in colonies produced only by fertilized females.

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The corpus allatum, about which it once seemed that everything was known, is now, Dr. Scharrer reported, less satisfactorily understood than the prothoracic gland. It does produce the same type of hormone in immature and adult insects, but the action of the hormone differs at these two periods in the life of the animal. In the larva, the corpus allatum is the source of "juvenile" hormone, which in combination with the products of the prothoracic gland causes the nymphal moult. In the adult, the corpora allata cause normal development of eggs and accessory sex glands.

Neurosecretory cells of the pars intercerebralis have fibers passing by a

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devious route to the corpora cardiaca and the corpora allata. Dr. Scharrer illustrated representative examples of the experimental procedures by which it was shown that materials actually passed along the lengths of these nerve fibers. Here, as frequently throughout the evening, the illustrations taken from her own work on the roach *Leucophaea* were especially impressive. The evidence indicates that secretions of the neurosecretory cells in the pars intercerebralis, like those of the corpus allatum, have different effects at different stages in the life cycle, stimulating the prothoracic glands in the nymphs, and being essential for normal egg formation in the adult.

Dr. Scharrer concluded with the intriguing observation that other hormones, of completely unknown function, are produced in the subesophageal ganglion, ventral ganglia, and elsewhere. For one example, taken from *Leucophaea*, she presented evidence that the release of hormones from the neurosecretory cell was itself controlled by hormones from the gonad. This led to two concepts new for insects: a feed-back mechanism for endocrine control, and the view that the gonads themselves might properly be considered organs of internal secretion.

At the conclusion of the question period, Mr. Cooper kindly offered to the members a few more copies of the Life of William T. Davis, courtesy of the Staten Island Museum.

The meeting was adjourned at 9:30 P.M.

EDWARD S. HODGSON, *Secretary*

MEETING OF FEBRUARY 21, 1956

A regular meeting of the Society was held at the American Museum of Natural History, Dr. Treat presiding. Three new members were elected: Lieutenant Milton E. Tinker, Mr. George F. Townes, and Dr. William J. Wall, Jr. The immediate election of the latter two applicants was accomplished by means of a temporary suspension of the by-laws. Mr. Teale called attention to a new book entitled "Selection of Writings of Henri Fabre", published by Premier Books.

The speaker of the evening was Dr. T. C. Schneirla of the Museum's Department of Animal Behavior, who discussed "Behavior Cycles in Army and Driver Ants". Dr. Schneirla used comparisons between his own observations on New World ants of the genus *Eciton* and the observations of Raignier and Van Boven on the genus *Anomma* of the Old World driver ants, to develop the concept of the extent of relationships between the environment, the general biology of a species, and the behavior which it exhibits.

Desiccation is a major selective factor operating against nomadic ant populations. Hence, the movements above ground show delicate adjustments to the size and reproductive state of the colony. For example, *Eciton hammatum*, with colonies numbering between 100,000 and 300,000 individuals can move the whole brood between dusk and dawn. If caught moving the brood after dawn, considerable losses may result. The Old World genus

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Anomma, which has much larger colonies, is largely subterranean and has a stately phase that is relatively longer than in *Eciton*.

The excitation leading to emigration of the colony coincides with the emergence of the callow workers of the new brood. This is true for *Eciton*, *Anomma* and *Dorylus*. The Old World types differ from *Eciton*, however, in that there are not significant excitation stimuli from the larval broods which develop in a different timing than with *Eciton*. Another difference between the two groups is that the Old World queen reaches the peak of egg laying at the time the colony emigrates, while the New World queen is physogastric for about a week in the middle of the stately phase.

Practically all of these comparisons between the Old and New World members of the subfamily Dorylini emphasized the general applicability of the concepts which Dr. Schneirla has so carefully formulated about the biology and behavior of *Eciton*. Indeed, they seemed to be good examples of a convergence of factors affecting groups which seem to have a very remote evolutionary relationship.

After a lively discussion, the meeting was adjourned at 9:45 P.M.

EDWARD S. HODGSON, *Secretary*

MEETING OF MARCH 6, 1956

A regular meeting of the Society was held at the American Museum of Natural History, Dr. Vishniac presiding. Mr. H. I. Williams, scheduled speaker, was unable to appear because of illness, but sent three remarkable color movies which were annotated by Mrs. Williams, Mr. Teale, and members of the Society. The films showed extreme closeups of flowers, wasps, and also an unusual photographic treatment of the theme of water. Mr. Teale pointed out that the film on wasps contained several photographic "firsts" and the esthetic values of Mr. Williams' work were equally impressive. President Vishniac extended the thanks of the Society to Mrs. Williams for the privilege of seeing the films, and also expressed the hope that Mr. Williams might be able to meet with us in the near future.

The meeting adjourned at 9:30 P.M.

EDWARD S. HODGSON, *Secretary*

MEETING OF APRIL 3, 1956

A regular meeting of the Society was held at the American Museum of Natural History, Dr. Vishniac presiding. The speaker was Mr. Vladimir Alexieff who discussed insects in music. Mr. Alexieff mentioned first a few musical misnomers which included insects in their titles, but actually consisted of non-entomological program music. Recordings of Schumann's "Papillions" and Moussorgsky's "Song of the Flea" were used to illustrate this point. Among the examples of bona fide insects in music which Mr. Alexieff played for us, were Grieg's "The Butterfly" (tentatively identified by Mr. Alexieff as the Red Admiral butterfly), an excerpt from Ravel's "Historie Naturelle" (identification seems unlikely), and folk dances of

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PHENACASPIS HETEROPHYLLAE COOLEY IN NEW JERSEY¹

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On September 2, 1956, a scale insect later identified (U. S. D. A. Insect Identification Number 56-12412) as *Phenacaspis heterophylla* Cooley was found on a five-foot sapling of pitch pine (*Pinus rigida* Mill.) located near the northern boundary of the Lebanon State Forest, Burlington County, New Jersey (74°30'-13" W. Long., 39°54'32" N. Lat.). The presence in New Jersey of this insect has not been previously reported although reports of its occurrence in seven eastern states, including the neighboring states of New York (Leonard, 1928) and Pennsylvania (Morrison, 1956),² have been recorded (Table 1). Severe infestation of this sapling occurred only on the leaves of one horizontal branch 3 feet from the ground. There was no evidence of the presence of the insect on any other branch of the sapling or on any other tree in the area.

The following discussion traces the reports of host trees with their locations and also the evolution of the revision of the nomenclatural status of the insect.

Cooley (1897) who originally described the pine needle scale and named it *Chionaspis pinifoliae heterophyllae* n. var. [Cooley], distinguished the species *pinifoliae* from the variety *heterophyllae* by use of the characters of larger size and more prominent rounded lobes in the female of the species as contrasted to smaller body size, less conspicuous lobes and . . . "the presence of the median notch" in the female of the variety. *C. pinnifoliae heterophyllae* was first collected in Florida upon Cuban pine (*Pinus heterophylla* (Ell.) Sudw.), hence the variety name. Berlese (1898) reviewed the original naming and listed *Chionaspis Pinifoliae* var. *heterophyllae* n. var. as the valid name.

¹ Paper of the Journal Series New Jersey Agricultural Experiment Station, Rutgers University, the State University of New Jersey, Department of Forestry, New Brunswick.

² Personal correspondence with author.

Language barriers produced an amusing incident in Berlese's Italian translation of portions of Cooley's 1897 paper. It seems that the former was confused by Cooley's B. S. degree for "By R. A. Cooley, B. S., Amherst, Mass." was translated to read "Cooley R. A. and Amherst S." Apparently Berlese knew little of dear old Amherst, Mass., for he assumed that the B was an English ampersand and that S. Amherst was the junior author.

A year later Cooley (1899) added some new data pertinent to the insect when he listed the host species as *P. heterophylla*, Florida; *P. sylvestris* L., Providence, Rhode Island; and *P. mitis*, Michx., St. George, Florida. He indicated that the insects are usually found at the leaf bases and sometimes on the bark of twigs of *P. heterophylla*. The scale insect was listed by Leonard (1928) as being found on pitch pine and Japanese red pine (*P. densiflora* Sieb. & Zucc.) at Glen Cove and Southold, Long Island, New York.

Ferris (1937) suggested a major revision of the insect's name. It was his opinion that *Phenacaspis pinifoliae* should be referred from the genus *Chionaspis* because of its unmistakable distinction and that *Phenacaspis pinifoliae heterophyllae* was sufficiently distinct to deserve specific recognition. Five years later Ferris (1942) stated that *P. heterophyllae* (Cooley) (officially using the current name which he offered in his 1937 paper) is normally found upon coniferous leaves but can occur on small branches. In addition to hosts previously mentioned, he listed shortleaf pine (*P. echinata* Mill.) and slash pine (*P. caribaea* Morelet) both from Mississippi. Ferris also described the normal range of the insect as the southeastern United States and perhaps the Caribbean area.

Morrison (1956) indicated that two unpublished reports of occurrence of the insect on pitch pine in Pennsylvania and North Carolina are on file with the Entomology Research Branch, Agricultural Research Service, U. S. D. A.

Finally, Ferris (1956) summarized the revision of nomenclature of *Chionaspis pinifolii* [pinifoliae] *heterophyllae* Cooley to *Phenacaspis heterophyllae* (Cooley) crediting the change to Ferris (1942). Noted also in his remarks are the host species *P. caribbeana* [caribaea] and an undetermined pine, both from Mississippi. Table 1 lists the recorded hosts, states and authors.

Based on recorded information the genus *Pinus* is apparently a lone host to the insect and of the eighty to ninety recognized species of *Pinus* (Harlow and Harrar, 1950) only six thus far have been reported as infested.

In conclusion, it is apparent that within the last 50 years nomenclature for both the insect and its host has undergone considerable revision and several inadvertent misspellings. The sub-

TABLE 1

HOST TREES OF *Phenacaspis heterophyllae* WITH THEIR LOCATIONS BY STATE.
NAMES IN PARENTHESES REPRESENT CURRENT NOMENCLATURE
ACCORDING TO LITTLE (1953).

<i>Species</i>	<i>State</i>	<i>Citation</i>
<i>Pinus caribaea</i> (<i>P. elliottii</i> Engelm.)	Miss.	Ferris, 1937
<i>P. densiflora</i>	N. Y.	Leonard, 1928
<i>P. echinata</i>	Miss.	Ferris, 1937
<i>P. heterophyllae</i> (<i>P. elliottii</i>)	Fla.	Cooley, 1897
<i>P. mitis</i> (<i>P. echinata</i>)	Fla.	Cooley, 1899
<i>P. rigida</i>	N. Y.	Leonard, 1928
	Pa., N. C.	Morrison, 1956
<i>P. sylvestris</i>	R. I.	Cooley, 1899

stitution of the species name *pinifolii* for *pinifoliae* (Ferris, 1956) is probably an editorial or typographical error, although Ferris (1942) stated that *pinifolii* was a misspelling.

It is also evident that *P. heterophyllae* is a rather rare insect in the northeastern United States and at the present time is more important as a matter of entomological record than as a forest tree pest.

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Russia and Italy. Mr. Alexieff outlined some authoritative program notes on the well known "Flight of the Bumblebee" and concluded with some admittedly apocryphal, but delightful, revelations concerning the therapeutic values ascribed to dancing of the Tarantella.

The meeting adjourned at 9:45 P.M.

EDWARD S. HODGSON, *Secretary*

MEETING OF APRIL 17, 1956

A regular meeting of the Society was held at the American Museum of Natural History, President Vishniac in the chair. The appointment of member Frank A. Soraci as Director of the Division of Plant Industry of the New Jersey Department of Agriculture was announced, and it was agreed that a letter be sent to Mr. Soraci expressing the congratulations of the Society.

The speaker of the evening was Dr. Joseph Copeland of the City College of New York, who discussed "Insectivorous Plants." Dr. Copeland noted that insectivorous plants are found in nitrogen-deficient habitats, usually in acid bogs or as epiphytes. Accordingly, the secretions of the plants contain proteinases rather than carbohydrases. Dr. Copeland described the insectivorous activities of various pitcher plants, bladder worts, butterworts, sundews and Venus-fly-traps, illustrating each with many kodachromes. The manner of conduction of the excitation from the trigger mechanism to the closing mechanism of the Venus fly trap is not known, nor is the physiological mechanism for the summation of the initial triggering stimuli which must come from the bending of at least two sensory hairs. After the talk, Dr. Copeland exhibited mounted specimens of many insectivorous plants, and a lively discussion was precipitated, during which mention was made of the larva of the Pine Barrens moth which bores holes into and drains pitcher plants preparatory to eating them, and the fact that it was an early New York lepidopterist, Henry Edwards, who described the activities of the Western pitcher plant.

The meeting was adjourned at 9:30 P.M.

EDWARD S. HODGSON, *Secretary*

MEETING OF MAY 15, 1956

A regular meeting of the Society was held at the American Museum of Natural History, Dr. Vishniac presiding.

The speaker of the evening was Dr. Thomas Smyth of Pennsylvania State

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CONCENTRATION OF CERTAIN ORGANIC
COMPOUNDS IN THE BLOOD OF THE
AMERICAN COCKROACH, *PERIPLANETA*
AMERICANA LINNAEUS¹

BY MARGARET E. TODD

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Most of the published material on the composition of insect blood deals with insects having a holometabolous life cycle. This work has been reviewed in texts on insect physiology by Chauvin (1949), Wigglesworth (1950) and Roeder (1953). In general they are in agreement that insect haemolymph is characterized by a high concentration of non-protein nitrogen, 50 to 80 per cent being amino nitrogen and a high concentration of reducing substances.

Since very little work has been done on the organic constituents of the blood of paurometabolous insects, this study was undertaken to determine the concentration of various nitrogenous fraction and reducing compounds in the blood of the American cockroach, *Periplaneta americana*.

MATERIAL AND METHODS

The cockroaches were kept at room temperature in glass jars containing laboratory food pellets and were supplied with water. To obtain uncoagulated blood, the insects were etherized, Ludwig (1951). The antennae were clipped with a pair of sharp scissors and the haemolymph was allowed to drip into a depression of a porcelain spot-plate. To facilitate bleeding, the abdomen was compressed during the process. The blood was measured with a micro pipette and 0.1 ml. was used for each test.

Protein and non-protein nitrogen were determined by the micro-Kjeldahl procedure. Amino acid nitrogen was measured by the method of Danielson as modified by Frame, Russell and Wilhelmi (1943). Reducing compounds were determined by the

¹ Dissertation submitted in partial fulfillment of the requirements for the degree of Master of Science in the Department of Biology at Fordham University. The author wishes to gratefully acknowledge the able direction of Dr. Daniel Ludwig under whose supervision this work was carried out.

Hagedorn Jensen method as described by Hawk, Oser and Summerson (1951) and non-fermentable reducing compounds by a modification of the method of Somogyi (1927). These procedures were used as described by Ludwig (1951) for the study of insect blood. Uric acid nitrogen was determined by the method of Brown (1945).

OBSERVATIONS

The results of all the determinations are compiled in Table 1. Protein nitrogen was 740, and non-protein nitrogen, 259 mg.

TABLE 1

CONTENT OF CERTAIN ORGANIC COMPOUNDS IN THE HAEMOLYMPH OF THE AMERICAN COCKROACH. VALUES ARE GIVEN IN MILLIGRAMS PER CENT.

Substance	No. of Tests	Minimum value	Maximum value	Average values
Protein				
nitrogen	10	476	1,000	740
Non-protein				
nitrogen	10	154	322	259
Amino acid				
nitrogen	10	67.4	109	78
Reducing				
compounds	11	110	288	221
Non-fermentable				
reducing compound	10	88	280	192
Uric acid				
nitrogen	10	2.97	5.77	4.68

per cent. Total nitrogen, estimated by adding protein and non-protein nitrogen, was approximately 1,000 mg. per cent. Amino acid nitrogen was found to be 78 mg. per cent or about 35 per cent of the total non-protein nitrogen. Uric acid was 14.30, and uric acid nitrogen, 4.68 mg. per cent.

The average concentration of reducing compounds was 221, and of non-fermentable reducing compounds, 192 mg. per cent. Hence, that of fermentable reducing compounds (glucose) was only 30 mg. per cent.

In general these analyses on the haemolymph of the American cockroach agree with the results obtained by investigators on the blood of other insects as given by Buck (1953). The figures for

amino acid nitrogen in the blood of insects reported by Buck, averaged 224 mg. per cent. However, these readings were made on insects with holometabolous development. The American cockroach contained only 78 mg. per cent amino nitrogen. Leifert (1935) in her work on the blood of the larvae of the moth *Antheraea pernyi*, reported 80 mg. per cent, and Levenbook (1950) reported 94 mg. per cent amino nitrogen in the blood of larvae of the botfly, *Gastrophilus intestinalis*. The concentration of amino acid nitrogen obtained in the present work was estimated to be about 35 per cent of the total non-protein nitrogen. Wigglesworth (1950) and Buck (1953) estimated that the amino acid nitrogen is from 50 to 80 per cent of the non-protein nitrogen. However, these percentages were also based on readings obtained for holometabolous insects.

Yeager and Fay (1935) studied the reducing compounds in the American cockroach in connection with a study of the coagulation of the haemolymph. They fractionated the blood after treating the insects in different ways. One method was to collect the haemolymph under oil and allow it to stand 15 minutes and then remove the coagulum of cells. The mean total reducing substances found by them was 62, as compared with 221 mg. per cent found here. However, the present determinations involve the use of whole blood and consequently are not comparable to those of Yeager and Fay.

SUMMARY

A study was made on the concentration of nitrogenous and reducing compounds in the haemolymph of the American cockroach, *Periplaneta americana*.

Total nitrogen concentration was 1,000 mg. per cent, 740 of which was contained in the protein and 259, in the non-protein fraction. Amino nitrogen averaged 78 mg. per cent, or 35 per cent of the total non-protein fraction. The concentration of uric acid was 14.3 and of uric acid nitrogen 4.68 mg. per cent.

The total value of reducing compounds was 221 mg. per cent of which 192 mg. per cent were not fermentable. Hence, only about 30 mg. per cent were fermentable and may be considered glucose.

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University, who discussed flight controls in insects. Dr. Smyth discussed the body form of most insects, which renders them unstable for flight. A variety of mechanisms exist for controlling flight. In the early 1940's, Hollick showed that production of movements in the antennae of flies contributed to the maintenance of flight and regulated pitching movements of the insect's body, through changes in the angle of the wing stroke. Sensory hairs in the head, and at the base of the halteres of several flies have been shown to serve similar functions with regard to rolling movements of the insect in flight. Dr. Smyth indicated that, although generally without critical study, changes in metabolism during prolonged flight can modify the speed and angle of flight. Newer methods of studying insect flight include application of DDT to the sense organs regulating flight and observing the resultant changes in the insects behavior, and the technique of recording the nerve impulses from sense organs contributing to the regulation of steady flight.

After a discussion period, the meeting adjourned at 9:30 P.M.

EDWARD S. HODGSON, *Secretary*

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DROSOPHILA OF THE ITASCA PARK, MINNESOTA REGION

BY HERMAN T. SPIETH

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Stimulated by the pioneer studies of Sturtevant (1921), Sturtevant and Dobzhansky (1936), and Patterson and his associates (see Patterson and Stone 1952), various investigators recently have made relatively extensive collections of *Drosophila* from divers parts of North America. Thus Spiess (1949) studied New England; Carson and Stalker (1951), Missouri; Spencer (1952), Wyoming; Levitan (1952), southwest Virginia; Stevenson (1952), Tennessee–North Carolina; Williams and Miller (1952), Nebraska; Levitan (1954), New York and New Jersey; and Carpenter and Giordana (1955), Tennessee populations. These studies, plus the extensive investigations of other workers, especially those of Patterson and his students, have established the broad outlines of the distribution of many of the common wild species of *Drosophila* in North America.

Inspection of these records shows, however, a lack of information of the *Drosophila* populations dwelling in the upper Mississippi Valley. Representative of this area is the region about Lake Itasca, Minnesota. During August 1950 and '51, and July and August 1952, collections of the drosophilids of the Itasca State Park region were made along with some ancillary studies on the biology of several of the species. The data derived from these collections and experiments are incomplete and limited but since there appears to be no opportunity within the foreseeable future of adding to them they are herewith presented.

Area Characteristics: Itasca State Park, approximately square in shape, covers about 32,000 acres (49 sq. miles). Contained within its boundaries are numerous ponds and lakes which occupy about 4,000 acres and include Lake Itasca, the headwater lake from which the Mississippi River originates. Except for a limited number of roads, three public camp grounds, State Park Headquarters, a bathing beach, the State Lodge and the University of Minnesota Biological Station, the park is relatively un-

molested. Much of it contains virgin stands of timber. Both the northern coniferous and the southern deciduous hardwood or "Big Tree" forests are represented by "pure" stands. In addition, a typical prairie lies only a few miles to the west of the Park. Consideration of the nature and history of the vegetation and the type of terrain of the Park leads one reasonably to believe that the drosophilid populations now in existence in Itasca Park can give an accurate indication as to what the original populations were like before white man and his techniques seriously disturbed the biota of the region.

Methods: Fifty pound lard cans were used as traps. Rotting, yeasted bananas were placed in the bottom of the cans and served as bait. Two strips of wood (1" × 1" × 16") were laid across the open top of each can and the lid then was rested upon these boards. Thus the flies were able freely to enter or leave the trap, but since the light intensity was much reduced and the humidity considerably elevated within the can, the flies tended to remain within the trap after they had fed. Typically the traps were set upon the ground, but in areas where raccoons (*Procyon lotor*) were abundant it was found necessary to sling the traps in the air about 3 feet above the ground in order to protect the bait. Specimens were collected from the traps in both the morning and evening and most of the trapping was done in the area about the University Biological Station. To insure sampling as many as possible of the various ecological habitats, collections were made in various parts of the Park and also in the surrounding country. The specimens that were found in the traps were captured by means of an insect net and then transported to the laboratory where they were etherized, identified and tabulated. Table 1 indicates the species and number of each taken during the three summers.

OBSERVATIONAL DATA ON THE VARIOUS SPECIES

Drosophila athabasca Sturtevant and Dobzhansky

Drosophila algonquin Sturtevant and Dobzhansky

These two species, both belonging to the same subgroup (affinis) of the obscura species group, were the most abundant drosophilid species collected in the area. *D. athabasca*, however, was consistently 4-5 times as abundant (in the collections) as *D. algonquin*. Adults of both species seemed to range throughout the entire

area for, regardless of where the traps were set, representatives of both were usually present in each collection that was made. If the traps were located in swampy regions, there generally was an increase in the relative number of individuals of *D. algonquin*, especially in areas where there were specimens of maple trees (*Acer rubrum*).

TABLE 1

<i>Drosophila</i>	1950	1951	1952	Total
<i>D. duncani</i>	.....	.....	25	25
<i>D. busckii</i> *	1	.....	1	2
<i>D. algonquin</i>	273	64	343	680
<i>D. athabasca</i>	1092	257	1656	3005
<i>D. melanogaster</i>	17	19	12	48
<i>D. borealis</i> + <i>D. lacicola</i>	256	114	82	452
<i>D. palustris</i>	.....	.....	1	1
<i>D. quinaria</i>	.....	.....	1	1
<i>D. transversa</i>	15	5	83	103
<i>D. testacea</i>	.....	1	23	24
<i>D. funebris</i> *	6	10	29	45
<i>D. macrospina</i>	.....	.....	6	6
<i>D. robusta</i> + <i>D. colorata</i>	82	19	114	215
<i>D. melanica paramelanica</i>	82	36	24	142
<i>D. hydei</i> *	4	.....	1	5
<i>D. repleta</i>*	.....	.....	2	2
Chymomyza				
<i>C. aldrichi</i>	.....	.....	2	2
<i>C. amoena</i>	.....	.....	8	8
Scaptomyza				
<i>S. graminum</i>	2	3	2	7
TOTAL	1748	492	2391	4631
# of collections**	17	7	34	

* = domestic or cosmopolitan species.

** = each collection represents a collection date—for any one collection a number of containers, often scattered over several miles of territory, might be employed.

D. affinis which both Spiess (1949) and Levitan (1955) found associated with *D. algonquin* and *D. athabasca* in the eastern part of the United States was not collected at Lake Itasca although it, as well as the other two species, was abundant at St. Paul, Minnesota, approximately 200 miles south of Itasca.

An intensive but unsuccessful search was made for the habitats of the larvae of these two species. Certain negative evidences should be recorded. The species apparently do not breed in the slime fluxes of the American elm (*Ulmus americana*). Such fluxes were abundant in the region and were inhabited by a number of insect larvae including *D. robusta* and perhaps *D. colorata* as well as numerous individuals of *Aulacogaster* sp.?. Wounds or fluxes on other trees also had no larvae of *algonquin* and *athabasca*, although other insects did dwell in such places. Obviously the microhabitats in which the larvae of these two species dwell must be relatively numerous and uniformly dispersed throughout the area. Since the two species are closely related it can be expected that in nature their larval requirements will be similar but sufficiently different to keep the two species from seriously competing with each other. Carson and Stalker (1951) found *D. athabasca* breeding sporadically in fungi, slime fluxes (red oak, *Quercus borealis*) and rotting fruit (wild persimmons; *Diospyros virginica*) in the vicinity of St. Louis. It is possible that species of the affinis subgroup, to which *athabasca* and *algonquin* belong, are opportunistic forest dwellers that utilize any microhabitat that possesses the resources necessary for the production of an adequate flora of microorganisms.

Drosophila borealis Patterson and *D. lacicola* Patterson

These two members of the Montana subgroup of the virilis species group were relatively common in the area. Since the adults of both species are extremely similar and can be identified readily only by cytological means or by study of the internal anatomy, especially the female spermatheca, the individuals were not consistently determined to species rank. In every instance where specific identity of a series was made, it was found that *borealis* far outnumbered *lacicola*. Typical was a series of 40 female individuals that Hsu (see Patterson 1952) checked cytologically and in which he found only one specimen of *lacicola* and 39 of *borealis*. The breeding site of these two species, as has been reported previously (Spieth 1951), is in the rotting phloem of various species of aspen. Although the identity of *D. borealis* was known in 1951, the species was not described until 1952 (see Patterson 1952), and therefore all specimens in my 1951 paper were listed as *D. lacicola*, although unquestionably many of them

must have belonged to *D. borealis*. Study of these two species confirmed that (1) the adults normally never leave the immediate vicinity of bodies of water—a characteristic they share with other wild species of the virilis group, (2) they will oviposit freely upon the rotting phloem tissue of various species of aspen, and (3) the larvae normally feed and develop by burrowing in the soft decomposing phloem tissues, apparently feeding upon the microorganisms which are abundant in the woody tissues. Rarely an adult was collected from a trap that was located some distance from a body of water, but in all such instances a gentle but persistent rain had been falling for a considerable period immediately before the collections were made. Apparently when the atmosphere is completely saturated with water vapor, then the adults are no longer rigidly restricted to the immediate vicinity of bodies of water and are able to migrate and thus reach isolated ponds or lakes.

The population density of these species is never great because of the rigidly restricted range of the adults and the exacting requirements of the larvae. Specifically, only in exceptional instances will conditions exist where there is an abundant supply of properly rotting aspen phloem located immediately along the edges of bodies of permanent water. In Itasca Park two such unique situations were found, i.e., (1) in beaver ponds where the animals had felled aspen trees and (2) in a small pond on the campus of the University of Minnesota Biological Station where a number of aspen trees had been felled and cut up into cord wood during a dry period and then subsequently inundated. Similar aspen cord wood located away from the water bodies did not have a population of *lacicola-borealis* larvae even though the condition of the phloem tissues seemed identical with that near the ponds. Apparently the adults will not leave the vicinity of bodies of water in order to oviposit. The rotting phloem does, however, attract the flies if it is located near bodies of water. A piece of bark approximately 2 feet square was peeled from an aspen stump at the edge of the pond mentioned above and numerous adult individuals immediately assembled on the exposed surfaces and remained there throughout the entire day—an extremely atypical behavior since usually the adults are found on the feeding and ovipositioned sites only during the early morning and later afternoon.

Drosophila palustris Spencer, *D. quinaria* Loew, and *D. transversa* Fallen

These three species, all members of the *quinaria* species group, have been reported regularly from the eastern part of the United States. Within the same species group another series of species is distributed in the western U. S., but none of these western species was taken at Itasca. Of the three species only *D. transversa* was common and only one specimen each of *D. quinaria* and *D. palustris* was taken. Carson and Stalker (1951) have confirmed earlier workers in showing that this group is essentially restricted to fungus for breeding sites although some of them can breed in other sorts of materials.

Drosophila testacea van Roser

This fungus feeder, as indicated by Patterson and Stone (1952), is the northern representative of the group and is replaced southwards in the U. S. by the common species *D. putrida*.

Drosophila macrospina Stalker and Spencer

Only two members of the *funnebris* group were collected, i.e., the domestic *D. funnebris* Fab. and the wild *D. macrospina* Stalker and Spencer. The latter was found at only one specific area where six individuals were collected on July 16 and 17, 1952.

Drosophila robusta Sturtevant and *D. colorata* Walker

Both of these species were present in the area but unfortunately the presence of *D. colorata* was not recognized until late in 1952. The specimens have all therefore been lumped together in Table I. Numerous slime fluxes were present in the elm trees (*Ulmus americana*) of the area and specimens of *D. robusta* were bred from these fluxes, thus agreeing with the findings of Carson and Stalker (1951).

Drosophila melanica paramelanica Patterson

Only one species of the *melanica* group *D. m. peremelanica* was found in the Itasca region. Even this subspecies was relatively rare here (143 specimens collected during the three summers) in comparison to the area around St. Paul, Minnesota, where it was one of the most abundant drosophilids of the region.

Chymomyza aldrichi Sturtevant

This species as well as *C. amoena* (Loew) was collected from the bait cans during the summer of 1952. During the previous summer no adult specimens of these species had been found at the bait, but a number of *C. aldrichi* had been reared from larvae and eggs collected in the field. The larvae, as well as pupae of *C. aldrichi*, were first found in the field on July 29, 1951. On July 14, a sharp wind storm had blown down several aspen trees on the University of Minnesota campus area. The heavy bark of these trees had been splintered and on the exposed inner surface (the cambia surface), where the bark was pulled free from the wood or xylem tissue, were found not only various larval stages of *C. aldrichi* but also pupal cases. The larvae and pupae were both taken into the laboratory and adults reared therefrom. Subsequently in 1951 and also 1952, eggs, larvae and pupae of *C. aldrichi* were collected from aspen bark that had been torn loose from the underlying xylem by an agency of one sort or another. A study of the larval habits showed that, unlike larvae of *D. borealis* and *D. lacicola* which bored into the rotting phloem tissue, the larvae of *C. aldrichi* restricted their activities to the inner exposed surface of the bark. Apparently, whenever an accident occurs that results in the exposure of the inner surface of the aspen bark, the females of *C. aldrichi* quickly deposit their eggs upon the surface and when the larvae hatch they feed upon the microorganisms that develop on the moist, somewhat gummy surface. Thus, bark that had been injured on July 14, 1951, had by July 29 produced mature pupae. *C. aldrichi* larvae appear to be one of the first macroscopic invaders of such wounded places on the aspen and perhaps other trees and, because of the relative time of their invasions and their habits of feeding upon the surface of the food, they are out of competition with the forms that burrow in the bark. Wheeler (1952) found the adults on peeled areas of trees, mainly aspen, fir and pine.

DISCUSSION

Excluding the cosmopolitan species such as *melanogaster*, *buseckii*, *hydei*, *repleta* and *funnebris*, only 13 species of wild drosophilids were collected in the Lake Itasca area during the

three summers of 1950, '51, and '52. Most of these 13 species range throughout the deciduous forest areas of northeastern North America, but are not found in the western part of the continent. Thus, of the 13 species, only *D. borealis* and the wide-ranging *D. athabasca* are found in the western part of the country. Therefore the drosophilid fauna of the area is essentially eastern in character.

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REGULATION OF CASTE IN SOCIAL HYMENOPTERA*

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Communal life in the social Hymenoptera (wasps, bees, and ants) is so completely integrated that the nature and the operation of the mechanisms which in each generation cause the offspring of a mated female to develop into several castes with each caste relatively constant in numbers are highly cryptic.

In the Hymenoptera, however, the framework of social organization apparently consists of the interaction of two phenomena, the environmental control of sex and the environmental control of caste (Flanders, 1946). This interaction is the basis of the following analysis of the hymenopterous society.

The primary effect of the interrelation of sex and caste control is the limitation of true castes to the female sex. Because of this limitation it is logical to assume that the circumstances that initiate the fertilization of the egg also initiate caste formation. This assumption seems to be verified by the existence of the necessary mechanisms (Flanders, 1953). The following discussion therefore describes the critical mechanisms involved and advances certain hypotheses concerning the methods by which these mechanisms operate to regulate caste ratios.

The essential physiological mechanisms involved in the regulation of caste ratios include those involved in the control of sex—the spermatheca, the spermathecal gland, and the spermathecal duct—the spermatheca having a sperm storage capacity sufficient for the fertilization of all eggs deposited, the spermathecal gland having a capacity for producing sperm-activating secretion sufficient to permit the fertilization of all eggs regardless of the rate of oviposition, and the sperm duct having a lumen adapted to holding several sperms enroute to the oviduct (Flanders, 1939).

These mechanisms become essential factors in sex and caste control when, as in the social Hymenoptera, sex determination is haplodiploid (unfertilized eggs usually becoming males and fer-

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tilized eggs becoming females), ovulation is environmentally induced, the spermathecal gland is responsive only to environmental stimuli, and oviposition by the queen is largely limited to mated individuals.

The stimulus to which the hymenopterous female responds in controlling the sex of her progeny is definitely derived from the environmental conditions existing at the time of egg deposition; that is, the production of females in contrast to the production of males results from the stimulation of the spermathecal gland. The gland, however, secretes only in response to environmental stimuli that are within a certain range of intensity. The intensity of the stimulation is a function of the spatial, meteorological, or chemical nature of the environment at the moment of oviposition.

THE ATTAINMENT OF CASTE

In the progressive evolution of the social Hymenoptera the worker characteristics may have occurred in the following sequence: first, reproductive diapause, then division of labor, and finally morphological differentiation (Flanders, 1953).

It is highly probable, as demonstrated by Bier (1954) in his classic study of *Formica rufa*, that the worker caste develops from eggs that have been undernourished prior to ovulation. Undernourishment is indicated by a reduced amount of yolk in the "ripe" egg and the extension of the preovulation period of such eggs. The physiological conditions supposed to cause this change in status are the precocious deterioration of the nurse cells (Bier, 1954) and the partial absorption of the ripe ovarian egg (Flanders, 1953). These conditions appear to be environmentally induced.

Environmental temperatures may determine the occurrence of undernourished ovarian eggs, as reported for *Formica rufa* (Bier, 1954). This phenomenon may also occur in the wasps. According to Deleurance (1950), the overwintering female of *Polistes* may start her colony more or less simultaneously with two types of female progeny. Although morphologically alike, one type is a worker, the other a reproductive. The occurrence of the worker appeared to be induced by median temperatures, that of the reproductive by the extremes of temperature. The ratio of queens to workers in the stingless bees (*Melipona* spp.) varies with en-

vironmental temperatures (Kerr, 1946), a ratio possibly derived from the relation between the rate at which eggs are generated and that at which they are deposited. Since all individuals as larvae receive equal amounts of food the *Melipona* queen is likely to be smaller than the worker because of the greater nutritional needs of the ovaries.

In the colonies of the ant *Rhizomyrma fuhrmanni* Forel, an obligate coccidophile, it is probable that the occurrence of caste-initiating undernourishment in the ovarian egg is regulated by the humidity of the nest. This is indicated by the following colony conditions as recently observed by the writer in central Colombia: (1) the monophagic subsistence of the ant on a species of the root-feeding coccid near *Eumyrmococcus smithi* Silv. and the regulation of the entire coccid population in the area according to the nutritive needs of the ant population, and (2) the constant temperature of the nest throughout the year; estimated to be 21° C. plus or minus one degree (Flanders, 1957a).

In the regressive evolution of the relatively few parasitic species, the "dwarfing" of the individual apparently proceeded to the point at which developmental caste-initiating undernourishment rarely if ever occurs. In such species workers are few or absent.

THE REALIZATION OF SEX AND OF CASTE AS SYNCHRONOUS PHENOMENA

The nature of the environment during the period of oviposition regulates the occurrence of the castes as well as of the sexes so that sex control and caste control are more or less synchronized.

The realization of the worker caste occurs when nest conditions are indigent. The reproductives, queen and male, are fully nourished, a sign that nest conditions have been or are opulent. The occurrence of indigent or of opulent nest conditions appears to be determined by the environmental circumstances that also regulate the activation of the spermathecal gland, full nourishment being associated with the inactivation of the spermathecal gland, undernourishment with its activation.

In the honey bee and the army ant, the conditions that inhibit the activation of the spermathecal gland initiate a sequence of events that results in the full nourishment of the individual.

In the primitive species of ants, bees, and wasps in which the castes lack marked morphological differentiation, it is probable that most, if not all, of the workers remain in a nongravid (neotenic) condition until the colony either lacks a queen or the queen ceases the deposition of fertilized eggs. When such a situation occurs, oogenesis may be initiated in one or more of the adult workers. Presumably, the worker that first mates after attaining a gravid state receives additional food and takes on the status of a queen, thus re-establishing the colony conditions which inhibit and depress ovarian development in the unmated female.

The reversal of the reproductive status of the adult female undoubtedly takes place much less readily when the morphological differentiation of the castes is sufficient to prevent mating. In strongly polymorphic species the reversal in caste may be limited to the larval stage, provided that the predisposition of caste initiated in the ovarian egg is not firmly established and can be nutritionally counteracted (Bier, 1954; Brian, 1954).

Caste, however, may be regulated in the larval stage only in species having a stereotyped colony condition (either structure or behavior) which usually prevents full feeding during that stage. Such a condition is exemplified in the honey bee by brood cells of constant size but so small that the larva developing in each cannot be fully fed. In the tropical army ant, *Eciton* s. str., the absence of full nourishment during the larval stage is usually insured by a constant adult worker-larval brood ratio brought about by the regular occurrence of discrete broods which arise usually with little if any mortality from large batches of eggs deposited periodically, the number of eggs in each batch being practically constant (Schneirla and Brown, 1952).

The queen of the honey bee develops in an extra-large brood cell which permits her to be fully nourished (Haydak, 1943). The queens of the tropical army ant occur when an occasional brood is bisexual and this brood in its egg stage or early larval stages is reduced 90 per cent by cannibalistic action of the attending workers, this action apparently being a more or less indirect response to the environmental factors that inhibited the action of the spermathecal gland. The remaining members of such a brood develop under opulent conditions; males and females are then more or less fully nourished, and the latter become queens.

THE DESTINY OF THE OVULATED EGG IN RELATION TO CASTE

In the Hymenoptera the normal male is derived only from the unfertilized egg. With species in which at all times the secretion of the spermathecal gland can keep pace with oviposition, the fully mated female produces males only when gland stimulation during oviposition is lacking.

In the queen of the social species the inactivation of the spermathecal gland may be an effect not only of the absolute character of the environment, as appears to be the case in *Formica rufa*, but of a change in that environment from the usual to the unusual, from the accustomed to the unaccustomed, as is apparently the case in the honeybee and the army ant. Because of this apparent preferential nature of the fertilization and nonfertilization of the egg, it is possible for the male to continually escape exposure to conditions that initiate polymorphism (Flanders, 1946).

The lack of castes in the male may result from the fertilization of all eggs that are deposited under indigent nest conditions. In many species the ovarian eggs that are undernourished and then ovulated are usually, if not always, fertilized and consequently are workers. Caste differentiation is limited to the female, because the male either develops under opulent nest conditions, is inherently lacking in susceptibility to caste-determining undernourishment, or possesses a threshold of undernourishment so relatively low that caste is rarely realized.

In all of the social Hymenoptera the completely absorbed eggs constitute a large percentage of the total number of eggs generated. Consequently it is significant that with the species having numerous ovarioles the determination of the biparental queen is limited to the larval stage (Flanders, 1957b).

In such species it is logical to assume that all of the deposited eggs have been subjected to caste-initiating undernourishment (regardless of environmental conditions) and that as a consequence the full-nourishment of the larva quantitatively or qualitatively is necessary for the production of biparental queens. Social systems such as those of the honey bee and the army ant are essential for the segregated feeding of the larvae (either in space or in time), and the development of a certain proportion into queens.

The limitation of caste regulation to the larval stage and the development of biparental queens only from eggs predisposed to become workers may be characteristic of species in which colony reproduction takes place only by swarming. In such species the worker, having few ovarioles, may deposit eggs which are yolk-replete and are not reduced in size. Occasionally unfertilized eggs from workers become (uniparental) queens (Flanders, 1945).

It is probable that in all species of the social Hymenoptera the worker develops from an undernourished egg. An egg not thus predisposed to become a worker rarely if ever does so, yolk-replete eggs being deposited when colony conditions are opulent and consequently usually unfertilized.

As suggested by Schneirla and Brown (1952), in the army ant the order of egg deposition in the formation of any brood may establish regular graduated differences in ovisorption susceptibility and thus furnish a basis for the relative differences in attainable size and (in fertilized egg) polymorphic threshold.

It is evident that the trophic mechanisms involved in the realization of caste in the social Hymenoptera are pre-larval, larval, and post larval.

THE ATTAINMENT OF CASTE RATIOS

Continuity of reproduction necessitates the simultaneous occurrence of queens and males. It is obvious that the recurrent periods of indigent and opulent nest conditions determine the ratio of workers to reproductives. The mechanisms involved function also in determining the ratios of queens to males and of queens to workers.

The deposition of eggs destined to develop under opulent conditions and consequently to become males and biparental queens occurs when the secretion of sperm-activating fluids by the spermathecal gland is inhibited. It is the fertilization of the egg under such circumstances which insures the simultaneous occurrence of the reproductive forms and determines the ratios of the sexes and of the castes.

On the basis of studies by Flanders (1939), Hagen (1954), and Schneirla and Brown (1952), it appears that the fully nourished female or queen is usually derived from an egg fertil-

ized by a residual sperm—that is, a sperm which was activated during oviposition under environmental conditions that stimulate the spermathecal gland, but which was in the sperm duct enroute to the oviduct when such oviposition ceased and was not used until oviposition was resumed under conditions that inactivate the spermathecal gland and induce full nourishment of the developing individuals. The egg that the queen honeybee deposits in the preconstructed queen cell, for example, is fertilized by a sperm activated during her oviposition in worker cells (Snodgrass, 1956). The larva from that egg is full-fed.

The queens produced by the tropical army ant are limited to broods originating under certain dry-season conditions that inhibit the activation of the spermathecal gland. The first eggs deposited are the only eggs of this brood that receive sperms (Schneirla and Brown, 1952). This is satisfactorily explainable only on the hypothesis that the sperms thus used were residual sperms held over in the sperm duct after the fertilization of the eggs of the preceding all-worker brood. The spiral convolutions of the spermathecal duct in this species appear to be an adaptation for this purpose (Hagen, 1954).

In the small fallow ant, *Formica rufa*, which produces queens and males when the queen is subject to cool weather (Bier, 1954), the eggs that develop into queens presumably are fertilized by residual sperms. At temperatures of 15.5° C. the spermathecal gland is not activated and the ovarian eggs are not subjected to caste-initiating undernutrition (Gösswald and Bier, 1955). The egg, if then fertilized, would necessarily have received a residual sperm that had moved into the sperm duct when temperatures were higher and workers were being produced.

In species such as *Formica rufa*, it is probable that the numbers of queens relative to the males would vary inversely with the duration of the period of opulence—the shorter the period, the greater the proportion of queens.

RESUMÉ

In species of social Hymenoptera possessing a system for differential larval feeding as in the army ant and the honey bee, each ovulated egg is predisposed to become a worker and does so if it is fertilized and the resultant larva is not fully fed.

In species that lack a system for differential larval feeding only a part of the ovarian complement of eggs is subjected to caste-initiating undernourishment, a differentiation which is presumably an effect of a differential retention of the mature ovarian eggs.

In all species environmental conditions that inhibit the action of the spermathecal gland are conducive to colony opulence and the full nourishment either embryonically or larval of one or more individuals and consequently to the production of queens as well as of males. The fertilized yolk-replete egg may become a queen regardless of subsequent nourishment.

Under opulent conditions the fertilization of an egg is accomplished by a residual sperm—that is, a sperm which was in the sperm duct enroute to the oviduct when oviposition under circumstances that stimulate the spermathecal gland ceased, and hence was not used until oviposition was resumed under circumstances which inactivate the spermathecal gland.

Consequently, in most if not all of the social Hymenoptera the worker is usually derived from an egg which at the moment of ovulation had a reduced amount of yolk. The predisposition of such an individual to be a worker may be nutritionally counteracted during either the larval or adult stages. It then becomes a queen.

CONCLUSION

It is concluded that the castes in the social Hymenoptera usually originate as follows: the worker from a fertilized egg which when ovulated had a reduced amount of yolk; the queen from any diploid egg, provided that the larva from a fertilized egg with a reduced amount of yolk is full-fed; the male from any unfertilized egg regardless of its yolk content. The ratio of females to males is apparently a function of the relative lengths of the periods of indigence (activation of the spermathecal gland), and of opulence (inactivation of the spermathecal gland). In most species the ratio of queens to workers appears to be a function of the number of eggs fertilized by residual sperms during the period of opulence, this number being determined either by the actual number of residual sperms or by the duration of the period of opulence prior to the utilization of all the residual sperms.

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(Continued from page 88)

MEETING OF MAY 29, 1956

A regular meeting of the Society was held at the American Museum of Natural History with President Vishniac in the chair. Drs. Treat and Forbes were unanimously elected as the official delegates of the Society at the International Entomological Congress scheduled to convene in Montreal in August.

This being the last meeting of the season, the program consisted of talks and demonstrations by the members. Dr. Louis Marks discussed new insect stamps, with special reference to the topical collection of insects on stamps exhibited at the last International Philatelic Show. Dr. Marks promised to project color slides of some of these stamps when the society next convenes on October 2nd. Lieutenant Milton Tinker discussed the horse chestnut rust mite and the biology of the armoured scale insects. Lt. Tinker pointed out that the mite is widespread in this area, although often inconspicuous and exhibiting considerable food-plant specificity. The life history is complex, including two nymphal instars and two adult forms, one of which overwinters. The armoured scale insects present a number of curious contrasts to other Homoptera, some species appearing to spend more time moulting than feeding. Mr. Peter Dix discussed Scarab beetles in Egyptian culture, demonstrating several ornaments marked with scarabs and tracing a number of the intricate relationships of the scarab symbol and religious beliefs in Egypt. Dr. Treat demonstrated an unusual new long-playing phonograph record of insect sounds.

The meeting and the season were brought to a close at 10:30 P.M.

EDWARD S. HODGSON, *Secretary*

EFFECTS OF ADDING SUBSTRATES AND INHIBITORS ON THE HOMOGENATE RESPIRATION OF THE JAPANESE BEETLE, *POPILLIA JAPONICA* NEWMAN, DURING EMBRYONIC DEVELOPMENT*

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Ludwig and Barsa (1956) compared the respiration of 10 per cent homogenates of eggs of the Japanese beetle, *Popillia japonica*, and of the mealworm, *Tenebrio molitor*, with that of the whole eggs. They found that homogenization of newly laid Japanese beetle eggs resulted in a reduction of 50 per cent in O₂ consumption. From the third to the sixth days of embryonic development at 30°C., there was no reduction, but towards the end of the embryonic period, a reduction of more than 50 per cent was again obtained. They correlated the varying effects of homogenization on O₂ consumption with water content and the degree of organization of the egg. During the first 4 days of development at 30°C., the egg increases in weight from 0.83 to 2.3 mg., associated with the imbibition of water. During this time the constituents of the egg are greatly diluted and homogenization has little effect on respiratory rate. However, homogenization of the mealworm egg resulted in a reduction of approximately 48 per cent in O₂ consumption which was constant throughout the embryonic period at 30°C. Mealworm eggs do not imbibe water and the weight remains constant.

Ludwig and Barsa (1957) studied the effects of adding various substrates and inhibitors of the succinoxidase system to 5 per cent homogenates of the mealworm egg on its O₂ consumption for each day of embryonic development at 30°C. The addition of either cytochrome *c* or sodium succinate alone failed to increase respiratory rate. However, when both were added it was increased to that of the intact egg. The addition of the inhibitors, KCN, sodium malonate and DDT, when used singly, elimi-

* This work was supported in part by the Medical Research and Development Board, Office of the Surgeon General, Department of the Army, under Contract No. DA-49-007-MD-444.

nated all of the O₂ uptake produced by the addition of substrates and a great deal of the endogenous respiration. Because of the physiological differences between the eggs of the mealworm and Japanese beetle noted above, it was decided to repeat this series of experiments using 5 per cent homogenates of Japanese beetle eggs.

MATERIAL AND METHODS

Eggs were collected daily so that when obtained they were always less than 24 hours old. They were kept in 1-ounce metal salve boxes containing moist soil at 30°C. At the desired stage, they were homogenized for one minute with a motor driven glass homogenizer in 0.03 molar phosphate buffer adjusted to a pH of 7.4. Readings on the O₂ consumption of 5 per cent homogenates were made over a 2-hour period in Warburg constant volume manometers at 30°C., according to the method outlined by Umbreit, Burris and Stauffer (1945). The substrates, sodium succinate and cytochrome *c* were added singly and together to the homogenate. The inhibitors, KCN, alcohol, or DDT in alcohol, were added singly to homogenates containing added sodium succinate and cytochrome *c*. All solutions were made in 0.03 molar phosphate buffer at a pH of 7.4. In each experiment, the thermobarometer contained all of the test solutions but no tissue homogenate. The final concentrations in the manometer flasks were:

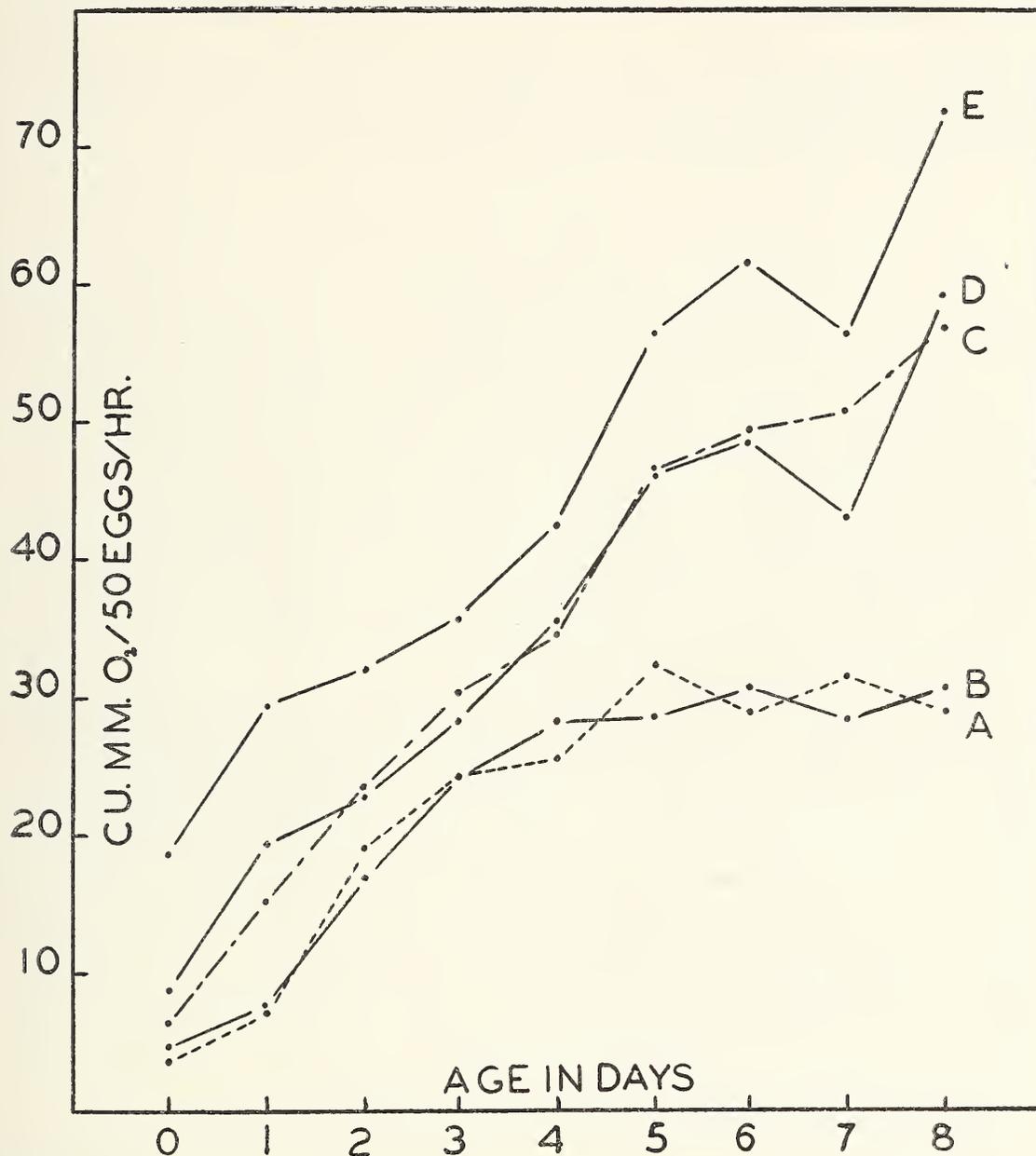
- (a) M/9 sodium succinate,
- (b) 0.6×10^{-4} M cytochrome *c*,
- (c) 10^{-4} M KCN,
- (d) 1.25 per cent ethyl alcohol,
- (e) 10^{-3} M DDT in 1.25 per cent ethyl alcohol.

The DDT was prepared by dissolving the crystals in 5 ml. of ethyl alcohol and adding this solution to 95 ml. of phosphate buffer. Cyanide inhibition was measured by the method of Robbie (1946). Throughout each experiment, the manometers were rocked horizontally 100 times a minute. Homogenates from the same individuals were used throughout one series of experiments.

OBSERVATIONS

The results are given in Figure 1. Each point is an average of at least 10 determinations. The O₂ consumption of unfortified homogenate is shown in Graph A. Endogenous metabolism

showed a progressive increase during the first 5 days of the embryonic period and then remained constant until the time of hatching. Sodium succinate (Graph C) and cytochrome *c*



EXPLANATION OF THE FIGURE

Figure 1. O_2 consumption of 5 per cent homogenates during embryonic development. Graph A, unfortified homogenate; Graph B, homogenates with cytochrome *c* and sodium succinate and with either KCN, 1.25 per cent alcohol, or DDT in 1.25 per cent alcohol; Graph C, homogenate with sodium succinate; Graph D, homogenate with cytochrome *c*; Graph E, homogenate with sodium succinate and cytochrome *c*.

(Graph D), when added singly, increased the rate of O_2 consumption to the same extent throughout the embryonic period. However, their stimulating effect was greatest during the latter part of this period when the rate of endogenous metabolism re-

mained constant. When both substrates were added simultaneously to the homogenate (Graph E), the increase in respiration was greater than with either substrate alone. The addition of KCN, alcohol, or DDT in alcohol to homogenates containing both substrates (Graph B) reduced the O₂ consumption to the level of the unfortified homogenate (Graph A). Each of the inhibitors decreased the respiratory rate to the same extent.

DISCUSSION

Since the addition of sodium succinate or of cytochrome *c* increased the respiration of homogenates of Japanese beetle eggs for each day of embryonic development, the enzymes of the succinoxidase system appear to be in excess throughout the embryonic period. The observation that respiration is enhanced during the second half of the egg stage to a greater extent than it is earlier, agrees with the results of Ludwig and Wugmeister (1955) that beginning with the 5-day egg at 30°C., the activities of cytochrome oxidase and succinic dehydrogenase increase rapidly until the end of the embryonic period.

Ludwig and Barsa (1957) found that the inhibitors, KCN or DDT when added to homogenates of mealworm eggs containing cytochrome *c* and sodium succinate, eliminated a great deal of the endogenous respiration. However, with Japanese beetle eggs, none of the endogenous metabolism was eliminated by these inhibitors. This observation indicates that a part of the endogenous metabolism of mealworm egg homogenates is mediated through the succinoxidase system; while in Japanese beetle eggs, the endogenous respiration is mediated entirely through a cyanide insensitive system such as a flavoprotein.

Ethyl alcohol (1.25 per cent) reduced the respiratory rate of homogenates of mealworm eggs, but its narcotic effect diminished towards the end of the embryonic period (Ludwig and Barsa, in press). The present experiments show that with homogenates of Japanese beetle eggs, the inhibitory effect of alcohol remained constant throughout embryonic development.

SUMMARY

The effects of adding substrates and inhibitors of the succinoxidase system on the O₂ consumption of 5 per cent homogenates were determined throughout the egg stage of the Japanese beetle at 30°C.

The addition of sodium succinate or cytochrome *c* stimulated respiration, the effect being greater during the second half of the egg stage. When both substrates were added simultaneously, the increase in respiration was greater than with either substrate alone.

KCN, alcohol, or DDT in alcohol, decreased the respiration of homogenates to which sodium succinate and cytochrome *c* had been added to the level of the unfortified homogenate. These inhibitors did not eliminate any of the endogenous respiration.

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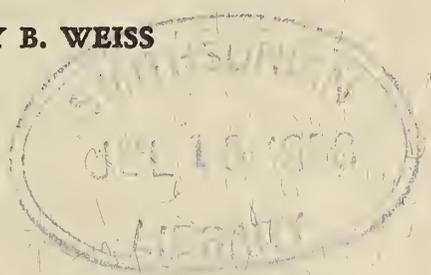
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NEW HORIZONS IN INSECT PATHOLOGY¹

BY EDWARD A. STEINHAUS

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During the past two decades the field of insect pathology has experienced marked advances in both its basic and applied phases. Microbial control, i.e., the use of microorganisms to control insect and other pests, appears to be about to enter the realm of general practicability and commercial feasibility. Several manufacturers in both the United States and Europe are now in the "pilot plant" stage of producing pathogens for use in microbial control. Nevertheless, a more complete realization of the applications of insect pathology depends on further advances in our understanding of the basic principles involved. (Moreover, microbial control is only one of the applications of insect pathology—a branch of entomology that has much to contribute to nearly all other branches, and to agriculture, medicine and biology generally.) In insect pathology, as in other sciences, it is the basic and fundamental research that is the fountainhead of practical accomplishments. This maxim is well-known and given much lip-service. It is not my intention, therefore, to use this occasion to mouth further platitudes on this important but verbally belabored subject. Instead, I should like to point out briefly what to me are some of the frontiers of research, the new horizons, that insect pathology is offering to those who pursue its study. Especially, I should like to emphasize four or five of the numerous branches of research in insect pathology that need

¹ Talk presented before the Entomology Division of the Ninth Pacific Science Congress held at Bangkok, Thailand, November 18 to December 9, 1957. Published with the consent of the Organizing Committee.

attention and which, if crowned with sufficient discovery and understanding, will lead to rapid strides and to a new pace in applied insect pathology.

It is my earnest contention that we must not spend our time thinking in terms of success or failure of microbial control methods. Rather, we should concentrate on and be thinking in terms of accumulating knowledge. Depending on the particular phase concerned, insect pathology and microbial control are now about in the stage of development that insect ecology (particularly insect parasitology) and biological control were fifty or sixty years ago. Accordingly, although we should not hesitate to pursue the applications of insect pathology as vigorously as we know how, we should appreciate and be all the more dedicated to a fundamental approach to the problems that confront us. Our approach must possess that range of vision that accompanies a profound and scholarly pursuit of both the theoretical and practical aspects of our science. At the same time, our activity must be more than research for research's sake, efficiency just to be efficient, or perfection without a purpose. Instead, on the firm foundation of basic knowledge, we must strive for quality research, efficiency, and perfection (insofar as these qualities can be attained) for a purpose, and for a goal attuned to man's need and benefit.

In the time allotted to me I should like to discuss briefly several important segments of insect pathology presently standing in need of a greater amount of fundamental research, and which, when we know more about them, will certainly yield rich rewards for the further development of our field. These are: (1) the development of methods of mass-producing insect viruses and protozoa, such as in tissue cultures, (2) methods of producing resistant stages of bacteria, fungi, protozoa, and nematodes, (3) a greater understanding of the effects of disease on insect populations, and of applying this knowledge in the field application of insect pathogens, (4) principles governing immunity and resistance in insects, and (5) the role of stress and predisposing factors in insect disease.

THE MASS-PRODUCTION OF ENTOMOPHILIC MICROORGANISMS

Ever since the time of Metchnikoff, in 1879, it has been recognized that for certain types of field applications of entomophilic

microorganisms it would be necessary first to develop methods of producing large numbers of these agents. With those microorganisms, such as certain bacteria and fungi, that grow well on artificial media, there may be no great problem in producing massive quantities in the laboratory or for commercial purposes. In the United States, the well-known *Bacillus thuringiensis* Berliner is about to be commercially produced in artificial media. Some manufacturers may use large tanks, each of which yield about a ton of spores, which should enable them to produce the material at relatively low cost.

In the case of most insect viruses and protozoa the problem of mass-production has been more difficult to solve. Indeed, very little progress of any kind has been made toward a satisfactory solution. The two currently used methods of accumulating large quantities of these pathogens—field collection of diseased insects and the infection of insectary-reared insects—while satisfactory in some instances, are not, in general, adequate or feasible for commercial production. More efficiently productive methods are required if entomophilic protozoa and viruses are to be made available to growers on a commercial scale. For this reason our laboratory has decided to devote a considerable amount of its time and resources to the development of methods of mass-producing these agents in tissue cultures.

Dr. M. E. Martignoni is the leader of our tissue culture project. It is his objective to develop methods of cultivating insect tissues and cells *in vitro*, and to use such cultures to study further the basic nature of viruses and to provide for their mass production. Of course, once insect tissues are successfully cultivated, numerous other applications of this technique will undoubtedly be made. For example, arthropod-borne plant and animal pathogens, intracellular symbiotes, and the general physiology and morphology of insect tissues, will all yield to further study and examination by means of tissue culture procedures. There is no question but that the perfection of methods of cultivating insect tissues will open the flood gates to an inundation of many new areas of research not only in insect pathology but in biology generally. And as it relates to the subject of our discussion, it will almost certainly provide industry with a new method of mass-producing certain insect pathogens in commercial quantities.

PRODUCTION OF RESISTANT STAGES OF INSECT PATHOGENS

It is not enough merely to devise methods of growing and mass-producing insect pathogens as such, especially if the object of such production is to obtain material suitable for field distribution. It is also essential that the form or stage of the pathogen so produced be such as to endure the rigors of field application and to survive in an infectious form for a period of time sufficient to be contacted by a susceptible host. Many insect pathogens occur in a resistant form (e.g., spore, cyst, dauer stage, etc.) as well as in a vegetative form. Unfortunately, it appears to be easier to grow and produce the vegetative or nonresistant stages of most bacteria, fungi, protozoa, and nematodes than the more durable resistant stages. In some cases it is not so much a question of being able to produce the resistant stage as it is of producing it in sufficient quantity for practical use. Thus, *Bacillus thuringiensis* Berliner readily forms spores, and the associated toxic crystals, in ordinary bacteriological media. However, such spore production may vary from 60 to 95 per cent. Naturally, the manufacturer is interested in using production methods in which spore formation approaches 100 per cent. To accomplish this, thorough nutritional and cultural studies are required.

From the standpoint of microbial control, one of the most promising groups of entomogenous fungi are the members of the order Entomophthorales. These obligate insect pathogens are at last yielding to cultivation on artificial media. Unfortunately, when so cultivated they usually produce only the short-lived conidia rather than the thick-walled resistant stages known to occur occasionally in nature. Recently, Dr. I. M. Hall of our laboratory in Riverside, California, has been successful in devising media and cultural conditions which, in the case of at least three species, has given rise to the sought-after resistant stages. If the production of these resistant stages can be accomplished on a large-scale basis, the ease with which these fungi can be used in the field will be materially enhanced.

Similar hopes may be expressed with respect to the entomophilic protozoa and nematodes, the resistant stages of each being nature's gift to those who desire to use these organisms as control agents in the field. In the case of the protozoa, it is precisely because they form spores that certain members of the class

Sporozoa offer the greatest hope of being adaptable to microbial control methods. But to realize these potentialities we must know a great deal more about the resistant stages, their properties, their limitations, and how to produce them.

EFFECTS OF DISEASE ON INSECT POPULATIONS

A greater understanding of the effects of disease on insect populations will almost certainly increase our ability to exploit microorganisms for use in microbial control. Most of our knowledge of the epizootiology of disease among insects has been gained incidental to other studies, or has been inferred by our understanding of the epidemiology of disease among humans.

The subject is much too profound and involved to attempt a detailed discussion of it here. I wish only to emphasize that epizootics among insects are vibrant, dynamic manifestations of powerful and awesome forces. We must increase our understanding of these forces through concentrated studies of the phenomenon as a whole, and of the infectious agent, the insect host, and the environment, each in its own particulars. The problem is basically an ecological one and, therefore, might best be attacked by means of an ecological approach.

In the same manner, we must gain a better understanding of what takes place in a population of insects when pathogens are applied for control purposes. What happens to the pathogen itself, and what is the range of its activities? What are the effects on the host, and how does the host react? What is the role of the environment in the entire process? How do these artificially induced epizootics differ from those that occur naturally? What are the general effects of varying dosages, methods of application, preparation of the pathogen prior to application, etc.? In our laboratory, Drs. Y. Tanada, I. M. Hall and others are engaged in important investigations along these lines, seeking answers to some of these questions. They are concerned not only with the general problems of epizootiology, but with the respective roles of pathogen, host, and environment in natural as well as artificially induced epizootics. Such studies include the careful examination of such subtle phenomena as synergism between two viruses occurring in the same host and the comparative value of different pathogens in controlling relatively inaccessible insects. I am

confident that the applications of insect pathology will never be fully realized until we have a deeper understanding of the effects of disease on insect populations, and of the mode of action and dynamics of disease in such populations.

IMMUNITY AND RESISTANCE IN INSECTS

In spite of some apparently convincing work on the manifestations of humoral and cellular immunity in insects, our knowledge of this general subject is grossly inadequate. Indeed, recent evidence observed in our laboratory and elsewhere strongly suggests that much of what has previously been believed concerning immunity in insects is in error, or must be radically revised. Moreover, it begins to appear that the principles of humoral immunity in insects, and perhaps other invertebrates, are considerably different from those operating in higher animals.

At the moment the situation is very confused and fluid, and greatly in need of a stabilizing core of critical research designed to elucidate the basic nature of the resistance demonstrated by certain insects against certain pathogens, and the nature of humoral immunity as it operates in insects.

In this connection, there is a need for the development of serological and immunological techniques and testing procedures designed for the specific study of insect immunity. It is not unlikely that insect immunology and serology has suffered from the too direct application of techniques used in vertebrate studies, and from the all too ready assumption that the same kinds of immunological phenomena operating in the case of vertebrates operates in the case of invertebrates. In any event, here lies a fascinating field of research awaiting the attention of capable investigators.

THE ROLE OF STRESS AND PREDISPOSING FACTORS IN INSECT DISEASE

For the past several years I have been concerned with the phenomenon of stress in insect disease. I am frank to say that during this time the relationship between stress and the occurrence of disease in insects has been found to be a much more profound, occult, and mysterious phenomenon than had been originally anticipated. That the occurrence and course of diseases in insects were frequently affected by predisposing causes has been

known for a long time. Unfortunately, however, very little has been accomplished in clarifying the exact mechanisms involved and the true cause-and-effect relationships.

Our efforts have been concerned with attempting to understand the relation between various diseases in insects and certain stressors (e.g., crowding, heat, cold, chemicals, nutrition, etc.). Progress has been disappointingly slow and laborious, but what we have so far learned enables us to say with conviction that here, too, is a field standing in need of intense and penetrating research.

One aspect of this work has been the phenomenon of latency in insect virus diseases. The implications of work now going on in this field in several laboratories is difficult to assess. Certainly, however, one can predict that when the role of stress in insect disease is understood, our understanding of disease processes in insects will be much better understood, and the applications in microbial control will be many. If only we can better understand what is involved in triggering an epizootic or in making a population more susceptible to infectious agents, latent or active, the efforts put into the laborious and frequently frustrating research will be more than rewarded.

While it is difficult to discern accurately at just which points insect pathology will have its greatest future development, I feel confident that at least some of the areas of research I have mentioned will figure prominently in this development. It is characteristic of the various branches of science to forge ahead and accelerate spasmodically or by spurts. It is my feeling that the next such rapid advance in insect pathology and microbial control will follow the realization of gains made in basic research along the lines I have indicated. If this should be so, these areas of research deserve the concentrated attention of insect pathologists, as well as the interest and support of entomologists and biologists generally.

It is, of course, appropriate on this occasion to consider the possible future developments in insect pathology and microbial control in the general Pacific area. The applicability of biological control generally in insular areas is well known, especially as it concerns parasites and predators. There is no reason to doubt that similar results may be attained through the use of insect

pathogens. The advantages of microbial control methods (e.g., relative inexpensiveness, absence of toxic residues, compatibility with other types of control, etc.) are as attractive in Pacific areas as elsewhere.

As with parasites and predators, the islands of the Pacific offer excellent opportunities for well-controlled experiments in microbial control. The geographic isolation of the islands permits the conduct of experiments which may be considerably more difficult on large land areas. A study of epizootiological effects of introducing pathogens into uninfected insular populations would appear to be particularly attractive.

Especially I should like to point out the need for more survey work with regard to insect diseases throughout the entire Pacific area. We are now beginning to obtain a fairly good idea of the nature and kinds of insect pathogens affecting insects in Europe and North America. Surely the Pacific area with its variety of environmental and ecological conditions must abound in numbers and kinds of microorganisms that affect insects. There are indications that there is a rich flora of entomogenous fungi in the tropical zones of the Pacific area. However, detailed study of these, as well as entomophilic viruses, bacteria, protozoa, and nematodes is meager. Therefore, we must somehow provide the means of support—and inspiration—to entomologists and others throughout the Pacific to undertake a comprehensive survey of this part of the world to discover and isolate insect pathogens of all kinds. This, of course, must be followed by thorough scientific studies of the diseases in the insects concerned, their epizootiology, and their potentialities as microbial control agents.

While our own facilities at the University of California are sorely strained and overtaxed, we are in a position to provide some help toward these objectives. In the first place, we are able to give qualified students complete graduate academic training in insect pathology. The University offers a curriculum in this field leading to both a Master of Science degree and a Doctor of Philosophy degree. Secondly, our Laboratory provides, without charge, to any individual or institution anywhere in the world, a diagnostic service for dead or diseased insects. We are in a position to attempt the diagnosis of any type of infectious disease of any insect or arachnid. Accordingly, we shall be especially

pleased to receive from entomologists and others in the Pacific area any specimens of dead or diseased insects they may wish to submit to us for diagnosis. Instructions for submitting specimens may be obtained by communicating with our Laboratory.

To be sure, such survey work is only the first step toward a realization of the potentialities of insect pathology and microbial control in this part of the world. There must be a well-rounded, adequately supported program of basic and applied research, conducted by adequately trained personnel. On the basis of what has already been accomplished in other parts of the world, there is good reason to believe that such a program would be rewarding not only to Pacific agriculture, but to medicine and general biology as well.

BOOK NOTICE

A Synopsis of the Tabanidae (Diptera) of Michigan by Kirby L. Hays. Miscellaneous Publications, Museum of Zoology, University of Michigan, No. 98. December 21, 1956. 79 pp., 3 plates \$1.15.

This very fine contribution deals with 102 species and subspecies, 27 of which are reported from the State for the first time. There is a discussion of bionomics, ecology and zoogeography in addition to keys to the genera and females of the various genera. Each species is briefly described and Michigan records noted. The three plates of the wings of *Chrysops* are excellent.—C. H. Curran.

THE NEOTROPICAL SPECIES OF THE ANT GENUS
STRUMIGENYS FR. SMITH: GROUP OF
MARGINIVENTRIS SANTSCHI

BY WILLIAM L. BROWN, JR.

MUSEUM OF COMPARATIVE ZOOLOGY, HARVARD UNIVERSITY

The present paper is a continuation of my series on the New World fauna of the dacetine ant genus *Strumigenys* Fr. Smith. Earlier parts, containing keys to the abbreviations for measurements and proportions, may be found in Jour. New York Ent. Soc. 61: 53-59, 101-110 (1953). Other parts have been published in the same journal, or are in press.

The present section deals with two species, *S. marginiventris* Santschi and *S. longispinosa* new species. The first of these has been considered as a subspecies of *S. fusca* Emery by Santschi, but actually, *marginiventris* is not close to *fusca* at all. *S. longispinosa* shares with *S. marginiventris* the general head form of the *cordovens* group and the single preapical tooth.

It is supposed that *S. marginiventris* and *S. longispinosa* are related to each other and to the *cordovens* group, but, like all other assumed relationships among the New World *Strumigenys*, this one would bear much further thought and examination. The two species are similar in general size and habitus, and both are so far known from the Panama-Colombia area, where they have been collected on few occasions. Nothing direct is known of their biology, except that they are rain forest inhabitants.

***Strumigenys longispinosa* new species**

(Figs. 1, 2)

HOLOTYPE WORKER: TL 3.5, HL 0.80, ML 0.72, WL 0.81 mm.; CI 74, MI 90. (One paratype worker: TL 3.4, HL 0.78, ML 0.71, WL 0.80 mm.; CI 72, MI 91.) Head much like that of *marginiventris* and the majority of neotropical *Strumigenys* in general shape, deeply and semicircularly excised behind, slightly dorsoventrally depressed, the dorsum very weakly convex. Antennal scrobe narrow, shallow and ill-defined, bounded by a weak carina above, posteriorly not quite extending as far as the point of greatest lateral expansion of the occipital lobe. Scrobe split anteriorly by a sharp longitudinal carina which extends posteriorly to the eye. Eye fairly large and convex, with 7-8 ommatidia in the greatest diameter (not quite so large as the eye of *marginiventris*); side of head immediately in front of eye mod-

erately but distinctly concavely excavated, so that eye appears more protuberant and slightly prosopient. Clypeal disc weakly concave, anterior border broadly and feebly rounded. Labral lobes short and truncate apically, the pair of trigger hairs arising from them fine, divergent, half or a little more as long as the mandibles.

Mandibles very long and slender, shafts nearly straight; external borders very weakly convex, drawn in rather sharply at the insertions and, near the apices, curving very evenly into the apical fork. Inner border practically straight, so that the inner and outer borders of the shaft are parallel or very nearly so from the basal constriction to the preapical tooth, distal to which the shaft narrows a little more strongly until the fork. Armature of each mandible consisting of an apical fork of two very long, slender spiniform teeth (the ventral tooth slightly longer) bent inward at approximately a right angle; no intercalary teeth or denticles; and a single straight, acute preapical tooth, about half as long as the dorsal apical tooth, situated precisely at the first apical quarter of the mandibular length. No other teeth or denticles on the mandibles with the exception of the hidden basal process.

Antennal scape (L 0.70 mm.) longer than the distance from its insertion to the posterior border of the occipital lobe on the same side, very nearly straight and quite slender, almost imperceptibly thickened at about the basal quarter. Funiculus (L 0.83 mm.) very slender; apical segment (V) about as long as or very slightly shorter than I-IV taken together; basal segment (I) shorter than IV, but longer than II plus III; II and III slender, subequal.

Alitrunk slender; promesonotum in lateral-view profile with a horizontal, only weakly convex outline; posterior mesonotum gently concave; dorsum of propodeum extremely weakly convex. Pronotum as seen from above with a distinct, arched anterior border, subangulate humeri, each with a low piligerous tubercle, and straight, submarginate, posteriorly convergent dorsolateral borders, below which the sides of the pronotum bulge behind the humeri, so that the anterior half of the alitrunk seen from above forms a circular outline. Both promesonotal and metanotal sutures obliterated, the latter marked by a weak constriction when the alitrunk is seen from above. Propodeal teeth spiniform, exceptionally long, slender, straight and acute, divergent and directed dorsad from the plane of the propodeal dorsum at an angle of about 30° or slightly more; much longer than the distance between the centers of their bases, longer than the propodeal declivity beneath them, and about as long as the postpetiolar disc is wide. Each tooth subtended beneath by a cariniform vestige of infradental lamella bordering each side of the steep, concave propodeal declivity.

Petiole subclaviform, peduncle long and slender, nearly as long as the long, low node, and only weakly set off from it. Node seen from above oval, $2/3$ as broad as long and about $5/6$ as broad as the small postpetiolar disc. Petiolar spongiform tissues reduced to a thin, loose band along the upper half of the posterior nodal margin, and a small, narrow ventral strip beneath the node. Postpetiolar disc nearly twice as broad as long, with

rounded, sharply marginate sides, its surface convex, smooth and shining; laterally and ventrally with voluminous spongiform appendages.

Mandibles, clypeus, antennal scapes and legs very finely and densely punctulate-granulose. Head, alitrunk and petiole finely and densely punctulate, with superimposed fine, mostly indistinct longitudinal rugulae; lower pleura of alitrunk with sculpture more or less effaced. Basal gastric costulae 15-17, strong and distinctly separated, extending about $\frac{1}{4}$ the length of the basigastric segment. Remainder of gaster smooth and shining. Mesonotum with a fine median longitudinal carina.

Ground pilosity of head consisting of fairly abundant, slender, weakly clavate, arched, reclinate or decumbent hairs, longest toward the occiput. Anterior clypeal border with 12 spatulate hairs, curved mesad, the central pair longest. Scapes each with 10 curved, very weakly clavate hairs, decumbent in an apical direction along the anterior border; other decumbent slender hairs directed apicad on other surfaces. Six longer erect hairs on the posterior cephalic dorsum are little if at all apically enlarged, arranged in a row of four across the vertex posterior to the eyes, and a pair just in front of the occipital excision. Ground pilosity of alitrunk like that of head, but sparser; 4 long, straggling flagellate hairs, one on each humeral tubercle, and one on each posterolateral margin of the pronotum, straddling the mesonotum. Nodes of peduncle and dorsum of gaster with moderately abundant, well-spaced, long, straggling, erect and recurved flagellate hairs. General color light ferruginous, gaster very slightly darker, more tan.

Holotype worker (N. A. Weber Collection) taken by Dr. Weber on Barro Colorado Island, Panama Canal Zone (Weber Cat. No. 1139). The paratype included in the measurements above (MCZ) was taken with the holotype. Three additional paratypes (Weber Collection, USNM, MCZ) were seen belatedly. One of these was taken with the holotype, and the second is also from Barro Colorado (E. C. Williams, Jr. leg., No. 65-2); a third, found among MCZ unidentified miscellany, was taken at Quipo, Panama (J. Zetek leg.).

S. longispinosa resembles *S. marginiventris* in its slender form and long mandibles with a single slender preapical tooth on each, but *longispinosa* lacks the marginate gaster and the dorsigastric striolation of *marginiventris*. There are many other differences in proportions and minor characters. From the *cordovens* group of *Strumigenys*, which also boasts very long, slender mandibles, *longispinosa* can be distinguished at a glance by means of its single preapical tooth and its long, slender propodeal spines.

Weber (1952, Amer. Mus. Novitates, 1554: 3) gives the ecological data for the type collection on Barro Colorado; the ants

nested in the soil of the rain forest, below the soil cover, and the nest was surmounted by a small crater.

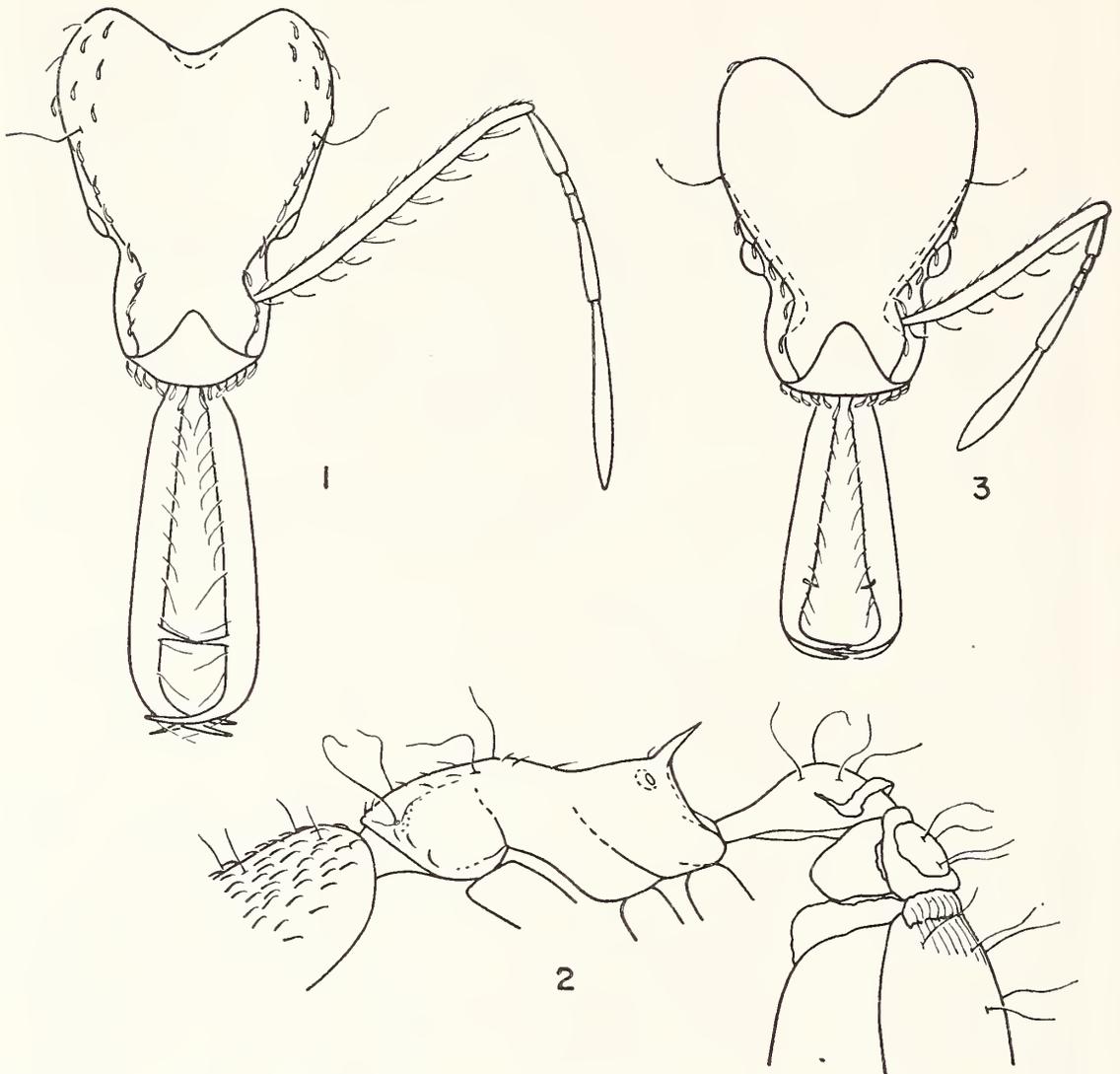


FIG. 1. *Strumigenys longispinosa* new species, paratype worker from Barro Colorado Island, Panama, head and mandibles from dorsal view. FIG. 2. Same, alitrunk and nodes in side view. FIG. 3. *S. marginiventris* Santschi, worker from Barro Colorado Island, head and mandibles from dorsal view. In Figs. 1 and 3, only the prominent pilosity near the borders of the outlines is shown. All drawn to the same scale. Drawings by Nancy Buffler.

***Strumigenys marginiventris* Santschi new status**
(Fig. 3)

Strumigenys (*Strumigenys*) *fusca* st. *marginiventris* Santschi, 1931, Rev. Ent., Rio de Janeiro, 1: 275, worker. Type loc.: France Field, Panama. Type in Basel Naturhistorisches Museum, not seen.

WORKER: TL 2.9-3.2, HL 0.68-0.73, HW 0.54-0.59 (CI 78-82), ML 0.51-0.57 (MI 75-79), WL 0.68-0.72 mm. Form of head and mandibles shown

in Fig. 3. Apical fork without intercalary denticles or teeth; the single preapical tooth weak and arising from the dorsal surface of the blade, not from the inner margin proper. Alitrunk much like that of *S. longispinosa* (Fig. 2), but the propodeal teeth are not quite so long, and they are involved in a broad infradental lamella which becomes convex below. Petiole similar to that of *longispinosa*, but the node a trifle higher and a bit more distinctly set off from its peduncle. Postpetiolar node longitudinally striolate, sericeous-opaque.

Conformation of gaster unique in this genus. Tergum of basal segment depressed, only gently convex discad, on each side drawn out into a strong, upturned dorsolateral margin that runs back to or nearly to the posterior border of the segment. This margin is distinct from, and situated well above the true lateral tergal border. Since the basal segment takes up nearly its entire length, the gaster thus acquires a rather peculiar plate-like dorsal aspect. The dorsal surface of the gaster is very finely and densely punctulate-striolate anteriorly, and is here sericeous-opaque, while in the posterior half, the punctulae are dense, but the striolation is suppressed, and the surface is feebly shining. The basigastric costulae are distinct also, and extend about $\frac{1}{4}$ the length of the basal segment. The gastric dorsum also bears numerous (36-40 or more) but not crowded fine, erect flagellate hairs, the longest averaging about 0.22 mm. long, or more than half the greatest depth of the gaster. Petiolar node with 2 pairs, postpetiolar node with 4 pairs of decumbent flagellate hairs, and two pairs of flagellar hairs on the alitrunk placed as in *longispinosa*. The stiffly erect, slender, clavate head hairs are limited to a single pair on the middle occiput; pilosity otherwise mostly similar to that of *longispinosa*; though the shorter scapes naturally bear fewer hairs.

Head and alitrunk densely punctulate-granulose, overlain by weak, fine, predominantly longitudinal rugulation. Legs and most of mandibles punctulate-granulose, mostly opaque, with a light decumbent pilosity. Color ferruginous yellow.

FEMALE (dealate): TL 3.4-3.6, HL 0.73-0.78, HW 0.60-0.65 (CI 83-84), ML 0.57-0.59 (MI 76-78), WL 0.80-0.83 mm. The female shows the caste differences usual for the genus. The longitudinal rugules over the mesonotum are distinct, and some long, fine hairs arise here, too. The sculpture of the gastric dorsum is more distinct than in the worker, and leans more toward longitudinal striolation. The erect flagellate hairs appreciably more numerous, perhaps 50-70 or more in number.

MALE: Unknown.

I have studied material of *S. marginiventris* from the Panama Canal Zone: Barro Colorado Island (K. W. Cooper leg., 1 worker; J. Zetek leg., female and several workers). Frijoles (E. J. Brundage leg., 1 worker). Colombia: Sevilla, Magdalena (G. Salt leg., 2 females and 9 workers, "small colony in soil near or

among harvester ants of N. 349.''). The Sevilla series averages slightly smaller than the Canal Zone samples in both castes.

Although Santschi placed *marginiventris* as a race of *S. fusca* Emery, these two forms are not closely related. I have seen the type of *S. fusca* recently, and this is a member of the *S. louisianae* group close to, and possibly conspecific with, *S. unidentata* Mayr. There should be no difficulty in distinguishing *S. marginiventris* from all other species of the genus, since no others are known with the laterally marginate gaster.

NOTES ON WESTERN ANTS
(HYMENOPTERA: FORMICIDAE)

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Recently found among my alcoholic collections were three nest series of *Myrmecocystus pyramicus* M. R. Smith which had been taken from an extensive sand dune area, near Hammett, Idaho, on April 10, 1932 and from a sand hill, near Twin Falls, Idaho, on October 4, 1932. The series include both males and females. At each station there were colonies of *M. mojave* Wheeler which also contained the winged castes.

My workers of *pyramicus* compare very favorably with paratypes of this species, which was described by Smith (1951, p. 91) from a sand area in Washoe County, Nevada, and also with Dr. Smith's description.

I have noted what I consider to represent the following distinctive differences between the sexes of *pyramicus* and *mojave*. In the male of *mojave* erect body hairs are abundant and comparatively short, thus giving a rather brush-like appearance to the surface; on the thorax they are longest on the scutellum. They cover all surfaces of the antennal scapes and the legs. On the gula they are sparse. In the male of *pyramicus* the body is very sparsely pilose. The hairs are long and those on the gula are both longer and more numerous than those on the gula of *mojave*. Hairs are absent from the scapes and from the legs except for the flexor surfaces. In the *mojave* male the petiolar scale is, in profile, rather low, very thick at the base, and moderately attenuated toward the apex. It is much thicker basally and also notably shorter than that of the *pyramicus* male. Viewed from the front, its apex is entire, directed upward mesally, and narrow. In *pyramicus* the petiolar scale, when viewed in profile, is comparatively high, much narrower apically than basally, and has a rather sharp superior border. In frontal view, the apex is wide, emarginate, and not directed upward mesally.

In the female of *mojave* the body pilosity is abundant. Hairs on the thorax are short. They are numerous on all surfaces of

the scapes and the legs. In the female of *pyramicus* body pilosity is sparse. Thoracic hairs are long. Hairs are absent from the scapes and on the legs they are confined to the flexor surfaces. The female of *mojave* is apparently a larger ant than that of *pyramicus*, if my series are any criterion for establishing such a distinction.

It is my opinion that the males and females of *pyramicus* possess characteristics which can be used not only to separate them from the comparable castes of *mojave* but also from the sexes of other known species in the genus.

My notes on the Idaho collections show that the workers of both species were foraging actively at 10 a.m. and 2 p.m. It would appear, then, that these species do not have nocturnal habits. All nests were marked by small, circular, sand craters.

In the region of Lacuna Dam, north of Yuma, Arizona, I have observed many adjoining nests of *Dorymyrmex pyramicus* (Roger) and the red and black form which is considered by Creighton (1950, p. 249) to be the subspecies *bicolor* Wheeler. Studies of my collections from the station mentioned, as well as some from Southern California, show distinctive and non-intergrading color differences. I believe the coloration of *bicolor* to be a stable genetic character which designates the population wherever it may be found. Therefore, I propose that *bicolor* be given full specific status.

At Laredo, Texas, from a nest marked only by a small entrance in sandy-gravelly desert, I collected a series of *Pheidole* which I was unable to place to species. Dr. Creighton, who kindly examined a sample, determined it as *macclendoni* Wheeler. My series consists of majors, minors, and intermediates. The majors fit well the original description (Wheeler, 1908, p. 450) of this caste of *macclendoni*, but they are quite unlike the figure (*op. cit.*, Pl. 27, fig. 36). My majors have both the pronotum and the postpetiole much more strongly transverse. Wheeler's figure appears to be one of a larger intermediate rather than that of a major. When Dr. Creighton examined, during the preparation of his 1950 monograph, the type series of *macclendoni* at both the Museum of Comparative Zoology and the American Museum of Natural History it seemed to consist of majors and minors together with a few specimens which could be considered as inter-

mediates. Thus *macclendoni* appeared to be only very weakly polymorphic. Dr. Creighton, therefore, used the largest specimens (considering them as majors) as a basis for his key characteristics. Inasmuch as the true major caste is now known objectively and is notably different from the intermediate, it is evident that Dr. Creighton inadvertently incorporated characteristics of the intermediate rather than those of the major into his key. The pronotum of the major bears transverse striae. Hence one's progress is stopped at couplet 45 of the key (Creighton, 1950, p. 166).

It appears likely that the majors of *macclendoni* were misplaced after Wheeler had described them but before the ant had been figured. One of the largest intermediates in the remainder of the type series was undoubtedly used for the illustration inasmuch as the agreement is accurate. Thus Wheeler described the major but figured an intermediate. The majors which were recently collected at the type locality of this strongly polymorphic species have resolved the confusion which has been associated with *macclendoni*.

The following records, which are essentially reports of range extensions, may be of interest.

Leptothorax tricarinatus Emery—Jacob's Lake, Arizona.

Pheidole dentata Mayr—Ft. Davis, Texas.

Ph. artemisia Cole—Portal, Arizona.

Ph. creightoni Gregg—Weed, California.

Literature Cited

- CREIGHTON, W. S. 1950. The ants of North America. Bull. Mus. Comp. Zool. 104: 1-585. 57 pls.
- SMITH, M. R. 1951. Two new ants from western Nevada (Hymenoptera: Formicidae). Great Basin Nat. XI: 91-96. 3 figs.
- WHEELER, W. M. 1908. The ants of Texas, New Mexico and Arizona. Bull. Amer. Mus. Nat. Hist. XXIV: 399-485. 2 pls.

BOOK NOTICE

A Study of African Chironomidae, Parts I and II, by Paul Freeman. Bulletin of the British Museum (Natural History): Entomology, Vol. 4, Nos. 1 and 7. 1955-56.

Part I deals with the subfamilies *Podominae*, *Tanypodinae*, *Diamesinae* and *Clunioninae*. Following the introduction, historical survey, etc., are keys to the genera, subgenera and species, except that no species of *Podominae* are known from south of the Sahara Desert, the region covered in the treatise. All species in the collections available to the author are redescribed or described for the first time.

Part II treats the subfamilies *Orthocladinae* and *Corynoneurinae*, thus leaving the large subfamily *Chironominae* for future study. The two parts comprise 148 pages, 32 textfigures, most of which contain figures, and one excellent plate. This is an extremely fine piece of work and should greatly stimulate the study of the Chiromids of Africa.—C. H. Curran

THE NEOTROPICAL SPECIES OF THE ANT GENUS
STRUMIGENYS FR. SMITH: GROUP OF
OGLOBLINI SANTSCHI

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The present paper is a continuation of my series on the New World fauna of the dacetine ant genus *Strumigenys* Fr. Smith. Earlier parts, containing keys to the abbreviations for measurements, proportions and institutions of deposition of the types, may be found in Jour. New York Ent. Soc. 61: 53-59, 101-110 (1953). Other parts have been published in later issues of the same journal, or are in press.

The present section deals with two related species, *S. ogloblini* Santschi and *S. perparva* new species. Both of these species have rather short mandibles for *Strumigenys* species of the New World, both have single preapical teeth, and both tend to have developed a lamelliform border on each side of the head along the upper margins of the scrobes.

The relationships of these species may be with the groups of *louisianae* Roger and *silvestrii* Emery, but this remains to be tested by further examination of all the New World species of the genus. *S. perparva* is one of the real dwarfs of the genus, and it may have been confused with *S. silvestrii* Emery or *S. schmalzi* Emery in the past.

***Strumigenys perparva* new species**

(Fig. 1a)

HOLOTYPE WORKER: TL 1.6, HL 0.40, ML 0.20, WL 0.40 mm.; CI 81, MI 50. This minute ant is one of the very smallest *Strumigenys*, being smaller even than *S. schmalzi* Emery. An outstanding character is the short, very feebly bowed mandibles, each with a slender, prominent preapical tooth situated remote from the apex, near the apical third of the exposed length of the shaft. In general pattern, this mandible resembles that of the larger species *S. ogloblini*. There is no extra preapical tooth or denticle on the inner border of the mandible. Unlike *ogloblini*, *perparva* lacks an intercalary denticle in the apical fork (seen at 144×).

Head convex dorsally over posterior half, the surface feebly concave just

behind clypeus. Preocular laminae feebly converging and weakly convex in outline as seen from above, the distance across them at the level of the antennal insertions about 0.20 mm. Dorsolateral margins of head (dorsal scrobe borders) with a feeble lamellate border on each side, much weaker than the corresponding borders in *ogloblini*. Clypeus broadly triangular, nearly plane, anterior border weakly concave in the middle. Eyes very small, flat, situated on dorsal side of well defined ventral scrobe borders. Antennal scape (L 0.22 mm.) much narrowed at base, slightly bent at basal quarter, gently incrassate from bend to beyond midlength. Funiculus slender, L 0.33 mm.; apical segment approximately twice as long as I-IV taken together, slender, tapered to an acute apex; segment I longer than IV or II plus III, rather thick; II and III very short, transverse, forming a basally narrowed stalk socketted on the much broader I; IV about as broad as long. Head beneath with curving transverse postoral sulcus.

Alitrunk compact; pronotum broadly rounded anteriorly, with very feebly indicated humeral angles, and a fine median carinula continuing back across mesonotum. In profile, dorsal outline of alitrunk forms one gentle even convexity, strongest in pronotal region; metanotal groove straight, faint, not markedly interrupting lateral-view profile. Propodeal teeth small but acute, parallel, not half as long as the distance between centers of bases, elevated, subtended by narrow, concave infradental lamellae which broaden at ventral extremes to form low rounded angles.

Petiole with a small node, which is shorter over its free portion than is the slender peduncle; node tilted posteriad and obliquely depressed from an anterodorsal direction, its appendages reduced to cariniform vestiges. Postpetiole transverse, considerably broader than petiole, but still moderate in size, strongly convex, spongiform masses well developed ventrally and posterolaterally. Gaster broad-oval, dorsal surface only gently convex, with distinct, parallel basal costulae extending $\frac{1}{4}$ or a little more the length of the basal segment.

Remainder of gaster smooth and shining, as are also posterior sides of alitrunk and propodeal declivity. Head and alitrunk densely but rather coarsely punctulate, legs, scapes and petiolar node more finely punctulate, opaque; mandibles and funiculi subopaque. Postpetiolar disc apparently smooth and shining, but in this specimen fouled with foreign matter.

Ground pilosity of head consisting of some rather broad but inconspicuous, short, reclinate cochlear hairs, much fewer and even more inconspicuous on alitrunk. Anterodorsal scape borders each with about 5 short, reclinate cochlear hairs, directed posteriorly (some missing in holotype). Posterior occiput with a pair of short, erect spatulate hairs (the female has a second similar pair on the vertex, which may have been rubbed off the worker). Lateral border of each occipital lobe with a short, crooked subflagellate hair. Humeral and lateral mesonotal pairs flagellate, looped back in this specimen. Anterior border of scape with 4 conspicuous, slender spatulate hairs, nos. 1 and 4 directed apicad, 2 and 3 basad. Nodes with a few fine reclinate hairs; postpetiole and gaster with a few posteromedially slanting weak flagellate hairs, the tips looped back in the type nest series. Underside of head and surfaces of legs with fine, short appressed and decumbent pilosity; a few

fine erect hairs on apex and under surface of gaster. Color slightly sordid yellow.

The holotype (N. A. Weber Collection) came from Pitch Lake, Trinidad, British West Indies, June 22, 1935 (N. A. Weber leg., Cat. No. 206). A paratype worker and a dealate female with the same data as for the holotype are in MCZ and Weber Collection.

FEMALE, dealate: TL 1.7, HL 0.40, ML 0.20, WL 0.42 mm.; CI 86, MI 51. Differs from worker in the usual ways. Petiolar node even more depressed, and wider. Mesonotum evenly and densely punctulate, with carina or rugulae; with a few short, fine erect hairs. Eyes very small for a female *Strumigenys*, only weakly convex.

Additional paratypes are a dealate female from Belém do Pará, Brazil (C. R. Gonçalves leg.) and workers from Agudos, S. Paulo, Brazil (C. Gilbert leg.); Kempf Collection, No. 1376; very similar to holotype, differing slightly in size, proportions and depth of color. *S. perparva* is closest to *ogloblini*, but is much smaller and differs in minor structural characters as well.

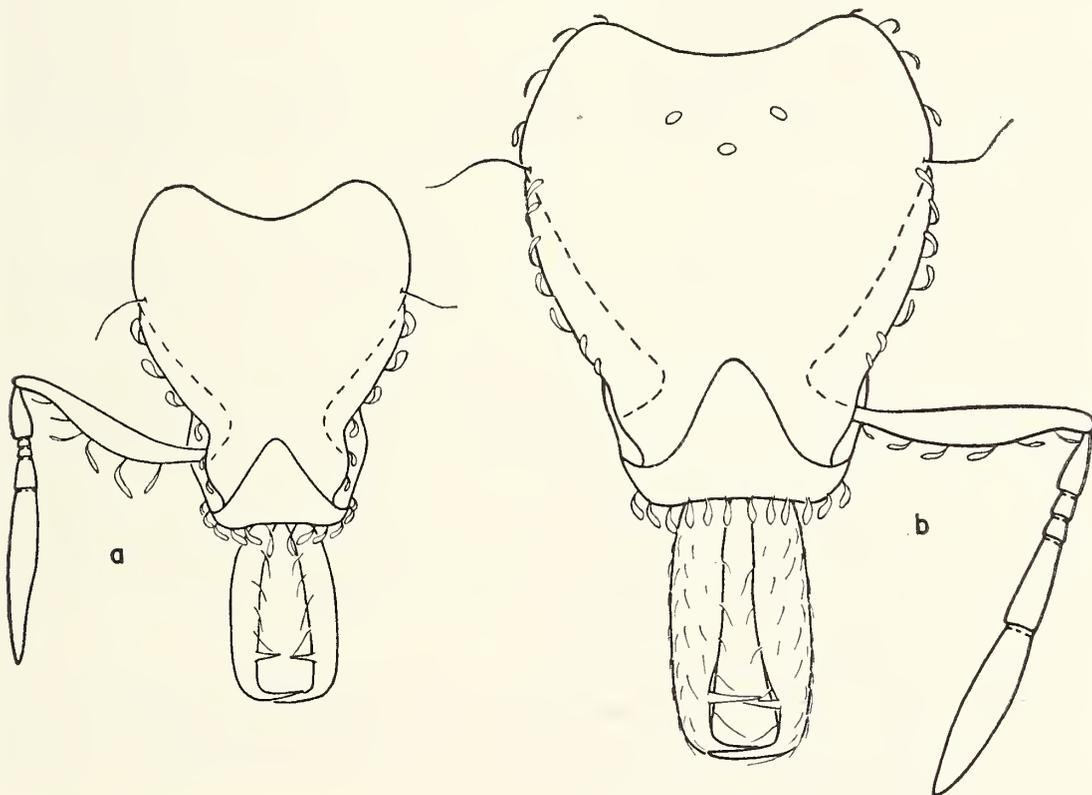


FIG. 1. *Strumigenys* spp., dorsal view of head, showing fringing pilosity only; drawn to same scale. a, *S. perparva* new species, worker from type nest series, Pitch Lake, Trinidad. b, *S. ogloblini* Santschi, female from Tucumán, Argentina. Drawings by Nancy Buffler.

Strumigenys ogloblini Santschi
(Fig. 1b)

Strumigenys (*s. str.*) *ogloblini* Santschi, 1936, Rev. Ent., Rio de Janeiro, 6: 409, figs. 15, 16, worker. Type loc.: Loreto, Misiones, Argentina, "nest in ground." Type in Basel Naturhistorisches Museum, not seen.

WORKER: TL about 2.3–2.5 (estimate), HL 0.55–0.56, HW 0.44–0.45 (CI 80–81), ML 0.28–0.29 (MI 51–52), WL about 0.55 mm. (estimate). Readily distinguished by the strongly convex cephalic dorsum, the broad translucent margins along each dorsal scrobe border, and the mandibular form and dentition. There is a single preapical tooth on each mandible (no other preapical or submedian teeth or denticles) at some distance from the apical fork (see Fig. 1b); two principal teeth of fork subequal in length; a single well developed and acute intercalary denticle between them.

Propodeal lamellae each in the form of a short, acute tooth above, below this concave, then broadly convex over the greater part of the length. Petiole with slender, dorsally bicarinate peduncle and small, anteroposteriorly compressed node, subtriangular and bluntly pointed above as seen from the side, but truncate anteriorly as seen from above. Node with broad posterodorsal spongiform collar extended down the sides as thick posterolateral flaps. Ventral spongy band well developed. Postpetiole transverse-elliptical, convex, its surface obscurely punctulate at the sides, becoming smooth and shining in the middle; surrounded by heavy spongiform borders and hung beneath with voluminous spongy masses. Gaster smooth and shining, with short but distinct basal costulae extending $1/5$ the length of the basal segment.

Ground pilosity of head and alitrunk consisting of short, curved, subreclinate spatulate or cochlear hairs over most surfaces and extending to scape margins (only marginal pilosity shown in Fig. 1b); some of the hairs in the center of the verticociput are longer and more nearly erect, curved anteriorly. Paired long flagelliform hairs—one hair on each lateral occipital border, one on each humerus, and one on each side at the base of the gastric dorsum. One or two pairs of posteriorly curved spatulate hairs on each node. Dorsal surface of gaster with 24–30 or more long, linear-spatulate hairs, curved posteromesad. Legs with short, fine, subreclinate, narrow-cochlear pilosity. Short fine pilosity on gula, underside of gaster and surfaces of mandibles. Color ferruginous.

FEMALE (One alate and one dealate): TL 2.6–2.7, HL 0.57–0.58, HW 0.46–0.48 (CI 81–83), ML 0.29 (MI 50–51), WL 0.61–0.62, forewing L 2.0 mm. Eye rather modest in size, about 0.10 mm. max. diameter. Mesepisterna smooth and shining for the most part.

MALE: I have males of several Argentinian *Strumigenys* and *Smithistruma* species, but have not yet been able to make secure association with the worker-female castes, so the *ogloblini* male cannot be described.

The above descriptions were taken from two workers and several females collected by Dr. N. Kusnezov at Tucumán, Argentina. They agree reasonably well with Santschi's description, although Santschi's figure of the head is evidently too narrow and incorrect in details of pilosity. Santschi's types were badly damaged, and lacked gasters and nodes, but the details of mandible form and dentition leave little doubt concerning the correctness of the present identification. Apparently this species is widely distributed in northern Argentina, and probably will be found also in southern Brazil. The total outstretched length of the workers, and also their alitrunk lengths (WL) are estimated because I neglected to take all the measurements at the time when I had workers available for study.

THE MCCAULEY EXPEDITION TO THE SAN JUAN REGION OF COLORADO IN 1877

BY F. MARTIN BROWN

Lieutenant Charles A. H. McCauley was dispatched from Fort Leavenworth, Kansas, in June 1877 to make a survey of the southwestern part of Colorado south of the San Juan Mountains between the Continental Divide and the Rio de los Animas. In accord with his instructions that "natural history collections made would be of interest" he collected extensively in all fields: botanical, zoological, geological and anthropological. His collections of invertebrates included a large number of butterflies and moths that were entrusted to Herman Strecker for determination and report. I have been able to learn of no Smithsonian field collector assigned to the expedition but am convinced that the above quoted phrase originated with Spencer F. Baird, secretary of the Smithsonian Institution. Since McCauley reserved the vertebrates to study and report upon himself, it seems highly probable that he doubled as officer-in-charge of the party and its naturalist.

He left Fort Leavenworth, Kansas, on 10 June 1877 and rendezvoused with his party at Fort Garland, Colorado, in the eastern edge of the San Luis Valley near the western approach to La Veta Pass. There he was joined by Lieutenant G. Valois and 22 men from the 22nd Cavalry Regiment. The party took to the field on 20 June, mounted, and accompanied by wagons. They returned to Fort Garland on 10 October having been in the field 123 days, established 96 different camps and travelled something over 2000 miles. I have not been able to discover a detailed account of the itinerary followed, nor a detailed map of it. The maps that accompany the published report of the expedition are rather general and summarize the routes of travel being used at that time throughout the region.

Because the types of one butterfly, *Boloria kriemhild* Strecker, and of eight moths described by Strecker were among the catch of the expedition I have felt it necessary to reconstruct an itinerary and thus amplify the published locality data for these insects.

The reconstruction is based upon data published in the McCauley report by Cyrus Thomas and Herman Strecker. I would like to note here that the report of the expedition has always been improperly cited in lepidopterological literature. It is invariably referred to as "Ruffner's Report." Lieutenant Ruffner was McCauley's superior and merely transmitted the report to the chief of Engineers. It took a year of occasional digging into government publications to discover this. The proper citation, a lengthy one, is given at the end of this paper which has been based upon McCauley's report and personal knowledge of the region he visited.

From Fort Garland the expedition struck across the San Luis Valley to its western side and then turned south, skirting the mountains, into New Mexico as far as Ojo Caliente. From there they turned southwest to the Rio Chama [7 July], up which they traveled to where the Rio Canjelson enters from the north. This stream was followed to the vicinity of the present town of the same name. Then the party struck north to Tierra Amarilla, following the Rio Chama and essentially over the route now traversed by U. S. Highway 285. They reached Tierra Amarilla, about 200 miles from Fort Garland, on 10 July. Although it was a good time of the year for it, little collecting was done on this leg of the journey. Apparently the party was hurrying to reach its primary area for exploration. A few miles from Tierra Amarilla they again picked up the Rio Chama and at the town of Chama took the west fork, Rito Chama, almost to its source. On [13 July] they crossed the divide to the upper Rio Navajo, a tributary of the Rio San Juan, and were on the Pacific slope. Once the San Juan country had been reached the survey and collecting began in earnest.

By 21 July, McCauley and his party were in Pagosa Springs and there established a base for operations. The distance from the Navajo to Pagosa Springs is about 30 miles, at most a day and a half of travel time. Thus the party may have reached Pagosa Springs as early as the 15th. The rest of the week involved was devoted to exploration of the Rio Blanco. Several days had been spent in setting up camp at Pagosa Springs during which time a good collection of Lepidoptera was made. The first real sally from Pagosa Springs was to the northwest.

The explorers penetrated the forested mountains as far as Weminuche Pass, just to the east of Rio Grande Pyramid, a towering peak that reaches 13,830 feet above sea level. By 31 July the party was back in Pagosa Springs and immediately struck out to the northeast. On 1 August they were camped on the upper Rio San Juan, probably in the meadows at the western foot of Wolf Creek Pass, now known as Bruce's Spruce Camp. They then turned southward to the headwaters of the Rio Navajo, crossing those of the Rio Blanco en route.

By 20 August, McCauley was again in Pagosa Springs. Now he traveled west and thoroughly covered the areas drained by the Rio Piedras, Los Piños and Florida from their headwaters at or above tree line to their confluence with the Rio de los Animas or the Rio San Juan. September 17th saw them in Camp 59 on the Rio de los Animas near its mouth, the most southwesterly point visited by the party. From there they turned eastward and toward Fort Garland. Little or no collecting was done then, the travelers were homeward bound and the season was late.

AN ANNOTATED ITINERARY OF THE EXPEDITION

I arranged in chronological order all of the dated localities that appear in the reports of Thomas and Strecker. When this was completed it became clear that some of the data as published were incorrect. Most of the errors were obvious and easily adjusted once the entire time-table was viewed. In the following table I have placed between quotation marks those data that I question for a particular date and proposed another date in *italics*. The page references that are given for each date refer to the McCauley report as cited in the bibliography.

DATE	LOCALITY	REMARKS
10.vi	Lv. Leavenworth, Kansas.	
13.vi	Arr. Fort Garland, Colo.	
20.vi	Lv. Ford Garland, Colo.	
4.vii	"waterfalls on San Juan, not far below Cp. 32"	This is from the note about <i>P. smintheus</i> , p. 1850. The date should be <i>4.viii</i> .
7.vii	Rio Chama, New Mexico	<i>N. persius</i> , p. 1858.
8.vii	"Rio Navajo Valley, upper part of river."	<i>D. plexippus</i> , p. 1853. The date should be <i>8.viii</i> .

DATE	LOCALITY	REMARKS
10.vii	Tierra Amarilla, New Mexico.	<i>Macroglossa senta</i> , n.sp., p. 1858.
13.vii	Rio Navajo, ca. 7800 feet. "Pagosa Springs"	<i>C. uhleri</i> , p. 1857; <i>Arctia F-pallida</i> , n. sp., p. 1860. <i>Eurymone excelsa</i> , n. sp., pp. 1863-4. The proper date is questionable, it may be 18.vii or possibly 15.viii.
14.vii	near headwaters of Rio Blanco	<i>Ps. hera</i> , p. 1860.
15.vii	Deer Creek, trib. of upper Rio Blanco. "South Fork of Rio Chama, near its headwaters."	<i>S. charon</i> , p. 1857; <i>Arc. cervinoides</i> , p. 1860. <i>E. epipsodea</i> , p. 1856. Date should read 5.vii.
16.vii	Rio Blanco.	<i>Ct. sanguinaria</i> , n. sp., p. 1858; <i>Sp. antigone</i> , n. sp., p. 1860.
17.vii	"near Rio de los Piños."	<i>P. daunus</i> , p. 1849, see 27.viii.
21.vii	Pagosa Springs.	<i>P. zelicaon</i> , p. 1849; <i>C. fragilis</i> , n. sp., p. 1859, et al.
22.vii	Pagosa Hot Springs.	p. 1846.
25.vii	Weminuche Pass, head of Rio de los Piños.	<i>Arg. atlantis</i> , p. 1854.
26.vii	Upper Weminuche Creek.	<i>B. myrina</i> , p. 1854.
27.vii	Weminuche Creek, head of Tule Valley.	p. 1846; <i>P. rutulus</i> , p. 1849; et al.
28.vii	Weminuche Creek to Rio Piedra; Near Rio Piedra; between Upper Rio Piedra and Rio Nutria.	<i>T. melinus</i> , p. 1852; <i>S. charon</i> , p. 1857; <i>Ps. hera</i> , p. 1860; <i>Ct. cressonana</i> , p. 1858.
31.vii	Pagosa Springs.	<i>E. tyndarus</i> , p. 1856. The species probably was collected on 25.vii on Weminuche Pass.
1.viii	Waterfalls of Rio San Juan.	<i>E. epipsodea</i> , p. 1856; <i>Ps. hera</i> , p. 1860.
2.viii	Headwaters of Rio San Juan.	<i>M. nycteis</i> , p. 1855; <i>N. plantageonis</i> and <i>geometrica</i> , p. 1859.
7.viii	Lower Rio Blanco near wagon-road.	p. 1846.
8.viii	Rio Navajo valley, upper river.	<i>N. iole</i> , p. 1851; <i>L. battoides</i> , p. 1852; <i>L. weidemeyeri</i> , p. 1856.

DATE	LOCALITY	REMARKS
10.viii	Rio Navajo at headwaters, near mouth of canyon.	<i>F. stalachtaria</i> , p. 1863.
11.viii	headwaters of Rio Navajo "Rio Florida"	<i>M. perlata</i> , p. 1863. <i>N. menapia</i> , p. 1850, see 11. <i>ix.</i>
13.viii	near headwaters of Rio Blanco.	<i>Ct. matthewsi</i> , p. 1858.
14.viii	Upper Rio Blanco.	p. 1846.
20.viii	Pagosa Springs.	p. 1846.
23.viii	Rio Piedra at bridge of upper crossing.	p. 1846; <i>E. epipsodea</i> , p. 1856.
25.viii	Camp on Rio Piedras at bridge of upper crossing.	p. 1846.
27.viii	Rio de los Piños, at mouth of Vallecito Creek. At the park.	p. 1846. <i>L. battoides</i> , p. 1852.
28.viii	Upper crossing of Rio de los Piños.	<i>T. titus</i> , p. 1852, <i>S. charon</i> , p. 1857.
29.viii	Valley of Vallecito Creek above its mouth.	p. 1846.
1.ix	upper part Vallecito Creek, below Camps 51 and 52	p. 1846.
2.ix	same as for 1.ix.	
3.ix	upper part of west fork of Vallecito Creek.	p. 1846.
4.ix	near Columbine Lake in Needles Mountains, 12,000 feet.	p. 1846.
11.ix	At upper crossing of Rio Florida, Camp 55.	p. 1846; <i>A. redimaculate</i> , p. 1860.
12.ix	Rio Florida, crossing of upper wagon-road.	p. 1846.
14.ix	Rio Florida "canon on upper part of Rio Blanco"	<i>L. ephestion (astyanax)</i> , p. 1856. p. 1846, see 14.viii.
15.ix	Lower Rio Florida, Camp 57. Above Indian Reservation.	p. 1846; <i>A. nokomis</i> , p. 1853; <i>et al.</i> <i>L. acmon</i> , p. 1852.
16.ix	Rio de las Animas, near mouth of Rio Florida.	p. 1846, Camp 58.
17.ix	Lower Rio de las Animas, near mouth, in New Mexico.	p. 1846.
18.ix	Rio de las Animas, near Camp 58.	p. 1846.
10.x	Fort Garland, Colorado.	

NOTES ABOUT CERTAIN BUTTERFLIES COLLECTED

“*Argynnis nokomis*,” p. 1853.

It was this butterfly that turned me to the study of McCauley's expedition. There is no doubt in my mind that Strecker was mistaken in his identification of it. His description and figures published in the McCauley report relate to *Speyeria cybele carpenteri* Edwards. McCauley's specimens, collected on 15 September, 1877, were taken in the valley of the Rio Florida somewhere between the present locations of U. S. Highway 160 and Colorado State Highway 284, about five miles west of Durango in La Plata County.

“*Argynnis*” [*Boloria*] *Kriemhild* p. 1854.

Strecker's description and figure acceptably apply to what we call *kriemhild* today. The trouble is two-fold. First, Strecker states that in addition to the McCauley material, “several specimens,” he had others from Arizona. No *kriemhild* have since come to light from the region nor from any place in the Rocky Mountains south of southwestern Wyoming. Second, the type locality is given as “Rio Florida.” McCauley was on the Rio Florida and actively collecting lepidoptera from the 11th to the 15th of September and possibly for a day around the 19th of that month. He collected downstream from where Colorado State Highway 160 crosses the river at about 8,000 feet elevation to the vicinity of the present hamlet Florida, at the northern boundary of the Ute Reservation, about 6,500 feet above sea level. These dates are very late in the year for *Boloria* at the elevations noted.

The situation needs considerable study. Possibly *kriemhild* is double brooded IF the material described by Strecker was collected by McCauley on the Rio Florida.

Erebia “*tyndarus*” [*callias*,] p. 1856.

Two captures are noted by Strecker: 27.vii at the head of Tule Valley on Weminuche Creek, and, 31.vii at Pagosa Springs. The latter is patently wrong. The species is an alpine insect and rarely found so low as tree line. Pagosa Springs is just over 7,000 feet elevation and is 5,000 feet below and many miles distant from tree line. However, on the 25th of July McCauley visited Weminuche Pass, 10,629 feet above sea level and he may have collected the specimens on the slopes of Rio Grande Pyramid

above tree line. I can see how the date number 25 in manuscript can be confused with 27. This does not explain the Pagosa Springs data. Around the 31st of August, McCauley was on upper Vallecito Creek. On the 4th of September he was at 12,000 feet at Columbine Lake and above it. It is possible that the specimen noted for 31 July Pagosa Springs really came from Columbine Pass region. Incidentally, the central peak of the eastern rim of Columbine Basin has been named McCauley Peak. It reaches 13,551 feet above sea level.

REFERENCES

MCCAULEY, C. A. H.—“Report on the San Juan Reconnaissance of 1877, by Lieutenant C. A. H. M'Cauley, Third Artillery, in charge.” In Index to the Executive Documents of the House of Representatives for the Third Session of the Forty-fifth Congress, 1878-'79. In 18 volumes. Volume V.—Report of the Chief of Engineers, Part III. pp. 1750-1867, Pl. I, II. Washington, D. C. 1879.

Those who wish to follow the routes traveled by the McCauley party can do so in a general way on any good highway map of Colorado. A map that gives a better idea of the terrain is Sectional Aeronautical Chart “Trinidad (S-4).” Those who need to know in detail the terrain cover will find these sheets published by the U.S.G.S. sufficiently accurate: 15' sheets of Colorado titled Ignacio, Creede, Pagosa Springs, San Cristobal, Summitville, and the 7½' sheet entitled Needle Mountains.

UNDESCRIBED SPECIES OF CRANE-FLIES FROM
THE HIMALAYA MOUNTAINS (TIPULIDAE,
DIPTERA), II*

BY CHARLES P. ALEXANDER

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The preceding part under this general title was published in the JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY, 64: 137-147, for 1956; published 1957. As was the case in the initial paper, the materials considered herewith were taken in Nepal by Dr. Edward I. Coher and Mr. Gobinda Prasad Joshi, to whom my sincere thanks are extended for these unusually interesting crane-flies. It is evident that the vicinity of the Simbhanjang Pass, in the Mahabharat Range, provides an unusually rich habitat for crane-flies and for many other groups of insects.

Tipula (Schummelia) notomelania new species

Size small (wing of male 9 mm.); mesonotum chiefly blackened, pleura transversely patterned with black and yellow; head with the vertex darkened; femora yellow, tips narrowly blackened; wings tinged with brown, restrictedly patterned with dark brown; m-cu at near midlength of M_{3+4} ; abdominal tergites bicolored, obscure brownish yellow, the incisure darkened; male hypopygium with the median area of the tergite produced into a flattened setiferous spatula; outer dististyle broad.

MALE. Length about 9 mm.; wing 9 mm.; antenna about 4.1 mm.

Frontal prolongation of head, including nasus, yellow, the sides dark brown; palpi brownish black. Antennae relatively long, as shown by the measurements; scape obscure yellow, pedicel light yellow, first flagellar segment brownish yellow, the remainder black; flagellar segments elongate, basal enlargements slightly developed; verticils shorter than the segments. Head above dark brown, sides of posterior vertex pruinose; front buffy, restrictedly patterned with brown spots; vertical tubercle compressed, darkened, the sides yellowed.

Pronotum testaceous above, blackened laterally. Mesonotal praesutum almost covered by a brownish black shield, the border broadly yellow; posterior sclerites of notum black, including the pleurotergite. Pleura blackened on anterior part, forming a transverse black line that includes the propleura, anepisternum and most of the sternopleurite, the mesepimeron abruptly whitened, especially the pteropleurite and meron, the metapleura again abruptly blackened; dorsopleural membrane light yellow. Halteres

* Contribution No. 1286 from the Department of Entomology, University of Massachusetts.

blackened, stem dusky, its base restrictedly yellowed. Legs with fore and middle coxae light yellow, posterior pair brownish black; trochanters yellow; femora yellow, the tips narrowly and abruptly black, the amount subequal on all legs; tibiae brown, tips very narrowly blackened; tarsi brownish to black; claws simple. Wings tinged with brown, restrictedly patterned with darker brown, including the large stigma, cell *Sc*, and seams along cord and vein *Cu*; less evident seams over the veins beyond cord; apical margin narrowly suffused, widest at end of vein *Cu*; restricted yellow areas at arculus and again at origin of *Rs*; veins brown, pale in the brightened and oblitative areas. Venation: *Sc*₂ ending just beyond origin of *Rs*, the latter very short, straight, about one-half *m-cu* or subequal to the basal section of *M*₁₊₂; cell *M*₁ deep, more than three times its petiole; *m-cu* near or before midlength of *M*₃₊₄.

Abdomen with basal tergite light brown, darker medially, second segment yellow at base, darkened outwardly; succeeding tergites obscure brownish yellow on central part, the incisures blackened; sternites light yellow; outer segments more uniformly blackened. Male hypopygium of unique type damaged but the essential parts preserved. Ninth tergite with the posterior border gently emarginate, fringed with yellow setae, the median region produced caudad into two greatly compressed blades that expand outwardly, on microscope slide appearing spatulate, the surface pale, densely covered with setae. Outer dististyle broadly flattened, the length only about twice the greatest width, outer margin convex, the inner more nearly straight. Inner dististyle broken at tip and its extent undetermined; beak short, obliquely truncated at apex; margin above the beak with a linear row of at least five pale areoles, each with a conical pale spine.

Holotype, ♂, Bhainse, Nepal, December 8, 1956 (Coher).

The present fly differs from other small regional species of the subgenus in coloration and in the structure of the male hypopygium. Such species include *Tipula* (*Schummelia*) *bicolorata* Alexander, *T. (S.) klossi* Edwards, *T. (S.) salakensis* Alexander, and *T. (S.) turea* Alexander, the first named being the most similar.

***Tipula* (*Tipulodina*) *subscimitar* new species**

Belongs to the *pedata* group; size small (wing of male 12.5 mm.); wings whitish hyaline, the dark pattern restricted, especially the area in cell *M*; microtrichia lacking in cells at and beyond the arculus; basal section of *R*₄₊₅ distinct, cell *2nd A* narrow; male hypopygium with the posterior margin of tergite broadly notched; outer arm of inner dististyle relatively long, straight, the blackened tip acute.

MALE. Length about 15 mm.; wing 12.5 mm.

Generally as in *Tipula* (*Tipulodina*) *scimitar* Alexander, of Burma, differing in the small size and structure of the male hypopygium.

Head broken. Fore legs with the pale femoral ring very broad and diffuse, about four times the darkened tip beyond it; white tibial ring

about one-half longer than the blackened tip; basitarsus blackened on more than the proximal third; hind femur with the tip broadly blackened, the basal white ring about one-half as extensive as the outer one, the latter more than twice the blackened tip; basitarsus with more than the proximal half blackened; claws simple. Wings whitish hyaline, the dark pattern restricted; darkened spot in cell *M* very reduced and pale, not extending half across the cell; dark seams on anterior and posterior cords conspicuous; dark area at wing tip solid, without pale centers, cell *Sc* dark. Microtrichia lacking in prearcular field and in bases of cells immediately beyond the arculus; in cell *M* the denuded area extends outward to beyond the darkened spot; in *scimitar*, microtrichia present in all cells beyond the arculus. Venation: *Rs* strongly arcuated; *R*₂ obliterated by the approximation of veins *R*₁ and *R*₂₊₃; basal section of *R*₄₊₅ distinct, transverse, nearly as long as *r-m*; vein *R*₃ relatively short, only a little more than twice *R*₁₊₂; cell *M*₁ small, about equal to its petiole; cell *2nd A* narrow.

Abdomen brown, variegated with yellow; hypopygium essentially brownish yellow. Male hypopygium with the tergite relatively long, slightly narrowed at outer end, apex broadly emarginate, on either side beneath with an incurved lobe, the outer margin with strong black setae. Outer dististyle very pale, slightly dilated on basal half; inner style with the disk high, beak obtuse, widely separated from the smaller lower beak; vestiture short, pale and inconspicuous; outer basal lobe cultrate, with conspicuous setae; outer arm of style a relatively long nearly straight spine that juts beyond the other hypopygial elements, the extreme tip acute, blackened, gently curved; sensory pits at base of outer arm, provided with very long setae; a narrow row of pale bristles extends from the sensory pits virtually to the tip of the arm.

Holotype, ♂, Amlekhgang, Nepal, 1690 feet, August 26, 1956 (Coher).

The fly differs from the most similar species, *Tipula* (*Tipulodina*) *barraudi* Edwards and *T. (T.) scimitar* Alexander, in the wing pattern, trichiation and venation, and in the structure of the male hypopygium. The details of the microtrichia of the wing cells are unknown for *barraudi*. It may be noted that the species figured by Brunetti (Fauna Brit. India, Dipt. Nematocera, 1912, pl. 5, fig. 5) as representing a species near *T. (T.) venusta* Walker actually pertains to *barraudi*.

***Tipula* (*Vestiplex*) *gurkha* new species**

General coloration gray, praescutum with four stripes that are margined by brownish black; basal flagellar segments bicolored; legs black, femoral bases obscure yellow; wings pale yellow, marbled with brown; abdomen yellow basally, the outer four segments black; male hypopygium with the basistyle produced into a slender spine; beak of inner dististyle slender; ninth sternite near suture of basistyle produced into a long simple spine.

MALE. Length about 12–13 mm.; wing 14–15 mm.; antenna about 4.3–4.4 mm.

FEMALE. Length about 14 mm.; wing 15 mm.

Frontal prolongation of head yellow, slightly darker on lower half, nasus distinct; palpi light brown, the outer two segments black. Antennae of moderate length; scape and pedicel yellow, basal flagellar segments bicolored, brownish yellow, the small basal enlargement black, outer segments uniformly black; segments longer than the verticils. Head broadly light yellow on central part, the sides of the posterior vertex light brown; a conspicuous suboval dark brown central spot on anterior vertex; vertical tubercle low, simple.

Pronotum gray, vaguely patterned with brown. Mesonotal praescutum light gray with four stripes, the intermediate pair slightly brownish gray, the lateral ones light gray, concolorous with the ground, all stripes narrowly bordered by brownish black, the midline narrowed in front; scutal lobes light gray, extensively patterned with brownish gray and darker brown; scutellum gray with a central brown vitta; mediotergite light gray with a central darkening, the posterior and lateral parts more glabrous. Pleura light gray, variegated by darker gray on the mesepisternum; dorsopleural membrane buffy brown. Halteres with stem yellow, knob black, the apex obscure yellow. Legs with coxae light gray; trochanters yellow; remainder of legs black, the femoral bases obscure yellow, on the fore and middle legs including about the basal third, on the hind legs about the basal half; claws toothed. Wings with the ground cream-yellow; prearcular field and cell *Sc* brighter yellow; stigma oval, dark brown; more than half the remainder of wing marbled with light brown, including the broad wing tip; basal of cord the ground and patterned areas more nearly equal in extent; veins brown, yellowed in the brightened parts. Squama glabrous. Venation: *Rs* long, slightly less than twice *m-cu*; *R*₁₊₂ preserved; petiole of cell *M*₁ subequal to *m*.

Abdomen yellow, the sixth and succeeding segments black, the lateral borders of tergites six and seven obscure yellow. Male hypopygium with the tergite relatively small, completely divided medially, each lobe obtuse at tip. Basistyle completely separated from the sternite by a suture; outer apical angle produced into a flattened yellow plushlike blade that is further extended into a slender black spine. Ninth sternite on either side adjoining the basistyle with a blackened knob that is produced into a long yellow simple spine, the acute tip black, directed dorsad and mesad. Outer dististyle a long blackened club; inner style with the beak unusually slender. Aedeagus subtriangular in outline, strongly narrowed outwardly. Eighth sternite unarmed.

Holotype, ♂, Simbhanjang Pass, Nepal, 8190 feet, October 27, 1956 (Coher). Allotopotype, ♀, pinned with type. Paratopotypes 3 ♂♀, July 24, October 1, 1956 (Coher).

The specific name is that of the ruling native group in Nepal. The fly is related to various species that are allied to *Tipula*

(*Vestiplex*) *subtineta* Brunetti, having a long spine on the extreme border of the ninth sternite of the hypopygium. The two most similar species are *T. (V.) subtineta* and *T. (V.) distifurca* Alexander, which have been described and figured in another paper by the writer (Rec. Indian Mus., 44: 42-46; 1942).

***Tipula (Vestiplex) lepcha* new species**

Size large (wing of male 20 mm.); general coloration of head and thorax gray, the praescutum with four more blackish gray stripes; posterior sclerites of notum and the pleura yellowed; legs black, femoral bases yellowed; wings light brown, with restricted creamy areas; basal abdominal segments fulvous yellow, the outer four black, including the hypopygium and its appendages; male hypopygium with the tergite small, divided medially by pale membrane; basistyle produced into a spine; outer dististyle bifid at apex; beak of inner dististyle very slender; phallosome with gonapophyses very slender, much longer than the aedeagus.

MALE. Length about 18 mm.; wing 20 mm.; antenna about 5 mm.

Frontal prolongation of head brown, sparsely pruinose; nasus long and slender; palpi black, the first segment and incisures paler. Antennae relatively long, as shown by the measurements; scape and pedicel obscure yellow to brownish yellow, first flagellar segment brown, succeeding segments black, with their outer stems a little paler, outer segments uniformly black; flagellar segments moderately incised, subequal to the longest verticils. Head with anterior vertex and narrow anterior orbits buffy, the posterior part of head grayish black.

Pronotal scutum grayish black, scutellum yellowed. Mesonotal praescutum with the restricted ground gray, with four blackish gray stripes that are narrowly bordered by darker, interspaces with conspicuous yellow setae; scutum gray, each lobe with two confluent blackish gray areas; scutellum brownish yellow, narrowly darkened medially; postnotum golden pollinose. Pleura blackish gray, pteropleurite, meron and metapleura yellowed; dorsopleural membrane buffy yellow. Halteres with stem brown, restrictedly yellowed at base, knob black. Legs with fore coxae blackish gray, remaining coxae brownish yellow to yellow; trochanters yellow; femora black, their bases yellowed, remainder of legs black; claws with a strong basal tooth. Wings light brown, restrictedly variegated with creamy areas, including two in cell *M*, the basal one larger, and a poststigmatal brightening; other smaller but similar pale areas before stigma and in the Anal cells; stigma small, medium brown; prearcular field and cell *Sc* clearer yellow; veins brown, more fulvous in the brightened parts. Squama naked; veins beyond cord with abundant trichia. Venation: R_{1+2} preserved; *Rs* a little less than twice *m-cu*.

Abdomen with basal five segments fulvous yellow, the sides narrowly light gray, bordered internally by light brown, this becoming black on the fifth segment; sixth and succeeding segments, including all parts of the hypopygium, black. Male hypopygium with the tergite small, divided

medially by pale membrane, the lobes obtuse at tips, with yellow setae. Basistyle large, completely cut off from both tergite and sternite, the outer end further separated from the base of the style, thence produced caudad into a slender arm that is glabrous and polished at apex, extended into a slender spine that is directed mesad, the surface with very long yellow setae. Outer dististyle blackened, expanded and slightly bidentate at tip, surface with sparse very small setae; inner style with the beak very slender. Phallosome distinctive, the very slender gonapophyses longer than the aedeagus, protruding caudad from the genital chamber, at its base with a median acute compressed spine that is directed chiefly caudad. Eighth sternite relatively small, not sheathing, unarmed.

Holotype, ♂, Simbhanjang Pass, Nepal, 8190 feet, October 1, 1956 (Coher). Paratopotypes, 2♂♂.

The species is quite distinct from other regional members of the subgenus, especially in the large size, coloration of the legs, and in the structure of the male hypopygium. The allied species have been listed in another paper (Philippine Jour. Sci., 57: 118–119; 1935) and the problem of assigning many such species to the present subgenus or to *Oreomyza* has been discussed in some detail. The reference of the present fly to *Vestiplex* appears to be correct.

***Limonia (Limonia) vajra* new species**

Size medium (wing of male 7.5 mm.); mesonotal praescutum with three obscure yellow stripes; legs with the femora brown or brownish yellow, with a darker subterminal ring, tips yellow; wings yellow, marbled with brown; *Sc* long, *m-cu* at or close to fork of *M*; male hypopygium with a group of about five spinelike setae on outer face of style.

MALE. Length about 6.5 mm.; wing 7.5 mm.

FEMALE. Length about 7.5 mm.; wing 8.5 mm.

Rostrum and palpi black. Antennae black throughout; flagellar segments oval, subequal to the longest verticils. Head dark grayish brown; anterior vertex narrow, about two-thirds the diameter of scape.

Pronotum yellow. Mesonotal praescutum with three obscure yellow stripes, the ground pale brown, deepening to darker brown on the posterior interspaces; centers of scutal lobes infuscated, remainder yellow; scutellum obscure yellow, narrowly bordered posteriorly by dark brown; postnotum dark brown, more intense in front. Pleura reddish yellow, vaguely patterned with slightly darker, forming a vague stripe from and including the fore coxae to the base of the abdomen. Halteres with stem weakly infuscated, apex of knob obscure yellow. Legs with fore coxae darkened, as described, remaining coxae and all trochanters yellow; femora dark brown, slightly paler basally, the tips abruptly yellow, in cases the femora more brownish yellow, with a conspicuous brownish black subterminal ring, in all cases the tips broadly yellow; tibiae and tarsi dark brown to black; claws with two elongate teeth, with smaller crowded more basal denticles. Wings with the

ground yellow, the prearcular and costal regions more saturated yellow; a conspicuous brown marbled pattern, the dark color being subequal in amount to the ground or slightly less; dark clouds occur over the veins and into the cells on the entire surface, slightly more extensive basad of the cord, beyond the latter appearing chiefly as seams over the veins; veins brown, yellow in the ground interspaces. Venation: Sc long, Sc_2 longer than Sc_1 , ending almost opposite the fork of Rs ; R_2 about one-half R_{1+2} ; $m-cu$ at or immediately before the fork of M ; vein $1st A$ relatively short, cells Cu and $1st A$ at margin subequal.

Abdomen obscure yellow, the posterior borders of the segments darkened, more extensive on the outer segments; hypopygium and preceding segment yellow. Ovipositor with cerci slender, very gently upcurved. Male hypopygium with the tergite large, narrowed posteriorly, the caudal border gently emarginate. Basistyle small, the ventromesal lobe very large. Dististyle single, oval, narrowed into a long beak, the usual rostral spines very slender, hairlike; a very compact group of about five spinelike setae on outer margin of body of style at near midlength. Gonapophysis with mesal-apical lobe relatively short, darkened, terminating in a subacute point. Aedagus broad, glabrous, the genital tubes lying close together at the midline, the tips produced slightly into short points.

Holotype, ♂, Simbhanjang Pass, Nepal, 8190 feet, July 24, 1956 (Coher). Allotopotype, ♀, October 1, 1956 (Coher).

In its marbled wing pattern, the present fly is most like *Limonia* (*Limonia*) *kashmirica* (Edwards), differing in the small size, coloration of the body, and position of the $m-cu$ cross-vein. The male hypopygium of *kashmirica* has not been described.

***Limonia* (*Libnotes*) *nepalica* new species**

Head dark gray, the narrow anterior vertex silvery; antennae with scape black, flagellum brownish orange; thorax fulvous, the notum with a narrow black central stripe, extending from the cervical region to midlength of the praescutum, becoming narrower behind; legs with coxae and trochanters yellow, the remainder uniformly black; wings whitish subhyaline, stigma and a narrow seam at origin of Rs dark brown; abdomen yellow.

FEMALE. Length about 6–6.5 mm.; wing 6.5–7 mm.

Rostrum and palpi black. Antennae with scape black, pedicel and flagellum brownish orange; flagellar segments oval, shorter than the verticils. Anterior vertex only about one-half as wide as the diameter of scape, silvery; posterior vertex dark gray.

Cervical region and dorsum of pronotum black, the sides of the latter yellow. Mesonotum fulvous, the praescutum with a narrow black vitta on about the anterior half, gradually narrowed behind, becoming obsolete at near midlength; posterior sclerites of notum yellow. Pleura fulvous yellow, unpatterned. Halteres with stem yellow, knob brownish black. Legs with the coxae and trochanters yellow; remainder of legs black. Wings whitish subhyaline, the prearcular and costal fields light yellow; stigma very small,

dark brown, transverse-oval; a comparable area at origin of *Rs*; much narrower to scarcely evident darkenings along cord; veins black, yellow in the brightened fields. Venation: *Sc* long, *Sc*₁ ending shortly before level of *r-m*; *Rs* arcuated at origin, about one-third to one-half longer than the basal section of *R*₄₊₅; cell 1st *M*₂ rectangular, subequal in length to the distal section of *M*₃; *m-cu* beyond fork of *M*, in cases to about one-third its length.

Abdomen yellow. Ovipositor with cerci small, virtually straight; hypovalvae large and powerful, straight.

Holotype, ♀, Amlekhgang, Nepal, 1690 feet, August 26, 1956 (Coher). Paratopotypes, 2 ♀♀, pinned with the type.

The most similar species is *Limonia (Libnotes) indica* (Brunetti), which has the coloration of the thorax generally the same, differing in the patterned legs and abdomen and in the details of wing coloration and venation.

Antocha (Antocha) perstudiosa new species

Close to *studiosa*; mesonotum patterned with brown, in cases extensively so; antennal flagellum dark brown; wings whitish, stigma brown; male hypopygium with the outer dististyle unequally bidentate at apex; inner gonapophysis distinctive, elongate, slightly sinuous, the outer end very slender, bent at a right angle.

MALE. Length about 3.5 mm.; wing 4 mm.; antenna about 0.7 mm.

Rostrum light yellow; palpi brown. Antennae with scape light yellow, remainder of organ dark brown; flagellar segments oval, longest verticils delicate, subequal to the segments; terminal segment tipped with four longer and stronger setae. Head light yellow; anterior vertex broad.

Pronotum very pale yellowish white. Mesonotal praescutum with the disk obscure yellow or pale brown, the margin broadly darker brown; remainder of notum of type yellow, the mediotergite chiefly brown, the cephalic part pale; in the paratype, the notum, excepting the scutellum, more uniformly darkened. Pleura and pleurotergite whitened. Halteres white. Legs with the coxae and trochanters white; remainder of legs pale brownish white; claws black, apparently simple. Wings whitish, prearcular and costal regions light yellow; stigma oval, small, relatively dark brown; veins brown, those of the costal areas paler. Venation: *R*₁₊₂ a little longer than *R*₂ but shorter than *R*₂₊₃; cell 1st *M*₂ closed; *m-cu* more than one-half its length before the fork of *M*.

Abdomen, including hypopygium, pale yellow. Male hypopygium with the dististyles slightly subterminal; outer style glabrous, unequally bifid at apex, both points obtuse at tips, the lower one longer; inner style a little longer, narrowed to the obtuse tip, with strong setae. Phallosome conspicuous; outer gonapophysis appearing as a long-oval pale blade; inner apophysis long, slightly sinuous, the outer end very slender, bent at a right angle. Aedeagus slender.

Holotype, ♂, Taubai, Nepal, December 8, 1956 (Coher). Paratopotype, ♂, pinned with the type. Occurred at seepage along foot of cliff.

The most similar regional species is *Antocha* (*Antocha*) *studiosa* Alexander, of the Nilgiri Hills, South India, which has the entire body and appendages pale yellow, and the inner gonapophysis of the male hypopygium of different conformation.

***Orimarga* (*Orimarga*) *sherpa* new species**

General coloration of mesonotum light brown, the lateral borders and the pleura more yellowed; antennae black; legs brown; wings very weakly tinged with darker; *r-m* lying some distance beyond the level of R_2 ; vein R_2 about two-thirds as long as R_{1+2} ; M_{3+4} longer than M_4 .

FEMALE. Length about 5 mm.; wing 4.6 mm.

Rostrum brown; palpi black. Antennae black; flagellar segments oval, with short verticils. Front and the narrow anterior vertex light gray, the posterior vertex darker brownish gray.

Pronotum light brown. Mesonotal praescutum light brown, the humeral and lateral parts more yellowed; posterior sclerites of notum light brown, sparsely gray pruinose. Pleura and pleurotergite obscure yellow. Halteres broken. Legs with the coxae and trochanters obscure yellow; remainder of legs medium brown. Wings very weakly tinged with darker, unpatterned; veins pale brown, costa more yellowed. Macrotrichia of veins beyond cord relatively numerous, with long series on vein R_3 , distal section of R_{4+5} , outer sections of M_{1+2} and M_3 , with fewer on basal section of R_{4+5} and one or two on vein M_4 . Venation: *Sc* relatively short, Sc_1 ending about opposite three-fifths *Rs*, Sc_2 a short distance from its tip; free tip of Sc_2 immediately before R_2 ; R_2 and R_{2+3} subequal, about two-thirds R_{1+2} ; *r-m* lying some distance beyond level of R_2 , only about one-half as long as the basal section of M_{1+2} ; M_{3+4} longer than M_4 ; *m-cu* about opposite one-third the length of *Rs*.

Abdomen yellowish brown, genital segment yellow. Ovipositor with the cerci small, slender, upcurved to the acute tips.

Holotype, ♀, Amlekhgang, Nepal, 1690 feet, September 19, 1956 (Coher).

From Brunetti's description of *Orimarga* (*Orimarga*) *peregrina* Brunetti, of the eastern Himalayas, the venation differs from that of the present fly in having R_{1+2} considerably longer and with *r-m* and R_2 in transverse alignment, together with other minor differences in venation. Bagehi's figure of the wing of *peregrina* (Fauna Brit. India, Dipt. Nematocera, 1912, pl. 8, fig. 11) is obviously incorrect in the length of *Sc* and in the shape of cell 1st A.

Paradelphomyia (Oxyrhiza) newar new species

Size large (wing 6 mm. or more); mesonotal praescutum light brown, posterior sclerites of notum and the pleura yellow; wings pale yellowish gray, unpatterned except for the pale brown stigma; outer cells of wing with numerous macrotrichia; cell M_1 present; abdominal tergites light brown, eighth segment darker brown to form a subterminal ring; male hypopygium with the basistyle produced at apex into a small spine; outer dististyle terminating in two acute spines that are separated by a narrow notch; spines of the ventral fork very slender.

MALE. Length about 5.5–6 mm.; wing 6–7 mm.

FEMALE. Length about 6–6.5 mm.; wing 6.5–7 mm.

Rostrum and palpi black. Antennae black; basal flagellar segments oval, passing into elongate, with conspicuous verticils. Head dark gray.

Pronotum testaceous, scutellum yellow. Mesonotal praescutum light brown or yellowish brown, without pattern; posterior sclerites more yellowed. Pleura yellow, unpatterned. Halteres with stem pale yellow, knob dark brown. Legs with the coxae and trochanters yellow; remainder of legs brownish yellow to yellowish brown, the outer tarsal segments a trifle darker. Wings pale yellowish gray, prearcular field light yellow; stigma pale brown, lying beyond vein R_2 ; veins brown, yellow in the prearcular field. Outer cells of wing with macrotrichia. Venation: Cell M_1 present; *m-cu* at or shortly before midlength of cell 1st M_2 .

Abdominal tergites light brown, sternites more yellowed; eighth segment dark brown, forming a narrow ring; ninth segment more yellowed, the styli dark brown. Male hypopygium with the basistyle produced at apex into a small spine, the dististyles thus slightly subterminal in position. Outer dististyle terminating in two acute spines, separated by a narrow notch, axial spine longer; inner style stout, tip obtuse. Spines of the ventral fork very slender, almost setaceous.

Holotype, ♂, Simbhanjang Pass, Nepal, 8190 feet, October 1, 1956 (Coher). Allotopotype, ♀, pinned with the type. Paratopotypes, 8 ♂♀, mostly in very poor condition, October 1–27, 1956 (Coher, Joshi & Pratap).

The most similar regional species is *Paradelphomyia (Oxyrhiza) flavescens* (Brunetti) (syn. *furcata* Brunetti), which is readily told by the smaller size and by the genital characters, including the unspined basistyle, shape of the dististyles, and, especially, the very distinct phallosome. I have a paratype of Brunetti's species (*furcata*) in my collection.

Limnophila (Elæophila) bicolorata new species

Size medium (wing of female about 7 mm.); mesonotum gray, the praescutum lined with darker; a central darkened vitta on the posterior sclerites; antennal flagellum bicolored; femora yellow with a narrow brown

subterminal ring, the actual tip paler; wings whitened, with a heavy spotted and dotted brown pattern; abdomen brownish black.

FEMALÉ. Length about 8-9 mm.; wing 6.5-7 mm.

Rostrum and palpi black. Antennae with the scape and pedicel dark brown; flagellar segments bicolored, with nearly the basal half of each black, the remainder light yellow; basal segments long, becoming progressively shorter and smaller outwardly. Head dark gray.

Pronotum gray, with a delicate black central line. Mesonotal praescutum gray with poorly defined darker stripes, the intermediate pair more intense at posterior ends; interspaces with a row of small blackened dots, humeral and lateral borders extensively blackened, the former including the pseudo-sutural foveae; scutum brown, the outer half of each lobe with a blackened area, medially with a blackened dash; scutellum pruinose; mediotergite yellowish gray pollinose, with a delicate central black vitta. Pleura dark gray, patterned with black, including a broader dorsal stripe extending from the cervical region to beneath the wingroot; ventral pleurites with the darkened areas more interrupted. Halteres with stem dusky, pale basally, knob blackened, paler at base. Legs with the coxae black, more or less pruinose; trochanters brownish yellow; femora yellow, with a narrow brown subterminal ring, the actual tip paler brown; tibiae and tarsi yellow, outer tarsal segments dark brown. Wings with the ground whitened, with a very heavy dark brown pattern of larger spots and numerous dots in all cells; the major areas occur at arculus and just beyond, origin of *Rs* and as a larger triangular area in the general region of the stigma, its posterior end at the fork of *M*; further darkenings near wing tip, at the supernumerary crossvein in cell *M*, and near the tip of vein *2nd A*; the smaller dots appear as transverse dashes in the costal and again in the cubital and anal fields, on the disk being more nearly circular; veins yellow, dark in the patterned areas. Venation: Supernumerary crossvein in cell *M* about opposite one-fourth the length of *Rs*; cell *M*₁ approximately twice its petiole.

Abdomen brownish black, the segments, especially the sternites, vaguely paler on the discal part. Ovipositor with the cerci very long and slender, the outer half horn-yellow.

Holotype, ♀, Amlekhgang, Nepal, 1690 feet, December 2, 1956 (Coher). Paratype, ♀, Bhainse, Nepal, December 8, 1956 (Coher)

The most similar described regional species is *Limnophila* (*Elæophila*) *fascipennis* (Brunetti), of the eastern Himalayas and Assam. This has the darkened dotted pattern of the wings much sparser than in the present fly. Brunetti describes the dark femoral ring of his species as being apical in position but in specimens in my collection that appear to be correctly named this darkened ring is slightly subterminal.

ETHOLOGICAL STUDIES ON DIGGER WASPS OF THE GENUS ASTATA (HYMENOPTERA, SPHECIDAE)

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Astata is a genus of worldwide distribution containing approximately 100 species. It is sufficiently unique structurally to justify being placed in its own subfamily, the Astatinae. The one other genus of this subfamily, *Diploplectron*, is smaller and has a discontinuous distribution; it is closely related to *Astata* and perhaps more primitive, although the wing venation seems more specialized. Adult Astatinae share some structural characters in common with the Sphecinae and particularly with the Larrinae. The larvae, however, are not at all similar to those of either of those groups (Evans, 1958).

Most commonly, the Astatinae are placed first among the subfamilies of Sphecidae, implying that they are primitive. If this is so, the ethology of the group should be particularly interesting and should shed light on the ancestral type of behavior in the family. In order to characterize the ethology of the subfamily, it is necessary to know the behavior of several species in some detail and to establish their similarities. Also, it is possible that any species differences may give clues as to the evolution of behavior within the group.

Unfortunately almost nothing is known about the behavior of the North America species of *Astata*, and still less about *Diploplectron*. The Peckhams (1898) presented a short account of some aspects of the nesting behavior of three species of *Astata*, and Barth (1910) published an even briefer note on two of these same species. More recently Williams (1946) has discussed the biology of *Astata immigrans*, a species apparently introduced into Hawaii from the Western United States. Even the Eurasian species are not particularly well studied, although considerable information has accumulated regarding the widely distributed *Astata boops*, a recent paper by Tsuneki (1947) on this species being particularly valuable. Minkiewicz (1933, 1934) has also discussed the behavior of *Astata minor* at considerable length.

Almost by accident, I have recently had an opportunity to study two species of *Astata* in moderate detail. One of them, *Astata unicolor*, has nested for the past two summers in the vegetable garden at my home in Ithaca, New York. The other, *occidentalis*, happened to be nesting in some numbers in the midst of a colony of *Bembix nubilipennis* which I was studying in Versailles, Indiana. I also found *Astata leuthstromi* nesting once. After describing the behavior of these three species, I have summarized briefly what is known of other species of the genus and have attempted to come to some conclusions regarding the position of the Astatinae as suggested by ethological characters.

This study was supported by a grant from the National Science Foundation. Note numbers in the text refer to field notes and associated specimens now on permanent file at Cornell University. I would like to express my appreciation to Herbert Ruckes for identifying the hemipterous prey of *Astata*, to Curtis W. Sabrosky for identifying the dipterous parasites, and to Karl V. Krombein for checking the identity of the species of *Astata*.

OBSERVATIONS ON *ASTATA UNICOLOR* SAY

Astata unicolor is a relatively common species throughout much of temperate North America. In the Northeast, there is clearly only one generation a year. I have seen no specimens collected earlier than July 12 or later than September 10, and August is clearly the month of greatest abundance and most nesting activity. The species is not strongly restricted ecologically, but occurs in many types of open country: fields, meadows, gardens, waste places, and bare sandy areas. The wasps are particularly apt to be encountered on the flowers of *Daucus carota*, and have been so recorded by Krombein (1936). Mickel (1918) and Robertson (1938) record the species from many different flowers.

BEHAVIOR OF THE MALE. Males are on the wing for at least two weeks before the females appear in numbers. Aside from visiting flowers for nectar, the males often perch on flowers for considerable periods of time, flying off occasionally and returning again in a few seconds. More commonly, they perch on a slight elevation in an area of bare soil, for example, on a stone or clod of earth. Here the male may remain for several hours

during the warmest part of the day, at short intervals (from a few seconds to up to three minutes) flying swiftly, obliquely upward, then in an arc and back again to the perch. Back on the perch, he rotates his body in various directions and walks about a bit before finally coming to rest with the antennae extended rigidly. The flights vary in length from one to several meters, and are so swift that they often cannot be followed with the eye. These flights appear to be "spontaneous," that is, they are in response to no obvious stimulus. They cannot be elicited regularly by tossing pebbles over the perches, as can the precopulatory flights of certain other digger wasps. When two or more males perch in the same area, as often happens, they take up stations from .5 to 1 meter apart and show no obvious response to one another. At least I have never seen them attack one another as if defending a territory. However, Minkiewicz (1934), who observed very much this same type of behavior in *Astata minor* in Poland, found that if one male approached the perch of another too closely, the two rolled together "dans un corps-à-corps formidable."

The most curious aspect of this behavior of the male is that it occurs at some distance from the nesting area of the females (also noted by Minkiewicz in *minor*). During the summer of 1957, several males occupied their perches at the south edge of my garden from July 29 to August 17. No females were found nesting until the second week in August, and then they nested in another part of the garden, at least 8 meters away. Although I watched the males for brief periods on several different days, I never saw a female in this part of the garden. Presumably the females must enter the area patrolled by the males and be fecundated during one of their characteristic flights. Probably the females do this shortly after they first emerge. I have never observed copulation in *unicolor* and am not aware that it has been observed in *boops* or *minor*.

NESTING BEHAVIOR OF THE FEMALE. *Astata unicolor* appears to nest in almost any type of bare soil. Ferton (1901) remarks that "toutes les *Astata* de France et de Corse . . . creusent volontiers leurs terriers dans les sols sableux et durs, mais elles habitent aussi les terrains argileux. . . ." This seems to be equally true of *unicolor*. I have frequently seen both sexes in sand pits and small dunes, but have only one record of their nesting in

sandy soil. On August 14, 1954, C. S. Lin observed a female carrying a stinkbug into a nest in a sandy-gravel slope near Ithaca, New York (note no. 1346). He dug out the nest and found the burrow to be 17 cm. long, but gently curved so that the bottom was only 10 cm. beneath the surface; the upper 5 cm. were open, but the lower 12 cm. were loosely filled with earth. The stinkbug was found in the bottom of the burrow. From what is now known of the behavior of *unicolor*, it seems probable that this was a new nest and the wasp had not yet actually made a cell.

All the remainder of the observations reported here were made by myself in a very different habitat: the garden at my home two miles south of Ithaca. The soil here is a heavy clay containing much organic matter and many stones. It is difficult to dig in with a trowel, and must present infinitely greater problems to *Astata* than sand, not only because of its firmness but because it holds moisture to a much greater extent. Nevertheless, there were several individuals nesting here both in 1956 and in 1957. In all I found and eventually dug out five nests, but there were undoubtedly others which I did not discover. In 1956, all the nests were situated in a strip about .5 to 1.5 meters in size along two rows of carrots; in every case the nest entrances were beneath and well hidden by the drooping leaves of the carrots. In 1957, the nests were located in approximately the same place, but beneath the foliage of tomato plants, which happened to have been planted there that year. The Peckhams (1898) found *unicolor* nesting in their garden, and Barth (1910) remarks that the species "prefers ground to sand."

I did not observe the digging of the nest. The Peckhams report that the soil is pushed out of the burrow with the end of the abdomen and cleared away from the entrance with the hind legs. The initial burrow enters the ground at an angle of from 45 to 75 degrees with the surface and reaches a depth of from 7 to 15 cm. The diameter of the burrow is about 7 mm., slightly wider (about 9 mm.) at the entrance. The earth dug from the burrow is cleared from the entranceway only slightly, and comes to form a pile about 5 cm. wide and 7 cm. long, with the hole near one end of it. This pile of earth is never leveled by the female nor is any of it ever used for closing the burrow; only rarely is it added to. After a period of days it tends to weather away, and eventually it may disappear altogether. The Peckhams (1898)

also noted similar mounds of earth at the nest entrance. They found the burrow to be about 9 cm. long. Barth (1910) states that the burrow extends to a depth of from 8 to 14 inches (about 20 to 35 cm.), which is somewhat out of accord with the figures obtained by the Peckhams and myself.

The lower part of the burrow is kept filled loosely with soil. When the stinkbugs are brought in they are stored near the bottom of the burrow beneath this loose filling. Only after several

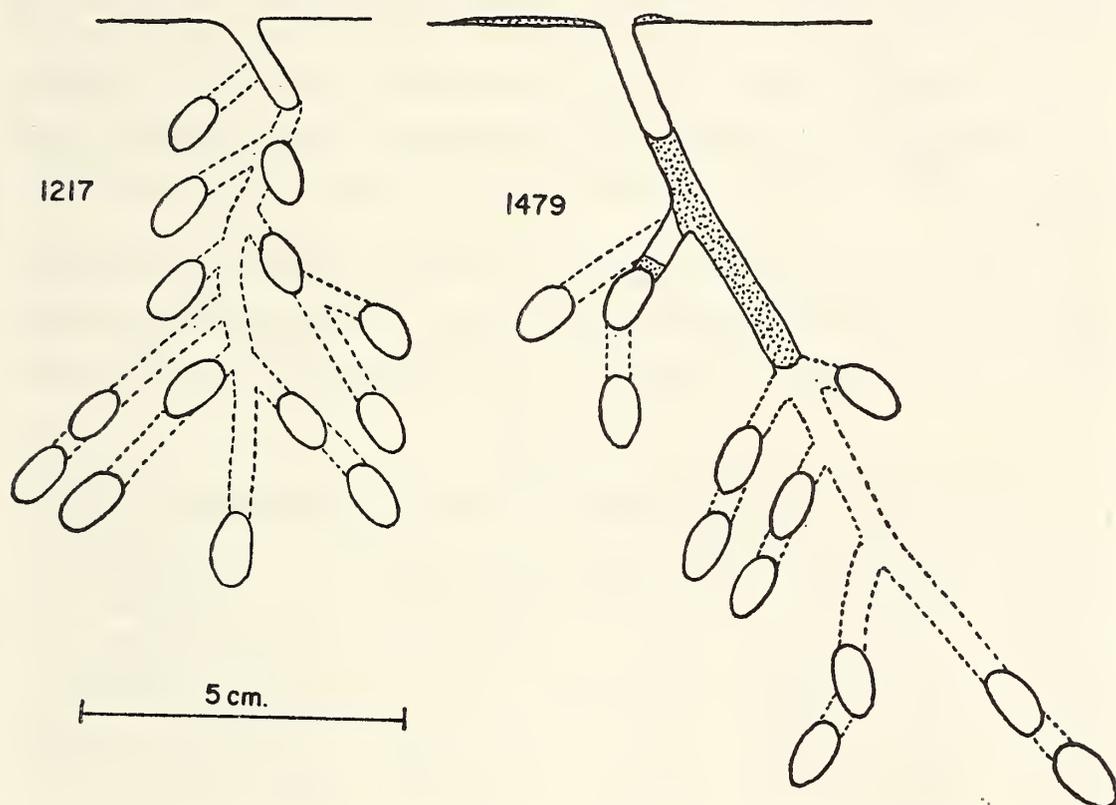


FIG. 1. Two nests of *Astata unicolor*, Ithaca, N. Y. Burrows indicated by dashed lines were filled solidly with soil and could not be traced, hence are somewhat hypothetical. Stippling in the burrows indicates a loose filling of earth.

stinkbugs have been stored in this manner is a cell constructed and provisioned. The first cell is constructed near the bottom of the burrow, provisioned from the bugs stored in the burrow, then closed off with soil. Successive cells are constructed progressively upward as the burrow is gradually shortened. Thus, in a nest containing several cells, the lower cells invariably contain cocoons or fully grown larvae, while the topmost cells contain eggs or small larvae (see Table II). The exact arrangement of the cells varies considerably from nest to nest, but in general it appears that many of them are constructed in short side-burrows (fig. 1). A single side-burrow may eventually contain two cells

in the same series, separated by a substantial barrier of earth (at least 3 mm.). In no case did I find more than two cells in a single series. The deepest cell found in any nest was 15 cm., the shallowest only 2 cm. One would expect a larva in a cell only 2 cm. deep to be subject to much higher temperatures and lower humidity than a larva in a cell 15 cm. deep, but such factors are apparently of little importance in this species.

The cells of this species measure approximately 12 mm. in length and 8 mm. in diameter. They are broadly elliptical in shape and oblique in position (fig. 2), rarely nearly horizontal or nearly vertical. The walls are remarkably smooth and polished for soil as coarse as this. Only at the upper end, where the cell is closed off after it is fully provisioned, is the wall not perfectly smooth.

It seems probable that a female normally spends her entire life digging and provisioning a single nest. It is possible that nest no. 950 (see Table I) may have been abandoned for some rea-

TABLE I

GENERAL NATURE OF FIVE NESTS OF *Astata unicolor*, ITHACA, N. Y.

Note no.	Date dug out	No. of cells	Depth of cells	Remarks
1212B	Aug. 15, 1956	9	12-15 cm.	Not completed
1216	Aug. 16, 1956	0		Newly constructed
1217	Aug. 27, 1956	14	2- 9 cm.	Completed
950	Aug. 31, 1956	2	9 cm.	Apparently completed
1479	Aug. 24, 1957	12	5-12.5 cm.	Completed

son, or the female may have met an untimely death. The full complement of cells seems to be from 12 to 14 per nest. It is possible that under ideal conditions the total number is considerably higher than this.

HUNTING AND PROVISIONING ACTIVITIES. The prey of *Astata unicolor* consists of immature stinkbugs (Pentatomidae). Generally speaking, last instar nymphs are taken, but occasionally earlier instars are used. The Peckhams (1898) recorded *Podisus modestus* Fabr. as prey. In 1956, I found the prey to consist entirely of two species of *Euschistus*, *tristigmus* Say and another species which was probably *euschistoides* Voll. The two species were well mixed in all the nests studied. The one nest

dug in 1957 contained all *E. tristigmus* except for one specimen of *Podisus maculiventris* (Say). The collections of the U. S. National Museum include one specimen from Clifton, Va., pinned with a nymph of *Euschistus tristigmus*.

The females appear to hunt their prey in the tall vegetation of fields and meadows. I have not observed the actually stinging of the prey. All bugs taken from nests or from wasps entering nests were very thoroughly paralyzed if not dead. The Peckhams (1898) observe that the sting of *unicolor* "proves fatal within a very short time."

I observed one female (no. 1212A) in tall vegetation apparently soon after she had stung her stinkbug. She was cleaning her antennae and wings on a blackberry leaf about one meter above the ground while the stinkbug lay completely immobile on its back on the leaf. After five minutes the wasp walked over to the bug, grasped it with her mandibles by the extreme base of the antennae, and straddled it. She held it in this manner, moving about over several different leaves, for about 15 minutes, when she finally took flight heavily, maintaining a height of about a meter. The Peckhams (1898) state that the middle legs are used to support the bug in flight, but it appeared to me, both on this occasion and on several later occasions at the nest entrances, that all the legs embrace the bug during flight. When the wasp lands, she immediately stands on all three pairs of legs, holding the bug only by the base of the antennae. At all times the bug is venter-up. (The manner of carrying the prey does not differ from that of *occidentalis*, shown in fig. 6).

After arriving in the nesting area, the wasp lands on vegetation near the nest, then proceeds circuitously by walking and short flights to the nest entrance, which is left open at all times during provisioning. She enters the nest still straddling the bug and holding it by the antennae with her mandibles. Frequently the bug is left just inside the entrance for a moment and then drawn in from the inside. On leaving the nest the female again takes a somewhat circuitous course from the entrance before flying off. This behavior has been described and figured by the Peckhams (1898), who state that their wasps "almost invariably made a long locality study, first running about on the ground . . . and then rising and circling all around the place."

I interpreted this as analogous to the usual rather devious manner of entering the nest, perhaps serving to deceive potential parasites. Certainly this manner of entering and leaving the nest, added to the fact that the nest entrances are invariably located beneath overhanging vegetation, makes the nests exceedingly difficult for a human observer to find.

The bugs brought in are not taken directly to a cell, but are left in the bottom of the burrow, usually venter-up. Only after a certain number of bugs accumulate (often, probably, after the completion of a day's hunting) is a new cell prepared and the bugs placed in it in a very specific manner. Tsuneki (1947) found this to be true in *boops*, and he believes the wasps may

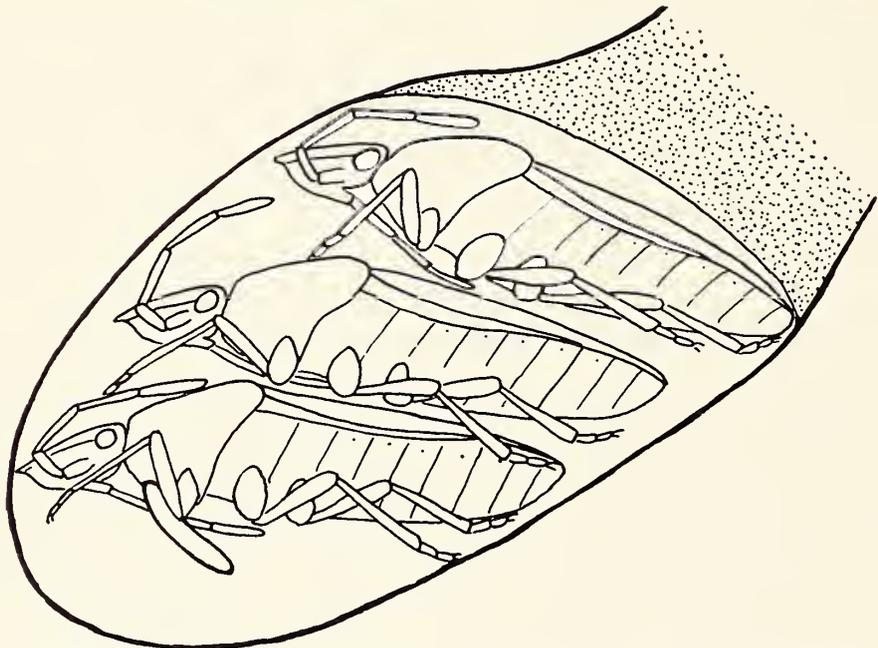


FIG. 2. A cell of *Astata unicolor* provisioned with stinkbugs and closed off. The egg is attached to the prothorax of the bottom bug.

prepare and provision several cells at a time in this manner. This unusual manner of provisioning has confused many earlier workers and led to a number of erroneous statements. Both the Peckhams (1898) and Barth (1910) are incorrect on details of cell structure and egg position, and Ferton (1901) is led to the paradoxical statement that the egg of *Astata* is laid on the bottom bug in the cell but not until after the cell is fully provisioned!

Actually, the egg is laid on the first bug placed in the cell from the supply in the burrow. This bug is placed in the bottom of the cell, venter-down, more or less horizontally, in such a way that there is a small open space beneath it formed by the smooth, oval contours of the cell (fig. 2). The egg is attached

to the prosternum and extends backward along the midline of the body with its posterior end free from the body. It is about 2 mm. long. The remaining stinkbugs are placed on top of the first one, also venter-down, and the cell is closed off from above, the closure being made directly on the dorsum of the top bug. The number of bugs per cell varies from 2 to 4, with an average of 2.8. The bugs fit the cell very tightly, the only appreciable free space being beneath the bottom bug surrounding the egg and later the small larva.

As already mentioned, the entrance to the burrow is never closed during provisioning. During periods of inactivity, that is, from late afternoon until morning and during inclement weather, a closure of the burrow is ordinarily visible not at the entrance, but at a distance from one to two centimeters inside the entrance.

DEVELOPMENT. The egg hatches in about three days. The larva remains attached for about two days at the point of attach-

TABLE II

CONTENT OF NEST 1212B, ITHACA, N. Y., AUG. 15, 1956

Cell no.	Depth	No. of bugs	State of wasp progeny	Development
1	15 cm.	Pasty mass (3?)	Larva 12 mm. long	Accidentally killed
2	14 cm.	Pasty mass (3?)	Larva 10 mm. long	Full grown August 16
3	14 cm.	3	Larva 5 mm. long	Full grown August 20
4	13.5 cm.	2	Larva 3 mm. long	Full grown August 22
5	13 cm.	2	Larva 2.5 mm. long	Full grown August 24
6	12.5 cm.	2	Larva 2.5 mm. long	Full grown August 24
7	12.5 cm.	3	Egg	Hatched Aug. 16; Full grown Aug. 25
8	12 cm.	2	Egg	Hatched Aug. 18; Full grown Aug. 26
9	12 cm.	4 (small)	Egg	Hatched Aug. 18; Full grown Aug. 26

ment of the egg, feeding through the front coxal membrane or in the neck region. Then it loses its attachment, but remains in

an inverted position, hollowing out the first bug from the ventral side and then the other bugs in turn. The larva possesses a strong mid-dorsal lobe on the fourth abdominal segment, and this lobe apparently serves as a pseudopod and assists the larva in moving about in the cell. As the larva approaches maturity, the bugs become reduced to a pasty mass. About eight days are required for the larva to reach maturity (see Table II).

In spinning its cocoon, the larva apparently merely lines the smooth walls of the cell with silk. The resulting cocoon is unusually frail, and seems particularly so at the upper end, where the cell walls are somewhat more irregular. A certain amount of earth tends to adhere to the outside of the cocoon, but none is incorporated into the cocoon itself. Having spun the cocoon, the larva enters diapause and remains in diapause throughout the winter months.

NATURAL ENEMIES. The Peckhams (1898) observed a cuckoo wasp of the genus *Chrysis* lurking about a nest of *unicolor* and even entering it, but they did not determine whether or not it was actually parasitizing the wasp. They also found "a parasitic larva" in the cells of one nest. None of the nests which I studied appeared to be parasitized, and I saw no cuckoo wasps or miltogrammine flies around the nest entrances.

OBSERVATIONS ON *ASTATA OCCIDENTALIS* CRESSON

This species also occurs from coast to coast in North America, but its center of distribution appears to be somewhat more southerly than that of *unicolor*. Nothing has previously been recorded on its biology except for a prey record by Townes (1951) and a brief note by Ashmead (1894). Townes records the stink-bug *Peribalus limbolarius* Stål as prey. His record is based on a series of 33 adult bugs of that species in the U. S. National Museum, taken as prey of *occidentalis* at the "So. End of Long Bridge, Va.," July 18, 1920, by J. C. Bridwell. In the National Museum there is also an adult *Thyanta custator* Fabr. taken as prey of this species in Los Angeles Co., Calif., Oct. 15, 1893, by D. W. Coquillett. This is apparently the specimen referred to by Ashmead (1894); Ashmead calls the wasp *Astata nubecula*, but the specimen in the National Museum is clearly *occidentalis*. According to Ashmead, Coquillett found this wasp storing bugs "in a burrow formed in a limestone formation."

I found a considerable aggregation of nests of this species at Versailles, Indiana, July 17-23, 1957, and was able to work out many of the details of the nesting behavior. No males were observed during this period, and it is possible that they had completed their period of activity and disappeared. The nesting of the females seemed well advanced. The nesting site was a baseball diamond one mile east of the town of Versailles. The soil here was a hard-packed clay, throughout the nesting area completely devoid of vegetation of any kind. *Bembix nubilipennis*

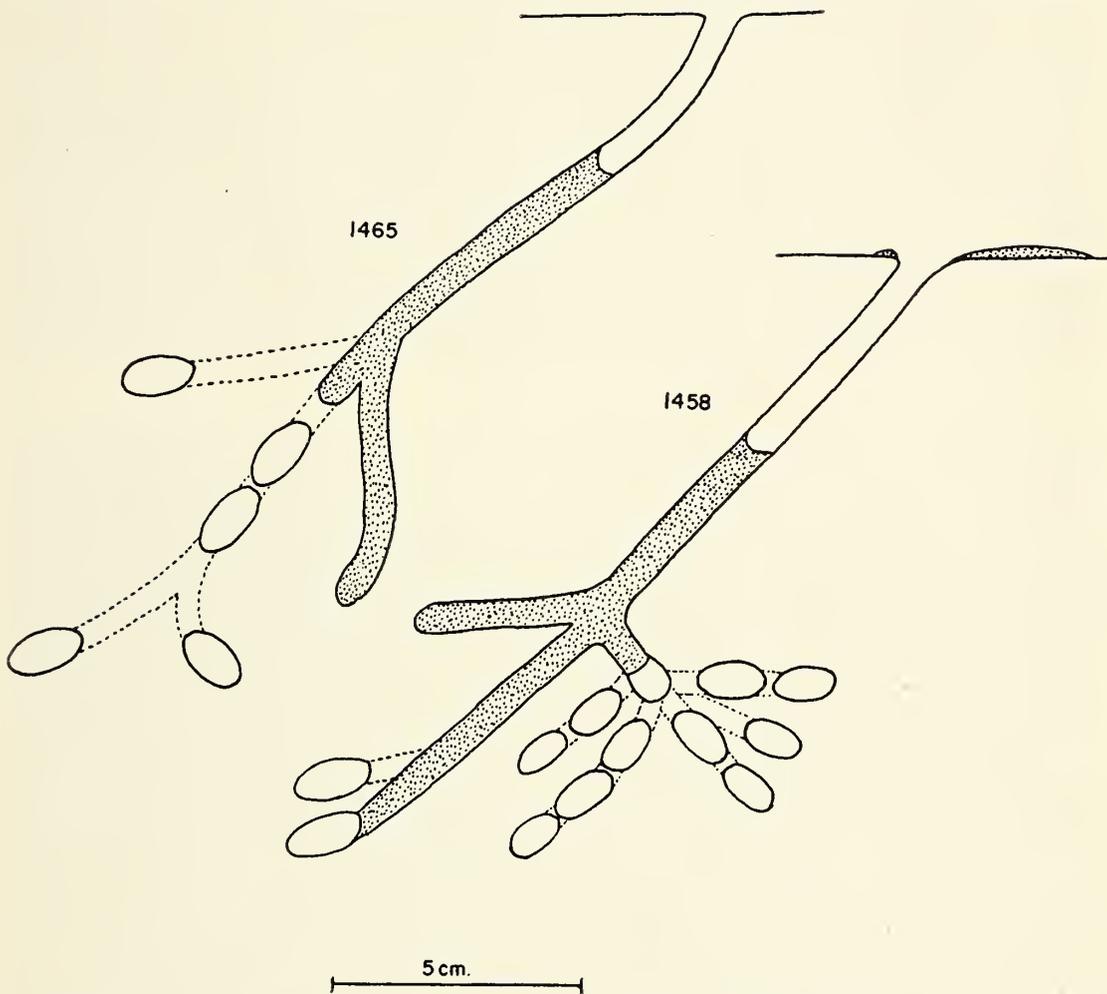


FIG. 3. Two nests of *Astata occidentalis*, Versailles, Ind. Burrows indicated by dashed lines were filled solidly with soil and could not be traced, hence are somewhat hypothetical. Stippling indicates a loose filling of earth.

and *Cerceris fumipennis* also nested in considerable numbers in this very hard soil. In all, I marked and eventually dug out eight nests of *Astata occidentalis*, but the actual number of nesting females was probably at least twice this. All the nests were located in an area about five meters square, with no two nests closer together than about half a meter. Each nest entrance was

surrounded by a rim of soil and was very conspicuous on the bare, smooth surface of the baseball diamond.

NESTING BEHAVIOR. The wasps break the soil with their mandibles and produce a weak buzzing sound as they do so. The soil is scraped back with the fore legs, rather slowly, while the body is held rather low, the middle hind legs spread widely. The soil is permitted to plug the entrance to the burrow, and the wasp then comes out and clears it away. As she backs away from the entrance scraping soil, she produces a small trough in the mound of earth (fig. 4). The soil is never actually leveled in the manner of some other digger wasps (e.g., *Bembix nubilipennis*), but eventually it comes to be fairly well spread out, with evidence of several troughs emanating from the entrance to the nest. In active nests, there appears to be fresh digging nearly every day, so that the rim of soil around the entrance is always conspicuous. The nest entrance is never closed at any time.

The burrow of *occidentalis* is about 8 mm. in diameter and penetrates the soil at an angle of from 50 to 80° with the horizontal. Very often the burrow has a lateral curvature, in some cases such that the cells actually lie directly beneath the entrance. The burrow may be as much as 18 cm. long and may reach a depth of as much as 12 cm. (Table III). The top 2-5 cm. are kept open, while much of the remainder of the burrow is filled loosely with soil. As in *unicolor*, the bugs are stored in the bottom of the burrow, beneath this loose soil, and only after the accumulation of several bugs is a cell prepared and the bugs moved into it. The first cells are constructed at the bottom of the burrow, and later cells progressively closer to the surface. Often the cells are constructed in short series, but in no case did I find more than three cells in one series. Up to 14 cells may be constructed per nest (probably more under some conditions) (Table III; figs. 3, 5).

The cells of this species are broadly elliptical and usually oblique, occasionally nearly horizontal or nearly vertical. They are smooth-walled and measure, on the average, about 8 × 15 mm. The closure of the cell is made directly on the back of the top stinkbug. When cells are in series, the closure between them may consist of no more than a very thin barrier of soil (1-3 mm.).

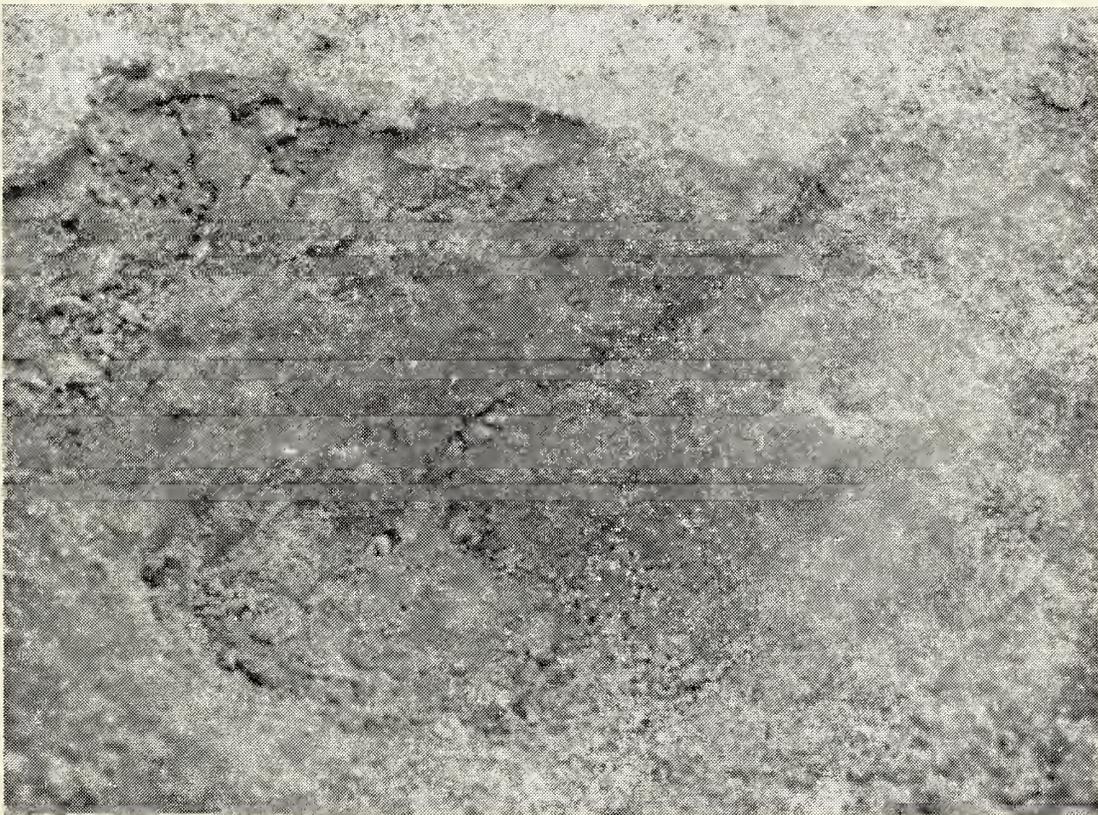


FIG. 4. (Above) *Astata occidentalis* digging at the nest entrance. Note the trough extending from the open entrance.

FIG. 5. (Below) A nest of *A. occidentalis* showing four cells. This is nest no. 1465, shown also, after further excavation, in figure 3. The cell on the lower left contains a full-grown larva; the two upper cells contain stink bugs and small larvae; the cell on the lower right contains the remains of several bugs which have been consumed by maggots of *Senotainia*.

All of the 58 cells dug out were within the narrow range of 6–12 cm. in depth; in individual nests the cells were often grouped very close together (in nest 1466, 14 cells between 8 and 11.5 cm. deep). The exact arrangement of the cells showed much

TABLE III

NATURE OF EIGHT NESTS OF *Astata occidentalis*, VERSAILLES, IND.

Note no.	Date dug out	No. of cells	Depth of cells	Remarks
992	July 18, 1957	2	6–7 cm.	Relatively new nest
1452	July 20, 1957	11	8–11 cm.	Wasp still active
1458	July 21, 1957	12	8–10 cm.	Wasp still active
1459	July 22, 1957	5	8–10.5 cm.	Wasp still active
1462	July 22, 1957	6	7–9 cm.	Wasp still active
1463	July 22, 1957	3	7–10 cm.	Apparently an inactive nest
1465	July 23, 1957	5	8–12 cm.	Wasp still active
1466	July 23, 1957	14	8–11.5 cm.	Wasp still active

variation from nest to nest; apparently cells are constructed both in the main burrow, in short side-burrows, and in major branches of the burrow (fig. 3).

HUNTING AND PROVISIONING ACTIVITIES. The wasps in this nesting aggregation preyed exclusively on adult Pentatomidae. The 122 bugs taken from cells or from wasps represented 6 species in the following numbers:

<i>Hymenarcys nervosa</i> (Say)	57
<i>Thyanta calceata</i> (Say)	27
<i>Thyanta pallidovirens accerra</i> (McAtee)	19
<i>Euschistus variolarius</i> (Beauv.)	14
<i>Peribalus limbolarius</i> Stål	4
<i>Banasa calva</i> (Say)	1

Individual wasps seemed to prey on one or a very few species of bugs. For example, of the 52 bugs taken from the 12 cells of nest no. 1458, 51 were *Hymenarcys nervosa* and 1 was *Thyanta calceata*. The 13 identifiable bugs taken from nest no. 1466 were all *Euschistus variolarius*. But 13 bugs taken from nest no. 1462 represented four species! Apparently individual wasps tend to

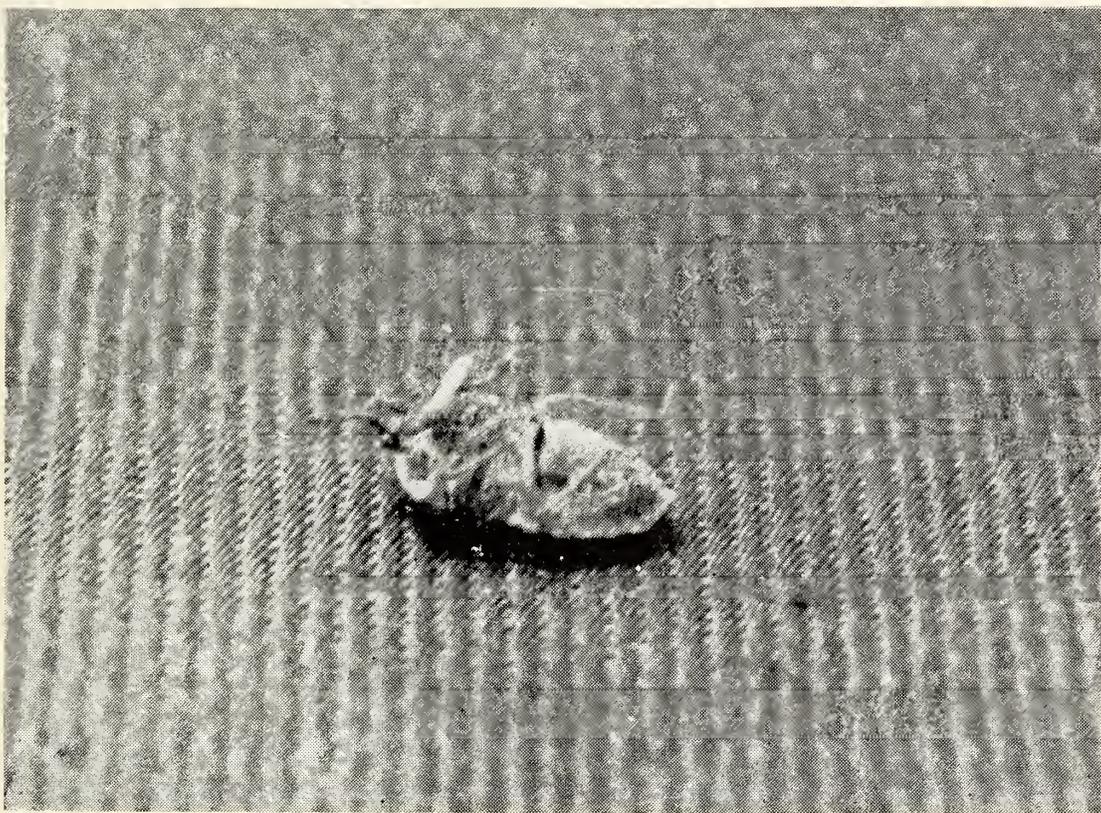


FIG. 6. (Above) *A. occidentalis* female carrying a stinkbug toward the nest entrance. Note that the bug is held venter-up by the base of the antennae.

FIG. 7. (Below) The egg of *A. occidentalis* on a stinkbug which has been removed from a cell. In normal position, the bug is venter-down and the egg extends downward as shown in figure 2.

return to the same place each time for their bugs, but the species may be characterized as able to utilize virtually any species of adult stinkbug of medium size.

The number of bugs per cell varies from 3 to 6, with an average of 3.8. The bugs are placed in the cell head-in, venter-down, exactly as in *unicolor*. The egg is about 2 mm. long and is attached to the first bug placed in the cell in the same manner as in *unicolor* (fig. 7). The larva is very similar to that of *unicolor* and feeds in the same manner.

Females enter the nesting area from various directions and usually at a considerable height (roughly 2 meters). Characteristically, they land on the ground a short distance from the entrance of their burrow. They carry the stinkbug beneath their body venter-up, holding the base of the antennae (or apparently sometimes the base of the beak) with their mandibles. In flight, the bug is also embraced with all three pairs of legs, but upon landing the wasp stands upon all the legs and holds the bug only with her mandibles (fig. 6). When a wasp lands with her bug, she produces a fairly loud "plop," apparently a result of the back of the stinkbug hitting the hard ground. The wasp proceeds to the open nest entrance by a somewhat devious path and may not actually enter the nest for several minutes after arriving in the area. Eventually she enters the nest straddling the bug in the usual manner, leaves the bug just inside the entrance, then a moment later pulls it in from the inside. When the wasp reappears (after a period of several minutes, often as long as 30 minutes) she usually again walks in a circuitous path before taking flight. Provisioning proceeds at a very slow pace. Wasp no. 1457B brought in her first bug on July 21 at 1000, her second bug at 1108; by noon she had not yet brought in a third. The condition of the bugs stung by *occidentalis* seems to vary considerably. Most bugs seemed thoroughly paralyzed if not dead, and some taken from relatively new cells were actually stiff. On the other hand, it was not uncommon to find a bug, even in a cell which had been provisioning 2-3 days earlier, which still exhibited movements of the legs and antennae. Development of the egg and larva and spinning of the cocoon are so similar to *unicolor* that they need not be described separately.

In the morning, many wasps could always be seen digging at

the entrances of their nests, presumably clearing away some of the soil which accumulates in the course of digging new cells. After a period of digging, each wasp would move away from the nest entrance by a devious path before finally flying off to hunt a stinkbug. For example, no. 1457A dug at her nest from 0835 until 0910 on July 21. Then she walked and flew around the nest in approximately the pattern shown in figure 8, finally flying

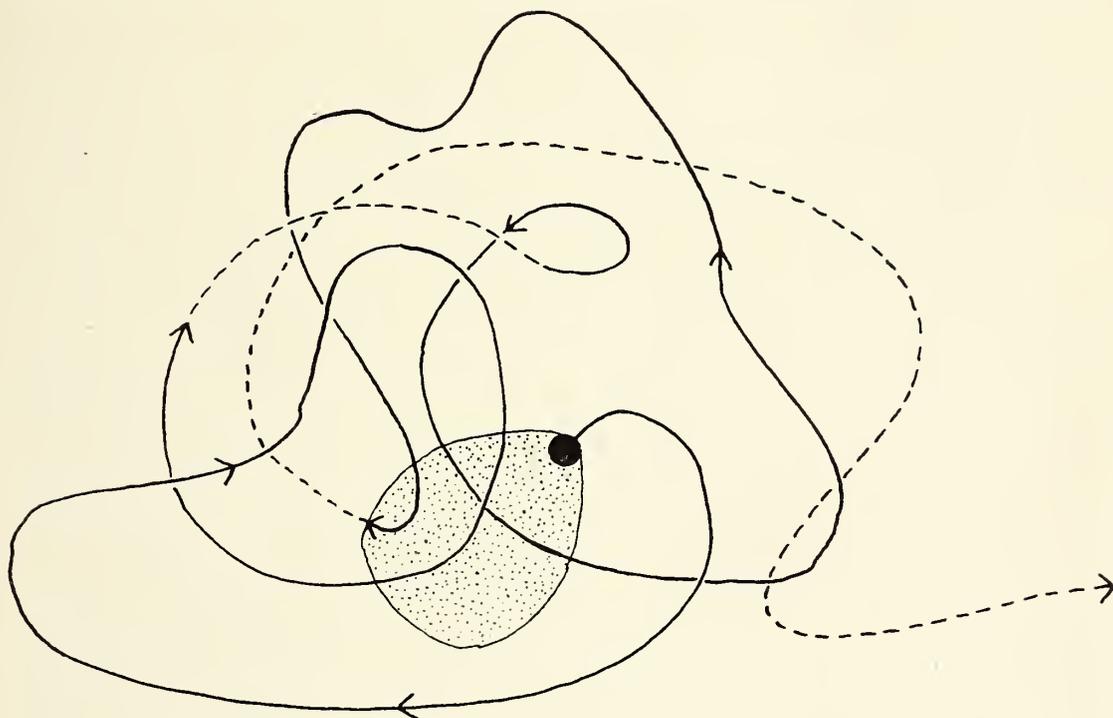


FIG. 8. Movements of wasp no. 1457A away from the nest entrance. Walking is indicated by a solid line, flying by a dashed line. The mound of earth at the nest entrance is stippled.

off at 0913. Later in the day, wasps leaving their nests behave similarly, but take fewer loops and turns and less time in the process. Doubtless this behavior is primarily concerned with orientation, but since the wasp also behaves similarly when entering the nest with its prey, it seems possible that it also functions to deter parasitism.

NATURAL ENEMIES. This colony of *Astata occidentalis* was very heavily parasitized by the fly *Senotainia trilineata* Wulp (Sarcophagidae, Miltogramminae). On many occasions wasps approaching their nests with prey were seen to be trailed by these flies, which would hover a few centimeters behind the wasp and await an opportunity to larviposit on the bug. Some wasps trailed by flies would leave the area and re-enter, or fly about

from one part of the nesting area to another, in an apparent effort to shake off the pursuers. On one occasion I watched an *Astata* fly about for over ten minutes in an unsuccessful effort to escape a *Senotainia*; finally the wasp left the bug on the earth and flew off. Several times I found stinkbugs lying on the ground, apparently abandoned by wasps which had not been able to reach their nests safely.

No less than 26 of the 58 cells dug out contained maggots of *Senotainia trilineata*. The number of maggots per cell varied from 1 to 6, except for one cell (no. 1466A) which contained 24. In the latter case it is possible that the maggots from several cells had broken through the walls and come to form a common mass.

The adult *Senotainia* apparently deposits one or more larvae on the stinkbug before it is placed in the nest. The wasp proceeds to store the bug in the burrow and later place it in a cell in the usual manner. For the first day or two the *Senotainia* maggots are very small and appear to feed on the surface of the bug beneath the wings. Then they begin to grow very rapidly, devouring the wasp egg and eventually the entire contents of the cell. When full-grown, the maggots leave the cell and form their puparia in the soil beneath or beside it. All the maggots collected July 17-23 gave rise to adult flies during the first week of August. Doubtless the fly has several generations a year and attacks several different digger wasps.

OBSERVATIONS ON *ASTATA LEUTHSTROMI* ASHMEAD

This is a small and relatively uncommon species. I have found it nesting in the garden at my home near Ithaca, but in smaller numbers than *unicolor*. On August 7, 1956, a female was seen raking earth over the entrance to a nest located beneath a dead weed which was lying on the ground (no. 1213). She scraped earth from several directions over the entrance, but left before the nest was fully concealed. Believing this to be a temporary closure, I marked the nest and observed it intermittently over the next week. However, the wasp was not seen again, and when the nest was dug out on August 14 the burrow could not be traced. Two cells in close proximity were discovered only 4 cm. beneath the surface. Each cell contained several pentatomid nymphs, but the cell contents were completely molded.

While digging this nest, I accidentally uncovered another nest only 10 cm. away. This one contained two (or perhaps three) cells, also in a close group about 4 cm. deep. Unfortunately the cells were destroyed before I could observe their structure. In all they contained 13 nymphs of the small pentatomid *Cosmo-pepla bimaculata* Thom. One small wasp larva was found, but it failed to grow in a rearing tin. While I was digging, the adult *Astata* returned with another stinkbug nymph, again the same species. She landed on the ground and began walking and flying from place to place around her nest. The bug was held venter-up by the base of the antennae, exactly as in *unicolor*, and apparently supported in flight by all three pairs of legs. The wasp was captured for identification.

The Peckhams (1898) observed a single individual of this species, also in their garden. They noted that there was a heap of earth around the entrance and that the wasp closed the entrance from the inside for the night. They were not successful in excavating the nest.

ETHOLOGY OF OTHER NORTH AMERICAN SPECIES OF ASTATA

Astata bicolor Say. The Peckhams (1898) found this species nesting in the hard soil of their garden. They noted that the nests are usually located beneath overhanging vegetation and have a small mound of earth at the entrance as in *unicolor*. The wasps enter and leave the nest in the usual circuitous manner and leave the entrance open during provisioning. The one nest they dug out was very shallow, a burrow about 6 cm. long leading to a group of cells only about 4 cm. beneath the surface. The Peckhams observed malaxation and stinging of the prey in a jar and found that most of the bugs were killed by the sting. Although they speak of *bicolor* as preferring a certain species of bug, they do not state the species, or even the family, of the bug; at one point they mention a wasp carrying a "small homopterous insect." Mickel (1918) took a specimen at Lincoln, Nebr., which "had attacked a nymph of *Pentatomidae* sp. and was dragging it away." Mickel also presents several flower records.

Astata nubecula Cresson. Ashmead's (1894) note on this species should properly be referred to *occidentalis*, as indicated under that species. In the U. S. National Museum there is a

specimen of *nubecula* from Salt Lake, Utah, pinned with an immature stinkbug identified by H. G. Barber simply as "Gen. & sp.?"

Astata immigrans Williams. Williams (1946) found that this species, described from Hawaii but apparently native to western United States, preys upon immature lygaeid bugs of the genus *Nysius*. Williams was able to observe mating, stinging and malaxation of the prey, and nesting activities all in large glass jars. Digging, he reports, is done with the mandibles, and the earth thrown out with the front legs. The bugs are carried in the same manner as I have described for *unicolor* and *occidentalis*. The nest is always left open and is "a short affair of more than one cell." The egg is "glued obliquely to the bug's breast." Williams also describes the behavior of the male, who "stations himself upon some stem or other convenient object" and "pivots about alertly or pursues some passing insect, to return to or near his station again. He appears to mate frequently and is often carried about by the female."

ETHOLOGY OF EURASIAN SPECIES OF ASTATA

Astata boops (Schrank). There are many published notes on this widely distributed species, and I shall not attempt to review all of them. Apparently Shuckard (1837) was the first to publish on its behavior, and later Fabre (1856), Ferton (1901), Adlerz (1903), and several others contributed additional observations from western Europe. Piel (1936) made some fairly detailed studies on the species in China, and Tsuneki (1947) in Korea. Tsuneki's paper is in Japanese, but his tables and his English summary provide the best single source of information on the behavior of this species.

The behavior of the male is in general similar to that of *unicolor*; Shuckard noted long ago that the male flies very rapidly and "settles upon small clods, whence it momentarily makes wide circumvolations." The females dig their burrows in various situations but chiefly in hard soil; in eastern Asia burrows are often constructed in the clay plaster of the walls of stone buildings. As many as 12 cells may be built in a single nest. These are constructed in various branches, many of them in series of up to three cells, the cells separated by thin partitions of earth.

The cells are broadly elliptical, oblique or almost vertical, and the walls are very smooth. From 2 to 15 (usually 3 to 6) bugs are placed in a cell, and the egg is laid in the same manner as in *unicolor* and *occidentalis*. To the best of my knowledge, all of the numerous bugs recorded as prey of this species are immature Pentatomidae and Cydnidae.

The bug is usually killed by the sting of the wasp. It is carried to the nest in flight, the wasp grasping it by the antennae with its mandibles and supporting it with the middle legs (Tsuneki) or with all three pairs of legs (Piel). At the nest entrance the wasp deposits the bug while she clears the entrance, enters, comes out, grasps the bug by the antennae, and drags it in backwards. The bugs are stored temporarily in various places in the burrow surrounded by loose sand; Tsuneki found as many as nine bugs in one burrow, and believes the wasp normally makes and provisions several cells at a time from the bugs stored in the burrow.

Astata minor Kohl. This species has been studied briefly by Ferton (1901) in Corsica and at considerable length by Minkiewicz (1933, 1934) in Poland. I have already mentioned, under *unicolor*, Minkiewicz' studies on the males. The females nest chiefly in bare, hard soil, often digging their nests in small depressions. The soil is cleared away from the entrance so that no mound of earth accumulates there. The nest is shallow and contains at least two cells; the cells vary considerably in depth. The prey consists of immature bugs of several genera, chiefly Pentatomidae but including a few Cydnidae and Lygaeidae. The bugs are stored in the cells in much the manner of the species already described; the usual number is about five per cell. According to Minkiewicz, the entrance is invariably closed from the outside when the wasp leaves the nest. When the wasp arrives with a bug, she drops it at the entrance, opens the nest, enters, and draws the bug into the nest. The manner of prey carriage and oviposition are said to be the same as in *boops*.

Astata picea Costa. This species is recorded as preying upon immature bugs of the family Pentatomidae and, less commonly, Coreidae. Ferton (1901) observed stinging and malaxation of the prey. Apparently the behavior resembles that of *boops* in most details.

Astata costai Piccioli. According to Ferton (1901), this species

also attacks pentatomid nymphs, but lays its egg with its long axis perpendicular to that of the body of the prey.

Astata rufipes Mocsary. Ferton (1901, 1908) and Berland (1925) record as prey several genera of immature bugs, all Cydnidae.

Astata tricolor Van der Linden. Ferton (1901, 1908) records two genera of immature Lygaeidae as prey of this species.

Astata stigma Panzer. Verhoeff (1951) cites two prey records for this species, one a pentatomid and the other a scutellerid. Earlier prey records for this species cannot be trusted, since several species have been confused under the same name.

Astata pinguis (Dahlbom). Verhoeff (1951) lists three prey records for this species, all Lygaeidae.

Astata freygessneri Carl. Verhoeff (1951) cites two prey records, both Pentatomidae.

ETHOLOGY OF THE SPECIES OF DIPLOPLECTRON

These very small wasps are poorly known both taxonomically and ethologically. The genus is known to occur only in North America and in South Africa. Judging from the few published observations, these insects seem to occur mostly in sandy areas, the female digging her nest in open sand. Rohwer (1909) described several species from Colorado which were taken "flying over dry sand." Krombein (1939) found *D. peglowi* "on sandy knolls sparsely covered with grass." He states that "the species evidently constructs its burrows in the sand since three females were taken while burrowing." Williams (1946) found an unidentified species nesting in the sand at San Francisco, California. This species was found to prey on immature Lygaeidae and store several bugs per cell, laying the egg "on the breast of one of these bugs." The prey is grasped by the antennae and carried to the nest in flight. Williams found another unidentified species preying upon adult and immature Lygaeidae.

From these very limited observations, it seems probable that the species of *Diploplectron* resemble *Astata* in many details of behavior. They do, however, exploit a different type of soil for nesting purposes, for the species of *Astata* only rarely nest in open sand.

DISCUSSION

The preceding survey of ethological data on the Astatinae is not exhaustive (except, I believe, for the North American species) but it will suffice for a few general remarks on the behavioral characteristics of the group. In general, the species which have been studied appear to be remarkably similar in their behavior. Only three species, *Astata unicolor*, *occidentalis*, and *boops*, have been studied in sufficient detail to permit any real comparison (Table IV), and I find it difficult to attach any particular significance to the rather minor differences between these species. The practice of building the nest beneath overhanging vegetation, observed in *unicolor*, may well be an adaptation for escaping the attacks of certain natural enemies such as miltogrammine flies. The building of cells in series is an efficient way of exploiting very hard soil, since it involves less digging than if each cell occupied a separate branch of the nest. Both *occidentalis* and *boops* nest in extremely hard soil, while *unicolor* nests in the clay-loam of gardens; the latter species appears to have less tendency to build cells in series.

A. occidentalis differs not only from *boops* and *unicolor* but from virtually all species of *Astata* in preying exclusively on adult Hemiptera rather than immatures. It is interesting to note that while Pentatomidae form the major prey of *Astata*, a number of species employ Cydnidae, Scutelleridae, Coreidae, or Lygaeidae, either instead of or along with Pentatomidae. Several of the species which use Lygaeidae show structural convergence toward the genus *Diploplectron*, which also preys on Lygaeidae. This includes *immigrans*, *tricolor*, and *pinguis*, all of which belong to the subgenus *Dryudella*. This subgenus approaches *Diploplectron* in such characters as the small size, delicate habitus, and very short marginal cell.

The close similarity of the species which have been studied makes it feasible to generalize regarding the behavior of the group as a whole and to enquire as to the relationships of the group as suggested by ethology. This is best done by considering some of the more outstanding characters of the group one by one. Useful in interpreting the significance of these characters are the papers of Nielsen (1936), Iwata (1942), and Leclercq (1954).

TABLE IV
COMPARISON OF SOME ASPECTS OF NESTING BEHAVIOR OF THREE SPECIES OF *Astata*

Species	Location of nest	No. cells per nest	Arrangement of cells	Manner of entering nest	Type of prey
<i>unicolor</i>	Beneath overhanging vegetation	Up to 14	Individually or two in series, separated by thick barriers of earth.	No closure during provisioning; female enters with prey, leaves prey well inside entrance and draws further in from inside.	Immature Pentatomidae
<i>occidentalis</i>	Bare places devoid of vegetation	Up to 14	Often in series of up to 3 cells, separated by very thin barriers of earth.	As above	Adult Pentatomidae
<i>boops</i>	Bare places devoid of vegetation	Up to 12	As above	Nest closed during provisioning; female drops prey outside entrance, clears entrance, then pulls in prey.	Immature Pentatomidae and Cydnidae

(1). The nest is many-celled and relatively complex, the cells smooth-walled and often in short series separated by barriers of earth. This is a highly specialized type of nest and not strongly reminiscent of that of any other digger wasp.

(2). The prey is allowed to accumulate in the burrow, more or less covered with soil, and only later is a cell prepared and the prey moved into it. This practice is common in the Philanthinae, but uncommon in other groups of Sphecidae.

(3). The prey is placed in deep paralysis by the sting of the wasp. This characteristic is shared with many of the more specialized Sphecidae.

(4). The prey consists of Hemiptera, suborder Heteroptera, with Pentatomidae the family most commonly used. Few other wasps use Pentatomidae, but they form the major prey of *Bicyrtes* (Nyssoninae) and *Paranysson* (Larrinae). Many Nyssoninae employ Homoptera and several genera of Larrinae employ Heteroptera.

(5). The bugs are placed tightly in the cell, venter-down, with the egg beneath the bottom bug; the larva feeds in an inverted position. I am not familiar with any other digger wasps exhibiting this behavior.

(6). The egg is attached to the prosternum of the prey and extends backward along the midline of the body. This type of oviposition is termed by Iwata a modified "Sphex-type"; it is similar but not identical to the common type in the Sphecinae and Larrinae.

(7). The prey is grasped in the mandibles and carried to the nest in flight. This is a relatively unspecialized method of prey transport, and occurs in several groups, including the Larrinae and Sphecinae, where, however, the prey is usually held dorsum-up rather than venter-up.

On the whole there seems little justification for regarding the Astatinae a particularly primitive group. Certainly there are genera in the Sphecinae and the Larrinae in which the behavior is much less advanced in every respect. Yet it can hardly be denied that the Astatinae bear some relationship to these two groups. This is borne out by adult structure and by behavioral characters 6 and 7 above. Yet I do not feel the relationship is a close one. Probably the Astatinae split off long ago from a

primitive sphecine stock and evolved independently of other groups of Sphecidae. Their predilection for Hemiptera, their manner of carrying the prey venter-up in flight and storing it in the burrow before placing it in a cell, and their complex, many-celled nests all suggest that the Astatinae may actually have split off (rather early) from that stock which gave rise to the two related subfamilies Nyssoninae and Philanthinae. This is supported by larval morphology. Obviously, a linear arrangement of the subfamilies which is also phylogenetic is impossible. Because the Astatinae appear first in catalogs, one should not necessarily look to them for indications of primitive behavior. If one does, he will be most disappointed, for the Astatinae are in many ways highly advanced. In some aspects of their nesting behavior, and also in the male behavior, they are in fact unique.

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SOME UNDESCRIBED SPECIES OF THE GENUS
BACCHA FABRICIUS
(DIPTERA: SYRPHIDAE)

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A study of miscellaneous Diptera from South America brings to light several new species of *Baccha* Fabricius, which are described here.

Baccha hippolite, new species

Related to *Baccha vierecki* Curran. The wings, instead of being yellowish with the costal border brown throughout, are hyaline with a distinct but diffuse, smoky spot at the apex. The pterostigma is yellowish brown. Face tuberculate. Length 7 or 8 mm.

FEMALE. HEAD: The face, cheeks and front light yellow, the latter with a medial orange line and a small, distinct, black spot on the preantennal callus. Frontal and facial pile yellow. The antenna is entirely orange, the arista black except narrowly at the base. The vertex is brownish black, quite slender. The occiput is brassy black with greyish yellow pollen and golden pile except on the upper third, where it is black.

THORAX: The mesonotum is reddish brown with a light coppery reflection and a pair of yellowish pollinose vittae, which become evanescent before they reach the scutellum. The sides of the mesonotum, including the postalar callosity and humerus and a medial stripe that encircles the humerus are pale yellow. Scutellum yellow, very faintly brownish on the disc only when viewed obliquely. The mesonotal pile is yellow. Scutellar pile very sparse, fine and black. Ventral fringe composed of about 2 or 3 pairs of long, fine, black hairs. The pleuron is pale yellow with an oblique, dark, brown band which occupies nearly all of the metapleuron and hypopleuron and the metanotum but only touches the anterior edge of the posterior spiracle. Squamae and border are sepia, the halteres yellow with the knobs sepia.

LEGS: The anterior and middle legs are entirely pale yellow, the posterior fringe of the middle femur yellow. The hind femur is yellow with an unusually wide, sharply delimited, sepia, subapical annulus and with a slightly less dark, more diffuse basal band. Hind tibia yellow at the base and in the middle and with distinct subbasal and apical sepia bands. The hind tarsi are entirely pale brownish yellow.

WINGS: The wings are nearly hyaline, including the costal cell. The pterostigma is light yellowish brown, the apex of the wing with a distinct but diffuse, smoky brown spot covering the end of the marginal cell, be-

gining at the end of the first vein and extending downward throughout the end of the submarginal cell and below it. The costa is considerably drawn downward, the third vein very gently arched but almost straight. The alula is long and narrow, not wider than the basal section of the costal cell. Preanal spuria faint. Subapical crossvein sigmoid and short.

ABDOMEN: The abdomen is petiolate, sepia brown with yellow pattern; the brown portions past the middle of the third segment have slight violaceous reflections. The first segment is yellow, narrowly brown along the posterior margin, except on the sides. The second segment is subcylindrical with parallel sides except that near the anterior third the segment expands gently towards the base. This segment is brown, lighter and more translucent basally, narrowly and diffusely yellow in the anterior corners with a wide, distinct, slightly diagonal yellow band on either side meeting in the midline; it is indented anteriorly and posteriorly and narrowly bordered in front by opaque brown and more widely bordered behind. The third segment has similar, wider and more widely separated orange bands on either side lying in the middle of the segment, narrowly bordered with opaque brown. Fourth segment with a pair of distinct, inverted V-shaped, orange spots, widely separated and deeply cleft posteriorly; the anterior limb is a little narrowed, reaching the base and these spots are therefore more widely separated towards the base than at their posterior ends, which lie a little beyond the middle of the segment. The clefts are narrowly opaque and the middle of this segment is shining. Fifth segment with a pair of submedial, distinct, elongate, orange, vittate spots, which do not reach the posterior margin. They are more narrowly separated than the spots of the preceding segment. Pile of first segment yellow, of the remaining segments sepia brown to black.

Type. Female, Chanchamayo, Peru, August 19, 1948, J. Schunke collector. Paratype female, same locality, August 1, 1948. In the collection of the author.

***Baccha ulrica*, new species**

Related to *Baccha danaida* Hull. The yellow markings of the third abdominal segment are band-like, not triangular. Those of the fourth segment have a prominent, sublateral, posteriorward, tail-like extension. Length 10.5 mm.

FEMALE. HEAD: The face and cheeks are yellow, the front yellow laterally with a broad, medial, somewhat diffuse, dark, brown stripe running from vertex to the posteriorly attenuate and acutely triangular shining black spot of the preantennal callus. The pile of the front is black and on the upper half of the face black. The remainder of the facial pile is yellow. The antenna is brownish orange, distinctly blackish from the arista to the apex of the segment. Arista narrowly yellowish at the base, the remainder blackish. Antennal pile black. The vertex is brassy black with dark, golden brown pollen and black pile lying in a single row. The occiput is

brassy black with pale golden brown pollen and long, golden or reddish hairs, which are not scalous or flattened. The upper pile of the occiput is black.

THORAX: The mesonotum is golden brassy in reflection over the black ground color with a pair of wide and widely separated, pale reddish brown pollinose vittae, which do not reach the scutellum. The sides of the mesonotum including humerus and postalar callosity are broadly yellow. The scutellum is pale brownish yellow, somewhat darker brown in oblique view and contrasting with the sharp, declivitous base, which is yellow. Almost the entire mesopleuron, the upper sternopleuron and a large spot above the anterior coxa and on the anterior third of the pteropleuron are light yellow. The remainder of the pleuron is metallic black. Squamae brown with reddish brown fringe. Knob of halteres reddish brown. The pile of the mesonotum is fine and yellow, the scutellar pile longer and black, the ventral fringe consists of some 4 or 5 pairs of long, slender, blackish hairs.

LEGS: The anterior and middle legs are entirely yellow, the fringe of the latter yellow basally, brownish apically. The hind femur is yellow, widely dark sepia annulate preapically and narrowly brown at the base. The hind tibia is diffusely and widely but distinctly sepia annulate subbasally. The remainder of this tibia is yellowish but rendered darker by the black lateral and dorsal pile. Ventrally the golden pile of the hind tibia extends widely over the outer half and more linearly to the base. The hind tarsi are entirely yellow.

WINGS: The wings are tinged with light brown throughout, the pterostigma is sepia brown. Third vein gently arched, the costa considerably drawn backward. The subapical crossvein is deep sigmoid but only moderately long. The preanal spuria is distinct. The alula is narrow but apically barely wider than the width of the first section of the costal cell.

ABDOMEN: The abdomen is broad and spatulate and not greatly narrowed basally, dark sepia brown in color with a pale, yellowish brown pattern. The first segment is yellow, narrowly shining brown on the posterior margin, except laterally. The second segment has the sides plane or straight and the segment but little wider posteriorly. This segment is one and one-fourth times as long as its least width. It is brown, the lateral margin narrowly lighter in color with a rather wide, complete, slightly arched, brownish yellow fascia, which lies across the middle of the segment and is bordered anteriorly and posteriorly with opaque brown. The third segment is a little wider than long with a similar arched fascia in the middle, which is narrowly interrupted by brown in the middle. It also is rather widely bordered by opaque brown. The fourth segment has a pair of distinctly separated, elongate-oval, subbasal spots, which are slightly convergent posteriorly; from the anterolateral corners of each of these spots there is a slender, arched band of the same yellowish brown color, which turns backward but does not reach the lateral margin. These fourth segment spots are surrounded by opaque sepia and the posterior indentations are filled with opaque sepia. The fifth segment has a pair of submedial, medially rounded and posteriorly arched, acute, yellowish brown vittate spots, which basally extend outward towards the sides and which border the basal margin more

narrowly near the lateral margins. These vittae do not reach the posterior margin and their posterior angles together with the area between are opaque. Sixth segment quite short. Anterior pile of the first segment reddish yellow, remainder of this pile and all of the other abdominal pile black. On the third and fourth segments the basal margin is very narrowly yellowish brown, except for a minute space in the middle on the fourth segment.

Type. Female, Chanchamayo, Peru, August 19, 1948; paratypes 2 females, June 8, 1948, same locality, collected by J. Schunke. In the collection of the author.

A FEW SCOLYTIDAE FROM THE WEST INDIES*

BY KARL E. SCHEDL

LIENZ, AUSTRIA

Collections of Scolytidae and Platypodidae from the West-Indies are very rare even from Islands frequently visited by entomologists or such with Agricultural Experiment Stations. Therefore the fauna of this most interesting region is rather badly known and every opportunity must be welcomed to learn more of its composition and the distribution of species belonging to these two families.

Lately, Dr. Peter F. Bellinger of the Osborn Zoological Laboratory at Yale University has kindly sent me a small lot of Scolytidae originating from Jamaica and Trinidad, and some others from Cuba and Santa Lucia I found among material forwarded to me by the Department of Entomology of Cornell University, Ithaca, N. Y. Four more records came about during determination work in recent years.

All specimens from Jamaica were collected from Berlese samples of litter proving once more that even in subtropical and tropical countries a good number of Scolytidae spent their seasonal diapause in the litter of the soil, sometimes still immature, in other instances fully colored and in both sexes.

The species found are:

Hypothenemus eruditus Westw.

Trinidad: Pitch Lake, Aug. 7, 1956, G. Underwood.

Jamaica: Cane River Falls, St. Andrew Parish, 500 ft., March 31, 1956, from damp leaf litter in shady hollow, P. F. Bellinger.

3 miles north of Negril, Westmorland Parish, 500 ft., April 10, 1956, leaf litter and red soil, P. F. Bellinger.

Near Mammee River, below "Maryland," "St. Andrew Parish, 750 ft., May 10, 1956, in damp leaf litter and underlying humus in thicket, P. F. Bellinger.

* 139th Contribution to the morphology and taxonomy of the Scolytoidea.

Cuba: San Vicente, P. d. Rio, July 14, 1940, J. C. Bradley.
 Vinales, P. d. Rio, March 23, 1939, J. C. Bradley.
 El Retiro, Sierra Rangel, P. d. Rio, March 26, 1939,
 J. C. Bradley.

Hypothenemus intersetosus Egg.

Jamaica: Beside road east of Lindo's Gap, St. Andrew Parish,
 March 31, 1956, from dead leaves on ground, P. F.
 Bellinger.

Cuba: San Vicente, Pinai del Rio, July 9, 1940, J. C. Bradley.
Stephanoderes moschatae Schauf.

Trinidad: Oropuche Cave, Aug. 15, 1956, G. Underwood.

Among a number of females there was a hitherto undescribed male with the following characters:

MALE.—Piceous brown, 0.8–0.9 mm. long, about twice as long as wide. Compared with *Stephanoderes hampei* Ferr. the male of *S. moschatae* Schauf. is decidedly smaller, somewhat more cylindrical, the apex of the elytra not quite as narrowly rounded and the elytral declivity more convex. The punctuation of the elytra is not as coarse, the striae very feebly to indistinctly impressed and the setae of the interstices shorter and stouter.

Type in collection Schedl.

Some more males have been found among a lot of females originally referred to *Stephanoderes hampei* Ferr. (Schedl, Ent. Ber. XIII, 1951, p. 376) from Surinam, Port Peperpot, Feb. 2, 1951, in Koffiebessen, Dr. D. C. Geyshe. Females only are represented in a lot from Cuba: San Vicente, P. D. Rio, July 14, 1940, J. C. Bradley.

Stephanoderes glabratulus n. sp.

Pitchy black, 1.25 mm. long, 2.3 times as long as wide. A small but rather stout species easily recognizable by the strongly shining and very finely sculptured elytra.

Front narrow, feebly convex, densely punctured, with a fine short pubescence.

Pronotum wider than long (16:13), widest shortly in front of the base, postero-lateral angles rectangular and closely attached to the elytra, sides subparallel on the basal fourth, thence strongly incurved, apex moderate-broadly rounded and armed with six fine and slender asperities of equal size; summit somewhat behind the center, anterior area obliquely convex, with a patch of medium sized more blunt asperities on a rather narrow triangular

space, basal area very densely granulate-punctate; pubescence short and stout. Scutellum small, triangular.

Elytra as wide and 1.8 times as long as the pronotum, cylindrical and the sides parallel on the basal two fifths, thence gradually incurved, apex moderately broadly rounded, declivity commencing in the middle, uniformly convex; disc with rows of very fine punctures bearing extremely short inclined hairs in not impressed lines, interstices with similar puncturation but the setae erect and stout; on the declivity the inclined hairs of the main striae more conspicuous, the setae of the interstices larger and somewhat spatulate distally.

Types in collection Schedl.

Locality: Jamaica. Rum Cave vicinity, St. Ann Parish, Jan., 30, 1955, in leaf litter & humus, P. F. Bellinger.

Among the five females there is a single male very similar in shape and sculpture to that of *Stephanoderes moschatae* Schauf. *Poecilips caraibicus* Schedl.

Puerto Rico: Rio Piedras, Sept. 22, 1952, from seeds of *Mamea americana* L., Wolcott leg.

Poecilips confusus Egg.

Jamaica: Trail from Guava Ridge to Bellevue, St. Andrew Parish, Dec. 18, 1955, in mixed pine & hardwood litter, P. F. Bellinger. The pines, probably *Pinus caribaea*, are not native to Jamaica.

Coccotrypes palmarum Egg., mase. nov.

MALE.—Yellowish brown, 1.4 mm. long, twice as long as wide. Distinctly smaller and more slender than the female.

Front feebly convex, finely punctured, with short inconspicuous pubescence.

Pronotum about as wide as long, postero-lateral angles rectangular and closely attached to the elytra, sides feebly arcuate on the basal half, broadly rounded in front, subapical constriction merely indicated; disc less convex than in the female, finely asperate, the asperities fading out towards the median line behind; pubescence short. Scutellum minute, triangular.

Elytra somewhat wider and nearly twice as long as the pronotum, widest shortly before the middle, sides broadly arcuate, more strongly narrowed behind the basal third and obliquely convex; surface with the puncturation similar to that of the female but much finer; the pubescence restricted to long erect

setae arising from the punctures of the interstices.

Types in collection Schedl.

Locality: Trinidad: Oropuche Cave, Aug. 15, 1956, G. Underwood.

Cryptocarenum seriatus Egg.

Santa Lucia: Gastries, Sept. 10, 22, 1919, J. C. Bradley.

Pterocyclon brittoni Schedl.

Jamaica: Corn Puss Gap, St. Thomas-Portland Parish line, 2200 ft., June 27, 1954, in humus and soil under Santa Maria trees (*Calophyllum jacquinii*), P. F. Bellinger.

Xyleborus affinis Eichh.

Jamaica: Cooper's Hill, St. Andrew Parish, 2400 ft., Feb. 10, 1955, from leaf litter and red soil in thicket, P. F. Bellinger.

Xyleborus mascarensis Eichh.

Cuba: El Retiro, Sierra Rangel, P. d. Rio, March 26, 1939, J. C. Bradley.

San Vicente, P. d. Rio, July 15, 1940, J. C. Bradley.

Puerto Rico: Rio Piedras, Feb. 9, 1940, in sugar cane, C. Perez.

Xyleborus perforans Woll.

Santa Lucia: Castries, Sept. 10, 22, 1919, J. C. Bradley.

Xyleborus torquatus Eichh.

Trinidad: South slope, Aripo Forest, 1500 ft., Aug. 10, 1956, G. Underwood.

Pitch Lake, Aug. 7, 1956, same collector.

Oropuche Cave, Aug. 15, 1956, same collector.

Cuba: El Retiro, Rio Taco-Taco, P. d. Rio, 1000 ft., March 26, 1939, J. C. Bradley.

El Retiro, Sierra Rangel, P. d. Rio, March 26, 1939, J. C. Bradley.

Xyleborus spinulosus Blandf.

Trinidad: Oropuche Cave, Aug. 15, 1956, G. Underwood.

Platypus ratzeburgi Chap.

Puerto Rico: from dead or freshly felled firewood of Inga Vera or Inga Laurina, George N. Wolcott.

Platypus rugulosus Chap.

Cuba: Ent. Agric. Colon. Paris, in the wood of cases enclosing cigar boxes.

A CONTRIBUTION TO THE TAXONOMY,
DISTRIBUTION AND BIOLOGY OF THE
VAGRANT ANT, *PLAGIOLEPIS ALLAUDI* EMERY
(HYMENOPTERA, FORMICIDAE)

BY MARION R. SMITH

ENTOMOLOGY RESEARCH BRANCH
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About 1946 a small, yellow *Plagiolepis* was intercepted by Plant Quarantine Inspectors of the U. S. Department of Agriculture on such plants as gladiolus, croton, poinsettia, daisy, hibiscus, bryophyllum, pampas grass and Surinam cherry from the Bermuda Islands. At that time only a generic identification was made, although it was recognized that the ant was an introduction from the Old World. *Plagiolepis* is native only to the Old World. Furthermore, although species of *Plagiolepis* have been spread by commerce over various parts of the world, so far as I am aware none has been correctly reported from the New World. *Plagiolepis flavidula* Roger (1863, Berlin Ent. Ztschr. 7:162, worker, type locality unknown but thought to have been Cuba) is definitely a species of *Brachymyrmex*, according to H. Bischoff, who recently examined the type. These circumstances led me to investigate thoroughly the intercepted *Plagiolepis* in order to determine its status, distribution, and recorded biology. I thought the ant might be *allaudi* Emery, a species originally described from the Seychelles, or a closely related form. The type specimen of *allaudi* was borrowed from the Museo Civico di Storia Naturale of Genoa, and the type of *foreli* Santschi from the Naturhistorisches Museum of Basel. Types of *augusti* Emery (*foreli* Mann not Santschi) are in the National Museum at Washington, D. C. Examination of the types of these three nominal species showed them to represent a single species, identical with the intercepted *Plagiolepis*, to which the name *allaudi* should be applied. I am indebted to W. L. Brown for ascertaining that the type of *mactavishi* W. M. Wheeler, in the Museum of Comparative Zoology, Cambridge, Mass., is so nearly identical with *allaudi* that the name *mactavishi* should be and is herewith

synonymized. I was not able to obtain types of *ornata* Santschi, but am synonymizing that species on the basis of the description alone.

For the kindness of loaning me types of the various nominal species I wish to thank the following: Delfa Guiglia of Genoa, Ed. Handschein of Basel, and Charles Ferriere of Geneva.

Below are listed references to *alluaudi* and its synonyms, with an indication of caste or castes from which described, type locality and type repository. Also cited are other helpful bibliographic references.

Plagiolepis alluaudi Emery

- Plagiolepis alluaudi* Emery, 1894. Soc. Ent. de France Ann. 63: 71, *worker*. (La Misere, Mahe, Seychelles; types in Museo Civico di Storia Naturale, Genoa, Italy.)
- Plagiolepis mactavishi* W. M. Wheeler, 1908. Amer. Mus. Nat. Hist. Bul. 24: 166, *worker*. (Moorea, Tahiti, Society Islands; types in Museum of Comparative Zoology, Cambridge, Massachusetts.) *New syn.*
- Plagiolepis foreli* Santschi, 1920. Soc. Vaud. des Sci. Nat. Bul. 53: 165, figs. G. H. I, *worker*. (Botanical Garden, Zurich, Switzerland; types in Naturhistorisches Museum, Basel, Switzerland.)—Emery, 1921. Soc. Ent. de Belg. Ann. 61: 318 (as *alluaudi* var. *foreli*.) *New syn.*
- Plagiolepis foreli* var. *ornata* Santschi, 1920. Soc. Vaud. des Sci. Nat. Bul. 53: 166, *worker*. (New Caledonia; types in Naturhistorisches Museum, Basel, Switzerland.)—Emery, 1914. Nova Caledonia Zool. 1: 421 (misdet. as *exigua* var. *quadrinaculata* Forel.)—Emery, 1921. Soc. Ent. de Belg. Ann. 61: 318 (as *alluaudi* var. *ornata*.) *New syn.*
- Plagiolepis foreli* Mann, 1921. Harvard Univ., Mus. Compar. Zool. Bul. 64: 473, *worker*. (Suava, Viti Levu, Fiji Islands; types in the United States National Museum, Washington, D. C.) *Preocc. New syn.*
- Plagiolepis augusti* Emery, 1921. Soc. Ent. de Belg. Ann. 61: 317. *New name for foreli* Mann. *New syn.*

I offer here a redescription of the worker only, with emphasis on the more salient characters.

WORKER. Length: 1.25–1.33 mm.

Apex of scape very distinctly surpassing the posterior border of the head

(by at least the length of the first funicular segment); the second and third funicular segments extremely short, and distinctly broader than long; all other funicular segments longer than broad. Eye with 8 to 10 ommatidia in its greatest diameter. Thorax with a very distinct mesoepinotal constriction but the metanotal suture obsolescent. Clypeus with a group of approximately 6 rather long, anteriorly projecting hairs. A pair of short, suberect or erect hairs near the middle of the posterior border of the head (these not clearly seen unless the hairs are in profile; one or both of the hairs are sometimes missing, probably due to rubbing). Posterior border of each gastric segment with a transverse row of long, suberect to erect hairs dorsally, the hairs usually as long as, or longer than the space separating adjacent hairs. Pubescence on body rather sparse, closely appressed, best seen only in certain lights and positions. Color highly variable even in individuals from the same colony, ranging from an almost uniform light yellowish to rather dark brown; gaster commonly darker than the remainder of the body. Integument or body rather smooth and shining.

Evidence obtained from literature indicates that *alluaudi* is of Ethiopian origin and has been spread by commerce to various parts of the world. In Europe it has been found in hot houses or botanical gardens in England, Scotland, Ireland, Germany, and Switzerland. It has also been collected from many islands in the Indian and Pacific Oceans, especially those nearest Africa and Madagascar. Its presence on islands in the Pacific Ocean is presumably due to introduction. In addition to the Bermuda Islands, I have seen individuals from Catalina Island, California, collected by W. M. Mann, and from St. Lucia and St. Kitts in the British West Indies intercepted on plants by Plant Quarantine Inspectors of the U. S. Department of Agriculture. So far as I am aware, records from these four localities have not been previously published. More specific information on the distribution of *alluaudi* may be obtained in the following references: (as *alluaudi*) W. M. Wheeler, 1922, Amer. Mus. Nat. Hist. Bul. 45: 928, 1035; Donisthorpe, 1927, British Ants, p. 396, Geo. Routledge and Sons Ltd., London; (as *mactavishi*) W. M. Wheeler, 1935, Bernice P. Bishop Mus., Occas. Papers 11 (11): 38, and 1936, *op. cit.*, 12 (18): 16; (as *ornata* and *augusti*) W. M. Wheeler, 1935, *op. cit.*

The following notes on the habits of *alluaudi* in Bermuda have been kindly supplied by I. W. Hughes. It is fairly definite that the species has been in Bermuda for at least 5 or 6 years, and although widely distributed it does not seem to be numerous anywhere. The species frequently nests under the bark of dead oleander limbs or in tunnels in this or other plants made by the

cerambycid *Leptostylus praemorsus* (F.). Some colonies are rather large and they may even be polydomus. The large size of many colonies can no doubt be attributed to the numerous egg-laying females. The largest colony observed was in a clump of oleander heavily infested with *Pulvinaria psidii* Maskell and containing much dead wood. The workers are rather inconspicuous on the plants and do not seem inclined to wander far from their nests. They apparently live on good terms with other ants, especially with *Pheidole megacephala* (F.). The workers are primarily sweet-eating and accustomed to tending honeydew-excreting insects, such as the green shield scale, *Coccus viridis* Green, *Pulvinaria psidii* and a species of the genus *Saissetia*. *P. alluaudi* is a household pest of some importance, commonly invading houses at night and seeking out sweets and fats. However, it is not as common or economically important in Bermuda as *Iridomyrmex humilis* Mayr and *Pheidole megacephala* (F.).

P. alluaudi may be the only species in Hawaii, although it has been recorded from there as both *mactavishi* W. M. Wheeler and *exigua* Forel. Philipps (1934. Univ. Hawaii Expt. Sta. of Pineapple Producers Coop. Assn. Ltd., Bul. 15: 54) states that the species is widely distributed there. He attributes its success to a short life cycle, tolerance of limits of temperature and humidity, and an ability to live in harmony with other ants, especially the more aggressive ones. In Hawaii as in Bermuda, workers commonly tend honeydew-excreting insects, but their importance in fostering or distributing these insects, particularly the pineapple mealybug, is not so clearly established as is that of some of the other ants. The ants are said to nest in houses, algaroba hollows, and pineapple stumps, and under stones and mulch. Ehrhorn (1931. Proc. Haw. Ent. Soc. 7: 393) found *alluaudi* in houses, especially after rains. He stated that this species and *Pheidole megacephala* entered electric conduits and destroyed the insulation. Krauss in a letter referred to *alluaudi* as a house-infesting ant in Hawaii with a fondness for sweets.

Plagiolepis alluaudi is admirably adapted for becoming widely distributed by commerce throughout the tropical and semitropical parts of the world. It would not be surprising to learn of its presence in many more localities than are now known. The fact that it is a tramp species also accounts for many of the synonyms.

NEW SPECIES OF FLIES OF THE GENUS BATHYPOGON LOEW

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This genus is a characteristic one in the southern hemisphere but is restricted to Chile and Australia. It appears to be a comparatively large and successful group within the family.

Bathypogon calabysi, new species

A very small species, characterized by the widely black mesonotum, with nearly black, lateral margins; by the brownish white, facial bristles; the black bristles of the supraocciput, mesonotum and scutellum. Hypandrial plate of terminalia with a very minute tooth. Length 11 mm.

MALE. HEAD: The ground color of the head everywhere black except for a narrow band of medium brown color just above the epistoma, which is continued on to the anterior half of the cheeks beneath the eyes, but is interrupted by a diffusely arranged black spot, which also reaches to the eye. As a result, the posterior cheeks are black, followed by brown, and in front of this brown area there is a diffuse blackish spot representing a lateral extension of the epistomal margin. Lying upward or above and medial to the lower spot of brown, there is a second spot or band of brown. The upper two-thirds of the face is black. Pollen is brownish white or very pale yellow along the eye margins. The bristles of the face are few in number; on the middle of the low elevation there are 5 or 6 long, stout, pale brown bristles and several additional pairs on the oral margin. Besides these in the middle of the face there are from 25 to 30 shorter, much more slender, white bristles or bristly hairs. The antenna is black; the apex of the second and base of the third segments quite narrowly brown; antennal and palpal pile white. The short, upper bristle row of the occiput and the ventral, occipital pile is white. The postvertical bristles of the occiput, 2 or 3 bristles between the ocelli, and 1 on either side of the anterior vertex are all dark brown but not black. The postvertical cluster contains 7 or 8 bristles.

THORAX: The mesonotum is black with the exception of the humerus, which is medium brown, perhaps slightly reddish. The lateral margin is narrowly and obscurely brown. The pollen of the dark areas is quite dark brown with a slight golden cast. Lateral pile is pale brownish yellow. The compliment of mesonotal bristles consists of the usual 12 and all are black, including the scutellar bristles. The postalar callosity is pale in color. All pleural bristles are pale, except 2 stout, metapleural elements, which are brown. The pleuron is medium brown with several black areas, which consist of the center of the upper propleuron, which is extended laterally on to

the middle of the anterior coxa, the lower half of the sternopleuron, all of the mesopleuron, except the anterior and posterior parts, and the anteroventral half of the hypopleuron. Pleural pollen pale brown.

LEGS: The legs are medium to light brown in color with the anterior half and most of the dorsal margin of the anterior and middle femora black from base to apex and the lateral and dorsal surfaces of the hind femur and the whole lateral surface of the hind tibia black. The anterior surface of the anterior tibia and anterior and middle surface of the middle tibia are dark brown; the remainder of these tibiae rather light brown and slightly reddish. Medial surface of hind tibia and all of the tarsi dark brown. The claws are unusually slender from both dorsal and lateral view, are comparatively sharp and are light brown on at least the basal third.

WINGS: The wings are pale, brownish hyaline, the apex at most only faintly darker, the veins are sepia, except before the humeral crossvein, where they are light brown. The lower end vein of the discal cell makes a strong angle with the end vein of the fourth posterior cell.

ABDOMEN: The abdomen is black and rather shining. The pollen on the dorsal surface of the tergites is thin and light sepia brown in color. Lateral margin of the first 3 tergites nearly completely margined narrowly with pinkish brown, but subapically indented by a diffuse, blackish extension. Traces of the same color are at the base of the fourth and fifth tergites and these areas with similarly colored pollen. Pile of the abdomen is quite pale, brownish yellow or brownish white. Sides of the first segment with 3 bristles. Terminalia distinctly light brownish red dorsally at the base of the superior forceps, and medium red or brownish red on the whole of the hypandrium and its dorsal extension. The hypandrium has only the most minute tooth.

Type. Male, Owieandana, North Flinders Range, collected by Hale and Tindale. No date given. Named in honor of Mr. John Calaby of Perth.

***Bathypogon douglasi*, new species**

A small species characterized by the wholly black legs; the thorax is black, except the humerus. All bristles are pale, although those of the mesonotum are medium reddish brown. Terminalia distinguished by the stout, tooth-like processes on the hypandrium and the down-curved, sharply pointed tooth on the apex of the superior forceps. Length 15 mm.

MALE. HEAD: The head is black, the pollen and pubescence completely greyish white except on a small triangle adjacent to the eye behind the ocelli where it is light brown. Pile on the lower half of the occiput, proboscis and palpus opaque white, the palpus and proboscis shining black. Bristles of upper occiput, vertex, face and antenna quite pale brown. Antenna black, the third segment unusually slender; the style is well developed.

THORAX: The thorax is black with only the humerus dark reddish brown. The anterior stripes of the mesonotum are distinct, separated by a narrow

yellowish brown stripe of pollen which from the anterior view becomes almost as wide as the adjacent dark stripe. The pollen over the middle of the mesonotum is reddish brown, but laterally pale, yellowish grey and more golden brown anteriorly between the humeri; pollen of the pleuron pale grey. The complement of thoracic bristles consists of 1 posthumeral, 2 notopleural, 1 supraalar, 2 postalar, 2 pairs of scutellar bristles, 4 or 5 post-dorsocentral and 1 or 2 differentiated metapleural bristles. The metapleural bristles are pale brownish yellow. The mesonotal bristles and scutellar bristles are light reddish brown.

LEGS: The legs are comparatively slender and everywhere black. The bristles and pile brownish yellow.

WINGS: The wings are hyaline, veins dark brown. Lower end vein of discal cell nearly three times as long as upper vein (discal crossvein) and making a strong angle with the lower end vein of the fourth posterior cell. Apex of wing not darker and without villi. Base of anterior branch of third vein with a distinct stub in one wing and a strong angle in the other wing.

ABDOMEN: The abdomen is black, the apex of the fifth tergite, the apical half of the sixth, the whole of the seventh and eighth light reddish brown. The dorsal pollen is distinctly reddish brown; the lateral pollen is widely grey. Terminalia light brownish red, except in the medial portion of the apical half of the superior forceps. These forceps are strongly rounded, convex distally with sharp, tooth-like, apical process. Hypandrium with stout but sharp, tooth-like process.

Type. Male, Townsville, Queensland, collected by G. F. Hill. No date given. Named in honor of Mr. Athol Douglas of Perth.

***Bathypogon flavifemoratus*, new species**

A small species characterized by the light yellow femora, which are distinctly though diffusely brownish black on the apical sixth or less, with an additional extension of black towards the base, situated dorsally and of varying length according to the pair. All tibiae and tarsi dark sepia brown; all bristles pale and the antennal segments brownish black. Length 15 mm.

FEMALE. HEAD: The head is black in ground color, except on the upper half of the face, which laterally is diffusely light yellowish brown or clay color, leaving most of the facial protuberance and a medial spot beneath the antenna blackish. The medial portion of the facial protuberance is pale. The pollen of the occiput and front and the pubescence of the face pale grey with a slight yellowish cast. The postvertical bristles are brownish yellow and the medial and lower bristles of the face are the same color and exceptionally stout, and reach only to the apex of the proboscis. The bristles of the antenna are brownish yellow; the lower occipital pile is nearly white. The first 2 segments of the antenna are brownish black; third segment unusually slender, with prominent style, blackish in color, becoming on the lower surface near the apex dark red. Palpus swollen, shining with nearly white pile, its color reddish sepia.

THORAX: The thorax is narrowly black down the middle of the mesonotum, the black forming 2 submedial stripes, which are separated anteriorly by red and throughout their length by a narrow stripe of brownish yellow pollen. These black stripes end at a point corresponding to the anterior plane of the postalar callosity and leave a large rectangle of reddish brown color in front of the scutellum. In addition to the submedial black stripes, which are completely bordered by red, there is a much wider but shorter black stripe beginning halfway on that portion of the mesonotum which lies in front of the suture and extends back to the posterior end of the postalar callosity. This lateral stripe has reddish brown pollen, except along the diagonal path of the transverse suture, which is pale grey pollinose. The anterior and lateral pollen on remaining red portion of the mesonotum is light brownish yellow. Pleuron chiefly light red with a small, black spot on the lower middle portion of the mesopleuron, the anterior pteropleuron, the lower sternopleuron and hypopleuron. Pleural pollen pale brownish yellow. The thoracic complement of bristles consists of 1 posthumeral, 2 notopleural, 1 supraalar, 2 postalar, 2 pairs of scutellar bristles and 4 postdorsocentral bristles, all of these being light reddish brown. Metapleuron without strong bristles and all other thoracic bristles pale yellowish white.

LEGS: The femora are comparatively slender, light yellow in color; the anterior pair has the apical sixth dark and an anterodorsal dark streak extends obliquely to the base. Middle pair with the apex dark and a dorsal stripe extending only over the outer third dark in color. On the hind femur there is a similar dark apex extending dorsally and obliquely upon slightly more than the apical third. All tibiae and tarsi very dark sepia brown. The ventral surfaces of the tarsi are medium reddish brown. Pile and bristles of the legs yellowish white. Bristles of hind femur unusually well developed, long and stout with 5 or 6 bristles laterally. Claws sharp, and reddish in color on the basal third.

WINGS: The wings are nearly hyaline with a faint tinge of brown. All the veins beyond the humeral crossvein are dark brown. Lower end vein of discal cell more than twice as long as the upper vein and making a strong angle with the end vein of the fourth posterior cell.

ABDOMEN: The abdomen is black, the second to fifth tergites with thin, dark, reddish brown pollen; the black lateral margins bear dense, grey pollen, which near the middle of each tergite extends triangularly in towards the middle of the segment but not as far as the red line. As the result, the dorsal, shining, black portion on tergites 2 to 5 has somewhat the appearance of broad, posteriorly rounded, saddle-like spots. Seventh and eighth tergites wholly shining black; pile and bristles of the abdomen yellowish white and weakly developed. Sides of the first tergite with 3 moderately strong bristles.

Type. Female, Townsville, North Queensland, collected by G. F. Hill. No date given.

The types of species described in this paper are in the South Australian Museum.

A REVISIONARY STUDY OF PHEIDOLE VASLITI PERGANDE (HYMENOPTERA: FORMICIDAE)

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During the period from 1950 to 1953 the writer observed a large number of colonies belonging to the *vasliti* complex in southern Arizona and Mexico. Samples from these colonies brought home for further study have indicated that the existing taxonomic structure of the complex is not altogether satisfactory. Much of this trouble results from the variable color of these insects, which cannot be correlated with distribution or even with differences in nest sites. But after it had been determined that the named color varieties in this complex have no distributional significance, a serious difficulty still remained. This is the exact nature of Pergande's species *vasliti*.

As is shown in this study, Pergande had a very hazy concept of the character of *vasliti*. It is not surprising, therefore, that those who later worked with this insect based their ideas of *vasliti* on something more tangible, notably Forel's variety *hirtula*. This procedure was not entirely unfortunate, for it can be shown that *hirtula* is a sound species in its own right. Indeed, there is room for the view that the status of *hirtula* has been too sound. Because it is so distinct and so easily recognized, *hirtula* has carried the unrecognizable *vasliti* on its back for nearly sixty years without anyone appreciating the drastic shortcomings of the latter species. It is evident that Forel (1899) believed that he could recognize *vasliti*, for he described *hirtula* as a variety of it. But Forel did not know that the worker caste of *hirtula* is polymorphic until Wheeler sent him nest series from Queretaro in 1900. Forel then realized that the insect which he had previously treated as Pergande's *obtusospinosa* is actually the major of *hirtula*. Then Forel (1901) took characteristic action—he protected his variety *hirtula* by declaring that *obtusospinosa* is the major worker of *vasliti*. In a few years this mistake was recognized and corrected, but Forel's equally mistaken contention that *hirtula* is a variety of *vasliti* has been accepted without question to the present.

W. M. Wheeler (1914) published a paper in this Journal which carried a revision of the *vasliti* complex. Wheeler had seen some, although not all, of Pergande's types. He also had a fairly substantial amount of material from several stations in Mexico and southern Arizona. He was, therefore, in a position to give the best account of the *vasliti* complex which had appeared up to that time. Wheeler showed that the members of the *vasliti* complex are divisible into two distinct groups on the basis of structural differences shown by their respective majors. In one group (*hirtula*, *acolhua*) the head of the major is strongly cordate, because it is narrowed at the level of the insertion of the mandibles. Measurements made by the writer show that the head of such majors has a maximum width of 2.8 mm. and a width at the level of the insertion of the mandibles of 1.8 mm. In addition, neither of the two large apical teeth of the mandibles of such majors is depressed. Because of this the upper surface of the mandible forms an even curve, broken only by a narrow groove between the two apical teeth. In the second group (*subdentata*, *arizonica*) the head of the major is less strongly cordate because it is less constricted at the level of the insertion of the mandibles. In such majors measurements by the writer give the greatest width of the head as 2.8 mm. and the width at the level of the insertion of the mandibles as 2.0 mm. In the mandible of such majors, the outermost of the two apical teeth and the portion of the mandible just behind it are both distinctly depressed. Because of this flattening the upper face of the mandible does not form an even curve but breaks sharply at the inner tooth, descending abruptly to the flattened terminal portion.

There are other important differences which Wheeler did not mention. In the major of *hirtula* the rugae on the occipital lobes and most of the front are very feeble or absent. These areas bear many prominent, elongate, piligerous punctures, between which is a rather feebly granulate surface. In addition there are prominent striae at the base of the mandible and the remainder of the upper surface of the mandible is covered with coarse, piligerous punctures (Plate VI, Fig. 1). In *subdentata* the occipital lobes and the front of the head of the major are covered with delicate, but quite easily discernible, longitudinal rugae. These and the granulose surface between them always obscure

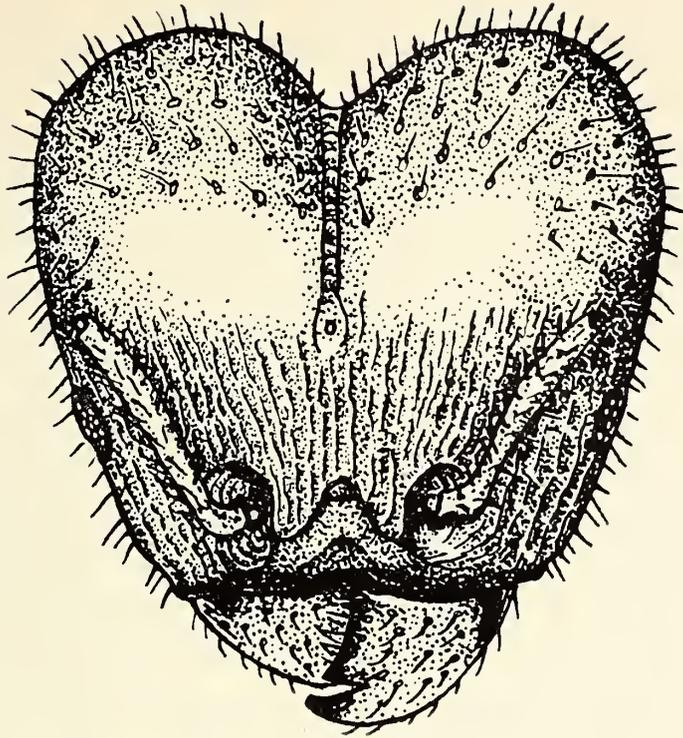


FIG. 1

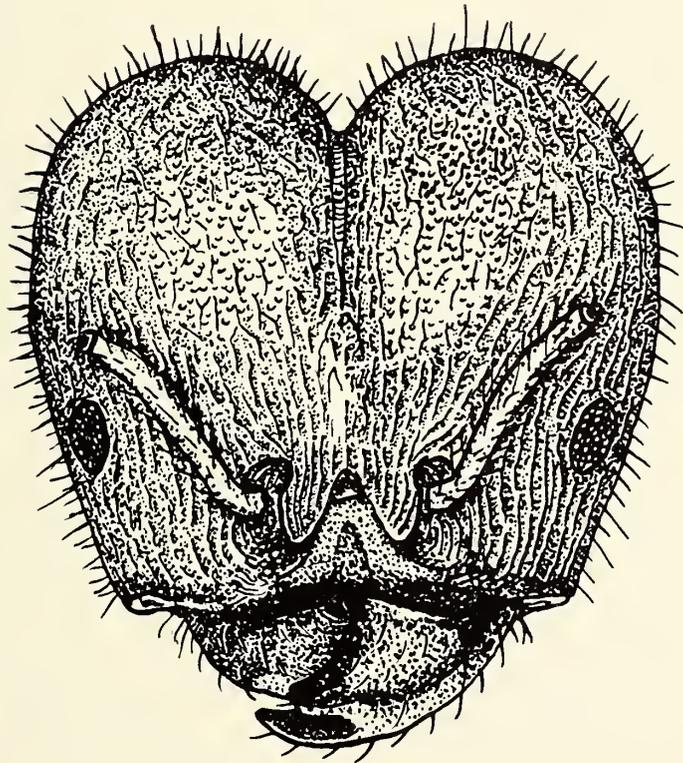


FIG. 2

FIG. 1. Head of the major of *Pheidole hirtula* Forel. Maximum head width 2.8 mm.

FIG. 2. Head of the major of *Pheidole subdentata* Pergande. Maximum head width 2.8 mm.

the piligerous punctures to some extent and often make the punctures difficult to see. The basal striae on the mandibles of such majors are feeble or absent and the upper surface of the mandible bears small, piligerous punctures (Plate VI, Fig. 2). These differences, plus those of dentition, are usually shown by the larger medias as well. They are less clearly shown by the smaller medias (those in which the antennal scapes reach the occipital angles) and not shown at all by the minors. Even so, these distinctions are more serviceable than those based on proportions which change with the size of the worker. It is unfortunate that Wheeler employed two such characters in the key which accompanied his revision. The shape of the head and that of the postpetiole both fall into this category. It is true that Wheeler restricted his key to the major worker but he did not give any measurements by which this caste could be certainly recognized. If distinctions of this sort are to be useful they should be accompanied by a reliable measurement of the size of the worker which shows them.

Wheeler preferred to treat these two populations (*hirtula* and *subdentata*) as subspecies and on this basis he gave the *vasliti* complex the following constitution:

- Ph. vasliti* Pergande
- var. *hirtula* Forel
- var. *acolhua* Wheeler
- subsp. *subdentata* Pergande
- = *obtusospinosa* Pergande
- var. *arizonica* Santschi

It is clear from this arrangement that Wheeler had recognized Forel's error in treating *obtusospinosa* as the major of *vasliti*, but it is equally clear that he did not question Forel's view that *vasliti* and *hirtula* are essentially the same; nor did Emery (1921), who used Wheeler's arrangement in the *Genera Insectorum*. The only alteration to the above plan which has been suggested is that of the writer, (1950), who treated *arizonica* as a subspecies. I now know that this treatment is incorrect, for *arizonica* cannot be separated from *subdentata*.

The material which the writer collected in Mexico and southern Arizona falls readily into one or the other of the above groups. The definitive structural features which separate these groups

are maintained with high constancy throughout the entire range of each population. Moreover, these ranges appear to be entirely separate. The eastern population which, for reasons to be explained later, will have to be called *hirtula*, is primarily a Plateau species. Its range begins in northern Chihuahua and runs southwards through Coahuila, Durango, Nuevo Leon, San Luis Potosi and Zacatecas to Hidalgo, Queretaro and Jalisco. The vertical range of this species extends from 3500 to 7600 feet but the majority of the records occur between the 5000 foot and 7000 foot levels. Along the Sierra Madre Oriental, *hirtula* occasionally occurs east of the crest of the mountains, but always at considerable elevations. On the western side of the Plateau it never gets near the crest of the Sierra Madre Occidental, apparently because its inability to tolerate elevations in excess of 7600 feet restricts it to lower levels on the eastern slopes of the Sierra. The fully developed nests of *hirtula* are very populous with many majors present, and it occasionally dominates an area to the exclusion of most other ground-dwelling ants. The marriage flight has not been observed but, since the sexual castes appear in the nests as early as April and remain in them until the middle of August, it seems probable that the marriage flight occurs in late August or early September.

The distribution of the western population, *subdentata*, is not as well known. It occurs at elevations up to 6300 feet in many of the mountains in southern Arizona. It apparently does not occur on the Sonoran coastal plain but is present in some of the hills which border the inner edge of this plain. Under such conditions its elevational range may descend to 1000 feet or a little less. Since the types of *subdentata* come from Tepic, in Nayarit, it seems safe to assume that this insect occurs in the western foothills of the Sierra Madre Occidental through southern Sonora and Sinaloa. The colonies of *subdentata* are also large but the number of majors in a colony is much smaller than in the nests of *hirtula*. While the number of *subdentata* nests in an area is often quite large, this species never seems to exclude other ants from such areas. The marriage flight of *subdentata* occurs in early July in southern Arizona.

It should be apparent from the foregoing discussion that *hirtula* and *subdentata* differ not only in the structure of the

major but also in a number of other ways as well. The problem is not to defend the separate specificity of these two insects but rather to show what relationship they have to the virtually unknown *vasliti*. The types of *vasliti* were taken in the Sierra San Lazaro, a small range at the southern tip of Baja California. It seemed to me, therefore, that on the basis of distribution it was more logical to expect that they should be related to *subdentata* than to *hirtula*. The only way to test this was to examine Pergande's types of *vasliti*. I was enabled to do this through the courtesy of Dr. M. R. Smith who arranged matters so that I was able to study all the type material of *vasliti* at present in the collection of the U. S. National Museum. The importance of these types to this work cannot be overestimated and I am happy to thank both Dr. Smith and the National Museum for the privilege of examining them.

In Pergande's (1895) original description of *vasliti* (which he described as *vaslitii*) he notes that the species was based on 9 soldiers and 13 workers. There are now in the collection of the National Museum 13 specimens of this series consisting of 6 majors and 7 minors. Because of what is to follow it is necessary to discuss the labeling of these specimens, for this is not uniform. Eleven of the specimens (4 majors and 7 minors) bear Pergande's hand written locality label, "Sierra San Lazaro, Cape region, L. Cal., Mex.". The ink on these labels has faded to a brownish tint and the paper of the label is slightly yellowed. Below the locality label is a printed label "Collection T. Pergande." Two of these specimens (1 major and 1 minor) bear an identification label also written by Pergande and also in the same faded ink. Each of these labels carries the notation "*Pheidole vaslitii* n. sp." In the lower left-hand corner of the label is the word "Type" in the lower right-hand corner is the word "Perg."

The other two specimens (both majors) are differently labeled. In each the locality label is hand written and the writing is, apparently, that of Pergande. But neither the ink nor the paper of the label has faded and the locality is given as "Sierra S. Lazaro, Mex.". In place of the printed collection tag each specimen bears a red type label marked "Type No. 4488 U.S.N.M." One of the specimens has an identification label, again in Pergande's writing, which reads "*Pheidole vaslitii*."

The word "Perg." occurs in the lower right-hand corner of this label and also in the lower left-hand corner, where it occupies the space marked "Type" in the other labels. Dr. Smith informs me that Pergande noted in the type book of the National Museum that he had marked three specimens of *vasliti* as types. It would appear that when he did so he altered the locality labels of these three specimens, probably because he realized that the original labels were not holding up as well as might have been wished.

The importance of the above data will be appreciated when it is realized that there are four different species present in the 13 specimens from the type series of *vasliti*. These are as follows: (1). Four majors (one marked as the type of *vasliti*) are the insect which W. M. Wheeler described in 1908 as *Ph. cockerelli*. There can be no doubt whatever about this nor, in my opinion, is there room for doubt that these four specimens were the source of Pergande's description of the major of *vasliti*. They agree in every particular with his description, even to the two faint longitudinal grooves which Pergande stated were present on the dorsum of the postpetiole.

(2). Three minors (one marked as the type of *vasliti*) are Wheeler's *crassicornis tetra* which was also described in 1908. These workers have a quadrate head with an almost straight posterior border. They are sparsely provided with short erect hairs and have acute, erect epinotal spines. They seem to have furnished Pergande with some of the features included in the description of the minor of *vasliti*.

(3). Four minors (none marked as a type of *vasliti*) appear to be Emery's *Ph. hyatti*. These minors are clearly the main source of Pergande's description of the minor of *vasliti*. Their heads are elongate, with the convex sides passing to the curved occipital border through very much rounded angles. Most of the thorax is densely granulated and there are feeble transverse rugae present on the pronotum. They are abundantly provided with long erect hairs. The epinotal spines are slender but slope to the rear.

(4). Two majors each bearing the U.S.N.M. type label No. 4488 are the most puzzling of the lot. One of these specimens is badly damaged, both the head and thorax having partially collapsed. The light color of this specimen indicates that it was a callow

and the damage is probably the result of drying. Both these specimens are unusually hairy, with many short hairs of equal length interspersed with longer hairs present on the head and thorax. In both specimens the mandibles are highly shining, without a trace of striae and with sparse, small punctures. In both specimens the antennal scapes are slender and the tip of the scape falls just short of reaching the occipital angle. In both specimens the head is slightly longer than broad (1.5 mm. \times 1.4 mm. in the undamaged specimen) with the sides gradually narrowed from the eyes to the insertion of the mandibles. The impression of the occiput is broad and quite shallow. In the undamaged specimen, and presumably in the other one also, prior to the distortion of the thorax, the mesonotum is rounded when seen in profile. The cephalic rugae are coarse and the granulations between them are unusually dense. It appears impossible at present to state what these two specimens are. They may be the medias of a polymorphic species related to *subdentata* or the majors of a dimorphic one related to *hyatti*. But there is no doubt about one thing; neither of them contributed anything to Pergande's description of the major of *vasliti*.

It seems to me that in dealing with this extraordinary tangle it is essential to seek a solution which does the least violence to the existing taxonomic structure of the genus *Pheidole*. If the two specimens marked by Pergande as the types of *vasliti* (U.S.N.M. No. 4488) had been the source of his description of the major of *vasliti*, his action would have been a plain case of lectotypic designation. But since these specimens were not described, Pergande's action in marking them as types can scarcely be considered as the designation of a lectotype. However, I see no reason why I cannot make such a selection, for I have briefly described these specimens in the foregoing paragraphs. I, therefore, designate as the lectotype of *vasliti* the undamaged specimen in the collection of the U. S. National Museum which bears the type number 4488. This action avoids any possibility of name changes in the case of Wheeler's *cockrelli* or *tetra*. It is also true that it leaves us still in the dark as to exactly what *vasliti* is. But since we have managed to do pretty well for half a century with a totally fallacious view as to

the real nature of *vasliti*, I cannot see that we are any worse off now that we are not sure what it is. It is, of course, necessary to provide a name for the eastern population formerly treated as a variety of *vasliti* for, whatever *vasliti* may be, it is not closely related to this population. Since this population was first described as the variety *hirtula*, it is necessary to use *hirtula* as the name for this species. On this basis the *vasliti* complex would have to be arranged as follows:

Pheidole vasliti Pergande (lectotype only)

Pheidole hirtula Forel

= var. *acollhua* Wheeler (NEW SYNONYMY)

Pheidole subdentata Pergande

= *obtusospinosa* Pergande

= var. *arizonica* Santschi (NEW SYNONYMY)

There follow new locality records for *hirtula* and *subdentata*. Unless otherwise stated the records are those of the writer.

Pheidole hirtula Forel

CHIHUAHUA: 13 miles west of Chihuahua City (5100')

COAHUILA: Diamante Pass near Arteaga (7200'); 5 miles east of Arteaga (5800'); 2 miles east of Ramos Arizpe (4900')

NUEVO LEON: 4 and 6 miles west of Iturbide (6200')

DURANGO: 5 miles east of San Lucas (6100'); 7 miles east of Durango (6200'); Arroyo el Sauz, 33 miles north of Durango (6200'); Durango City (6200'); 22 miles south of Villa Ocampo (5700'); 10 miles south of Cueneame (6200'); 25 miles south of Durango (6500'); Rio Mimbres, 27 miles west of Durango (7500'); 10 miles west of Durango (7200')

SAN LUIS POTOSI: 15 and 27 miles west of Ciudad del Maize (3400-3500'); 3 miles west of Ventura (5900'); 17 miles west of San Luis Potosi (7600')

ZACATECAS: 11 miles north of Ojocaliente (6900'); 30 miles east of Sombrerete (6900'); 4 miles west of Sombrerete (7500')

HIDALGO: 15 miles west of Jacala (6500')

JALISCO: 5 miles north of Encarnacion (6200'); 16 miles south of Encarnacion (6600'); 5 miles west of Lagos (6000')

F. G. Werner.

Pheidole subdentata Pergande

- ARIZONA: Huachuca Mountains: Sylvania Ranch (6300');
Garden Canyon (5400'); Canello Pass (5300')
Peloncillo Mountains: Cottonwood Canyon (4800')
Baboquivari Mountains: Brown Canyon (3600-
4200')
Ajo Mountains (OCNM): Alamo Canyon (2200')
Organpipe Cactus National Monument: Quitoba-
quito (900')
Pima County: Total Wreck Mine (4400')
- SONORA: Cibula (3600'); Puerto Gonzalitos (2500')

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A REDESCRIPTION OF HAFENFERREFIA
NITIDULA (BANKS) AND NOTES ON THE
DISTRIBUTION OF OTHER SPECIES IN
THE FAMILY TENUIALIDAE
(ACARINA: ORIBATEI)¹

BY HAROLD G. HIGGINS² AND TYLER A. WOOLLEY³

When Sellnick (1952) described *Hafenrefferiella nevesi*, a new genus and species of oribatid mite from Portugal, he indicated that *Galumna nitidula* Banks, 1906, might belong to this genus. Jacot (1939) had suggested previously that Banks' species was similar to *Hafenferrefia gilvipes* Oudemans, but constituted a new genus, which he called *Hafenferrefia*. He described this new genus and designated *G. nitidula* Banks as type.

During the past year specimens of this genus were collected by the senior author, from Washington and Oregon. The writers compared these specimens with others collected by Dr. Stanley and Dorothea Mulaik, and with the descriptions and drawings of Banks and Jacot. As a result of these comparisons, it appears that these specimens are representatives of *Hafenferrefia nitidula* (Banks, 1906), Jacot, 1939. The following redescription is a composite of the descriptions of Banks (1906) and Jacot (1939) and the personal observations of the writers.

Genus *Hafenferrefia* Jacot, 1939, p. 325.

Type: *Galumna nitidula* Banks, 1906, p. 491.

DIAGNOSIS: Anterior rostral margin entire; lamellae narrow, translamella incomplete, interrupted medially; lamellar hairs inserted in apex of truncate lamellar cusps; pteromorphae short, stout triangles, sclerotized along basal half of medial margin.

Hafenferrefia nitidula (Banks, 1906), Jacot, 1939.

DIAGNOSIS: Pteromorphae triangular, rigid, thickened along basal half of medial edge; lamellae narrow, translamella incomplete; tarsus I with a dorsal setal complex of four setae, one of which may be bent. Differs from *Hafenrefferiella nevesi* Sellnick

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in the entire rostral margin, not notched as in *H. nevesi*, and in the insertions of rostral and lamellar hairs. The rostral hairs insert in short tubercles at the lateral edges of the rostrum; lamellar hairs arise from a small notch in the distal end of each lamella. The lamellar cusps are truncate, not pointed as in *H. nevesi*. The number of hysterosomal setae varies between these species as *H. nitidula* exhibits six pairs, *H. nevesi* more than six pairs.

DESCRIPTION: Color deep reddish-brown. Propodosoma and hysterosoma separated by a well-defined suture; propodosoma about one-third as long as hysterosoma, nearly as broad at base as long. Rostral hairs two-thirds as long as lamellar hairs, inserted half their length posterior to tip of rostrum, arched over end of rostrum. Lamellae long, rather narrow, widest at base of cusp; cusp one-fourth as long as lamella, truncate, with a lateral dens. Lamellar hairs nearly twice as long as rostral hairs, inserted in a notch in anterior tip of truncate lamellar cusp, curved inward. Translamella incomplete, reduced to a short, medial bar at base of cusp (fig. 1). Interlamellar hairs as long as distance from pseudostigmata to translamella, inserted medial to pseudostigmata near anterior margin of hysterosoma, insertions separated about the length of one hair. Pseudostigmata cup-like, situated near notch formed by pteromorphae and anterior margin of hysterosoma. Pseudostigmatic organs recurved outward and backward, clavate and barbed toward tip, distal end pointed.

Hysterosoma broadly oval, arched dorsally, with six pairs of long setae (fig. 1). Pteromorphae triangular, projected forward two-thirds the distance to translamella, sclerotized along medial edge, longer than wide, lateral margin entire, posterior border confluent with margin of hysterosoma.

Camerostome oval in outline; palpi five-jointed, mandibles chelate, ventral setae as in figure 2. Genital opening trapezoidal in outline, between bases of legs IV, three times its length anterior to anal aperture; covers longer than broad, each with a row of six setae, setal insertions closer to medial edge of cover than to lateral; g: 1 in anterior margin of cover, other setae subequally spaced posteriorly. Anal opening about as wide as long, narrowed anteriorly; anal covers with two pair of setae (fig. 2).

Legs moderately long, tarsus tridactyle, middle claw largest. Tarsus I with a dorsal setal complex of four setae, one of which may be bent; tibia I with a long seta near the anterior edge that is nearly as long as tarsus; coxa and trochanter III and IV flattened and with a distinct keel.

Seven specimens from Washington and Oregon have the following minimum, average and maximum body measurements: total length, 714 μ , 735 μ , 780 μ ; hysterosoma 530 μ , 555 μ , 600 μ ; width 561 μ , 581 μ , 600 μ .

DISCUSSION: Specimens of *Hafenferrefia* show a closer morphological relationship to *Hafenrefferiella* than to any other genus in the family. This relationship is expressed in the

similarity of body outline, pteromorphae, lamellae, and in the number of genital and anal setae. Although *Hafenferrefia* lacks the serrate-edged pteromorphae of *Tenuiala*, it exhibits a similarity to this genus in the dorsal setal complex of tarsus I, which is found in *Tenuiala kurti* (Woolley and Higgins, 1955).

In Banks' original description no mention is made of hysterosomal setae. The writers observed that the dark pigmentation of *H. nitidula* makes the fine setae of the hysterosoma difficult to see and may account for the omission of this detail in Banks' description and figure.

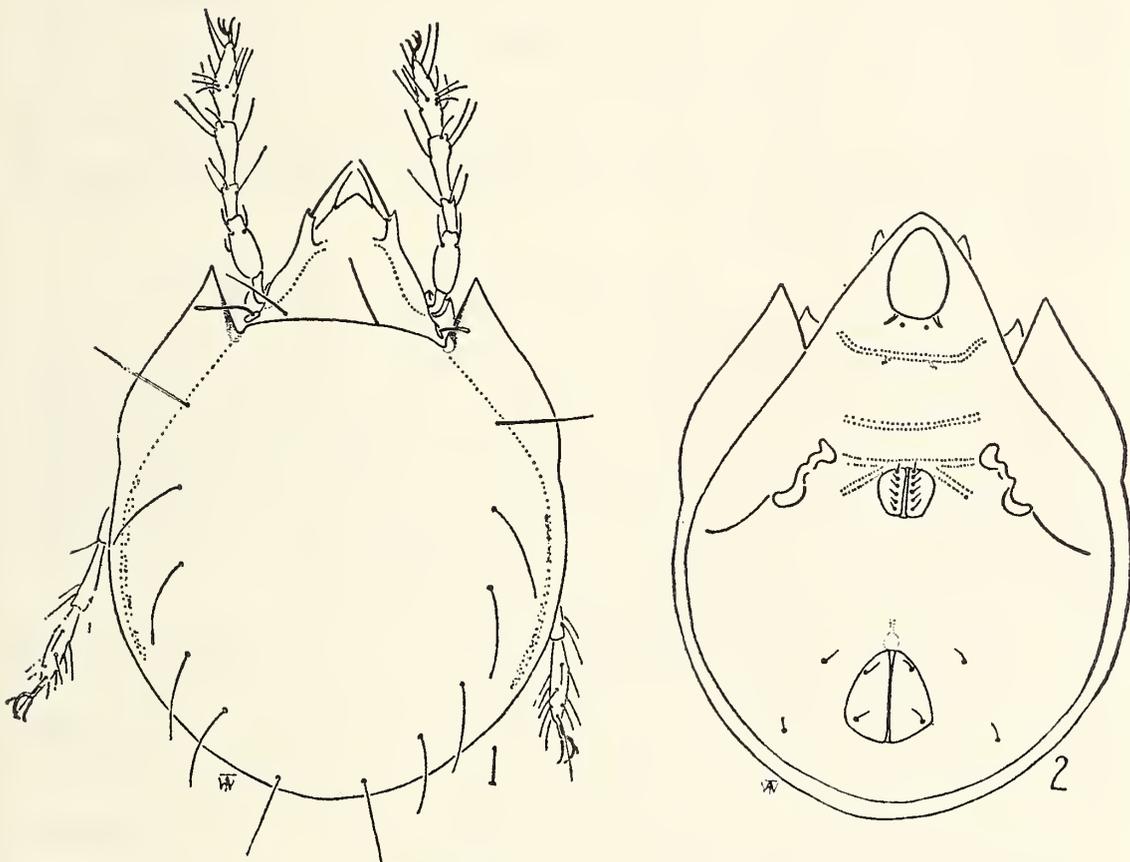


FIG. 1. *Hafenferrefia nitidula* (Banks) from the dorsal aspect.

FIG. 2. *Hafenferrefia nitidula* (Banks) from the ventral aspects, legs omitted.

The habitat of *H. nitidula* appears to be similar to that of other members of this family that have been found in North America. All specimens of *H. nitidula* from Washington and Oregon were found on rotting logs or in decaying leaves in moist, wooded areas.

SPECIMENS EXAMINED: OREGON: three specimens, Cottage Grove, August 24, 1956, H. & M. Higgins; four specimens, Oak-

ridge, June 22, 1952, S. & D. Mulaik. WASHINGTON: two specimens, Neah Bay, August 23, 1956, H. & M. Higgins.

The following collection data are included to amplify the existing records of other species in the family Tenuialidae. Figure 3 indicates known distribution records of species in the western United States and includes collection data cited by Woolley and Higgins (1955).

Tenuiala nuda Ewing, 1913, p. 133

NEW RECORDS: CALIFORNIA: one specimen, Burnt Ranch, Route 299, July 9, 1946, S. Mulaik. UTAH: seven specimens, The Spruces Recreational Area, Salt Lake County, June 8, 1955, H. Higgins; WASHINGTON: two specimen, Mt. Si, July 4, 1956, M. Higgins; one specimen, Sequim Bay State Park, H. & M. Higgins, August 23, 1946; two specimens, Neah Bay, August 23, 1956, H. & M. Higgins.

Tenuiala kurti Woolley & Higgins, 1955, p. 48.

NEW RECORDS: OREGON: one specimen, Cottage Grove, August 24, 1956, H. & M. Higgins. UTAH: one specimen, Oak Creek Canyon, 4 miles E. Oak City, April 17, 1955, H. & M. Higgins; one specimen, Tucker, May 31, 1955, H. Higgins. COLORADO: Middle St. Vrain, Boulder Co., 28 August 1954, T. A. Woolley; Cameron Pass, 13 August 1955, T. A. Woolley.

Variations in the genera *Hafenrefferia*, *Hafenrefferiella*, and *Tenuiala* are delineated by Woolley and Higgins (1955). The genus *Hafenferrefia*, however, is different from any of the above genera and is placed in the key of the above authors as follows:

1. Lamellae narrow, not extending beyond the anterior end of gnathosoma, with or without a translamella; pteromorphs short 3
Lamella broad and long, extending beyond the anterior end of gnathosoma; with or without a translamella; pteromorphs long Genus
Tenuiala 2
2. Lamellae broad, unnotched laterally and joined by a translamella
T. nuda Ewing, 1913.
Lamellae broad, notched laterally and joined at their antero-medial margins without a translamella *T. kurti* Woolley and Higgins, 1955.
3. With a partial or complete translamella; lamellar hairs inserted in apex of lamellar cusps 4
Without a translamella; lamellar hairs subapical in insertion on lamellae; pteromorphae slightly sclerotized along proximal half of medial margin *Hafenrefferiella nevesi* Sellnick, 1952.

- 4. Anterior rostral margin notched; with a complete translamella, pteromorphae heavily sclerotized along entire medial margin
Hafenrefferia gilvipes (C. L. Koch, 1839) Oudemans, 1906.
- Anterior rostral margin entire; usually with a partial translamella; pteromorphae sclerotized along basal half of medial margin
Hafenferrefia nitidula (Banks, 1906) Jacot, 1939.

△: *T. nuda*
 ▲: *T. kurti*
 □: *H. nitidula*



FIG. 3. A Distribution Map Showing the Known Locations of *Tenuiala nuda* Ewing, *Tenuiala kurti* Woolley & Higgins, and *Hafenferrefia nitidula* (Banks) in the Western United States.

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ITINERARIES OF THE WHEELER SURVEY NATURALISTS 1871—FERDINAND BISCHOFF

BY F. M. BROWN

The main effort of the Wheeler Survey in 1871 was in Nevada and Arizona with several weeks stay in the Owens Valley region of California and a few days around St. George, Utah. Three naturalists were on the party: Dr. W. J. Hoffman, acting assistant surgeon, and Ferdinand Bischoff, zoological collector, assigned by Prof. S. F. Baird of the Smithsonian Institution; and John Koehler, zoological collector, selected by Lt. Wheeler from the men who were with him in Nevada in 1869. Only Bischoff is known to have been an entomological collector. (Wheeler 1889, p. 660).

Ferdinand Bischoff is something of a mystery man. His certificate of naturalization is in the archives of the Smithsonian Institution. It is "dated March 3, 1858, in Peoria County, Illinois, but it gives no information at all about him except that he was formerly a subject of the Grand Duke of Saxe Weimar." (Clark, letter 5. VI. 56). An amusing letter among Baird's correspondence suggests that he was married (Baird, 22. IV. 67). I have not been able to discover anything else about his life before 1865 nor after 1871. Yet during these few years he contributed many specimens new to science from out-of-the-way places in North America. W. H. Dall (1915, p. 377) noted that he was a German taxidermist and that he was lost on the New Mexico desert. I suspect, but have no evidence, that this happened in 1872. There is no mention of Bischoff in Baird's reports for years following 1871. Ewan (1950, p. 165) sought to connect Ferdinand Bischoff with Carl Gustav Christoph Bischoff, the physician-naturalist, with no success. It was through the office of Baird that Bischoff was recommended to and employed by two important exploring expeditions as naturalist, and spent additional time in the field for the Smithsonian Institution.

Bischoff's first appearance in the literature that I have searched is as a naturalist working under Robert W. Kennicott, a good friend of Baird. This was in 1865 and 1866 when Kennicott was

Chief of the Scientific Corps for the Russian Overland International Telegraph Expedition. Sometimes the expedition is referred to as the Western Union Telegraph Expedition, in honor of its American sponsors. The purpose was to scout and locate a telegraph line from Moscow in Europe to Chicago in North America. (Rothrock, with whom Ewan (*l.c.*) connects Bischoff, was botanist of the expedition. He interrupted his training in medicine to accept the post.) En route to Alaska the party of naturalists sailed from New York to Nicaragua where they took the usual route up the Rio San Juan and through Lakes Nicaragua and Managua to the Pacific. There they embarked for San Francisco (Baird 1867, p. 86). According to the minutes of the meetings of the California Academy of Natural Science, members of the expedition were guests at the meetings held on May 1, June 5, and July 3, 1865 (Proc. Calif. Acad. Nat. Sci. 3: 197, 199, 201. 1866).

During 1865 and 1866 Bischoff spent 14 months collecting in the vicinity of Sitka on Baronoff Island. "A letter from Baird to Joseph Henry Secretary of the Smithsonian Institution in March, 1867, announces the return to Washington of the Russian Telegraph Expedition and says: "Much of the most important portion of the material received consist of the collections made by Mr. F. Bischoff at Sitka during a period of over a year. . . . The specimens filled over 140 cubic feet of space . . ." (Clark, letter 5. VI. 56). From Sitka he returned to San Francisco. Correspondence, dated April 22, 1867, in Baird's letter press book suggests that Bischoff was in Washington in the winter of 1866-67 or early Spring of 1867. In the March letter to Henry quoted above, Baird suggests that Bischoff "the experienced collector to whom I have referred, be sent back to San Francisco, thence to proceed to the Aleutian Islands and to Kamtschatka and to remain a year or longer." Henry evidently agreed to the suggestion for there is an 'Open Order' dated 1867, signed by Governor General of Eastern Siberia, saying that the bearer, Ferdinand Bischoff, is to be given protection, permission to travel over Kamtschatka, in Kurilian and the Aleutian Islands as well as on the Amoor River, etc. etc. "for the purpose of making collections of objects of natural history."

Back in San Francisco, Bischoff embarked with part of the

telegraph party for Plover Bay on the Asiatic side of Behrings Strait. Their camp is still marked on hydrographic charts of the Strait, as Telegraph Camp. He returned to San Francisco in August, 1867, and continued on to Washington, D. C. The return was made via Mazatlan, Mexico, where at Baird's request Bischoff spent some time with Colonel Grayson, a contributor to the Smithsonian Institution. While in Washington, Bischoff was called upon to testify before the Senate Committee on Foreign Relations during the discussions relative to the purchase of Alaska (Baird 1868, p. 42-43).

In 1868 Bischoff was again in Alaska, this time for the Smithsonian Institution. He spent a year on Kodiak Island. During the year the Smithsonian received material from Bischoff's previous visit to Asia and some Kodiak specimens (Baird 1869, p. 24, 55). In 1869 he shipped "Eight boxes zoological collections from Alaska" and Baird noted "Mr. Ferdinand Bischoff has kept up his research in Alaska, first at Kodiak then at Kenia." (Baird 1871, p. 53).

There are several letters from Bischoff written in Gothic script from San Francisco during July and August, 1870, in Baird's correspondence file. These relate to personal matters. When Bischoff was in San Francisco he made the acquaintance of several entomologists. He gave or sold at least some of his Alaskan catch to Behr, Behrens, and Henry Edwards. Some of this material reached William H. Edwards. These became the types of *Coenonympha kodiak*, *Argynnis bischoffi*, *Lycaena kodiak*, *Pieris hulda*, and *Cyclopides skada*. Although in the original descriptions Edwards cited Kodiak, Alaska, as the type locality for each species, he corrected this for *bischoffi* to a "heath 2 miles from Sitka, Alaska, in July." (in BUTTERFLIES OF NORTH AMERICA vol. 2, *Argynnis* 3).

I have yet to discover what Bischoff did during the latter half of 1870. Perhaps he was employed at the Smithsonian, working on the material brought in by the Telegraph Expedition. When Wheeler organized the Survey West of the 100th Meridian, Baird dispatched Dr. Hoffman and Bischoff to Camp Halleck to join the party. If one reads between the lines of Wheeler's notes, it is clear that he was not too happy about having these men thrust upon him. Army records carry the two in the medical section

of the field party, Hoffman as a medical officer and Bischoff as a hospital orderly. Wheeler (*l.c.*) calls Bischoff a zoological collector on his roster of personnel for 1871. The details of the travels of Bischoff during 1871 are of particular interest to entomologists.

THE FIELD SEASON OF 1871

The 1871 season in the field extended from the 3rd of May until the first days of December. During this time the expedition, usually divided into two parties with a naturalist-collector attached to each, traveled from the Central Pacific Railway in north central Nevada to Tucson, Arizona. The first phase of the expedition was to move in two lines, one from Halleck Station and the other from Battle Mountain, south to Belmont in south central Nevada. This was done in May, June and July, when butterfly collecting in the region is at its best. It should have produced a grand haul of specimens, and probably did. Unfortunately the collected material was started on its journey east from Belmont just in time to be destroyed at Pioche, Nevada, when a disastrous fire demolished that mining town in early August. The material collected by Wheeler's party moving from San Francisco to Halleck station was not lost in this fire. The butterflies reached W. H. Edwards who found no new species among the specimens.

The second phase, from the camp in Meadow Canyon in the valley north of Jeff Davis Mountain, north of Belmont, to Camp Independence, California, was through rugged desert country too late for the spring butterflies and too early for the fall ones. Some material may have been collected, but I have had no success trying to identify it.

The third phase moved the party from Camp Independence, California, to Truxton Springs, Arizona. Two columns, one to the south of Death Valley and the other across the valley, converged on Cottonwood Springs on the east side of the Spring Mountains in Nevada near the present city of Las Vegas. This portion of the journey produced butterflies that have invariably been credited to "Arizona." From Cottonwood Springs the parties moved eastward to St. George, Utah, and then south and across the Colorado River just west of the Grand Canyon to

Truxton Springs. Wheeler and a picked group that included Dr. Hoffman moved from the camp at Cottonwood to Camp Mohave and traveled up the Colorado River through the canyons to a meeting with the land party some miles above the point at which the crossing had been achieved, a few miles up stream from what is now called Pierce's Ferry.

The last two phases lead from Truxton Springs, to Prescott, Arizona, and from there to Camp Apache and finally to Tucson where the party closed the season. Detailed itineraries for all of the parties throughout the season will be published elsewhere with supporting evidence and detailed maps. Here I will confine myself to details of Bischoff's travels from Camp Independence, California, to Prescott, Arizona. This is the area that produced the material W. H. Edwards described as new species from the expedition of 1871.

In the following time-tables for Bischoff those dates that are set in brackets are estimates by me. Neither the Corps of Engineers library, the Library of Congress nor the National Archives have been able to discover for me a copy of the list of camps occupied by the parties in this field season. I have based the following data upon reconstructions from reports of Lieutenants Wheeler, Lockwood and Lyle. (Wheeler, 1872). Throughout the period under consideration Bischoff was with Lockwood's party.

CAMP INDEPENDENCE, CALIFORNIA, TO COTTONWOOD
SPRINGS, NEVADA. (Map No. 3*)

18.vii—10.viii, at Camp Independence, California.

There is no published account of Bischoff's activities during this stay at Camp Independence. However, a careful study of the species of butterflies collected by the 1871 party makes it perfectly clear that he made at least one trek into the Sierra Nevada to the west of camp. It seems very likely that he also collected extensively in the bottoms of Owens River, possibly as far as Owens Lake. Bischoff left camp with Main Party No. 2 on 10.viii and struck southward to the vicinity of the present town of Mohave.

* These maps belong in a series prepared for the more extended study of the expedition, and thus bear numbers that have little meaning here.

- 10.viii—Lone Pine.
- 10.viii—Owens Lake.
- 11.viii—Star Ranch—This is now the town of Olanche.
- 11.viii—Hawee Meadows—This is now the town of Haiwee.
- 11.viii—Cow Springs.
- 12.viii—Little Owens Lake, known today as Little Lake.
- 13.viii—Indian Wells, somewhat north of present-day Freeman.
- 14.viii—Coyote Springs.
- 15.viii—Desert Springs, now called Desert Wells.
- 16.viii—Mosquito Springs.
- 18.viii—Surveyor's Wells.
- 18.viii—a little north of Granite Wells.
- 19.viii—Burnt Rock Springs.
- 22.viii—Saratoga Springs, southwest corner of Death Valley.
- 23.viii—Salt Springs, California.
- 27.viii—Ivanpha, Nevada.
- 29.viii—Cottonwood Springs, Nevada.

During the stay at Cottonwood Springs a side party visited Mount Charleston and it is quite possible that Bischoff was a member of this party. Another side party crossed the Las Vegas desert to Mormon Wells. I doubt that Bischoff was with this group since collecting was better in the vicinity of the camp than it could have been on the desert. The march was resumed on 15.ix.

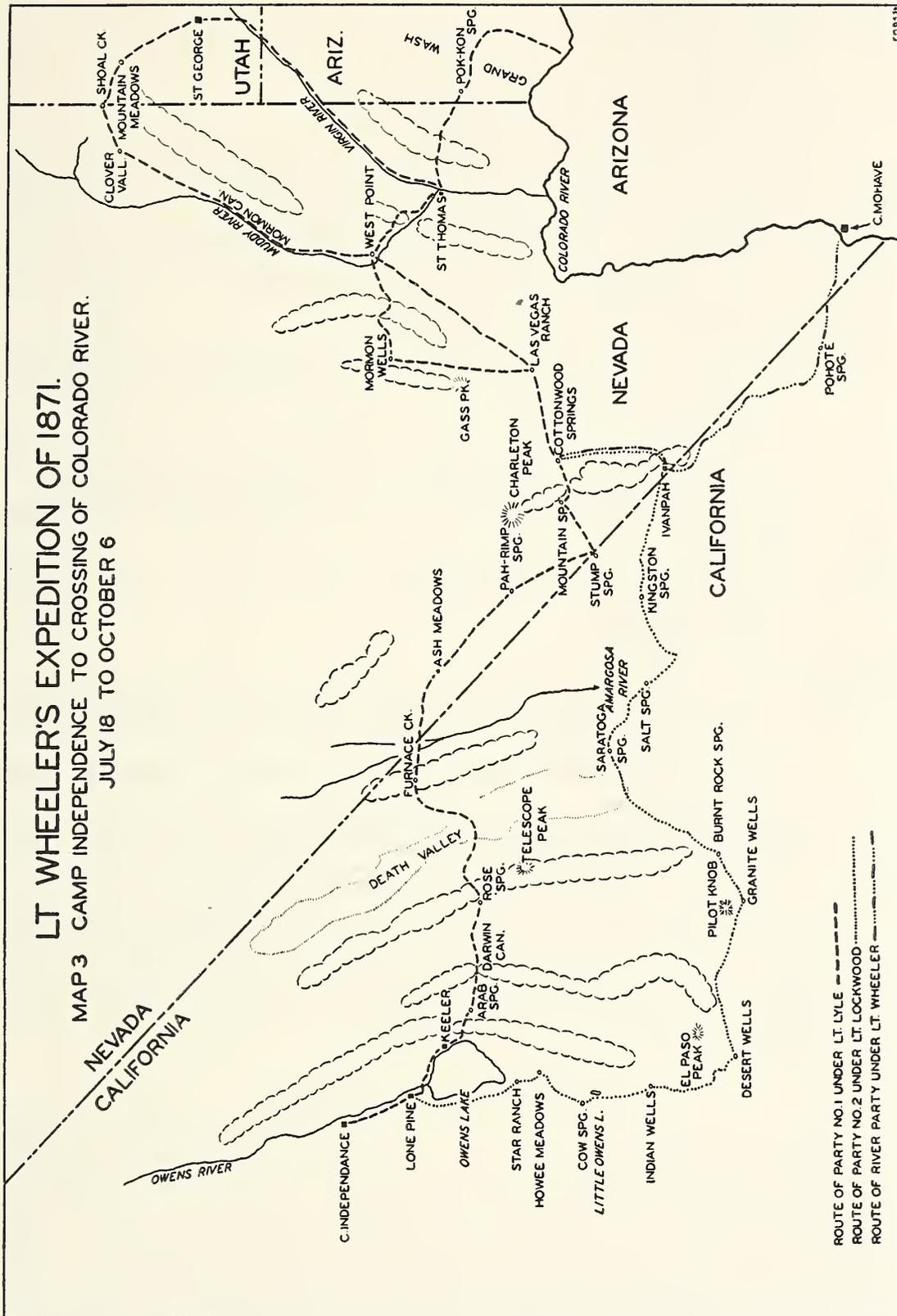
COTTONWOOD SPRINGS, NEVADA TO TRUXTON SPRINGS, ARIZONA.

(Maps 3 and 4)

- 15-20.ix—Las Vegas Ranch, now the city of that name.
- 20.ix—crossed the Las Vegas desert at night.
- 21.ix—arrived at the Muddy River, former site of West Point, a Mormon town that had been abandoned in 1870.

At this point Lockwood's command was broken into three sections. I have not been able to determine which of these contained Bischoff. All of them converged upon St. George, Utah. One party travelled via Clover Valley and Shoal Creek; the wagon followed the old Salt Lake Road; the main party followed up the Virgin River. Camp was established at St. George on 26.ix and broken on 1.x.

- 1.-2.x—passage down the bed of the Virgin River.
- 3.-4.x—camped at Pok-koon Springs.
- 5.x—arrived on the north bank of the Colorado River just up stream from the mouth of Grand Wash.
- 6.x—the entire party crossed the river into Arizona.



Through the region shown on this map Bischoff was with the party under Lt. Lockwood indicated by the dotted line.

- 7.x—Tin-nah-kah Springs.
- 8.x—At-too-vah Springs.
- 9.x—Pah-rosh Springs.
- 10.x—rounded the northwest and western side of Music Mountain to Truxton Springs.
- 10.x-24.x—camped at Truxton Springs, Arizona.

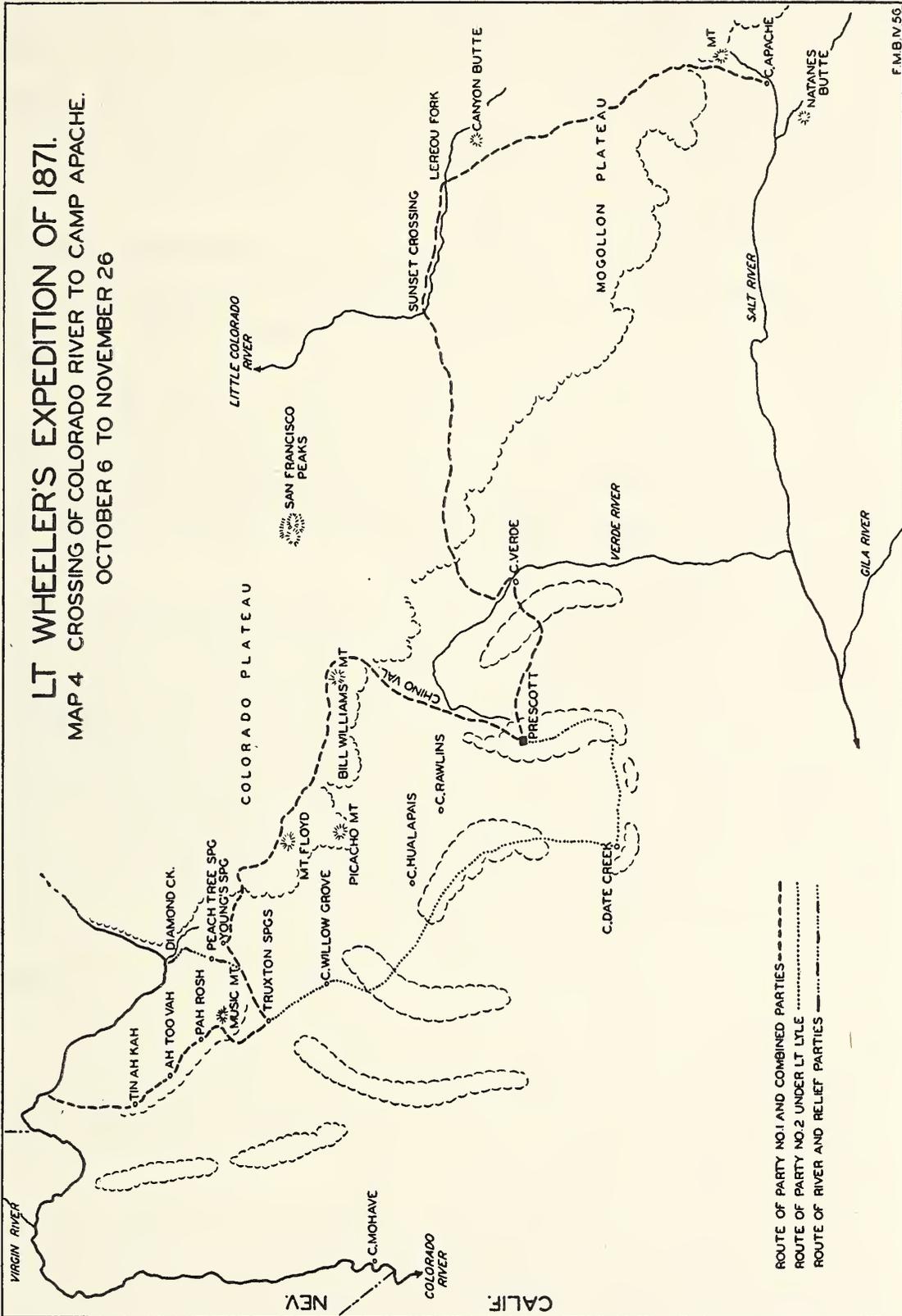
During this time there was extensive travel to and from the Colorado River at the mouth of Diamond Creek, and east and north of Truxton. The details of Bischoff's movements are not known. He probably worked the area north of Truxton on Music Mountain and in the canyons.

- 24.x—left Truxton Springs and travelled east for three days along the location stakes for the railroad. This brought the party somewhat east of Mount Floyd.
- 27.x—continued eastward north of Bill Williams Mountain until the road from Prescott to the San Francisco Mountains was intercepted.
- 28.x—followed this road toward Prescott and descended from the Colorado Plateau.
- 29.x—crossing Hell Canyon and Rattlesnake Canyon and the intervening rough ground to
- 30.x—the Chino Valley.
- 31.x—arrived at Prescott, Arizona.
- 1-10.xi—stayed at Prescott. During this time Bischoff collected assiduously in the district.
- 10.xi—The party left Prescott and crossed the Black Hills into the valley of the Rio Verde.
- 11.xi—The Rio Verde was crossed a short distance north of Old Camp Verde.
- 12.xi—The surface of the Mogollon Plateau was gained via Beaver Creek.

By the time the party gained the level of the Mogollon Plateau the season was so advanced that there was little entomological collecting to be done. The party worked its way to Camp Apache and disbanded at Tucson in December.

THE BUTTERFLIES COLLECTED

Although there are numerous references to butterflies collected by the Wheeler Expeditions in Southern Arizona or Arizona, I have included here only those definitely collected in 1871. The others came from collections made in 1873, 1874 and 1875. Very often it is only after following a long trail through the literature, that proof is available that a particular species or specimen was collected by the Wheeler parties. The tracking that is necessary can be shown by the case of *Atrytonopsis Deva* Edwards. In the



During this stage of the journey Bischoff was with the combined party the track of which is shown by a dashed line.

original description (Edwards 1876, p. 292) is this statement of the type locality: "From a single example received from Prescott." Five years later (Edwards 1881, p. 4) in a note about the species we find; "I described a female of this species received from Prescott, Arizona." At last there is a reference to the Wheeler Expedition! "*Deva* was originally described from a single female received from the Wheeler Expeditions, 1875 or 1876" (Edwards 1882, p. 138).

With this preamble, I will set forth a brief discussion of each of the species that I believe was collected by Bischoff in 1871. For some I have come to definite conclusions, for others I must pass the task to more astute students. For wide spread species I can do no more than note that the species was taken.

*Satyrus wheeleri** Edwards—"From nine males taken by the naturalists of Lieutenant Wheeler's Expedition, 1871, between the Cascade and Rocky Mountains, but the precise locality not indicated" (Edwards 1873, p. 343).

The type locality for this large *Cercyonis* has been guessed at from Owens Lake to Camp Apache. The guesses that I have seen have been based upon the original series and no others. There are several specimens in the collections of the University of Utah that compare very favorably with plates of both Edwards and Mead. These specimens all came from the southwest corner of Utah. One in my collection was taken at Washington, Utah, only five miles from St. George, where Bischoff camped between the 26th of September and the 1st of October in 1871. The time of the year fits well with the late summer appearance of our Great Basin *alope*-like butterflies. Another possible site for the type locality of *wheeleri* is Cottonwood Springs, Nevada, where Bischoff collected between August 30 and September 15.

Argynnis nokomis Edwards, (*apacheana* Skinner)—"Specimens of this magnificent insect were brought by the expedition from Arizona in 1871" (Mead 1875, p. 751).

This is the re-described *nokomis* of Edwards and the type material of *Speyeria nokomis apacheana* Skinner. In the original description Edwards (1862, p. 222) stated the type locality of *nokomis* as "Rocky Mountains, and the mountains of California."

* Throughout I will use the generic designation used in the original description.

Later (BNA I, Argynnis IV) he states "From 5 ♂, 2 ♀, brought from Arizona by the Exploring Expedition under Lieut. Wheeler, in 1871, but with no further intimation of their locality. The original specimen from which the description of the species was drawn was received by me in 1862, through the Smithsonian, and was labelled 'Bitter Root Mountains.' Until the present year (1872) it has been an unique in my collection and, so far as I know, not found in any other." As you can see this statement does not wholly agree with that made in the original description. Edwards' single specimen could not have come from both sides of the Great Basin, and he knew of no other in a collection in 1872.

Thus far the industrious collectors of California have found *apacheana* in a restricted area at the north end of Owens Valley. This area extends from Round Valley to Mono Lake. The region lies several miles west of the track followed by Dr. Hoffman on his entry into Owens Valley. Bischoff may have been with him. However, the party was traveling fast and I know from the records that they made no side trips into the Round Valley — Mono Lake region. Although we do not know of a colony of *apacheana* in the mountains west of Camp Independence there may have been one there in 1871, or there may be colonies in several of these east slope valleys of the Sierras. Since Bischoff's stay at Camp Independence coincides with the flight period of *apacheana* it seems reasonable to surmise that the type locality is in the mountains west of Camp Independence.

Melitaea palla Boisduval—"This species was taken by the Expedition of 1871, probably in Utah or Nevada." (Mead 1875, p. 759).

Melitaea palla does not fly in the regions visited by the expedition in 1871. There are two other butterflies described later than 1874 that Mead may have confused with *palla*. There are *neumoegeni* Skinner and *acastus* Edwards. The expedition arrived too late in *neumoegeni* territory to find it and the insect is so much lighter than *palla* that I doubt very much if Edwards, who named all of the material for Mead, had *neumoegeni* before him when he determined "*palla*." The flight period for *acastus* in Nevada is May and June. It is possible that Bischoff collected the specimens in question between Battle Mountain and Belmont

and that these "*palla*" escaped destruction at Pioche. Only examination of the specimens which should be at the Carnegie Museum in Pittsburgh will settle the question.

Melitaea hoffmannii Behr—"brought by the expedition of 1871" (Mead 1875, p. 760).

This is an alpine insect. If Edwards was correct in his determination Bischoff must have made one collecting trip into the high country west of Camp Independence. This is the only place he stayed long enough to have done so. Since Edwards was in close touch with Behr I think we can accept the determination with confidence that it is correct.

Phyciodes marcia Edwards—"taken by the expedition in 1871" (Mead 1875, p. 763).

Phyciodes canace Edwards—"The type of this species was taken in Southern California. The only other known specimens are those collected by the expedition in 1871, probably in Arizona" (Mead 1875, p. 764).

This butterfly name is considered a synonym of *picta* Edwards. Edwards (1882, p. 22) corrected his statement about the type locality of *canace*: "It was originally described from a ♂ received from Arizona, while *picta* was described from several males brought by the late Mr. Ridings from Nebraska." Bauer (1954, p. 100) says of *picta* "Along the Verde River." Martin and Truxal (1955, p. 17) say of it "Arizona, Aug.-Oct." Since Bischoff was in the extreme northwestern part of Arizona during October, I think it safe to assume that these specimens were collected in the vicinity of Truxton Springs.

Pyrameis carye Huebner—"by the expedition of 1871, probably from Arizona" (Mead 1875, p. 770).

Libythea carinenta Cramer—"brought in by the expedition of 1871, probably from near the border of Mexico." (Mead 1875, p. 772).

From Tucson in December? It seems more likely that Bischoff took *larvata* somewhere between the Colorado River and the Rio Verde.

Lemonias dumeti Behr—"taken by the expedition in 1871, probably in Utah or Arizona." (Mead 1875, p. 786).

Since both *dumeti* and *cythera* (*q.v.*) generally are considered synonyms of *mormo* Felder and Felder, it is possible that the

specimens referred to here are those that Edwards described as *cythera*. Mead received from Dr. H. C. Yarrow the information that Edwards had given the Corps of Topographical Engineers about the specimens collected. This was compiled by Mead, added to with data from his own experience in Colorado and with information given him directly by Edwards. It looks as though through oversight or ignorance Mead did not delete the name *dumeti* from the data presented him by the Corps.

Lemonias cythera Edwards—"collected by the expedition in Arizona" (Mead 1875, p. 786).

In the original description Edwards (1874, p. 346) states that three males were taken by the 1871 expedition. According to Bauer (1954, p. 100) there are scattered colonies of *mormo* in the Verde Valley. I assume that this is generally true of northwestern Arizona. The second brood is on the wing through September and October. It is likely that Bischoff collected this material on the dry scrubby hillsides north of Truxton Springs, either on Music Mountain or the Grand Wash Cliffs. Thus a good statement of the type locality of *cythera* is the vicinity of Truxton, Arizona.

Thecla halesus Cramer—"brought in by the expedition of 1871" (Mead 1875, p. 777).

Thecla sylvinus Boisduval—"brought in by the expedition of 1871" (Mead 1875, p. 778).

This and the preceding species are associated with oak chaparral. There are two "most likely" spots where Bischoff collected *sylvinus*. Examination of the material which should be in the Carnegie Museum should pin point it to one. If the specimens are race *putnami* Hy. Edwards, then Meadow Canyon north of Belmont, Nevada, is the best bet for the area in which they were collected. If on the other hand the specimens prove to be *desertorum* Grinnel, it is likely they were collected in the vicinity of Camp Independence.

Lycaena melissa Edwards—"I have also received this species from Nevada, and from Arizona by Lieut. Wheeler's Expedition of 1871" (Edwards 1873, p. 348).

Lycaena piasus Boisduval—"collected by the expedition of 1871" (Mead 1875, p. 785).

Most likely in the foothills west of Camp Independence.

Colias edwardsii "Behr"—"Specimens were taken by the expedition at Owen's Lake, California." (Mead 1875, p. 749).

Mead erred in crediting the species name to Behr. It is a Behr manuscript name validated by W. H. Edwards and honors Henry Edwards. Bischoff was in the vicinity of Owens Lake at the right time of the year for *edwardsii*. 1871 was the only year between 1871 and 1874, the period covered by Mead's report, when a Wheeler party visited Owens Lake region.

Papilio bairdii Edwards—"the expedition took specimens in New Mexico in 1871, and in Arizona in 1873." (Mead 1875, p. 741).

This statement does not conform with what we know about the Wheeler Expeditions. There was no collecting in New Mexico done in 1871. In 1873, Wheeler, with the main party, was based upon Santa Fe, New Mexico. The states should be reversed in the quotation from Mead.

Papilio pilumnus Boisduval—"This species was taken by the expedition in 1871. It occurs in New Mexico and southward." (Mead 1875, p. 741).

This species is exceedingly rare along the Mexican border of Arizona and possibly New Mexico. I suspect that the specimen was collected in Arizona on one of the later expeditions. There is a possibility that it was collected by Bischoff after the 1871 season closed and while he was in New Mexico where he lost his life.

Leucoscirtes ericetorum Boisduval—"Brought in by the expedition of 1871, probably from Utah or Arizona." (Mead 1875, p. 787).

Bischoff was too late for the species in Arizona. It is on the wing there from April through August and into September. Both Bauer (1954, p. 101) and Comstock (1927, p. 209) note that it is a mountain species. My best guess is that the material was collected west of Camp Independence or in the Spring Mountains of Nevada.

Atalopedes huron Edwards—"Brought in by the expedition of 1871" (Mead 1875, p. 789).

This is now called *campestris* Boisduval. Material in my collection suggests that both names may be needed in subspecific standing.

Hesperia yuma Edwards—"From a single male received from

Arizona by Lieut. Wheeler's Expedition of 1871.'" (Edwards 1873, p. 346).

A very careful study of the distribution of this insect by Dr. J. W. Tilden, coupled with my own studies of the Wheeler naturalist's itineraries suggest strongly that this species was collected by Bischoff in the vicinity of Owens Lake, California, around August 10th. The details of this are published elsewhere in the LEPIDOPTERISTS' NEWS.

Hesperia chusca Edwards—"From a single ♀ brought from Arizona by Lieut. Wheeler's Expedition of 1871.'" (Edwards 1873, p. 346).

This is a synonym of *Polites sabuleti sabuleti*. Lindsey, Bell, & Williams (1931, p. 102) state that the insect is found from southern California to Arizona and northward through Nevada to Oregon from April through September. Martin & Truxal (1955, p. 31) extend the temporal range to October in southern California. Bauer (1954) does not list the species from the upper Rio Verde Valley in Arizona. It looks as though the type may have come from anywhere along the route except Arizona! The fact that Bauer did not find it in the Verde Valley does not eliminate the Truxton area as the type locality.

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BY-LAWS OF THE NEW YORK ENTOMOLOGICAL SOCIETY*

ARTICLE I

MEMBERS

The Society shall consist of active, life and honorary members.

1. Active members shall be persons interested in entomology, who shall be entitled to vote and hold office.

2. Life members shall be active members who shall have reached the age of 45 years and who shall have paid the sum of one hundred dollars (\$100) at any one time in lieu of further annual dues. They shall be entitled to vote and hold office.

3. Honorary members shall be eminent entomologists elected in recognition of their service to science. There shall not be more than twelve (12) honorary members at any one time. They shall not be entitled to vote or hold office.

ARTICLE II

ELECTION OF MEMBERS

All candidates for membership must be proposed by an active member of the Society at a regular or annual meeting. They shall be voted upon individually at the following regular meeting and the affirmative vote of at least two-thirds of the members present (given by voice, or by ballot if demanded) is required for election unless these provisions are waived by unanimous consent of the members present.

ARTICLE III

OFFICERS AND COMMITTEES

1. Officers of the Society shall consist of a President, a Vice-President, a Secretary, an Assistant Secretary, a Treasurer, an Assistant Treasurer, and an Editor, and an Associate Editor.

2. Elective committees of the Society shall consist of five trustees (one of whom shall be the president) who shall constitute the Executive Committee who are hereinafter referred to as such, and a Publication Committee. The Executive Committee shall be composed of the President (Chairman), and four active members, all entitled to vote. The Editor, Vice-President, Associate Editor, Secretary, and Treasurer shall also be members of the Executive Committee but not entitled to vote. The Publication Committee shall be composed of the Editor (Chairman), Associate Editor and two active members.

3. Standing Committees of the Society to be appointed by the President, shall consist of an Auditing Committee composed of three active members; a Program Committee and a Field Committee, each composed of two active members.

* Corrected to and including amendments of 19 November, 1957.

4. Temporary committees may be appointed by the President at his discretion to perform special duties which he shall define. The President also shall appoint a Nominating Committee, consisting of three active members, to nominate a full slate of officers, trustees and elective committees at the annual meeting.

ARTICLE IV

ELECTION OF OFFICERS AND COMMITTEES

1. Officers, trustees and members of elective committees shall be elected at the annual meeting of the Society by a majority vote of the members present, or voting by proxy. They shall hold office for one year and/or until their successors shall be elected.

2. Any vacancy that may occur among the officers, or elective committees, except as hereinafter provided, shall be filled by appointment by the Executive Committee. The person appointed to fill the vacancy shall hold office until the next annual meeting and/or until the election of his successor.

ARTICLE V

DUTIES OF OFFICERS AND COMMITTEES

1. The President shall preside at all meetings. He shall appoint all committees except the elective committees, and shall be chairman of the Executive Committee and a member *ex-officio* of all other committees except the publication committee.

2. The Vice-President shall assume the duties of the President in case of the death, resignation, absence or disability of the President. In case both the President and Vice-President are absent at a meeting a temporary chairman may be chosen by the members present to preside at that meeting.

3. The Secretary shall keep the minutes of the meetings of the Society and of the Executive Committee; give notice of the meetings of the Society when not otherwise herein provided for; advise members of their election; attend to all general correspondence; keep all records and files of the Society and generally perform such services as may be delegated to him by the Society. At the expiration of his term of office the Secretary shall deliver to his successor all papers, books, and other records belonging to the Society.

4. The Assistant Secretary shall act in case of the death, resignation, absence or disability of the Secretary and shall assist the Secretary as need be.

5. The Treasurer shall receive all moneys for the Society and deposit them in the name of the Society in such banking institutions as the Executive Committee may direct; he shall pay therefrom by draft or check all bills and obligations not exceeding Twenty-five Dollars (\$25.00), and all others when approved by the President or the Editor. He shall keep an account of all monetary transactions and shall exhibit a statement of them when called for by the President, Editor, Executive Committee or Auditing Committee and shall make a full report for the preceding calendar year at the annual meeting. He shall notify members respecting the payment of dues within

ten days after their election and thereafter when annual dues become payable, and shall send out membership cards on receipt of dues. At the expiration of his term of office, the Treasurer shall deliver to his successor all funds, papers, books and vouchers belonging to the Society.

6. The Assistant Treasurer shall act in case of the death, resignation, absence or disability of the Treasurer and shall assist the Treasurer as need be.

7. The Editor shall have general charge, management and supervision of the publication known as the Journal of the New York Entomological Society. The Editor shall be Chairman of the Publication Committee, as hereinbefore provided.

8. The Executive Committee shall meet at the call of the President, who shall be Chairman thereof. It is empowered to call for a report from any of the officers or committees of the Society at its discretion. It shall keep minutes of its proceedings which shall be submitted at the next succeeding regular meeting of the Society. It shall have general charge of the funds, investments and property of the Society. It shall decide on the status of members in arrears of dues. It shall determine the subscription price of the Journal and discounts allowed in connection with its sale, as well as the price of any other publications of the Society. It shall appoint one active member of the Society as Delegate to meetings of the New York Academy of Sciences.

9. The Publication Committee shall cooperate with the Editor in the publication of the Journal of the Society. If, at any time, other publications are undertaken, the Publication Committee shall be in charge of the production thereof.

10. The Auditing Committee shall examine the accounts and reports of the Treasurer and shall report to the Society thereon.

11. The Program Committee shall plan and arrange for the programs of the meetings.

12. The Field Committee shall arrange for and manage the excursions and outings of the Society.

13. The Society's Delegate to the New York Academy of Sciences shall attend meetings thereof and shall report at the next regular meeting of the Society concerning any action taken which may affect the Society. The Delegate shall have no power to obligate the Society without previous authorization of the Executive Committee or except by action taken at a meeting of the Society.

ARTICLE VI

PUBLICATION FUNDS

All funds subscribed or donated for the Journal or other publications of the Society shall be used for no other purpose than those specified.

ARTICLE VII

DUES

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. New members,

if elected on or after October 1, shall pay no dues for the year of their election. Honorary members shall be exempt from the payment of any dues.

ARTICLE VIII

MEMBERS IN ARREARS

All members in arrears in the payment of dues for one year, shall lose the privilege of voting or holding office. Before the annual meeting the Treasurer shall present a list of the members in arrears in the payment of dues to the Executive Committee, which shall decide upon dropping such members from the roll of the Society or postponing for good cause the payment of their dues for a definite period.

ARTICLE IX

SUBSCRIPTION TO THE JOURNAL

1. The subscription price of the Journal, the price of single numbers to active members, and the price of sets shall be determined by the Executive Committee.

2. Subscriptions shall be payable in advance on the first of January of each year.

3. The Journal shall be sent gratis to all Life and Honorary members.

ARTICLE X

MEETINGS

1. Regular meetings of the Society shall be held at The American Museum of Natural History (or at such other place as the membership shall determine) on the first and third Tuesdays of each month at 8:00 P.M. No regular meetings will be held during the months of June, July, August and September or upon a legal holiday or upon the first Tuesday of January.

2. The annual meeting of the Society shall be held at The American Museum of Natural History (or at such other place as the membership shall determine) on the first Tuesday in January in each year at 8:00 P.M., if not a legal holiday, otherwise on the third Tuesday.

3. Special meetings of the Society may be called by the Secretary upon a written request of the President or 10 active members. Such request shall state the purpose for which the meeting is to be called and the time and place where it is to be held. No other business except that specified in the call shall be transacted except by unanimous consent of the members present.

4. Eleven (11) members shall constitute a quorum for the transaction of business at an annual meeting and seven (7) members shall constitute a quorum at any regular meeting.

5. At any special meeting, members in good standing may vote or be represented by proxy.

6. Whenever notice of any meeting is required by these by-laws it shall be deemed sufficient if published in the Bulletin of the New York Academy of Sciences or the Calendar of the American Museum of Natural History, or if given by postal card and addressed to each member of the Society at his last

known address at least ten (10) days and not more than twenty (20) days before the meeting, or if given as required by the General Corporation Law of the State of New York.

ARTICLE XI

THE ORDER OF BUSINESS

The order of business of regular meetings shall be as follows:

1. Reading of minutes.
2. Reports of officers.
3. Reports of committees.
4. Election of members.
5. Proposals for membership.
6. Miscellaneous business.
7. New business.
8. Reading of papers and scientific discussion.
9. Adjournment.

The order of business of the annual meeting shall be as follows:

1. Reading of minutes.
2. Roll call, verification of proxies.
3. Annual reports of officers.
4. Reports of committees.
5. Election of officers, trustees and elective committees for ensuing year.
6. Miscellaneous business.
7. Proposals and elections for membership.
8. Reading of papers and scientific discussion.
9. Adjournment.

The order of business may be changed or suspended at any meeting with consent of two-thirds or more of the members present.

ARTICLE XII

AMENDMENTS

These by-laws may be amended at any regular meeting or at a special meeting of the Society called for that purpose by the vote of two-thirds or more of the members present, provided that the proposed amendment or amendments shall have been submitted in writing and presented at a previous meeting of the Society and due notice thereof having been given in conformity with the provisions of Article X.

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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.

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Devoted to Entomology in General

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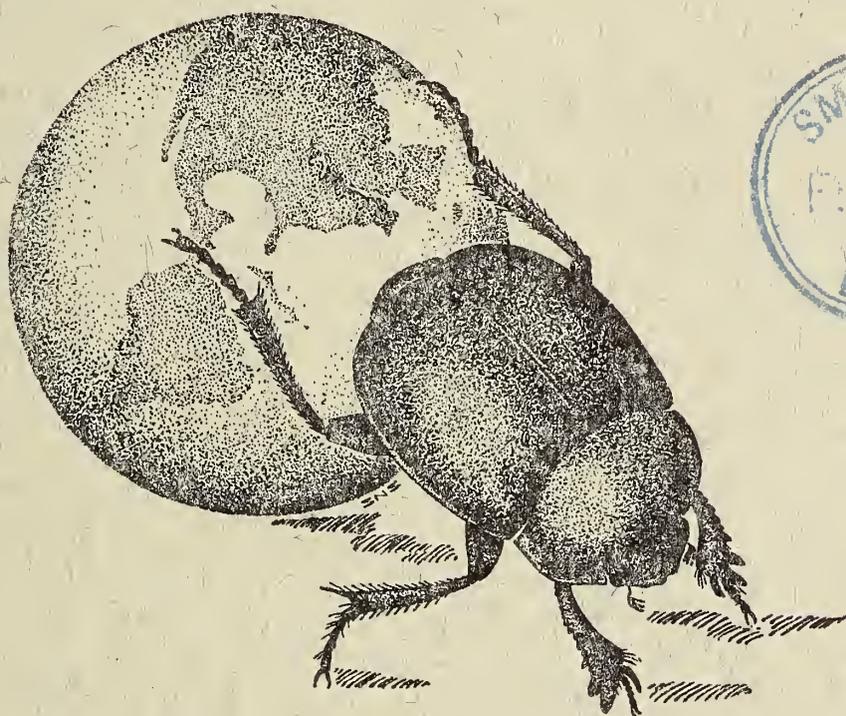
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March, June, 1958

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Editor Emeritus HARRY B. WEISS



Edited by FRANK A. SORACI

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Journal of the New York Entomological Society

VOL. LXVI

MARCH, JUNE, 1958

Nos. 1, 2

FRANK EDWARD WATSON, 1877-1947

Frank Edward Watson was born at New York City, New York, on May 11, 1877, and died at Flushing, Long Island, New York, on November 6, 1947.

He was a son of Edward Watson and Mary Frost Watson, both of New York City. There were at least two brothers, Edward and Walter, and one sister, Myra, but whether they survived him is not known.

Frank's elementary education was undoubtedly in the public schools, and completed at Cooper Union, New York City, from which he graduated in 1900 with the degree B.Sc. For a number of years thereafter he was in the employ of the Otis Elevator Company as a draftsman, a work for which he had great talent.

His interest in lepidopterology demonstrated itself very early in life, and at the first opportunity he applied for a position with the American Museum of Natural History, where on September 12, 1914, he was appointed an Assistant in the Department of Invertebrate Zoology. In 1921 his title was changed to Assistant in Lepidoptera in the Department of Entomology when Entomology was set up as a separate unit, and again in 1929 his title was changed to Staff Assistant in Lepidoptera, which he held until his resignation on November 1, 1939.

During his long association with the American Museum of Natural History, Frank Watson made a number of collecting trips for that institution, in addition to those in the neighborhood of New York City. In 1914 he was in Puerto Rico (Field Nos. 3551 to 3605), and Florida (Field Nos. 3600 to 3647), in 1915 in Santo Domingo (Field Nos. 3648 to 3699 and 3765 to 3799), in 1916 in the southeastern United States, especially Georgia and Alabama (Field Nos. 4301 to 4332), in 1919-1920 in Jamaica,

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West Indies (Field Nos. 4413 to 4524), and in 1921–1922 in Haiti (Field Nos. 4606 to 4662), during all of which trips he collected numerous insects of all orders. Unfortunately not much was published by him concerning these trips, but the information he gathered has been used by other authors.

While his primary interest when we met in 1931 was Lepidoptera, Frank had a keen interest in and knowledge of birds. When he came to visit me he would arise early in the morning and sit on the rear terrace to listen to the birds, all of which he recognized by their songs. One of his discoveries at my home in Mendham, New Jersey, was Henslow's sparrow, a bird seldom seen, which appeared to be at home in a field in back of my house. Toward the end of Frank's life, birds seemed to have interested him more than insects, and eventually superseded the latter so as to result in the complete neglect of his butterfly collection, which became the prey of dermestids and was of slight value when acquired by the author. It was most regrettable, as many of Frank's records for the vicinity of Paterson, New Jersey, Van Cortlandt Park and New York City, New York, will never be repeated.

While any day spent collecting with Frank was interesting because of his knowledge of good localities and the flora and Lepidoptera fauna thereof, one day stands out vividly in my memory. On July 17, 1932 we had been collecting in Sussex County, New Jersey, and were cruising southward between Newton and Springdale on U. S. Route 206 (New Jersey Route 31), when suddenly Frank remarked that a place on the right-hand side of the road appeared interesting, so we stopped the car to investigate. What we saw was a long, narrow field bounded on one side by a limestone ridge covered by an open woods. As we walked in the field, Frank being on my right towards the woods, I saw him net something, bottle it, and throw his cap up in the air, at the same time letting out a loud whoop. Hurrying to his side to inquire the cause of his excitement, he said, "*Calephelis borealis*," and so it was. Up to that moment this rare Riodinidae had not been taken in New Jersey, although its type locality was only some miles northward near Newburgh, New York.

Placing a hat on the ground to mark the spot of capture, we began circling, on the theory that where there was one there must

be two. So there were, however not in the field but in the woods, which, every time we entered as a result of our widening circle, produced the insect. My notes show that we took twelve specimens in short order. It was several years later before the author was able to see a female oviposit and do the life history, which was published in the *Canadian Entomologist* for August of 1936.

Probably a day that must have stood out in Frank's memory was May 5, 1907, when with John H. Cook at Lakewood, New Jersey, they collected every *Incisalia* at that time recorded from the northeastern United States, Frank's contribution being the only specimen of *I. henrici henrici* ever taken that far south in New Jersey, and both catching a number of *I. polios*, then unnamed. That was indeed a banner day.

For many years it was Frank's habit to keep a loose-leaf journal in which he made daily entries of the weather, and during the spring, summer, and fall, of collecting records. When this practice commenced and ended is not known, but at the time his collection was acquired, some of these journals were received also, and covered the years 1904 in part, 1906–1910, 1911 in part, 1912–1913, 1915, and 1923–1925. Most of these books are indexed, and all in all it is a very business-like affair. What became of the missing volumes is unknown.

With meticulous care Frank entered in these journals his field experiences, describing in detail with whom he collected, where he went, how much the carfare cost, and what was collected. Sometimes these records were supplemented by those of friends in their own handwriting, and incorporated in that manner in the journals. In many instances Frank was particular to draw maps of his collecting localities. Of these places there are maps of the following New York spots: Alpine, Pine Island, Southfield-Tuxedo, and Van Cortlandt Park, and in New Jersey of Andover, Atlantic Highlands, Boonton, Greenwood Lake, Hammondsville, Jamesburg, Lakehurst, Lakewood, Newark-Elizabeth Port, New Brunswick, Overpeck Creek and Marsh, Schooley's Mountain, and South Orange. In many of these localities he gave fanciful names to sublocalities, as for instance, "The Garden of the Hesperids," "Incisalia Way," etc., etc.

We learn also from these journals the names of lepidopterists of that period, which otherwise would be lost forever, such as, L. V. Coleman, J. Bennett Hill, and John Bull.

As Frank grew older he became a person of many peculiarities, and not of a very smooth disposition. Quite often he would take offense at something or other, and one was at a loss to know what it was all about. Usually he was very reserved, and seldom spoke of his life, family, or previous occupation. Invariably he wore a cap, often a faded jacket and plus fours. In a restaurant there was frequently a big argument about serving the meat course without gravy or sauce. Sometimes it was sent back to correct something against which he had a strong prejudice. Frank was not a good mixer or overly friendly with most people, but with young people he was a real "scout leader," and would spend time without end answering questions and furnishing information. In this way he was largely responsible for the development of several of our outstanding entomologists who, in their youth, came under Frank's influence. Among these are F. Martin Brown and Alexander Barrett Klots.

Watson was a life and honorary member of the New York Entomological Society, as well as a member of the Brooklyn Entomological Society, from which he resigned in 1916.

While connected with the Museum, Frank maintained an apartment on the upper west side of New York City. Upon his retirement in 1940 he lived with friends in Astoria, and during his last days resided at Flushing, New York.

It has not been possible to supply a photograph of Frank Watson, but one will be found in the *Entomological News* for March of 1930.

The author is indebted to Mr. John H. Cook of Albany, New York, one of Watson's lifelong friends, for much information concerning him; my colleagues Mr. Ernest L. Bell, Sr., of Flushing, New York, and Prof. Alexander Barrett Klots of Pelham, New York, both with the Department of Insects and Spiders of the American Museum of Natural History, and who knew Watson for many years; Mr. John T. Nichols, Curator Emeritus of Fishes, Department of Fishes and Aquatic Biology of the American Museum of Natural History for having supplied some details concerning Watson's interest in birds; Mrs. Charlotte Stove of the Office Service Division of the American Museum of Natural History for research work and information concerning Watson's collecting expeditions, and for having searched the Museum files and furnished considerable biographical data.

I. Papers by Frank Edward Watson

1913. Four new additions to our local list of Rhopalocera. Bull. Brooklyn Ent. Soc. **8**: 45-46.
1915. Some miscellaneous local records of Lepidoptera. Jour. New York Ent. Soc. **23**: 70-71.
1916. Local records of Lepidoptera. *Ibid.* **24**: 155.
1917. *Acronycta funeralis* Grote & Robinson. *Ibid.* **25**: 196.
1917. Writing of W[illiam] D[unham] Kearfott (compiler). *Ibid.* **25**: 238-239.
1918. A large number of species of butterflies observed in one day's collecting. *Ibid.* **26**: 3-7.
1918. Butterfly collecting for the season of 1918. *Ibid.* **26**: 228.
1919. Miscellaneous collecting notes for 1919. *Ibid.* **27**: 342-343.
1920. Miscellaneous notes and records of local Lepidoptera, with the description of a new form. *Ibid.* **28**: 227-235.
1921. Miscellaneous notes and records of local Lepidoptera, and description of two new aberrations. *Ibid.* **29**: 168-173.
1922. Miscellaneous notes and records of local Lepidoptera, and description of two new aberrations. *Ibid.* **30**: 131-135.
1929. *Eurymus eurhytheme f. amphidusa f. ♀ pallida* Cockerell. *Ibid.* **37**: 48.
1932. Miscellaneous note. *Ibid.* **40**: 98.
1932. [Book notice.] The butterfly book, new and thoroughly revised edition. A popular and scientific manual, describing and depicting all the butterflies of the United States and Canada. By W. J. Holland. *Ibid.* **40**: 100-102.
1932. Doctor Ottolengui's collection of Phytometrinae. *Ibid.* **40**: 438.
1937. New Hesperiidæ from the Antilles (Lepidoptera: Rhopalocera). Amer. Mus. Novitates, no. 906. 10 pp.
1938. A new *Eurema* from Puerto Rico (Lepidoptera: Rhopalocera). *Ibid.* no. 971. 2 pp.

II. Paper by Frank Edward Watson
and L[?] V[?] Coleman

1912. *Iphiclides ajax* and *Eurymus interior* [Lepid.] from the summit of Mt. Marcy, N. Y. Bull. Brooklyn Ent. Soc. **8**: 4-6.

III. Paper by Frank Edward Watson
and William Phillips Comstock

1920. Notes on American Lepidoptera with descriptions of new varieties. Bull. Amer. Mus. Nat. Hist. **42**: 447-457.

IV. Papers by John Hawley Cook
and Frank Edward Watson

1907. A new butterfly of the genus *Incisalia*. Canadian Ent. **39**: 202-204.

1908. Practical and popular Entomology.—No. 25. Oviposition of *Epidemia epixanthe*. *Ibid.* 40: 85–88.
1909. A variety of *Basilarchia archippus*. *Ibid.* 41: 77, pl. 5.
1909. *Incisalia* (Lepidoptera) from Texas. *Ibid.* 41: 181–182.

V. Papers by Frank Edward Watson
and Frank Eugene Lutz

1926. Our common butterflies. *Nat. Hist.* 26: 165–183, 17 pls. (2 colored), 1 fig., table.
1930. Our common butterflies. *Amer. Mus. Nat. Hist. Guide Leaflet no. 38*, sixth and revised edition: 1–21, 17 pls. (2 colored), 1 fig., table.—
CYRIL F. DOS PASSOS, Mendham, New Jersey.

KEY TO THE SPECIES OF PHEIDOLE
(HYMENOPTERA: FORMICIDAE) IN THE
UNITED STATES

BY ROBERT E. GREGG

DEPARTMENT OF BIOLOGY, UNIVERSITY OF COLORADO

It is eight years since Creighton (1950) published a comprehensive revision of the North American ant fauna. In this work a key to the species and subspecies of the genus *Pheidole* north of Mexico was attempted for the first time, and with a high degree of success for a very difficult assemblage of forms. In the interval following the appearance of Dr. Creighton's book, however, some important changes in our knowledge of the ants in this group have been made and others are included in this report. Ten new taxa have been described altogether, ten have been placed in synonymy, and eight have been revised in one way or another in the light of recent data. The latter includes a complex tangle of species and subspecies associated with the ant now recognized as *Pheidole tepicana* Pergande (Creighton and Gregg, 1955), and certain adjustments in concepts concerning the members of the *flavens* group occurring in the United States. Two species new to this fauna have been found since 1950, and were recorded by M. R. Smith in the Catalog of Hymenoptera of America North of Mexico. One subspecies is being raised to full species rank.

In view of the large number of species of *Pheidole* (69) known from this part of the world at the present time, a key is definitely advantageous for anyone wishing to identify these ants, unless examples of all of them are in his possession or available museum collections. Owing to the extreme rarity of many of the forms, a complete collection is virtually impossible for most investigators, as some species are known from but a few specimens, and others are still known only from types. Furthermore, in view of recent advances in the nomenclature and knowledge of the distribution of the species, Dr. Creighton's treatment has been rendered somewhat less usable, and it is considered desirable to offer a revised key which takes these changes into account.

The advantages of continuity with the work of previous authors, however, has led me to depart as little as possible from the key Creighton presented in 1950, for the most part adopting only those changes that are clearly imperative. One subgenus, namely *Ceratopheidole*, has been discovered new to the fauna of the United States, and this brings to three, the number of subgenera of *Pheidole* which it is now necessary to handle. For reasons already expressed by Creighton, and because two of the subgenera are represented in our area by only one or two species so far, it is not thought advisable to give separate tables for these species. As Creighton demonstrated, adequate determination of the species of *Pheidole* depends on samples consisting of both worker major (soldier) and worker minor castes, consequently both of these are freely used wherever necessary or unavoidable, and no effort is made to provide separate keys for each caste. In a limited segment of the North American fauna, involving just a few species and subspecies of *Pheidole*, it is perfectly possible to construct tables for the separate castes, but it is quite impossible to do so as yet for the entire continent.

I am under obligation to Dr. Creighton for the gift of numerous specimens, for the opportunity of studying material in his personal collection, and for valuable assistance in working out this revision. Dr. M. R. Smith and Dr. A. C. Cole have both been very helpful through the loan and gift of specimens critical to the study. Dr. Charles Ferrière, of Geneva, Switzerland, has made it possible for me to examine a number of type specimens of species originally described by Forel and Mayr. The contributions of all of these persons is sincerely appreciated and is acknowledged with pleasure.

The diagnostic plan which follows may be regarded as an effort to assemble the more recent data as well as the older data concerning the North American *Pheidole* fauna (not including Mexico), with emphasis on its taxonomy. Detailed treatment of the distribution of the various species has been omitted purposely, not because this is unimportant, but the information is still fragmentary for many forms and a greater abundance of records is needed for most of the species. Additional studies are contemplated which should yield a better understanding of the geographic distribution and the biology of this interesting group of

insects. The group is widely spread in the tropics and subtropics over the world, occurring also in the southern Palearctic and in the Nearctic Regions. It is the latter which is of special concern here, of course, and of particular interest are the northern and the altitudinal limits of penetration of *Pheidole* in our territory. The ants are decidedly thermophilous, and only a few species actually reach those limits, the number of species increasing notably at low elevations and southern latitudes. These ants are also absent from the upper levels of many isolated mountain ranges in the west and southwest.

Key to the Species of *Pheidole*
(majors and minors)

1. Antennal club composed of four segments (Subgenus *Ceratopheidole*) 2
 Antennal club composed of three segments 3
2. Eyes of the minor with 10-12 facets in the greatest diameter; head subquadrate; dorsum of head, thorax, pedicel, and gaster somewhat shining; color reddish brown *grundmanni*
 Eyes of the minor with 8-10 facets in the greatest diameter; head longer than broad; dorsum of body subopaque; color black *clydei*
3. Gaster truncate or subtruncate at the base; species small to moderately large in size, usually dimorphic though occasionally polymorphic (Subgenus *Pheidole*) 4
 Gaster not truncate at the base; giant species, polymorphic; epinotal spines unusually long and sharp (Subgenus *Macropheidole*) *rhea*
4. Head of major cylindrical in cross-section and obliquely truncate in front, the truncation involving the clypeus, frontal area, and mandibles *lamia*
 Head of major not cylindrical in cross-section and not truncate 5
5. Scapes of major reaching or surpassing the occipital angles 6
 Scapes of major not reaching the occipital angles 7
6. Upper surface of the head of the major densely granulo-rugose and dull; epinotal spines slender and directed upward *grallipes*
 Upper surface of the head of the major with prominent longitudinal rugae, the interrugal spaces not granulo- or at most very feebly granulo- with the surface shining; epinotal spines thick at the base and directed posteriorly *desertorum*
7. Antennal scape of the major abruptly bent at the base so that the scape turns toward the midline of the head in passing to the antennal socket, the basal portion of the scape flattened, and as broad or broader than the distal portion 8
 Antennal scape of the major not abruptly bent at the base, not flattened or only slightly so, and the base never as broad as the distal portion of the scape 17

8. Antennal scape of the major reaching three-fourths or more of the distance between its insertion and the occipital angle 9
 Antennal scape of the major reaching two-thirds or less of the distance between its insertion and the occipital angle 14
9. The entire dorsal surface of the head of the major covered with reticulo-rugose sculpture, the interrugal spaces granulose 10
 The reticulo-rugose sculpture of the head of the major largely confined to the anterior half, the occipital lobes punctate or feebly granulose, the surface moderately to strongly shining at least on the posterior half of the head 12
10. Head of minor densely sculptured and completely opaque; postpetiole transversely oval and twice as wide as the node of the petiole *texana*
 Head of the minor in part, especially the frons, strongly shining and smooth, the rest punctate; postpetiole globular and less than twice as wide as the node of the petiole 11
11. Pronotal rugae of the major coarse, transverse, and with interrugal spaces notably shining; petiolar notch broad and shallow; gastric hairs long, nearly of equal length, coarse, blunt at the tips, and widely spaced *sciara*
 Pronotal rugae of the major weak and somewhat reticulate, with interrugal spaces granular, subopaque; petiolar notch feeble; gastric hairs short, uneven in length, fine, pointed at the tips, and more numerous *cockerelli*
12. Head of minor densely punctate, opaque; erect hairs on the gaster of the major sparse and widely spaced *vallicola*
 Head of the minor smooth and shining; erect hairs on the gaster of the major numerous, long, and closely spaced 13
13. Head of major measuring 1.4 mm. × 1.3 mm.; female 7 mm. in length *hyatti*
 Head of major measuring 1.2 mm. × 1.1 mm.; female 5 mm. in length *hyatti* subsp. *solitanea*
14. Occipital lobes of the major striato-granulose and scarcely shining *subdentata**
 Occipital lobes of the major strongly shining and bearing piligerous punctures only 15
15. The flattened basal portion of the scape of the major notably broader than the distal portion *porcula*
 The flattened basal portion of the scape of the major no wider than its distal portion 16
16. Erect gastric hairs, when present, much longer and coarser than the fine appressed pubescence *crassicornis*

* The strongly polymorphic worker caste of *subdentata* is a source of considerable confusion. The larger medias run through the key to *hyatti* or *cockerelli*, from which they would differ in having more rugose occipital lobes. The smaller medias approach the condition found in the major of *desertorum*, but have shorter and more numerous erect hairs on the thorax and gaster. For recent changes in the nomenclature of this and related species, see discussion at the end of this paper.

- Erect gastric hairs very numerous, rather short and so fine that they merge with the pubescence, most of which is semi-erect
 *crassicornis* subsp. *tetra*
17. The tops of the occipital lobes of the major, and usually their front faces as well, covered with sculpture, the surface opaque or feebly shining 18
 The tops of the occipital lobes of the major, and usually their front faces also, free from sculpture except for piligerous punctures, the surface in most cases strongly shining 35
18. Anterior border of the clypeus of the major with a deep semicircular emargination which extends inward almost to the level of the frontal lobes *tepicana*
 Anterior border of the clypeus of the major entire, or if impressed, the emargination is shallow and not semicircular 19
19. Humeral angles of the pronotum of the major weakly developed and not forming lateral bosses 20
 Humeral angles of the pronotum of the major strongly developed and forming distinct, epaulet-like lateral bosses 23
20. Occipital lobes of the major with deep, broad, piligerous foveolae
 *sitarches* subsp. *littoralis*
 Occipital lobes of the major with distinct, transverse rugae 21
21. Head and thorax of minor punctate, opaque; hairs on the promesonotum of the major and especially the minor strongly clavate
 *sitarches* subsp. *campestris*
 Head and thorax of minor, at least in part, strongly shining; hairs not clavate 22
22. Entire head and promesonotum of minor smooth and strongly shining; transverse pronotal rugae of the major weak *sitarches*
 Head of the minor with the frons striato-punctate and the occipital border punctate; pronotal rugae of the major prominent
 *sitarches* subsp. *soritis*
23. Postpetiole of the major lenticular in shape, the lateral connules well-developed 24
 Postpetiole of the major trapezoidal, the lateral connules absent or poorly developed 31
24. Head of the major 0.85 mm. in length, or less 25
 Head of the major 1.4 mm. in length, or more 26
25. Occipital sculpture of the major reticulate, with no trace of transverse or longitudinal rugae *dentigula*
 Occipital sculpture of the major longitudinal, continuous with that of the rest of the head, and extending fully to the posterior occipital margin *nuculiceps*
26. Transverse rugae on the occiput of the major pronounced and usually extending onto the front face of the lobes 27
 Transverse occipital rugae of the major much finer, resembling striations, and largely confined to the top of the occiput 30
27. Occipital rugae of the major straight or wavy, but not reticulate; lateral postpetiolar connules very prominent and sharp 28

- Occipital rugae of the major notably reticulate and often coarse; lateral postpetiolar connules usually blunt 29
28. Cephalic rugae of the major wavy, with interrugal spaces granular producing a subopaque appearance; thorax except for the pronotum, granular and subopaque, dorsal rugae transverse *senex*
 Cephalic rugae of the major straight, with interrugal granules very fine or absent producing a shining surface; thorax almost completely smooth and shining *creightoni*
29. Longitudinal rugae extend across the entire length of the head of the major; interrugal spaces finely punctured, opaque *pilifera*
 Longitudinal rugae on the head of the major interrupted at the vertex, which is distinctly shining and possesses only scattered hair punctures *pilifera* subsp. *artemisia*
30. Front and vertex of the head of the major with coarse, widely spaced, piligerous foveolae, longitudinal rugae, and interrugal granulations; feebly shining *pilifera* subsp. *coloradensis*
 Front and vertex of the major with almost no sculpture other than small piligerous punctures, strongly shining; occipital rugae feeble *pilifera* subsp. *pacifica*
31. Transverse occipital sculpture of the major in the form of fine rugules or striations 32
 Occipital sculpture of the major in the form of more or less coarse rugae 33
32. Occipital striations very fine and turning forward onto the genae where they extend to the insertions of the mandibles *micula*
 Occipital striations heavier and more obvious, but not turning forward onto the genae *rugulosa*
33. Sides of the epinotum on the major granulose, weakly shining or opaque 34
 Sides of the epinotum on the major not granulose, very smooth and shining *californica* subsp. *pyramidensis*
34. Occipital rugae of the major coarse and wavy, usually forming reticulations in the occipital sulcus *californica*
 Occipital rugae of the major finer, straight or nearly so, and usually not forming reticulations in the occipital sulcus *californica* subsp. *oregonica*
35. Head of the major cordate, gradually but distinctly narrowed toward the mandibular insertions, broadest at the occipital lobes *megacephala*
 Head of the major not cordate, either quadrate or rectangular with sides parallel, or if slightly convergent, the broadest part of the head anterior to the occipital lobes 36
36. Head of the minor with a well-developed psammophore on the ventral surface, the latter flattened or slightly concave *psammophila*
 Head of the minor without a psammophore on the ventral surface, the latter convex 37
37. Head, thorax, and gaster of the minor, and often the major as well, with distinct violaceous or bluish reflections 38

- Head, thorax, and gaster of the minor and major without violaceous reflections 39
38. Head of the minor in large part sculptured, only a narrow central strip smooth and shining *metallescens*
 Head of the minor largely smooth and shining
 *metallescens* subsp. *splendidula*
39. Entire thorax of minor densely covered with granulose sculpture and completely opaque 40
 At least a part of the promesonotum shining in the minor, or, if the entire thorax is opaque, the promesonotum is longitudinally striate and not densely granulose 45
40. Antennal scapes of the minor surpass the occipital angles by an amount greater than the length of the first funicular segment, sometimes twice as great *sciophila*
 Antennal scapes of the minor just reach the occipital angles or barely surpass them by an amount less than the length of the first funicular segment 41
41. Both major and minor with the entire dorsal surface of the first gastric segment finely and densely granulose and opaque *anastasii*
 Dorsum of the first gastric segment in both major and minor entirely, or at least largely, smooth and shining; sculpture when present confined to an area near the base of the gaster 42
42. Pronotum of the major strongly convex when seen from behind, the humeral angles not prominent and lying well below the level of the middle of the pronotum; head of the minor largely free from sculpture and strongly shining *davisi*
 Pronotum of the major flat or feebly convex when seen from behind, the humeral angles sharp, prominent, and lying at or near the level of the middle of the pronotum; head of minor usually densely sculptured and completely opaque, but if not at least the sides of the head are sculptured and only the middle is shining 43
43. Postpetiole of the minor small and globular, not more than one-and-one-half times as wide as the petiole *flavens*
 Postpetiole of the minor not globular but pyriform, and twice as wide as the petiole 44
44. Occipital lobes of the major smooth and shining throughout; clypeus with several longitudinal rugae; hairs long, tapering, and pointed
 *floridana*
 Occipital lobes of the major reticulo-rugose and opaque, except for a narrow shining band along their posterior margins; clypeus without rugulae; hairs short and obtuse *floridana* subsp. *constipata*
45. Epinotum of the major angular at the junction of the basal and declivous faces, but the angles not produced into distinct teeth or spines 46
 Epinotum of the major armed with distinct teeth or spines 48
46. Prothorax of the major with well-developed humeri; postpetiole with prominent lateral connules *barbata*

- Prothorax of the major without well-developed humeri; postpetiole without prominent lateral connules 47
47. Abdominal pilosity largely limited to coarse, erect hairs; length of the major 3.5-4 mm. *morrissi*
Abdominal pilosity with many fine, subappressed hairs in addition to the coarse, erect hairs; length of the major 4-5 mm.
..... *morrissi* subsp. *impexa*
48. Large species, the head of the major at least 2 mm. in length and usually more 49
Small species, the head of the major not exceeding 1.5 mm. in length and usually less 54
49. Pronotum of the major with transverse striae 50
Pronotum of the major without transverse striae 52
50. Head of the major with longitudinal rugae confined to the anterior half, posterior half without sculpture except for piligerous punctures 51
Head of the major with longitudinal rugae extending onto the anterior portions of the occipital lobes *titanis*
51. Head of the major with a flattened, rugose area interposed between the frontal lobe and the eye, and furnished with large, interrugal foveolae; petiole with prominent lateral spiracles *macclendoni*
Head of the major without a flattened, rugose area between the frontal lobe and the eye; petiole unarmed *virago*
52. Postpetiole of the major, seen from above, very strongly transverse and notably constricted posteriorly, with prominent, sharply pointed lateral connules *spadonia*
Postpetiole of the major, seen from above, only moderately transverse and not greatly constricted posteriorly, with rather short and blunt lateral connules 53
53. Head of the major notably longer than broad (2.2 mm. × 1.6 mm.); the genae suddenly expanded just behind the insertions of the mandibles
..... *ridicula*
Head of the major very little broader than long (2.5 mm. × 2.4 mm.); the genae not expanded above the insertions of the mandibles *militicida*
54. Sculpture on the head of the major extending to the vertex, only the occiput smooth and shining *ceres*
Sculpture on the head of the major largely confined to the anterior half of the head, the posterior half smooth and shining 55
55. Mesonotum of the major depressed below the adjacent portion of the pronotum so that in profile it forms a distinct step or angular projection between the pronotum and the epinotum *dentata*
Mesonotum of the major not depressed below the adjacent portion of the pronotum, in profile the two forming an evenly curved outline which usually descends abruptly at the mesoëpinotal suture 56
56. Eyes of the major with 60 facets, or more 57
Eyes of the major with 40 facets, or less 60
57. Head of the major with a flattened area extending posteriorly from the antennal fossa toward the occipital lobe; occipital lobes compressed

- dorso-ventrally, the posterior one-third of the head, seen in profile, with dorsal and ventral surfaces converging notably toward the crest of the lobe 58
- Head of the major without a flattened area extending posteriorly from the antennal fossa; the occipital lobes not compressed dorso-ventrally, thick and evenly rounded when seen in profile, and not sharply set off from the anterior part of the head *yaqui*
58. Major with the dorsum of the pronotum covered with numerous, coarse, reticulate rugae in addition to the more nearly parallel transverse rugae on the anterior face and on the neck; interrugal surfaces heavily coriaceous, opaque or nearly so *xerophila* subsp. *tucsonica*
- Major with the dorsum of the pronotum bearing few or no rugae, the rugae mainly restricted to the anterior face and neck of the pronotum, and not noticeably reticulate; interrugal surfaces smooth to slightly coriaceous, moderately to strongly shining 59
59. Postpetiole of the major trapezoidal, the lateral connules short and obtuse; color golden yellow to dull yellow, head of the minor sometimes infuscated *gilvescens*
- Postpetiole of the major strongly transverse, with long lateral connules; color ferruginous red to blackish red, the minor piceous brown *xerophila*
60. Vertex and occiput of the minor with small, close-set punctures which give the surface a noticeably duller appearance on those parts than elsewhere on the head 61
- Vertex and occiput of the minor strongly shining or only slightly less shining than the rest of the head, the punctures widely scattered over the whole head 62
61. Basal face of the epinotum of the major sculptured and opaque.... *casta*
- Basal face of the epinotum of the major in large part shining, its sculpture restricted to punctures near the mesoëpinotal suture *cerebrosior*
62. Basal face of the epinotum of the major free from sculpture and strongly shining *humeralis*
- Basal face of the epinotum of the major distinctly sculptured, feebly shining and opaque 63
63. Sides of the epinotum of the minor largely free from sculpture and strongly shining *tysoni*
- Sides of the epinotum of the minor densely punctured, feebly shining and opaque 64
64. Lateral connules on the postpetiole of the major prominent and sharp pointed *pinealis*
- Lateral connules on the postpetiole of the major blunt and not prominent 65
65. Erect hairs on the thorax of the minor short, sparse, and strongly clavate *marcidula*
- Erect hairs on the thorax of the minor long, abundant and, although often blunt at the tips, not clavate 66

66. Anterior clypeal margin of the major sinuate; pronotum smooth and shining *bicarinata* subsp. *paute*
 Anterior clypeal margin of the major bluntly bidentate; pronotum punctate and usually with transverse rugae or striae 67
67. Basal face of the epinotum in the major largely covered with transverse striae, and with punctures confined to the region of the mesoepinotal suture; pronotal rugae coarse and prominent *bicarinata*
 Basal face of the epinotum in the major largely punctate, transverse striae, when present, restricted to the area between the bases of the epinotal spines; pronotal rugae feeble 68
68. Epinotum of the minor armed with thick, short spines
 *bicarinata* subsp. *vinelandica*
 Epinotum of the minor armed with angular teeth which are broad at the base and do not resemble spines *bicarinata* subsp. *longula*

Subgenus CERATOPHEIDOLE

1. *Pheidole* (*Ceratopheidole*) *clydei* Gregg
Ph. (*Ceratopheidole*) *clydei* Gregg, Jour. N. Y. Ent. Soc., 1950, 58, p. 89, ♀; Gregg, Amer. Mus. Novit., 1953, No. 1637, 24.
 Type locality: Carrizozo, New Mexico
2. *Pheidole* (*Ceratopheidole*) *grundmanni* M. R. Smith
Ph. (*Ceratopheidole*) *grundmanni* M. R. Smith, Jour. N. Y. Ent. Soc., 1953, 61, p. 143, ♀.
 Type locality: Vernal, Utah

Subgenus MACROPHEIDOLE

3. *Pheidole* (*Macropheidole*) *rhea* Wheeler
Ph. rhea Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 452, ♀.
Ph. (*Macropheidole*) *rhea* M. R. Smith, Proc. Ent. Soc. Wash., 1943, 45, p. 5, 24, ♀; Gregg, Psyche, 1949, 56, p. 70, ♀, ♀, 24; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 168.
 Type locality: Nogales, Arizona

Subgenus PHEIDOLE

4. *Pheidole anastasii* Emery
Ph. anastasii Emery, Bull. Soc. Ent. Ital., 1896, 28, p. 76, ♀, 24; Forel, Mitt. Naturh. Mus. Hamburg, 1901, 18, p. 78, ♀; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 169.
 Type locality: Jimenez, Costa Rica

5. *Pheidole barbata* Wheeler

Ph. barbata Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 448, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 170; Creighton and Gregg, Univ. Colo. Stud., 1955, Ser. Biol. No. 3, p. 1.

Type locality: Mojave Desert, Needles, California

6. *Pheidole bicarinata* Mayr

Ph. bicarinata Mayr, Verh. Zool-bot. Ges. Wien, 1870, 20, p. 989, ♂; Mayr, Ibid., 1887, 37, p. 596, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 170.

Ph. hayesi M. R. Smith, Ent. News, 1924, 35, p. 251, ♀, ♂.

Type locality: Illinois

7. *Pheidole bicarinata longula* Emery

Ph. vinelandica var. *longula* Emery, Zool. Jahrb. Syst., 1895, 8, p. 292, ♀, ♂; Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 453, ♂.

Ph. vinelandica subsp. *longula* Wheeler, Ibid., 1915, 34, p. 405.

Ph. bicarinata longula Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 171.

Type locality: Pueblo, Colorado

8. *Pheidole bicarinata paiute* subsp. nov.

MAJOR: Length, 4.25 mm.; head length (excluding mandibles), 1.08 mm.; head width, 1.00 mm.; head index, 0.93; thorax length, 0.92 mm.

This ant runs in Creighton's key to *Ph. bicarinata vinelandica*, and comparison with undoubted specimens of that form confirms the close relationship. It is, however, not identical, and may be distinguished from *vinelandica* by the following characters: head slightly longer and overall body size a little larger; anterior clypeal margin broadly sinuate (a narrow median emargination in *vinelandica* and other subspecies of *bicarinata* is bounded by prominent though rounded lobes); cephalic sculpture more restricted anteriorly, so that in some cases, fully 2/3 of the head, including the frons, vertex, and occiput is smooth and shining; the humeral angles less prominent, and the pronotum with punctures completely absent and virtually no transverse rugules or striae, the surface very shining; basal face of the epinotum punctate, sometimes with one or two weak interspinal striae, but the surface somewhat shining (heavily punctate and opaque in *vinelandica*); strong rugae running diagonally from the mesoëpinotal suture to the bases of the spines and enclosing the punctate epinotal base (absent on *vinelandica*); color almost identical except that the head is a little lighter yellowish red.

MINOR: practically indistinguishable except a little larger in size than *vinelandica* and with longer epinotal spines.

Holotype: Major.

Paratypes: 36 majors and 135 minors

The type material was collected by W. S. Creighton at Goldfield, Nevada, on October 17, 1952, elevation 5800 feet, and was obtained from two colonies.

This subspecies is known at present only from the type locality, and this makes it difficult to correctly appraise its status. It might be regarded as a Great Basin race of *bicarinata*, and in fact has been described as a subspecies because of its close morphological resemblance to that species, but further revision must depend on future collections and better knowledge of its general distribution. It is conceivable that *painte* may have to be interpreted later as a full species.

9. *Pheidole bicarinata vinelandica* Forel

Ph. bicarinata race *vinelandica* Forel, Ann. Soc. Ent. Belg., 1886, 30, p. 45, ♀, ♂, ♀, ♂.

Ph. vinelandica Mayr, Verh. Zool-bot. Ges. Wien, 1886, 36, p. 458, ♂; Emery, Zool. Jahrb. Syst., 1895, 8, p. 292; Forel, Ann. Soc. Ent. Belg., 1901, 45, p. 348, ♀, ♂, ♀, ♂; Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 453.

Ph. (Allophaidole) vinelandica Forel, Mem. Soc. Ent. Belg., 1912, 19, p. 237.

Ph. (Allophaidole) vinelandica var. *nebrascensis* Forel, Rev. Suisse Zool., 1922, 30, p. 92, ♀, ♂, ♀.

Ph. vinelandica laeviuscula Emery, Zool. Jahrb. Syst., 1895, 8, p. 292, ♀, ♂.

Ph. vinelandica subsp. *buccalis* Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 454, ♀, ♂, ♀.

Ph. vinelandica longula var. *castanea* Wheeler, Bull. Amer. Mus. Nat. Hist., 1915, 34, p. 405, ♀, ♂.

Ph. vinelandica longula var. *huachucana* M. R. Smith (nom. nov.) Cat. Hym. Amer. No. of Mex., 1951, U. S. D. A. Mon. No. 2, p. 805.

Ph. bicarinata buccalis Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 171.

Ph. bicarinata vinelandica Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 172.

Type locality: Vineland, New Jersey

10. *Pheidole californica* Mayr

Ph. californica Mayr, Verh. Zool-bot. Ges. Wien, 1870, 20, p. 987, ♂, ♀; Emery, Zool. Jahrb. Syst., 1895, 8, p. 289; Wheeler, Bull. Amer. Mus. Nat. Hist., 1915, 34, p. 406, ♂, ♀; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 172.

Ph. californica var. *incenata* Wheeler, Bull. Amer. Mus. Nat. Hist., 1915, 34, p. 407, ♂, ♀.

Ph. californica var. *satura* Wheeler, Ibid., 1915, 34, p. 407, ♂, ♀.

Type locality: San Francisco, California

11. *Pheidole californica oregonica* Emery

Ph. oregonica Emery, Zool. Jahrb. Syst., 1895, 8, p. 291, ♂, ♀.

Ph. californica subsp. *oregonica* Wheeler, Bull. Amer. Mus. Nat. Hist., 1915, 34, p. 407, ♂, ♀; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 173.

Ph. californica var. *shoshoni* Cole, Ann. Ent. Soc. Amer., 1933, 26, p. 618, ♂, ♀.

Ph. californica *shoshoni* Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 174.

Ph. californica var. *hagermani* Cole, Canad. Ent., 1936, 68, p. 35, ♂, ♀.

Type locality: The Dalles, Oregon

12. *Pheidole californica pyramidensis* Emery

Ph. californica subsp. *nevadensis* Wheeler, Bull. Amer. Mus. Nat. Hist., 1915, 34, p. 408, ♂, ♀.

Ph. californica subsp. *pyramidensis* Emery, in Wytsman, Gen. Insect., 1921, Fasc. 174, p. 105 (nomen novum); Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 173.

Type locality: Pyramid Lake, Nevada

13. *Pheidole casta* Wheeler

Ph. casta Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 454, ♂, ♀; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 174.

Type locality: Canyon of the Rio Grande, Langtry, Texas

14. *Pheidole cerebrosior* Wheeler

Ph. vinelandica subsp. *cerebrosior* Wheeler, Bull. Amer. Mus. Nat. Hist., 1915, 34, p. 405, ♂, ♀.

- Ph. cerebrosior* Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 175; Creighton and Gregg, Univ. Colo. Stud., 1955, Ser. Biol. No. 3, p. 3. 4.
Type locality: Tucson, Arizona
15. *Pheidole ceres* Wheeler
Ph. ceres Wheeler, Bull. Amer. Mus. Nat. Hist., 1904, 20, p. 10, ♀, 4, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 174.
Type locality: Colorado Springs, Colorado
16. *Pheidole cockerelli* Wheeler
Ph. cockerelli Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 464, ♀, 4; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 175.
Type locality: Arroyo Pecos, Las Vegas, New Mexico
17. *Pheidole crassicornis* Emery
Ph. crassicornis Emery, Zool. Jahrb. Syst., 1895, 8, p. 296, 4; Forel, Ann. Soc. Ent. Belg., 1901, 45, p. 350, ♀, 4, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 175.
Ph. crassicornis var. *diversipilosa* Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 467, ♀, 4, ♀.
Type locality: Charlotte, North Carolina
18. *Pheidole crassicornis tetra* Wheeler
Ph. crassicornis subsp. *porcula* var. *tetra* Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 467, ♀, 4.
Ph. crassicornis tetra Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 176.
Type locality: Austin, Texas
19. *Pheidole creightoni* Gregg
Ph. creightoni Gregg, Psyche, 1955, 62, p. 19, ♀, 4, ♀, ♂.
Type locality: Applegate, Oregon
20. *Pheidole davisii* Wheeler
Ph. davisii Wheeler, Bull. Amer. Mus. Nat. Hist., 1905, 21, p. 380, ♀, 4; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 176.
Type locality: Lakehurst, New Jersey
21. *Pheidole dentata* Mayr
Ph. morrisoni var. *dentata* Mayr, Verh. Zool-bot. Ges. Wien, 1886, 36, p. 457, ♀, 4, ♂.

Ph. dentata Forel, Ann. Soc. Ent. Belg., 1901, 45, p. 351, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 177.

Ph. dentata var. *faisonsica* Forel, Ann. Ent. Soc. Belg., 1901, 45, p. 352, ♀, ♂.

Ph. commutata Mayr, Verh. Zool-bot. Ges. Wien, 1886, 36, p. 459, ♀, ♂; Emery, Zool. Jahrb. Syst., 1895, 8, p. 289, ♀, ♂.

Ph. dentata var. *commutata* M. R. Smith, Cat. Hym. Amer. No. of Mex., 1951, U. S. D. A. Mon. No. 2, p. 802.

Type locality: Florida

22. *Pheidole dentigula* M. R. Smith

Ph. dentigula M. R. Smith, Ent. News, 1927, 38, p. 310, ♀, ♂; M. R. Smith, Ibid., 1928, 39, p. 245, ♀; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 178.

Type locality: A & M College, Mississippi

23. *Pheidole desertorum* Wheeler

Ph. desertorum Wheeler, Bull. Amer. Mus. Nat. Hist., 1906, 22, p. 337, ♀, ♂, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 178.

Ph. desertorum var. *comanche* Wheeler, Bull. Amer. Mus. Nat. Hist., 1906, 22, p. 339, ♀, ♂, ♀.

Ph. desertorum var. *maricopa* Wheeler, Ibid., 1906, 22, p. 339, ♀, ♂.

Type locality: Ft. Davis, Texas

24. *Pheidole flavens* Roger

Ph. flavens Roger, Berlin Ent. Zeitschr., 1863, 7, p. 198, ♀, ♂; Mayr, Verh. Zool-bot. Ges. Wien, 1870, 20, p. 981, 983; Emery, Bull. Soc. Ent. Ital., 1894, 26, p. 155; Emery, in Wytsman, Gen. Insect., 1921, Fasc. 174, p. 107.

Type locality: Cuba

25. *Pheidole floridana* Emery

Ph. flavens subsp. *floridana* Emery, Zool. Jahrb. Syst., 1895, 8, p. 293, ♀, ♂, ♀.

Ph. floridana Emery, Bull. Soc. Ent. Ital., 1896, 28, p. 77; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 179.

Ph. lauta Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 470, ♀, ♂, ♀, ♂.

Ph. floridana lauta Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 179.

Type locality: Coconut Grove, Florida

26. *Pheidole floridana constipata* Wheeler

Ph. constipata Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 468, ♀, ♂, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 175.

Type locality: Austin and New Braunfels, Texas

27. *Pheidole gilvescens* Wheeler

Ph. xerophila tucsonica var. *gilvescens* Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 448, ♀, ♂.

Ph. gilvescens Creighton and Gregg, Univ. Colo. Stud., 1955, Ser. Biol. No. 3, p. 5, ♀, ♂.

Type locality: Phoenix and Tucson, Arizona

28. *Pheidole grallipes* Wheeler

Ph. susannae subsp. *longipes* Pergande, Proc. Calif. Acad. Sci., 1895, (2), 5, p. 885, ♀, ♂ (nec F. Smith).

Ph. longipes Forel, Biol. Centrali. Amer. Hym., 1899, 3, p. 65; Wheeler, Bull. Amer. Mus. Nat. Hist., 1915, 34, p. 397, ♀.

Ph. grallipes Wheeler, Psyche, 1916, 23, p. 40 (nomen nov.); Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 180.

Ph. grallipes var. *vistana* M. R. Smith, Cat. Hym. Amer. No. of Mex., 1951, U. S. D. A. Mon. No. 2, p. 802.

Type locality: Sierra San Lazaro, Mexico

29. *Pheidole humeralis* Wheeler

Ph. humeralis Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 456, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 180.

Type locality: Corsicana, Texas

30. *Pheidole hyatti* Emery

Ph. hyatti Emery, Zool. Jahrb. Syst., 1895, 8, p. 295, ♀, ♂; Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 462, ♀, ♂, ♀; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 180.

Ph. hyatti var. *ecitonodora* Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 463, ♀, ♂, ♀, ♂.

Type locality: San Jacinto, California

31. *Pheidole hyatti solitanea* Wheeler
Ph. hyatti subsp. *solitanea* Wheeler, Bull. Amer. Mus. Nat. Hist., 1915, 34, p. 409, ♀, ♂, ♀; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 181.
Type locality: Point Loma, San Diego, California
32. *Pheidole lamia* Wheeler
Ph. lamia Wheeler, Amer. Nat., 1901, 35, p. 534, ♀, ♂; Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 477, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 182.
Type locality: Austin, Texas
33. *Pheidole macclendoni* Wheeler
Ph. macclendoni Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 450, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 182.
Type locality; Laredo and Corsicana, Texas
34. *Pheidole marcidula* Wheeler
Ph. marcidula Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 457, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 182.
Type locality: Barton Creek, Austin, Texas
35. *Pheidole megacephala* (Fabricius)
Formica megacephala Fabricius, Ent. System., 1793, 2, p. 361, ♂.
Pheidole megacephala Emery, Gen. Insect., 1921, Fasc. 174, p. 85; M. R. Smith, Cat. Hym. Amer. No. of Mex., 1951, U. S. D. A. Mon. No. 2, p. 803.
Type locality: Isle de France. (Mauritius)
36. *Pheidole metallescens* Emery
Ph. metallescens Emery, Zool. Jahrb. Syst., 1895, 8, p. 294, ♀; Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 476, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 183.
Type locality: St. George, Florida
37. *Pheidole metallescens splendidula* Wheeler
Ph. metallescens subsp. *splendidula* Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 474, ♀, ♂, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 183.
Type locality: Del Rio, Texas

38. *Pheidole micula* Wheeler
Ph. californica subsp. *micula* Wheeler, Bull. Amer. Mus. Nat. Hist., 1915, 34, p. 408, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 173.
 Type locality: Miller Canyon, Huachuca Mts., Arizona
39. *Pheidole militicida* Wheeler
Ph. militicida Wheeler, Bull. Amer. Mus. Nat. Hist., 1915, 34, p. 398, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 183; Creighton and Gregg, Univ. Colo. Stud., 1955, Ser. Biol. No. 3, p. 9, ♀, ♂.
 Type locality: Hereford and Benson, Arizona
40. *Pheidole morrisi* Forel
Ph. morrisi Forel, Ann. Soc. Ent. Belg., 1886, 30, p. 46, ♀, ♂; Forel, Ibid., 1901, 45, p. 350, ♀, ♂, ♀, ♂ (*morrisi*); Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 183 (*morrisi*).
Ph. morrisi var. *vanceae* Forel, Ann. Soc. Ent. Belg., 1901, 45, p. 351, ♀, ♂, ♀, ♂.
 Type locality: Vineland, New Jersey
41. *Pheidole morrisi impexa* Wheeler
Ph. morrisi var. *impexa* Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 461, ♀, ♂, ♀, ♂.
Ph. morrisi impexa Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 184.
 Type locality: Del Valle, Austin, Texas
42. *Pheidole nuculiceps* Wheeler
Ph. nuculiceps Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 473, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 184.
 Type locality: Comal River, New Braunfels, Texas
43. *Pheidole pilifera* (Roger)
Leptothorax pilifer Roger, Berl. Ent. Zeitschr., 1863, 7, p. 180, ♀.
Pheidole pilifera Emery, Zool. Jahrb. Syst., 1895, 8, p. 290, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 184.
Ph. pilifera var. *simulans* Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 436, ♂.
Ph. pilifera subsp. *septentrionalis* Wheeler, Ibid. 1908, 24, p. 436, ♂.

Ph. pennsylvanica Roger, Berl. Ent. Zeitschr., 1863, 7, p. 199, ♂; Mayr, Verh. Zool-bot. Ges. Wien, 1886, 36, p. 455, ♀, ♂, ♀, ♂.

Type locality: Pennsylvania

44. *Pheidole pilifera artemisia* Cole

Ph. pilifera subsp. *artemisia* Cole, Ann. Ent. Soc. Amer., 1933, 26, p. 616, ♀, ♂; Cole, Amer. Midl. Nat., 1938, 20, p. 372, ♀; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 187.

Type locality: Provo, Utah

45. *Pheidole pilifera coloradensis* Emery

Ph. pilifera var. *coloradensis* Emery, Zool. Jahrb. Syst., 1895, 8, p. 290, ♀, ♂.

Ph. pilifera subsp. *coloradensis* Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 434, ♀, ♂, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 187.

Ph. pilifera coloradensis var. *neomexicana* Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 436, ♂.

Type locality: Westcliffe (West Cliff) and Pueblo, Colorado

46. *Pheidole pilifera pacifica* Wheeler

Ph. xerophila subsp. *pacifica* Wheeler, Bull. Amer. Mus. Nat. Hist., 1915, 34, p. 404, ♀, ♂, ♀, ♂.

Ph. pilifera pacifica Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 187.

Type locality: Pasadena and Lakeside, California

47. *Pheidole pinealis* Wheeler

Ph. pinealis Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 459, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 187; Creighton and Gregg, Univ. Colo. Stud., 1955, Ser. Biol. No. 3, p. 12, ♀, ♂.

Type locality: Limpia Canyon, Ft. Davis, Texas

48. *Pheidole porcula* Wheeler

Ph. crassicornis subsp. *porcula* Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 466, ♀, ♂.

Ph. porcula Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 187.

Type locality: Chisos Mountains, Texas

49. *Pheidole psammophila* Creighton and Gregg

Ph. psammophila Creighton and Gregg, Univ. Colo. Stud., 1955, Ser. Biol. No. 3, p. 15, ♀, ♂.

Type locality: Greys Well, Imperial County, California

50. *Pheidole ridicula* Wheeler

Ph. ridicula Wheeler, Proc. New Eng. Zool. Club, 1916, 6, p. 29, 4; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 188.

Type locality: Brownsville, Texas

51. *Pheidole rugulosa* sp. nov.

MAJOR: Length, 3.62 mm.; head length (excluding mandibles), 1.08 mm.; head width, 1.0 mm.; head index, 0.93; thorax length, 0.83 mm.

Head, without the mandibles, slightly longer than broad, occipital lobes prominent but well-rounded; cephalic sulcus well-developed and rather broad toward the rear; frontal area small and depressed; clypeus with very weak median carina, its anterior border sinuate, and the median emargination very shallow. Frontal carinae short and slightly divergent. Antennae 12-segmented; scapes slender at the base, widened apically and extending $\frac{1}{2}$ or slightly more of the distance from their insertions to the occipital corners; funiculus with distinct 3-segmented club whose articles are longer than broad. Mandibles stout, abruptly curved, with two apical teeth and the remaining border edentate except for a small basal denticle. Eyes with approximately 65 facets.

Promesonotum strongly convex, descending through an obtuse angle to the mesoëpinotal suture, which is impressed; humeral bosses well-defined; basal face of epinotum and the declivity subequal, and joined through an obtuse angle; epinotal spines stout but pointed. Petiole with a long anterior peduncle, anterior face of the node gently sloping, posterior face vertical, and the crest blunt, transversely flat to faintly concave. Postpetiole trapezoidal, widest anterior to the middle, the lateral angles blunt, rounded, and poorly developed. Gaster truncate at the base, and slightly smaller than the head.

Sculpture: Cephalic rugules longitudinal and fine, crossing the clypeus, frons, diverging from the carinae, and extending to the vertex where they disappear; rugules present on the genae, extending from the mandibles to a little beyond the posterior border of the eyes, and on the lateral aspects also of the gula. Transverse rugules or striae cross the occipital lobes and converge into the cephalic sulcus. Vertex, upper portions of the genae, and middle of the gula smooth and shining. Piligerous punctures coarse and deep. Dorsum of the pro-mesonotum longitudinally rugose, front of pronotum transversely rugose, subopaque to weakly shining; prothoracic pleurae longitudinally rugose-punctate, mesopleurae and epinotal pleurae punctate and opaque. Epinotal base and declivity punctate and opaque; one or two interspinal rugulae. Petiole punctate and opaque; postpetiole punctate laterally but smooth and shining dorsally. Gaster smooth and shining.

Pilosity: Hairs yellow, pointed, numerous on the head and short, mixed on the thorax, and long and numerous on the pedicel and gaster; sparse on the appendages. Pubescence limited mostly to the antennae; sparse on the legs and completely absent from the gaster.

Color: Reddish brown, appendages and gaster somewhat lighter (some individuals are dark brown, approaching black).

MINOR: Length, 2.42 mm.; head length (excluding mandibles), 0.5 mm.; head width, 0.46 mm.; head index, 0.92; thorax length, 0.5 mm.

Head a little longer than broad, occipital border feebly concave, clypeal border straight, clypeus ecarinate, frontal area depressed, frontal carinae straight to faintly divergent. Antennal scapes like those of the major, except they reach almost to the occipital corners. Eyes with about 50 facets.

Thorax moderately convex and sharply depressed at the meso-epinotal suture. Epinotal spines stout, sharp, and pointed upward. Petiole with long anterior peduncle, and postpetiole lacks connules; in general similar to the corresponding segments in the worker major.

Sculpture: Head smooth and shining except for a few striae on the sides of the frons associated with the frontal carinae, and a few rugules with weak interrugal punctures on the genae between the eyes and the mandibles. Pronotum and propleurae for the most part smooth and shining, rest of thorax, petiole, and sides of postpetiole punctate, opaque. Dorsum of postpetiole and gaster shining.

Pilosity: Similar to that of the worker major.

Color: Like that of the major.

FEMALE: Length, 4.67 mm.; head length (excluding mandibles), 0.87 mm.; head width, 0.92 mm.; head index, 1.06; thorax length, 1.42 mm.

Head broader than long, occipital border almost flat, sides straight. Clypeus ecarinate, anterior border weakly sinuate. Frontal area small, depressed and pear-shaped. Frontal carinae small and slightly divergent. Antennae like those of the soldier; scapes reaching $\frac{3}{4}$ of the distance from their insertions to the occipital corners. Eyes large, convex, and composed of 180 or more facets; placed in front of the middle of the head. Ocelli large and prominent.

Thorax flat dorsally, as wide as the head through the wing insertions, and tapering posteriorly to the epinotum. Scutum, scutellum, metanotum, and epinotum all separated by well-marked sutures. Epinotal base slightly shorter than the declivity, and both joined by a depressed trough with no angle. Epinotal spines stout, blunt, and directed upward and backward. Petiole with moderate peduncle, and narrowed but blunt and flat-crested node. Postpetiole transverse, almost 1 and $\frac{1}{2}$ times as wide as the petiole, and with blunt, subconnular lateral angles.

Sculpture: Entire upper surface of head (except clypeus and frontal area which are shining) furnished with longitudinal rugae which are divergent on the occiput, and which become reticulate on the genae and the occipital corners; opaque. Cephalic punctures coarse; interrugal sculpture weak. Clypeus crossed with fine, longitudinal striae which do not dull the surface. Gula smooth and shining. Mandibles coarsely punctate, shining. Dorsum of thorax smooth and shining except for coarse, deep, scattered, piligerous punctures. Sides of prothorax and epinotum longitudinally rugose, the remainder of thorax smooth and shining. Epinotal base with rugae transverse and also converging toward the bases of the spines. Petiole and postpetiole punctate and weakly shining. Gaster slightly shagreened.

Pilosity: Like that of the major; pubescence limited to the legs and antennae.

Color: Similar to that of the major.

MALE: Length, 3.82 mm.; head length, 0.54 mm.; head width (including eyes), 0.67 mm.; head index, 1.24; thorax length, 1.33 mm.

Head, as measured through the eyes, much broader than long. Eyes so large they occupy most of the sides of the head, and contribute to the broad, flat, anterior margin of the head, the mandibles (when closed) and the clypeus hardly projecting. Sides of head behind the eyes converging rapidly to the occiput, which is almost flat. Vertex surmounted by prominent ocelli. Antennae 13-segmented; scape short, about equal in length to the first two funicular segments. Second funicular segment globular. Mandibles with two, weak, blunt denticles.

Thorax broader than the head, promesonotum flat, scutellum raised slightly. Mayrian furrows feeble. Epinotal base and declivity subequal, the former strongly sloping and the two joined by a very obtuse angle. Epinotal spines reduced to very faint tubercles. Petiole slender, peduncle long, node low and merging with the peduncle. Postpetiole trapezoidal, 1 and $\frac{1}{2}$ times as wide as the petiole.

Sculpture: Head longitudinally striate and punctate, somewhat shining on the frons and clypeus where punctures are reduced, the rest opaque; thorax smooth and shining. Pedicel smooth and shining above, sides of both petiole and postpetiole punctate. Gaster smooth and shining.

Color and pilosity: As in the other castes, except legs, mandibles, antennae and genitalia are yellow. A male from Naco, Arizona, is slightly larger, darker in color and has more definite epinotal denticles.

Wings transparent, with yellow veins and stigma, one open marginal cell, two submarginal cells and one discoidal cell. Cerci small and knobbed; stipites small, rounded and mesially curved into blunt hooks.

Holotype: Major

Paratypes: 18 majors, 145 minors and 3 dealate females.

The type material comprises two colonies collected by Miss Mina Winslow at Harding's ranch near Tucson, Arizona, on February 25, 1920.

Additional specimens which are referable to this species were collected at the following localities:

Greaterville, Arizona, 5300 feet, July 7, 1950, W. S. Creighton (17 majors, 24 minors, 1 male); Ft. Huachuca and desert near Ft. Huachuca, Arizona, 5000 feet, August 26, 1932, W. S. Creighton, (10 majors, 29 workers); Brown Canyon, Baboquivari Mts., Arizona, 4000 feet, September 16, 1951, W. S. Creighton (4 majors, eight minors); 7 miles east of Aguila, Arizona, 2200 feet, April 6, 1952, W. S. Creighton (2 colonies, 35 majors,

41 minors, 1 female); 20 miles east of Gila Bend, Arizona, 2700 feet, October 29, 1952, W. S. Creighton (3 majors, 6 minors); Ranger Station, Nogales, Arizona, May 26, 1946, L. F. Byars (4 majors, 19 minors); Bisbee Junction, Arizona, October 2, 1948, L. F. Byars (2 majors, 26 minors); Naco, Arizona, September 30, 1948, on whitethorn mesquite, L. F. Byars (7 majors, 3 minors, 1 male).

Some of the majors in the above colonies are a bit darker in color, have more pronounced prothoracic longitudinal rugae and a slightly broader postpetiole, but as these differences are not confined to separate colonies nor to any different geographic areas, it appears certain that the ants are all members of the species herein described.

Pheidole rugulosa may be distinguished from *Ph. micula*, its closest relative, in the following manner: overall size a little larger; transverse occipital rugules (resembling striae) very similar to those of *micula* except somewhat coarser, more abundant in the cephalic sulcus, extending further onto the vertex, but *absent* from the upper portions of the genae; piligerous punctures on the smooth areas of the head larger and more evident; humeral bosses more prominent; transverse rugae of the pronotum extending to the prothoracic pleurae, the surface opaque: promesonotum more convex; petiolar node more truncate or straight at the summit; postpetiole wider, the lateral angles distinct though blunt (practically absent in *micula*).

52. *Pheidole sciara* Cole

Ph. sciara Cole, Jour. Tenn. Acad. Sci., 1955, 30, p. 47, ♀, 2.

Type locality: Lordsburg, New Mexico

53. *Pheidole sciophila* Wheeler

Ph. sciophila Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 443, ♀, 2, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 188; Creighton and Gregg, Univ. Colo. Stud., 1955, Ser. Biol. No. 3, p. 19, ♀, 2.

Ph. sciophila var. *semilaevicephala* M. R. Smith, Ann. Ent. Soc. Amer., 1934, 27, p. 385, 2.

Ph. sciophila semilaevicephala Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 188.

Ph. proserpina Wheeler, Bull. Amer. Mus. Nat. Hist., 1908,

24, p. 437, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 188; Creighton and Gregg, Univ. Colo. Stud., 1955, Ser. Biol. No. 3, p. 19.

Type locality: Austin and New Braunfels, Texas

54. *Pheidole senex* Gregg

Ph. senex Gregg, Amer. Mus. Novit., 1952, No. 1557, p. 1, ♀, ♂.

Ph. pilifera subsp. *anfracta* Cole, Jour. Tenn. Acad. Sci., 1952, 27, p. 278, ♀, ♂; Cole, Ibid., 1953, 28, p. 298.

Type locality: Campo, Colorado

55. *Pheidole sitarches* Wheeler

Ph. sitarches Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 440, ♀, ♂, ♀; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 189.

Ph. sitarches var. *transvarians* Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 442, ♀, ♂.

Type locality: New Braunfels, Texas

56. *Pheidole sitarches campestris* Wheeler

Ph. sitarches subsp. *rufescens* Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 443, ♀, ♂, ♀.

Ph. sitarches rufescens var. *campestris* Wheeler, Ibid., 1908, 24, p. 443, ♀, ♂.

Ph. sitarches campestris Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 189.

Type locality: Henrietta, Texas

57. *Pheidole sitarches littoralis* Cole

Ph. sitarches littoralis Cole, Ann. Ent. Soc. Amer., 1952, 45, p. 443, ♀, ♂.

Type locality: Lido Beach, Sarasota, Florida

58. *Pheidole sitarches soritis* Wheeler

Ph. soritis Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 439, ♀, ♂.

Ph. sitarches soritis Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 190.

Ph. tepicana subsp. *cavigenis* Wheeler, Bull. Amer. Mus. Nat. Hist., 1915, 34, p. 403, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 190.

Type locality: Albuquerque, New Mexico

59. *Pheidole spadonia* Wheeler

Ph. spadonia Wheeler, Bull. Amer. Mus. Nat. Hist., 1915,

34, p. 400, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 190; Creighton and Gregg, Univ. Colo. Stud., 1955, Ser. Biol. No. 3, p. 22, ♀.

Type locality: Santa Cruz River, Tucson, Arizona

60. *Pheidole subdentata* Pergande

Ph. subdentata Pergande, Proc. Calif. Acad. Sci., 1895, 5, p. 888, ♀; Creighton, Jour. N. Y. Ent. Soc., 1957, 65, p. 203.

Ph. obtusospinosa Pergande, Proc. Calif. Acad. Sci., 1895, 5, p. 889, ♂.

Ph. arizonica Santschi, Bull. Soc. Ent. Ital., 1909, 41, p. 3, ♂.

Ph. vasliti subsp. *subdentata* Wheeler, Jour. N. Y. Ent. Soc., 1914, 22, p. 50, ♂; Emery, in Wytsman, Gen. Insect., 1921, Fasc. 174, p. 102.

Ph. vasliti subdentata var. *arizonica* Wheeler, Jour. N. Y. Ent. Soc., 1914, 22, p. 50, ♂.

Ph. vasliti arizonica Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 192.

Type locality: Tepic, Nayarit, Mexico

61. *Pheidole tepicana* Pergande

Ph. tepicana Pergande, Proc. Calif. Acad. Sci., 1895, 5, p. 878, ♀, ♂; Creighton and Gregg, Univ. Colo. Stud., 1955, Ser. Biol. No. 3, p. 24, ♀ (media; minor), ♂.

Ph. rugifrons Pergande, Proc. Calif. Acad. Sci., 1895, 5, p. 880, ♂.

Ph. carbonaria Pergande, Ibid., 1895, 5, p. 881, ♀, ♂.

Ph. kingi E. André, Bull. Soc. Ent. France, 1898, p. 244, ♀, ♂.

Ph. townsendi E. André, Ibid., 1898, p. 246, ♀, ♂.

Ph. kingi subsp. *instabilis* Emery, Ibid., 1901, p. 120, ♀, ♂; Wheeler, Bull. Amer. Mus. Nat. Hist., 1907, 23, p. 2, ♀, ♂, ♀, ♂; Wheeler, Ibid., 1908, 24, p. 431, ♀, ♂, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 181.

Ph. kingi subsp. *torpescens* Wheeler, Bull. Amer. Mus. Nat. Hist., 1915, 34, p. 404, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 182.

Type locality: Tepic, Nayarit, Mexico

62. *Pheidole texana* Wheeler
Ph. texana Wheeler, Psyche, 1903, 10, p. 97, ♀, ♂; Wheeler Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 464, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 191.
Type locality: Travis County, Texas
63. *Pheidole titanis* Wheeler
Ph. titanis Wheeler, Psyche, 1903, 10, p. 95, ♀, ♂; Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 461, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 191; Creighton and Gregg, Univ. Colo. Stud., 1955, Ser. Biol. No. 3, p. 35, ♀, ♂.
Type locality: Paisano Pass, Brewster Co. and Chisos Mts., Texas
64. *Pheidole tysoni* Forel
Ph. tysoni Forel, Ann. Soc. Ent. Belg., 1901, 45, p. 348, ♀, ♂, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 191.
Type locality: Mt. Mitchell, North Carolina
65. *Pheidole vallicola* Wheeler
Ph. crassicornis subsp. *vallicola* Wheeler, Bull. Amer. Mus. Nat. Hist., 1915, 34, p. 409, ♀, ♂.
Ph. vallicola Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 191.
Type locality: Miller Canyon, Huachuca Mts., Arizona
66. *Pheidole virago* Wheeler
Ph. virago Wheeler, Bull. Amer. Mus. Nat. Hist., 1915, 34, p. 401, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 192.
Type locality: Santa Cruz River, Tucson, Arizona
67. *Pheidole xerophila* Wheeler
Ph. xerophila Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 446, ♀, ♂, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 192; Creighton and Gregg, Univ. Colo. Stud., 1955, Ser. Biol. No. 3, p. 37, ♀, ♂.
Type locality: Ft. Davis, Texas
68. *Pheidole xerophila tucsonica* Wheeler
Ph. xerophila subsp. *tucsonica* Wheeler, Bull. Amer. Mus. Nat. Hist., 1908, 24, p. 448, ♀, ♂; Creighton, Bull. Mus. Comp. Zool., 1950, 104, p. 192; Creighton and Gregg, Univ. Colo. Stud., 1955, Ser. Biol. No. 3, p. 40, ♀, ♂.
Type locality: Tucson, Arizona

69. *Pheidole yaqui* Creighton and Gregg

Ph. yaqui Creighton and Gregg, Univ. Colo. Stud., 1955,
Ser. Biol. No. 3, p. 43, ♀, 4.

Type locality: Yaqui Well, Anza Desert State Park,
California

It will be apparent from the foregoing key and the list of species now recognized in the North American fauna, that there are important changes from the revision which Creighton presented in 1950. Many of these innovations have been treated in our joint paper of 1955 and need not be repeated here, but a few additional ones made since then deserve explanation.

Pheidole californica micula has been raised to species rank because, though related to the *californica* complex, it is quite distinct from the various subspecies of this complex. It is similar to the *californica* group in the possession by the worker major of a small, trapezoidal postpetiole, with no connules, and a shining promesonotum, but it differs in that the cephalic rugae are not rugae at all (rather fine rugules or better striations), and striations are present on the genae also. The humeri lack bosses, and the vertex is smooth and shining. In some respects, *micula* is related to the *sitarches* complex, from the appearance of the transverse occipital striations and the absence of humeral bosses. But it differs from this group in that the vertex is virtually smooth and shining (opaque in *sitarches*), postpetiole is not furnished with blunt connules, and the pronotum is not transversely striated and punctured. In other words, *micula* is structurally intermediate between these two groups, and is best regarded as an independent species.

It has been suspected that *Pheidole californica shoshoni* Cole might be an invalid taxon, and to help determine its status Dr. Cole kindly lent me two paratype soldiers. Comparison of these with soldiers of the subspecies *oregonica* showed the forms to be indistinguishable from each other. The subspecies *shoshoni* must be placed in the synonymy of *oregonica* as the latter has priority. Comparisons were made also between the types of *shoshoni* and the typical *californica*, with the following results. The occipital rugae of *shoshoni* are straight, rugae are almost absent from the sulcus, and the cephalic punctures are no wider in diameter than the hairs, whereas in *californica* the occipital rugae are wavy, rugose reticulations are visible in the sulcus, and the cephalic hair punctures are distinctly wider than the

hairs arising from them. The crest of the petiole in *californica* is broadly and shallowly emarginate, but in *shoshoni* it is entire and straight. These are the distinctions which separate *californica* and *oregonica* also, and would be expected of *shoshoni*, of course, if as now thought, it is identical with *oregonica*.

Pheidole sciara Cole is closely related to *Ph. cockerelli* Wheeler, and Dr. Cole (1956) has presented a detailed and careful differentiation between these two ants. Upon comparing specimens of *cockerelli* with paratypes of *sciara* kindly given me by Dr. Cole, I am confident they are separate species, and I have summarized the observed differences in the accompanying key. It may be added here that the workers have pilosity like that of their conspecific soldiers, and the pronotum in *sciara* is less shining. Also, the scapes of the *sciara* major are slightly shorter than $\frac{3}{4}$ the distance from their insertions to the occipital border, and thus approach the condition in *crassicornis*.

Pheidole sciara might be easily confused with the polymorphic species *Ph. subdentata* if only intermediates of the latter form were available for identification. Comparison of the major of *sciara* with individuals of *subdentata* comparable in size, shows a number of notable differences as follows: occipital lobes of *sciara* fully rounded (lobes of *subdentata* somewhat flattened laterally, more pointed toward the rear, and producing a constricted aspect to the posterior portion of the head); clypeal border with a distinct and narrow notch (clypeus sinuate in *subdentata*); scapes of *sciara* decidedly shorter; apical mandibular teeth sharp and quite similar except that in *subdentata* a conspicuous sulcus on the blade of the mandible separates the two teeth basally; epinotal spines longer, further apart and quite blunt and rounded at the tip in *sciara*; postpetiole much broader than long in *sciara*, more quadrate in *subdentata*. The full-sized major of *subdentata* shows all these differences in more pronounced degree except the occipital character; the head of the major in *subdentata* is very broad.

The workers (minors) of these two species are readily distinguished by the fact that in *sciara* the head (except for frons and clypeus), the thorax and the pedicel are heavily punctured and opaque, while in *subdentata* the head, pronotum and the tops of the pedicular nodes are smooth and shining. There is a marked notch in the promesonotum of *sciara* and the epinotal

spines are long, strong, and pointed upward (in *subdentata* reduced to minute points, almost denticles).

The two species may be separated also on the basis of color; *sciara* is dark red-brown while *subdentata* is ferruginous to yellowish in the minor.

Pheidole floridana and *Ph. floridana lauta* are here considered to be identical, and the latter falls as a synonym. In the American Museum of Natural History are types of both which Dr. Creighton has carefully compared for me. Specimens from Florida which I left with him were also compared to the types. His conclusions (in litt.) may be reproduced as follows: "Your specimens from Royal Palm Park are identical with the types of *floridana* in the A.M.N.H. collection. . . . I also compared them again with the types of *lauta*. The differences which Wheeler notes in clypeal sculpture and shape of the mesothorax in the major simply don't exist. The sculpture on the first gastric segment of the minor varies. Two of your specimens have it (therefore would be *lauta* according to Wheeler) and two of them lack it (therefore would be *floridana*)." It is also worthy of notice that in Creighton's 1950 treatment of these ants (p. 180), he anticipated the possibility that further study would show them incapable of subspecific separation. My study of authentically determined specimens of *floridana* and of *lauta* shows that, in the major, the clypeus is longitudinally rugose and medially carinate in both, the thorax is equally punctate, and the mesonotum equally angular. In the minor the base of the gaster is opaque or subopaque in many individuals of *floridana*.

The ant Wheeler described as *Pheidole constipata* is still known only from type material, and its proper status cannot be conclusively determined. It appears, however, to be only a western race of *floridana* as far as we could tell from re-examination of the types, and the differences are cited in the accompanying key.

Creighton suggested in 1950 that *Pheidole ceres* might be divisible into two subspecies, the usual form being represented by populations in the southern part of its range, and a more heavily sculptured, northern race centered around Boulder, Colorado. At that time he also restricted the type locality to Colorado Springs in an effort to clarify the nature of the species.

Wheeler had included material from several localities in the type series.

In order to test the above possibility, I have examined specimens from many colonies of *Pheidole ceres* collected in Colorado at widely separated stations. There are heavily sculptured soldiers and others with the cephalic sculpture reduced enough to leave the vertex virtually smooth and rather shining. But I could not find any correlation between these conditions and geographic position. Furthermore, there are a number of collections representing mixed nest series, for example, one from Kosslers Lake, near Boulder, one from Turkey Canyon, at Morrison, west of Denver, two from Colorado Springs, one from Durango, and one from Mesa Verde, Colorado. It may be concluded that there is considerable lability in the head sculpturing of the major caste in *ceres*, so that a good series of specimens is desirable for making determinations of this species, but there is no evidence so far to support the recognition of any subspecies. The species is fairly common, and sufficient material has been studied to warrant the conclusions drawn.

Considerable doubt exists as to the validity of the ant which Wheeler described as *Pheidole vinelandica* subsp. *buccalis*. Creighton designated this ant a subspecies of *bicarinata*, but stated that it intergrades with *vinelandica* in western Texas. Any of the subspecies of a species may breed (at least potentially or theoretically) with any other, but since *vinelandica* is, according to Creighton, an eastern and southern race which extends to Texas, and since it was thought to intergrade with *buccalis* in west Texas, it would seem that *buccalis* is more closely related to *vinelandica* than to the typical *bicarinata*, and to be a southwestern form whose range overlaps that of the southern race. The range of *buccalis* is given as Arizona, southern Utah and east to Texas. Morphological examination of specimens which key out to *buccalis* appear to bear out this conclusion. In 1956, Cole published the results of his experience with this form in Arizona (including the type locality, Prescott), and in New Mexico. He states that it occurred intimately interspersed with colonies of typical *bicarinata* (the latter was not supposed to extend west of the Rockies as far as Creighton's records showed in 1950), and even to nest in identical stations. If this is the case, then the two forms cannot be geographic races, and must

be either distinct species, or one a synonym of the other. The confusing structural intermixture of supposed *buccalis* with both *vinelandica* and *bicarinata* makes it extremely unlikely that *buccalis* can be an independent species, and to demonstrate that it is such would take many more data than at present exist. I can see no objection to accepting Dr. Cole's suggestion (1956) for relegating *buccalis* to synonymy, but I have placed it under the subspecies *vinelandica* to which it seems somewhat more closely linked and under which it was originally described (vide supra).

Cole also suggested (1956) that *Ph. bicarinata longula* be raised to full specific rank. Though there is apparently no known evidence of intergradation between *longula* and the typical *bicarinata* as yet, the morphological differences between them are very slight, and the range and habits of *longula* are imperfectly understood. I agree with Creighton that the evidence for specific distinctness here is weak and am disinclined to follow Cole's proposal. Until more information is obtained, it seems preferable to regard *longula* as a subspecies of *bicarinata*. Structural characteristics and geographical range of the ant are not, so far, inconsistent with this view.

The discovery of a new member of the *bicarinata* complex in Nevada has been described above as the subspecies *paiute* and is carried in the key. Its status at this time is provisional owing to the small amount of material available for study.

In 1953 Cole, after studying types of both, proposed that *Ph. sitarches campestris* be synonymized with *Ph. sitarches soritis* on the basis of inconsequential differences between them. Later, in 1956, upon reviewing numerous samples from New Mexico and Arizona, he reversed this decision by concluding that *soritis* was a variant population within the widespread, typical subspecies, and therefore suggested that *soritis* be made a synonym of *sitarches sitarches*. It cannot be denied that much variability exists in the representatives of this complex coming from New Mexico and Arizona, but Dr. Cole's contention that this does not indicate intergradation between two subspecies (*soritis* and *sitarches*) is open to reasonable doubt. As Dr. Creighton has pointed out, Wheeler's type series for the typical *sitarches* included specimens from New Braunfels and Austin, Texas, and he showed that Austin is an area of intergradation for *sitarches*

with its northern race, *campestris*. Wheeler's unfortunate inclusion of the Austin specimens created confusion with respect to the nature of the true *sitarches*, and Creighton (1950) attempted to correct this by restricting the type locality to New Braunfels where the ants show more constant characters, and where a certain number of the types of *sitarches* were obtained. Cole states that west of Amarillo, Texas, there is a blending zone of the subspecies *campestris* with the subspecies *sitarches*. It thus appears that the region from which part of the original type series of *sitarches* came (Austin), and from which the types of *soritis* were collected (Albuquerque), are areas of extensive mixing and intergradation. It would not be surprising then to find the differences between the types of these forms something less than convincing. The restriction of the type locality for *sitarches* to New Braunfels appears to be a step in the right direction toward elucidation of the tangle, as the following points will indicate. Dr. Creighton kindly supplied me with homotypes of *sitarches* collected at Iturbide, Nuevo Leon, Mexico, which differ from the Wheeler types only in being darker in color. The promesonotum and the entire head of the minor, except for weak striae on the anterior genae, are smooth and shining, agreeing in part with the original description which was based on a mixed series. He also sent me specimens of *soritis* from Parral, Chihuahua, Mexico and from the Henry Mountains in southern Utah, in which the heads are striato-punctate.

These data lead to the conclusion that three western races of *sitarches* do in reality exist, and from them we may draw a tentative picture of the distributional pattern. The typical *sitarches* has a coastal range centering around Brownsville, Texas and southward into Mexico, extending inland to a limited degree. The subspecies *soritis* has a very large range reaching from Parral in southern Chihuahua through west Texas, New Mexico, Arizona, and into southern Utah. The subspecies *campestris* occurs from central Texas to Mississippi, north to Missouri, and (from recent records) west into the plains of Colorado. A confusing intergradation of these forms seems to take place from the region of Austin, Texas, north and west, and it is precisely this area in which a large number of the records so far gathered have come. This, coupled with the description of races based on collections made in that region, have served

to compound the uncertainties. The evaluation of the subspecies of *sitarches* in western North America as presented here is offered not as a final solution, but as one subject to further modification with the acquisition of more information. The region of southern Texas and particularly adjacent states in northern Mexico, eventually, should yield critical data bearing on this problem. I venture to suggest that *sitarches* may turn out to be a coastal and lowland race, and that *soritis* will be seen as a subspecies of the mesas and mountain flanks of the high interior. Intergradation between the two in northern Mexico, has, so far as I know, not been demonstrated, but this may be attributed to the scarcity of records.

Pheidole sitarches littoralis Cole is quite distinct morphologically and geographically from the other forms of the species. In fact, one may suspect that *littoralis* is an independent species on the basis of the cephalic sculpture of the soldier, which is reticulate and foveolate rather than transversely striate, but until more is known about this ant, it seems best not to elevate its position.

In 1951, Smith listed all forms of *Pheidole* that up to that time had been recorded from America north of Mexico, and this included two new introductions. *Pheidole flavens sculptior* is a West Indian species that is now said to be present in Florida also. *Pheidole megacephala* is a well-known tropical tramp of considerable economic importance, and has apparently reached Florida in recent years.

The most aggravating situation with respect to our North American forms of *Pheidole* centers around certain species of the *flavens* group. In 1908, Wheeler described *Pheidole nuculiceps* from a single soldier and three workers taken at New Braunfels, Texas. I am informed by Dr. Creighton (in litt.) that the type major and a minor are now present in the collection of the American Museum, and this means that the only type of the soldier caste in existence is in the possession of that institution. According to Wheeler, *nuculiceps* is very distinct from all the described North American species of the *flavens* group. But he says it closely resembles *Ph. exigua* Mayr of South America, the main difference being that the head sculpture of *nuculiceps* is heavier and extends over the occiput, whereas in *exigua* this region is smooth and shining.

In 1941, Mrs. Gregg and I collected a member of the *flavens* group in Brickel Hammock, Miami, Florida, and its identification has caused no small amount of difficulty. In Creighton's key of 1950, it runs out to *nuculiceps*, but upon comparison with the original description, with which it appears to coincide very well, there is an important discrepancy in the cephalic sculpture. Creighton has very kindly compared my specimens, side-by-side, with the above mentioned types in the American Museum, and is able to assure me that the two ants are *not* conspecific. He states that the type of *nuculiceps* has a much broader postpetiole and the lateral connules are prominent. It also shows the cephalic rugae crossing the occipital lobes all the way to their rear margins, whereas in the Miami specimens the occiput is smooth and shining; the difference is stated to be very striking. This has led to the conclusion that the Brickel Hammock specimens may be, in reality, *Pheidole exigua* Mayr, and thus constitute an addition to the North American fauna.

The difficulty, however, does not end here. As indicated above, Smith recorded *Ph. flavens sculptior* from Florida, and in the interest of further clarification, I have asked Dr. Smith for permission to examine specimens of *sculptior* and *exigua* which he obtained in good series during residence on the island of Puerto Rico. Dr. Smith replied by lending me samples of *sculptior* from Martinique, St. Croix, and Puerto Rico in the West Indies, and from Miami, Florida, but said that he was unable to locate any *exigua* in the collection of the National Museum. Wheeler (1908) provided a detailed description of the worker, soldier, and female castes of *exigua*, based on three females, numerous soldiers, and workers collected in Puerto Rico. The Brickel Hammock specimens agree fairly well with this description, except that the flattened, scrobe-like areas on the head of the major are distinctly punctate (not indistinctly), and shining. According to Mayr (1887), the major of *exigua* has the antennal furrows smooth, humeral angles weak, and the mesonotum without transverse striae but finely reticulo-punctate. The first two of these characters, and particularly the first, would appear to differ from the Florida ants to hand. Emery, in 1894, from examination of a topotype of *exigua*, states that the antennal scrobes are smooth and very shining, and further

maintains it is so similar to the typical *flavens* that it should rank only as a subspecies of that form.

It will be noticed that there is disagreement among these accounts with regard to the nature of the so-called antennal scrobes, which in most of the forms are not truly scrobes but flattened or slightly concave areas lying beneath the scapes when these are in repose. Emery possessed presumably typical examples from Cayenne (the type locality), but it is not clear whether he also had seen any of Mayr's types for comparison. Wheeler received two workers of *exigua* from Emery, and this may have led him to identify his Puerto Rican material as *exigua* and to the redescription of that ant as outlined in the preceding paragraph. The worker caste among related species and subspecies of *Pheidole* is so often unreliable for specific identification it is surprising that Wheeler would have made use of them (Emery workers) in this way, and it is further possible that Wheeler may not have possessed specimens of the true *exigua* at all. In the American Museum collection a tray labelled *exigua* contains two pins of specimens from British Guiana, but they cannot be that insect, nor even members of the *flavens* group, for the head and thorax of the minors are smooth and shining. Wheeler's 1908 description of *exigua* is supposed to have been based upon a long series of specimens, but if they are in the American Museum, they are not in the tray of *exigua* specimens, and thus far have not been located.

The difficulties with regard to these species, however, are not insoluble. Dr. Charles Ferrière, at the Museum of Natural History in Geneva, Switzerland, generously permitted me to borrow a single cotype soldier of *Pheidole exigua* Mayr, from Cayenne, and several types of *Pheidole flavens sculptior* Forel, from the collections of the museum. I have made careful comparisons of the *exigua* cotype with Wheeler's description of this species as given in the Bulletin of the American Museum, Volume 24, page 134 (1908). The agreement between the two is very good, except for certain apparent discrepancies which can be traced to the difficulties of language and interpretation. Since it is impossible to know precisely what Wheeler meant, we are forced to rely on his probable meaning. The head is stated by Wheeler to be a little longer than broad, and indeed it appears

to be, but actual micrometer measurements show that the length (excluding the mandibles) exactly equals the width. It is possible Wheeler depended upon apparent conditions and may not have taken measurements. The mandibles are said to have two apical teeth and two smaller basal ones. The closed mandibles of the type make it impossible to see the basal teeth, and the apical ones are not present, though it is evident they did exist and have been worn off. According to Wheeler, the anterior $\frac{3}{4}$ of the head, thorax, petiole, and sides of the postpetiole are subopaque. The specimen agrees with this except for the head, which, though sculptured anteriorly, is nevertheless shining. The expressions "shining", "subopaque", and "opaque" are susceptible to variable shades of meaning, as anyone who has studied myrmecological descriptions can testify. Whether a surface is thought to be subopaque or shining can depend upon the amount of illumination and the power of magnification used, and it has been observed also that the same investigator may vary in his interpretation, regarding a surface of a given texture as subopaque in one species and as quite shining in another. On the type of *exigua* the cephalic interrugal sculpture is faint enough to leave the surface virtually shining. This, of course, might not be true if one had additional specimens to examine, and it points up one of the serious limitations of type material, despite the admittedly great importance of such material. Wheeler further states that the antennal scrobe is sharply defined laterally by a distinct ruga, and that all rugae on the sides of the head stop abruptly at the scrobes, their surfaces being indistinctly punctate and shining. At first sight this seems to be a serious discrepancy between the type and the description, but upon closer examination the situation clears up. In certain other members of the *flavens* group, the so-called "scrobe" is nothing more than a broad flattened area on the side of the head between the frontal carina and the eye, and is much wider than the antennal scape. This same flattening is evident also on the *exigua* type, but there appears to be a much deeper longitudinal groove just below the carina (which extends far posteriorly), and this groove is wide enough only to accommodate the scape. There are no rugae in the groove, it is shining, and it is bounded laterally by a long ruga which parallels the frontal carina. Be-

yond it, other rugae cross the flattened area on the head, which upon initial view appear to disagree with Wheeler's statement. If this is the correct interpretation of Wheeler's treatment, then the above-mentioned inequities among the descriptions of Mayr, Emery, and Wheeler with reference to the scrobe, disappear, and we may conclude that the latter's description of *exigua* was based on specimens belonging actually to that taxon.

It is now necessary to return to the ants which Dr. Smith sent me as representatives of *Ph. flavens sculptior*. Those from St. Croix and Puerto Rico (Smith det.), and from Martinique (Forel det.) fit precisely the characters given in Smith's key to the ants of Puerto Rico (1936). Smith's conception of this species (in litt.) is based upon Wheeler's determined specimens and published descriptions. The specimens of *Ph. flavens sculptior* sent me from Geneva are labelled "Typus" and they are from the Island of St. Vincent, the type locality. Dr. Ferrière cautions, however, that while there are several cotypes of *sculptior*, he sent specimens marked as types because it is not always certain that specimens labelled cotypes in Forel's collection are really from the same locality. Nevertheless, these ants are the only samples of presumably undoubted type material I have been able to examine. Upon comparison of them with Smith's specimens from Puerto Rico, I find there is complete agreement, and we may conclude that Dr. Smith had examples of the true *sculptior* when he wrote his account of the ants of Puerto Rico.

Before attempting to decide what the Miami, Florida ants are, it seems advisable to distinguish between *exigua* and *sculptior*, especially in view of the opportunity for comparing type material. The results of this study may be outlined as follows. The cephalic rugae on *exigua* are coarse, far apart, and cover the anterior $\frac{3}{4}$ of the head, leaving the vertex and occiput smooth and shining. The interrugal sculpture is sparse so even the anterior sculptured part of the head is shining also. The antennal scrobe is distinct, smooth surfaced, bordered by a long frontal carina and a lateral ruga, and appears to be truly a scrobe for the reception of the scape. The flattened area of the head continues the scrobe laterally and is crossed by coarse rugae.

The cephalic rugae on *sculptior* are finer, closer together, and

merge into weak reticulations on the vertex. Interrugal punctures are dense making the whole head opaque except for the narrow zone at the extreme rear margin of the head surrounding the foramen magnum, which is shining. The flattened lateral area of the head is hardly a true scrobe, the carina bordering it medially is weak and short, there is no lateral carina, its surface is densely punctate, and it is not traversed by rugae.

The promesonotum of *exigua* has prominent, wavy, transverse rugae anteriorly, whereas the posterior portion behind the humeral angles is heavily punctate. Viewed from behind, the promesonotum is transversely arched and strongly convex, with humeral angles inconspicuous. The mesonotum descends very abruptly in a vertical plane (even slightly undercut) to the mesoëpinotal suture, which is deep. The promesonotum antero-posteriorly is also decidedly convex.

The promesonotum of *sculptior* has a weaker, reticulate, transverse sculpture, but is also punctate posteriorly. Viewed from behind, the transverse convexity is weaker and lower so that the humeral angles are much more pronounced. The antero-posterior convexity is low, but the descent to the mesoëpinotal suture is abrupt as in *exigua*. The epinotal declivity is transversely striate in *exigua* and the hairs are short, stubby and sparse, whereas the declivity is punctate in *sculptior* and the hairs are long, uneven in length, and numerous.

Next, a specimen of the major of the typical *Pheidole flavens* Roger from Soledad, Cuba, sent me by Dr. Creighton, clearly shows important distinctions from the two foregoing species. The "scrobe" is much less distinct than that of *exigua*, being only a flattened lateral area between the carina and the eye, crossed by a few faint rugules and definitely punctate, but still it is shining. Dr. Creighton informs me that other variants of *flavens* show this same condition. The scrobe is even flatter and less distinct than the corresponding region on *sculptior*, which it will be recalled is a bit concave, is densely punctate and opaque, and is not crossed by rugae. Furthermore, the vertex and occiput of *flavens* are smooth and shining as in *exigua*, but the rest of the head is subopaque owing to interrugal sculpture, though not dense enough to render the head opaque as in *sculptior*.

The promesonotal rugae are weaker than in *exigua* and reticulate, being in this respect like those of *sculptior*. The epinotal spines of *flavens* point vertically upward in contrast to those of the other ants, which though they stand upright, slope diagonally to the rear. In view of all these differences, it is doubtful if *exigua* can be regarded as a subspecies of *flavens*, as Emery treats it, and therefore shall be designated a full species, *Pheidole exigua* Mayr. On the other hand, *Pheidole flavens sculptior* Forel is less distinct anatomically and its distributional behavior accords well with that of a subspecies. I believe it should remain in that status.

The specimens of *sculptior* from Miami, Florida (Buren det.) and the sample obtained from Brickel Hammock are indistinguishable. Despite the similarities of the scrobes and their sculpture, these ants are not identical, however, with the examples of *sculptior* from Puerto Rico and Martinique, nor with the types from St. Vincent. This is evident especially from the smooth (almost sculptureless) and shining occipital lobes of the Florida ants. In *sculptior*, the cephalic rugae and punctures completely cover the head, making it opaque, except at the extreme posterior margin around the foramen which is smooth and shining. In addition, the epinotal spines of the Brickel Hammock ants are longer and sharper than those of *sculptior*. These two samples of the *flavens* group in Florida cannot represent *Ph. flavens sculptior* (from the West Indies), and unless this subspecies is known from Florida by other specimens, or is there but not yet collected, this discovery requires a revision of the North American list. *Pheidole flavens sculptior* must be dropped, and that is the plan followed in this paper.

The Miami specimens cannot be considered *Ph. exigua* either, because of a number of structural differences. The scrobes are too weak, they are punctate, and the head is shining only posteriorly on the vertex and occiput. The promesonotum is not strongly arched in a transverse direction so that the humeral angles are more prominent as a consequence, and the descent of the mesonotum to the mesoëpinotal suture is sloping and gradual. They differ from *flavens* by having the scrobes slightly more concave and densely punctate (the flattened areas of *flavens* are sparsely punctured and shining), but otherwise these ants seem

to be closer to the typical *flavens* than to any of the other forms. Therefore, it may be assumed that the Miami ants are either a new species or that they represent a variant of the *flavens* population at the tip of the Florida peninsula, perhaps a new subspecies. I incline to the latter interpretation, but until a good series of specimens of this ant can be obtained for more complete study, it is preferred not to supply a formal name. The population will be regarded for the moment as not quite typical representatives of *Pheidole flavens*. The proximity of Cuba to south Florida and the ease of accidental spread to the mainland at some time in the remote past make this supposition at least plausible.

Whether *nuculiceps* will ultimately prove to be a synonym of *sculptior* (owing to the similarity of the cephalic sculpture which entirely covers the head), it is impossible to say. The types of these ants would have to be compared, but in view of the wide gap in known distribution and the fact that *sculptior* is an insular form on a number of the islands of the Caribbean, it is decidedly improbable, unless a rare introduction onto the mainland of Texas could have taken place, in which case it ought to show up at intermediate points also. Furthermore, the relatively broad postpetiole and its prominent lateral connules would seem to preclude any possibility that *nuculiceps* would be the same as *flavens* or any of its variants.

Recently, a taxonomic tangle centering around *Pheidole vasliti* Pergande from Mexico has been detected by Creighton. He has published a revision of this complex which proposes to treat *vasliti*, *hirtula*, and *subdentata* as full species. The variety *arizonica* described by Santschi originally as a full species falls as a synonym of *subdentata*. Thus the ant designated by Creighton in 1950 as *Pheidole vasliti arizonica* Santschi now becomes *Ph. subdentata* Pergande. This is the only member of the group, so far as known, that occurs within the boundaries of the United States.

In 1950, Creighton placed the ant *Pheidole macclendoni* in a group where the major was supposed to lack transverse striae on the pronotum. This has been found to be in error because at the time his key was compiled he had not seen the true major of this polymorphic species, and it is now known that the latter caste

does possess transverse pronotal striae. Wheeler's description of the major of *macclendoni* fits the characters of that caste accurately, to judge from specimens collected recently by Cole near Laredo, Texas. Measurement of the head lengths in the various castes of this series give the following results: minors, 0.75 to 0.83 mm.; a larger media, 2.1 mm.; and majors, 2.5 mm. A smaller media (one of Wheeler's cotypes) in Creighton's collection has a head 1.5 mm. long. Wheeler states in the original description of the species that the head length of the intermediates varies from 1 to 2 mm., and that the length of the soldier head is 2.6 mm. Though the head of the majors in Cole's series is one tenth of a millimeter shorter than the measurement given by Wheeler for the type soldier, it would appear that they do belong actually to the major caste. There is one feature of this caste mentioned in Wheeler's description, however, that does need some clarification. According to his account, the petiole viewed from above is "violin-shaped," and as broad in front as it is behind, with concave sides. This appearance is due to the presence on the sides of the peduncle of broad, blunt, lateral tubercles, bearing the petiolar spiracles at their extremities. These protuberances are as prominent as the lateral borders of the petiolar node, and the margin of the segment between them and the node is consequently concave.

Besides the characters given in the key, the soldier of *macclendoni* can be distinguished from *titanis* by its bidentate clypeal margin as opposed to the deep, narrow notch on the clypeus of the latter species, and by its stout, convex mandibles as compared to the longer, straighter and sharper mandibles of *titanis*. From *virago* it differs by its bidentate rather than sinuate clypeal margin, its smooth rather than longitudinally rugulose median clypeal lobe, its longer scapes which reach as far as the eyes and a postpetiole which is less than twice as wide as the petiole. The petiolar tubercles mentioned above also clearly separate *macclendoni* from *virago* and the two ants differ much in size, the major of the former measuring 5.5 to 6.0 mm. and the latter 4.0 to 4.5 mm.

The ant described by Wheeler in 1915 as *Pheidole tepicana cavigenis* has been reviewed in connection with *tepicana* Pergande and other species which were formerly confused with it (Creigh-

ton and Gregg, 1955). In our revision it was shown that *cavigenis* could not be related to *tepicana*, despite Wheeler's placement of it, because it lacks the deep clypeal emargination so typical of *tepicana*, and for other reasons also. At that time it was suggested that *cavigenis* probably belongs to *sitarches*. The difficulty in this allocation results from the fact that several members of the *sitarches* complex are most certainly recognized from features shown by the minor. Since *cavigenis* was described from the major only, its exact relationship may never be certain. However on the basis of distribution it seems probable that *cavigenis* is a synonym of *sitarches soritis*. It has been so treated in this study.

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EFFECTS OF VARIOUS FACTORS ON THE
SYNTHESIS OF ASCORBIC ACID BY THE
AMERICAN COCKROACH, *PERIPLANETA*
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Ascorbic acid has been found in the tissues of a number of insects. Joly (1940) reported it in the blood of the queen termite, *Bellicositermes natalensis*. Haydak and Vivino (1943) showed that the adult honeybee, *Apis mellifica*, contains an average of 1.88 micrograms of the vitamin per gram of tissue. In the aphid *Myzodes persicae*, Barmstedt (1948) found ascorbic acid in the epithelium of the posterior, but not in the anterior mid-gut or in the hind-gut. Metcalf (1943) demonstrated the presence in large amounts of ascorbic acid in the Malpighian tubules of the cockroach, *Periplaneta americana*. Gamo (1941) reported that ascorbic acid is exceedingly important in the development and metamorphosis of the silkworm, *Bombyx mori*. The growth of the larva depends chiefly upon the content of the vitamin in the mulberry leaves upon which it feeds. Day (1949) using a histochemical method, found a few granules in the larva, but none in the adult, of *Tenebrio molitor*.

Wollman, Giroud and Ratismananga (1937) have presented indirect evidence that the cockroach, *Blattella germanica*, is able to synthesize ascorbic acid. They raised cockroaches under aseptic conditions on a vitamin C-free diet for fifteen years and found that the content of ascorbic acid was the same as that in specimens which were not raised in this manner and which were fed a diet containing ascorbic acid.

Gamo and Seki (1954) presented direct proof for the ability of the insect to synthesize ascorbic acid. They demonstrated that homogenates of pupal fat bodies of the silkworm, *B. mori*, were

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able to convert mannose into vitamin C. This ability varied considerably during the period from the prepupa to the four-day pupa at 25° C.

The purpose of the present work is to determine whether homogenates of the cockroach, *P. americana*, are able to synthesize ascorbic acid and the optimal conditions for this synthesis.

MATERIALS AND METHODS

The cockroaches used in all experiments were raised in the laboratory on a diet of dog pellets and water.

The method for ascorbic acid determination was that of Roe and Kuether (1943) as modified by Schaffert and Kingsley (1955), except that only 1 ml. of filtrate was used in each determination, and the amounts of the other reagents were adjusted accordingly. The insects were immobilized with ether and then weighed. Homogenates of whole nymphs were made using a 0.3M phosphate buffer adjusted to the proper pH. One milliliter of the homogenate was then shaken with 3.5 ml. of the substrate in a 15 ml. centrifuge tube and incubated for the desired period of time. A blank consisting of 3.5 ml. of the substrate solution and 1 ml. of buffer was used to compensate for any colored compounds that might be formed by the reaction of the substrate with the reagents. A third tube was used which contained 1 ml. of the homogenate to which 3.5 ml. of the substrate were added at the end of the incubation period. The purpose of this blank was to obtain the amount of ascorbic acid in the homogenate. When this value was subtracted from the reading obtained for the incubated homogenate, the amount of ascorbic acid synthesized was obtained. The three tubes (the tubes containing the reaction mixture, the homogenate blank, and the substrate blank) were incubated at a given temperature for the desired period of time. Readings were made with a Beckman DU spectrophotometer at a wave length of 520 m μ , and a slit width of 0.03 millimeters.

The following factors were studied, and in these tests, mannose was used as the substrate except where others are specified.

- (1) The nature of the substrate. Substrates used were mannose, glucose, sucrose, galactose, fructose and xylose.
- (2) The effect of substrate concentration. Values tested were 10^{-3} , 3×10^{-3} , 5×10^{-3} and 10^{-2} M.

- (3) The effect of homogenate concentration using 10, 20 and 30 per cent.
- (4) The length of the incubation period. Periods tested were 1, 2, 3, 6, 9 and 14 hours.
- (5) The effect of various pH values. Tests were made using solutions adjusted to 4.4, 5.6, 6.8, 7.4, 8.4. The pH values were determined by means of a Beckman pH meter.
- (6) The effect of various incubation temperatures. Those tested were room temperature (approximately 25°), 30°, 35°, 40° and 45° C.
- (7) The effect of manganese ion. Solutions of 0.01, 0.05 and 0.10 per cent MnCl₂, were used.
- (8) The effect of using homogenates of fat bodies alone. Ten per cent homogenates at pH 6.8 were incubated for three hours at 25° C. with substrate solutions of 5 × 10⁻³M concentration.

OBSERVATIONS

The ability of the cockroach to utilize sugars as precursors of ascorbic acid is evident from the figures given in Table I. When

TABLE I

THE EFFECT OF THE USE OF VARIOUS SUGARS AS SUBSTRATES ON THE SYNTHESIS OF ASCORBIC ACID BY *P. americana*.

Substrate	No. of Tests	Amount synthesized μg./gm. (with Standard Error)
Mannose	60	18.6 ± 0.58
Glucose	10	15.1 ± 1.34
Fructose	10	13.7 ± 2.00
Sucrose	10	11.6 ± 1.77
Galactose	10	14.6 ± 1.40
Xylose	10	7.2 ± 1.70

sucrose was used, an average synthesis of 11.6 μg./gm. was obtained. Mannose was utilized most efficiently, resulting in the formation of 18.6 μg./gm. while xylose was the least effective, producing 7.2. In a few tests, regardless of substrate, negative values were obtained. Table II contains statistical analyses of the results obtained when the different substrates were used. A significant difference exists between the amount of ascorbic acid

TABLE II
PROBABLE SIGNIFICANCE BETWEEN THE AMOUNT OF ASCORBIC ACID
SYNTHESIZED FROM DIFFERENT SUBSTRATES*

Substrates Compared	Difference between Means	Standard Error of Difference	$\frac{\text{Difference}}{\text{Standard Error of Difference}}$
Mannose & Glucose	2.90	1.43	2.03
Mannose & Fructose	4.30	2.00	2.05
Mannose & Sucrose	6.40	1.77	3.44
Mannose & Galactose	3.60	1.50	2.26
Mannose & Xylose	10.80	1.80	6.00
Xylose & Glucose	7.90	2.17	3.64
Xylose & Fructose	6.50	2.61	2.10
Xylose & Sucrose	4.40	2.48	1.77
Xylose & Galactose	7.20	2.20	3.27

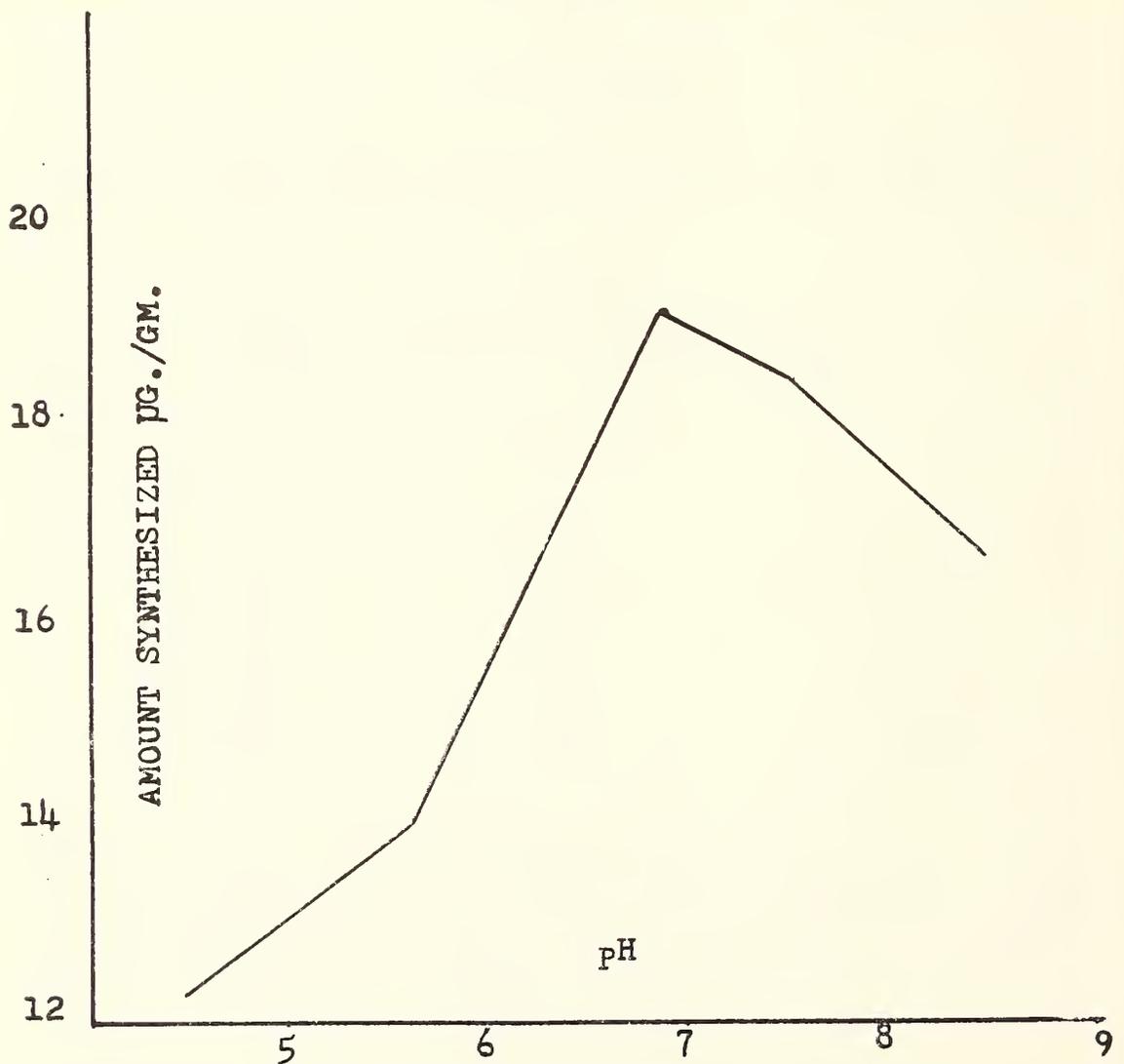


FIG. 1. Effect of pH of the homogenate on the synthesis of ascorbic acid.

* Two means are statistically different when the difference between the means divided by the standard error of the means is equal to two or more.

obtained from mannose and that obtained from the other sugars. Significant differences were also found between xylose and glucose, xylose and fructose, xylose and galactose.

The effect of pH on the synthesis of ascorbic acid is shown in Figure 1. This synthesis is considerably affected by the pH of the homogenate. A value near neutrality appeared to be the most favorable, with an average of $19.0 \mu\text{g./gm.}$ being formed at a pH of 6.8. An inspection of Figure 1 shows that increasing the alkalinity or acidity resulted in a sharp drop in the amount of

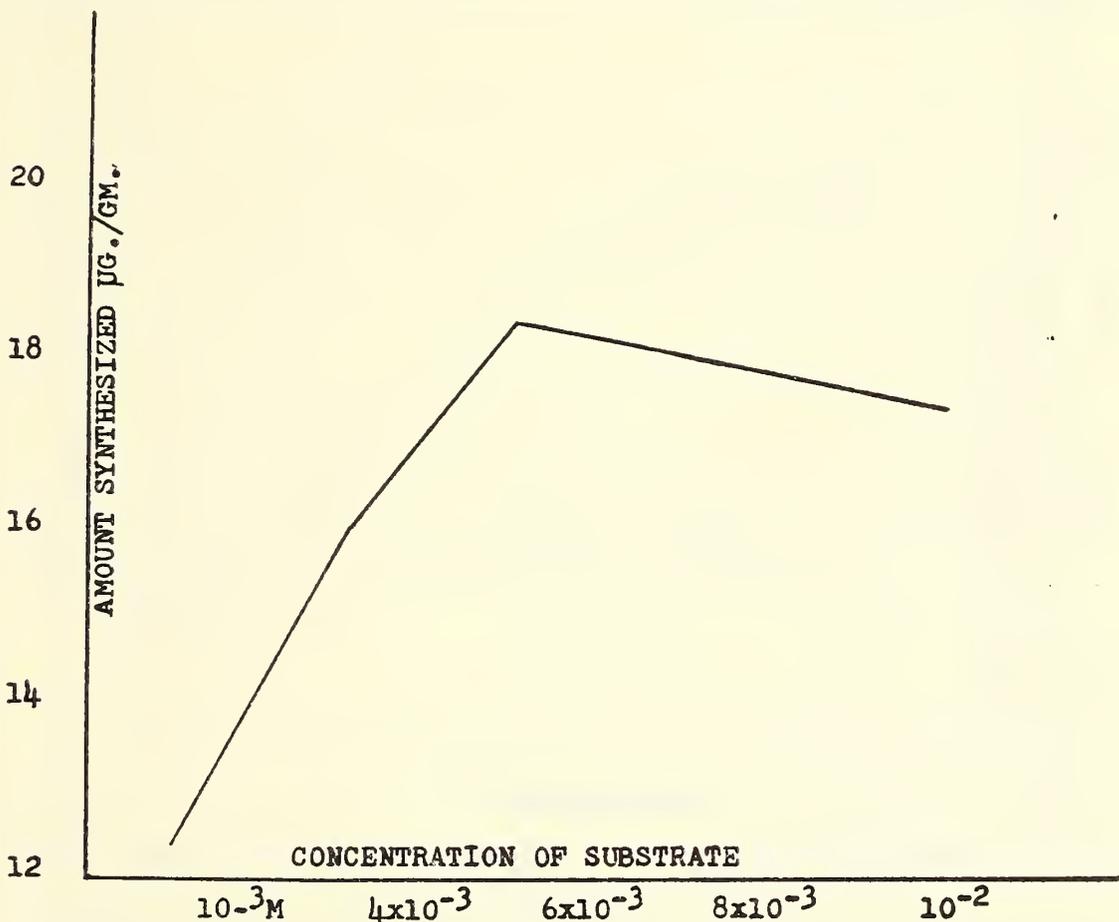


FIG. 2. Effect of concentration of substrate on the synthesis of ascorbic acid.

ascorbic acid formed, with values of 12.2 at a pH of 4.4, and 14.7 at a pH of 8.4.

The concentration of the substrate was also important in determining the ability of insect tissue to synthesize ascorbic acid as shown in Figure 2. Increasing the substrate concentration from 10^{-3} to $5 \times 10^{-3}\text{M}$ resulted in an increase in synthesis, the maximal amount of ascorbic acid being produced at the latter concentration. Figure 2 also shows that an increase in concentra-

tion to $10^{-2}M$ did not result in any further synthesis. These results indicate that concentrations between 5×10^{-3} and $10^{-2}M$ are optimal.

Varying the period of incubation resulted in a steady synthesis of ascorbic acid for the first three hours, with an average rate of approximately $6 \mu\text{g./gm./hr.}$ A continuation of the incubation period to six hours produced a decrease, the rate being

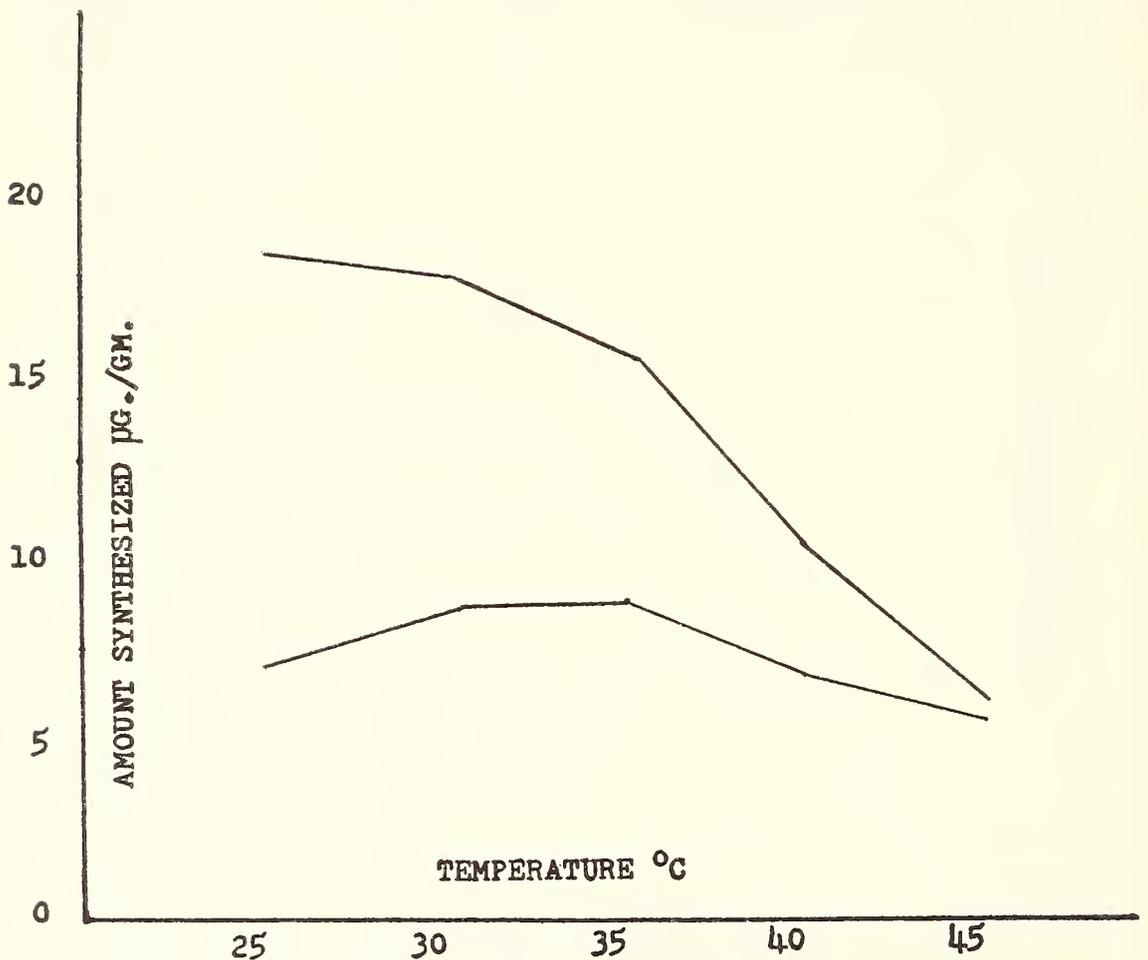


FIG. 3. The effect of the temperature of incubation on the synthesis of ascorbic acid.

Upper graph—three hours incubation

Lower graph—one hour incubation

$3 \mu\text{g./gm./hr.}$; with nine hours of incubation, it was 1.7, and with fourteen hours, 0.93. Hence the optimal incubation period was three hours.

The temperature of incubation also modifies the amount of ascorbic acid synthesized (Figure 3). Since any determination of optimal temperature must take into account the duration of the test, measurements were after one hour and after three hours

of incubation. In the former case, the differences between the amounts synthesized were not large, 30° C. appearing to be the most favorable temperature. Under these conditions 8.8 $\mu\text{g./gm.}$ were synthesized as compared with 7.2 at room temperature (approximately 25° C.). As the temperature was increased, less ascorbic acid was synthesized. When measurements were made after a three hour incubation period, the level of ascorbic acid production remained almost constant between room temperature and 30° C. Increases in temperature beyond this point resulted in a progressive decrease in synthesis to a low value of 5.0 $\mu\text{g./gm.}$ at 45° C.

Homogenate concentration was found to be important. When it was increased from 10 to 20 per cent the amount of ascorbic acid produced increased from 16.5 to 19.2 $\mu\text{g./gm.}$ A further increase to 30 per cent resulted in a small decrease to 18.5 $\mu\text{g./gm.}$ These results indicate the best homogenate concentration to be 20 per cent.

The addition of manganese ion in the form of MnCl_2 did not result in any increased synthesis.

Homogenates of fat bodies produced greater amounts of ascorbic acid than homogenates of whole insects. The amount synthesized was 26.0 as compared with 18.6 $\mu\text{g./gm.}$

DISCUSSION

In the technique used here, ascorbic acid already present in the tissues and that which may have been in the food in the digestive tract are accounted for by the use of the homogenate blank. However, the blank does not eliminate the possibility that microorganisms could be responsible for its synthesis. Tests using only homogenates of fat bodies greatly reduce the possible role of microorganisms. They do not exclude the possibility that symbiotes present in the mycetocytes of fat bodies could play some part in this synthesis. (Gier, 1936).

The decrease in rate of synthesis when the incubation period was extended beyond three hours or when the temperature was raised above 30° C, may in each case be due to a breakdown of ascorbic acid. Aqueous solutions, and extracts of ascorbic acid, readily undergo oxidation when left exposed to air. The increase in temperature may accelerate oxidation, producing oxalic and

L-threonic acids, compounds which do not couple with the phenylhydrazine reagent. The low values obtained at 40° and 45° C may also be due to thermal inactivation of the enzyme. The temperature of 25° C., optimal in the present experiments, was also found by Gamo and Seki (1954) to be optimal for synthesis of ascorbic acid by the silkworm, *Bombyx mori*.

The lack of increased synthesis when manganese was added to the incubation mixture appears to indicate that manganese is not a necessary cofactor. These results are in agreement with the work of Boyer, Shaw and Phillips (1942) who were unable to substantiate Rudra's (1938) findings that manganese increases the in vitro formation of ascorbic acid when rat and guinea pig liver tissues were supplied with mannose, glucose or galactose.

The ability of insect tissue to utilize sugars in the formation of ascorbic acid agrees with results obtained with vertebrate tissues. Guha and Ghosh (1936) working with spleen, liver and cardiac muscle of rats found that mannose was converted into ascorbic acid. Ruffo and Tartaglione (1948) reported a utilization of mannose, glucose and fructose in the synthesis of ascorbic acid by rat liver and kidney brei. The conversion of glucose to ascorbic acid reported here also agrees with the results obtained with vertebrates. Jackel, Mosback, Burns, and King (1950) as well as Horowitz and King (1953) reported that ascorbic acid was formed when labeled glucose was fed to chloretone-treated rats. However, Smythe and King (1942) found that mannose and glucose were ineffective substrates in the formation of ascorbic acid by rat liver and kidney slices.

The results obtained in this work agree with those of Gamo (1941) who found a synthesis of ascorbic acid during the prepupal and pupal stages of the silkworm, *Bombyx mori*. They also agree with the results of in vitro experiments that Gamo and Seki published in 1954. They reported that the fat bodies of the silkworm were able to convert mannose into ascorbic acid. However, they found that this ability varies considerably during metamorphosis. During the period from the prepupal stage up to the four-day pupae, the amounts synthesized are comparatively great, while negative results were obtained with six-day and eight-day pupae. The synthesis was most intense in prepupae, one-day and two-day pupae. With prepupae they showed that

amounts as great as 97.7 $\mu\text{g./mg.}$ were synthesized; for one-day pupae it was 73.1; and for two-day pupae, 78.3. These values are higher than those obtained in this present work where an average of 26.0 $\mu\text{g./mg.}$ were synthesized by the homogenates of fat bodies. The greatest amount synthesized in any single test of the present experiments was 43.9 $\mu\text{g./gm.}$ The findings of this work also tend to confirm the indirect evidence presented by Wollman, Giroud and Ratismananga (1937) that an enzymatic synthesis of ascorbic acid occurs in the cockroach.

SUMMARY

The ability of the cockroach, *Periplaneta americana* to synthesize ascorbic acid was demonstrated. The monosaccharides mannose, glucose, fructose, galactose and xylose were shown to act as precursors. Of these tested mannose proved to be the best and xylose the poorest substrate. A disaccharide, sucrose, was also utilized in the synthesis of ascorbic acid. Glucoronolactone gave inconclusive results.

The following conditions proved to be most favorable for ascorbic acid synthesis: substrate concentration of $5 \times 10^{-3}\text{M}$, pH 6.8, three hour incubation period, temperature range of 25° - 30° C. and twenty per cent homogenate concentration.

Addition of manganese ion to the incubation mixture did not result in any increase in the synthesis.

Homogenates of fat bodies synthesized greater amounts of ascorbic acid than whole homogenates.

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THE LARVA AND TERRESTRIAL PUPA OF
IRONOQUIA PARVULA
(TRICHOPTERA, LIMNEPHILIDAE)*

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The genus *Ironoquia* was erected in 1916 by Banks to receive *parvula*, originally described in 1900 in *Chaetopterygopsis*. *Ironoquia* remained monotypic until 1951 when Schmid united the four species of *Caborius* with it. The species was originally described from specimens collected in New Jersey and has since been recorded from Massachusetts and New Hampshire. The immature stages have remained undescribed until the present. In the summer of 1957 the species was reared from Ringwood Preserve in Dryden, New York.

LARVA: Length 11 mm., width 1.5 mm. Shape eruciform; color of sclerites deep brown, abdomen white.

HEAD: (fig. 1) Brown, paling slightly posteriorly and ventrally, with a pale band following the epicranial sutures. Muscle insertion marks dark, indistinct, noticeable only posterior to eye. Face densely spinulate; mouth-parts typical of family.

THORAX: (fig. 2) Pronotum brown, with pale central band; a shallow transverse depression across anterior half. Mesonotum brown, with pale central band, posterior margin black. Metanotum with numerous short setae on membrane. Legs brown to straw. Prosternal horn sclerotized, not reaching apex of fore coxae.

ABDOMEN: Three spacing humps present, lateral ones much flattened. First segment dorsally with many short setae; lateral hump with scabrous patch apically; venter elevated transversely, with many long setae. Gills borne in bushy clusters of 12-15 branches. Oval sclerotized rings on venters of segments 3-8. Lateral line on anterior half of segment three composed of thick erect dark scales. Posterior margin of segment 8 dorsally with 8-10 long setae, and a varying number of short pale ones. Ninth segment chitin plate bearing 4 long black setae; one seta laterally of plate; another pair submedially on venter. Sclerite around anal claw with 13-15 setae; membranous ventral portion of prolegs with 3-7 setae.

PUPA: Length 7-8 mm., width 2 mm. Color white. General shape typical of family, fig. 3.

HEAD: Mandibles (fig. 4) curved, with 2 black setae externally. Labrum (fig. 5) with 3 black and 1 pale seta in each distal group; 2 long, straight,

* Supported by a predoctoral fellowship from the National Science Foundation.

black setae and 1 short pale seta in each proximal group. Front with 2 pairs of setae, another pair near eyes, pair between bases of antennae, and last pair on occipital region. Antennae reaching apex of abdomen and curving up and around apical segments; each antenna with 2 long black setae on ventral side of first segment, 3 more dorsally; second segment with 2 long black setae.

THORAX: Pronotum with a pair of setae submedially. Mesonotum with 2 pairs of long dark setae, posterior pair with 1-2 small setae. Metanotum with a pair of long, and a pair of short setae near middle. Fore coxae with 3 setae ventrally, middle coxae with 1 seta; hind legs with a very feebly developed fringe.

ABDOMEN: Segments 1-5 dorsally with 2 pairs of setae, segment 6 with 3 pairs, segment 7 with 4 pairs, and segment 8 with 7-8 pairs. Segments 2-8 with dorsal and ventral sclerotized rods. Segments 2-7 ventrally with a postero-lateral seta, segment 8 with 2 setae. Segments 2-8 laterally with a subdorsal seta; segment 6 with a posterior seta, 7-8 with a cluster of fine hairs here, probably remnants of lateral fringe. First segment dorsally lacking posterior rugosity; hook plates (fig. 6) may have from 1-3 spines per anterior plate. Anal appendages (fig. 7) reduced to rounded lobes.

CASE: Length 9-13 mm., width 2 mm. Slender, tapered and curved. Composed of small sand grains attached to give a very uniform surface.

The larvae will key to *Caborius* in Ross, from which they may be separated by the markings of the head. The larvae of *Caborius* and *Ironoquia* do seem to substantiate the union proposed by Schmid on the basis of adult characters. It will be interesting to see if the pupa of *Caborius* also substantiates this union.

The pupae can be separated from any known Nearctic limnephilid in that they lack anal processes, gills, etc.

BIOLOGY

The larvae were taken in a small kettle hole pool which contains water in the spring, but generally dries up in the summer. Larvae of *Limnephilus indivisus* Walk. are abundant in this pool, yet in a nearby swamp there *indivisus* is equally common not a single larva of *parvula* has been found. The larvae were abundant and conspicuous in May and June as they clambered over the submerged leaves and congregated by the dozens on the fallen inflorescences of *Acer rubrum*. Attempts were made to rear larvae in aquaria, but all attempts met with failure, the larvae dying in a few weeks for no apparent reason.

A trip to the pool on the rainy afternoon of June 20 showed the answer to the problem. A larva was observed out of the water crawling away from the pool. A search through the rotting leaves at the high water line yielded a number of larvae

secreted under the leaves. During the summer, aestivating larvae were found under the leaves, even when the pool had completely dried up. These larvae were inactive and retracted in their cases, which were unsealed.

The mortality among the aestivating larvae must be very high. It appeared that only a particular set of conditions would allow completion of development. Those larvae which were unprotected from the rain were washed out of the leaves. Their whitened cases were strewn by the hundreds over many areas. In other places where there were still layers of unrotted leaves, few larvae or pupae were found. The most productive area was where the ground was shielded by the trees, and a vigorous growth of poison ivy, yet the leaves had rotted so that only the uppermost few were still intact. The pupae were found buried in these early in September. The anterior end of the case had been sealed by a silken mesh, whose many small openings allowed easy access of air. The substrate now was not greatly different from the surrounding forest litter.

While the larvae live in a typical environment, and do not differ greatly from related forms, the pupae are markedly different in habits and morphology. The following interesting features of the pupae may be pointed out: reduction of the distal bristle group of the labrum, lack of gills, reduction of lateral line, and reduction of anal appendages into rounded pads. In these respects the pupae agree closely with the European terrestrial species, *Enoicyla pusilla*.

In addition to the larvae from New York, I have a few from Amherst, Massachusetts, collected on May 6, 1953 by R. A. Alaire. The larvae are labelled Mill Stream, which, if I interpret correctly, is a slowly flowing, sandy bottom stream, about 2 yards wide by 6 inches to 3 feet deep. If this is correct, it represents a great difference in habitats in the two collections.

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Ironoquia parvula (Bks.)

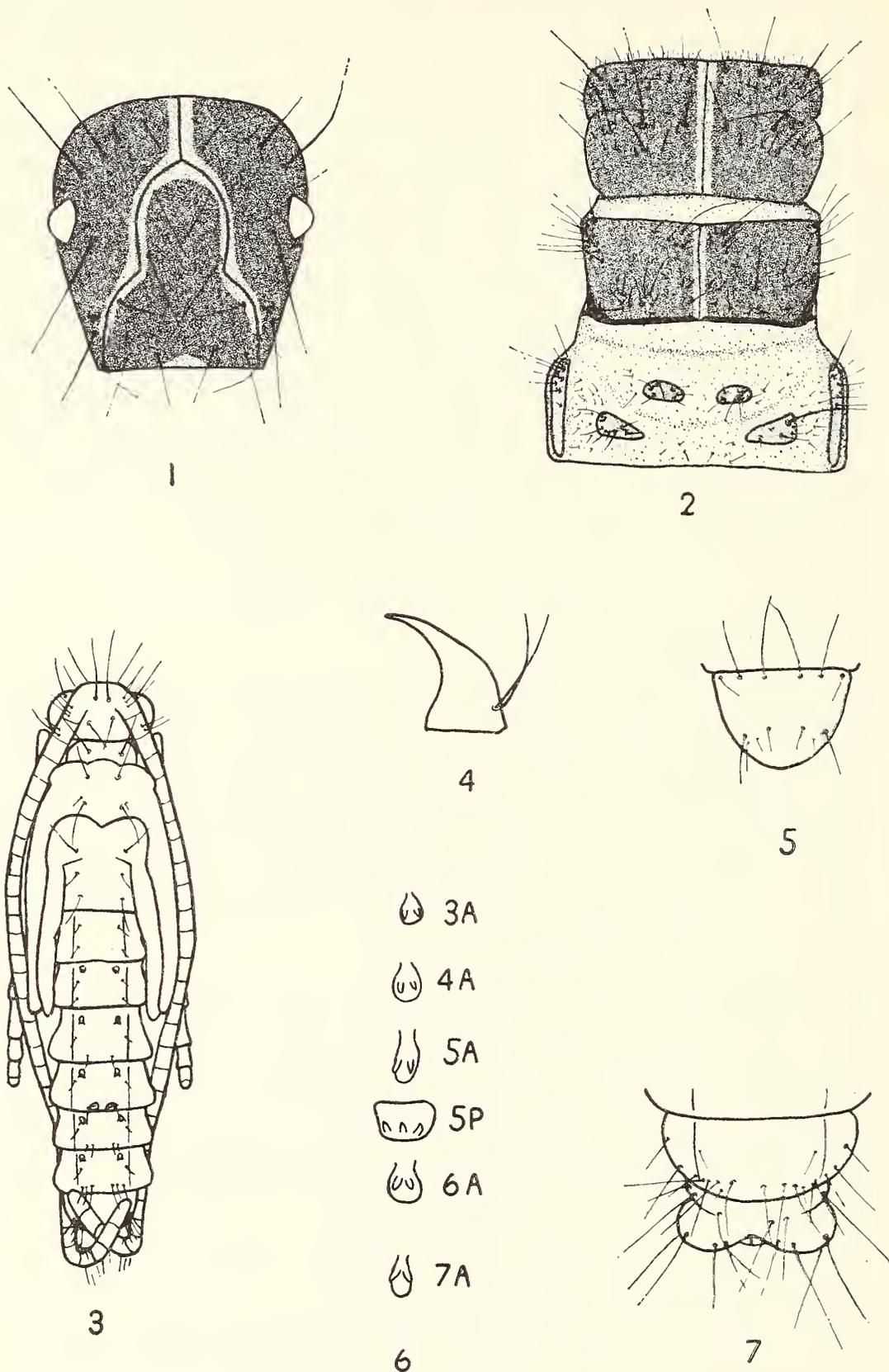


Fig. 1. Larva, head. Fig. 2. Larva, thoracic nota. Fig. 3. Pupa. Fig. 4. Pupa, mandible. Fig. 5. Pupa, labrum. Fig. 6. Pupa, hook plates, A—anterior, P—posterior. Fig. 7. Pupa, apex of abdomen.

A NEW SUBSPECIES OF COENONYMPHA
NIPISQUIT McDUNNOUGH FROM
NEW YORK STATE

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The addition of a resident species to the butterfly fauna of a state so well known as New York is an uncommon event. The discovery of *Coenonympha nipisquit* McDunnough, a member of the superspecies *tullia* Muller, on the islands in the St. Lawrence River off Clayton, New York, took place accidentally. I was visiting Mr. Bernard Heineman at his summer home on Picton Island to discuss with him the joint preparation of a book about Jamaican Butterflies. On Wednesday, August 21, 1957, Dr. William Creighton, an old friend, joined us and we toured the island to see the quarries, several of which supplied the granite that was used to build the original parts of the American Museum of Natural History. Picton Island is bilobed, the southern portion being composed of Potsdam Sandstone and the northern portion of Picton Granite. The lowland that connects the two parts is invaded from the northeast by several acres of marsh. Returning from our tour of the southern lobe of the island as we approached the connecting lowland a small dark butterfly started up from the path at my feet. My first reaction was that it was a Hair-streak but as it settled I saw at once that it was *Coenonympha*. Neither Creighton nor I had a net with us but Heineman was carrying one to collect Monarchs for an experiment relative to their acceptability as food by red squirrels. While Creighton and I herded the butterfly in a limited area the net was brought and the specimen captured. The butterfly proved to be a fresh male *Coenonympha* somewhat like *inornata* but much darker and somewhat smaller.

My first thoughts were that the insect was either a case of very late emergence or a rare example of a partial second brood such as has been observed upon one or two occasions with *inornata*. It then dawned upon me that this was the first capture of the species in New York State if not in the northeastern part of the United States. The next morning Heineman and I prowled

the marshy area referred to above for an hour or so and turned up another male, somewhat more worn than the first but obviously not a hanger-on from a spring brood. The next day we visited a friend of the Heinemans on near-by Grindstone Island, a much larger island than Picton. As we were about to return to Picton, Heineman saw another *Coenonympha* start up from the garden and fly out into a field. We had no nets and could not catch it. We returned to Grindstone that afternoon and headed for the marshes that almost cut the island through, just west of the Bentzen Farm. There we found *Coenonympha* to be abundant and in about an hour, from 2:30 to 3:30 p.m. captured over thirty specimens, most of them fresh males. Heineman returned on the 23rd and 30th seeking gravid females and picked up a few more specimens.

This array has allowed me to reach certain interesting conclusions. These Thousand Islands *Coenonympha* are different from any *inornata* with which I am familiar. They are marsh butterflies, usually weaving back and forth over the perimeter of the marsh and the adjacent dry grasslands. Whether or not they actually breed in the marsh is yet to be explored. When disturbed by an unsuccessful sweep of the net they head into the marsh for security. As is usual with these insects the flight is low, rarely does an individual rise to as much as three feet from the ground. Their more rapid darting flight when compared with the flight of *inornata* may be due entirely to the heat of August in the early afternoon. Colorwise they are darker than any strain of *tullia* from North America except *macissaci* Dos Passos, the strain found on Newfoundland. They differ from that butterfly in the quality of color, being redder and more like *nipisiquit* McDunnough from Bathurst, New Brunswick. The Thousand Islands insect and *nipisiquit* are the only strains in North America that are associated with a hardwood or slightly mixed forest rather than a coniferous forest. According to the map that accompanies Halliday's (1937) report on Canadian forests, Picton and Grindstone Islands lie in the Upper St. Lawrence Section of the Great Lakes—St. Lawrence Forest Region. Bathurst lies at the junction of the Temiscouata-Restigouche Section of the same forest region and the Mirimiche Section of the Acadian Forest Region. The various sections of these forest regions are clearly defined on pp. 29–39 of Halliday's paper.

Essentially there is a little more boreal element at Bathurst than there is on the islands.

The Thousand Islands strain of *tullia* is far more prone to show ocelli, or at least traces of them, on the under side of the hind wings than any other eastern strain of *tullia*. Like *nipisiquit* the newly discovered butterfly seems to be a summer butterfly, not a spring one. This is more important than it seems at first. Both are at the extreme southern border of the distribution of the species in the eastern part of North America and under such conditions one would look for a somewhat earlier emergence than farther north. Thus if the North American *tullia* are treated as several species instead of subspecies of an holarctic insect the new subspecies must be considered a subspecies of *nipisiquit* and not of geographically closer *inornata*. It has in common with the former, late appearance, marsh habitat and redder coloring. It differs from *nipisiquit* in its smaller size and the great degree in which the ocelli are present.

In my study of these insects (1955) I considered *nipisiquit* a subspecies of *inornata*. I expressed (p. 375) some concern about the ability of *nipisiquit* to withstand the climate of its range and said "Thus in search of the coolest areas *nipisiquit* crowded into the sea marshes where the cooling effect of the sea is most felt during warm summer months." Apparently this can be said for the Thousand Islands strain. The discovery of this second peripheral strain of *tullia* has fortified for me a part of the original manuscript that I did not publish in 1955. At that time I was not convinced that I was right since no evidence was at hand to show a relative of *nipisiquit* at the northern end of the Hudson Valley—Lake Champlain gateway to the north. My theory required that such a strain should exist to-day or in post-Wisconsin time. Now I am willing to set forth my ideas.

I visualize a pre-Wisconsin, Sangamon Interglacial period, distribution of *Coenonympha tullia* in eastern North America about the same as we know the distribution to be today. I imagine the insect of that period to be much like the strains found along the eastern front of the Rocky Mountains from northern New Mexico to northern Wyoming, weakly ocellate. The color difference that exists today between eastern and western strains I believe existed then and for the same reasons (*l.c.* 396–397), relative humidity. As the ice of the Wisconsin glacial period

began to extend southward the insects in question slowly retreated before it. The great mass moved down the Mississippi valley and found refuge possibly as far south as the latitude of northern Texas where paleobotanical studies tell us there was a forest similar to that in which the eastern strains of *tullia* thrive today. A lesser mass moved southward through the valley of the Hudson River and other more eastern river valleys onto the Atlantic coastal plain. This flow probably terminated somewhere in the Carolinas.

The *tullia* that waited out the Wisconsin ice age in the lower Mississippi valley were subjected to about the same climatic regime that they had experienced in their old, and present, homeland. The one great difference was the difference in the length of daylight throughout the year, shorter in summer and longer in winter. Something, either the change in daylight or the rigors of the long trek to and fro, eliminated from their complex of genes those that are responsible for ocelli. Those that were forced into the Atlantic coastal plain met with a different climate from that to which they had been accustomed. They were subjected to a maritime climate more equable than that enjoyed by their ancestors. They too suffered a change in daylight. Somehow the changes made it advantageous to emerge later in the year. Thus over the millenia spent in the southern refugia a spring butterfly changed to a summer one. With the retreat of the Wisconsin ice, beginning about 11,000 years ago, these butterflies slowly moved northward always staying in the ecological niches for which they were best fitted. New characters that had been gained during the period of refuge in the south were not all lost but only those that benefited the northward moving insects and those that had no effect upon survival have survived to today.

The Appalachian ranges separated the two diverging sets of strains during the Wisconsin period. As the northward movement took place these mountains channeled the homeward routes. The butterflies from the Mississippian refugia probably entered their present range over the prairies west of the Great Lakes and possibly the northern peninsula of Michigan. The butterflies from the Atlantic coastal refugia pressed northward east of the mountains. Some took a purely coastal route moving from salt marsh to salt marsh to terminate in New Brunswick as *nipisiquit*.

Others broke through the mountain barrier by way of the river valleys. The stream that moved up the Hudson Valley gave rise to the Thousand Islands strain. Apparently the seeds for the difference between *nipisiquit* and the New York strain were planted during the Wisconsin period. One strain had become adapted to the conditions of salt marshes, the other to those of fresh water marshes. The latter seems to have retained in its constitution more of the genes responsible for producing ocelli than any other strain east of the Rocky Mountains.

I take great pleasure in dedicating this interesting new subspecies to my good friend, Mr. Bernard Heineman of New York City.

***Coenonympha nipisiquit heinemani* n. ssp.**

MALES. The color and shading of the upper side of the males of *heinemani* are very much like those of *nipisiquit*. The ground color is deep brown tinged with reddish. The wings are broadly washed with smoky brown along the outer margins, especially on the hind wings where the smoky color may cover the entire wing. Just within the margin of the hind wing of most specimens there is a dark brown narrow zig-zag line or row of chevrons. The fringes are greyer than the wings, especially at the abdominal angle of the hind wings. In this respect *heinemani* differs from *nipisiquit* upon which the fringes are almost concolorous with the wings. Almost invariably the apex of the fore wing bears a black dot or spot in the usual position for the apical ocellus, thus differing from *nipisiquit*, *inornata* and *macissaci*. Usually this black mark is circled by a ring of deep brown free of any smoky overtones.

On the under side of the fore wing the ground color is of the same quality as on the upper side but of a little lighter shade. The apex and a tapering zone along the outer margin are both heavily washed with white or slightly yellowish scales. This gives a definitely yellow-greenish tone to these areas of fresh specimens and a salt-and-pepper appearance to others. In it is a well-developed apical ocellus, universally present and composed of a black iris with white pupil and ringed with yellow. The sinuous line that lies between the ocellus and the end of the cell usually extends at least as far as Cu_1 . It is black outwardly shaded with white. Occasionally there are supernumerary ocelli represented by black dots in spaces M_3 and Cu_1 . The hind wing has the basal half much darker than the outer half and darker than the disc of the fore wing. It is heavily powdered with light scales which are more densely set in the outer half than the basal half. The sinuous junction between the inner and outer portions of the wing usually is well defined. Very rarely there is a light patch at the base of the wing, a character usually found only on *ochracea* and its allies in the western states. Frequently there are one or more white or black points in the submargin representing the ocelli found similarly placed on western subspecies. The frequency with which these spots appear immediately sets *heinemani* apart from the other eastern subspecies.

FEMALES. The upper side of specimens of this sex is much lighter than that of the males. The ground color is ochre-brown, about the same as on *nipisiquit* and darker than on either *inornata* or the few *macissaci* females before me. There is very little of the smoky overtones along the margins in specimens of this sex. The fringe is somewhat yellower than on the males and in less contrast with the ground color of the wings. The location of the apical ocellus always is marked by a black dot or spot. Occasionally there are tiny black dots in spaces M_3 and Cu_1 .

The under side is much lighter than that of the male, light brown-ochre. Otherwise the two sexes are marked alike. The apical ocellus on the fore wing is fully developed on all of the specimens I have seen. Supernumerary ocelli on the fore wing are more frequent on the females than on the males and some of these are true ocelli not just black dots marking the positions of ocelli. Over half of the specimens examined bear indications of ocelli in the submargin of the hind wing. None showed any sign of a basal light patch.

The one characteristic that sets *heinemani* apart from all other eastern *Coenonympha* is the high frequency with which supernumerary ocelli are found on the under side of the fore wing of both sexes, and the frequency with which ocelli or representative points are found in the submargin of the same side of the hind wings of both sexes.

Holotype: a male, Grindstone Island, Clayton, Jefferson Co., New York, Aug. 22, 1957, collected by F. M. Brown.

Allotype: a female, the same data as the holotype.

Paratypes: 1-18, males with the same data as the holotype; 19-23, males with the same data as the holotype but collected by Heineman; 24-28, males from Grindstone Island collected on Aug. 23, 1957 by Heineman; 29-31, males from Grindstone Island collected Aug. 30, 1957 by Heineman; 32, a male from Picton Island collected Aug. 21, 1957 by Brown; 33, a male collected on Picton Island Aug. 22, 1957 by Brown; 34-36, females with the same data as the allotype; 37-40 females with the same data as the allotype but collected by Heineman; 41, a female collected on Grindstone Island Aug. 23, 1957 by Heineman; 42-44, females collected on Grindstone Island Aug. 30, 1957 by Heineman.

The holotype, allotype and the paratypes collected by Brown, except number 33, have been deposited at the American Museum of Natural History. Paratype 33 is in the Heineman Collection.

The data for *nipisiquit* and for *inornata* were taken from Brown, 1955, pp. 375 and 382-385. The "error" for each

Statistics of variation for several strains
of *Coenonympha tullia*.

MALES

	<i>nipisiquit</i>	<i>heinemani</i>	<i>inornata</i>
Number studied	141	34	66
Size, radius of left fore wing, mm.	18.76 ± 0.61	16.30 ± 0.83	17.60 ± 0.62
Coefficient of variation	3.3	5.1	3.5
Forewing, upper side			
Presence of ocellus or trace, %	12.0 ± 2.7	91.2 ± 4.8	6.1 ± 2.9
Fore wing, under side			
Presence of ocellus or trace, %	82.2 ± 3.2	100	54.6 ± 6.2
Supernumerary ocelli or traces, %	0.0	29.4 ± 7.8	0.0
Ray absent, %	0.0	2.9 ± 2.2	0.0
Ray ends at M ₃ , %	0.7 ± 0.5	0.0	0.0
Ray ends at Cu ₁ , %	47.5 ± 4.2	41.2 ± 8.4	13.6 ± 4.2
Ray reaches or exceeds Cu ₂ , %	51.8 ± 4.2	55.9 ± 8.5	86.4 ± 4.2
Hind wing, under side			
Ray complete, %	6.4 ± 2.1	52.9 ± 8.5	10.6 ± 3.8
Ray broken, %	83.7 ± 3.1	41.2 ± 8.4	63.6 ± 5.9
Ray ends at M ₃ , %	4.2 ± 1.7	5.9 ± 4.7	22.8 ± 5.2
Ray fragmentary, %	5.7 ± 2.0	0.0	3.0 ± 2.1
Submarginal marks absent, %	40.0 ± 4.1	100	48.5 ± 6.1
Ocelli or traces present, %	0.0	50.0 ± 8.6	0.0
Basal light patch present, %	0.0	2.9 ± 2.2	0.0

FEMALES

	<i>nipisiquit</i>	<i>heinemani</i>	<i>inornata</i>
Number studied	64	11	10-11
Size, radius of left fore wing, mm.	18.86 ± 0.58	16.79 ± 0.65	17.69 ± 0.63
Coefficient of variation	3.1	3.9	3.6
Fore wing, upper side			
Presence of ocellus or trace, %	57.7 ± 6.2	100	63.7 ± 14.5
Fore wing, under side			
Presence of ocellus or trace, %	95.3 ± 2.6	100	72.7 ± 13.5
Supernumerary ocelli or traces, %	0.0	63.7 ± 14.5	0.0
Ray ends at M ₃ , %	0.0	9.1 ± 8.6	0.0
Ray ends at Cu ₁ , %	9.4 ± 3.6	36.4 ± 14.5	20.0 ± 12.5
Ray reaches or exceeds Cu ₂ , %	90.4 ± 3.6	45.5 ± 15.0	80.0 ± 12.6
Hind wing, under side			
Ray complete, %	14.1 ± 4.4	63.7 ± 14.5	60.0 ± 15.0
Ray broken, %	84.4 ± 4.5	27.3 ± 13.5	40.0 ± 15.0
Ray ends at M ₃ , %	1.6 ± 1.6	9.1 ± 8.6	0.0
Submarginal marks absent, %	62.5 ± 6.0	100	20.0 ± 12.6
Ocelli or traces present, %	0.0	63.7 ± 14.5	0.0
Basal light patch present, %	0.0	0.0	0.0

measurement is its standard deviation. This was determined for the per cent by extracting the square root of the product of npq , where n is the number of cases, p the decimal frequency of occurrence and q is $1.00-p$. The data for the males are based upon sufficiently long series to have meaning. Those for the females of *heinemani* and *inornata* are best considered no more than trends unless the frequency is greater than 40 per cent.

NOTES ON IMMATURE STAGES

On August 30 Heineman returned to Grindstone Island and collected several gravid females. These he enclosed over lawn grass with a little sweetened water. After three days of inactivity one (?) of the females laid five eggs on September 2. A week later when no more eggs had been laid Heineman sent me the five by airmail. They arrived in Colorado Springs on September 12.

EGG. When received, ten days after they had been laid, the five eggs were pale straw colored and lightly mottled with reddish brown blotches. Less area was covered by the dark color than the light. Structurally they seemed to me to be inseparable from the eggs of other North American *tullia*. The diameter measured with an eye-piece micrometer at 14 diameters magnification was 0.75 mm. and the height 0.71 mm. The eggs hatched on September 18.

FIRST INSTAR LARVA. Upon emergence three of the five larvae ate the egg shell from which they had escaped, the others made no attempt to do so. The larvae are elongate conical in shape, tapering rather abruptly from the large head through the thoracic segments and less pronouncedly through the abdominal segments. The head is pale brown and finely granulate. The thorax and abdomen are white with a mid-dorsal and two lateral bands of pale reddish brown. Between the two lateral stripes is a third broken stripe of the same color. Pendant from the lower of the two solid stripes are lobes of reddish brown that include the spiracles. The caudal tabs are yellow-ochre. This is somewhat different from the excellent drawings of first instar larvae of *californica* published by Edwards (1897) and Davenport's description of the same stage of *inornata*. The surface of the larva is densely studded with minute tubercles each bearing one or more very fine colorless hairs that are clubbed at the tip. These hairs are visible only under considerable magnification and with proper lighting. There are similar hairs on the head. Initial length is 1.65 mm., transverse diameter of the head is 0.52 mm., and length of the head 0.26 mm. I could not measure the vertical depth of the head on these larvae, they were too lively in the warmth of the lamp. It seemed to be a little greater than the transverse diameter.

None of the larvae made any attempt to eat the fresh lawn grass that I supplied during the first days out of the egg. They

were very sluggish and hardly moved from day to day. Several days after emergence one of them while being watched through a binocular microscope seemed particularly lively in the warmth of the lamp light. As I watched, it essayed a bite at the edge of a grass blade. This larva then began to feed regularly but very sparingly. Each morning fresh food was supplied and no more than three or four millimeters had been nibbled along the edge of a blade of grass during the previous twenty-four hours. On the morning of October 3 I found that it had passed its first moult.

SECOND INSTAR LARVA: Total length at beginning of instar was 2.95 mm. I could see no marked difference in the appearance after this moult. These changes had taken place: the color became somewhat greenish, the reddish brown stripes perhaps a little darker and the hairs perhaps a little longer.

A bout with influenza confined me to bed for about ten days soon after these observations had been made. When I returned to my laboratory the vial containing the second instar larva showed moulded grass and a dead caterpillar. The other four larvae were still healthy. They had made no attempt to feed and now are buried beneath leaves in the grass at the north side of the laboratory to await spring. Whether they will survive Colorado's erratic winter weather and desiccating air is questionable.*

In latitudes somewhat north of Grindstone Island *inornata* begins its hibernation while the weather is still warm and when the larvae are in the fourth instar. It seems quite probable that *heinemani* passes the winter as a first instar larva. This is in keeping with what we suspect of the behavior of *nipisiquit*.

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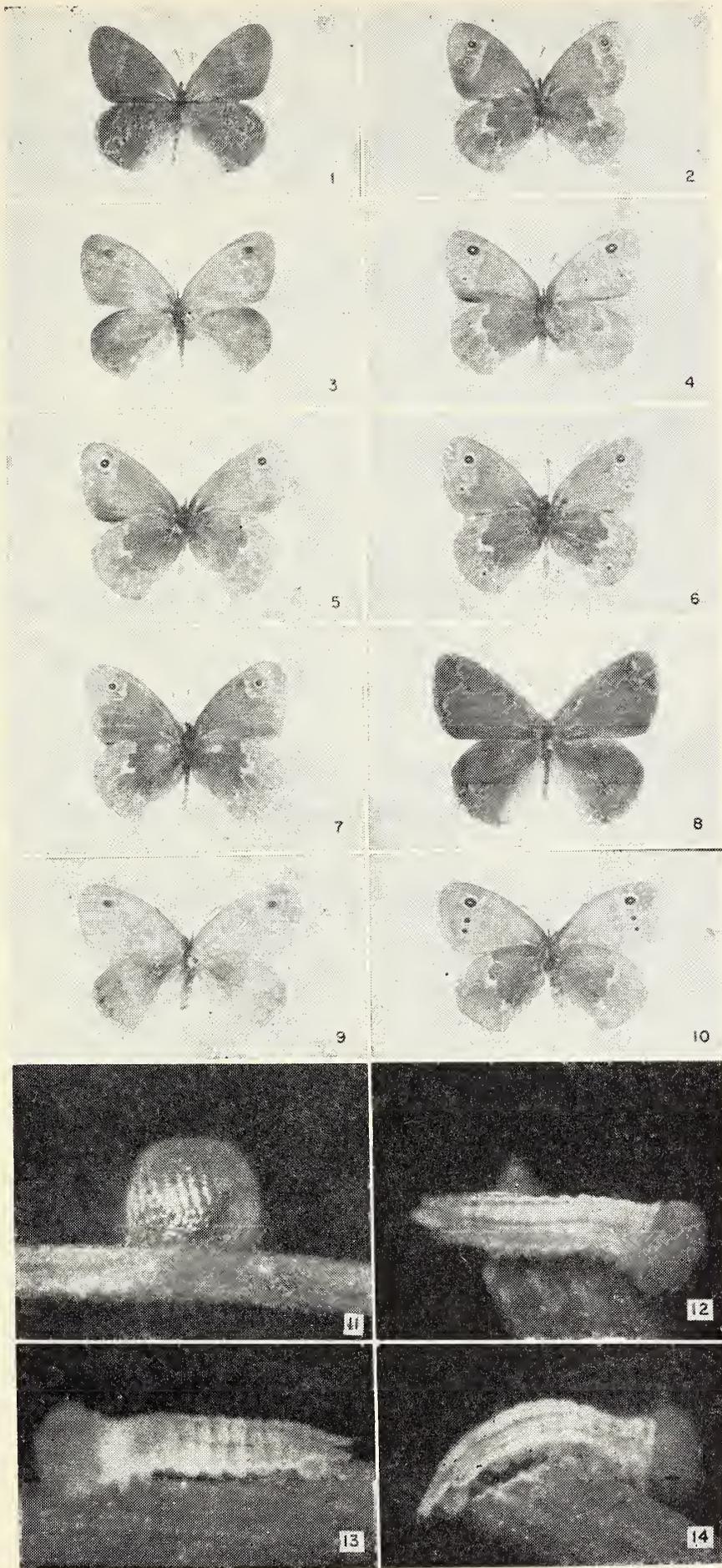
* They did not survive.

EXPLANATIONS OF PLATE II

Figs. 1-10. *Coenonympha nipisiquit heinemani* Brown. 1. Holotype, male, Grindstone Island, Clayton, New York, August 22, 1957, collection Brown, upper side. 2. Holotype, under side. 3. Allotype, female, same data, upper side. 4. Allotype, under side. 5-7. Paratypes, males, same data, showing variations in development of ocelli and basal light patch on hind wing. 8. Paratype, male, Grindstone Island, Clayton, New York, August 30, 1957, collection Heineman, showing dark submarginal row of "chevrons" on hind wing. 9-10. Paratype, female, Grindstone Island, Clayton, New York, August 30, 1957, collection Heineman, light colored with well developed supernumerary ocelli.

Fig. 11. Egg. 12-14. First instar larvae, about 24 hours old.

Figs. 1-10. Three-quarters natural size. Figs. 11-14. Magnified approximately 20 diameters.



THE ANATOMY AND HISTOLOGY OF THE LARVAL
ALIMENTARY CANAL OF THE EUROPEAN
CHAFER, AMPHIMALLON MAJALIS
RAZÓUMOWSKY (SCARABAEIDAE)¹

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The larvae of the European chafer, *Amphimallon majalis*, are serious pests of lawns, nursery stock and crops in the vicinity of Wayne county and other areas of northwestern New York. No studies have been made on the histology of this economically important grub. The following study describes the anatomy and histology of the alimentary canal of the third-instar larva, the most destructive stage in the life history of the chafer.

Third-instar larvae were fixed in Bouins fixative. Gross anatomical dissections were made in 70% ethyl alcohol, and histological studies were made from serial sections cut at 10 microns and stained with eosin and hematoxylin.

The morphology and musculature of the larval mouthparts of *A. majalis* and how they function in feeding has been described by Butt (1944); and Gyrisco et al. (1954) have described the life history of this beetle. Areekul (1957) has completed the most recent study of the comparative internal anatomy of several genera of larval Scarabaeidae; Wildbolz (1954) has worked on the anatomy and histology of the alimentary canal of the larva of *Melolontha melolontha*, L.; Schäfer (1954) has worked on *Rhizotrogus aestivus*; Subklew (1938) described the larval morphology of *Melolontha hippocastini*, but did not include studies on internal anatomy; Patterson (1937) studied the larval and adult digestive tracts of *Passalus cornutus*; Malouf (1932) described the anatomy of the head, stomodaeum and nervous system of the grub of *Pentodon dispar*; Fletcher (1930) studied the alimentary canal of the adult of *Phyllophaga gracilis*; Swingle (1930) has described the alimentary canal of the adult Japanese beetle, and Rittershaus (1927) described the alimentary canals of *Phyllopertha horticola* and *Anomala aenea*.

¹ The Grace H. Griswold fund is acknowledged for payment of plates.

The alimentary canal (Figs. 1 & 2) of the larval third-instar European chafer is approximately 30 mm. long and is slightly longer than the length of the larval body. Three divisions of the canal are easily recognized: the stomodaeum, ventriculus and proctodaeum. The stomodaeum and proctodaeum are ectodermal derivatives of the embryonic blastoderm while the ventriculus, or mesenteron, is an endodermal derivative. However, Johannsen and Butt (1941) state that in the Coleoptera, development of the mid-gut epithelium from the entoderm as well as from the ectoderm has been described.

The stomodaeum, extending from the mouth opening to the mesothoracic segment, is approximately 3 mm. long and is the shortest division of the alimentary canal. The stomodaeum consists of five areas: the buccal cavity, pharynx, esophagus, crop and esophageal valve.

The buccal cavity (Fig. 2, bc), is approximately 0.4 mm. in diameter and appears as an anterior dilation of the stomodaeum. Immediately posterior to the buccal cavity is the pharynx (ph), and posterior to the pharynx is the esophagus (es) which continues as a narrow tube approximately 1 mm. in length and 0.2 mm. in diameter. Posteriorly, the esophagus joins the crop. The crop (cr) is approximately 0.4 mm. in diameter, and appears as a posterior dilation of the stomodaeum. Generally, the crop has the characteristic function of food storage, as in the grasshopper, but the crop in the larval chafer appears to have lost this function almost completely, and the ventriculus appears to have taken over the greater part of food storage. The esophageal valve (Fig. 4, esv) is oval and approximately 0.6 mm. in diameter. It extends from the posterior region of the crop into the anterior end of the ventriculus where numerous folds of stomodaeal intima and epithelium project into the lumen of the ventriculus. This arrangement prevents to some degree the flow-back of food particles into the stomodaeum.

The ventriculus (Figs. 1 & 2, ven) is a large, round tube which extends from the mesothoracic segment to the 7th abdominal segment. The ventriculus is approximately 13 mm. long and 3-5 mm. wide and is the largest and longest part of the alimentary canal. The anterior limit of the ventriculus is defined by the esophageal valve and the posterior limit by the pyloric valve.

Caecal diverticula, sometimes called gastric caeca, (Figs. 1 & 2, acd, pcd) occur at the anterior and posterior areas of the ventriculus. There are ten anterior diverticula (Fig. 3, acd), eight being concentrically arranged around the anterior end of the ventricular-stomodaeal junction and two more are arranged within the the eight and below this junction. There are four posterior diverticula (Fig. 1, pcd) which lie ventrally on the ventriculus and immediately anterior to the external manifestation of the pyloric valve. In some dissections small rudimentary diverticula, four to six in number, were found on the mid-region of the ventriculus. Snodgrass (1935) says that caecal diverticula occur sometimes on parts of the ventriculus other than the anterior end surrounding the esophageal valve, and he figures three sets occurring in the scarabaeid larva of *Popillia japonica*. Rapp (1947) says that in the Scarabaeoidea the gastric caeca when present may number up to at least four sets, as in *Osmoderma eremicola*, and that the generally accepted belief that the gastric caeca are located at the anterior end of the midgut does not hold, since the gastric caeca in the Scarabaeoidea may be located on any portion of the ventriculus. It is apparent from this discussion that the number of caecal diverticula in larval insects may have taxonomic significance.

The proctodaeum is approximately 10 mm. long and consists of the anterior intestine (Fig. 2, ai), Malpighian tubules (mt), and the posterior intestine (pt), the latter being anatomically divided into the rectal sac (rs) and rectum (rt).

The anterior intestine is approximately 3 mm. long and has its greatest diameter, approximately 2 mm., where it joins the ventriculus. This large, funnel-shaped portion of the anterior intestine, sometimes called the proximal ileum, continues posteriorly to join the rectal sac.

The pyloric valve (Figs. 1 & 2, pv) is transversely concentric and has its most anterior articulation with the ventriculus on the ventral aspect of the alimentary canal near the posterior caecal diverticula. In a macroscopic sagittal section, the pyloric valve (Fig. 5, pv) appears as a circular swelling of ectodermal cells and intima which projects into the lumen of the canal.

There are four Malpighian tubules (Figs. 1 & 2, mt) and they are of the cryptonephridic type. Two tubules have their ampullar origins ventrally at the junction of the anterior intestine

with the ventriculus and two more have their origins laterally at this junction. These tubules extend anteriorly along the ventriculus to the area of the anterior caecal diverticula where they bend and extend posteriorly to terminate in a membrane on the ventral surface of the rectal sac (see Fig. 1). At their point of termination with the rectal sac, the tubules become intimately convoluted and entwined with one another to form a mesh-like network which is held in place by an enveloping membrane. Marcus (1938) says that in only a small number of the Coleoptera do the Malpighian tubules end freely in the body cavity, and Wigglesworth (1956) says that in many beetles the upper parts of the Malpighian tubules closely invest the rectum, being bound to it by a delicate membrane. Wigglesworth says further that this arrangement probably serves to add the absorptive powers of the Malpighian tubules to those of the rectal epithelium and that this arrangement seems always to be associated with remarkable powers of drying the excrement. Patton and Craig (1939) who studied the physiology and absorption of the cryptonephridic tubules of the mealworm, *Tenebrio molitor*, conclude that Malpighian tubes of this type serve only to absorb materials from the haemolymph, the entire reabsorption of water and utilizable materials taking place in the walls of the rectum.

In the chafer larva the excrement contained in the rectal sac is conspicuously dry and hard, and it seems to adhere to the thin intima of the rectal sac since it is very difficult to clean away. This undoubtedly indicates that the cells of the rectal sac play an active role in the reabsorption of water and utilizable food materials contained in the rectal sac.

The posterior intestine (Fig. 2, pt) is U-shaped and extends from the eighth through the tenth abdominal segments. It consists of the rectal sac (rs), approximately 5 mm. long and 5 mm. wide, and the rectum, approximately 3 mm. long and 2 mm. wide.

HISTOLOGY OF THE ALIMENTARY CANAL

The cells of the stomodaeum (Fig. 6) are generally cuboidal, but in the area of the esophageal valve (Fig. 9, esv) they appear columnar. Some of these cells and their intima are thrown into longitudinal folds which project into the lumen of the ventriculus, there being approximately six such folds. Such an arrange-

ment allows for the expansion of the stomodaeum while the larva ingests food.

The intima of the stomodaeum appears to be composed of primary and secondary intima. The primary intima (Fig. 6. pi) is continuous with the body wall and stains dark with hematoxylin. The secondary intima (si) is much thicker than the primary intima and appears as thin, almost transparent protoplasmic strands or fibrillae which are being secreted by the epithelium of the stomodaeum. The secondary intima stains light with hematoxylin, and such a staining reaction may suggest that the secondary intima being secreted is weakly acidic in comparison with the basic staining reaction of the cytoplasm with alcoholic eosin, and in comparison with the acidic staining reaction of the nucleus with hematoxylin.

The cells of the ventriculus (Fig. 11) consist of large columnar epithelium with a striated border (sb). The height of these cells is approximately 81 micra and the width approximately 18 micra. The nuclei are oval, finely granular and measure approximately 7.2 micra wide and 18 micra tall.

The striated border is irregular and is approximately 1.5 micra wide. Day and Waterhouse (1953) state that only the conspicuous nature of the striated border has resulted in its being considered anything but a normal cell specialization. Furthermore, they state that the striated border appears to occur in cells in which unusually active transfer occurs across the cell boundary. The fact that the striated border does not possess the motile characteristics of cilia suggest that it probably is made up of minute protoplasmic fibrillae. Maximow and Bloom (1955) state that in all vertebrates the cells of the simple columnar intestinal epithelium have a distinct layer of modified protoplasm, the striated border, on their free surface. They say further "electron microscopy fails to demonstrate a cement like substance, although the rod-like processes are clearly seen. Presumably, it (striated border) plays an important role in the absorption of nutritive substances from the intestinal cavity." It is clearly evident from the above discussion that the striated border of the ventricular epithelium of insects is strikingly similar both cytologically and functionally to the striated border of vertebrate epithelial cells. Further studies with the electron microscope on the striated border of the ventricular epithelium in the larval chafer are anticipated by this author.

The basal region of the ventricular epithelium is irregular and a basement membrane (bm) approximately 0.7 micra wide is evident. The nidi (ni), or regenerative cells, lie irregularly in groups of four–six near the basement membrane. The nidi stain conspicuously darker with hematoxylin than do the nuclei of the columnar cells. Wildbolz (1954) states that the middle intestine of *Melolontha melolontha* possesses two morphologically different regions; he says that in the anterior region of the ventriculus the epithelium has regularly arranged crypts and the regenerative cells lie at the base of the crypts, while in the posterior region of the ventriculus the epithelium is even and only a few regenerative cells are found. Areekul (1957) has found that the replacement cells of the ventriculus in several scarabaeid larvae have 3–4 nuclei in each group, and he apparently found no morphologically different regions in the ventriculus. Areekul says further that the structure of the gastric caeca does not differ from that of the ventriculus except that the number of epithelial cells seems to increase tremendously at times.

In the anterior and posterior regions of the ventriculus of *A. majalis*, the nidi are not found in crypts, and the epithelial cells in all regions of the ventriculus are even. In the anterior region of the ventriculus near the anterior caecal diverticula crypts may be found, but these crypts are not regularly arranged nor do the nidi appear to be found in a regular fashion at the bases of these crypts.

A thin peritrophic membrane (Fig. 9, pm) is present and envelops the food contents of the ventriculus. This membrane protects the epithelial cells of the ventriculus from ingested food stuffs and is permeable to digestive enzymes and to the products of digestion. Day and Waterhouse state that two types of peritrophic membranes occur in insects and that two methods of formation have been described. The first type is a single, uniformly continuous structure which is produced as a viscous secretion by a ring of cells at the junction of the stomodaeal and ventricular epithelium (see Butt, 1934). The second type is a tube consisting of a series of concentric lamellae and is thought to be produced by all the epithelial cells of the ventriculus secreting a series of thin lamellae. Snodgrass (1935) states that in the formation of the second type there is no reason for supposing

that chitin could not be produced from endodermal (ventriculus) as well as from ectodermal derivatives (stomodaeum) of the blastoderm. Snodgrass says further that the second type of peritrophic membrane is evidently to be regarded as a chitinous intima of the ventriculus.

Intracellular protozoans (Fig. 11, p) were noticed in the distal ends of many cells of the ventricular epithelium. The nuclei of these protozoans are coarsely granular and are slightly smaller than the nuclei of the columnar cells. The nucleoplasm of the protozoans stains darker with hematoxylin than do the nuclei of the columnar cells, and the cytoplasm of the protozoans appears to stain similarly to that of the columnar cells. A clear, hyaline area is generally found around the entire protozoan. These protozoans are quite numerous in the epithelium of the ventriculus and approximately 3–4 were found for each ten cells observed. It is difficult to say at present what type of intracellular protozoan this may be and if it is a parasite or a symbiont. Further studies are being made in order to classify the complete protozoan fauna of this larval beetle.

The cells of the anterior intestine (Fig. 7) are cuboidal and elongated cuboidal. Cell boundaries are, in general, not clearly distinguished and cells appear as a syncytium. The nuclei (n) are oval and are approximately 10.8 micra long and 7.2 micra wide. In the region of the pyloric valve (Fig. 10, pv) the cells attain columnar form with their nuclei lying near the distal end of the cells.

Longitudinal folds of epithelium and intima similar to those of the stomodaeum project likewise into the lumen of the anterior intestine. The intima of the anterior intestine is also composed of primary and secondary intima. The thickness of the primary intima varies from 1.8 to 3.6 micra.

The rectal sac (Fig. 12) is made up of contiguous and alternating areas of elongated cuboidal cells and hillocks of near columnar cells. The epithelial wall, in cross-section, appears much thinner than the cell wall of the anterior intestine. The nuclei of these cells are rounder than the nuclei of the anterior intestine. The elongated cuboidal cells are approximately 21 micra long and 9 micra high. The near columnar cells are approximately 40 micra high and 15 micra wide. A basement membrane (bm) is usually evident and describes an irregular

course about the basal region of the cells. The muscularis of the rectal sac is similar to that of the anterior intestine, but there is a reduction in the number of muscles.

The cells of the rectum (Fig. 13) are taller and wider than those of the anterior intestine and rectal sac. They are approximately 60 micra high and 20 micra wide. These cells appear to be irregularly cuboidal and columnar. The nuclei are oval, lie near the basal end of the cell and are approximately 12 micra tall and 7 micra wide. The longitudinal folds of the rectum are similar to those of the anterior intestine, but they are not as numerous nor do they project as far into the lumen of the rectum as do the folds of the anterior intestine.

The cells of the Malpighian tubules (Fig. 8) are cuboidal and appear to give off secretions of the merocrine type. The nuclei of these cells are oval and are approximately 13 micra in diameter. A basement membrane (bm) is evident and a small striated border (sb) similar to that found in the ventricular epithelial cells is also evident. A nucleated peritoneal sheath (pms) surrounds the tubules and is approximately 4.3 micra thick.

SUMMARY

The alimentary canal of the larval European chafer consists of three anatomically and histologically differentiated areas—the stomodaeum, ventriculus and proctodaeum; the stomodaeum and proctodaeum are ectodermal derivatives of the embryonic blastoderm, while the ventriculus is an endodermal derivative. The stomodaeum consists of the buccal cavity, pharynx, esophagus, and much reduced crop, while the proctodaeum consists of the anterior intestine, rectal sac, and rectum.

The histology of the stomodaeum and proctodaeum is similar, consisting of cuboidal epithelium which secretes a chitinous intima. The epithelium and intima of the stomodaeum and proctodaeum are thrown into approximately six folds which project into the lumen of the canal. This allows for expansion as greater amounts of food are ingested or excreted.

The cells of the rectum appear to be active in the reabsorption of water and utilizable food materials from within the rectal sac.

The Malpighian tubules are of the cryptonephridic type and the tubules may also play an active part in the absorption of water and materials from the rectal sac.

The ventriculus contains two sets of caecal diverticula, ten anterior and four posterior. These may be of some taxonomic value. The histology of the ventriculus appears to be uniform in that it consists of columnar epithelial cells with a striated border. The striated border appears to be analogous both in structure and function to the striated border of vertebrate epithelial cells. The nidi are irregularly arranged along the bases of the ventricular epithelium and they stain darker with hematoxylin than do the nuclei of the ventricular epithelial cells.

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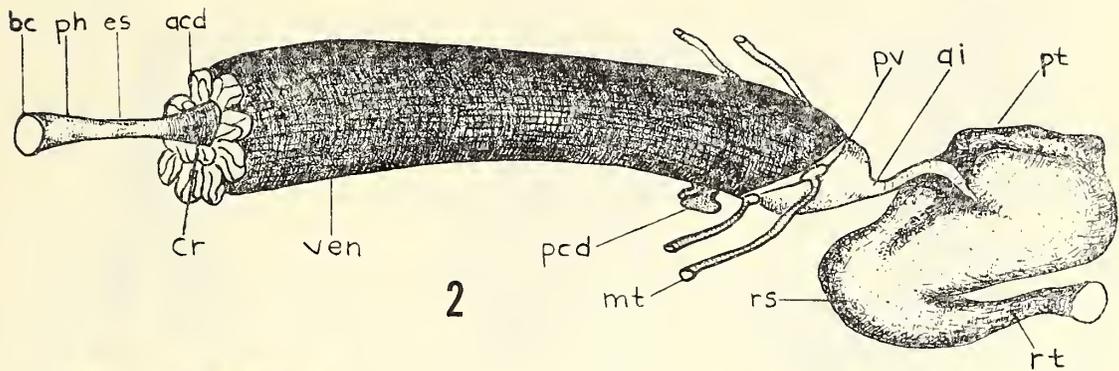
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ABBREVIATIONS

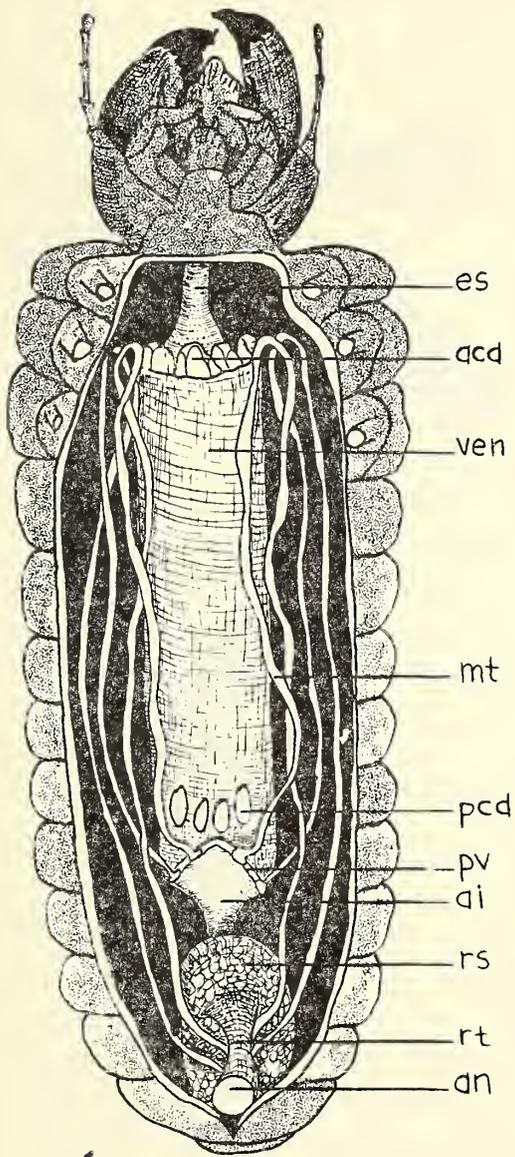
acd—anterior caecal diverticula	p —protozoan
ai —anterior intestine	pcd —posterior caecal diverticula
an —anus	ph —pharynx
bc —buccal cavity	pi —primary intima
bm —basement membrane	pm —peritrophic membrane
cm —circular muscles	pms—peritoneal sheath
cr —crop	pt —posterior intestine
es —esophagus	pv —pyloric valve
esv —esophageal valve	rs —rectal sac
in —intima	rt —rectum
lm —longitudinal muscles	sb —striated border
mt —Malpighian tubules	si —secondary intima
n —nucleus	ven —ventriculus
ni —nidi	

EXPLANATION OF FIGURES

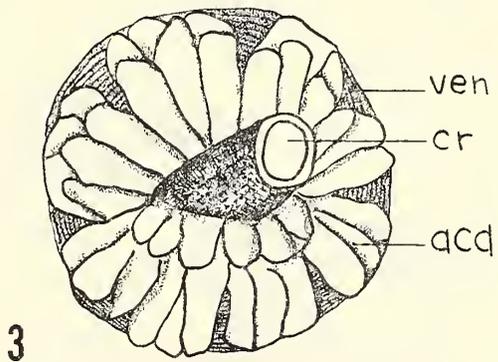
Fig. 1—ventral dissection of third-instar larva showing ventral aspect of alimentary canal; Fig. 2—lateral aspect of complete alimentary canal; Fig. 3—external frontal aspect of ventriculus showing anterior caecal diverticula; Fig. 4—internal frontal aspect of ventriculus showing esophageal valve; Fig. 5—macroscopic sagittal section of ventriculus and anterior intestine showing pyloric valve; Fig. 6—cross-section of stomodaeum; Fig. 7—cross-section of anterior intestine; Fig. 8—longitudinal section of Malpighian tubule; Fig. 9—sagittal section of stomodaeum and ventriculus showing esophageal valve; Fig. 10—sagittal section of ventriculus and anterior intestine showing pyloric valve; Fig. 11—cross-section of ventriculus; Fig. 12—cross-section of rectal sac; Fig. 13—cross-section of rectum.



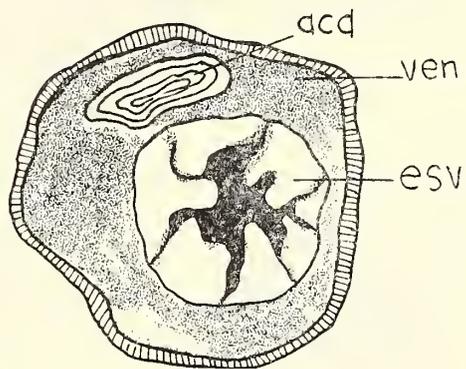
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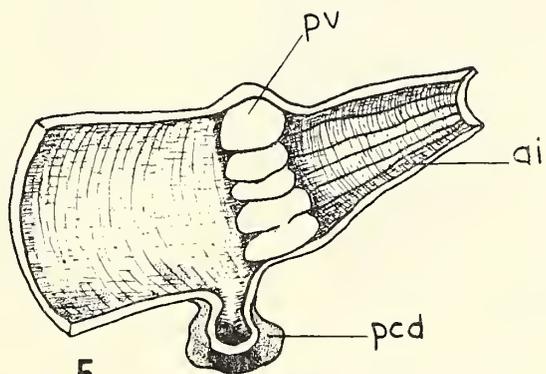
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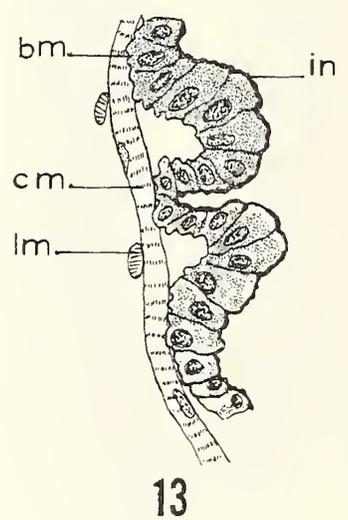
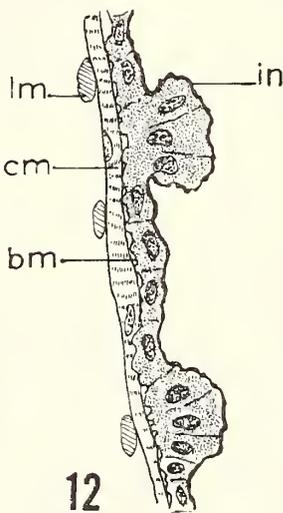
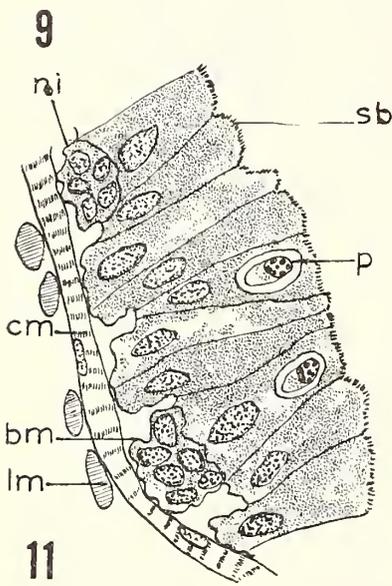
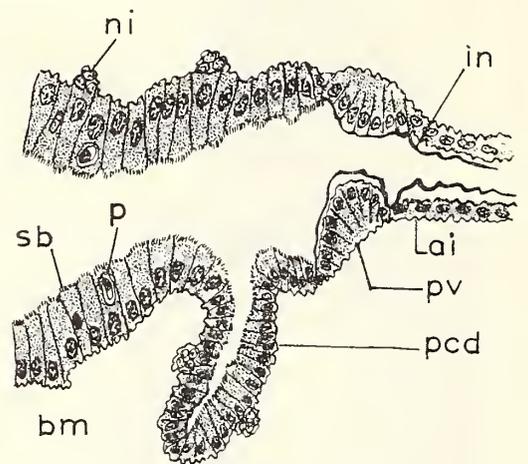
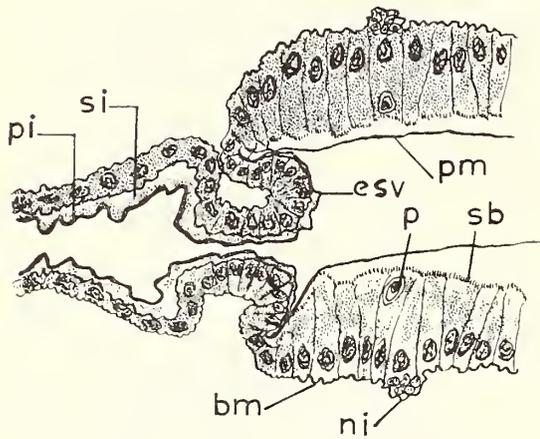
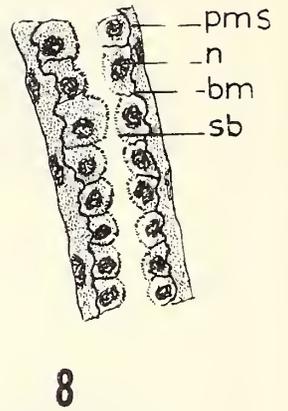
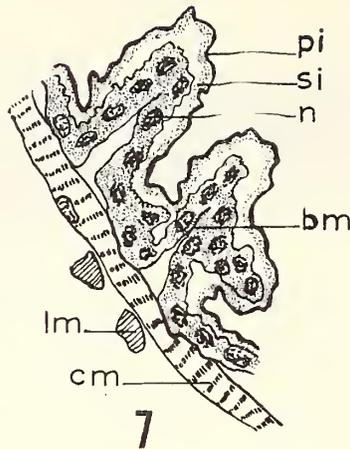
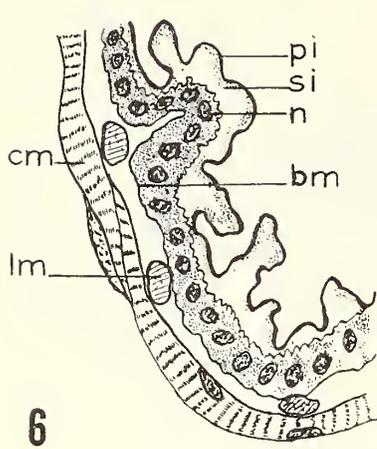
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NOTES ON ARADIDAE FROM THE EASTERN HEMISPHERE XV (HEMIPTERA)*

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Studying further material of Aradidae from the collections of the Hungarian National Museum in Budapest, and the Drake collection, now incorporated into the collections of the U. S. National Museum in Washington, D. C., I found one new genus and a few new species belonging to the subfamily Mezirinae Oshanin.

I express my sincere gratitude to Dr. Eva Halaszfy, curator of the Department of Zoology, Hungarian National Museum, Budapest, and Dr. Carl J. Drake of the U. S. National Museum for the privilege to study their Aradidae.

Subfam. MEZIRINAE Oshanin, 1908.

Tribe Carventini Usinger, 1951.

I. *CARVENTUS* Stal, 1865.

Carventus australis new species

FEMALE. HEAD. Slightly shorter than wide through the eyes (22:25); anterior process robust, anteriorly slightly dilated and bifid, reaches to $\frac{3}{4}$ of the first antennal segment; antenniferous tubercles dentiform, slightly divergent, reach to $\frac{2}{5}$ of the first antennal segment. Antennae one and a half time longer than the head (34:22), finely granulated; the proportions of the antennal segments (1-4) are: 9:6:10:9. Eyes exerted. Vertex with a finely granulated, longitudinal ridge, and laterally of it, on each side, with a very fine, parallel, longitudinal carina. Postero-lateral borders, behind the postocular tubercles, straight and slightly oblique; along them runs from one eye to another a fine, arcuate sulcus. Rostrum does not reach the hind border of the head; rostral groove shallow, posteriorly closed.

PRONOTUM. Shorter than wide across the humeri (29:52), divided into two lobes by a deep, transverse furrow; fore lobe narrower than the hind lobe (42:52); collar neatly separated from the disc; the fore border of the fore lobe deeply emarginate laterally of the collar, there provided with a small tubercle, and on the outer side form two (1+1) small, rounded lobes, directed sideways; the lateral borders deeply and roundly emarginate, terminating with a small tooth just before the interlobal sulcus. Fore disc with a small elevated triangle behind the collar, and with an X-shaped median furrow near the hind border; laterally of it with two (1+1)

* Aradidae from the Oriental and Australian Regions 10.

crescent-shaped ridges. Hind lobe inflated, behind the humeri slightly emarginate; hind border straight before the scutellum, angularly projects backward laterally of it. Hind disc with a small tubercle on the median line, and with a fine transverse furrow along the hind border. (Fig. 1).

SCUTELLUM. Short (14:30); lateral borders convex, tip rounded; disc slightly inflated and coarsely punctured; median carina fine, granulated. Along basal border runs a fine, arcuate sulcus.

HEMELYTRAE. Reach to the middle of tergum VII; corium reaches to the middle of the scutellum; its outer border carinate; membrane large, with obsolete veins.

ABDOMEN. Ovate, longer than wide (72:70), (in this, and all following species, the length of the abdomen was taken on the upper side from the tip of the scutellum to the tip of segment IX). The outer borders of the connexiva II to V scarcely convex; those of VI less, and of VII more convex; postero-exterior angles (PE-angles) of the connexiva II to V slightly protruding, those of VI, and particularly of VII, angularly protruding. Dises of the connexiva scabrous, finely granulated, and with bigger and smaller rounded, callous spots. Venter finely granulated; sterna with inflated posterior borders, and a few rounded callous spots on the dises. Spiracles of segment II ventral, those of III to VII lateral and visible from above, those of the lobes (VIII) terminal (Fig. 2).

LEGS. Inermis.

COLOR. Yellow-brown, mostly covered with whitish incrustation. Two (1+1) callous spots on the fore border of the hind lobe of the pronotum. The median carina of the scutellum, an irregular spot near the middle of the outer border of the hemelytrae, middle and hind acetabula, are piceous. Rostrum and tarsi pale yellow-brown. Membrane yellowish.

FEMALE. Total length 4.7 mm.; width of the pronotum 2.3 mm.; width of the abdomen 2.3 mm. Paratype is smaller: 4.2, 1.5 and 2.0 mm. respectively.

Holotype, Female. Nanango District, Queensland, Australia—H. Hacker collector, Nov. 1937; deposited in the Drake-collection, U. S. National Museum, Washington, D. C., U.S.A.

Paratype, 1 Female. Macay, Queensland, Australia—W. A. McDoogall coll., Aug. 12, 1932, in the collection of the author.

The new species is allied to *Carventus griseolus* (Signoret), 1880, from New Guinea, but differs from it by: the fore lobe of the pronotum is much narrower than the hind lobe; the proportions of the antennal segments are different. The genus *Carventus* was not recorded from Australia.

Among Aradidae from the Hungarian National Museum is one specimen of *Carventus* from Glen Innes, N.S.W., Australia, which represents another species, but as this specimen is without head, I restrain from the description.

II. **DRAKEIDA** new genus

Elongately ovate; most of the head, borders, tubercles or carinae of the pronotum, scutellum, and connexivum, with longer or shorter bristles pasted together with an ivory incrustation, forming brush-shaped palisades, rows or protuberances. Ventral surface with flattened lines or bands of very short bristles covered with ivory incrustation.

HEAD. Shorter than wide through the eyes, mostly covered with erect bristles pasted together with incrustation. Anterior process tiny, as long as antenniferous tubercles; latter short, dentiform, but the cover of incrustation make them look blunt. Eyes small; infraocular carinae heavily incrustated, forming high tubercles; postocular tubercles dentiform, project beyond the outer border of the eyes. Posterior border of the head widely rounded, and carinate. Antennae rather stout; the first segment the stoutest, clavate, and curved outward; the second the smallest; the third the longest, almost twice as long as the second; the fourth pyriform, longer than the first, but shorter than the third. Rostral groove deep, posteriorly closed; rostrum does not reach the hind border of the groove.

PRONOTUM. Transverse, divided into two lobes; fore lobe is lower and narrower than the hind lobe; borders and discs provided with a pattern of higher and lower brush-shaped palisades, rows or protuberances, formed by the pasted together erect bristles. Collar distinct. Fore disc with two (1+1) outer, large and high tubercles, and two (1+1) much smaller and lower tubercles between them. Hind lobe transversely inflated. Lateral borders of both lobes rounded; hind border of the pronotum subtruncate.

SCUTELLUM. Small, triangular, shorter than wide at the base, with high palisades of incrustated bristles on the borders, and obliquely across the disc, leaving a middle cordate, callous spot.

ABDOMEN. Longer than wide; lateral borders parallel, posterior in the female rounded; connexivum with exterior and interior high palisades of pasted together bristles; the connexivum II (the first visible) is twice as long as III. Spiracles of segment II lateral, placed on the top of high tubercles; those of III also lateral, but placed directly on the border; both visible from above. Spiracles of IV to VII ventral, placed close to the lateral margin, but not visible from above; those of the lobes (VIII) terminal.

Venter with transverse and inflated posterior borders of sternum III to VI; sternum VII in the female cut into two lateral, subtriangular plates; genital plates (VIII) touching the hind border of sternum VI; genital lobes divergent, reaching the middle of IX; the latter posteriorly tricuspidate.

LEGS. Femora inermis, but with a fine setigerous granulation; tibiae cylindrical, also with a fine setigerous granulation; fore tibiae on inner side, slightly before the tip, with a fine, curved spur; others inermes. Tarsi without arolia, and with fine claws.

Genotype: *Drakeida incrustata* n. sp.

The new genus is allied to the neotropical genus *Proxius* Stal, 1873, differing from it by: pointed postocular spines; quite different pattern of the incrustated bristles on the head, pronotum, scutellum and abdomen; first two pairs of the spiracles lateral and visible from above, and fore tibiae armed.

It is a pleasure to dedicate this genus to Dr. Carl J. Drake.

Drakeida incrustata n. sp.

FEMALE. HEAD. Much shorter than wide through the eyes (22:32), or across the postocular tubercles (22:35). Anterior process tiny and declivous, reaches to $\frac{1}{4}$ of the first antennal segment. Almost all surface of the head is heavily incrustated, leaving without incrustation only: on the upper side, two (1+1) narrow and deep L-shaped fissures, placed between the median elevation of the vertex and infraocular carinae; on the ventral side, the bases of the antennal tubercles, and rostrum. The proportions of the antennal segments (1 to 4) are: 13(7):8(4 $\frac{1}{2}$):15(4):14(5), the figures between brackets representing the maximal width of the segment.

PRONOTUM. Shorter on median line than wide across the humeri (38:68); fore lobe narrower than the hind lobe (53:68); collar with a fine, transverse carina formed by erect, incrustated bristles; antero-lateral angles rounded and provided with a high, brush-shaped palisade of incrustated bristles; the high outer tubercles of the fore lobe each with an oblique, divergent backward, high palisade of similar bristles; another smaller and lower row is at the inner side of each high palisade; median line with a low incrustated carina running backward to $\frac{1}{3}$ of the hind lobe, where it forms a cross-shaped figure; laterally of the latter are placed two (1+1) very high, erect, curved, incrustated carinae. Inflated hind lobe with a low, transverse, incrustated carina, three times interrupted: on the median line and laterally, where it is crossed by two (1+1) very high, incrustated palisades. Lateral borders of the hind lobe provided with low incrustated carinae; posterior border with a patch of low incrustated bristles in the middle. The surface of the pronotum between the carinae and palisades is naked and shiny.

SCUTELLUM. Shorter than wide at the base (21:35); lateral borders almost straight, the tip pointed (Fig. 3).

ABDOMEN. Longer than wide (102:75). The inner row of the incrustated bristles on the connexiva are higher and wider than the outer rows. The genital lobes are also incrustated (Fig. 4).

COLOR. Yellow-brown; incrustation ivory.

FEMALE. Total length 3.07 mm.; width of the pronotum 1.13 mm.; width of the abdomen 1.27 mm.

Holotype, Female. Mt. Makiling, Luzon, Philippines Republic—Baker coll.; deposited in the Drake-collection, U. S. National Museum, Washington, D. C., U.S.A.

Tribe Mezirini Van Duzee, 1916.

III. *ARTABANUS* Stal, 1865.*Artabanus australis* n. sp.

FEMALE. Closely allied to *Artabanus lativentris* Esaki & Matsuda, 1951, having the same shape of the body and pattern of colors, but is relatively narrower, antennae shorter, less than twice as long as the head (46:25); all femora without bigger spines, only with a few very fine teeth on the inferior side.

BIOMETRICAL MEASURES. Head as long as wide through the eyes (25:25); the proportions of the antennal segments (1 to 4) are: 12:7:17:10; pronotum much shorter than wide across the humeri (27:50); scutellum shorter than wide at the base (20:25); abdomen about as long as wide (64:65).

FEMALE. Total length 6.85 mm.; width of the pronotum 2.50 mm.; width of the abdomen 3.25 mm.

Holotype, Female. Queensland, Australia; deposited in the Hungarian National Museum, Budapest.

IV. *MEZIRA* Amyot & Serville, 1843.*Mezira sulcata* n. sp.

MALE. HEAD. Shorter than wide through the eyes (δ —28:31, ♀ —30:33); anterior process stout, anteriorly slightly emarginate, reaches to $\frac{2}{3}$ of the first antennal segment; antenniferous tubercles stout, dentiform, subparallel, reach to $\frac{1}{3}$ of the first antennal segment. Eyes exerted. Postocular tubercles small, dentiform, do not reach the outer border of the eyes; infraocular carinae high, and narrow. Vertex convex, with a few granules. Antennae stout, less than twice as long as the head (50:28); the proportions of the antennal segments (1 to 4) are: δ —12:13:13:12, ♀ —14:14:14:13. Rostrum reaches to the hind border of the head.

PRONOTUM. Shorter on the median line than wide across the humeri (δ —37:68, ♀ —40:71). Fore lobe separated from the hind lobe by a very deep and narrow, transverse furrow, directed down and forward, so that the hind borders of the four stout ridges of the fore lobe are slightly overhanging the hind lobe. Antero-lateral angles of the fore lobe are slightly expanded and reflexed, evenly rounded. Fore disc with four (2+2) stout, granulated ridges, and with a very deep and narrow median furrow. Hind lobe is much wider than the fore lobe (δ —68:48, ♀ —71:52); lateral borders parallel, anteriorly convergent; hind border deeply, subangularly emarginate; posterior angles angularly projected backward. Disc transversely elevated; laterally, along the humeri, slightly depressed; anteriorly with a few very big granules; posteriorly with a smaller granulation, which is somewhat obliterated in the middle of the disc.

SCUTELLUM. Subtriangular, shorter than wide (δ —30:38, ♀ —35:40); all three borders carinate; disc transversely rugose, and with a narrow median carina; the tip of the scutellum excised.

HEMELYTRAE. Reach to the middle (δ), or to the fore border (♀) of tergum VII; corium granulated, basal costal border of the latter reflexed.

apical border slightly emarginate interiorly, convex exteriorly; apical angle acute, reaches to $\frac{2}{3}$ of connexivum III (the second visible).

ABDOMEN. Longer than wide (δ —97:75, ♀ —110:85); in the male parallel, from segment VI roundly convergent, posteriorly subtruncate, the posterior border of connexivum VII emarginate in the middle. Hypopygium small, subcordate; its disc depressed on each side along the median ridge; lobes (VIII) very small. In the female abdomen is widened till segment VII, then rounded; lobes subtriangular, short; segment IX slightly projected backward. All spiracles ventral, placed far from the lateral borders.

LEGS. Inermis.

COLOR. Dark ferruginous; membrane piceous; rostrum and tarsi yellow-brown.

Total length δ —9.85, ♀ —10.85 mm.; width of the pronotum δ —3.4, ♀ —3.5 mm.; width of the abdomen δ —3.75, ♀ —5.5 mm.

Holotype, Male. New South Wales, Australia; deposited in the Hungarian National Museum, Budapest.

Allotype, Female. Collected with the holotype; in the same collection.

Paratypes, 1 ♂ and 1 ♀ . Queensland, Australia; in the same collection, and in the collection of the author.

New species is somewhat allied to *Mezira membranacea* (F.), 1798, but differs from it by: pronotum very deeply sulcate; hypopygium much smaller, and differently shaped; connexivum VII of the males emarginate; and different color.

V. *CTENONEURUS* Bergroth, 1887.

Ctenoneurus halaszfyi n. sp.

MALE. Elongate, subparallel, slightly widening backward till segment IV, then narrowing.

HEAD. Almost as long as wide through the eyes (23:22) anterior process long and parallel, apically slightly notched, distinctly projecting beyond the tip of the first antennal segment; antenniferous tubercles acute, exteriorly parallel, reach to the basal third of the first antennal segment. Eyes moderately exerted. Postocular tubercles acute, reach to the outer border of the eyes; infraocular carinae fine and low, granulated; vertex convex, finely granulated. Antennae one and a half times as long as the head width through the eyes (34:22); the proportions of the antennal segments (1 to 4) are: 7:7:9:11; the first curved at the base; the second and third tapering toward the base; the fourth fusiform. Rostrum reaches to the base of the head.

PRONOTUM. Rather convex, half as long as wide across the humeri (22:45); the transverse interlobal furrow fine and shallow; anterior border slightly emarginate; collar very fine; antero-lateral borders narrowly expanded; antero-lateral angles slightly projecting forward, rounded; lateral notch almost imperceptible; lateral borders of the fore lobe converging;

those of the hind lobe subparallel; hind border widely and shallowly emarginate. Fore disc evenly convex, with a fine, shallow median furrow; laterally of it with a pattern of fine, concentric rugae; hind disc finely granulated (Fig. 5).

SCUTELLUM. Shorter than wide at the base (23:27); lateral borders rimmed, slightly emarginate, before the apex convex, the tip rounded. Disc granulate, and with a low, transversely rugose, median carina, running from the basal third to the tip of the scutellum.

HEMELYTRAE. Slightly project beyond the fore border of tergum VII; corium finely granulated, its apical border shallowly emarginate; its apical angle acute, reaches to the middle of connexivum III (the second visible); exterior border reflexed at the base.

ABDOMEN. Longer than wide (73:51), parallel, posteriorly rounded; its maximal width across segments III and IV; postero-exterior angles of the connexiva not protruding; discs of the connexiva densely punctured. Hypopygium short and wide (10:16); disc with a badly defined median carina, finely granulated. Venter convex. Spiracles II to VII ventral, placed far from the lateral border; those of the lobes (VIII) lateral and visible from above (Fig. 6).

COLOR. Dark ferrugineous; rostrum and tarsi ochraceous; membrane piceous.

MALE. Total length 7.15 mm.; width of the pronotum 2.25 mm.; width of the abdomen 2.5 mm.

Holotype, Male. Simbang, Huon Golf, New Guinea—Biró coll., 1898; deposited in the Hungarian National Museum, Budapest.

It is a pleasure to dedicate this species to Dr. Eva Halaszfy.

Ctenoneurus halaszfyi n. sp. is allied to *C. hochstetteri* (Mayr), 1866, but differs from it by: body is more parallel; the fore lobe of the pronotum more convex; antennae relatively longer; the apical angle of the corium more acute; hypopygium of the males differently shaped; color is lighter, ferrugineous. *Ctenoneurus* was not recorded from New Guinea.

VI. *NEUROCTENUS* Fieber, 1861.

The genus *Neuroctenus* Fieber, 1861, with almost worldwide distribution, is far less heterogeneous than the genus *Mezira* A.S. Most of its species are very easily distinguished from the latter, though there is a small group of oriental species, which at first sight resemble some species of *Mezira*, and some of which were described in that genus, i.e.: *Neuroctenus ater* (Jakovlev), 1878, *N. castaneus* (Jakovlev), 1878, and *N. confusus* Kormilev, 1955. Now I am able to add to this group two species more, both from New Guinea. These species are isolated in the genus.

Neuroctenus meziroides n. sp.

FEMALE. HEAD. Almost as long as wide through the eyes (22:23); anterior process big, jugae expanded, anteriorly rounded and cleft, project far beyond the tip of the first antennal segment; antenniferous tubercles large, flat, acute, slightly divergent, reach to the middle of the first antennal segment. Antennae slender, one and a half times as long as the head (33:22); the proportions of the segments (1 to 4) are: 8:7:10:8. The first segment short and clavate, the second and third tapering toward the base, the fourth elongately fusiform. Eyes exerted; postocular tubercles acute, slightly project beyond the outer border of the eyes; infraocular carinae fine, granulated; vertex inflated and granulated; lateral shelves depressed, callous. Rostrum short, does not reach the hind border of a wide and deep rostral groove.

PRONOTUM. Less than half as long as wide across the humeri (19:42), divided into two lobes by a distinct, transverse furrow; the fore lobe is narrower than the hind lobe (34:42); fore border truncate; collar very fine, granulated; antero-lateral angles expanded as small rounded lobes; lateral borders subparallel, posteriorly divergent; disc with four (2+2) semiobliterated, and granulated ridges. Hind lobe twice (1+1) depressed on the disc; lateral borders parallel, anteriorly convergent; hind border widely and evenly emarginate (Fig. 7).

SCUTELLUM. Large, triangular, transversely rugose, and with a fine, low median carina; lateral borders straight, carinate, the tip rounded.

HEMELYTRAE. Do not reach the hind border of tergum VI, corium reaches to the first third of connexivum III (the second visible); its outer border narrowly reflexed, does not project beyond the outer border of the abdomen; its apical angle pointed, its apical border twice shallowly emarginate; disc granulated.

ABDOMEN. Ovate, longer than wide across segment IV (67:56). Posterior border of segment VII truncate; lateral borders of the abdomen evenly convex; postero-exterior angles of the connexiva scabrous, each with two rounded, callous spots; disc of tergum VII scabrous, and depressed in the middle. Genital lobes large, triangular, projecting far beyond the tip of segment IX; the tip of IX is shallowly notched, the genital valves being slightly longer than the oviduct (Fig. 8).

COLOR. Uniformly ferruginous; posterior borders of the connexiva, trochanters, tibiae, tarsi and rostrum yellow-brown; membrane brown.

FEMALE. Total length 6.5 mm.; width of the pronotum 2.1 mm.; width of the abdomen 2.8 mm.

Holotype, Female. Sattelberg, Huon Golf, New Guinea—Biró coll., 1898; deposited in the Hungarian National Museum, Budapest.

Neuroctenus luteomarginatus n. sp.

MALE. Smaller and narrower than the preceding species.

HEAD. As long as wide through the eyes (18:18); anterior process slender, tapering to the tip, on the tip slightly notched, reaches to the tip of the first antennal segment; antenniferous tubercles dentiform, acute,

divaricating. Antennae slender, the proportions of the antennal segments (1 to 4) are: 8:7:9:8 (?), the tip of the fourth is broken off one antenna, two apical segments lacking from another. Postocular tubercles acute, reach to the outer border of the eyes; rostrum a little longer than in the preceding species, though also do not reach the hind border of the groove.

PRONOTUM. Less than half as long as wide across the humeri (16:38); fore lobe narrower than the hind lobe (28:37); fore border roundly emarginate; collar thin, but more conspicuous; antero-lateral angles slightly expanded, rounded, and slightly projecting forward; lateral borders subparallel, anteriorly rounded; disc with a narrow median furrow, and four (2+2) low, granulated ridges. Hind disc as in the preceding species (Fig. 9).

SCUTELLUM. Shorter than wide (18:23); lateral borders slightly emarginate before the tip, the tip angular; disc granulated, and with a cross-shaped median ridge.

HEMELYTRAE. Reach to $\frac{2}{3}$ of tergum VII; apical angle of the corium not so acute as in the preceding species; apical border emarginate interiorly; disc granulated.

ABDOMEN. Longer than wide across segment V (56:47); postero-lateral angles of the connexiva II to IV scarcely protruding, those of V and VI slightly protruding, those of VII produced backward as small rounded lobes, reaching to the middle of the hypopygium; hypopygium subcordate, depressed in the middle, rounded posteriorly; lobes (VIII) slender and long, reach to the tip of the hypopygium (Fig. 10).

COLOR. Ferruginous; posterior margins of the connexiva II to VI, tarsi and rostrum, yellow; membrane brownish, with a piceous spot at the first third of the outer border.

Other characters as in the preceding species.

MALE. Total length 5.45 mm.; width of the pronotum 1.85 mm.; width of the abdomen 2.35 mm.

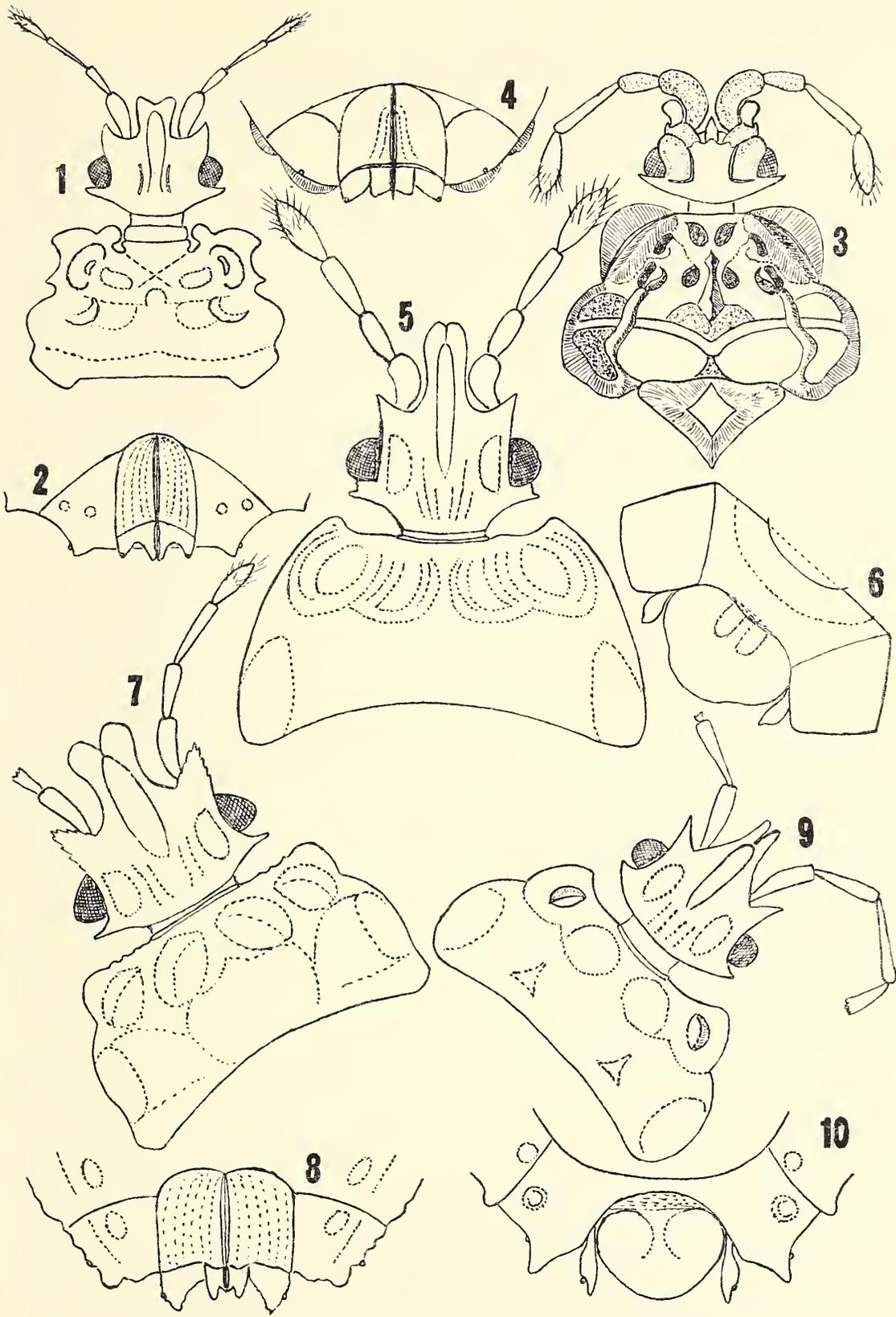
Holotype, Male. Sattelberg, Huon Golf, New Guinea—Biró coll., 1898 deposited in the Hungarian National Museum, Budapest.

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EXPLANATION OF PLATE V

- Fig. 1. *Carventus australis* n. sp., ♀, head and pronotum.
Fig. 2. *Carventus australis* n. sp., ♀, the tip of the abdomen from below.
Fig. 3. *Drakeida incrustata* n. g., n. sp., ♀, head, pronotum and scutellum.
Fig. 4. *Drakeida incrustata* n. g., n. sp., ♀, the tip of the abdomen from below.
Fig. 5. *Ctenoneurus halaszfyi* n. sp., ♂, head and pronotum.
Fig. 6. *Ctenoneurus halaszfyi* n. sp., ♂, the tip of the abdomen from above.
Fig. 7. *Neuroctenus meziroides* n. sp., ♀, head and pronotum.
Fig. 8. *Neuroctenus meziroides* n. sp., ♀, the tip of the abdomen from below.
Fig. 9. *Neuroctenus luteomarginatus* n. sp., ♂, head and pronotum.
Fig. 10. *Neuroctenus luteomarginatus* n. sp., ♂, the tip of the abdomen from above.



THE GENERIC NAME ANETIA HUEBNER (DANAIDAE, RHOPALOCERA)

BY F. M. BROWN AND BERNARD HEINEMAN

While preparing the manuscript for an account of the butterflies of Jamaica, B. W. I., we became aware of confusion about the proper spelling for the name of the danaid butterflies long called *Clothilda*. The first uses of generic names coupled with species now included in the genus are these:

- 1797. *Papilio pantheratus* Martyn
- 1820. *Argynnis briarea* Godart
- [1823]. *Anetia numidia* Hübner
- [1823]. *Anelia numidia* Hübner
- 1840. *Clothilda briarea*, Blanchard
- 1847. *Danais numidia*, Poey
- 1848. *Anicia* (a misspelling), Doubleday
- 1870. *Synalpe euryale* Boisduval

The first two names associated with the species, *Papilio* and *Argynnis*, now are properly associated with species in families of butterflies other than Danaidae. Thus the first available generic names associated with species of the genus are *Anetia* and *Anelia* of Hübner. These he proposed in SAMMLUNG EXOTISCHE SCHMETTERLINGE, volume 2, plates [22] and [23] respectively. The use of *Anetia* for a common Tachinid genus in Diptera long postdates its use in Rhopalocera.

Of the two spellings, *Anetia* and *Anelia*, used by Hübner the former has both page and temporal priority. *Anetia* is used on plate [22] and *Anelia* on plate [23]. *Anetia* was issued in [1823] as Lieferung 114a, and *Anelia* in the same year but at a later date as Lieferung 119a (Hemming, 1937, vol. 1, p. 331).

On plate [22] Hübner presented figures of both surfaces of *Anetia numidia* ♂. On the next plate he figured what he considered the female of that species but used the generic name *Anelia*. We believe that the difference in spelling was an engraver's mistake. Study of the second plate proves that Hübner confused two species and that his figure of the female "*numidia*"

really represents the species named earlier by Martyn, *pantheratus*. Since the two species, *numidia* and *pantheratus*, are congeneric this mishap has little effect upon the problem.

The problem is this: Which of the two spellings used by Huebner [1823] is the correct spelling? With the exception of Kirby (1906 ?), d'Almeida (1939) and de la Torre y Callejas (1952) the spelling *Anelia* has been in vogue. We believe that this has come about because Geyer, who continued the SAMMLUNG after Huebner's death in 1826, used *Anelia* for the figure of his species *thirza* (vol. 3, plate [6], 1833).

When Salvin (1869) reviewed the genus, as *Clothilda*, he followed Geyer and accepted *Anelia* as the proper spelling, but remarked that *Anicia* (*sic*) Huebner had priority over *Anelia* and possibly over *Clothilda* Blanchard. Scudder (1874, p. 112) listed only *Anelia* and designated *numidia* as its type species, stating "Sole species, and therefore type." Kirby (1906 ?) in his edition of the SAMMLUNG used *Anetia* throughout, even on the figures originally designated *Anelia* in the Huebner-Geyer edition. Hemming (*l.c.*, vol. 2, pp. 152-153) accepted *Anelia* and referred *Anetia* to it without explanation.

After careful study of the use of the two spellings we were dissatisfied with the general acceptance of *Anelia* as opposed to *Anetia*. We believe that *Anetia* should be used and base our conclusions upon the listing found in the INDEX SYSTEMATICUS for volume 2 of the original edition of the SAMMLUNG. There on the first of the four unnumbered pages, at the bottom of the left hand column, included under Dryades the last two entries read:

"7 Anetia Numidia (mas) [22]
— — — ead. (foem) [23]"

These pages were published by Geyer in [1 July 1827]—[summer of 1832] according to Hemming (*l.c.*, vol. 1, p. 361). Although published after Huebner's death these pages may have been prepared by him. Apparently Hemming found no conclusive evidence of authorship for them. Whether actually written by Huebner or by Geyer they seem to us to be strong support that *Anetia* is the proper spelling of the name in question.

The problem of type species for both *Anetia* and *Anelia* must be reviewed. In 1869 Salvin designated *eurvale* Klug (= *thirza* Geyer) as the type species of *Anelia*. This designation cannot be

accepted since *thirza* which Geyer placed in *Anelia* was published ten years after the first publication of *Anelia*, and *euryale* Klug was published in 1836, still later. Scudder (1874, p. 112) designated "*Numida (Numidia)*" as the type species of *Anelia*. This falls since the trivial name *numidia* associated with the generic name *Anelia* on plate [23] is a synonym of *pantheratus* Martyn and not the female of *numidia* on plate [22] as assumed by Huebner. We now designate *numidia* ♀ Huebner (= *pantheratus* Martyn) as the type species of *Anelia* since it is the only species associated with that generic name upon its first publication.

D'Almeida (1939, p. 58) was correct when he designated *numidia* ♂ Huebner as figured on plate [22] of the SAMMLUNG EXOTISCHE SCHMETTERLINGE as the type species of *Anetia*. No other species can be considered since *numidia* is the sole species associated with *Anetia* at the time the name was first published.

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AN ANNOTATED LIST OF THE LYCAENIDAE (LEPIDOPTERA, RHOPALOCERA) OF THE WESTERN HEMISPHERE

BY WILLIAM PHILLIPS COMSTOCK AND EDGAR IRVING HUNTINGTON

FOREWORD

When the late William P. Comstock and the writer undertook the rearrangement of the Lycaenidae of the Western Hemisphere in the collection of the American Museum of Natural History, we soon realized that a dependable list would be of great assistance in our work. Accordingly, we proceeded to compile such a list which would include references to the publication in which appeared the original description as well as such subsequent descriptions and figures as might assist in identification. Also included would be the type locality and information as to the collection in which the type was deposited.

In the course of compiling this data we came across many misspellings as well as misidentifications which had been repeated by writers over the years. These errors we attempted to correct as the work proceeded. This necessitated the reading of numerous original descriptions and the comparison with plate figures. Where there were specimens in the Museum collection, they were compared with the original description and figure and so labeled. Fortunately this work had been completed prior to Mr. Comstock's illness in 1950, as his knowledge and attention to detail were indispensable to its proper compilation.

The writer's sincere thanks are due to Mr. F. Martin Brown for having furnished references to descriptions published through 1954. Dr. Frederick H. Rindge of the American Museum of Natural History has rendered great assistance in preparing the data for publication as has Miss Marilyn Badaracco in arranging and typing the manuscript. It is the writer's hope that this list

may be of help to others who may be working in this group of the Lepidoptera.—EDGAR IRVING HUNTINGTON

PART I: GENERA

Agriades Hübner, Jacob

Original Description: 1819, Verzeichniss bekannter Schmettlinge, p. 67, no. 654 (Augsburg).

Genotype: *Agriades orbitulus* Hübner (Not de Prunner), 1819, (= *Papilio glandon* de Prunner, 1798).

Additional References: Scudder, Samuel H., 1875, Proc. Amer. Acad. Arts Sci. Boston., vol. 10, p. 105, no. 38 (Boston, Mass.). (Fixes the generic type.) Hemming, Francis (ed.), 1950, Bull. Zool. Nomen., vol. 4, p. 484; 1954, Intern. Comm. Zool. Nomen., Opinion 270.

Arawacus Kaye, William J.

Original Description: 1904 (June), Trans. Ent. Soc. London, p. 197 (London).

Genotype: *Papilio linus* Roemer (not Sulzer), 1789, (= *aetolus* Sulzer, 1776).

Arcas Swainson, William

Original Description: 1832–1833, Zool. Illus., 2nd Series, Insects, p. 88, pl. 88. (Describes *Arcas* as a subgenus.)

Genotype: *Papilio imperialis* Cramer, 1775.

Note: A monotypic genus.

Argus Boisduval, Jean A.

Original Description: 1832, Icones Hist. Lep. Europe, vol. 1 (5, 6), p. 49 (Paris).

Genotype: *Papilio alcon* Schiffermüller, 1775.

Additional References: Boisduval, Jean A. and John LeConte, 1833, Histoire Générale et Iconographie des Lépidoptères et des Chenilles Américan septentrionale, p. 113 (Paris). (Includes *filenus*, *pseudoptilettes*, *pseudargiolus* and *comyntas*.) Hemming, Francis, 1934, Generic Names Holarctic Butterflies, vol. 1, p. 110 (London). Homonym of *Argus* Bohadsch, 1761.)

Atlides Hübner, Jacob

Original Description: 1819, Verzeichniss bekannter Schmettlinge, p. 80, no. 814 (Augsburg).

Genotype: *Papilio halesus* Cramer, 1777.

Additional Reference: Scudder, Samuel H., 1875, Proc. Amer. Acad. Arts Sci. Boston, vol. 10, p. 124, no. 147 (Boston, Mass.). (Selects generic type.)

Aurotis Dalman, Johann Wilhelm

Original Description: 1816, K. Vetenskaps. Acad. Handl., 1st half, pp. 63, 90 (Stockholm).

Genotype: *Papilio quercus* Linnaeus, 1761.

Additional References: Scudder, Samuel H., 1875, Proc. Amer. Acad. Arts Sci. Boston, vol. 10, p. 124, no. 152 (Boston, Mass.). (Selects *quercus* Linnaeus, 1761, as the generic type.) Hemming, Francis, 1934, Generic

Names Holarctic Butterflies, vol. 1, p. 115, no. 299 (London). (Corrects generic synonymy and makes *Aurotis* a synonym of *Thecla* Fabricius by selecting *betulae* Linnaeus as the genotype.)

Note: Dalman (page 63) gave "Subdiv. I. (*Aurotis*)". This was the first subdivision of his genus *Zephyrus* and its position was that of a subgenus.

Bithys Hübner, Jacob

Original Description: 1818, *Zuträge zur Sammlung exotischer Schmettlinge*, vol. 1, p. 18 (Augsburg).

Genotype: *Rusticus leucophaeus* Hübner, 1818.

Additional Reference: Riley, N. D., 1922, *Jour. Bombay Nat. Hist. Soc.*, vol. 28, p. 466 (Bombay). (Selects the generic type.)

Brangas Hübner, Jacob

Original Description: 1819, *Verzeichniss bekannter Schmettlinge*, p. 80, no. 809 (Augsburg).

Genotype: *Papilio caranus* Cramer, 1780.

Additional Reference: Scudder, Samuel H., 1875, *Proc. Amer. Acad. Arts Sci. Boston*, vol. 10, p. 128, no. 174 (Boston, Mass.). (Selects the generic type.)

Brephidium Scudder, Samuel H.

Original Description: 1876 (May), *Bull. Buffalo Soc. Nat. Sci.*, vol. 3, p. 123 (Buffalo, N. Y.).

Genotype: *Lycaena exilis* Boisduval, 1852.

Bythis Geyer, Carl

Original Description: 1832, *Zuträge zur Sammlung exotischer Schmettlinge*, vol. 4, p. 26 (Augsburg).

Note: Misspelling of *Bithys* Hübner.

Callicista Grote, Augustus R.

Original Description: 1873 (October), *Bull. Buffalo Soc. Nat. Sci.*, vol. 1, p. 178 (Buffalo, N. Y.).

Genotype: *Callicista ocellifera* Grote, 1873.

Callipareus Scudder, Samuel H.

Original Description: 1872, A systematic revision of some of the American Butterflies; with brief notes on those known to occur in Essex County, Mass., p. 30 (Salem, Mass.).

Genotype: *Strymon melinus* Hübner, 1809-1813.

Additional References: Scudder, Samuel H., 1872, *Fourth Ann. Rept. Peabody Acad. Sci. for 1871*, p. 51 (Salem, Mass.). Scudder, Samuel H., 1876 (May), *Bull. Buffalo Soc. Nat. Sci.*, vol. 3, p. 107 (Buffalo, N. Y.). (Says that *Callipareus* Scudder was preoccupied.) Neave, S. A., 1939, *Nomenclator Zool.*, vol. 1, p. 535 (London). (Says *Callipareus* is not a homonym of *Calliparea* Bonaparte, 1851—Aves.)

Callipsyche Scudder, Samuel H.

Original Description: 1876 (May), *Bull. Buffalo Soc. Nat. Sci.*, vol. 3, p. 106 (Buffalo, N. Y.).

Genotype: *Thecla behrii* Edwards, 1870.

Callophrys Billberg, Gustav Johann

Original Description: 1820, *Enumeratio Insectorum*, p. 80 (Stockholm).

Genotype: *Papilio rubi* Linnaeus, 1761.

Additional Reference: Scudder, Samuel H., 1875, *Proc. Amer. Acad. Arts Sci. Boston*, vol. 10, p. 132, no. 202 (Boston, Mass.). (Selects generic type.)

Calycopis Scudder, Samuel H.

Original Description: 1876 (May), *Bull. Buffalo Soc. Nat. Sci.*, vol. 3, p. 108 (Buffalo, N. Y.).

Genotype: *Rusticus armatus poeas* Hübner, 1811.

Celastrina Tutt, J. W.

Original Description: 1906, *Ent. Record*, vol. 18, p. 131 (London).

Genotype: *Papilio argiolus* Linnaeus, 1761.

Chalceria Scudder, Samuel H.

Original Description: 1876 (May), *Bull. Buffalo Soc. Nat. Sci.*, vol. 3, p. 125 (Buffalo, N. Y.).

Genotype: *Chrysophanus rubidus* Behr, 1866.

Chalybs Hübner, Jacob

Original Description: 1819, *Verzeichniss bekannter Schmettlinge*, p. 76, no. 759 (Augsburg).

Genotype: *Papilio janius* Cramer, 1779.

Additional Reference: Scudder, Samuel H., 1875, *Proc. Amer. Acad. Arts Sci. Boston*, vol. 10, p. 139, no. 244 (Boston, Mass.). (Selects generic type.)

Chilades Moore, Frederic

Original Description: 1880-1881, *Lepidoptera of Ceylon*, vol. 1, p. 76 (London).

Genotype: *Papilio laius* Cramer, 1782.

Additional Reference: Kaye, William James, 1921 (December), *Memoirs Dept. Agr. Trinidad and Tobago*, no. 2, p. 88 (Trinidad, B. W. I.). (Places *hanno* Stoll in this genus.)

Chrysophanus Hübner, Jacob

Original Description: 1818, *Zuträge zur Sammlung exotischer Schmettlinge*, vol. 1, p. 24, no. 68 (Augsburg).

Genotype: *Rusticus mopsus* Hübner, 1809-1813.

Additional References: Riley, N. D., 1922, *Jour. Bombay Nat. Hist. Soc.*, vol. 28, p. 467 (Bombay). (Selects generic type.) Hemming, Francis, 1934, *Generic Names Holarctic Butterflies*, vol. 1, p. 119, no. 305 (London). (Corrects the synonymy.)

Cupido Schrank, Franz von Paula von

Original Description: 1801-1803, *Fauna Boica*, vol. 2, (1), pp. 153, 206 (Ingolstadt).

Genotype: *Cupido puer* Schrank ♀, 1801 (= *Papilio minimus* Fuessly, 1775).

Cyaniris Dalman, Johann Wilhelm

Original Description: 1816, *K. Vetenskaps. Acad. Handl.*, 1st half, pp. 63, 94 (Stockholm).

Genotype: *Papilio argiolus* Linnaeus, 1761.

Additional References: Scudder, Samuel H., 1872, A systematic revision of some of the American Butterflies; with brief notes on those known to occur in Essex County, Mass., p. 34 (Salem, Mass.). (Selects generic type.) Hemming, Francis, 1934, Generic Names Holarctic Butterflies, vol. 1, p. 110 (London). (Erroneously states that *Cyaniris* is a monotypic genus and selects *Zephyrus argianus* Dalman, 1816 (= *Papilio semiargus* Rottenburg, 1775) as the genotype.)

Note: Dalman (page 63) gave "Subdiv. III. (*Cyaniris*)". This was the third subdivision of his genus *Zephyrus* and its position was that of a subgenus.

Cyclargus Nabokov, V.

Original Description: 1945, *Psyche*, vol. 52, p. 14 (Cambridge, Mass.).

Genotype: *Lycaena ammon* Lucas, 1857.

Cygnus Hübner, Jacob

Original Description: 1819, *Verzeichniss bekannter Schmettlinge*, p. 81, no. 820 (Augsburg).

Genotype: *Papilio phaleros* Linnaeus, 1767.

Additional Reference: Scudder, Samuel, H., 1875, *Proc. Amer. Acad. Arts Sci. Boston*, vol. 10, p. 151, no. 309 (Boston, Mass.). (Selects the generic type.)

Dipsas Westwood, John Obadiah

Original Description: 1852, *Genera of Diurnal Lepidoptera*, vol. 2, p. 479.

Genotype: *Thecla syla* Kollar, 1844.

Additional Reference: Hemming, Francis, 1934, *Generic Names Holarctic Butterflies*, vol. 1, p. 116, no. 302 (London). (Points out that the name is a homonym of *Dipsas Laurenti*, 1768 in *Reptilia* and that the genotype *syla* is congeneric with *betulae* Linnaeus.)

Dolymorpha Holland, William J.

Original Description: 1931, *The Butterfly Book* (revised ed.), p. 228 (Garden City, N. Y.).

Genotype: *Thecla jada* Hewitson, 1869.

Echinargus Nabokov, V.

Original Description: 1945, *Psyche*, vol. 52, p. 27 (Cambridge, Mass.).

Genotype: *Lycaena isola* Reakirt, 1866.

Endymion Swainson, William

Original Description: 1832-1833, *Zool. Illus.*, 2nd Series, Insects, p. 85, pl. 85 (London); describes *Endymion* as a subgenus.

Genotype: *Papilio regalis* Cramer, 1775.

Note: A monotypic genus.

Epidemia Scudder, Samuel H.

Original Description: 1876 (May), *Bull. Buffalo Soc. Nat. Sci.*, vol. 3, p. 127 (Buffalo, N. Y.).

Genotype: *Polyommatus epixanthe* Boisduval and LeConte, 1833.

Erora Scudder, Samuel H.

Original Description: 1872, A systematic revision of some of the Ameri-

can Butterflies; with brief notes on those known to occur in Essex County, Mass., p. 32 (Salem, Mass.).

Genotype: *Thecla laeta* Edwards, 1862.

Additional Reference: Scudder, Samuel H., 1872, Fourth Ann. Rept. Peabody Acad. Sci. for 1871, p. 53 (Salem, Mass.).

Eucharia Boisduval, Jean A.

Original Description: 1870, Considérations sur des Lépidoptères Envoyés du Guatemala à M. de l'Orza, p. 14 (Rennes).

Genotype: None selected. Names mentioned; *ganymedes*, *imperialis* and *regalis*.

Note: The name is preoccupied by *Eucharia* Hübner, 1820, Verzeichniss bekannter Schmettlinge, p. 181, no. 1865 (Augsburg).

Eumaeus Hübner, Jacob

Original Description: 1819, Verzeichniss bekannter Schmettlinge, p. 67, no. 643 (Augsburg).

Genotype: *Eumaeus minyas* Hübner, 1819 (= *Rusticus adolescens minijas* Hübner, 1809).

Eumenia Godart, Jean B.

Original Description: 1823, Encyclopédie Méthodique, vol. 9, Supplement p. 826 (Paris).

Genotype: *Eumenia toxea* Godart, 1823 (= *minijas* Hübner).

Eupsyche Scudder, Samuel H.

Original Description: 1876 (May), Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 112 (Buffalo, N. Y.).

Genotype: *Thecla m-album* Boisduval and LeConte, 1833.

Evenus Hübner, Jacob

Original Description: 1819, Verzeichniss bekannter Schmettlinge, p. 78, no. 783 (Augsburg).

Genotype: *Papilio regalis* Cramer, 1775.

Additional Reference: Scudder, Samuel H., 1875, Proc. Amer. Acad. Arts Sci. Boston, vol. 10, p. 176, no. 456 (Salem, Mass.). (Selects the generic type.)

Everes Hübner, Jacob

Original Description: 1819, Verzeichniss bekannter Schmettlinge, p. 69 (Augsburg).

Genotype: *Papilio amyntas* Schiffermüller and Denis, 1775 (= *Papilio argiades* Pallas, 1771).

Additional References: Scudder, Samuel H., 1872, Fourth Ann. Rept. Peabody Acad. Sci. for 1871, p. 56 (Salem, Mass.). (Selects *amyntas* Fabricius as the generic type.) Hemming, Francis, 1934, Generic Names Holarctic Butterflies, vol. 1, p. 106 (London). (Corrects the generic synonymy.)

Fenisecca Grote, Augustus R.

Original Description: 1869 (April), Trans. Amer. Ent. Soc., vol. 2, p. 307 (Philadelphia, Pa.).

Genotype: *Hesperia tarquinius* Fabricius, 1793.

Gaeides Scudder, Samuel H.

Original Description: 1876 (May), Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 126 (Buffalo, N. Y.).

Genotype: *Chrysophanus dione* Scudder, 1868.

Glaucopsyche Scudder, Samuel H.

Original Description: 1872, A systematic revision of some of the American Butterflies; with brief notes on those known to occur in Essex County, Mass., p. 33 (Salem, Mass.).

Genotype: *Lycaena lygdarnus*, 1872 (= *lygdamus* Doubleday, 1841).

Additional Reference: Scudder, Samuel H., 1872, Fourth Ann. Rept. Peabody Acad. Sci. for 1871, p. 54 (Salem, Mass.).

Habrodais Scudder, Samuel H.

Original Description: 1876 (May), Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 113 (Buffalo, N. Y.).

Genotype: *Thecla grunus* Boisduval, 1852.

Habrodias Dyar, Harrison G. (Not Scudder)

Original Description: "1902" [1903], Bull. U. S. Natl. Mus., no. 52, p. 35.

Note: Misspelling of *Habrodais* Scudder.

Hemiargus Hübner, Jacob

Original Description: 1818, Zuträge zur Sammlung exotischer Schmetlinge, vol. 1, p. 19, no. 50 (Augsburg).

Genotype: *Hemiargus antibubastus* Hübner, 1818 (= *Papilio hanno* Stoll, 1790).

Additional References: Scudder, Samuel H., 1875, Proc. Amer. Acad. Arts Sci. Boston, vol. 10, p. 186 (Boston, Mass.). (Selects the generic type.) Nabokov, V., 1945, Psyche, vol. 52, p. 20 (Cambridge, Mass.).

Heodes Dalman, Johann Wilhelm

Original Description: 1816, K. Vetenskaps. Acad. Handl., 1st half, pp. 63, 91 (Stockholm).

Genotype: *Papilio phlaeas* Linnaeus, 1761.

Additional References: Scudder, Samuel H., 1875, Proc. Amer. Acad. Arts Sci. Boston, vol. 10, p. 187, no. 516 (Boston, Mass.). (Selects the generic type.) Hemming, Francis, 1934, Generic Names Holarctic Butterflies, vol. 1, p. 112, no. 287 (London). (Erroneously selects *Papilio virgaureae* Linnaeus, 1758, as the generic type.)

Note: Dalman (page 63) gave "Subdiv. II. (*Heodes*)". This was the second subdivision of his genus *Zephyrus* and its position was that of a subgenus.

Holochila Felder, Cajetan

Original Description: 1862, Verh. Zool.-bot. Ges., vol. 12, p. 490 Wien.

Genotype: *Holochila absimilis* Felder and Felder, 1862.

Hypaurotis Scudder, Samuel H.

Original Description: 1876 (May), Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 112 (Buffalo, N. Y.).

Genotype: *Thecla chrysalus* Edwards, 1873.

Hyrcus Kaye, William J. (not Hübner)

Original Description: 1921 (December), Memoirs Dept. Agr. Trinidad and Tobago, no. 2, p. 90 (Trinidad, B. W. I.).

Note: Misspelling of *Hyrcus* Hübner.

Hyrcus Hübner, Jacob

Original Description: 1819, Verzeichniss bekannter Schmettlinge, p. 70, no. 692 (Augsburg).

Genotype:

Additional Reference: Scudder, Samuel H., 1875, Proc. Amer. Acad. Arts Sci. Boston, vol. 10, p. 195, no. 558 (Boston, Mass.). (Remarks that the name is preoccupied in birds.)

Note: Hübner gave *lingeus* Cramer, *ericus* Fabricius, *palemon* Cramer, *misenes* Cramer from which a generic type may be selected.

Iaspis Kaye, William J.

Original Description: 1904 June, Trans. Ent. Soc. London, p. 196 (London).

Genotype: *Thecla temesa* Hewitson, 1868.

Icaricia Nabokov, V.

Original Description: 1945 (February), Psyche, vol. 51, p. 104 (Cambridge, Mass.).

Genotype: *Lycaena icarioides* Boisduval, 1852.

Incisalia Scudder, Samuel H. (not Minot MS.)

Original Description: 1872, A systematic revision of some of the American Butterflies; with brief notes on those known to occur in Essex County, Mass., p. 31 (Salem, Mass.). (Selects generic type.)

Genotype: *Licus nippon* Hübner.

Additional Reference: Scudder, Samuel H., 1872, Fourth Ann. Rept. Peabody Acad. Sci. for 1871, p. 52 (Salem, Mass.).

Iophanus Draudt, Max

Original Description: 1920 (December), The Macrolepidoptera of the World, vol. 5, p. 814 (Stuttgart).

Genotype: *Chrysophanus pyrrhias* Godman and Salvin, 1887.

Note: Monotypic genus.

Ipidecla Dyar, Harrison, G.

Original Description: 1917, Proc. U. S. Natl. Mus., vol. 51, p. 1 (Washington, D. C.).

Genotype: *Ipidecla miadora* Dyar, 1917.

Additional References: Draudt, Max, 1921 (January), The Macrolepidoptera of the World, vol. 5, p. 824 (Stuttgart). (Places *Ipidecla* in the Lycaenidae.) Stichel, H., 1930, Lepidopterorum Catalogus (Riodinidae), vol. 26, pt. 41, p. 595 (Berlin).

Note: Dyar described the genus in the Riodinidae.

Itylos Draudt, Max

Original Description: 1921 (January), The Macrolepidoptera of the World, vol. 5, p. 821 (Stuttgart).

Genotype: *Cupido speciosa* Staudinger, 1894.

Additional References: Hemming, Francis, 1929, *Ann. and Mag. Nat. Hist.*, vol. 3, p. 240 (London). (Selects *Cupido speciosa* Staudinger, 1894 as the generic type.) Nabokov, V., 1945, *Psyche*, vol. 52, p. 38 (Cambridge, Mass.). (Revised the genus *Itylos* and selects *Cupido moza* Staudinger, 1894 as the genotype.)

Note: The selection by Nabokov would seem unjustified as it is predicated on page preference in a publication issued on a single date.

Jaspis Draudt, Max (See *Iaspis* Kaye)

Original Description: Draudt, Max, 1919 (December), *The Macrolepidoptera of the World*, vol. 5, p. 763 (Stuttgart).

Lampides Hübner, Jacob

Original Description: 1819, *Verzeichniss bekannter Schmettlinge*, p. 70, no. 683 (Augsburg).

Genotype: *Lampides zethus* Hübner, 1819.

Additional Reference: Hemming, Francis, 1934, *Generic Names Holarctic Butterflies*, vol. 1, p. 105 (London).

Lamprospilus Geyer, Carl

Original Description: 1832, *Zuträge zur Sammlung exotischer Schmettlinge*, vol. 4, p. 30 (Augsburg).

Genotype: *Lamprospilus genius* Geyer, 1832.

Leptodes Barnes, William J. and James H. McDunnough (not Scudder)

Original Description: 1912 (July), *Contributions to the natural history of the Lepidoptera of North America*, vol. 1, no. 6, p. 9 (Decatur, Ill.).

Note: Misspelling of *Leptotes*.

Leptotes Scudder, Samuel H.

Original Description: 1876 (May), *Bull. Buffalo Soc. Nat. Sci.*, vol. 3, p. 124 (Buffalo, N. Y.).

Genotype: *Lycaena theonus* Lucas, 1857.

Licus Hübner, Jacob (See *Lycus* Hübner)

Original Description: 1823, *Zuträge zur Sammlung exotischer Schmettlinge*, vol. 2, p. 7, no. 102 (Augsburg).

Genotype: *Papilio rubi* Linnaeus, 1761.

Lycaeides Hübner, Jacob

Original Description: 1819, *Verzeichniss bekannter Schmettlinge*, p. 69 (Augsburg).

Genotype: *Lycaeides argus* Hübner, 1819 (not Linnaeus) (= *Papilio argyrognomon* Bergstrasser, 1779).

Additional References: Scudder, Samuel H., 1872, *Fourth Ann. Rept. Peabody Acad. Sci.* for 1871, p. 54 (Salem, Mass.). (Fixes the generic type as *argus* Linnaeus.) Hemming, Francis, 1934, *Generic Names Holarctic Butterflies*, vol. 1, p. 107 (London). (Corrects the synonymy.); 1950, *Bull. Zool. Nomen.*, vol. 4, pp. 479, 484; 1954, *Opinion 270, Intern. Comm. Zool. Nomen.*

Lycaena Fabricius, Johann Christian

Original Description: 1807, *Systema Glossatorum*, p. ix (Brunswick).

Genotype: *Papilio phlaeas* Linnaeus, 1761.

Additional References: Illiger, Johann Carl Wilhelm, 1807, *Magazin für Insektenkunde*, vol. 6, p. 285, no. 32 (Brunswick). Curtis, John, 1828, *British Ent.*, vol. 5, pl. 12 (London). (Fixes the generic type.) Hemming, Francis, 1934, *Generic Names Holarctic Butterflies*, vol. 1, p. 111 (London). (Corrects the generic synonymy.)

Lycaenopsis Felder, Cajetan and Rudolf Felder

Original Description: 1864–1867, *Reise der Osterreichischen Fregatte "Novara" um die Erde*, vol. 2, p. 257, no. 303, pl. 32, figs. 10, 11 (Wien).

Genotype: *Lycaenopsis ananga* Felder and Felder, 1865.

Note: Monotypic genus.

Lycus Hübner, Jacob

Original Description: 1819, *Verzeichniss bekannter Schmettlinge*, p. 74, no. 730 (Augsburg).

Genotype: *Papilio rubi* Linnaeus, 1761.

Additional Reference: Scudder, Samuel H., 1875, *Proc. Amer. Acad. Arts Sci. Boston*, vol. 10, p. 210, no. 651 (Boston, Mass.). (Says name is preoccupied in Coleoptera.)

Macusia Kaye, William J.

Original Description: 1904 (June), *Trans. Ent. Soc. London*, p. 198 (London).

Genotype: *Thecla satyroides* Hewitson, 1869.

Micandra Schatz, Ernst

Original Description: 1892, *Familien und Gattungen der Tagfalter*, p. 265, pl. 46 (Bayern).

Genotype: *Thecla platyptera* Felder, 1864–1867.

Miltoura Wright, W. S.

Original Description: 1922 (October), *Bull. So. Calif. Acad. Sci.*, vol. 21, no. 2, p. 19 (Los Angeles, Calif.).

Genotype: *Miltoura spinetorum cuyamaca*, 1922.

Note: Misspelling of *Mitoura* Scudder.

Mithras Hübner, Jacob

Original Description: 1819, *Verzeichniss bekannter Schmettlinge*, p. 79, no. 802 (Augsburg).

Genotype: *Papilio nautes* Cramer, 1779.

Additional Reference: Scudder, Samuel H., 1875, *Proc. Amer. Acad. Arts Sci. Boston*, vol. 10, p. 220, no. 704 (Boston, Mass.). (Selects the generic type.)

Mitoura Scudder, Samuel H.

Original Description: 1872, *Fourth Ann. Rept. Peabody Acad. Sci. for 1871*, errata following p. 24 (Salem, Mass.).

Genotype: *Papilio damon* Cramer, 1784.

Mitouri Scudder, Samuel H.

Original Description: 1872, *A systematic revision of some of the Amer-*

can Butterflies; with brief notes on those known to occur in Essex County, Mass., p. 31 (Salem, Mass.).

Genotype: *Thecla smilacis* Boisduval and LeConte, 1833.

Additional Reference: Scudder, Samuel H., 1872, Fourth Ann. Rept. Peabody Acad. Sci. for 1871, p. 52 and errata (Salem, Mass.).

Note: Misspelling of *Mitoura* Scudder.

Mitura Kirby, W. F.

Original Description: 1872, Zool. Record, vol. 9, p. 350 (London), 1874.

Note: Misspelling of *Mitoura* Scudder.

Molus Hübner, Jacob

Original Description: 1819, Verzeichniss bekannter Schmettlinge, p. 78, no. 791 (Augsburg).

Genotype: *Papilio phalanthus* Cramer, 1780.

Additional Reference: Scudder, Samuel H., 1875, Proc. Amer. Acad. Arts Sci. Boston, vol. 10, p. 220, no. 708 (Boston, Mass.). (Selects the generic type.)

Nomiades Hübner, Jacob

Original Description: 1819, Verzeichniss bekannter Schmettlinge, p. 67, no. 644 (Augsburg).

Genotype: *Papilio acis* Schiffermüller and Denis, 1775 (= *Papilio semiargus* Rottemburg, 1775).

Additional References: Scudder, Samuel H., 1875, Proc. Amer. Acad. Arts Sci. Boston, vol. 10, p. 228, no. 753 (Boston, Mass.). (Fixes the generic type.) Hemming, Francis, 1934, Generic Names Holarctic Butterflies, vol. 1, p. 110, no. 281 (London). (Makes *Nomiades* a synonym of *Cyaniris* Dalman.)

Oenomaus Hübner, Jacob

Original Description: 1819, Verzeichniss bekannter Schmettlinge, p. 76, no. 767 (Augsburg).

Genotype: *Papilio ortygnus* Cramer, 1779.

Additional Reference: Scudder, Samuel H., 1875, Proc. Amer. Acad. Arts Sci. Boston, vol. 10, p. 231, no. 765 (Boston, Mass.). (Fixes the generic type.)

Olynthus Hübner, Jacob

Original Description: 1819, Verzeichniss bekannter Schmettlinge, p. 80, no. 807 (Augsburg).

Genotype: *Papilio narbal* Stoll, 1790.

Additional Reference: Scudder, Samuel H., 1875, Proc. Amer. Acad. Arts Sci. Boston, vol. 10, p. 232, no. 771 (Boston, Mass.). (Fixes the generic type.)

Paiwarria Kaye, William J.

Original Description: 1904 (June), Trans. Ent. Soc. London, p. 199 (London).

Genotype: *Papilio venulius* Cramer, 1779.

Panthiades Hübner, Jacob

Original Description: 1819, Verzeichniss bekannter Schmettlinge, p. 79, no. 794 (Augsburg).

Genotype: *Papilio pelion* Cramer, 1775.

Additional Reference: Scudder, Samuel H., 1875, Proc. Amer. Acad. Arts Sci. Boston, vol. 10, p. 237, no. 801 (Boston, Mass.). (Says that sole species is generic type.)

Parachilades Nabokov, V.

Original Description: 1945, Psyche, vol. 52, p. 7 (Cambridge, Mass.).

Genotype: *Lycaena titicaca* Weymer, 1890.

Paralycaeides Nabokov, V.

Original Description: 1945, Psyche, vol. 52, p. 36 (Cambridge, Mass.).

Genotype: *Itylos inconspicua* Draudt, 1921.

Parrhasius Hübner, Jacob

Original Description: 1819, Verzeichniss bekannter Schmettlinge, p. 79, no. 796 (Augsburg).

Genotype: *Papilio polibetes* Cramer, 1781.

Additional Reference: Scudder, Samuel H., 1875, Proc. Amer. Acad. Arts Sci. Boston, vol. 10, p. 242, no. 815 (Boston, Mass.). (Fixes the generic type.)

Phaedrotes Scudder, Samuel H.

Original Description: 1876 (May), Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 115 (Buffalo, N. Y.).

Genotype: *Lycaena catalina* Reakirt, 1866.

Philotes Scudder, Samuel H.

Original Description: 1876 (May), Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 116 (Buffalo, N. Y.).

Genotype: *Lycaena regia* Boisduval, 1869.

Plebeius Kirby, William F. (see *Plebejus* Kluk)

Original Description: 1871, A Synonymic Catalogue of Diurnal Lepidoptera, p. 653. (London).

Genotype:

Additional Reference: Hemming, Francis, 1934, Generic Names Holarctic Butterflies, vol. 1, p. 107 (London). (Says that the name was both a homonym and synonym of *Plebejus* Kluk.)

Plebejus Kluk, Krzystof

Original Description: 1780, Historyja naturalna zwierzat domowych idzikich osobliwie krajowych, vol. 4, p. 89 (Warszawa).

Genotype: *Papilio argus* Linnaeus, 1758.

Additional References: Hemming, Francis, 1933, Entomologist, vol. 66, p. 224 (London). (Selects the generic type *argus*, no. 15 of Kluk's list.); 1934, Generic Names of Holarctic Butterflies, vol. 1, p. 106 (London); 1950, Bull. Zool. Nomen., vol. 4, p. 495; 1954, Intern. Comm. Zool. Nomen., Opinion 278. Paelt, J., 1955 (September), Beitr. Ent. Deutsches Ent. Institut Berlin, pp. 428-431.

Plebulina Nabokov, V.

Original Description: 1945 (February), Psyche, vol. 51, p. 104 (Cambridge, Mass.), (1944).

Genotype: *Lycaena emigdionis* Grinnell, 1905.

Polyniphes Kaye, William J.

Original Description: 1904 (June), Trans. Ent. Soc. London, p. 191 (London).

Genotype: *Polyommatus dumenilii* Godart, 1822.

Polyommatus Latreille, Pierre André

Original Description: 1804, Nouveau Dictionnaire d'Histoire Naturelle, vol. 24 (Tab.), pp. 185, 200 (Paris).

Genotype: *Papilio icarus* Rottemburg, 1775.

Additional References: Hemming, Francis, 1934, Generic Names Holarctic Butterflies, vol. 1, p. 109 (London). (Discusses the synonymy.) 1946, Internatl. Comm. Zool. Nomenclature, Opinion 175 (London). (Designates the generic type as *icarus* Rottemburg.); 1950, Bull. Zool. Nomen., vol. 4, p. 484; 1954, Intern. Comm. Zool. Nomen., Opinion 270.

Pseudochrysops Nabokov, V.

Original Description: 1945, Psyche, vol. 52, p. 12 (Cambridge, Mass.).

Genotype: *Hemiargus bornei* Comstock and Huntington, 1943.

Pseudolucia Nabokov, V.

Original Description: 1945, Psyche, vol. 52, p. 32 (Cambridge, Mass.).

Genotype: *Lycaena chilensis* Blanchard, 1852.

Pseudolycaena Wallengren, H. D. J.

Original Description: 1859, Ofversigt Kongl. Vetenskaps. Akad. Forhandlingar, vol. 15, p. 80 (Stockholm).

Genotype: *Papilio marsyas* Linnaeus, 1758.

Additional Reference: Scudder, Samuel H., 1875, Proc. Amer. Acad. Arts Sci. Boston, vol. 10, p. 259, no. 914 (Boston, Mass.). (Says it is sole species and generic type.)

Pseudothecla Nabokov, V.

Original Description: 1945, Psyche, vol. 52, p. 11 (Cambridge, Mass.).

Genotype: *Thecla faga* Dognin, 1895.

Rekoa Kaye, William J.

Original Description: 1904 (June), Trans. Ent. Soc. London, p. 198 (London).

Genotype: *Papilio meton* Cramer, 1779.

Rumicia Tutt, J. W.

Original Description: 1906, Ent. Record, vol. 18, p. 131 (London).

Genotype: *Papilio phlaeas* Linnaeus, 1761.

Ruralis Tutt, J. W.

Original Description: 1906, Ent. Record, vol. 18, p. 130 (London).

Genotype: *Papilio betulae* Linnaeus, 1758.

Additional Reference: Hemming, Francis, 1934, Generic Names Holarctic Butterflies, vol. 1, p. 115, no. 301 (London). (Discusses the synonymy.)

Rusticus Hübner, Jacob

Original Description: 1807, Sammlung exotischer Schmettlinge, vol. 1, pls. 102, 104 (Augsburg).

Genotype: *Papilio gnidus* Fabricius, 1787.

Additional Reference: Hemming, Francis, 1934, *Generic Names Holarctic Butterflies*, vol. 1, p. 98 (London). (Selects *gnidus* as the generic type.)

Note: As *gnidus* is congeneric with *cupido* Linnaeus, the generic type of *Helicopsis* Fabricius, the generic name *Rusticus* is not required.

Satyrium Scudder, Samuel H.

Original Description: 1876 (May), *Bull. Buffalo Soc. Nat. Sci.*, vol. 3, p. 106 (Buffalo, N. Y.).

Genotype: *Lycaena fuliginosa* Edwards, 1861.

Scolitantides Hübner, Jacob

Original Description: 1819, *Verzeichniss bekannter Schmettlinge*, p. 98, no. 668 (Augsburg).

Genotype: *Papilio battus* Schiffermüller, 1775 (= *Papilio orion* Pallas, 1771).

Additional References: Tutt, J. W., 1906, *Ent. Record*, vol. 18, p. 131 (London). (Fixes the generic type.) Hemming, Francis, 1934, *Generic Names Holarctic Butterflies*, vol. 1, p. 110 (London).

Siderus Kaye, William J.

Original Description: 1904 (June), *Trans. Ent. Soc. London*, p. 195 (London).

Genotype: *Siderus parvinotus* Kaye, 1904.

Strymon Hübner, Jacob

Original Description: 1818, *Zuträge zur Sammlung exotischer Schmettlinge*, vol. 1, p. 22 (Augsburg).

Genotype: *Rusticus melinus* Hübner, 1809–1813.

Additional Reference: Riley, N. D., 1922, *Jour. Bombay Nat. Hist. Soc.*, vol. 28, p. 472 (Bombay). (Selects the generic type.)

Syntamcoides Kaye, William J.

Original Description: 1921 (December), *Memoirs Dept. Agr. Trinidad and Tobago*, no. 2, p. 89 (Trinidad, B. W. I.).

Note: Misspelling of *Syntarucoides*

Syntarucoides Kaye, William J.

Original Description: 1904 (June), *Trans. Ent. Soc. London*, p. 190 (London).

Genotype: *Papilio cassius* Cramer, 1775.

Additional Reference: Kaye, William J., 1921 (December), *Memoirs Dept. Agr. Trinidad and Tobago*, no. 2, p. 89 (Trinidad, B. W. I.). (Places *Syntarucoides* (misspelled *Syntamcoides*) in synonymy of *Leptotes* Scudder.)

Syntarucus Butler, A. G.

Original Description: 1901, *Proc. Zool. Soc. London*, p. 929 (London), (1900).

Genotype: *Papilio telicanus* Lang, 1789.

Tharsalea Scudder, Samuel H.

Original Description: 1876 (May), *Bull. Buffalo Soc. Nat. Sci.*, vol. 3, p. 125 (Buffalo, N. Y.).

Genotype: *Polyommatus arota* Boisduval, 1852.

Thecla Fabricius, Johann Christian

Original Description: 1807, *Systema Glossatorum*, p. x, no. 36 (Brunswick).

Genotype: *Papilio betulae* Linnaeus, 1761.

Additional References: Illiger, Johann Carl Wilhelm, 1807, *Magazin für Insektenkunde*, vol. 6, p. 286, no. 35 (Brunswick). Swainson, William, 1821, *Zool. Illus.*, vol. 2, pl. 69 (London). (Fixes the generic type.)

Theclopsis Godman, F. D. and Osbert Salvin

Original Description: 1887 (October), *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 2, p. 99 (London).

Genotype: *Thecla lebena* Hewitson, 1868.

Theorema Hewitson, William C.

Original Description: 1865, *Illus. of Diurnal Lepidoptera*, vol. 1, p. 69 (London).

Genotype: *Theorema eumenia* Hewitson, 1865.

Note: Monotypic genus.

Thereus Hübner, Jacob

Original Description: 1819, *Verzeichniss bekannter Schmettlinge*, p. 79, no. 793 (Augsburg).

Genotype: *Papilio lausus* Cramer, 1779.

Note: Monotypic genus.

Theritas Hübner, Jacob

Original Description: 1818, *Zuträge zur Sammlung exotischer Schmettlinge*, vol. 1, p. 31 (Augsburg).

Genotype: *Theritas mavors* Hübner, 1818.

Note: Monotypic genus.

Thestius Hübner, Jacob

Original Description: 1819, *Verzeichniss bekannter Schmettlinge*, p. 78, no. 785 (Augsburg).

Genotype: *Papilio pholeus* Cramer, 1777.

Additional Reference: Scudder, Samuel H., 1875, *Proc. Amer. Acad. Arts Sci. Boston*, vol. 10, p. 281, no. 1043 (Boston, Mass.). (Selects the generic type.)

Tmolus Hübner, Jacob

Original Description: 1819, *Verzeichniss bekannter Schmettlinge*, p. 76, no. 762 (Augsburg).

Genotype: *Papilio echion* Linnaeus, 1767.

Additional Reference: Scudder, Samuel H., 1875, *Proc. Amer. Acad. Arts Sci. Boston*, vol. 10, p. 285, no. 1061 (Boston, Mass.). (Selects the generic type.)

Trichonis Hewitson, William C.

Original Description: 1865, *Illus. of Diurnal Lepidoptera*, vol. 1, p. 68 (London).

Genotype: *Papilio theanus* Cramer, 1777.

Note: Monotypic genus.

Uranotes Scudder, Samuel H.

Original Description: 1876 (May), Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 107 (Buffalo, N. Y.).

Genotype: *Strymon melinus* Hübner, 1809-1813.

Note: *Uranotes* is a new name for the preoccupied name *Callipareus* Scudder.

Vaccinia Forster, Walter (not Tutt)

Original Description: 1938, Mitt. Münchner Ent. Ges., vol. 28, p. 112 (Munich).

Note: Misspelling of *Vacciniina* Tutt.

Vacciniina Tutt, J. W.

Original Description: 1909, Ent. Record, vol. 21, p. 108 (London).

Genotype: *Papilio optilete* Knoch, 1781.

Note: Forster, Walter, 1938, Mitt. Münchner Ent. Ges., vol. 28, p. 112 (Munich), made "*Vaccinia*" a subgenus.

Zephyrius Billberg, Gustav Johann

Original Description: 1820, Enumeratio Insectorum, p. 80 (Gadelianis).

Note: Misspelling of *Zephyrus* Dalman.

Zephyrus Dalman, Johann Wilhelm

Original Description: 1816, K. Vetenskaps. Acad. Handl., 1st half, pp. 62, 63, 90 (Stockholm). (Made *betulae* the generic type.)

Genotype: *Papilio betulae* Linnaeus, 1758.

Note: Dalman (page 63) made three subdivisions of his genus *Zephyrus*: *Aurotis*, *Heodes* and *Cyaniris*, which see.

Zesius Hübner, Jacob

Original Description: 1819, Verzeichniss bekannter Schmettlinge, p. 77 (Augsburg).

Genotype: *Zesius chrysomallus* Hübner, 1823.

Additional Reference: Scudder, Samuel H., 1875, Proc. Amer. Acad. Arts Sci. Boston, p. 292, no. 1098 (Boston, Mass.). (Selects generic type as *chrysomallus* which is an East Indian species; the genus does not occur in the Western Hemisphere.)

Zizula Chapman, T. A.

Original Description: 1910 (December), Trans. Ent. Soc. London, p. 483 (London).

Genotype: *Lycaena gaika* Trimen, 1862.

Additional Reference: Stempffer, H., 1933, Bull. Soc. Ent. France, vol. 38, p. 325 (Paris). (Places *tulliola* Godman and Salvin in the genus *Zizula*.)

(To be Continued)

A REVIEW OF THE SPECIES OF *CREMATOGASTER*,
SENSU STRICTO, IN NORTH AMERICA
(HYMENOPTERA: FORMICIDAE) PART I*

BY WILLIAM F. BUREN

Few groups of North American ants are as poorly understood taxonomically as *Crematogaster*. Ideas as to the identity and limits of some of our commoner widespread species have remained nebulous, and the "quadrinomial" system, formerly so widely used in myrmecology, may have led describers and reviewers toward only superficial examination of forms and the lumping of them under supposedly well known species as subspecies or mere varieties. At one time or another many of the forms have been lumped under *lineolata* (Say), but most of them show no more relation to typical *lineolata* than to any other species. Furthermore, several of these forms live side by side with *lineolata* in very similar ecological niches and yet do not intergrade with it, so far as I have been able to determine from a study of a large number of colonies and individuals. This seems ample evidence to consider them as "good" species.

The identity of four of the commonest and most widespread species, *lineolata* (Say), *cerasi* (Fitch), *laeviuscula* Mayr, and *clara* Mayr, seems to have been the subject of the greatest confusion and number of errors. This once resolved, the whole classification becomes easier to understand and falls readily into good order. Synonymy and discussions of each of these species will be found in Part III.

Previous to the publication of Dr. William S. Creighton's book on the ants of North America, 1950, no comprehensive treatment of *Crematogaster* had appeared since that of Emery, 1895. The attempt by Miss Jane Enzmann, 1946, to give a key, descriptions of new forms, and revisionary changes, could only have added to the confusion had it been accepted by American myrmecologists. Creighton, 1950, ably criticized this paper and there is no need for further comment here.

About 40 species are now known to me from North America

* Revised from a thesis presented at Cornell University, Ithaca, N. Y., in partial requirement for the degree of Doctor of Philosophy.

(including the West Indies and Mexico) and will be treated in this and following sections. Nearly half of the species are new to science. Thus *Crematogaster*, s. str., emerges as the third largest subgeneric group in North America from the point of view of number of species known. Only *Formica*, s. str. and *Pheidole*, s. str. have more. It is also my opinion that it is at least fourth, fifth, or sixth ranking in number of individuals and colonies from a continental standpoint. Only *Lasius* and *Formica* clearly outrank it in numbers and only *Camponotus*, s. lat., *Dorymyrmex*, *Pheidole* and *Solenopsis*, s. lat., seem to be rivals in this respect. This important genus in North America has not had the attention which it deserves.

The group is extremely adaptive. From the cypress swamps of the southeastern states to the cactus covered deserts of the southwest, there are one or more species present, each apparently well adapted to the particular environment. None of the species, however, seems to reach as far north or as high in altitude as some of the species of *Formica* or *Lasius* or several other genera.

ACKNOWLEDGMENTS AND BASIS OF STUDY

The material on which the study is based is as follows: The writer's personal collection of at least twenty thousand specimens, collected mostly in Iowa, Louisiana, Texas, Mississippi, Florida, New York, New Jersey, California, and Arizona, with scattered records in other states and in Mexico; several thousand specimens loaned by Dr. A. C. Cole and J. W. Jones, mostly from Tennessee, Utah, Idaho, Arizona, New Mexico, Colorado, and Florida; several hundred specimens from Arizona loaned by Dr. L. F. Byars; approximately 340 mounted specimens, mostly from California, Arizona, and Baja California, loaned by Dr. E. S. Ross of the California Academy of Natural Sciences; 860 mounted specimens, loaned from the National Museum and the collection of Dr. William M. Mann, at the kind recommendation of Dr. M. R. Smith; several hundred mounted specimens from the Museum of Comparative Zoology, loaned by Dr. William L. Brown, Jr., and the collection at Cornell University, which contains numerous mounted specimens.

I have become very indebted to Dr. William S. Creighton for the gift and loan of approximately five thousand specimens collected in the Southwestern States, in California, and in Mexico.

They were received too late to be included in the writer's unpublished thesis but have been treated in the present paper.

The writer has also been permitted to study the collections at the Museum of Comparative Zoology, Cambridge, Massachusetts, American Museum of Natural History, New York, N. Y., and the National Museum, Washington, D. C., through the kindness of Dr. Joseph Bequaert and Dr. William L. Brown, Jr., H. F. Schwarz and Dr. M. A. Cazier, and Dr. Marion R. Smith, respectively. To all of these men, the writer expresses his heartfelt appreciation. It is especially desired to tender appreciation to Dr. V. S. L. Pate, formerly of Cornell University, and Dr. Howard Evans, Department of Entomology, Cornell University, under whose direction the thesis which forms the basis for this paper was completed.

THE UNIQUE STING OF *Crematogaster*

The sting of *Crematogaster* is apparently unique in the Hymenoptera, and, since nothing seems to have been published about it, some description may not be out of place here.

Before describing the sting itself, it is necessary to show its relationship to other unique characters of *Crematogaster*. These ants have long been known to be able to swing their gasters up and over the thorax and head so that the tip of the gaster with its sting is presented in a cephalad direction. When in this defensive position a drop of liquid can be seen to exude from, and cling to, the sting. The singular position of the gaster is possible through several modifications. The dorsum of the petiole is flattened, the postpetiole is attached to the apparent anterior dorsum of the gaster rather than its base, and the gaster itself is flattened above, quite convex below, and capable of considerable flexion dorsally but very little ventrally. Thus when the animal takes its defensive position the petiole is raised until its dorsal face meets the declivous face of the epinotum, the postpetiolar attachment to the gaster permits a cephalad turning of the gaster, and the gaster itself is still farther flexed in that direction. Furthermore, nearly all species of *Crematogaster* (at least the North American group studied and various tropical species available to the author) have some very constant hairs or setae on the petiole and postpetiole, often only a single pair posteriodorsally. When in the defensive position, these setae

impinge or rest upon the surfaces of the succeeding parts, and therefore, I believe, act as kinesthetic sense organs, enabling the insect to know whether or not her gaster is in the right position.

Microscopic examination of the North American species and all others available shows that the sting is much flattened and enlarged at the tip, in fact spatulate, and so thin and delicate there that it may easily be bent back and forth with a needle without breaking, even in well dried specimens. Also, if live specimens are observed under high magnification, the poison droplet is seen to exude not from the tip or near it but from an opening just preceding the spatulate portion. I believe that these ants are quite unable to sting, but use their stings merely as an outlet for the defensive liquid, whose vile smell seems very obnoxious to insect enemies. The spatulate portion of the sting is probably an adaptation for increasing surface area and thus forms a base to which the poison droplet can cling. Some fine hairs which surround the cloacal opening probably act as guard hairs to prevent the droplet from spreading back on the surface of the gaster.

Upon dissection (*cerasi* used for this dissection) the sting is seen to consist of the usual parts, with shaft and stylet and two very slender, delicate lancets. The end of the stylet forms the spatulate portion. I believe the lancets to be non-functional.

In testing this concept of the inability of *Crematogaster* to sting, I have let them crawl on my hands many times while collecting. These ants then spread their legs and flatten themselves against the skin, and are able to deliver a sharp little nip with their strong mandibles alone, but I have never seen the tip of the gaster with its sting placed in contact with the skin. Indeed, for a long time I believed these ants incapable of flexing their gasters far enough ventrally to even touch the cloacal area to the surface upon which they were standing. But this is not correct, for in the case of one species at least, I have observed them thus bending their gasters, but for an altogether different purpose than that of stinging.

The species was *C. vermiculata* Emery which I have observed alive under magnification bending their gasters downward and touching the surface beneath in order to wipe poison droplets off their stings. They draw their whole bodies forward a little while doing this leaving a short wet line of poison. Probably this

habit is necessary so that the liquid will not harden on the sting and clog it. Possibly many or all of the other species will eventually be shown to have this habit.

I seriously doubt that these phenomena have been closely observed previously, and therefore believe that accounts of the "stinging" powers of *Crematogaster* must be mistrusted. The bite of *Crematogaster* is almost indistinguishable in sensation from a sharp prick as if with a sting. I imagine that the often very active and populous nests of *Crematogaster* in the tropics could make things interesting enough for a collector so that he would be little concerned as to whether he were being "bitten" or "stung".

HABITS

The habits of the North American species of *Crematogaster* have been the subject of several excellent papers, notably those of Wheeler, 1906 and 1919, so that there is little that the writer wishes to add. These ants' propensity for constructing little carton or earthen sheds for the protection of their aphid or coccid "cattle" or sometimes constructing large enough carton nests to serve as homes for themselves, has been well documented (Osten Sacken, 1862; Couper, 1863; Trelease, 1882; Atkinson, 1887; Comstock, *in litt.* to Wheeler; Wheeler, 1906, etc.). It should be pointed out, however, that much of this early work must now be rechecked, due to the lack of proper identification of the species involved. Wheeler first realized this in his 1919 paper describing *atkinsoni*, a species which has a much greater tendency to build carton nests than any other North American species, and he reversed his former opinion that the carton making habits of "*lineolata*" were vestigial instincts, left over from a tropical existence where this habit is the usual one, and now restricted to certain special conditions and occasions.

However, it is possible that Wheeler's 1906 opinions are not altogether implausible. I have seen many nests of *atkinsoni* around Miami, Florida, where this species had merely utilized available spaces in stumps and logs or hollow stems of bushes rather than build a carton nest, and as a corollary, I know of at least one well constructed nest from a region far out of the known range of *atkinsoni*, a carton nest in the Cornell University collection presented by Mr. Rhea from Reynoldsville, Jefferson County, Pennsylvania, altitude 1300 feet. My observations in

south Florida thus seem to lend some credence to Professor Atkinson's original view (1887) that high water levels had forced the ants to build a carton nest high above the ground rather than in the usual sites. Even *atkinsoni* apparently does not build its carton nest when it is not necessary, and it is apparent also, from the Reynoldsville, Pennsylvania nest, that on rare occasions at least, one of the northern species must be capable of constructing carton nests.

Wheeler, 1906, had also found some rather large carton masses under stones at about 7000 feet altitude in Colorado. These ants, identified by Wheeler as *lineolata*, were almost certainly not that species, however.

The small succursal nests or "tents" housing the "cattle" of the ants appear to be constructed by several species and to be of two types: those fashioned of wood and plant detritus, thus true carton, and those constructed of earth or sand. Wheeler, 1906, records that he was able to find these tents on only one occasion; this was in New Jersey and was the work of *pilosa* Emery, a species that prefers moist nesting situations. The writer observed several structures, apparently composed of earth, far out over the water on the cattails growing in Bayou Beouf near Alexandria, Louisiana. The architects were *clara* Mayr, another species which prefers swampy, moist nesting sites. But at this writing, it is impossible to fix the identification of the species involved in numerous other records. I should add too, that the above record for *clara* seems to be an unusual one, as I have never seen any other structures made by them in any other locality.

Most of the species march in long, narrow files, and gather what prey or dead insect material they can, but depend also on the secretions of aphids and coccids. Wheeler, 1910, records that he often found *punctulata* Emery attending dense herds of *Eriococcus texanus* on the roots of plants in central Texas. This habit has not been recorded for any other species.

A few of the species, notably *ashmeadi*, are aboreal, nesting in hollow twigs and branches. *C. sanguinea* and some of its relatives nest in twigs and branches and *Tillandsia*. *C. vermiculata* Emery is aboreal also. I found workers running on the trunk of a large cypress tree in a swamp near Alexandria, Louisiana, and assume, because the tree was surrounded by water, that they were nesting somewhere up in the tree. At Skene near Cleveland,

Mississippi, I found several polydomous colonies in dry trunk thorns of honeylocust in cypress swamps and observed them marching in files on cypress trees. The young colonies of *C. laeviuscula* Mayr are usually arboreal, nesting in cynipid galls and twigs and branches, but the largest colonies are often in rotten tree trunks or logs. *C. clara* utilizes a variety of arboreal and semi-arboreal nesting sites such as cane stems, rotten limbs and tree trunks, rotten logs and stumps.

In the western deserts several of the species which occur there have achieved notable ecological adaptation by living in the lower stems and roots or in the soil among the roots of such common desert plants as the creosote bush and several species of cholla cactuses. It may be postulated that such adaptation ensures a more adequate and even supply of moisture than would otherwise be available. Subterranean pasturage of aphids or coccids may also be suspected for these species but I have no first hand evidence of this habit for them at present. *C. depilis* Wheeler is a widespread species in this group and together with related species forms one of the dominant and most abundant segments of the desert ant fauna.

Most of the other species nest under stones or rocks or in old stumps or logs. I found *C. punctulata* Emery nesting directly in the ground near De Ridder, Louisiana and in several other localities. There is a certain plasticity and adaptability in the behavior of all the species, but some appear to be more restricted in habitat than others.

The remarks under each species in the taxonomic sections contain brief discussions of the habits and ecology known specifically for that species.

THE QUESTION OF *Acrocoelia*

The name *Acrocoelia* has been used so many times for the subgenus termed *Crematogaster*, s. str., in the present paper, that I feel some explanation is needed.

The original description of *Crematogaster* is that of Lund in June, 1831, in an article "sur les Habitudes de quelques Fourmis du Bresil" published in the *Annales des Sciences Naturelles*, Vol 23, p. 123. A German translation of this article appeared the same year in von Froriep's *Notizen*, Vol. 32, p. 97. Lund's description is brief but leaves no doubt that he had *Crematogaster* in mind. However, he did not assign any species to this

new genus. There the matter rested until Mayr picked up the name *Crematogaster* twenty-four years later. In the meantime Mayr, 1852, (Verh. Zool.-bot. Ver. Wien, Vol. 2, p. 146) had described a new genus *Acrocoelia*, and had assigned two species, *ruficeps* Mayr and *schmidti* Mayr, to it. But in 1855, (Verh. Zool.-bot. Ver. Wien, Vol. 5, p. 468,) Mayr realized that *Acrocoelia* was congeneric with *Crematogaster*, and placed *Formica scutellaris* Olivier and *Myrmica sordidula* Nylander in *Crematogaster* and sank both *ruficeps* Mayr and *schmidti* Mayr as synonyms of *scutellaris* Olivier.

In the remaining years of the 19th century numerous species were described in *Crematogaster* by various authors until it became a very large genus. But no genotype was set until the designation of *C. scutellaris* (Olivier) by Bingham, 1903, in the Fauna of British India, Hym., Vol. 2, p. 124. This designation was an entirely proper one. In fact, *scutellaris* Olivier and *sordidula* Nylander were the only species open for designation, since they were the first species included in *Crematogaster* (see opinion 46 of the International Commission on Zoological Nomenclature). Nevertheless, Emery, 1921, in Wytsman's Genera Insectorum, fasc. 174, attempted to negate Bingham's designation and designated instead *Formica acuta* Fabricius as the type of his "*Crematogaster, sensu stricto*", and *Acrocoelia ruficeps* Mayr = *Formica scutellaris* Olivier as the type of *Crematogaster* subgenus *Acrocoelia* Mayr. This was done on the ground that Lund had only South American species in mind in describing *Crematogaster*. But as Lund never specifically limited his concept of the genus *Crematogaster* to South American specimens and did not specifically mention or indicate any species, and as several of the subgenera of *Crematogaster*, including the *Crematogaster*, s. str. of the present work, occur in South America, Emery's procedure cannot be justified under any rule or opinion of the nomenclatorial code. *Acrocoelia* Mayr must therefore fall as an absolute isogentopyic synonym of *Crematogaster* Lund, while the "*Crematogaster, sensu stricto*," of Emery, 1921, is a synonym of *Crematogaster* subgenus *Eucrema* Santschi, 1918.

It may be noted here also that Sherborn's Index Animalium for 1801-1850 contains two curious errors. In the index to generic names, showing trivial names associated with each, 1801-1850, the specific names "*cephalotes*" and "*histica*" are listed

for *Crematogaster*. But both of Lund's papers clearly show that he considered *cephalotes* the type of *Atta* Fabr., and "*histica*" is not mentioned.

Since writing the above, I have examined *Crematogaster acuta* (Fabr.). Judging from its morphology, especially that of the female, I believe there is strong presumptive evidence that it is parasitic. The female is small compared with the worker, with a very smooth and highly polished integument as contrasted with the roughly sculptured integument of the worker, and has a disproportionately long apical mandibular tooth. The thorax is slender and the abdomen small and there are many other striking characters.

But parasitic or not, it is certainly a highly modified form and quite remote from any "basic" or "typical" stock in the genus. The designation of such a species as the type could have had a very unsettling effect on the taxonomy of *Crematogaster*, possibly leading to the splitting of the genus into several genera with most of the species now in *Crematogaster* having to be removed entirely, or other nomenclatorial juggling which I would deem deplorable and foolish.

CREMATOGASTER Lund

Crematogaster Lund, Ann. So. Nat., Vol. 23, p. 132 (1831).

Crematogaster Mayr, Verh. Zool.-bot. Ver. Wien, Vol. 5, p. 468 (1855).

Crematogaster Santschi, Bull. Soc. Ent. France, p. 182 (1918).

Crematogaster Emery, Wytsman's Genera Insectorum, fasc. 174, p. 127, (1921).

Acrocoelia Mayr, Verh. Zool.-bot. Ver. Wein, Vol. 2, p. 146 (1852).

Myrmica (in part) Say, Sykes, Nylander, Fitch, etc.

Formica (in part) Olivier, Latreille, Fabricius, etc.

Atta (in part); *Monomorium* (in part); *Oecodoma* (in part) Buckley (1867).

Type: *Formica scutellaris* Olivier (designation of Bingham, 1903).

WORKERS.—Small to medium sized ants, usually monomorphic. Mandibles with a few strong teeth, often 4 in number. Frontal carinae far apart, the clypeus evenly and convexly produced between them. Antennae ordinarily 11-jointed, rarely 10- or even 9-jointed. Usually the last 2 or 3 joints of the funiculus forming a heavy club; rarely the last 4 joints form

it, or the funiculus filiform. Eyes of moderate size, situated at about the middle of the sides of the head.

Thorax always with distinct meso-spinotal impression. Pro-mesonotal impression variable. Epinotum armed with a pair of spines, rarely unarmed. Metathoracic glands well developed, in certain species enormously so.

Petiole flattened above and thus capable of being raised until flush against the declivity of the epinotum. The bases of the epinotal spines are always far enough apart so as not to hinder this operation. Postpetiole somewhat more nodiform but never strongly so, always attached to the apparent anterio-dorsal surface of the gaster. This odd placement is allowed by a strong overlapping of the first gastric sternite onto the anterior dorsal surface. From above, the gaster is heart-shaped, tapering more or less acutely; in profile, it is quite convex below and flattened above. It may be flexed only dorsally. This whole petiolar-gastral apparatus allows the gaster to be raised up over the head and thorax and the tip of the gaster to be presented forward.

Sting incapable of piercing, very delicate, thin, and broad at apex, spatulate in shape, with the opening for poison just before the flattened portion. The poison appears to be repugnatory toward other insects.

FEMALES.—Usually much larger than the workers and mostly with the structures of the workers as they apply to the petiole, postpetiole, and gaster. Eyes larger; ocelli present. Mandibles often with a few more teeth than in the worker. Thorax and gaster usually large. Mesonotum overlapping the pronotum, seen from above. Epinotal spines usually shorter than in the worker. Mesosternum convex below. Sting as in the worker.

MALES.—Much smaller than the females, in general about the same size as the workers, although in a few species considerably larger.

Mandibles denticulate, with fewer teeth than workers or females. Eyes and ocelli well developed. Antennae 12-jointed, rarely 10 or 11-jointed. Scapes very short. First joints of funiculi very short and then the rest filiform or somewhat nodiform. Thorax similar to the female. No epinotal spines or these much reduced. Mayrian furrows present or absent. Petiole flat above and postpetiolar attachment to gaster similar to that of worker and female but less strongly modified. The genitalia have not been studied, except for a few species examined by the writer and described below.

Subgenus CREMATOGASTER, sensu stricto

Crematogaster, subgenus *Crematogaster* Santschi, Bull. Soc. Ent.

France, p. 183 (1918)—M. R. Smith, in Hymenoptera of America north of Mexico, p. 808 (1951).

Crematogaster (in part) Mayr (1855), Bingham (1903), etc. *Acrocoelia* Mayr, Verh. Zool.-bot. Ver. Wein, Vol. 2, p. 146 (1852).

Crematogaster subgenus *Acrocoelia* Emery, Wytsman's Genera

Insectorum, fasc. 174, p. 140 (1921). Type designated: *Acrocoelia ruficeps* Mayr = *Formica scutellaris* Olivier).

Crematogaster subgenus *Acrocoelia* M. R. Smith, Amer. Mid. Nat., Vol. 37, no. 3, p. 563 (1947).—Creighton, Bull. Mus. Comp. Zool. Harv., Vol. 104, p. 206 (1950).

Type: *Acrocoelia ruficeps* Mayr = *Formica scutellaris* Olivier.

WORKERS.—With the characters of the genus. Distinguishable from other subgenera by always having a 3-jointed antennal club, antennae 11-jointed, epinotal spines of normal size, metathoracic glands not excessively developed, petiole trapezoidal seen from above, and postpetiole with definite median impression or groove.

In addition a few other characters may be described, which will hold good, at least, for the Nearctic species.

The mandibles have 4 strong teeth. The mandibles, clypeus, and genae always more or less striate. The head robust, often broader than long, with more or less convex sides; the posterior border straight in the middle or slightly concave. Scapes usually surpassing the hind corners of the head a little or at least nearly reaching them. The 3–6th funicular joints usually as broad as long or broader, rarely longer than broad.

Pronotum usually with distinct shoulders, sometimes with only a trace of them; if present, there are nearly always shallow, oblique impressions on the sides of pronotum. Oblique pro-mesonotal impressions usually present on the dorsum but these usually not very strong. Mesoepinotal impression shallow to deep, always distinct. Often the mesonotum showing a somewhat angulate declivous surface down into the mesoepinotal impression when seen in profile. Epinotal spines variable in size and shape. Epinotal spiracles immediately latero-ventrad of the bases of the spines. Postpetiole variable in shape and depth of median impression. I have termed the two lobular sections thus separated the "hemilobes." Mesonotum usually with a median longitudinal carina.

Sculpture varying from smooth and shining to striate or rugose or to densely punctate. Hairs varying from fine and slender to bristle-like, either scattered over most of the surface and thus fairly numerous or arranged in small groups, usually quite constant within the species in either case. In nearly all species there are a pair of constant hairs or setae on the posterior lateral corners of the petiole, and a similar pair or more than one pair on the postpetiole, whose function is discussed in a previous section.

FEMALES.—Mostly with the characters of the workers except for winged thorax and large abdomen. Eyes larger and ocelli present, sometimes large. Mandibles usually with 5 teeth, occasionally with six. Funiculi more evenly incrassate, sometimes without a definite club.

Mesonotum overlapping the pronotum seen from above, the latter rather narrow in front. Mesosternum very convex below. Sides of thorax more or less striate. Epinotum with small spines. Metanotum narrow, beneath the scutellum; it may or may not be produced into a blunt point. Petiole,

postpetiole and gaster similar to worker. Impression on postpetiole much less developed and anterior lateral corners much more developed than in the workers.

Two aberrant forms, known only from females, have been described from North America as workerless parasites. These are very small, very pilose females, but otherwise show little specialization. As I shall show, these "species"—*kennedyi* Wheeler and *creightoni* Wheeler—are probably B-form or mutant females of the so-called "host" species with which they were found, *cerasi* (Fitch) and *pilosa* Emery, respectively.

MALES.—Size variable, often smaller than the worker. Mandibles 3-denticulate with rare exceptions. Scapes short. Funicular joints, at least the basal ones, rather nodiform. Head with convex sides and posterior border. Eyes large, hemispherical. Ocelli small to large. Thorax similar to that of female. Mayrian furrows absent in this subgenus. Sometimes a transverse impression on posterior of mesonotum. Epinotal spines absent or reduced to teeth. Postpetiole without trace of longitudinal impression.

The eastern species of *Crematogaster* all have rather small males with distinct but small ocelli. Several western species, however, notably *californica* Emery, have large males with relatively enormous ocelli, an adaptation, possibly, to nocturnal wedding flights.

Genitalia retractile, usually only the tips of the parameres showing; of simple construction, the aedoeagus consisting of two flattened plates, and when seen from the side, with simple, roundly convex apex and a series of retrorse teeth on ventral border, otherwise unmodified. Volsellae very simple in construction, each consisting only of a rather simple, flattened, oval plate much smaller than the aedoeagal plates, and without development into distinct digitus and cuspis, merely with a deep notch on ventral side. Parameres triangulately lobate, densely clothed with setae apically, hollowed out on inner side and thus forming an enclosing structure for the other parts.

The genitalia of the various species of North American *Crematogaster*, s. str., appear to have such a simple construction and to vary so little between the species, that I consider them useless for species diagnosis. The western species with giant males have very large genitalia, but the construction is nevertheless very similar.

The species groups

Several rather poorly defined species groups may be recognized. These are hard to delimit but may aid somewhat in understanding the various interspecific relationships.

1. The *coarctata* group. This group is the only one having species whose workers regularly have large striae on the lower part of the mesopleura, the thoracic dorsum densely and strongly striate, the mesonotal declivity very strong and angulate, the

antennae long, the sulcus of the postpetiole rather shallow and the hemilobes semiangulate behind, and the hairs fine, elongate and sparse. The females are among the largest of North American *Crematogasteri*.

2. The *californica-opaca* group. This large and complex group is characterized in the worker by a basically densely punctate head and thorax, although sometimes this sculpture is more or less obscured by rugae on the thorax or lost on the head. The pilosity varies from very pilose species to extremely sparsely haired species like *depilis*. The known females of the species closely related to *californica* are all comparatively large elongate insects measuring about 10 mm. with the head subrectangular and having large eyes and ocelli. The males of some of these species are extremely large and have the scutellum unimpressed laterally and have large eyes and ocelli, possibly for nocturnal use.

3. The *lineolata-laeviscula* group. As in the preceding group I have tried to emphasize the complex nature of this group by giving it a compound name. The group varies from strongly rugose forms like *lineolata* to smooth and shining forms like *laeviscula* but nevertheless comprises an inseparable complex. The mesonotal declivity is usually present. The epinotal spines are divergent and straight or nearly so. The petiole is broad and the postpetiole has simple, rounded hemilobes with rather moderate sulcus. The male always has the scutellum laterally impressed.

4. The *sanguinea-ashmeadi* group. This too is a complex group composed of *sanguinea* and its close relatives and *ashmeadi* and its relatives. Nearly all the species have a curious outward thickening or convexity on the bases of the spinotal spines. This involves only the base in long-spined forms like *sanguinea* but the whole spine in very short-spined forms like *ashmeadi*. This group is essentially arboreal.

Besides the four large groups above, two groups are known from a single new species each. These are treated in Part II.

If we postulate that the North American *Crematogaster*, s. str., fauna originated from several immigration waves across the Siberia-Alaskan land bridge, then it seems reasonable that the *coarctata* group may represent the last of such waves, having never spread far from the west coast, whereas the *sanguinea-*

ashmeadi group may represent the oldest wave, being the only group to have representatives in the West Indies, and having the only species with a possible discontinuous distribution—*C. vermiculata*.

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BLOOD COMPOSITION OF THE COCKROACH, *LEUCOPHAEA MADERAE* FABRICIUS*

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The chemistry of insect haemolymph has been studied extensively since the pioneer work of Bishop, Briggs and Ronzoni (1925) on the blood of the honey bee larva, *Apis mellifica*. Florkin (1936 a, b, c) published a series of papers on protein and non-protein nitrogen, glucose and uric acid concentrations in the blood of the silkworm, *Bombyx mori* and of the water beetle, *Hydrophilus piceus* at different stages of development. Florkin (1937) described the biochemical characteristics of insect blood as (1) a high concentration of non-protein nitrogen, 50 to 80 per cent of which is amino nitrogen; (2) a high concentration of reducing substances, very little of which is glucose; (3) a high concentration of magnesium.

Florkin and Duchâteau (1942) recognizing the high amino nitrogen so characteristic for insect blood, attempted to isolate biochemically the individual amino acids. They were able to identify tyrosine and histidine in the blood of the beetle, *Dytiscus marginalis*. Pratt (1950) using the newer chromatographic methods, determined the free amino acids in the blood of the honey bee, *Apis mellifica*, the bee moth, *Galleria mellonella* and the cockroach, *Blattella germanica*. He found that the amino acids glycine, alanine, glutamic acid, tyrosine, leucine or isoleucine, methionine, proline, serine and valine were present in each species.

Florkin, Duchâteau and Leclercq (1949) separated insects into two groups depending on the concentration of sodium in the blood. Since that time many studies on the inorganic ion content have been made, the results of which have been compiled into a table by Buck (1953).

Most of the published material concerns those insects with a

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holometabolus life cycle. In these forms the amino nitrogen was approximately 200 mg. per cent which is about 50 to 80 per cent of the total non-protein nitrogen. Todd (1957) studied the organic constituents in the blood of a paurometabolous insect, the American cockroach, *Periplaneta americana* and found total amino nitrogen to average only 78 mg. per cent which was 40 per cent of the non-protein nitrogen. Because of the paucity of work on paurometabolous insects the present work was undertaken to determine the concentration of various inorganic ions, nitrogenous compounds including individual amino acids, and reducing substances in the blood of another paurometabolous insect. The tropical cockroach, *Leucophaea maderae*, was chosen because of its large size and the ease with which its blood can be obtained.

MATERIAL AND METHODS

The cockroaches were kept at room temperature in glass jars, and were supplied with laboratory food pellets and water. The insects were etherized to obtain uncoagulated blood (Ludwig 1951). The antennae were clipped with scissors and the haemolymph allowed to drip into the depression of a porcelain spot-plate. One-tenth of a milliliter of blood was used for each test.

The ionorganic ions calcium, potassium and sodium were measured by the Beckman flame photometer, and magnesium was determined by the method of Denis as modified by Fiske and Subbarow (1925). The concentration of reducing substances was obtained by the Hagedorn and Jensen technique as outlined in Hawk, Oser and Summerson (1951). Trehalose was determined using the anthrone test (Wyatt and Kalf 1957). Protein and non-protein nitrogen were determined by the micro-Kjeldahl procedure. Urea nitrogen was determined according to the method of Ormsby (1942) as modified by Kawerau (1946). Uric acid nitrogen was measured by the method of Brown (1945), and amino acid nitrogen by that of Danielson as modified by Frame, Russell and Wilhelmi (1943).

Amino acids were separated qualitatively by the method of McFarren (1951) for paper partition chromatography, and the quantitative determinations were made according to the techniques described by McFarren, Brand and Rutkowski (1951) and McFarren and Mills (1952). The filtrate for these determina-

tions was prepared according to the procedure outlined by Pratt (1950).

OBSERVATIONS

The results of the determinations on inorganic ions and organic compounds are shown in table 1. The concentration of inorganic

TABLE 1. CONCENTRATION OF CERTAIN ORGANIC AND INORGANIC COMPOUNDS IN THE HAEMOLYMPH.

Substance	No. of tests	Mg. per cent		
		minimum	maximum	average
Sodium	5	236	262	230
Potassium	5	29	55	38
Calcium	5	13	20	16.5
Magnesium	5	4.2	4.7	4.6
Protein nitrogen	10	532.38	812.58	686.46
Non-protein nitrogen	10	126.09	448.32	235.36
Urea nitrogen	10	7.50	9.10	7.97
Urea	10	16.00	19.50	17.05
Uric acid nitrogen	12	3.22	5.18	4.08
Uric acid	12	9.67	15.55	12.24
Amino acid nitrogen	10	76.15	97.27	85.44
Reducing compounds	12	136.00	340.00	228.00
Non-fermentable reducing compounds	10	56.00	320.00	163.00
Fermentable material (as glucose)	—	—	—	65.00
Trehalose	7	580.00	780.00	677.00

ions were calcium 16.5, potassium 38.0, sodium 230 and magnesium 4.2 mg. per cent. Total reducing compounds were 228, non-fermentable reducing compounds 163, and fermentable material (glucose) 65 mg. per cent. Trehalose a non-reducing disaccharide was 677 mg. per cent. Concentrations of nitrogen in various compounds were protein 686.46 and non-protein nitrogen 235.36. Fractionation of the non-protein nitrogen showed urea 7.9, uric acid 4.08 and amino acid nitrogen to be 85.44 mg. per cent.

The amino acids separated and identified in four solvent systems are shown in table 2. Normal-butanol-acetic acid-water was the best of all the systems used for the identification of the individual amino acids because it required no adjustment of pH

TABLE 2. AMINO ACIDS IDENTIFIED BY PAPER PARTITION CHROMATOGRAPHY.

Solvent	pH	Time for runs	Amino acids
Normal-butanol- acetic acid- water		51-55 hours	alanine arginine cysteine glycine histidine hydroxyproline norleucine ornithine phenylalanine proline serine threonine tyrosine valine
ortho-cresol	8.4	51-55 hours	beta alanine citrulline glycine methionine norleucine ornithine taurine threonine valine
Phenol	12.0	36-40 hours	alanine aspartic acid glutamic acid glycine serine threonine
Phenol	6.2	17-20 hours	Composite spots 1. norleucine phenylalanine tryptophane valine 2. alanine tyrosine 3. arginine histidine threonine 4. cysteine ornithine serine

nor previous buffering of the paper. The resolution and separation of spots of both the unknown in the filtrate and the standards were the clearest in this solvent. Fourteen amino acids were identified with n-butanol-acetic acid, the most in any solvent used. Ortho-cresol, saturated with buffer at pH 8.4, yielded the identification of nine amino acids but only four of these were different from those identified with n-butanol-acetic acid. They were methionine, beta alanine, taurine and citrulline. Phenol at pH 12.0 aided in the separation of six amino acids but again four had been previously identified with n-butanol-acetic acid. The two which had not been identified in the other solvents were aspartic and glutamic acids. Phenol at pH 6.2 was not a satisfactory solvent because the amino acids did not separate into individual spots. Composite spots were obtained and therefore, no positive identification could be made with this solvent.

Table 3 lists the quantitative results of the individual amino

TABLE 3. QUANTITATIVE MEASUREMENTS OF AMINO ACIDS ISOLATED BY PAPER CHROMATOGRAPHY.

Figures in parenthesis indicate number of readings made in each solvent.

Amino acid	Solvent		Amino nitrogen mg. per cent
Alanine	n-butanol-acetic acid	(2)	6.20
Arginine	n-butanol-acetic acid	(3)	13.16
Aspartic acid	phenol pH 12.0	(2)	trace
Beta alanine	o-cresol pH 8.4	(3)	trace
Citrulline	o-cresol pH 8.4	(3)	8.06
Cysteine	n-butanol-acetic acid	(2)	trace
Glycine	phenol pH 12.00	(2)	6.62
	o-cresol 8.40	(3)	
Histidine	n-butanol-acetic acid	(2)	5.05
Methionine	o-cresol pH 8.4	(3)	3.60
Norleucine	n-butanol-acetic acid	(3)	13.16
Ornithine	n-butanol-acetic acid	(2)	5.30
Phenylalanine	n-butanol-acetic acid	(2)	5.50
Proline	n-butanol-acetic acid	(2)	trace
Serine	phenol pH 12.0	(2)	2.60
Taurine	o-cresol pH 8.4	(3)	trace
Threonine	n-butanol-acetic acid	(3)	2.48
	phenol 12.0	(4)	
Tyrosine	n-butanol-acetic acid	(2)	2.55
Valine	n-butanol-acetic acid	(2)	3.60
Total			92.66

acids which were determined using the same solvent systems as for the qualitative results. However, in some instances not all the amino acids isolated in a particular solvent could be measured quantitatively because they were not present in sufficient concentrations. They are recorded as trace amounts. The amino nitrogen for each amino acid obtained in each solvent was averaged for the final figure. The total amino nitrogen determined by this method was 92.66 mg per cent.

DISCUSSION

The blood of the cockroach, *Leucophaea maderae* has a high sodium and low potassium as well as a low magnesium of 4.2 mg. per cent. Thus by its ion index this insect falls into the category of high sodium described by Florkin, Duchâteau and Leclercq (1949). They described insects with a high sodium as being ancestral forms or those whose development was independent of the evolution of plants. It is well known that the cockroach is a primitive insect. Barsa (1954) studied the concentrations of inorganic ions in the blood of an insect representative of the two groups. She found that the grasshopper, *Chortophaga viridifasciata*, another primitive insect, had a high sodium and low potassium and the pupa of the Cynthia moth *Samia walkeri* a high potassium and low sodium but both insects had a high magnesium index. However, in spite of the high magnesium concentration in the blood of insects, this ion is toxic to the insect. It was suggested that magnesium is not free but in the bound form. Therefore, it would seem that these insects do not conform to the rule of Florkin, Duchâteau and Leclercq (1949) that those insects with a low sodium and high potassium index have a higher magnesium content than those of the more primitive group. However, the grasshopper, which is the exception with both a high sodium and magnesium, is not as primitive as the cockroach.

The concentration of reducing substances is expressed as equivalents of glucose although only about one-fourth of the total reducing substances is glucose. Many other substances such as ascorbic acid, uric acid and glutathione will reduce ferricyanide in hot alkaline solution. A characteristic of insect haemolymph is its high concentration of non-fermentable reducing substances. In *L. maderae* they amount to 163 mg. per

cent. The exact nature of these compounds is still unknown. Buck (1953) suggested that they are a complex of phenolic compounds concerned with the hardening and darkening of the cuticle. It has been shown that these polyphenols and phenolic amino acids have a high reducing value.

Wyatt, Loughheed and Wyatt (1956) in their work on the chemistry of the silkworm, *Bombyx mori*, noticed that acid hydrolysis of the haemolymph caused the release of a fermentable substance. Wyatt and Kalf (1957) identified this substance as trehalose, a non-reducing disaccharide. They reported that in 10 insects this substance ranged between 306 in *Bombyx* larvae, to 1,398 mg. per cent in the moth, *Telea polyphemus*. In the cockroach the concentration of this sugar is 677 mg. per cent. Trehalose thus appears to be a major blood sugar in this species.

The concentrations of the nitrogenous substances in the blood of *L. maderae* are in agreement with those found in other insects as shown in the tables compiled by Buck (1953). In the tropical cockroach, amino nitrogen is 85 mg. per cent or about 35 per cent of the total non-protein nitrogen. These results are in agreement with those of Todd (1957) on the blood of the American cockroach, *Periplaneta americana*. These values are lower than the 50 to 80 per cent quoted by Buck (1953). However, he based that percentage on insects with a holometabolous life cycle.

Po-Chedley (1956) isolated 21 amino acids from the blood of the oriental beetle, *Anomala orientalis*. In phenol at pH 12.0, he identified nine amino acids. In the present work, six were identified in this solvent. Po-Chedley was able to separate leucine and isoleucine with collidine. However, this solvent did not completely separate the amino acids in the blood filtrate of the cockroach and was discarded early in the experiments. Po-Chedley was able to isolate lysine and taurine with n-butanol-acetic acid. However, in the present work lysine could not be positively identified. Taurine was isolated in o-cresol pH 8.4 but not in any other solvent. Pratt (1950) isolated 17 amino acids from the blood of the cockroach, *Blattella germanica* and 11 from that of the American cockroach. In *Blattella* he found no histidine, hydroxyproline, phenylalanine, tryptophane or taurine. All these were found in the blood filtrate of *L. maderae* and citrulline was identified in o-cresol at pH 8.4. To the

author's knowledge, this is the first time that this amino acid has been found in insect blood.

SUMMARY

The average concentration of inorganic ions, expressed as mg. per cent, are sodium 230, potassium 38, calcium 16.5 and magnesium 4.2.

The average concentration of the nitrogenous fractions expressed as mg. per cent, are protein 686.46 and non-protein 235.36. Fractionation of the non-protein nitrogen showed urea to average 7.97, uric acid 4.08 and amino acid nitrogen 85.44 mg. per cent.

The average concentration of reducing substances was 228, and that of non-fermentable reducing substances 163 mg. per cent. Glucose, the fermentable reducing substances averaged 65 mg. per cent. Trehalose, a non-reducing disaccharide, was 677 mg. per cent.

The nineteen amino compounds isolated by paper chromatography were alanine, arginine, aspartic acid, beta alanine, citrulline, cysteine, glycine, histidine, hydroxyproline, methionine, norleucine, ornithine, phenylalanine, proline, serine, taurine, threonine, tyrosine and valine.

The total amino nitrogen determined by paper chromatography was 92.66 mg. per cent.

The best solvent for these experiments, isolating fourteen amino acids, was n-butanol-acetic acid-water.

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PROCEEDINGS OF THE NEW YORK ENTOMOLOGICAL SOCIETY

MEETING OF OCTOBER 2, 1956

A regular meeting of the Society was held at the American Museum of Natural History; President Vishniac presiding.

The secretary was instructed to write to Mrs. William P. Comstock, expressing deepest sympathy upon the passing of long-time member and friend, William P. Comstock.

Drs. Treat and Klots reported on the meetings of the International Congress of Entomology, held in Montreal in August. In addition to the scientific value of the Congress, as evidenced by a display of the abstracts of talks, everyone seemed impressed with the excellent planning of the meetings and the pleasant and friendly atmosphere which existed throughout the sessions.

The members of the Society reported on their summer activities. Dr. Klots showed a number of exceptional kodachromes of insects which he had taken during the summer. Another highlight of the discussion was Dr. Schneirla's description of the recently opened Southwest Research Station at Portal, Arizona, which gives convenient access to a wealth of entomological fauna in that area.

The meeting was adjourned at 10:00 P.M.

EDWARD S. HODGSON, *Secretary*

MEETING OF OCTOBER 16, 1956

A regular meeting of the Society was held at the American Museum of Natural History; President Vishniac presiding. Mr. Peter Farb was proposed for membership. The publication and excellent reviews of Mr. Teale's book "Autumn Across America" were announced.

The speaker of the evening was Mr. Melville Osborne, President of the Newark Entomological Society, who discussed "Mass Rearing of Lepidoptera". Mr. Osborne explained his methods of collecting female moths and the artifices used to induce them to mate. The latter range from relatively simple procedures such as temporary isolation to actual surgical techniques, including severing the abdomens and hand-matings. Mr. Osborne explained that even after viable eggs had been obtained the rearing of the caterpillars was subject to a number of hazards, including diseases of the larvae which may kill them en masse. Division of the larval populations into small groups and frequent replacement of food materials reduce the mortality rates from such diseases, and under some conditions, it is also advantageous to raise different species of lepidopterans together, to restrict the spread of species-specific disease.

The talk was followed by a lively discussion period until the meeting adjournment at 10:00 P.M.

EDWARD S. HODGSON, *Secretary*

(continued on page 152)

FOUR NEW SPECIES OF NEOTROPICAL PENTATOMIDS (HETEROPTERA, PENTATOMIDAE)

BY HERBERT RUCKES¹

The following four new species are of interest in so much as each represents a separate Tribe within the Pentatomidae. With the exception of the specimens listed under the name of *Sciocoris crassus*, new species, all examples have been in the collection of the American Museum of Natural History for many years. It is only proper that they be assigned names at this time.

In the descriptions the various numerical ratios given are dimensions measured through a binocular microscope using a $\times 2$ objective and a $\times 9$ ocular filled with a micrometer scale divided into 200 linear units. They are not in terms of millimeters except as specified for the holotypes and allotypes.

I wish to extend my sincere thanks to Mrs. Rose Ismay for typing the manuscript of this article.

Tribe Sciocorini Amyot and Serville

Sciocoris crassus, new species

Oval, moderately convex above, more so below; sordid fulvous; punctures sometimes ferruginous, sometimes fuscous, moderately coarse and moderately dense.

Head slightly declivent, about one-fourth wider through the eyes than long medianly (100×80), its median length equal to the median length of the pronotum (80×80); lateral margins provided with a blunt lobule or small dentation just before each eye, then weakly sinuate to a broadly rounded apex; disc coarsely and regularly punctured, the apical portion between the overlapping juga and tylus weakly impressed; ocelli dull red and twice as far apart as each is from its eye; eyes fuscous. Antennae reddish brown, the apical segment darker; basal segment stouter than the others; segmental ratios: 15/23/13/20/27, i.e., segment III the shortest and subequal to I; segment V the longest.

Pronotum almost rectangular, two and a quarter times as wide across the humeri as long medianly (180×80); humeri very obtusely rounded, not at all produced and grading into the obsolescent posterolateral margins; posterior margin transverse; anterolateral margins with a slight convex curvature; anterior margin shallowly excavated behind the head and then

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truncate behind the eyes; anterior lateral angles obtusely rounded; disc thickish inside the anterolateral margins, the outer surface then sloping gradually to the margins which are subcarinate; a broad but shallow transverse groove across the middle of the disc and ending laterally in enlarged, deeper, subrotund impressions; punctures coarse but shallow.

Scutellum about as wide as long (117×113), reaching well behind the middle of the abdomen; each basal angle provided with a minute, fuscous to piceous, calloused spot, followed posteriorly by a small subfoveal impression; a broad basal, vaguely triangular paler area raised slightly above the remaining portion of the disc; surface of the disc slightly convex, giving the impression of thickness; apex broadly rounded; punctures rather evenly distributed and moderately dense. Hemelytra more finely punctured; the apical margin essentially straight and the outer apical angle rectilinear to acute, definitely not obtusely rounded; membrane sordid amber, veins ill-defined, when showing, they are subparallel. Connexivum rather narrowly exposed, the margins thickish; apical segmental angles rectilinear to obtuse and not at all produced, the entire lateral margin continuous; segments alternated sordid fulvous and fuscous, the punctures moderately coarse; apical angle of the sixth segment, obtuse.

Venter quite convex, sordid fulvous or paler with ferruginous and fuscous punctures; thorax coarsely and irregularly punctured; a broad longitudinal fuscous or dark brown band extending each side of the abdominal disc, becoming evanescent posteriorly in the male but completely infuscating the median portion of the sixth sternite in the female; this fuscous band followed laterally by a parallel pale band which in turn is followed laterally by another interrupted and posteriorly evanescent fuscous band; submarginal portion of the abdominal disc pale and finely punctured; segmental incisures bearing marginal small, squarish fuscous patches; spiracles ferruginous; anterior median margin of the sixth abdominal sternite in the male obtusely roundly angled; coxae and trochanters fulvous; femora infuscated beyond the basal two-thirds; tibiae and tarsi concolorous sordid brown to fuscous.

Apical margin of the male genital segment nearly straight, showing little evidence of sinuosity, and subtended medianly by a transverse oval fovea; head of the paramere (clasper) thin, foliaceous and somewhat spoon shaped, lying entirely within the cavity of the segment. Basal plates of the female genital valves setigerous, subtriangular and each about as long as wide at the base.

Described from 10 specimens.

Holotype: Male: 7.5 mm. long; 4.5 mm. wide across the humeri. Tejupilco, Temescaltepec, Mexico. June 29, 1933. H. E. Hinton and R. L. Usinger, collectors. Deposited in the collection of the California Academy of Sciences, San Francisco.

Allotype: Female: 8.0 mm. long; 4.5 mm. wide across the humeri. Same data as above.

Paratypes: Six males and two females. Same data as above

except that one male and one female are deposited in the collection of the American Museum of Natural History.

Unlike either of the two other species of *Sciocoris* (*microphthalmus* Flor and *longifrons* Barber) heretofore recorded from North America. The more reddish tone of the body, its thickness and more robust appearance readily distinguish it. The obtuse angles at the four corners of the pronotum, the obsolescent nature of the posterolateral margins of that part, the longitudinal fuscous banding on the abdominal venter, and ferruginous spiracles are other characteristics that separate this species from the other two mentioned above.

Tribe Discocephalini Fieber

Dinocoris robustus, new species

This is the largest and most robust species of the genus that I have so far encountered. Unfortunately all the available specimens are females. No study of the male genitalia being possible at the present time, the phylogenetic relationship to allied species is doubtful.

Broadly oval, quite convex above and quite flat below; rich fulvous to ochraceous; punctures very coarse and for the most part congested; punctures and bandings dark reddish brown, castaneous or fuscous.

Head shorter medianly than wide through the eyes (110 × 135); lateral margins weakly sinuate and moderately reflexed, converging to a narrowly rounded apex; juga not exceeding the tylus by more than the width of one jugum there and then narrowly overlapping; a single line of dark reddish punctures bordering the vertex laterally and lying adjacent to the ocelli; ocelli bright red and twice as far apart as each is from its eye; eyes fuscous. Antennal tubercles very large, each as big as an eye and totally visible from above; antennae at least three-fourths the length of the body, rich orange brown with the apical third of segment II and the distal halves of segments III and IV piceous; segmental ratios: 70/250/175/150, i.e., antennae four-segmented with segment II the longest, as is typical for the genus.

Pronotum two and two-thirds as wide across the humeri as long medianly (400 × 150); humeri slightly tumid, the angles rectilinear, hardly produced; anterolateral margins mildly sinuate and narrowly reflexed anteriorly; punctures coarse and congested laterally, somewhat more widely spaced centrally; the center ones reddish, the lateral ones castaneous to fuscous; the embossed ochraceous or fulvous portions irregularly reticulate.

Scutellum about one-half longer than wide at the base (340 × 225); basal third gibbous, the crest of this elevation higher than the adjacent surface of the pronotum, very coarsely and deeply pitted with castaneous and

fuscous, basal angles calloused ochraceous; middle third ochraceous with a very few small punctures but with a median line of five or six rotund, very shallow, reddish brown pits; basal half of the distal third, just beyond the point where the frenum ends, provided with two large squarish castaneous, or darker, patches, apical half of this third ochraceous with some shallow coarse punctures; apex narrowly rounded. Hemelytra light ochraceous, provided with a broad band of castaneous, or darker color, across the corium and embolium and continuous with the same colored patches on the scutellum, producing the effect of a very broad dark-colored fascia extending across the middle of the body; additional irregular castaneous or darker patches on the basal portion; membrane hyaline with five subparallel light brown veins. Connexivum alternated, widely exposed, the punctures obsolescent to obsolete; the segmental incisures bordered each side with rich castaneous, broad bands, the intermediate parts bright orange.

Venter essentially concolorous rich orange-brown, impunctate except for a few scattered punctures on and near the acetabula. Evaporatorium castaneous and coarsely rugose; auricle of the metasternal orifice short, finger-like and straight. The second and third (first and second visible) abdominal sternites each provided with a pair of large darker spots, one on each side of the very shallow and broad abdominal furrow; spiracles bordered with reddish brown; each segmental incisure provided with a marginal reddish brown triangular patch. Rostrum relatively long, reaching onto the third abdominal sternite. Legs ochraceous, the femora lightly clouded with brown subapically, the distal ends of the tibiae dark brown; tarsi concolorous ochraceous.

Described from 10 specimens.

Holotype: Female: 18.75 mm. long; 10.2 mm. wide across the humeri. Rio Tapiche, Peru. March, 1928. H. Bassler, collector. Deposited in the American Museum of Natural History.

Paratypes: Eight females, same data as above. One female, Rio Ucayali, Peru. November, 1929. H. Bassler, collector. All deposited in the American Museum of Natural History.

In color pattern this species most nearly approaches *Dinocoris maculatus* (Laporte). The most distinguishing characteristics probably are the over-all larger size and greater dorsal convexity, the contrasting rich ochraceous and castaneous colors, the broad transverse dark band across the middle of the dorsum, the almost concolorous rich orange-brown venter and the femora and tibiae devoid of well-defined fuscous annuli. The least that this new species could be would be a geographical race of *Dinocoris maculatus* in which size has been emphasized and color intensified; it is the author's feeling, however, that it warrants full species status.

Tribe Halyini Stal

Neadoxoplatys longirostra, new species

Obovate, the greatest body width across the suture between the third and fourth abdominal segments; depressed above, mildly convex below; sordid yellow or tan, punctures fuscous, deep and coarse, somewhat irregularly distributed on the pronotum.

Head almost as long medianly as wide through the eyes (100×105); juga and tylus subequal, apex of the head not incised as in related species but moderately rounded; lateral margins sinuate before the eyes and then subparallel; vertex and tylus transversely rugose; parallel bands of congested fuscous punctures extending from the ocelli to the tips of the juga; bases of the juga somewhat impressed just before the eyes, lateral margins very mildly reflexed; eyes brownish red; ocelli bright red, moderate in size and twice as far apart as each is from its eye. Antennae short, barely exceeding the combined length of the head and pronotum, concolorous fulvous, segment I not reaching beyond the apex of the head; segmental ratios: 30/22/40/60/82, i.e., segments II the shortest.

Pronotum three times as wide across the humeri as long medianly (238×80) and twice as wide there when measured longitudinally from the anterior lateral angle (238×120), i.e., the anterior margin deeply excavated to receive the head up to the eyes; margin behind the eyes somewhat oblique; humeri obtusely rounded, not produced; anterolateral margins essentially straight and weakly reflexed; each anterior lateral angle produced as a small, subrectangular lobe, reaching well beyond the lateral limit of the eye; punctures coarse across the middle of the disc; a band of smaller, congested punctures just inside the anterior margin; a band of well-defined fuscous punctures, uniformly spaced and paralleling the anterior two-thirds of the anterolateral margins; remaining punctures sparingly scattered; posterior margin transverse.

Scutellum somewhat longer than wide at the base (190×150), punctures rather regularly distributed but becoming smaller and denser toward the acutely rounded apex; basal angles vaguely calloused sordid yellow. Hemelytra rather regularly punctured, but possessing a triangular, impunctate, discal spot; apical margins very weakly sinuate, the external apical angles rectilinear. Connexivum moderately exposed and moderately punctate, the segmental incisures clouded each side with medium brown; apical segmental angles rectilinear and not exceeding the margin of the abdomen, those on segment VI obtuse.

Venter sordid yellow; base of head and the pleura coarsely punctured with fuscous; abdomen more finely punctured and diffused with testaceous clouding. Mesosternal carina piceous; rostrum long, the apex reaching onto the sixth sternite (male), segmental ratios: 50/20 + 100/120/100, i.e., the second segment and its pseudobase taken together equal to segment III and taken alone equal to segment IV; median abdominal furrow broad and shallow, ill-defined, extending through the fifth sternite. Evaporatorium dark castaneous and irregularly rugose; auricle of the metasternal canal

narrow and evenly curved forward. All segments of the legs concolorous yellow, the ante-apical femoral spines small and fuscous.

Apical margin of the male genital segment trisinate; the submarginal portion of the segment broadly and deeply impressed; parameres (claspers) extending above the dorsal margin of the segment, the heads carinate on the mesal surfaces and provided with a small subapical notch along the posterior margins.

Described from one specimen.

Holotype: Male: 10.5 mm. long; 5.1 mm. wide across the humeri; 5.4 mm. wide across the widest abdominal portion. Amaya Cispata Bay, Colombia, South America. November 25, 1916. Deposited in the American Museum of Natural History.

Smaller than *Neodoxoplatys saileri* Kormilev and apparently related to *Neodoxoplatys haywardi* Kormilev in size and color, but differing from that species by the form of the apex of the head, the presence of lobulate anterior lateral angles on the pronotum, the deeply emarginated pronotal anterior margin, the longer rostrum and the less robust and more strongly curved auricle of the metasternal canal.

Tribe Pentatomini Stal

Oenopiella testacea, new species

Body broadly oval, abdomen somewhat expanded across the second and third segments, the body form, from across the humeral spines to the abdominal apex, subtriangular; background concolorous brick red (testaceous), punctures fuscous, very fine and very dense, those on the hemelytra slightly more wide-spaced; tergum bright orange red.

Head two-thirds the length of the pronotum (60×90) and half again as long medianly as wide between the eyes (60×40); margins sinuate before the eyes, very obscurely reflexed; apex narrowly rounded; tylus just slightly longer than the jugs and weakly elevated; disc somewhat obliquely rugose before the eyes; ocelli red, about four times as far apart as each is from its eye; eyes brownish testaceous. Antennae nearly reaching the apex of the scutellum, segment I not attaining the apex of the head; segments I, II and III fulvous to luteous, their apices narrowly fuscous, segments IV and V fuscous, their bases broadly luteous; segmental proportions: 20/35/32/60/60, i.e., segments II and III, IV and V respectively subequal.

Pronotum roundly excavated anteriorly to receive the head, almost three times as wide across the humeral spines as long medianly (262×90); humeri spinately produced laterally and moderately emarginate just behind the spines; anterolateral margins just before the humeral spines acute and weakly trisinate, then obtusely thickened, slightly tumid, edentate but roughened and terminating at the anterior angles in a minute, oblique denticle; puncturation very fine and very dense except on the cicatrices which are weakly impressed and slightly bronzed; a thin median raised

linea present; posterolateral margins proportionately long, each (including the humeral spine) half as long as the width of the posterior margin which is transversely straight.

Scutellum slightly wider across the base than long (140×130), the frenum ending two-thirds the distance from the base; apex moderately rounded; punctures fine and very dense with a very fine transverse rugosity evident on the basal two-thirds; basal angles minutely impressed but not foveolate or calloused. Hemelytra quite broad, the lateral margins distinctly sinuate at the basal third; apical margins essentially straight, the external apical angles roundly acute; punctures more widespaced than those on the pronotum and scutellum and very evenly distributed; membrane transparent, light fulvous with six or seven concolorous veins, one or two of which bifurcate. Connexivum concolorous, narrowly exposed; apical segmental angles rectilinear and very slightly produced; transverse diameter across the second and third segments equal to the width of the pronotum across the humeri, exclusive of the humeral spines.

Venter concolorous fulvous to sordid yellow except the propleura which are lightly infuscated; punctures confined to the thoracic pleura; evaporatorium concolorous with the disc and transversely rugose; auricle of the metasternal orifice small, not much longer than the diameter of the ostiole, and terminating abruptly. Legs luteous to fulvous; femora dotted with sharply defined, circular, castaneous spots which are arranged in three or four irregular annuli; tibiae terete, with similar castaneous spots, but these not arranged in a specific pattern; tarsi concolorous. Rostrum barely surpassing the metacoxae. Abdomen unmarked in any way.

Apical margin of the male genital segment thin, broadly and deeply emarginate (V-shaped); lateral apical angles thickish, acutely rounded, their inner surfaces tumid; parameres (claspers) quite small, their heads vertically weakly arcuate, blunt-tipped and not at all reaching the dorsal margins of the segment. Basal plates of the female genital valves proportionately small, nearly equilateral triangular, the apices acute and slightly tumid.

Described from four specimens.

Holotype: Male: 8.0 mm. long; 6.5 mm. wide across the humeral spines; 5.5 mm. wide across the greatest abdominal diameter. Rio Santiago, Peru. November 27, 1924. H. Bassler, collector. Deposited in the American Museum of Natural History. Unfortunately this specimen is in very poor condition; being the only male in the type series it is, however, chosen as the holotype.

Allotype: Female: 8.25 mm. long; 7.5 mm. wide across the humeral spines; 6.0 mm. wide across the greatest abdominal diameter. Rio Santiago, Peru. November 27, 1924. H. Bassler, collector. Deposited in the American Museum of Natural History.

Paratypes: One female, Upper Rio Maranon, Peru. October 11, 1924. H. Bassler, collector; one female, San Martin, San Martin, Peru. December 16, 1946. J. C. Pallister, collector. Both deposited in the American Museum of Natural History.

By virtue of the subtriangular shape of the major posterior portion of the body this species readily distinguishes itself from other known species. The brick-red dorsum, the strikingly spotted femora and tibiae, the ampliate nature of the basal portion of the abdomen and the impressed cicatrices are additional distinctive characteristics. As far as general color goes it is probably most closely related to *O. punctaria* Stal.

(continued from page 144)

MEETING OF NOVEMBER 20, 1956

A regular meeting of the Society was held at the American Museum of Natural History; President Vishniac presiding. The Society voted unanimously to send a letter of congratulations to Professor Von Frisch, upon his 70th birthday. A letter from the Zoological Society of London expressing thanks for our contribution to the Zoological Record Fund was read. Mr. Peter Farb was elected to membership in the Society.

Dr. Treat introduced the speaker of the evening, Dr. Ilse Schwink, a visiting investigator at New York University. Dr. Schwink discussed "Orientation in Moths", drawing extensively upon her own very interesting experiments conducted in Von Frisch's laboratory.

Females of the silkmoth, *Bombyx mori* secrete an odor which initiates the mating flight of the males. The male moths, however, do not locate the female by flying toward the source of this odor, as has commonly been supposed. Instead, the males fly against the wind, a reaction which usually brings them fairly close to a female moth. Then, over a distance of a few feet, the males can locate the females by smell, and mating ensues.

Dr. Schwink suggested that the female odor might more properly be considered a "releaser" of behavior than an attractant, and this hypothesis was supported by numerous laboratory experiments. The releaser substance has been chemically characterized in Professor Butenandt's laboratory, and found to be an alcohol-like substance of fairly low molecular weight, probably having 10 to 15 carbon atoms. The substance is active as an alcohol but not as an ester, or in its bound form within the gland. It is a stable substance during several hours in the atmosphere, and is largely species-specific.

Ablation experiments showed that the receptors for this odor are distributed over the entire antenna of the male moth; removal of parts of the antenna diminishing the response of the male in a manner exactly similar to the effect of diluting the releaser substance to a weaker concentration.

A lively question period continued until 9:45 P.M. when the meeting was adjourned.

EDWARD S. HODGSON, *Secretary*

(continued on page 160)

A NEW SPECIES OF STENEOTARSONEMUS, AND
ADDITIONAL INFORMATION ON THE PLANT-
FEEDING HABITS OF STENEOTARSONEMUS
FURCATUS DE LEON (ACARINA)¹

BY ROBERT E. BEER

DEPARTMENT OF ENTOMOLOGY, UNIVERSITY OF KANSAS

Very little is known about the food habits of tarsonemid mites. Of the forty-one species in the family Tarsonemidae known to occur in North America, twelve are definitely known to feed on the higher plants and five are definitely fungivorous. Of the remaining twenty-four species, circumstances attending their collection would suggest that five of the species probably feed on higher plants, twelve are probably fungivorous, possibly two species are parasitic on arthropod hosts and the feeding habits of five species are open to considerable question. Since it is obvious that behavioral differences and similarities often provide valuable clues for systematic alignment of species, this paper reports new information on feeding habits of two species of tarsonemid mites. It is to be noted that the new hosts here recorded are plants that are grown commercially and hence both of the mite species should be considered as potential greenhouse pests in situations where the host plants are grown.

Steneotarsonemus keiferi, new species

MALE.—Body broadly oval, broadest slightly behind main body suture. Legs short and stout, the anterior pairs subequal in size, posterior pairs both well-developed. Apodemes conspicuous and of typical design and location. Dorsum with three well-defined plates, each finely and densely punctate, the propodosomal shield trapezoidal and bearing near its lateral margins four pairs of setae; metapodosomal shield hemispherical, with three pairs of setae near its lateral margins; opisthosomal shield rectangular, with a pair of setae near posterolateral extremities. Dorsal propodosomal setae in linear longitudinal series, the third and fourth setae subequal in length but third more stout; first seta two thirds as long as third and one and one-fourth times as long as second. First dorsal hysterosomal setae slightly longer than longest propodosomals, twice as long as second and third dorsal hysterosomals which are of equal size. Dorsal opisthosomals

¹ Contribution No. 1012, Department of Entomology, University of Kansas.

slightly longer and more robust than second and third hysterosomals. First ventral propodosomal setae very small, one half as long as second dorsal propodosomals, situated one and one-half times length of seta from Y-shaped juncture of apodemes, toward middle of interapodemal area. Second ventral propodosomals only slightly longer than first setae, located near center of interapodemal areas. First ventral hysterosomals twice as long as ventral propodosomals, located on apodemes III at their anterior extremities. Second ventral hysterosomals slightly longer than setae of first pair, located on apodemes IV at about mid-length of apodemes.

Capitulum: Subcordate, as broad as long; length, 33μ ; greatest width 36μ ; dorsal setae as long as first dorsal propodosomals, ventral setae two-thirds as long. Palpi short and robust, terminal setae spinelike. Chelicerae short, needlelike; length from tips to slightly recurved and flanged bases about equal to length of third dorsal hysterosomal seta.

Legs: Legs I and II subequal in general size and segmentation; leg I with simple setae distributed as follows: femur and genu each with four, tibia with five, tarsus with three; modified setae as follows: tibia with three specialized setae located dorsally nearly in transverse alignment, the one nearest to inner margin of segment shortest and peglike, beside it a slightly longer capitate seta, beside capitate seta a slightly longer, tapering, peglike seta; four stout, curved, blunt setae on tarsus, one short, stout, peglike seta located dorsally near base of segment, a similar seta ventral in position near apex; tarsus subtended by a large disclike empodium and a stout curved claw. Leg II with simple setae distributed as follows: femur and genu each with three, tibia and tarsus each with four; two short, stout sensory pegs near base of tarsus, the segment subtended by two stout, curved claws and a broadly circular empodium. Leg III with simple setae as follows: femur with one, genu with three, tibia and tarsus each with four; one stout lanceolate seta located ventrally at apex of tarsus, this segment subtended by two stout, curved claws between and beyond which projects broad circular empodium. Leg IV robust, coxa with one ventral seta as long as segment; femur with outer margin strongly convex, inner margin with truncated projection at midlength of segment and bearing a short, stout, dorsal seta, one dorsal seta near outer margin at mid-segment, one ventral seta near inner margin at apex of segment; tibia slightly longer than broad, outer margin straight, inner margin slightly concave, with one stout spiculate seta twice as long as segment located ventrally near apex of segment, one dorsal peglike seta with length equal to width of segment situated near outer apical margin; tarsus very small, bearing three small setae, two of which are ventral, one dorsal; leg terminates with a strong, stout, curved claw.

Genital papilla: Length, 32μ ; width, 32μ ; subcordate, with a pair of short setae near lateral margins at posterior fourth of papilla; pregenital papilla conspicuous, heavily sclerotized, located the width of coxa IV anterior to anterior margin of genital papilla.

Measurements: Length from tips of palpi to apex of genital papilla, 219μ ; main body suture to apex of genital papilla, 120μ ; greatest width of body, 117μ .

FEMALE.—Body broadly oval, broadest at mid-length. Pseudostigmatic organs ovoid with acuminate apices, pedicel as long as expanded distal portion; situated laterally between and slightly above adjacent bases of coxae I and II in recessed groove overhung by dorsal shield of propodosoma. Apodemes strong and conspicuous, apodemes I, II and transverse apodemes clearly delineating the interapodemal areas of propodosoma; apodemes III and IV distinct, posterior median apodeme weak. Dorsal shield of propodosoma trapezoidal, well-defined and punctate as in male, with a pair of small setae at anterolateral extremities, a pair of stout setae as long as genu I located near posterior margin of shield, separated from each other by distance equal to three times length of seta. Stigmal openings conspicuous, located on lateral margins of dorsal shield of propodosoma, the length of first dorsal propodosomal seta behind these setae. Dorsum of hysterosoma divided transversally to form four distinct segments, the first segment with a pair of humeral and a pair of dorsocentral setae, second segment with a pair of dorsalcentrals, third segment with a pair of dorsolaterals and a pair of dorsocentrals, fourth segment with a pair of dorsolateral setae; all dorsal hysterosomal setae nearly equal in length except humerals which are twice as long. Ventral propodosomal setae minute, the first pair located in anterior fourth of interapodemal area, the second pair located adjacent to apodemes II at their mid-length. Ventral hysterosomal setae one and one-half times as long as ventral propodosomals, the first pair located on apodemes III, the second on apodemes IV; one pair of small setae near apex of hysterosoma.

Capitulum: Subcordate with posterior margin rounded truncate; length, 35μ ; greatest width, 36μ . Dorsal setae slightly longer and stouter than ventral setae. Palpi short and stout, subterminal seta short, tapering, peglike. Chelicerae needlelike, one half as long as capitulum, their outward curved bases expanded.

Legs: Anterior pairs robust, subequal in size and design. Leg I with simple setae distributed as follows: four each on femur and genu, eight on tibiotarsus; specialized setae as follows: two short, stout, lanceolate setae and four long, curved setae on apical half of tibiotarsus; one short peglike, one capitate and one long peglike setae arranged in transverse row, dorsally at basal fifth of tibiotarsus and one dorsal lanceolate seta at basal fourth of segment; tibiotarsus subtends a large subcircular empodium and a strong curved claw. Leg II with simple setae distributed as follows: three each on femur and genu, four each on tibia and tarsus; modified setae on tarsus only, a stout, peglike seta near base, two stout conical setae, one located dorsally at basal third of segment the other ventrally at apex; tarsus subtends two large, spreading, curved claws between and beyond which projects a large subcircular empodium. Leg III robust with simple setae distributed as follows: three on telofemur, four each on tibia and tarsus; one stout, conical seta located ventrally at apex of tibiotarsus, this segment subtending two large, curved, spreading claws between and beyond which projects a large subcircular empodium. Leg IV coxae and trochanters small and without setae; third segment seven times as long as broad, with two simple setae the distal seta one half as long as segment;

fourth segment one third as long as third segment, the stout, spiculate sub-terminal seta nearly twice as long as segment, terminal seta long and slender, as long as leg IV.

Measurements: Tips of palpi to apex of opisthosoma, 250 μ ; tips of palpi to main body suture, 98 μ ; greatest width of body, 146 μ .

HOLOTYPE: Male, Sharp Park, San Mateo County, California, January 14, 1957, W. Davis, on *Odontoglossum* orchid (hybrid).

ALLOTYPE: Female, same data as holotype.

PARATYPES: Twenty-six males, thirty-five females with same data as holotype.

LOCATION OF TYPES: Holotype, allotype, fifteen males and twenty females of paratype series deposited in the Snow Entomological Museum, University of Kansas. Six males and ten females deposited in the collection of the Bureau of Entomology, California State Department of Agriculture, Sacramento, California. Five males and five females of paratype series deposited in the United States National Museum, Washington, D. C.

This species has a close morphological resemblance to *Steneotarsonemus furcatus* De Leon and *S. pallidus* (Banks) from which males may be distinguished most readily by the chaetotaxy of leg IV. The single collection from which the species is now known was sent to me by H. H. Keifer of the Bureau of Entomology, California State Department of Agriculture. Mr. Keifer has communicated the information that the mites were reported damaging the host orchid, though the significance and type of damage was not known to him. The species is named to honor Mr. Keifer and thus in a small way serve to recognize the fine cooperation and encouragement that the present author and many students of acarology at the University of Kansas have received from him for many years.

Steneotarsonemus furcatus DeLeon

Since the publication of the original description of *S. furcatus* by DeLeon in 1955 in which this mite species was clearly identified as feeding on an ornamental grass, *Paspalum* sp., further host associations have not been reported. It is of considerable interest that a second green plant host is now known to be damaged by this mite. Several specimens were sent to me by A. E. Pritchard (University of California) with a notation that a report had been received that severe infestations had been discov-

ered in greenhouse-grown maranta plants. The mites were apparently causing a severe distortion of leaf growth giving a stunted appearance to the infested plants. This information was later confirmed by H. H. Kiefer (California State Department of Agriculture) who had received a similar report.

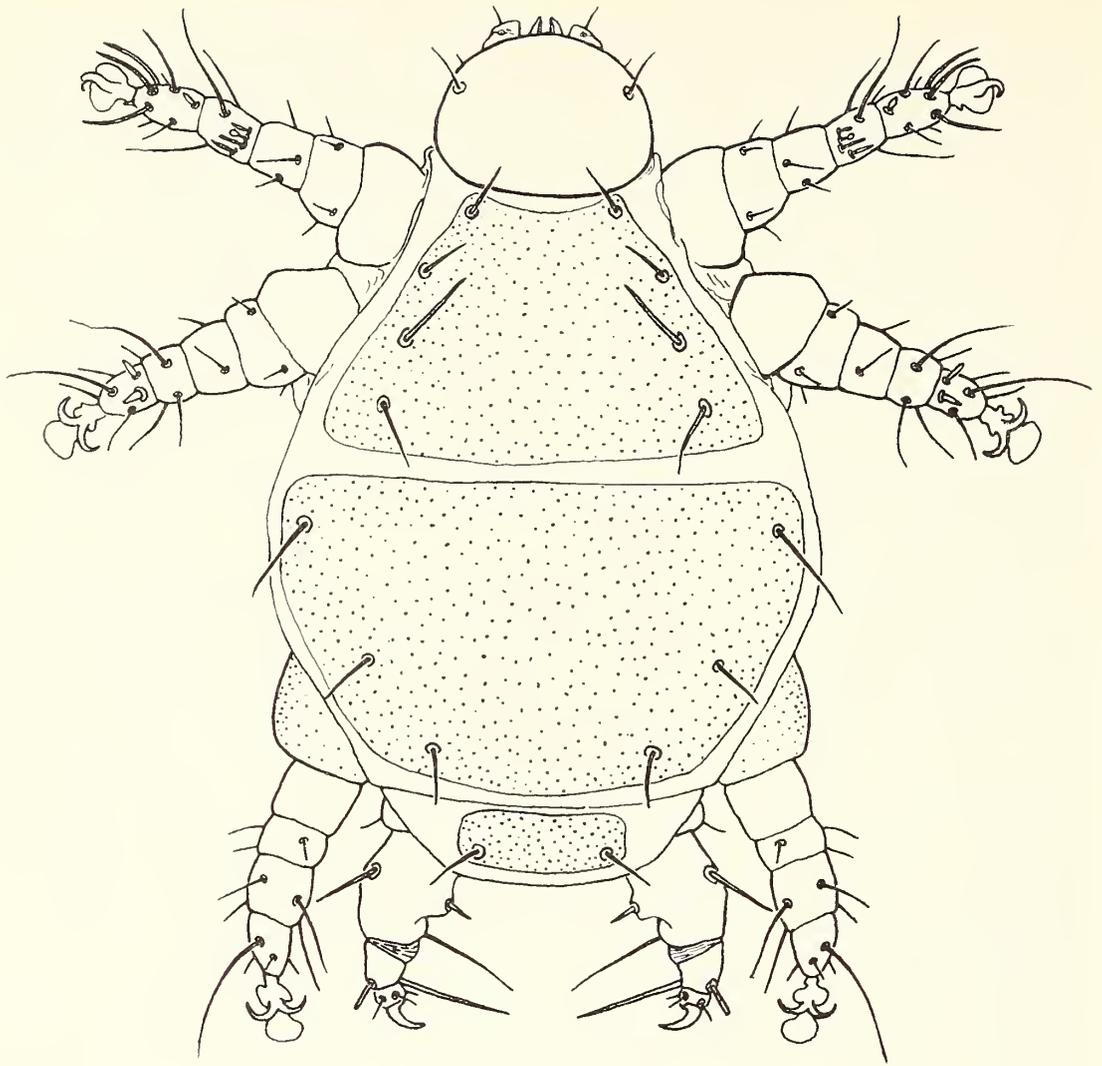
The first collections that I received were taken by an unidentified collector from *Maranta leuconeura* var. *Kerchoveana*, originally grown in Buena Park, Los Angeles County, California but intercepted in the city of Los Angeles on August 26, 1953. Subsequently several specimens collected by D. H. Byers from *Maranta leuconeura* at Buena Park on September 4, 1953 were sent to me for identification.

Most of the species of tarsonemid mites that are definitely known to feed on the higher plants seems to show a high degree of host specificity. Notable exceptions are *Steneotarsonemus pallidus* and *Hemitarsonemus latus*. Both of these species have long lists of plants that apparently are suitable hosts, however none of the included hosts are grasses. Several species of *Steneotarsonemus* show a definite predilection for various species of Gramineae, some apparently being restricted to a single host species and others feeding on several kinds of grasses. *S. furcatus* is therefore the first tarsonemid species for which a grass and a non-grass plant apparently serve as suitable hosts.

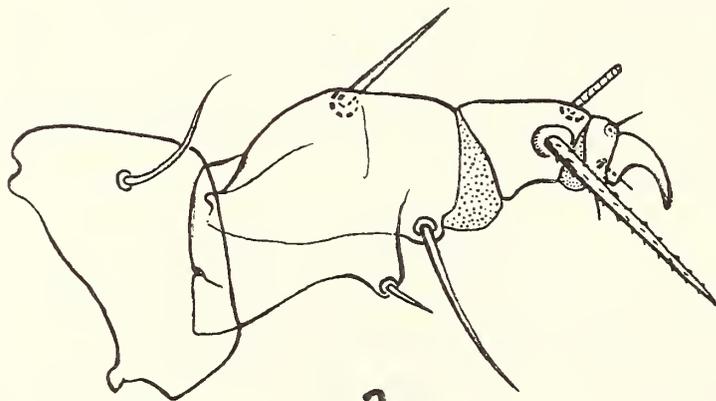
With this added bit of information, the somewhat paradoxical situation noted by Beer (1954) that within the genus *Steneotarsonemus* there was a sharp delineation of species groups based upon food plant preferences can be reconsidered. In the matter of host plant selection, at least, the members of the genus *Steneotarsonemus* now seem to consist of several species of grass-feeders, several non-grass feeders and this one species that feeds on both types of green plants.

LITERATURE CITED

- BEER, R. E. 1954. A revision of the Tarsonemidae of the Western Hemisphere. Univ. Kansas Sc. Bull. **36**: 1091-1387.
- DE LEON, D. 1956. Four new Acarina in the family Tarsonemidae. Florida Ent. **39**: 105-112.

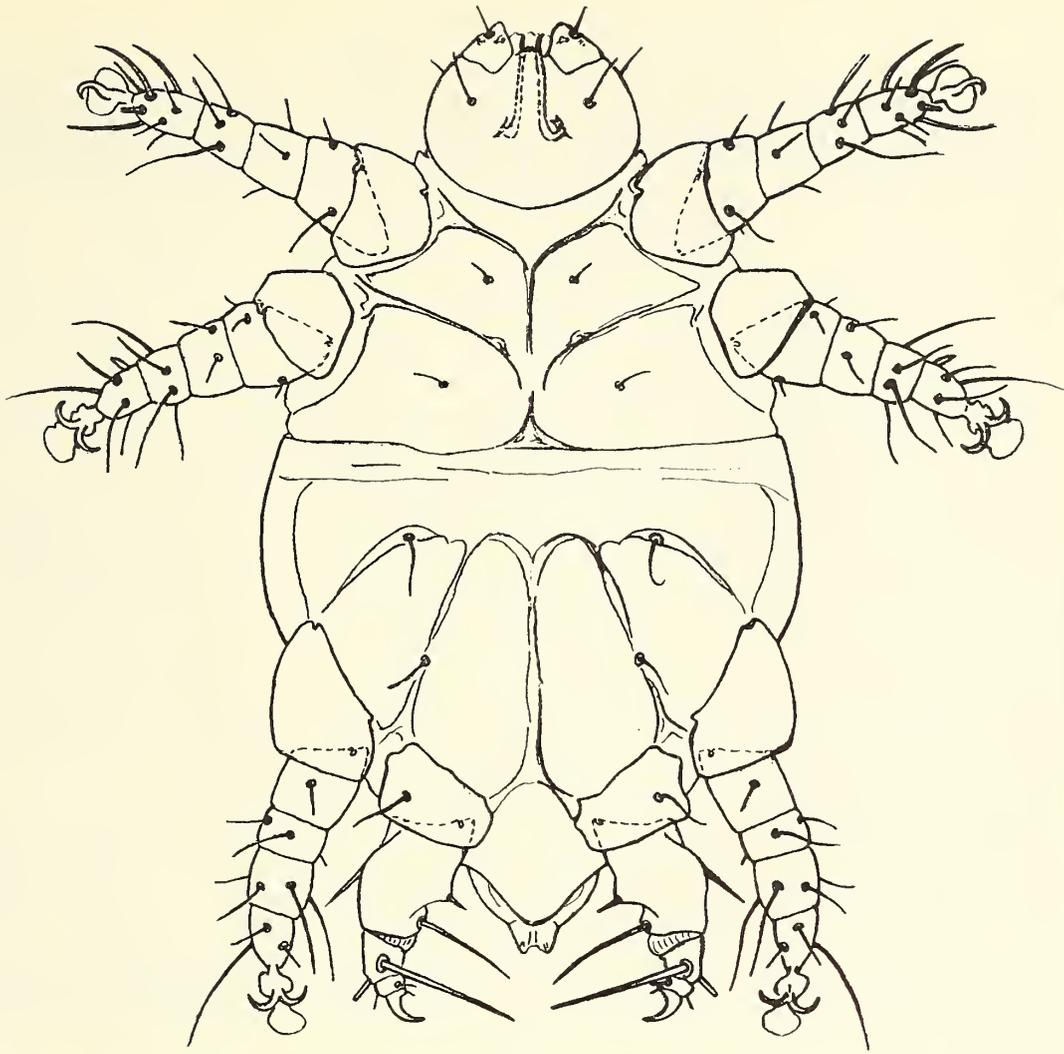


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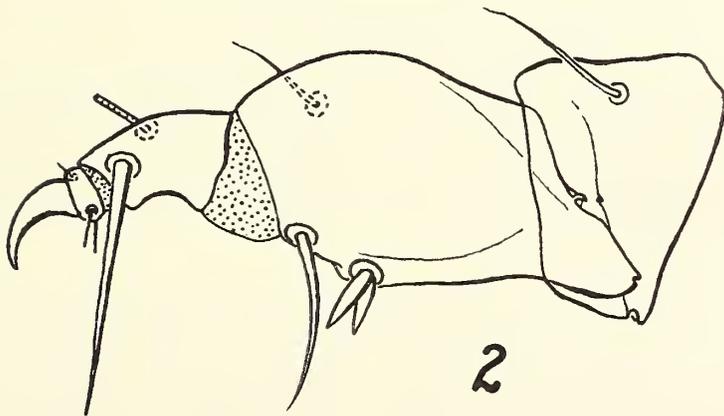


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Fig. 1. *Steneotarsonemus keiferi*, new species, male, dorsal aspect.
Fig. 2. *S. keiferi*, n. sp., male leg IV in ventral aspect.



1



2

Fig. 1. *Steneotarsonemus keiferi*, new species, male, ventral aspect.
Fig. 2. *S. furcatus* DeLeon, male leg IV in ventral aspect.

(continued from page 152)

MEETING OF DECEMBER 4, 1956

A regular meeting of the Society was held at the American Museum of Natural History; President Vishniac presiding. Drs. Treat and Vishniac gave brief announcements about the AAAS and Entomological Society of America meetings to be held in New York the last week of December.

The Society was especially fortunate to have honorary member Su Zan Swain, as the speaker of the evening. Mrs. Swain presented a "Survey of Illustrations of Insects" which included an exhibition of fifteen volumes and folios of special interest. Some of these were published before 1700, and most appeared before 1756. Mrs. Swain commented that the art of painting insects was most perfect about 200 years ago and has declined since.

Among the interesting examples discussed was the work of Marian Merian who came to America in 1690 for the sole purpose of studying insects in Dutch Guinea, and published hand painted wood engravings of many tropical species. The volume of paintings by Carl Clerck included insects mounted by Linnaeus himself, only six or seven copies of this rare work are known to be in existence. Another rarity, the paintings of Titian Peale, an early American naturalist, was also displayed. Mr. Peale's paintings and manuscript have not been published to this day.

Mrs. Swain exhibited some of her own insect paintings and discussed the problems and criteria of judgment involved in this type of illustration. Her objective has been to paint insect portraits, with the insect as naturally posed as possible, having all identifying characters clearly revealed. Microscopic study of live animals, museum specimens or photographs as well as special photographic paints and special methods of transferring sketches are used.

Following the talk the members and guests browsed over the exhibit of paintings which Mrs. Swain had assembled, and a few tasted of some caterpillars, grasshoppers, and bees which Mrs. Swain provided as surprise refreshments.

EDWARD S. HODGSON, *Secretary*

MEETING OF JANUARY 15, 1957

The meeting was called to order at 8:10 P.M. in Room 419 of the American Museum of Natural History. President Vishniac was in the Chair. There were 15 members and 40 visitors present.

This being the Annual Meeting of the Society, President Vishniac called for reports of the various officers.

Mr. Soraci, Editor of the Journal reported that the 1955 volume of the Journal was in the hands of the printer and would be issued shortly and that the 1956 volume was in the process of being compiled and would very soon go to the printer. It should be issued shortly after the appearance of the 1955 volume. Each will represent one full year's issue.

Dr. Asher Treat, Chairman of the Program Committee announced that

(continued on page 170)

UNDESCRIBED SPECIES OF CRANE-FLIES FROM
THE HIMALAYA MOUNTAINS (TIPULIDAE,
DIPTERA), III¹

BY CHARLES P. ALEXANDER
AMHERST, MASSACHUSETTS

The preceding part under this general title was published in the JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY, 65: 147-157; 1957 (publ. 1958). The materials discussed at this time were secured by Dr. Edward I. Coher and native assistants in various parts of Nepal in 1957. The conditions under which these collections were made is discussed in some detail in two earlier papers.² In these the opinion is expressed that the crane-fly fauna of east-central Nepal is quite distinct from that of the Darjeeling District some 200 miles to the east. The rich collections made by Dr. Coher in 1957 bear this out and it may be stated that the great majority of the species are distinct from those known from Darjeeling and vicinity, being more like those of western China and northeastern Burma. It is certain that an exceedingly rich crane-fly fauna exists throughout the eastern Himalayas. I wish to express my continued thanks to Dr. Coher for the time and effort devoted to collecting these flies, the types of all novelties being preserved in my collection.

Lipsothrix malla new species

General coloration of the mesonotum brown, pleura light yellow; antennae of male relatively long, about one-third the body; knobs of halteres infuscated; legs pale brown, tips of femora and tibiae narrowly darkened; wings with a weak dusky tinge, stigma pale brown; male hypopygium with the interbases very slender, slightly expanded at tips; phallosome large and complex, appearing as paired curved rods from expanded bases.

MALE. Length about 6.5-7 mm.; wing 7-7.5 mm.; antenna about 2-2.4 mm.

¹ Contribution No. 1293 from the Entomological Laboratory, University of Massachusetts.

² Alexander, C. P. Undescribed species of crane-flies from the Himalaya Mountains (Tipulidae, Diptera), I. Journ. N. Y. Ent. Soc., 64: 137-147; 1956 (published 1957).

Alexander, C. P. New or little-known Tipulidae from eastern Asia (Diptera), XLV. Philip. Journ. Sci. (in press, 1958).

Rostrum yellow to brown; palpi black. Antennae of male relatively long, about one-third the body; scape and pedicel yellow, flagellum dark brown; flagellar segments elongate, clothed with a dense white pubescence and sparse scattered slightly longer verticils that are much shorter than the segments. Head yellowed in front, darker behind; in the paratypes the head is darkened throughout.

Pronotum dark brown; pretergites yellow. Mesonotal praescutum with medium brown stripes, the restricted interspaces a little paler; scutal lobes dark brown; scutellum paler brown, parascutella yellow; mediotergite dark brown. Pleura light yellow, the pleurotergite a trifle darker. Halteres with stem whitened, knob infuscated. Legs with all coxae and trochanters pale yellow; remainder of legs pale brown, the tips of the femora and tibiae narrowly brown to black; claws with a single acute tooth. Wings with a weak dusky tinge; stigma oval, pale brown; veins brown. Venation: Sc long, Sc_1 ending opposite the fork of Rs , Sc_2 near its tip; R_2 shorter than either R_{1+2} or R_{2+3} , the latter shorter than R_{1+2} ; R_{2+3+4} slightly longer than cell 1st M_2 , the latter rectangular; $m-cu$ at or shortly beyond the fork of M . One wing of one paratype has cell M_2 open by the atrophy of m .

Abdominal tergites brown, the outer segments, including the hypopygium, still darker, sternites more reddish brown. Male hypopygium with the dististyles terminal, the outer style slender with both the apical and subapical spines acute; inner style broadest on basal half, narrowed outwardly, tipped with unusually long setae. Interbase very slender, the apex a little expanded, pale. Phallosome large and complex, appearing as paired curved rods from expanded bases, the length slightly greater than that of the basistyle.

Holotype, ♂, Simbhanjang Pass, Nepal, 8197 feet, June 24, 1957 (Coher). Paratopotypes, 2 ♂♂.

The most similar regional species include *Lipsothrix burmica* Alexander and *L. kashmirica* Alexander, readily distinguished by the structure of the male hypopygium, particularly the interbases.

***Lipsothrix chettri* new species**

General coloration of thorax yellow, the dorsum more fulvous yellow; head reddish brown; pronotal scutum dark brown; halteres yellow; legs yellow, the tips of the femora and tibiae very narrowly and inconspicuously darkened; wings pale yellow, veins yellow; Sc_1 ending nearly opposite the fork of Rs ; cell 1st M_2 very small, M_{3+4} from two-fifths to one-third as long as vein M_4 .

FEMALE. Length about 8 mm.; wing 7.5 mm.

Rostrum reddish brown; outer segments of palpi black. Antennae with basal segments brownish yellow, outer segments dark brown; flagellar segments subcylindrical, subequal to the longest verticils. Head reddish brown.

Pronotal scutum dark brown, scutellum and pretergites pale yellow. Mesonotum fulvous yellow, with an opaque more yellowed bloom. Pleura

yellow. Halteres yellow. Legs with all coxae and trochanters light yellow; remainder of legs obscure yellow, the tips of the femora and tibiae very narrowly and inconspicuously darkened; teeth of claws small, basal in position. Wings pale yellow, unpatterned; veins yellow. Veins of outer half of wing with macrotrichia. Venation: Sc_1 ending nearly opposite the fork of Rs , Sc_2 near its tip; R_{2+3+4} gently arcuated, about one-half longer than cell $1st M_2$; veins R_{2+3} , R_2 and R_{1+2} subequal; cell $1st M_2$ small, rectangular, vein M_{3+4} about two-fifths to one-third as long as M_4 ; $m-cu$ at or shortly beyond the fork of M .

Abdomen reddish brown, basal tergites darker brown medially above. Ovipositor with valves reddish horn color.

Holotype, ♀, Simbhanjang Pass, Nepal, 8197 feet, June 24, 1957 (Coher).

The most similar regional species having the body, halteres and wings pale yellow and with the venation somewhat the same is *Lipsothrix flavissima* Alexander, of northeastern Burma. This differs in slight details of coloration and venation, particularly of the medial field. I have no doubt but that the discovery of the male sex will provide stronger points of distinction between the two flies.

Gonomyia (Ellipteroides) ebenomyia new species

General coloration of body and appendages black, including the antennae, halteres and legs; wings strongly blackened; cell $2nd M_2$ slightly longer than its petiole, $m-cu$ nearly one-half its length before the fork of M ; ovipositor with the cerci unusually long and slender.

FEMALE. Length about 6.5 mm.; wing 5 mm.

Rostrum dull black; palpi black. Antennae black throughout; basal flagellar segments suboval, with truncated ends, outer segments slightly more elongate; verticils exceeding the segments. Head dull black, sparsely pruinose; anterior vertex broad.

Thoracic dorsum black, surface subnitidous; posterior sclerites and pleura somewhat duller; dorsopleural membrane and meron a trifle paler. Halteres and legs black throughout, the latter conspicuously hairy. Wings with a strong blackish tinge, the long narrow stigma darker; veins brown. Vein beyond cord with strong macrotrichia, lacking on R_{2+3+4} and bases of R_3 and R_4 . Venation: Sc_1 ending about opposite midlength of Rs ; R_{2+3+4} about twice the basal section of R_5 ; cell $2nd M_2$ slightly longer than its petiole; $m-cu$ from about one-third to nearly one-half its length before the fork of M .

Abdomen black. Ovipositor with the cerci only slightly hairy, long and slender, especially the outer half; in the type slide, the cerci are twisted just beyond midlength, possibly representing a normal condition.

Holotype, ♀, Parewavir, Nepal, March 28, 1957 (Coher).

The most similar regional species is *Gonomyia (Ellipteroides)*

schmidi Alexander, of the western Himalayas, differing particularly in the details of venation. The female sex of *schmidi* is still unknown. It may be noted that the structure and vestiture of the cerci of the present fly are quite different from the condition in various Ceylonese species of the subgenus where the female sex is known.

Gonomyia (Idiocera) coheriana new species

Mesonotum brown, the posterior sclerites darker; pleura infuscated dorsally, clear yellow below; rostrum and palpi black; basal segments of antennae light yellow, flagellum brownish black; legs yellow, the outer tarsal segments black; wings subhyaline, restrictedly patterned with darker; male hypopygium with the apical lobe of the basistyle stout, tip obtuse; four dististyles, the outer a slender rod with about five small spinules on surface; apex of aedeagus recurved.

MALE. Length about 5 mm.; wing 5.5 mm.

Rostrum and palpi black. Antennae with the scape and pedicel light yellow, flagellum brownish black; basal flagellar segments long-suboval, outer ones more elongate, a little shorter than the longest verticils. Head light yellow in front, more infuscated on posterior half and as a central darkening on the vertex.

Pronotum and pretergites light yellow. Mesonotal praescutum chiefly covered by three confluent brown stripes, the humeral and lateral regions yellow, pseudosutural foveae reddish; scutal lobes brown, scutellum and postnotum darker brown. Pleura with the dorsal half moderately infuscated, the ventral portion clear light yellow. Halteres infuscated. Legs with the fore coxae weakly infuscated, remaining coxae and trochanters yellow; remainder of legs yellow, tips of tibiae narrowly darkened, outer tarsal segments black. Wings subhyaline, base and costal region more yellowed; a restricted and inconspicuous brown pattern, including the small stigma and still smaller marks at origin of *Rs*, cord, *m-cu* and tip of vein R_4 ; a paler brown subterminal wash in cells R_3 and R_4 ; veins light brown, more brownish black in the patterned areas. Venation: *Sc* short, Sc_1 ending just beyond the perpendicular origin of *Rs*, Sc_2 retracted; distance on costa between R_{1+2} and R_3 only about one-third to one-fourth the latter; cell 2nd M_2 about one-half longer than its petiole; *m-cu* about twice its length before the fork of *M*.

Abdominal tergites brown, incisures narrowly pale, sternites light yellow; hypopygium brownish yellow. Male hypopygium with the lobe of the basistyle long, stout, tip broadly obtuse. Four dististyles or profound branches; outer style a long slender gently sinuous rod or spine, extended into a long point, on surface beginning at near midlength with five or six acute spinules, the outer one smallest; second style longest, on outer two-thirds more expanded into a curved flattened blade, tip obtuse, surface glabrous; intermediate style shorter, stem pale, apex darker and more expanded, weakly and unequally bifid, margins irregularly toothed or erose;

innermost style smallest, a simple straight rod that narrows to an acute spine, before apex with about three long pale setae, with still others along the lower margin; additional to the four major dististyles a further small pale needlelike point, about one-half as long as the innermost style. Aedeagus slender, its tips gently recurved into a crook.

Holotype, ♂, Parewavir, Nepal, March 26, 1957 (Coher).

I take great pleasure in dedicating this very interesting *Idiocera* to the collector, Dr. Edward I. Coher, my former student and fellow specialist in the Diptera. While generally similar to some other regional species, such as *Gonomyia (Idiocera) petilis* Alexander, it differs strikingly from all previously known species in the structure of the male hypopygium, particularly the outermost dististyle.

***Gonomyia (Idiocera) satanas* new species**

General coloration of entire body, including also the mouthparts, antennae, halteres and legs, black; wings strongly tinged with blackish, stigma still darker; Sc_1 fully twice as long as $m-cu$; vein R_3 suberect, on costa separated from R_{1+2} by a distance about two-thirds its length; $m-cu$ about its own length before the fork of M .

FEMALE. Length about 5.5 mm.; wing 5 mm.

Rostrum and palpi black. Antennae black throughout; flagellar segments oval. Head black.

Thorax uniformly dull black or plumbeous black, the pseudosutural foveae more intense polished black. Halteres black. Legs entirely black. Wings strongly tinged with blackish, the oval stigma still darker; veins brownish black, those in the prearcular field brown. Venation: Sc_1 ending just beyond the origin of Rs , Sc_1 alone fully twice $m-cu$; vein R_3 suberect, separated from R_{1+2} on costa by a distance about two-thirds its length; cell 2nd M_2 more than twice its petiole; $m-cu$ about its own length before the fork of M .

Abdomen dull brownish black to black, including the ovipositor.

Holotype, ♀, Jhawani, Nepal, March 19, 1957 (Coher).

Paratopotype, 1 ♀, pinned with the type.

Readily told from all other regional members of the subgenus by the black color of the body and appendages. The most similar regional species is *Gonomyia (Idiocera) phaosoma* Alexander, readily told by the coloration of the body and legs and by the venation.

***Gonomyia (Gonomyia) turritella* new species**

Mesonotal praescutum and scutal lobes blackish gray; rostrum yellow; antennae black throughout, pedicel enlarged; legs brown; wings faintly tinged with brown, stigma ill-delimited; Sc long, cell R_3 unusually large,

cell 1st M_2 small; male hypopygium with two terminal dististyles, outer style extended into a long slender spine, inner style with a long arm that bears a single spine at apex; phallosome with the aedeagus subhyaline, tip obtuse; gonapophyses equal in size, each narrowed apically into a long slender spine.

MALE. Length about 4–4.2 mm.; wing 4.6–4.8 mm.

FEMALE. Length about 4.5 mm.; wing 4.5 mm.

Rostrum obscure yellow; palpi brown. Antennae black; pedicel enlarged; flagellar segments elongate. Head blackish, gray pruinose.

Pronotum and pretergites light yellow. Mesonotal praescutum with three blackish gray stripes that are confluent or virtually so, lateral borders light yellow; scutal lobes blackish gray, the median region yellow; scutellum pale yellow, restrictedly darkened at base, parascutella obscure yellow; mediotergite darkened on central part and behind, the anterior angles yellowed; pleurotergite yellowed dorsally, more darkened behind. Pleura with the mesepisternum and sternopleurite weakly darkened, pteropleurites meron and metapleura light yellow; propleura and dorsopleural membrane yellow. Halteres with stem dirty white, knob infuscated. Legs with coxae brownish yellow, fore pair darker in front; trochanters brownish yellow; remainder of legs brown, the outer segments a little darker. Wings faintly tinged with brown, the prearcular and coastal regions more yellowed; stigma pale brown, ill-delimited; veins brown, paler in the brightened fields. Venation: Sc long, Sc_1 ending about opposite two-fifths the length of R_s , Sc_1 subequal to or shorter than $r-m$; cell R_3 unusually large, vein R_3 subequal to vein R_{2+3+4} , cell R_3 at margin about twice as extensive as cell R_2 ; cell 1st M_2 small; $m-cu$ at or beyond the fork of M .

Abdominal tergites brown, sternites more yellowed; hypopygium light yellow. Male hypopygium with the basistyle relatively slender, without a distinct apical lobe. Dististyles two, terminal in position; outer style smaller, appearing as a simple blade, broadest beyond midlength, gradually narrowed into a long spine, surface except at ends with abundant microscopic setulae; inner style with the body small, the fasciculate setae poorly indicated; outer surface of style produced into a long arm that extends caudad to beyond the level of apex of the outer style, before the obtuse tip with a single powerful black spine; a single seta on stem of arm at near midlength. Phallosome including a subhyaline central structure, its tip obtuse, at near one-third the length bearing a cylindrical arm; gonapophyses two, elongate, equal in size, broadest on proximal two-thirds, the outer end narrowed into a sinuous spine, the tip acute.

Holotype, ♂, Parewavir, Nepal, March 26, 1957 (Coher).

Allotopotype, ♀, March 28, 1957. Paratopotypes, 3 ♂ ♀, March 26–28, 1957 (Coher).

In its somewhat distinctive venation, the present fly is most like *Gonomyia* (*Gonomyia*) *resoluta* Alexander, of Malaya, differing in coloration and in the details of venation. The male sex of *resoluta* is still unknown.

Erioptera (Erioptera) regina new species

Size large (wing of female 6.8 mm.); general coloration of mesonotum polished fulvous and yellow, pleura yellow with blackened heavily pruinose areas; halteres yellow; legs yellow, tips of femora narrowly but conspicuously black; wings weakly tinged with brown, conspicuously patterned with light yellow, including the base, costal border and a broad seam over the cord; abdominal tergites brownish yellow, conspicuously blackened laterally and on the pleural membrane; sternites brownish black.

FEMALE. Length about 7 mm.; wing 6.8 mm.

Rostrum and palpi brown. Antennae with the scape black, remainder of organ brown; flagellar segments suboval, the outer ones more elongate, verticils exceeding the segments. Head polished black, vaguely pruinose in front.

Pronotum obscure yellow. Mesonotal praescutum and scutal lobes polished fulvous, the interspaces more brownish yellow; posterior sclerites of notum light yellow. Propleura dark brown; mesopleura polished yellow to fulvous, with brownish black areas on the anepisternum, ventral sternopleurite and metapleura, these regions heavily light gray pruinose; a blackened spot immediately before the wing root; dorsopleural membrane yellowed. Halteres short, pale yellow. Legs with coxae and trochanters yellow; remainder of legs light yellow, the tips of the femora narrowly but very conspicuously black, involving about one-fifteenth of the segment or less. Wings weakly tinged with brown, conspicuously patterned with light yellow, including the prearcular and costal regions and a broad seam over the cord; narrower and less evident yellow areas around the wing tip and along vein *Cu* to the margin; veins yellow. Venation: Vein *2nd A* moderately sinuous, ending opposite the posterior end of the oblique and gently sinuous *m-cu*.

Abdominal tergites obscure orange yellow, the basal segment, lateral borders of the remaining tergites, and the dorsopleural membrane blackened; sternites brownish black, terminal segment more yellowed. Ovipositor with the cerci horn-yellow, strongly upcurved to the acute tips.

Holotype, ♀, Suna Chudi, Nepal, in jungle, March 23, 1957 (Coher).

The most similar regional species is the equally large *Erioptera (Erioptera) rex* Alexander, of northeastern Burma, which differs especially in the coloration of the body and legs. The abruptly blackened femoral tips of the present fly are particularly distinctive.

Molophilus (Molophilus) gurkha new species

Belongs to the *gracilis* group and subgroup; size medium (wing of male 5.3 mm.); general coloration of mesonotum reddish brown, postnotum and dorsal pleura darker; legs yellow, tarsi brownish black; wings grayish yellow; hypopygium yellow, basistyle with only two lobes, both fleshy; two terminal dististyles, both large and conspicuous; outer style broad on basal

half, thence strongly bent and narrowed into a long black spine, inner style slender, its outer third blackened and dilated into a head; aedeagus unusually stout.

MALE. Length about 4.5 mm.; wing 5.3 mm.

Rostrum brown; palpi dark brown. Antennae broken beyond the pedicel. Head dark brown.

Cervical region and anterior pronotum dark brown, scutellum and pretergites yellowed. Mesonotal praescutum chiefly reddish brown, lightly gray pruinose, humeral region more yellowed, pseudosutural foveae pale; scutal lobes reddish brown, scutellum more testaceous; postnotum darker brown. Pleura brown dorsally and behind, the sternopleurite and meron more yellowed. Halteres weakly darkened, especially the knobs. Legs with all coxae and trochanters pale yellow; femora and tibiae yellow, the tarsi brownish black. Wings grayish yellow, the preareolar and costal fields clearer yellow; veins brownish yellow, macrotrichia darker. Venation: R_2 lying slightly beyond the level of $r-m$; R_{4+5} subequal to $r-m$; petiole of cell M_3 approximately three times $m-cu$; vein $2nd\ A$ gently sinuous, ending before the level of $m-cu$.

Abdomen dark brown; hypopygium yellow. Male hypopygium having the basistyle with only two lobes, the usual dorsal one apparently lacking, the remaining two placed close together and evidently representing the ventral and mesal lobes, the latter a little smaller. Dististyles two, terminal, large and conspicuous; outer style flattened on more than the basal half, thence bent at a right angle into a long black spine, surface of style glabrous; inner style blackened on the slightly enlarged outer third, the apex a short point, on outer margin near base of the head with a microscopic spinule. Aedeagus unusually stout, the tip very slender. Phallosomic plate relatively broad, the apex narrowly obtuse, surface microscopically setulose.

Holotype, ♂, Tribhuvnia Rath, Nepal, Bhainse-Kathmandu Road Mile 61.7, altitude 1925 meters, April 8, 1957 (Coher).

Molophilus (Molophilus) gurkha is readily told from all other generally similar regional species, including *M. (M.) inconspicuus* Brunetti, by the structure of the male hypopygium, especially the basistyle, dististyles and aedeagus.

***Molophilus (Molophilus) sherpa* new species**

Belongs to the *gracilis* group and subgroup; size small (wing of male less than 3.5 mm.); general coloration of thorax reddish brown; wings narrow, tinged with pale brown, costal region light yellow, vein $2nd\ A$ unusually short, ending before the level of $m-cu$; male hypopygium with the ventral lobe of basistyle with a small blackened point, mesal lobe a larger spine; two unequal dististyles, the inner one shorter, with a long brush of setae on mesal face.

MALE. Length about 3 mm.; wing 3.3 mm.

Rostrum brown; palpi black. Antennae short, brownish yellow; flagellar

segments suboval, basal verticils longer than the segments. Head brown.

Pronotum brownish yellow above, dark brown on the sides. Mesonotum almost uniformly reddish brown, the lateral borders narrowly more yellowed; posterior sclerites of notum reddish brown, postnotum vaguely pruinose. Pleura obscure yellow, weakly infuscated dorsally and behind. Halteres with stem obscure yellow, knob slightly more darkened. Legs with the coxae and trochanters obscure yellow; remainder of legs broken. Wings narrow, tinged with pale brown, more fulvous in the Anal field, costal area light yellow; veins pale brown. Venation: R_2 lying immediately before the level of $r-m$; petiole of cell M_3 about two and one-half times $m-cu$; vein 2nd A unusually short, gently sinuous, ending distinctly before the level of $m-cu$.

Abdomen brown, hypopygium more yellowed. Male hypopygium with the dorsal lobe of the basistyle relatively slender, obtuse at tip, with scattered setae to the apex; ventral lobe broad, terminating in a small blackened point or spine; what seems to represent the usual mesal lobe is a single powerful blackened spine. Two dististyles, the outer one long and slender, straight on about the basal six-sevenths, the tip narrowed and curved into a spine, with a small point or tubercle on outer margin at the bend; inner style about two-thirds as long, nearly straight, terminating in a long spine, inner margin at near midlength with a dense brush of long strong black setae. Phallosomic plate broad and obtuse, its surface microscopically setuliferous.

Holotype, ♂, Baridamar, Nepal, August 2, 1957 (Coher).

Molophilus (Molophilus) sherpa is quite distinct from the other described Himalayan species in the diagnostic features, especially those of the male hypopygium. While generally similar to species such as *M. (M.) diversilobus* Alexander and *M. (M.) inconspicuus* Brunetti, it is quite distinct in these structures.

***Molophilus (Molophilus) lepcha* new species**

Belongs to the *gracilis* group, *procericornis* subgroup; general coloration of thoracic dorsum dark reddish brown, pleura more blackened; antennae of male more than one-half the length of the wing; male hypopygium with the dorsal lobe of the basistyle longer than the body of the style, its apex narrowed and glabrous; two dististyles, the outer a blackened rod, the tip acute; inner style expanded on basal two-thirds, with sparse setae.

MALE. Length about 5.5 mm.; wing 5 mm.; antenna about 3 mm.

Rostrum dark brown; palpi black. Antennae of male black throughout, elongate, as shown by the measurements; flagellar segments elongate-fusiform, with very long outspreading black setae, as in the subgroup, these longer than the verticils. Head dark brown.

Thoracic dorsum chiefly dark reddish brown, the humeral region of the praescutum and the restricted pretergites obscure yellow. Pleura blackened, evidently darker than the notum. Halteres broken. Legs with the

coxae and trochanters yellowed; remainder of legs brownish yellow to light brown, the outer tarsal segments slightly darker. Wings broad, faintly tinged with brown; veins and macrotrichia darker brown. Venation: R_2 virtually in transverse alignment with $r-m$; petiole of cell M_3 about twice the oblique and somewhat sinuous $m-cu$; vein 2nd A relatively short, ending opposite the posterior end of $m-cu$.

Abdomen, including the hypopygium, dark brown. Male hypopygium with the dorsal lobe of the basistyle longer than the body of style, the narrowed glabrous apex slightly curved; ventral lobe basal in position, small, with retrorse setae at apex; mesal lobe apical, very slender, with long setae. Two dististyles, the outer a simple glabrous blackened rod, narrowed very gradually to the acute tip, inner style a trifle shorter, with nearly the basal two-thirds more expanded, provided with sparse setae; outer third narrowed and blackened, with a few setulae on outer margin immediately back from the acute tip.

Holotype, ♂, Nayagaon, Nepal, altitude 520 meters, March 10, 1957 (Coher).

Molophilus (Molophilus) lepcha is allied to species such as *M. (M.) laxus* Alexander and *M. (M.) assamensis* Alexander, differing from these and all other regional members of the *procericornis* subgroup in the structure of the male hypopygium.

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the programs for the coming meetings were completed except for one speaker.

Mr. Jacob Huberman, Treasurer, reported that there are 130 paid up members with subscriptions; 13 paid up members without subscriptions; and 196 subscribers without membership. The cash balance on hand is \$1112.44 and the capital fund amounts to \$4514.05.

The Secretary, Dr. Hodgson being absent, Dr. Ruckes was asked to substitute for him.

The Nominating Committee (Dr. James Forbes, Chm., Dr. Lucy Clausen and Edwin W. Teale) presented the following slate of Officers for the year 1957:

President, Dr. Asher Treat

Vice-president, Dr. William S. Creighton

Secretary, Dr. Edward Hodgson

Assistant Secretary, Robert Bloch

Treasurer, Jacob Huberman

Assistant Treasurer, Mrs. Patricia Vaurie

Executive Committee: E. Irving Huntington, Dr. A. B. Klots, Dr. Herbert Ruckes.

Delegate to the New York Academy of Sciences, Dr. Lucy Clausen.

There being no other nominations from the floor the nominations were

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EFFECTS OF STARVATION ON FREE AMINO ACIDS IN LARVAL BLOOD OF ORIENTAL BEETLE, *ANOMALA ORIENTALIS* WATERHOUSE¹

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INTRODUCTION

Although it has been established that the nonprotein nitrogen concentration of insect haemolymph is high, the amino acids of this component have not been as thoroughly determined. With the development of the paper chromatographic method, data about the free amino acids of insect blood have increased (Auclair, 1953; Auclair and Maltais, 1954). It has been shown by Drilhon (1950), Auclair and Durbeuil (1953) and Micks (1956) that most of the naturally occurring amino acids are represented in the free state in insect blood.

While effects of starvation on body protein have been studied in certain insects (Slowtsoff, 1905; Heller, 1926; Lafon, 1941; Ludwig, 1950; Newton, 1954) there are few data pertaining to effects upon blood protein. Heller and Moklowska (1930) reported a 40 per cent decrease of blood protein in the moth, *Deilephila euphorbiae*, during starvation. Beadle and Shaw (1950) found that, while the plasma protein nitrogen of larvae of the neuropteran, *Sialis lutaria*, fell to 5 per cent of its original value, the nonprotein nitrogen (amino acids) remained constant during starvation. Analyses of the blood of starving Japanese beetle, *Popillia japonica*, larvae by Ludwig and Wugmeister (1953) showed that the blood protein nitrogen remained constant and the nonprotein and amino nitrogen components increased approximately two-fold.

The object of the present study was to note to what extent starvation affected the plasma amino acids of third instar Oriental beetle, *Anomala orientalis*, larvae.

¹ Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Fordham University. The author wishes to express his appreciation to Professor Daniel Ludwig, at whose suggestion and under whose direction this investigation was conducted.

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MATERIAL AND METHODS

Larvae of the Oriental beetle were collected in the field and brought into the laboratory. Each larva was placed, individually, in one-ounce ointment tins containing moist soil and a few grains of wheat. The larvae were allowed to feed for two weeks at 25°C., moisture and food being replenished, when needed. At the end of the feeding period the larvae were placed in individual vials in a desiccator, the base of which was filled with distilled water. Bellucci (1939) observed that under these conditions the water content of larvae remained constant. The larvae were starved for four weeks, analyses being made at the end of each week.

Blood was collected from normal and starved larvae, etherized to prevent blood coagulation, according to the procedure reported by Ludwig (1951). Pooled, whole blood collected from larvae was used for protein and nonprotein determinations by the micro-Kjeldahl technique of Koch and McMeekin (1924) and for amino nitrogen data by the photometric method of Russel (1944). The preparation of blood for chromatographic amino acid analysis was essentially that described by Pratt (1950). A detailed account pertaining to the separation, identification and concentration of the free and derived amino acids has been reported (Po-Chedley, 1956).

OBSERVATIONS

The protein, nonprotein and amino nitrogen values are shown in Table 1. The protein nitrogen values were relatively constant

TABLE 1
CHANGES IN THE COMPOSITION OF ORIENTAL BEETLE BLOOD
DURING STARVATION (VALUES IN MILLIGRAMS PER CENT)

Degree of Starvation	Protein Nitrogen	Nonprotein Nitrogen	Amino Nitrogen
Normal	310.6	511.6	196.8
1 week	300.5	547.3	255.0
2 weeks	336.1	676.5	320.8
3 weeks	329.4	849.8	343.2
4 weeks	340.7	954.1	350.7

during the four weeks of starvation, the weekly reports approximating the normal average of 310.6 mg. per cent. The nonprotein nitrogen rose steadily from a normal average of 511.6 to a final average of 954.1 mg. per cent. There was a similar increase of amino nitrogen from a normal average of 196.8 to a terminal average of 348.7 mg. per cent.

TABLE 2

CHANGES IN THE AMINO ACIDS OF THE HAEMOLYMPH OF ORIENTAL BEETLE LARVAE DURING 4 WEEKS OF STARVATION (VALUES IN MG. PER CENT AMINO NITROGEN)

Compound	Normal	1 week	2 weeks	3 weeks	4 weeks
alpha-alanine	10.8	12.7	18.8	21.6	22.6
alpha-n-amino butyric acid	5.4	5.7	9.7	9.7	10.6
arginine	4.6	5.6	8.2	10.4	11.0
asparagine	3.1	3.4	5.0	1.8	1.5
aspartic acid	4.5	5.0	10.1	13.6	15.3
beta-alanine	3.7	4.4	7.1	7.5	7.7
cystine	1.8	2.1	2.8	2.9	3.0
glutamic acid	6.7	7.3	12.8	14.5	19.5
glutamine	12.4	14.3	18.9	7.4	4.4
glycine	33.1	51.1	68.8	73.4	76.6
histidine	4.8	4.9	7.6	8.6	8.8
isoleucine	10.6	12.2	16.2	17.4	17.4
leucine	7.5	7.7	10.3	11.7	11.5
lysine	7.9	9.3	12.3	13.7	15.5
methionine	5.4	5.8	8.7	9.3	10.0
ornithine	2.5	2.9	5.6	5.8	6.1
phenylalanine	10.4	10.9	11.4	12.3	12.0
proline	2.7	3.8	6.8	7.7	8.2
serine	2.4	3.8	6.0	7.9	8.1
taurine	4.8	5.1	5.4	5.7	6.6
threonine	3.6	4.0	5.4	6.5	8.8
tryptophane	14.6	14.7	18.7	20.2	22.3
tyrosine	12.3	13.4	12.1	6.6	2.2
valine	4.2	4.8	7.8	9.2	10.6
Total	179.8	214.9	296.5	305.4	320.8

The 21 free amino acids and 3 derivatives determined in the blood of this insect and total amino nitrogen values are listed in Table 2. The compounds which occurred in highest concentration in normal larvae are glycine, alpha-alanine, glutamine,

isoleucine, phenylalanine, tryptophane and tyrosine. All of the amino compounds, with the exceptions of the amides and tyrosine, increased during the period of inanition. The tyrosine concentration of 12.3 mg. per cent for normal larvae increased to 13.4 by the end of the first week and subsequently decreased to 2.2 mg. per cent at the end of the fourth week. The amides, asparagine and glutamine, increased during the first two weeks before decreasing to their final concentrations of 1.5 and 4.4 mg. per cent, respectively. The amino acids, isoleucine, leucine, arginine and phenylalanine, were relatively constant between the third and fourth weeks of starvation. Glycine existed in highest concentration during all analyses, whereas, cystine was consistently low.

DISCUSSION

The results of this study, which indicate that the blood protein is relatively constant in this insect during starvation, agree with the findings of Ludwig and Wugmeister (1953) for Japanese beetle larvae. The stability of blood protein in Oriental beetle larvae suggests its replacement by extravascular protein at a rate equal to its utilization. The increased amino nitrogen concentration in haemolymph of Oriental beetle larvae during starvation augments Newton's (1954) study. In that investigation of total nitrogen in starving Japanese beetle larvae the shift in nitrogen was represented by the increase of amino acids and nitrogen end-products in the blood.

It is apparent from Table 2 that the amino nitrogen of this insect is represented by a wide variety of amino acids and their derivatives, which, with three exceptions, increased in concentration during inanition. Certain phenomena, which occurred during starvation, may be interpreted on the basis of amino acid changes. The decrease in tyrosine concentration was anticipated because of observations on the blackening of blood during the bleeding process. The blood of normal and partially starved larvae usually darkens rapidly, when exposed to air, indicating the catalytic action of tyrosinase upon tyrosine to produce a melanin. This color was not as intense during the late weeks of starvation at which time the tyrosine concentration had decreased to 2.2 mg. per cent. In addition the larvae were also paler than normal at this period. This is in accord with the

findings of Golberg and De Meillon (1948) who found that both tyrosine and phenylalanine influence the pigmentation of the mosquito, *Aedes aegypti*. The phenylalanine concentration of the Oriental beetle larvae, which was relatively constant during this interval, could not, apparently, compensate for the tyrosine depletion.

The increased concentration of the amino acids, aspartic and glutamic, may be due to the conversion and decrease of asparagine and glutamine as suggested by Ussing (1946). The high concentration reported for glycine as well as the general increase for the amino acids would appear to result from the general diminished metabolic rate existing during starvation (Bellucci, 1939). In this respect Kutscher and Ackermann (1933), referring specifically to glycine, contended that the rapidity of insect metabolism prevented this acid from accumulating in high concentration in the blood. The increase of arginine during inanition suggests muscle proteolysis with the release and subsequent decomposition of phosphoarginine. Cystine values which were relatively constant indicate a retardation of its function as an important agent for moulting (Golberg and De Meillon, 1948). Similar unpublished data for the mealworm, *Tenebrio molitor*, show that both cystine and tyrosine increase in concentration prior to ecdysis and are present at a reduced level following the moult.

The two-fold increase of the free amino acids, which was observed, does not completely explain the elevated nonprotein nitrogen concentration. It may also depend on the discharge of other nitrogenous compounds, such as glucosamine, urea and various purine derivatives into the haemolymph.

SUMMARY

1. Oriental beetle, *Anomala orientalis*, larvae were starved 4 weeks. Determinations were made on the blood each week to establish changes occurring in the protein, nonprotein, amino nitrogen and free amino acid concentrations.
2. Protein nitrogen values were relatively constant during the entire period of study. Nonprotein and amino nitrogen concentrations increased approximately two-fold during the same period.
3. Twenty-one free amino acids and three derivatives were

identified by the paper chromatographic method in the blood of this insect.

4. All of the identified compounds, except tyrosine, asparagine and glutamine, increased in concentration throughout the four weeks of starvation.

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closed and the Secretary empowered to cast one ballot for the election of these officers.

Upon completion of the above business, President Dr. Asher Treat took the Chair and introduced the speaker of the evening, Dr. Roman Vishniac, who addressed the gathering on the topic: "Man in the world of Nature."

Dr. Vishniac presented his talk in essentially two parts, the first being an introductory discourse on the complexity of living things and the second being a showing of his remarkable Kodachrome slides of organisms illustrating this complexity.

The study of Biology as a science is always in a state of flux and our ideas of the nature and relationship of living things abruptly change from generation to generation. The earlier concept of classification was quite different from that of today. Living things and natural phenomena are now considered much more complicated than heretofore. The basic views are now being subjected to clarification and we have moved forward another step—that to question the origin of life itself.

The simplest living matter known today—protoplasm—is extremely complex, being made up of a systematic aggregation of numerous organic substances. How these more basic substances came into being is now under consideration. At this point Dr. Vishniac gave a brief resume of the various theses purporting to explain the origin of living matter in nature. Through experimental means some light has been thrown on the subject. Nitrites may be synthesized into amino acids by the use of ultra-violet light; in the process of cooling and condensation the miasma, during the period of the formation of the earth, carbon in the form of carbides or acetylene could possibly form nucleic acids, the building blocks of living matter; by the use of the cyclotron several isotopes of carbon may be formed from simple carbon; electrical discharges might bring about a polymerization of carbon and thus produce complex molecules; by subjecting simple basic substances to very high temperatures and pressure, complex end-products may be produced. All these are possibilities in explaining the

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first step in the formation of living matter. Still other phenomena might be involved—these yet to be discovered. It is possible that life arose by the application of several of these phenomena simultaneously. Thus a polyphyletic descent of the now living things from the primordial, might have occurred. Dr. Vishniac calculates that the one or two billion years that living matter is supposed to be in existence is not enough time for the formation of the great variety of living things we see around us today. He, therefore, supposes that the primordial living substances came into being, not all at once or in one locality but were formed, possibly in different ways and in different places in successive periods of the earth's history—indeed may be in the process of being formed today in a way similar to that in the earlier eons. Such a thesis could not only explain the great diversity and quantity of living things in the world today but might also account for the rapid evolution that took place in almost all groups of plants and animals.

The whole concept of nature is of utmost importance and interest to man. Without the other living organisms around us, we would be unable to exist. We depend upon many of them for food, clothing, shelter and protection. But more than this—living things are beautiful. With their beautiful shapes, bright colors and mathematical symmetry they are the acme of perfection. In their behavior, their courtship and reproduction they are at times most bewildering. This is the esthetic side of the picture and must not be overlooked. Indeed, were it not for our appreciation of the beauty of nature, life, after all would be rather drab.

By the use of his extraordinary colored slides, Dr. Vishniac portrayed the whole gamut of life, from crystalloid enzymes and hormones to the beautiful slime molds and protozoa, thence through the lichens, fungi, ferns and coelenterates to the flowering plants and vertebrates. Insects in flight were most remarkably illustrated and the universal interdependence of all living things was shown by a feeding praying mantis, pollinating bees, and parasitic ichneumon wasps.

A very appreciative audience applauded Dr. Vishniac's presentation of his subject.

There being no other business, the meeting adjourned at 9:30 P.M.

HERBERT RUCKES, *Secretary*, pro tem.

MEETING OF FEBRUARY 5, 1957

A regular meeting of the Society was held at the American Museum of Natural History; President Treat presiding.

The secretary was instructed to send a letter of sympathy to Dr. and Mrs. Vishniac, who were injured in an automobile accident. The Society moved unanimously to extend to Dr. Forbes, Mrs. Vaurie, and Mr. Huberman their thanks for valuable service to the Society in ordering the records and the stock of Journals.

In keeping with the tradition of the Society, the new President, Dr. Asher Treat, presented a talk on "Hearing in Insects, Birds, and Man". Dr.

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ON THE SPECIES OF MEGALOPTA DESCRIBED BY F. SMITH (HYMENOPTERA, APOIDEA)

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The genus *Megalopta* F. Smith has a quite deceptive history when one considers the way it has been interpreted by subsequent authors. Even F. Smith included in it various unrelated Halictinae whose positions are indicated below.

The most important error was made by Cockerell in 1900 when he designated *Megalopta bituberculata* as the type of the genus. It is further strange that Sandhouse (1943), when listing this species as the type, cited Meade-Waldo (1916, Ann. Mag. Nat. Hist., (8) 17: 451) as the author who made the designation. Actually, Cockerell (1900, Proc. Acad. Nat. Sci. Philadelphia, p. 374) could hardly have been more categorical. He said, "*M. bituberculata* Smith is to be regarded as the type of *Megalopta*."

As I have already stated in another paper, Cockerell's designation is not in accord with Smith's diagnosis, which refers clearly to the female, although *bituberculata* was described from the male. This can be shown also by reference to figures 13 and 14 of Smith's plate III. The antennae have twelve segments and the drawing of the labrum shows a configuration that could only be a female. The labrum is also minutely described in Smith's generic description and attention is called to the longitudinal carina, broadened basally, a character of females. The drawing of the wing undoubtedly corresponds to *M. bituberculata*, as shown by the position of the first m-cu considerably anterior to the apex of the second submarginal cell. However, in the description the reference is evidently to the type of wing of *M. idalia*. Moreover, the name, and the indication of large ocelli in the description, are only applicable to *M. idalia*.

¹ I wish to acknowledge aid received from the National Science Foundation through the University of Kansas which made my trip to the British Museum possible. It is a pleasure also to acknowledge a travel grant (GA-BMR-5611) received from the Rockefeller Foundation for the trip to the United States. Dr. C. D. Michener assisted by translating portions of this paper into English.

For the reasons indicated above, I have no doubt whatever that *M. idalia* is automatically the type species of the genus, in spite of the earlier designations of *bituberculata*. This was also the viewpoint of Ducke, to whom I referred previously [Moure, 1943, Rev. Ent. (Rio de Janeiro), 14: 480-481].

My *Tmetocoelia*, with *Megalopta sulciventris* Friese as the type, is a synonym of *Megalopta* as here interpreted. When I erected this genus, I did so on the basis of Meade-Waldo's key (1916) which stated that the third sternite of *M. idalia* is normal or almost normal. Actually, in *M. idalia*, it is profoundly bilobed, with a deep notch between the lobes.

Equally, *Megaloptella* Schrottky, 1906, having as type *Halictus ochrias* Vachal, is a synonym of *Megalopta*. As the male of *M. idalia* runs exactly to *H. ochrias* in Vachal's key, it is probably the same species or at least a very close one.

Megaloptidia Cockerell, 1900, is a good group (genus or subgenus) among the Megaloptas. I had an opportunity to study the type species in the Carnegie Museum, Pittsburgh, and made the following notes (type number 345):

General aspect as in *Megommation*, differing principally as follows: Sternites 1 to 3 with normal, weakly recurved, margins, fourth bilobed with profound median notch and the resulting lobes quite pilose, fifth membranous and normal with the margin practically straight, sixth truncate—bilobed with the notch very superficial. The labrum has the apical angle obtuse, almost right angular, and is strongly bowed in the basal two thirds, without a median carina, broader than long (22:16). The supra-clypeal area is broader medially than the upper part of the clypeus, because of the outward curvature of the subantennal sutures which narrow the paraocular areas. The frontal line is cariniform, confined to the interantennal elevation, without entering on the frons proper. The wings are rather notably pilose, the pterostigma four times longer than broad (58:14) and the prestigma a little longer than width of pterostigma (18:14); the marginal cell is quite elongate and tapering in the free part, four times as long as broad (128:30), and the apical free part almost twice as long as basal part occupied by the submarginal cells (90:40); distance to wing tip, taken from a line perpendicular to apex of cell, about a third of length of cell (44:128); first submarginal cell longer than the two following

together (proportions on vein M 60:18:34); second submarginal cell smaller, higher than long and receiving first m-cu at its apex; hamuli 10 on each wing.

I was able to find in the Hope Museum, Oxford University, the type of *Halictus insignis*. This species was designated as the type of *Megommation*. The specimens on which I based the generic description are conspecific with the type, and also with material of *Megalopta (Megaloptella) ipomoeae* Schrottky, whose synonymy I can now confirm. It is noteworthy that Bates refers to nesting of *Megalopta ianthina* Smith in branches of trees while nests of *Megommation insigne* (Smith) in the soil were found by C. D. Michener and R. B. Lange.

Ariphanarthra continues as an aberrant group of Megaloptas, distinguished by highly specialized characters, especially the greatly elongated palpi to which I called attention in my paper of 1951 (*Dusenias*, 2: 139).

Considering the species described by Smith, the following descriptions and comments show present generic positions, as well as some new synonymy. New generic and subgeneric names are proposed for two of them, *M. bituberculata* and *M. ornata*.

1. *Megalopta idalia* Smith, 1853

Type female: 17.a.1276. British Museum.

SIZE: Length 11.20 mm.; wing, including tegula, 9.20 mm.; head and abdominal widths 2.85 mm. and 3.80 mm.

Basal area of propodeum a little shorter than metanotum, smooth, limited by a very thin, delicate carina. Eye length more than twice upper interorbital distance, and this less than lower interorbital distance (112:51:69 and maximum interorbital distance 80)²; interocellar distance almost four times ocellocular distance and slightly longer than transverse diameter of median ocellus (19:5:17); ocelloccipital distance almost equal to interocellar, but a little shorter than orbitoccipital distance as measured in dorsal view (20:19:23); clypeal length almost half of clypeocellar distance (42:78); interalveolar³ distance shorter than alveolorbital (13:18), but alveolocellar as long as subantennal suture (35:35); proportional lengths of scape, pedicel and four basal segments of flagellum as 65:8:10:8:11:12 and maximum diameter of flagellum 12.

Type locality: Santarém, Pará, Brasil (53/60).

² All the measurements were made with 50 times magnification, and 1 division of the micrometric ocular corresponds actually to 20 microns (μ), or if multiplied by 0.02, to millimeters.

³ The alveoli concerned are the antennal sockets.

2. *Megalopta purpurata* Smith, 1879.

Type male, 17.a.1273. British Museum.

SIZE: Length 13.40 mm.; wing, including tegula, 12.60 mm.; head and abdominal widths 3.58 mm. and 3.60 mm.

Brown-ferruginous, with some metallic bronze reflections on head, sides of mesoscutum, scutellum, episterna and propodeum. Pubescence long and fuscous, but pale on genae, propodeum, and ventral side. Propodeum bowed, with a short (less than half length of metanotum), shining, shallowly micro-reticulate basal area. Third sternite deeply notched, bilobate, the notch deeper on fourth sternite, at its bottom with a strong, almost perpendicularly raised spine and lobes projected in a point backwards and with outer sides emarginate; fifth sternite membranaceous, slightly emarginate on its middle, the emargination a little deeper on sixth.

Eye length less than twice upper interorbital distance, but almost twice lower interorbital distance (120:74:62 and maximum interorbital distance 96); interocellar distance a little longer than ocellorbital, and almost equal to transverse diameter of median ocellus (18:13:17); ocelloccipital distance longer than interocellar, and equal to ocelloccipital distance (22:18:22); clypeal length conspicuously longer than half clypeocellar distance (44:75); interalveolar distance a little longer than alveolorbital (18:15), and alveolocellar slightly shorter than subantennal suture (32:33). Antennae missing.

Type locality: Tefé (= Ega), Amazonas Brasil. (70/16)

3. *Megalopta ianthina* Smith, 1861

Augochlora calliope Cockerell, 1905, Entomologist, 38:37 (new synonym).

Type female, 17.a.1023. British Museum. Type female of *A. calliope* 17.a.1031, in the same Museum.

This species and the following one can be distinguished from any other *Megalopta* by having a relatively large head and small ocelli. Color separates *ianthina* from *nigrofemorata* at first sight.

Postocellar sulci very conspicuous. Punctures very small on the posterior disc of mesoscutum, interspaces polished and 7 to 10 times puncture diameter. Basal area of propodeum half length of metanotum with weak radiating rugulae all over its surface. Basitibial plate small, weakly margined; inner hind tibial spur pectinate with four spines.

Eye length almost equal to upper interorbital distance and shorter than lower interorbital distance (109:104:117 and maximum interorbital distance 125); interocellar distance less than ocellocular, but almost twice transverse diameter of median ocellus (23:29:12); ocelloccipital distance almost twice interocellar, but a little shorter than orbitooccipital distance (43:23:47); clypeus much shorter than half clypeocellar distance (32:85) and almost four times broader than long; interalveolar distance much

shorter than alveolorbital (23:38), but alveolocellar conspicuously longer than subantennal suture (43:30); proportional lengths of scape, pedicel and five basal segments of flagellum as 74:8:11:10:11:12:13 and maximum diameter 12.

Measurements of the same distances on the type of *calliope* demonstrate conspicuous allometry. They are as follows: Eye length, upper lower and maximum interorbital distances as 98:79:85 and 95; interocellar, ocellular and transverse diameter of median ocellus as 20:20:10, and vertex notably shorter than on type specimen of *ianthina* as shown by ocelloccipital and orbitooccipital distances respectively 25:27. Clypeal length and clypeo-ocellar distance as 31:75, and clypeus only three times broader than long; interalveolar distance shorter than alveolorbital (17:25) and alveolocellar longer than subantennal suture (39:27); proportional lengths of scape, pedicel and four basal segments of flagellum as 60:8:10:8:10:11 and maximum diameter 11. Size: Length 9.8 mm.; wing, including tegula, 8.55 mm.; head and abdominal widths 3.04 mm. and 3.45 mm.

Type locality for both *ianthina* and *calliope*: Tefé (= Ega), Amazonas, Brasil. The specimen labelled *M. ianthina* is from Smith's collection, the other is numbered 58/6.

4. *Megalopta nigrofemorata* Smith, 1879.

Type female: 17.a.1020. British Museum.

SIZE: Length 9.60 mm.; wing, including tegula, 8.80 mm.; head and abdominal widths 3.4 mm. and 3.68 mm.

Eye length exceeding upper interorbital distance, almost equal to lower one (100:88:95 and maximum interorbital distance 98); interocellar distance shorter than ocellular distance and a little less than twice transverse diameter of anterior ocellus (19:25:11); ocelloccipital distance shorter than orbitooccipital but conspicuously longer than interocellar distance (27:32:19); clypeus a little shorter than half clypeo-ocellar distance (35:78), its width 2.6 times its length; interalveolar distance shorter than alveolorbital distance (20:29) and alveolocellar distance much longer than subantennal suture (42:28); proportional lengths of scape, pedicel and four basal segments of flagellum as 65:8:10:8:10:11.5 and maximum diameter of flagellum 11.5.

Radiating rugulae of basal area of propodeum weaker than in *ianthina*, and punctures of tergites shallower. Lateral corners of pronotum a little less produced.

Type locality: Tefé (= Ega), Amazonas, Brasil. (70/16).

Megaloptodes new genus

Type species: *Megalopta bituberculata* F. Smith, 1853.

The systematic relations of this species are not very evident. The supraclypeal area and, principally, the clypeus, are very

flat thus differing from other members of the *Megalopta* group. Even more distinctive is the lack of a pre-episternal sulcus on the mesepisternum. The pronotum is completely rounded all the way to the lobes without vestiges of the pronotal crest nor of the humeral angles. Although in *Megommation* and *Megaloptidia* the pronotum also lacks a crest, the humeral angles are clearly evident. This character is emphasized in *M. bituberculata* because the mesoscutum is truncate anteriorly and not arcuately procurved as in *Megalopta* and the groups mentioned above.

Another point that indicates separation from the Megaloptas is the aspect of the wing venation. The free apical part of the marginal cell in *Megaloptodes* is approximately equal to the basal part occupied by the submarginal cells, while in the Megaloptini (Moure, 1943) the free part is about twice as long as the part occupied by the submarginal cells.

Equally, the sterna without any modification and the last tergite which is truncate—bidentate are found exclusively in *Megaloptodes*, as are the two notable scutellar tubercles.

Knowledge of the female would clarify the position of the genus. Also, study of the genitalia might give indications of its relations. However, since the type is a unique and in none too good a state of preservation, I decided not to attempt a dissection.

MALE.—Punctures small and shallow. Without yellow marks and almost without metallic reflections. Tergites without basal or marginal bands of tomentous pubescence, or fringes of bristles.

a) Head moderate sized; face rather narrow; gena in profile narrower than eye and rounded.

b) Labrum rather short and broad (50:30), apex almost right angular, without median carina, and labral plate reduced to a vestigial rounded transverse basal carina. Labial palpi long, first segment as long as three following together; maxillary palpi a little longer than apical part of galea and this less than half length of eye (47:116). Mandibles mucronate, simple.

c) Clypeus flat, slightly broader than long (58:50), with a shallow median carina, projecting but little below lower orbital tangent, but surpassing and overhanging labro-clypeal articulation; lateral parts of epistomal suture diverging downwards and almost touching orbits. Supraclypeal area very weakly bowed, parallel-sided, almost twice as broad as paraocular area. Frons much shorter than clypeus and the frontal line shallowly sulcate, not carinate. Antennal alveoli closer to orbits than each to the other (15:22), placed on upper third of face, with alveolocellar

distance as long as subantennal suture (30:30). Malar area almost linear, one fortieth of eye length.

d) Eyes practically glabrous, large, slightly emarginate, converging in upper forth. Eye length almost twice upper interorbital distance and this slightly longer than lower interorbital distance (116:65:60 and maximum interorbital distance 83). Ocelli rather moderate sized, their diameters a little more than antennal alveolar diameters; interocellar distance longer than median ocellar diameter and twice ocellocular distance (22:15:10). Vertex short and rounded; postocellar sulci almost vestigial.

e) Scape longer than alveolocellar distance (45:30) or than pedicel and two basal flagellar segments together (45:8:13:20); second flagellar segment almost twice as long as its diameter; other segments missing.

f) Pronotum without crista and lateral laminae, rounded and just applied to mesoscutum, without humeral angles and without antero-lateral carinae. Mesoscutum not produced, truncate-rounded in front; median line, prescutal (notauli) and parapsidal sutures very shallow. Mesepisterna with preepisternal suture inconspicuous. Scutellum bituberculate, tubercles broad low cones.

g) Tegula of medium size, not dilated posteriorly. Pterostigma rather narrow (50:15), prestigma wide and short (12:10); marginal cell rather narrow (108:25) and distance from its apex to wing tip more than half length (108:74). Third submarginal cell longer than first, second the smallest, subquadrate, proportional lengths on M as 47:16:53; first m-cu in apical third of second submarginal cell, and second m-cu three tenths from apex of third submarginal cell (or 5 and 15 from apex respectively). Hamuli 11 per wing.

h) Legs normal. Proportional lengths of femur, tibia, and basitarsus of second pair as 80:62:61; of third pair as 100:106:83; no basitibial plate; a dense fringe of medium-sized hairs on distal half of inner side of middle tibia.

i) Propodeum short, bowed. Basal area very conspicuous and with some irregular rugae, limited by a sharp thin carina. Postero-lateral carinae very short, upper postero-lateral angles rounded.

j) Abdomen broad, sides subparallel; tergites with broad sub-membranous marginal depressions, wider on middle, rather narrow on first tergite. Seventh tergite broadly truncate, with a small tooth on each side. Six visible sternites, normal, neither emarginate or depressed; graduli present at least on second, third, and fourth sternites.

5. *Megaloptodes bituberculatus* (Smith, 1853) new combination

Megalopta bituberculata Smith, 1853, Cat. Hym. Br. Mus., 1: 84

Type male: 17.a.1275. British Museum.

SIZE: Length 11.6 mm.; wing, including tegula, 9 mm.; head and abdominal widths 3.28 mm. and 3.65 mm.

Face and thorax rather densely plumoso-pubescent. Scutellum bituberculate, almost as in *Rhathymus*.

Type locality: Amazonas, Brasil. From the F. Smith collection.

6. *Neocorynura pilosa* (Smith, 1879)

Megalopta pilosa Smith, 1879, Descr. N. Sp. Hym., p. 48.

Type female: 17.a.1024. British Museum.

SIZE: Length 8.4 mm.; wing, including tegula, 7.4 mm.; head and abdominal widths 2.4 mm. and 2.7 mm.

Eye length much longer than upper interorbital distance, this longer than lower interorbital distance, but shorter than maximum interorbital distance at emargination (80:61:54:85); interocellar distance shorter than ocellocular, but larger than transverse diameter of median ocellus (13:18:9); ocelloccipital distance longer than interocellar but a little shorter than orbitoccipital (17:13:23). Clypeal length less than half clypeocellar distance (31:66), 1.7 times broader than long. Inter-alveolar distance a little less than alveolorbital (16:20), and alveolocellar slightly longer than subantennal suture (30:28). Proportional lengths of scape, pedicel, and four basal articles of flagellum as 54:8:8:6:9:10, maximum flagellar diameter 12.

Pronotum with humeral corners strongly salient. Mesoscutum strongly produced forward and bilobate. Metasoma moderately claviform. Color and pubescence as in Smith's description. Punctures on clypeus and supra-clypeal area larger than on frons, but smaller than on disc of first tergite, interspaces polished on apical half of clypeus and larger than punctures, of the same size and reticulate above, and duller on supra-clypeal area. On mesoscutum punctures very crowded and uniform, on scutellum finer and shallower with some large punctures scattered; on first tergite large and deep on disc, smaller and closer towards borders; on following tergites dense and small.

Type locality: São Paulo de Olivenca, Amazonas, Brasil (70/16).

In my collection is one specimen from Tingo Maria, Perú.

7. *Neocorynura cuprifrons* (Smith, 1879)

Megalopta cuprifrons Smith, 1879, Descr. N. Sp. Hym., p. 49.

Type female: 17.a.1025. British Museum.

SIZE: Length 8.8 mm.; wing, including tegula, 7.7 mm.; head and abdominal widths 2.6 mm. and 3.0 mm.

Pronotum with humeral angles and anterior part of mesoscutum as in *N. pilosa*. Inner hind tibial spur pectinate with 5-6 spines. Punctures very dense (interspaces cariniform) on frons, mesoscutum and mesepisterna; larger and sparser on clypeus and supra-clypeal area, interspaces as large as punctures, polished and shining; on scutellum a little smaller and sparser than on mesoscutum, with some larger punctures scattered; on propodeum punctures large as on clypeus, interspaces as large as punctures

and covered with very fine punctures; on first tergite deep and large on disc, sparser towards base, denser and smaller towards posterior margin and sides; on second tergite slightly smaller than on mesoscutum, deep and very crowded, on third and following tergites much smaller. Basal area of propodeum with numerous (24-26) regularly radiating striae, median ones with apices bifurcate.

Eye length longer than upper interorbital distance and this greater than lower interorbital distance, but maximum interorbital distance longer than eye (85:65:57:92). Interocellar distance shorter than ocellular, greater than transverse diameter of median ocellus (14:18:9); ocellocipital distance greater than interocellar distance but shorter than orbitocipital (19:14:25). Clypeal length half clypeocellar distance (34:67), 1.5 times as broad as long. Inter-alveolar distance shorter than alveolorbital (17:22) and alveolocellar distance (between closer borders of antennal sockets and median ocellus) longer than subantennal suture (32:28). Proportional lengths of scape, pedicel and four basal segments of flagellum as 57:8:7:8:9:10 and maximum diameter of flagellum 13.

Type locality: São Paulo de Olivença, Amazonas, Brasil (70/16).

8. *Augochloropsis* (*Augochloropsis*) *vivax* (Smith, 1879)

Megalopta vivax Smith, 1879, Descr. N. Sp. Hym., p. 48.

Type female: 17.a.1224. British Museum.

SIZE: Length 8.4 mm.; wing, including tegula, 6.26 mm.; head and abdominal widths 2.6 mm. and 2.8 mm.

Vertex rounded. Humeral corners of pronotum salient, with a small outer emargination; lateral carina expanded in a broad lamina with a small sinuosity a little before outer emargination, partially translucent and ending in an acute angle on lobes. Mesocutum broadly shining on disc (interspaces sometimes large as 5 diameters of punctures and with a shallow micro-tessellation), punctures denser toward sides and forward, and very crowded and coarse on anterior corners as on frons; rough and shallower on lower paracocular areas, much sparser on clypeus and supra-clypeal area (interspaces shining and 2 to 5 times broader than punctures), with some transverse rugae on upper half of supra-clypeal area; on mesepisterna deeper, on metepisterna finer and denser, also on proximal part of propodeum, but sparser backward and downwards; postero-lateral angles of propodeum broadly polished and posterior surface shining but with scattered deep punctures; moderately strong on sides of first and second tergites, shallower on discs and sparser toward bases; marginal depressions on first and second tergites smooth, on third and fourth with a median area finely and densely punctured, leaving a narrow smooth fascia on basal and marginal border of these depressions. Legs pale-brownish, with some green reflections on tibiae, conspicuous on anterior ones. Inner hind spur pectinate with six teeth, the spur broadened at base. Marginal pale fringes on first and second tergites very well developed, on first larger than marginal depression, on second a little shorter in middle and at extreme

sides, the two fringes of the same length (9) and uniform. Semierect black bristles on discs of tergites 2 to 5, most conspicuous on the third. Basal area of propodeum semilunar with strong uniform radiating striae (about 26).

Eye length longer than upper interorbital distance, and this longer than lower one, but maximum interorbital distance longer than eye length (81:75:63:90). Interocellar distance a little shorter than ocellocular, but longer than twice transverse diameter of median ocellus (20:23:9). Clypeal length half of clypeocellar distance (as measured between upper part of epistomal suture and lower border of median ocellus) (30:60). Inter-alveolar distance shorter than alveolorbital (19:21), but alveolocellar distance twice as long as subantennal suture (35:18). Proportional lengths of scape, pedicel and four basal segments of flagellum as 46:7:8:6:7:8 and maximum flagellar diameter 10. Frontal carina shorter than distance to median ocellus (18:23). Anterior edge of clypeus with a strong tooth on each side.

Type locality: Pará, Brasil. N. 70/16.

A. atropos is a very different species by having denser puncturation on mesoscutum, and interspaces two to three puncture diameters in width, reticulate and duller, pronotal corners obtuse without lateral notch, and vertex transversely roof-shaped.

Augochloropsis (Glyptochlora) new subgenus

Type species: *Megalopta ornata* Smith, 1879.

This subgenus has points of similarity to the subgenus *Glyptobasia*, which it resembles by the foveate puncturation (even coarser than in that subgenus) and by the form of the propodeum, whose lateral posterior carinae unite in a transverse carina closing the area of the propodeum posteriorly. In *Glyptobasia* the vertex is rounded and not roof-shaped, and the marginal depressions of the abdominal terga are normal and with fringes of coarse bristles on the first and second terga.

FEMALE.—Metallic; with very large and deep punctures on frons, thorax and propodeum, on mesoscutum and scutellum with diameters of 0.02 mm.; without marginal bristle-fringes ("vibrissae") on first and second tergites.

a) Head much as in *Augochloropsis* s. str., face between orbital sinuses broader than eye length (98:108); gena in profile as broad as eye, sharply margined.

b) Labrum elongato-cuspidate, its basal half occupied by a thick bituberculate labral plate, distal half membranous, subsemicircular, surmounted by a carina projecting beyond apex and on its borders with some short upturned bristles. Labial and maxillary palpi normal, short. Apical part of galea one fifth of eye length (100:20). Mandible bidentate, apical

tooth broad, inner one much smaller, a small emargination on inner margin, simulating a third tooth.

c) Clypeus and supraclypeal area bowed; clypeus projecting a little beyond lower orbital tangent, almost twice as broad as long; epistomal suture evenly bent and lower clypeal corner separated from orbit by half an ocellar diameter. Frons longer than clypeus (50:42), frontal line carinate on its distal half. Antennal alveoli slightly closer to each other than to orbits (22:25), placed almost on middle of face, and alveolocellar distance much longer than subantennal suture (37:24). Malar area linear.

d) Eyes glabrous, with inner sides sinuate. Ocelli normal, interocellar distance equal to ocellorbital, and about twice median ocellar diameter. Vertex sharply transversely roofed, posterior ocelli one diameter from crest of vertex, posterior surface steep and slightly concave; without postocellar sulci.

e) Scape very long (163), surpassing vertex; second flagellar segment a little shorter than third, but together longer than first (11:8:9:11 and diameter 14).

f) Pronotum with crista concave in middle, meeting at an obtuse angle the very broad straight lateral lamina, which ends in a right angle on pronotal lobe; antero-lateral carina present, beginning at dorso-lateral angles and going down. Mesoseutum produced forward in an up-turned, medially notched, lamina; median line and parapsidal sutures narrow, sharp and straight. Pre-episternal suture formed by a row of pits a little larger than punctures. Scutellum normal.

g) Tegula elongato-elliptic. Pterostigma almost four times longer than broad (50:13); prestigma twice as long as broad (15:7); marginal cell shortly appendiculate, a little less than four times its width (95:27) distance from its apex to wing tip more than two thirds of its length (95:70). First submarginal cell as long as second and third together (on marginal cell 54:17:37), second the smallest, subquadrate, receiving first m-cu at its end, and second m-cu one seventh of its length from apex of third. Hamuli 11 per wing.

h) Legs normal; second basitarsus slightly shorter than tibia (70:60); hind tibia much shorter than tarsal segments together, and basitarsus three fourths of tibial length (220:160:90); basitibial plate absent; inner hind spur pectinate, with 7 to 8 teeth; femoral scopa strongly developed, dense, tibial scopa short but dense.

i) Propodeum with its posterior face subquadrate, outlined by a strong sublaminar carina; horizontal area smooth, well developed, defined by strong upper and postero-lateral carinae and enclosing the basal semilunar area, slightly depressed, with a median strong carina and some weaker radiating ones (about 18).

j) Tergites 1 and 2 without marginal fringe of bristles; marginal depressions very wide and broadened medially, on third tergite occupying more than two thirds of exposed portion. First sternite strongly carinate on its basal third, and its margin slightly recurved; margin of second straight, of third to fifth broadly procurved; graduli present only on second and third sternites.

9. *Augochloropsis* (*Glyptochlora*) *ornata* (Smith, 1879)
Megalopta ornata Smith, 1879, Descr. N. Sp. Hym., p. 49.
Type female: 17.a.1274. British Museum.

SIZE: Length 10.0 mm.; wing, including tegula, 9.0 mm.; head and abdominal widths 3.12 mm. and 4.0 mm.

Type locality: São Paulo de Olivença, Amazonas, Brasil (70/16).

Augochloropsis refulgens (Smith, 1861) (Type ♀ 17.a.1245) [= *A. deidamia* Smith, 1879, type ♀ 17.a.1253] shares some characters with *A. ornata*, as the sharply roofed vertex, broadly expanded lateral lamina on pronotum, and lack of fringe of bristles on the first and second tergites, but the mesonotum, propodeum and marginal depressions are normal as in *Augochloropsis*.

Augochloropsis atropos (Smith, 1879) [Type ♀ 17.a.1254] is also closely related to *refulgens*, but has well developed marginal fringes on the first and second tergites.

(continued from page 178)

Treat began with an explanation of the lateral line sensory mechanism of fish. The lateral line enables fish to locate the source of moving objects which are not themselves in direct contact with the fish. From this type of hearing mechanism, two main lines of evolution, one for amphibians and another for reptiles, birds, and mammals, have evolved . . . in relation to the aquatic or terrestrial habitats.

Among insects, including most of the orthoptera, many hemiptera, and lepidoptera, the basic mechanisms of hearing are quite unlike those of any vertebrate. Insect tympanic organs are sensitive not to pressure changes as such, but to actual mechanical movements of the tympanic membrane, or, in other words, to the actual particles which move the membrane. Dr. Treat drew upon his own work on hearing in noctuid moths to explain some of the neurophysiological aspects of insect hearing. The noctuid moth has only 2 sense cells associated with the tympanic membrane. Although certain noctuid moths have a great range of frequency sensitivity, extending up to well over 100,000 cycles per second, they cannot discriminate different frequencies, and could never be "out of tune". The minimum energy necessary to excite the noctuid tympanic mechanism is roughly comparable to that in vertebrates—which is about the maximum sensitivity that could exist before simple Brownian movement of particles in the auditory mechanism would excite the sensory cells. Dr. Treat showed slides of the nerve impulse messages recorded from the sensory cells in the noctuid auditory organ.

(continued on page 222)

THE CORRESPONDENCE BETWEEN WILLIAM
HENRY EDWARDS AND SPENCER FULLERTON
BAIRD. PART I.*

ANNOTATED BY F. MARTIN BROWN

Some years ago while visiting with the late Dr. Austin Clark and his charming wife in their Washington, D. C., home the conversation turned to my interest in the history of American entomologists. Mrs. Clark, who has recently retired as Librarian of the Smithsonian Institution, suggested that when the Baird papers were accessible they might yield some interesting correspondence between Edwards and Baird. None of the three of us that evening realized how prophetic Mrs. Clark's statement was to be. Since that time the Smithsonian Institution has built a vault to hold its archives and the Baird papers have been put in order. Through the good offices of Mrs. Clark and Mr. Everard De Atley, archivist of the Smithsonian, I have been able to read and organize the entire Edwards-Baird correspondence.

The letters from Edwards and other correspondents to Baird are bound in annual volumes. They are arranged alphabetically in groups by the writers' surnames and within a group by date. These are relatively easy to read although at times the binding has obscured a line or so of script. The letters from Baird to his correspondents are in copybooks. The copy was transferred from the original letter by pressing a moist piece of tissue paper against the letter. Reading them is a task of an entirely different order! Some of them were made with the tissue too wet and a badly smeared copy resulted. Others were made with too dry tissue and only a bit of a letter here and there made a bold transfer. Most of the letters fall between these extremes and are reasonably legible.

Mr. De Atley had microfilms prepared for me of all of the letters involved. The great majority of these I enlarged from the 35 mm. rolls of film to four by five inch photographic prints. A few were printed by the Eastman Recordak method through the good offices of Mrs. Dolores Renze, State Archivist for Colorado. The prints were then transcribed and the typescript of the entire collection put into chronological order. Mr. Cyril dos

* Published with the permission of the Secretary, Smithsonian Institution, Washington, D. C.

Passos has checked my reading of most of the letters. There still are a few words in some of the Baird letters that defy both of us.

My greatest problem has been how to present the material in these letters so other entomologists may derive the maximum benefit from them. I have come to the conclusion that the best thing to do is to publish them in their entirety and to annotate them to the best of my ability. The next decision to be made was how to publish this mass of important material. Commercial publication was out of the question. Too few copies are needed to satisfy the limited market for such a book to interest any publisher. The Smithsonian Institution has such limited funds for publication that it was felt unreasonable to devote any to the publication of material with such a restricted appeal as these letters. However, the Secretary of the Institution was "pleased to give its [the Institution's] permission for such a worthwhile effort to be published in the Journal of the New York Entomological Society."

Several little or unknown interesting facts developed as I began to work with this material. I doubt that any entomologist previously realized the great part that Spencer Fullerton Baird played in the development of our science in America. It does not take much reading of these letters to demonstrate how great an influence he had upon William Henry Edwards who is acknowledged the greatest rhopalocerist yet to develop in this country. Baird supplied Edwards with masses of material, put him in contact with collectors over the entire continent, helped him to solve knotty taxonomic problems and above all gave him advice and encouragement to produce *The Butterflies of North America*, Edwards' masterpiece. The title for this magnificent work was suggested by Baird.

From this point on I let the two great naturalists speak to you in their own words written a century ago.

477*

Newburgh, New York
13th Oct. 1859

* Numbers in the upper left hand corner of a letter received by Baird refer to the index numbers placed upon the letter in the Smithsonian Archives. No earlier correspondence between Edwards and Baird than this letter has been found thus far in the files. It is obvious that there was earlier correspondence.

Dear Sir.

Much obliged to you for your kind recollection of me in the matter of Kirby¹. I ordered the book at once from Waterman.²

Can you give me the name of any entomologist in Canada who will be a good one to exchange with?

Yours truly
W. H. Edwards

Prof. S. F. Baird
Washington

478

Newburgh. 13th Nov. 1859

Prof. Baird

Dear Sir.

I have put up a box of Panama crustaceans for Mr. Stimpson,³ and will forward them from New York in a day or two. With these are some insects in a small box for Mr. Drexler.⁴

Yours truly
W. H. Edwards

2582*

213*

Nov. 17 59

Dear Sir

The box of specimens was duly received. Mr. Stimpson begs particularly

¹ William Kirby (1759-1850): *Fauna boreale-Americana, or the Zoology of the Northern Parts of British America, containing descriptions of objects of natural history collected on the late northern land expedition, under command of Captain Sir John Franklin, by John Richardson. Part IV. The Insects, by W. Kirby.* London. Longman, London. 1837.

² A bookseller in New York, N. Y. (?) or Philadelphia, Penna. (?) The name may be Waterman or Westerman.

³ William Stimpson (1832-1872): marine biologist, naturalist of the North Pacific Exploring Expedition, 1852-1856; Smithsonian Institution, 1856-1865; director, Chicago Academy of Science, 1865-1871. See DAB 18: 31-32.

⁴ Constantin F. Drexler (-): taxidermist, and sometime field collector for the Smithsonian Institution, often assigned to U. S. Army parties as hospital steward for "housekeeping" purposes. He became a member of the Entomological Society of Philadelphia on December 26, 1859. An account of his collecting activities is in preparation.

* The number at the upper left refers to the serial number in Baird's correspondence for the year. Later each year was not separately numbered. The numbers in the upper right refer to the copy-book page upon which a "press" of the letter was made and from which the text presented was transcribed through the medium of microfilm.

to know whether the crabs were collected at Aspinwall⁵ in Panama. He was much pleased with them.

Truly yours
S. F. Baird

W. H. Edwards
Newburgh

2559?

252

November 23 59

Dear Sir.

Glad the butterflies⁶ were interesting. I sent another lot just received from Red River Settlements of the North.⁷

Sincerely yours
S. F. Baird

W. H. Edwards
Newburgh

P.S. I want you to do your bit to furnish funds to Kennicott⁸ even more than you promised. I have just had a letter from him at Methy Portage.⁹

⁵ Aspinwall, Panama, is the former name of the Caribbean terminal of the trans-isthmus railroad. The locality is now within the confines of Colon, Canal Zone.

⁶ The letter of transmittal and Edwards' reply referred to in 2559? are missing from Baird's files. These butterflies may have been some collected by Drexler in Washington, D. C., or in the West. The insects sent for Drexler mentioned by Edwards in letter 478, 13 November 1859 may have been a return exchange.

⁷ The Red River of the North flows northward from the boundary between Minnesota and South Dakota to Lake Winnipeg, Manitoba. It forms the boundary between North Dakota and Minnesota. The Red River settlements of the late 1850s are those that were founded by Lord Selkirk in 1811 in the vicinity that has now developed into Winnipeg, Manitoba. In the Annual Report of the Smithsonian Institution for 1859 are two references to material received from the Red River of the North. On p. 74 is: "*Gunn, Donald*—Skins of birds and mammals from North Red River."; on p. 75 is "*Chas. A. Hubbard*—Skins and eggs of birds from Red River of North." Either may have been the source of the butterflies. I prefer Hubbard since he accompanied Kennicott as far as Lake Winnipeg and then returned (Annual Report for 1859, p. 66).

⁸ Robert W. Kennicott (1835–1866): naturalist-explorer of the North; founder of the Chicago Academy of Sciences. At the time of this letter Kennicott was northward-bound on an expedition jointly financed by the Smithsonian Institution, University of Michigan, Audubon Club of Chicago, the Chicago Academy of Sciences and several private persons. See DAB 10: 338–339.

⁹ Methy Portage (109° 45' W. Long., 56° 35' N. Lat.) is in western Saskatchewan near the Alberta border. It is the trail over the height of land separating the Arctic and Hudson Bay watersheds between Lake Methy

He is to /* stay four years in the North. With funds at his command: one whole year on the Yukon in Russian America.

406

Newburgh, New York
Nov. 29, 1859

Prof. Baird

Dear Sir.

Yours of 23rd was duly recd. and the box came today. The butterflies¹⁰ were all ruined, every one of them, but it was no great matter as they were all of our common varieties. We will look for better luck next time when the Californian insects¹¹ come along.

With regard to Kennicot's prolonged stay, I will give \$50 per year so long as he remains exploring if you will send me his collections of / lepidoptera as received. I suppose this form of annual subscription is what you wish for. It is the most convenient to me and to others probably.

Yours truly
W. H. Edwards

479

Newburgh, New York
19th Dec. 1859

Dear Sir.

The box of Rocky Mountain lepidoptera¹² came duly. The specimens

and the Clearwater River, a tributary of the Athabaska River. La Loche Mission is situated on the east shore of Lake Methy.

* Here and hereafter this symbol, /, is used to indicate the end of a page of manuscript in the original letter.

¹⁰ From the Red River Settlements of the North.

¹¹ There is no mention of Californian material in any of the letters presently known in the Edwards-Baird correspondence. This may refer to material being shipped via the Smithsonian from one of the many collectors associated with the U. S. Army in California; the exchange of material with Edouard Ménétriés, (1802-1861) at St. Petersburg, Russia (see dos Passos, "The Entomological Reminiscences of William Henry Edwards" J. New York Ent. Soc. 59: 129-186, 1951, esp. pp. 137-138); or from Dr. Herman Behr of San Francisco via the Smithsonian.

¹² Edwards' letter of 7 April 1860 (q.v.) suggests that this material came to him from Drexler. However the true origin is not certain. The list of donations made in 1859 included in the Annual Report for that year contains reference to three collections from which these may have come. On p. 73: "*H. Brandt*—Box of insects, reptiles and mammals, Kansas." On p. 76: "*Lt. John Mullan, U.S.A.*—Three boxes zoological and geological collections made by John Pearsall on the Upper Missouri," and "*Captain W. F. Reynolds, U.S.A.*—"Zoological collections made in the Upper Missouri region by Dr. F. V. Hayden." On the basis of the specimens listed we can set aside the Brandt material, neither *Argynnis Zerene* nor *Melitaea Editha*

having been crowded into small full boxes were greatly broken and rubbed, but I have succeeded in spreading them out into very decent shapes.

The varieties are

Papilio Eurymedon
Argynnis Aphrodite
Argynnis Zerene
Melitaea Editha
Melitaea Tharos
Attacus Cecropia

of Mel. Editha there were a dozen specimens or so, and they constituted the / bulk of the collection.

Much obliged to you and shall be glad to see any thing more in same line.

Truly yours
W. H. Edwards

Prof. Baird

543

126

Feb. 28 60

My Dear Sir.

I would be glad to receive from you the 50.00 you subscribed for Kennicott as I must soon begin to think of forwarding to him. You will receive the lepidoptera of the Yucan collection. Mr. Kennicott will want to have a series of the duplicates, however, if any to spare.

We think somewhat of sending Drexler to south end of Hudson Bay this spring. Do you want any Lepidoptera from there? How would you like to pay 25.00 for these! The collections should be different from Kennicotts, who / is on the Mackenzies River and interior of Russian America.

Truly yours
S. F. Baird

W. H. Edwards
Newburgh
N. Y.

407

Newburgh, New York
1 March 1860

Prof. S. F. Baird

Dear Sir.

I have your letter of 28th ult. I will enclose in this the fifty dollars for Kennicott. I will be very glad to receive the collections he makes and will preserve the duplicates as you desire.

are found in the area just west of Denver which was the Rocky Mountain area of Kansas in 1859. The same reason dictates that Hayden did not collect these specimens in the Montana area visited in 1859. John Pearsall, Mullan's naturalist, was a founding member of the Entomological Society of Philadelphia and he may very well have collected just this material in the Bitterroot Mountains on the border of Idaho and Montana, where he was during 1859.

I will go in for Drexler's expedition to extent of \$25, if you send him, if I can have the butterflies and sphinges as in Kennicott's case. I see that Prof. Chadbourne¹³ of Williams College is about to head another expedition to Labrador the coming summer. If so, he will glean part of the field Drexler would enjoy.

I enclose a note to Drexler about his chrysalides now on hand, which he had better turn over to me if he goes away.

I received a letter from Cyrus Thomas¹⁴ of Illinois, Curator of the N. H. Society respecting naming their butterflies.¹⁵ I promised to do so, and expect large returns from them for which I have to thank you.

Do you know any way by which the Lepid. of New Mexico and Western Texas can be reached? If I can't get them in any other way I shall apply to entomological friends and try to organize an expedition there for next year.

Yours truly
W. H. Edwards

614

178

March 6 60

Dear Sir.

I have the pleasure of acknowledging the receipt of \$50.00 subscription to Kennicott for 1860. What ever may be the number and value of the Lepidopteras received by you from Kennicott. Your aid will be very considerable in accomplishing the general objects of the expedition.

Much obliged for the subscription of 25.00 to Drexlers exped. He will leave towards the end of April in all probability. Prof. Chadbourne's expedition will not interfere / with Drexler's ground. He goes overland from Montreal to James Bay and will be in quite a different region from the Labrador party.

I gave your letter to Drexler. He will write you.

I have friends at Military forts in the west who will aid any one sent out by us to collect Lepidoptera, etc. If Drexler does satisfactorily this time he can go to Fort Massachusetts¹⁶ or Cantonment Burgwyn¹⁷ next Spring. All we want is the funds.

Truly yours
S. F. Baird

W. H. Edwards
Newburgh

¹³ Paul Ansel Chadbourne (1823-1883): educator and naturalist; professor of botany and later of natural history at Williams College, Williamstown, Massachusetts, 1853-1867; president, University of Wisconsin 1867-1870; president of Williams College 1871-1881. See DAB 3: 585. Edwards was a member of the class of 1842 at Williams College.

¹⁴ Cyrus Thomas (1825-1910): entomologist and ethnologist, founder of the Illinois Natural History Society; State entomologist for Illinois 1874-1882 (?); Bureau of Ethnology, Washington, D. C., 1882-1910 (?). See DAB 18: 426.

March 25 60

Dear Sir.

I asked Collins¹⁸ to send Proof of Dr. Morris Catalogue¹⁹ to you. Please look over completely and report to me as soon as possible any correction or suggestions.

Dr. M. has just sent a mss of compilation of all descriptions of day butterflies.²⁰

Yours truly
S. F. Baird

W. H. Edwards
Newburgh

¹⁵ Among these may have been the *Melitaea nycteis* Doubleday described by Edwards from specimens taken in Illinois in his first series of descriptions (Proc. Acad. Nat. Sci., Phila., pp. 160-164, 1861.)

¹⁶ There were two Fort Massachusetts occupied by the U. S. Army in the late 1850s. One of these was situated on an island off Gulfport, Mississippi. The other in the Upper Rio Grande valley. Baird refers to the latter. The fort preceded Fort Garland in the San Luis Valley, Colorado. It was situated on Ute Creek near the forks in the foothills at the eastern edge of the valley. Hume (1942), p. 359, was incorrect when he stated that the only known picture of the fort is in DeWitt Clinton Peter's "Kit Carson's Life and Adventures, etc. etc." published in 1874 by Dustin, Gilman & Co., Hartford, Connecticut. Two other pictures are known to me, one by Kern in the Pacific Rail Road Surveys and the other by an unknown Signal Corps artist.

¹⁷ Cantonment Burgwyn was situated in New Mexico. The following excerpt from the diary of "James A. Bennett: A Dragoon in New Mexico, 1850-1856." (Brooks, Clinton E. and Frank D. Reeves, NEW MEXICO HISTORICAL REVIEW, vol. 22, p. 90, 1947) locates the establishment: "August 7 1852—Passed Las Rincones (The Corners), where a number of mountains appear to come to a point or corner. Scenery very picturesque. Arrived Taos and established our camp 8 miles south of the town in a cañon or gorge of the mountains. This is to be the future site of a fort [Cantonment Burgwyn] which we have come to build. Surrounded by mountains, it looks as though we were shut out from the world."

¹⁸ T. K. Collins was the printer in Philadelphia who at this time did much printing for the Smithsonian.

¹⁹ John Goodlove Morris [Johann Gottlieb Moritz] (1803-1895) *A Catalogue of the Described Lepidoptera of North America* accepted for publication by the Smithsonian Institution on October 1, 1859 and issued in May 1860. The origin of this and other similar entomological works of the time may be seen in the following quotation from Baird's report as Assistant Secretary in the Annual Report of the Smithsonian Institution for 1858 on p. 30:

"The greatest deficiency in American Natural History is to be found in the department of Entomology, there being no original treatise in reference

408

Newburgh, New York
7th April 1860

Prof. Baird

Dear Sir.

I received your letter and shortly after the proofs of Dr. Ms. Lepidoptera.²¹ The Dr. has sent me the sheets as printed heretofore and I have written him from time to time upon any omissions etc. that occurred to me. I am only acquainted with the Diurnal Species, and the Sphingidae, and so far the Synopsis appears correct. It is a work of / vast labor, and doubtless there are some species omitted, or synonyms of species. But it will be of great assistance to us in our studies of these insects. I hope the Smithsonian will see reasons for publishing the Descriptive Catalogue²² which Dr. Morris has been engaged upon. That will save a great deal of time trouble and expense in journeying to one place or another to examine some book of difficult access. /

If Mr. Drexler goes to Labrador²³ I hope he will go prepared to preserve his captures (in Lepid.) carefully. The specimens he brought from the west²⁴ were all damaged from having been improperly cared for after being

to this country applicable to the wants of the present day. The Institution has therefor made arrangements with eminent entomologists for the preparation of the following series of reports on the different orders . . . Lepidoptera to Dr. J. G. Morris, Baltimore, and Dr. B. Clemens, Easton, Pa."

²⁰ Morris' "*Synopsis of the Described Lepidoptera of North America. Part I. Diurnal and Crepuscular Lepidoptera* accepted for publication in October 1860 and issued in February 1862. This contains, on pp. 350-351, some notes by W. H. Edwards that have been overlooked by all of his bibliographers.

²¹ Morris' "Catalogue," see note 19.

²² Morris' "Synopsis," see note 20.

²³ Edwards seems to have Drexler's destination confused with that of Chadbourne, or he had a vague idea of the geography of northeastern Canada.

²⁴ No clue to the source of this material is to be found in the Annual Report for 1859. However, in the report for the previous year there is on p. 60: "*Drexler, C.*—Collection of vertebrates from Fort Bridger. Living *Spermophilus townsendi* and *Cynomys gunnisoni*." During 1858 Drexler was assistant to Cooper, the ornithologist, while engaged with the Department of Interior on the Wagon-road through South Pass, Wyoming, under the direction of William M. Magraw. Cooper, the surgeon-naturalist, returned to Washington, D. C., from Fort Laramie, Wyoming, before the party settled into quarters in the Wind River country for the winter of 1858-59. In March Drexler and Magraw moved to Camp Scott near Fort Bridger and remained until June during which time he collected in the general vicinity. Drexler seems to have been engaged to collect birds and mammals, thus any insects he took were his own to dispose as he saw fit.

taken. He ought to put each specimen in a folded paper by itself, and then carry them in a box—not in his pocket book as he did in the West—whereby the antennae and legs were all broken. Enjoin this upon him.

Yours truly
W. H. Edwards

461

April ?? 60

My Dear Sir.

As it will be necessary to start Drexler off in about a week, I would be glad if you have the money to spare to add to the limited funds the amt. you proposed to give him (25.00).

Sincerely yours
S. F. Baird

W. H. Edwards
Newburgh
N. Y.

The letter number and the date on the "press" of this letter in the copy-book is so blurred that neither can be read with certainty. The number of the letter impressed with this one Copy-book p. 461 seems to be 1010 and the date of it is either April 14 or 16, 1860.

409

Newburgh, New York
17th April 1860

Prof. Baird
Smithsonian Ins.
Washington
Dear Sir.

I enclose \$25. in check for subscription to Drexler's expedition. I hope you have enjoined on him great care in preserving his lepidoptera.

Yours truly
W. H. Edwards

1071

503

April 19 60

My Dear Mr. Edwards.

Your 25.00 for Drexler's trip just received. Much obliged. He promises vast improvement in his work this time.

Truly yours
S. F. Baird

W. H. Edwards
Newburgh
N. Y.

1169

578

April 27 60

Dear Sir.

I enclose a note which speaks for itself. Please send to Clemens²⁵—Morris when read.

May send a small box of Lepidop. from Nova Scotia.²⁶
Drexler left Friday.

Yours
S. F. Baird

W. H. Edwards
Newburgh

1430

62

May 17 60

Dear Sir.

Enclosed is a catalogue of European eggs and Lepidoptera for sale by
Dr. Wm. Heneleben²⁷

.....*

III.

If you want any of the latter, address for terms, etc, as above.

Yours ever
S. F. Baird

W. H. Edwards
Newburgh
N. Y.

410

Newburgh, N. Y.
21st May 1860

²⁵ James Brackenridge Clemens (1829–1867): physician and entomologist interested in moths, living at the time of this letter in Easton, Pennsylvania. Author of "*Instructions for collecting Lepidoptera*" published as an appendix to the Annual Report of the Smithsonian Institution for 1858, pp. 173–200.

²⁶ The Annual Report for 1860, p. 84, includes among the donations this note: "*Winston, W. G.*—Lepidoptera and skins and eggs of birds from Halifax." On p. 74 of the report is the notice that Dr. Morris and Mr. Edwards are the entomologists responsible for study of the Smithsonian Lepidoptera. This is the first announcement of an official connection between Edwards and the Institution. It probably was in this official capacity that he received material donated to the Institution. Previous material sent to him by Baird was collections placed with the Institution for sale.

²⁷ I have not been able to identify Dr. Heneleben. He is not listed in the usual biographical sources nor in either of Carpenter's bibliographies (1945, 1953).

* The town name is undecipherable. Mr. De Atley suggests Galena.

Prof Baird

Dear Sir.

I return the list you sent me. It mentions only European Lepidoptera so far as I discover. I will perhaps write to the gentleman^{27a} to learn if he collects in Illinois.

Much obliged to you however for thinking of me.

Yours truly
W. H. Edwards

1474

97

23?

May 26 60

Dear Sir.

I send a few Lepidoptera collected in Jamaica* by Dr. J. B. Smith²⁸ of New York.

Truly yours
S. F. Baird

W. H. Edwards
Newburgh

411

Newburgh, New York
21st Sept. 1860

Dear Sir.

Do you hear from Kennicott and Drexler and have you received any insects from either that are in my line. Perhaps D. will shortly be home himself.

Yours truly
W. H. Edwards

Prof. S. F. Baird

2354

620

Oct. 3 60

Drexler will be back in a few weeks. I hope he will bring some Lepidoptera. Kennicott will soon be home. . . .*

Yours truly
S. F. Baird

W. H. Edwards
Newburgh

^{27a} I have not been able to discover any evidence that Edwards procured material from Heneleben.

* This may be Jamaica. The first letter may be I, J or T the next two clearly are "am", the next three or four letters are anyone's guess! Mr. De Atley agrees that Jamaica is a reasonable reading of the word in question.

²⁸ This is not John Bernard Smith, the well-known entomologist, who was born in 1858 and died in 1912.

* The last three words are poor transfers and I can make no sense of the last one.

2578

70

Oct. 23 60

Dear Sir.

I send a few Lepidoptera received from Kennicott, etc. More will be here in a few weeks.

Truly yours
S. F. Baird

W. H. Edwards
Newburgh
N. Y.

2625

114

Oct. 31 60

Dear Sir.

I send by mail a few Lepidoptera brought by Drexler. His main collections are coming around by London and will be here in a few weeks.

Truly yours
S. F. Baird

W. H. Edwards
Newburgh

412

Newburgh, New York
4th Oct. 1860*
[4th Nov. 1860]

Prof Baird

Dear Sir.

I have been absent from home till yesterday for a month or so. On my return I found two letters from you with two packages. The larger I take to be from Kennicott. Both contain specimens of interest and in good order. I recognize several of the diurnals figd. by Kirby. I shall be in Washington about 15th Dec. and will call on you of course. But if anything for me comes along, send it on as before.

Yours truly
W. H. Edwards

2705

166

Nov. 17 60

Dear Sir.

We have requested Collins to mail you proof of second and all succeeding signatures of Morris' Lepidoptera.²⁹ Will you not oblige Prof. Henry³⁰

* Something is awry here. This letter is misdated by a month. Edwards states he has been away from home "a month or so", yet letter 411 from him to Baird is clearly dated "21st Sept 1860" and this one very clearly "4th Oct. 1860". Baird wrote three letters to Edwards during October 1860, one each on the 3rd, 16th and 31st. The first of these, 2354, answered Edwards letter of September 21st. The other two announced shipment of packages from Kennicott and Drexler respectively. This letter, 412, ob-

and the Institution by looking them over and returning to *us* with any corrections. Due credit will of course be given for such assistance.

Truly yours
S. F. Baird

W. H. Edwards
Newburgh
N. Y.

2791

233

Nov. 25 60

My Dear Sir.

For fear something may occur to prevent my seeing you on your return from Virginia I will write a line to thank you for your letter³¹ and criticisms on Morris Catalogue. This I have sent the Dr. and hoped it will be of use to him.

The present work does not pretend to be more than a compilation. To the monographic labors of yourself and Clemens we look hereafter for a thoroughly scientific elucidation of the whole subject. In the mean time however you will oblige Prof. Henry and the Institution greatly by helping to correct this book, and perhaps the best way will be to revise the sheets one by one carefully, make additions of localities, species, etc. to be inserted in the end as an appendix. A general index will & readily harmonize this with the body of the text. Of course any suggestions or corrections that can be inserted in the first sheets should be so treated.

As to localities, are not many of those referred to by you known only to yourself by specimens in your private collection, and not yet published to the world?

Sincerely yours
S. F. Baird

W. H. Edwards
Newburgh
N. Y.

viously acknowledges Baird's letters of the 6th and 31st and the packages they announce. The date must be later than October 31.

²⁹ Morris' "Synopsis," see note 21.

³⁰ Joseph Henry (1797-1878): physicist, the first Secretary of the Smithsonian Institution to whom Baird was assistant and successor. See DAB 8: 550-553.

³¹ The letter referred to here by Baird is missing from his files. Probably it was sent to Morris with the suggestions and corrections included with it or part of it. The information was incorporated by Morris as pp. 350-351 of the "Synopsis" (see note 21) and full credit given to Edwards as its author. Other corrections and suggestions may have been incorporated in the body of the text. The two pages cited may be considered Edwards' minimum contribution to the publication.

413

New York, 40 Wall St.

2 Jan., 1861

Dear Sir.

I am now in the city for the winter and my address will be as above. I have not received from the publishers the first sheet of Dr. Morris' book³² nor any after the third. I would like the others as they appear and will thank you to order them sent to me here instead of Newburgh. I conclude that Drexler found no more butterflies in his collections³³ just received.

Yours truly

W. H. Edwards

Prof. S. F. Baird
Smithsonian

414

New York 40 Wall St.

Feb. 22 1861

Dear Sir.

I have written a few lines to Kennicott which read and send with your next to him.

You can say to him that I subscribe to his expedition and wish to do so while he is in those regions, and urge him to do what he can for my department.

I will send \$50 to you shortly for him.

Dr. Gabb³⁴ writes me that his Texan expedn. is broken up, for which I am sorry.

Yours truly

W. H. Edwards

Prof. Baird

535

76

March

Dear Sir.

We enclose a letter from Mr. Wm. H. Hall³⁵ [or, Hale] of Boston asking for certain information which you can probably give him.

[no signature]

Wm. H. Edwards
40 Wall St
New York

³² Morris' "Synopsis," see note 21.

³³ From Hudsons Bay area.

³⁴ William Moore Gabb (1839-1878): paleontologist, member of the Academy of Sciences, Philadelphia, and of the Entomological Society of Philadelphia (elected May 12, 1862, with residence in San Francisco, California at that time). In 1861 Gabb was appointed to the Geological Survey of California and thus his proposed expedition to Texas was abandoned. See DAB 7: 81-82.

561

98

March 16 61

My Dear Mr. Edwards.

By hand a box of Lepidoptera just received from Wm. Vuille,³⁶ Yreka, Cal. (near Shasta Mt.) What are they worth to you and what will you give him for them. He wishes to sell, and will collect others, if things go off right.

A Mr. William Dean³⁷ of Lambertville (State not mentioned) writes us that he has a large collection of Lepidoptera. Better write him.

I would be glad to have the money for Kennicott as soon as possible as I should before long send him his funds.

Sincerely yours

S. F. Baird

W. H. Edwards

40 Wall St.

N. Y.

415

New York 40 Wall St.

Mar. 26th 1861

Prof Baird

Dear Sir.

Yours of 16th only came this morning, and I have heard nothing of Mr. Vuille's box. Possibly your letter is misdated, but if not and you sent the box as you advised, I had better look it up at the express office here.

I believe Lambertville is near Princeton, New Jersey.

I will send you the money for Kennicott in a few days, probably this week.

Yours truly

W. H. Edwards

424

Newburgh, New York

28th March [1861]*

Prof Baird

Dear Sir.

* The date cannot be deciphered. On the same leaf of the copy book is a letter to John Cassin, numbered 534 and dated March 14, 1861. This letter may have been prepared for Henry's signature.

³⁵ I can find no reference to William H. Hall, or Hale, in the biographical sources at my limited disposal.

³⁶ William Vuille (-): I can find no information about this man.

³⁷ William Dean (-): I can find no information about this man.

* The lack of year date upon this letter caused it to be bound with Baird's incoming correspondence of 1862. The content, when read with Edwards' letter 415, March 26, 1861 and Baird's letter 711 dated March 29, 1861 accurately places this letter here.

I have written the other letter³⁸ in such shape that you may send it to Mr. Vuille if you please. I have made him a good offer I think especially as he will send usual species that are of no value as being found in these States.

This lot just recd. is valueless, and you would not think I ought to pay for them in such condition I presume. Mr. V. evidently thought the *Sphinges* worth something, but every one was common all over the country.

W. H. E.

711

185

March 29 61

My Dear Sir.

Check for 50. was duly received for Kenicott.³⁹ Very much obliged.

I will send your letter to Vuille. The specimens I sent you were started from Cala. in October.

Of course if the specimens are worth nothing they are not worth anything.

Sincerely yours

S. F. Baird

W. H. Edwards

N. Y.

Let me know if you have not yet had proofs of Synop. of Morris.

416

Hunter, Greene Co., N. Y.
30 Sept. 1861

Prof Baird

Dear Sir.

Have you ever heard from Kennicott, or received anything from him for me or any other of our correspondents? If you have any packages for me, I will try to find some private opportunity of sending them to New York rather than trust to Express. Where is Drexler? If he is at Washington I will write him. I have described eleven / species of Diurnal Lepid in the last number of the Phila. proceedings.⁴⁰ Ten of these are new, and

³⁸ I believe that this letter, 424, was just a note transmitting a letter for Vuille. It is the only one I have come across signed only with Edwards' initials.

³⁹ No letter of transmittal for this check from Edwards is in Baird's file.

⁴⁰ Although the letter clearly states that eleven species were described only ten appear in the article "Descriptions of certain species of DIURNAL LEPIDOPTERA found within the limits of the United States and of British America." (*Proceedings of the Academy of Natural Sciences, Philadelphia, 1861, pp. 160-164, July number.*) This, the first entomological article published by Edwards, describes the following:

1. *Melitaea mylitta* from "Texas, Kansas, California."

The Texas record probably is in error. The Kansas record is possible, although not referring to Kansas as delimited today. Previous to February 1861 Kansas extended westward to the Conti-

(continued from page 207)

- mental Divide and *mylitta* is not rare in the canyons west of Denver, Colorado. Sources of the Texas and Kansas specimens need elucidation. The California material probably came from Dr. Hermann H. Behr, of San Francisco.
2. *Melitaea minuta* from "Texas," through J. W. Weidemeyer of New York, a close friend of Edwards.
Gideon Lincecum sold a large collection of Texan Lepidoptera to George William Peck of New York at this time. It is possible that some of this material found its way to Edwards via Weidemeyer. See Geiser, 1948, pp. 199-214.
 3. *Melitaea nycteis* Doubleday, from "Illinois and Missouri."
See letter to Baird dated 1 March 1860 about naming butterflies for the Illinois Natural History Society.
 4. *Limenites weidemeyeri* from "Rocky Mountains" through J. W. Weidemeyer.
Probably from specimens collected by J. Winslow Howard. See Brown 1957, pp. 45-47.
 5. *Satyrus silvestris* from "California," from Dr. H. H. Behr.
At this time of its history the Smithsonian was very active as a clearing house through which naturalists in this country, and those abroad, too, exchanged material. I am confident that Behr's shipment was passed on to Edwards by Baird but can find no letter to cover the shipment from Baird to Edwards. This may be from the California material mentioned by Edwards in his letter dated Nov. 29, 1859.
 6. *Coenonympha inornata*, from "Lake Winnipeg," collected by R. W. Kennicott.
Kennicott's route on Lake Winnipeg was from Fort Alexander at the head of Travers Bay in the southeastern corner of the Lake to Norway House in the northeast corner of the Lake. It is probable that he collected these specimens in June or early July, 1859, somewhere on the eastern shore of the Lake, most likely at Norway House.
 7. *Coenonympha ochracea*, from "Lake Winnipeg, California, Kansas."
Lake Winnipeg: probably collected by Kennicott in 1857 near Winnipeg among the Red River Settlements (see letter dated Nov. 23, '59) or in 1859—see *inornata*—. California: two possibilities, 1) from H. H. Behr, 2) from one of the various collections made in the Great Basin, known in the '40s and '50s as Upper, or New California—see map published by S. Augustine Mitchell, NE corner of Market & 7th St., Philadelphia, Pennsylvania in 1845—. If the specimen came from what we now know as California it probably was a specimen of *galactinus* or *eryngii*, if from the Great Basin it was properly associated with what we call *ochracea* today. I favor the latter situation. Kansas: from the Rocky Mountains west of Denver, Colorado, possibly collected by Brandt, Howard or Wood. —see Brown 1957, 41-47.
 8. *Lycæna anna* from "California," from Dr. H. H. Behr.
 9. *Lycæne scudderi*, from "Lake Winnipeg," through S. H. Scudder.

the other one heretofore only figured but not described. I have several others that will be ready soon. I still have your Kirby vol. 4, and will return it in a few weeks.

Direct to me as above. I shall be here till 1st Nov. and then at Newburgh.

Yours truly
Wm. H. Edwards

1582

627

Oct 13 61

My Dear Sir.

I heard from Kennicott to date of January 2.⁴¹ He was then on the Youkon of Russian America. It was too wintery to talk about butterflies. Some collections now on their way are said to contain Lepidoptera.⁴²

Drexler is now in Washington I believe.

Sincerely yours
S. F. Baird

W. H. Edwards
Hunter
Greene Co. N. Y.

1824

79

Nov 12 61

Dear Sir.

Are you aware of some descriptions of new Lepidoptera in Canada Naturalist for Feb. 1861.⁴³

We have some Lepid. from Slave Lake. Just received from Mr. Ross.⁴⁴

Truly yours
S. F. Baird

W. H. Edwards
Newburgh
N. Y.

Probably from Kennicott's 1857 material collected among the Red River of the North settlements.

10. *Lycaena fuliginosa*, from "California," from H. H. Behr.

⁴¹ This letter is quoted on pages 59–61 of the Annual Report of the Smithsonian Institution for 1861, in Baird's Appendix to the Report of the Secretary.

⁴² The only material received from Kennicott in 1861 is reported in the Annual Report for that year on page 66. "Kennicott, Robert.—Zoological specimens, plants, etc, from Great Slave Lake."

⁴³ Dr. Frederick Rindge of the American Museum of Natural History has checked this article for me. It is in *The Canadian Naturalist and Geologist, and Proceedings of the Natural History Society of Montreal*, volume 5, pp. 36–41. It was written by W. S. M. D'Urban and is entitled "Addenda to the Natural History of the Valley of the River Rouge." In it are descriptions of numerous new species of moths, written by Francis Walker, mostly from Montcalm township. There also are four new names proposed by Walker, without descriptions, assigned to the genus *Boarmia*.

417

Newburgh, New York
Nov. 19th 1861

Prof Baird

Dear Sir.

I did not know of the descriptions in the Canadian Jnl. you mention. I will obtain it if possible.

I will find an opportunity to send to you by [hand] for the lepidoptera you have on hand, in a few days.

Yours truly
W. H. Edwards

418

Newburgh, N. York
Nov. 25th 1861

Prof Baird

Dear Sir.

I dont find the opportunity I expected to send to you by [hand] for the lepidoptera from Slave Lake. As the only objection I have to their coming on by express is the risk of breakage, suppose I send you a box large enough to enclose your box. If as I understand you do not pay freight on packages sent to you, this plan will not increase the expense. You [tell] me the size of box that you have and I will at once forward mine, if it pleases you.

Yours truly
W. H. Edwards

1895

124

Nov. 26 61

My Dear Sir.

We have plenty of boxes, and can pack the smaller boxes of Lepidoptera in larger ones without difficulty. Will do so and send you.

Truly yours
S. F. Baird

W. H. Edwards
Newburgh

419

Newburgh, N. Y.
30th Dec. '61

⁴⁴ Bernard Rogan Ross (1827-1874): Hudsons Bay Company agent at Fort Simpson where Kennicott wintered in 1859-1860. He and his wife, Christina, (*q.v.* note 54) collected butterflies for Edwards at various Hudsons Bay Posts in northern Canada. There is a one-page biographical note by Mrs. J. M. Sherk about Ross in the Hudson's Bay Company magazine THE BEAVER, Dec. 1926, p. 25. See note 49.

Prof Baird.

Dear Sir.

I have a letter from Mr. Saunders⁴⁵ of London, C. W. [Ontario] asking the price of the Smithsonian Cat'ge. of Coleoptera⁴⁶ and where it can be procured. I wish you wd. give me the information for him.

I shall have several new Lepidoptera (diurnal) to describe in the Feby. Proceedings.⁴⁷ Among them a large *Argynnis* from the north that has been overlooked.

Yours truly
W. H. Edwards

1

212

Jan. 3 61 [62]*

My Dear Sir.

We have none of our Catalogue of Coleoptera now to spare: Leconte's classification⁴⁸ costs 1.00.

⁴⁵ William Saunders (1835–1914): an apothecary who long lived in London, Ontario, and was an outstanding entomologist, See Carpenter, 1945, p. 90.

⁴⁶ Probably refers to "Catalogue of described Coleoptera of United States." Friederich Ernst Melsheimer, revised by S. S. Haldeman and J. L. LeConte. S. I. Publ. No. 62. July, 1853.

⁴⁷ "Descriptions of certain species of DIURNAL LEPIDOPTERA found within the limits of the United States and British America. No. 2." *Proceedings of the Academy of Natural Sciences*, Philadelphia, 1862, pp. 54–58, February number. This paper contains the original descriptions of seven new species and re-description of one. The "large *Argynnis* from the north" is the first mentioned, *atlantis*.

1. *Argynnis atlantis*, from "Catskill Mountains, near Mountain House [N. Y.], Williamstown, Mass., Lake Winnipeg, through S. H. Scudder, Hudson's Bay, collected by C. F. Drexler, north side of Lake Superior, collected by L. Agassiz."
2. *Thecla acadica*, from London, C. W. [Ontario] through Wm. Saunders.
3. *Thecla laeta*, from London, C. W. [Ontario] through Wm. Saunders.
4. *Lycaena neglecta*, from Massachusetts, New York, Wisconsin, Lake Winnipeg.
[Massachusetts and New York: probably Edward's own captures; Wisconsin: possibly Kennicott material.]
5. *Chionobas taygete* Huebner, from Albany River, Hudson's Bay, collected by C. F. Drexler.
6. *Pamphila verna*, from Illinois through Benj. D. Walsh; and Washington, D. C.
[Walsh material was in all probability from the vicinity of Rock Island, Illinois; Washington, D. C., material probably supplied by Drexler.]
7. *Pamphila rurea*, from Rock Island, Illinois, through B. D. Walsh.
8. *Hesperia vialis*, from Rock Island, Illinois, and Lake Winnipeg.

We will send in a day or two the lots of Lepidoptera now here and you will receive an official announcement of the same from Prof. Henry. Send back second best series of Mr. Rosses Ft. Simpson⁴⁹ Lepidoptera to be sent to Montreal Nat. Hist. Soc.⁵⁰ The others are a box of Cubans (five) from Chas. Wright⁵¹ and some eaten up Amazonians of Lt. Herndon⁵² also from Kennicott in paper.⁵³

Yours truly
S. F. Baird

W. H. Edwards
Newburgh

7

213

[no date]

Dear Sir.

I write to announce the transmission of some boxes of Lepidopterous

[The Rock Island material from B. D. Walsh; Lake Winnipeg material doubtlessly from Kennicott.]

* Edwards made the usual lapse at the change of year date!

⁴⁸ John Lawrence Leconte (1825–1883): probably refers to "Classification of North American Coleoptera" Part 1. 1861. The work was not completed until 1873.

⁴⁹ Kennicott had left collecting equipment with the Rosses at Fort Simpson, H. B. T. (Mackenzie Territory today). The post is on an island in the Mackenzie River just below the point where the Liard River joins it from the west, 121° 21' W. Long., 61° 52' N. Lat.

⁵⁰ These collections are now in the Redpath Museum, McGill University, Montreal, Quebec.

⁵¹ Charles Wright (ca. 1810–1885): botanist, a graduate of Yale, class of 1835, who a few months after graduation moved south and in 1837 settled in Texas. He was a botanist for the United States and Mexican Boundary Survey in 1851–1852 and the North Pacific Exploring Expedition 1853–1855. He spent 1856–1857 botanizing in Cuba. From 1868–1876 he was variously employed at Harvard in the Herbarium and Bussey Institute, upon a short expedition to Santo Domingo (1871) and mostly in semi-retirement at his home in Wethersfield, Connecticut, where he died. See Geiser (1948), pp. 172–198.

⁵² William Lewis Herndon (1813–1857): naval officer; made a two-year journey across South America from Peru via the Amazon. (1851–1852). He reported his findings to Congress on 26 January 1853. His account was published by the Government in two volumes "Exploration of the Valley of the Amazon" 1853–1854. In true Navy fashion he went down with his ship as it foundered in a storm off Cape Hatteras during the night of 12–13 September, 1857. See DAB 8: 579–580.

⁵³ In the Annual Report for 1861 on p. 59 Baird remarks that no collections were received during the year from Kennicott except a few gathered in July and August 1860. This was material captured at Fort Resolution on Great Slave Lake, usually referred to as "Slave Lake."

insects received by us within a few weeks past. You will please us to personally under take charge of these specimens holding the first series subject to the order of the Institution and making such disposition of the remainder as may be for the best interest of Science.

We have however, in like case of the specimens furnished by Mrs. Christina Ross⁵⁴ to request that you will return the second best series of the specimens to us, labelled, in order that we may forward it to the Montreal Natural History Society, as desired by Mrs. Ross. We will also be pleased to have a list of the species contained in this box in order to send it to Mrs. Ross as an encouragement to further collection.

[no signature]

Wm. H. Edwards

Newburgh
New York

This is Baird's draft of the letter for Prof. Henry's signature mentioned in letter no. 1, dated Jan 3, 62.

60

254

Jan. 13 62

My Dear Sir.

Prof. Henry proposes to have a new edition of the directions for collecting insects.⁵⁵ Have you any corrections or additions to suggest? If so send along.

Truly yours
S. F. Baird

W. H. Edwards

Newburgh

Did you get the Lepidoptera?

420

Newburgh, 20th Jan. 1862

Prof. Baird.

I have yours of 13th. I will send a few directions for taking and putting up butterflies herewith.⁵⁶ The principle care is lest the specimens be injured by handling, or badly pinned. The box came in good order. I received Prof. Henry's letter about same time, and I will return a series of the Fort

⁵⁴ Christina Ross (-): wife of the Hudsons Bay Company official, Bernard R. Ross. (see note 41) She was the daughter of Donald Ross, who was in charge of the Norway House district at the time of the marriage in 1860. Mrs. Ross collected butterflies for Edwards at several posts in the old Hudson Bay Territory.

⁵⁵ The first edition of these instructions was published in the Appendix to the Annual Report of The Smithsonian Institution for 1858. The part devoted to "Instructions for Collecting Lepidoptera" is found on pp. 173-200, and was written by Brackinridge (*sic*) Clemens, M. D.

⁵⁶ I can find no evidence that Baird ever used this material. Although new instructions for field workers were published for other orders of insects nothing but Clemens' instructions were printed for Lepidoptera, see note 55.

Simpson species as he desires. There was nothing that I had not recd. before, unless perhaps one small *Argynnis* [*Boloria*], that I am not yet determined about. Mrs. Ross needs instructions badly. Most of the specimens seem to have been roughly handled, and are either broken or the scales are rubbed off. She uses very coarse pins. I would send her pins if I knew how to do it. Her species are mostly those common to our northern states, but there are a few Boreal ones, same as we get from Winnipeg and Slave Lake.

The Cuban species are very good and all named, which is admirable. Cant you get Mr. Wright to send more of them, not the rarities only, but the common ones. These last are the species often common to both *Cuba* and *Florida*.

I doubt very much if I shall be able to send anything to Kennicott this Spring. My monies are unfortunately locked up in Virginia, or owing me by rebels, and I must wait on Uncle Sam's armies.⁵⁷

I am about describing in the Proceedings of Phila./ several more descriptions of butterflies.⁵⁸ I am working up the material as fast as I can safely.

⁵⁷ This is the first mention of the Civil War in this correspondence although the conflict had been waged some nine months at the time the letter was written. Edwards coal properties in the Kanawha valley were in the "no man's land" created when western Virginia did not join with the Confederate States of America.

⁵⁸ "Descriptions of certain species of DIURNAL LEPIDOPTERA found within the limits of the United States and of British America, No. 3.", Proceedings of the Academy of Natural Sciences, Philadelphia, 1862, pp. 221-226, April number. Eight new species and re-descriptions of three others were published at this time.

1. *Argynnis nokomis*, from "Rocky Mountains and Mountains of California."

The type locality of this species is a moot question. In the original description Edwards states "Rocky Mountains and Mountains of California." Also, "This is much the largest of the Pacific species, equalling the largest specimens of *Cybele*. In color it most resembles *Aphrodite*. The female I have not seen."

This would lead me to believe that Edwards had at least two males before him when he wrote the description. However in his *Butterflies of North America*, volume 1, *Argynnis* IV, he states "The original specimen from which the description of the species was drawn was received by me in 1862, through the Smithsonian, and was labelled 'Bitter Root Mountains.' Until the present year (1872) it has been an unique in my collection and, so far as I know, not found in any other." More confusion is added by Edwards in his "Reminiscences" (see dos Passos, 1951, p. 143) where he states about *nokomis* ". . . a single male of which I found at the Smithsonian in a glass jar amid some cotton wool from southern Utah, or southeastern California. . . ."

The status of *apacheana* Skinner and of *nigrocaerulea* Cockerell

Yours truly
W. H. Edwards

P. S. I have written a few directions which I think cover the whole span, and I suppose the fewer the better. You can alter them or amend as you please as I send the draft as written.

421

Newburgh, New York
30th Jan. 1862

Prof. Baird.

Dear Sir.

I have put up as directed by Prof. Henry a set of the butterflies sent by Mrs. Ross. I think they are not worth sending to Montreal, but it is well enough to oblige the lady and hope for better lot next time. Nearly all of

depend upon discovery of the true source of the type specimens of *nokomis* Edwards.

2. *Grapta faunus*, from "Catskill Mountains, New York, Fort Simpson, Albany River, Lake Winnipeg."

Catskill Mountains, N. Y.: probably collected by Edwards himself; Fort Simpson, Mackenzie Territory: collected by either Kennicott or Mrs. Ross, most likely the latter; Albany River, Ontario: collected by C. F. Drexler; Lake Winnipeg, Manitoba: probably collected by Kennicott.

3. *Thecla californica*, from California through H. H. Behr.
4. *Thecla viridis*, from California, through H. H. Behr.
5. *Thecla affinis*, from "Utah collected by Mr. C. Drexler."

In 1858 Drexler was with the Department of Interior party under William M. Magraw working on the wagon road through South Pass, Wyoming, into Utah. The accession list for this year shows five boxes of vertebrates from Utah collected by Drexler. He probably retained the butterflies for his own collection and exchanged these with Edwards (see note 4) This would place the type locality either in Uinta County, Wyoming, or Summit County, Utah.

6. *Lycaena behrii*, from California through H. H. Behr.
7. *Lycaena pembina*, from Lake Winnipeg collected by R. W. Kennicott.
8. *Lycaena shasta*, from California through H. H. Behr.
9. *Lycaena scudderi* Edwards, description of the female from London, C. W., collected by Wm. Saunders, and from Fort Simpson.
10. *Parnassius smintheus* Doubleday, described from Californian specimens. True *smintheus* hails from the vicinity of Banff, Alberta. This description by Edwards refers to the Californian red-spotted form, *sternitzski* McDunnough, not the usual yellow-spotted one, *behrii* Edwards.
11. *Limenites eulalia* (sic) Doubleday, described from Californian specimens supplied by H. H. Behr.

True *eulalia* hails from Mexico. Edwards here described what Butler later called *californica*.

the specimens seem to have been either caught in the hand or much handled, so they are much rubbed. Except three or four species that are Northern the others all are common to our region as well. Some of the commonest she sent in greatest number, e.g. *Vanessa Milberti*. / There were 38 spec. of one little *Argynnis* [*Boloria*] that is valuable if in good condition but which comes in all the lots from Kennicott.

I could not make good looking specimens of them but have done the best I could.

You had better send Mrs. Ross the directions for preserving and taking these insects. She may hit on something very good, and therefore may as well be requested to catch everything.

I have sent nearly a dozen more descriptions to Phila. for publ.⁵⁹

Yours truly

W. H. Edwards

[P. S.]

I don't know whether you have heard that two gentlemen⁶⁰ in New York and myself are publishing privately plates of the North American (Mexican as well as U. S.) figs. of life, quarto form. We have an artist who works cheap and well. Each of us has one set colored and altogether about 100 impressions uncolored are taken from the stone. We have published eight sheets with about 40 figures. Many of these insects never have been figured and others badly. We have most of the species in one or other of our collections, and the drawings are from the object itself. I mention all this to show you on one/stone.

I have had several of the new species of Diurnals described by me figured, and I enclose one to show how it looks.

W. H. E.

These two pages are back to back and look as though they were written at the same time as letter 421 of 30 Jan. 1862. If marked as a postscript to that letter the indication has been covered during binding of the letters into the 1862 letterbook. Since Baird's letter of Feb. 2, '62, immediately following, refers to this note I assume it was enclosed with Edwards' letter 421.

157

308

Feb. 2, 62

My Dear Sir.

The box of insects came to hand yesterday in fine condition.

Suppose you address a letter to Mrs. Ross about collecting Lepidopt.

Do you know a work by Lederer on the European Noctuides including Labrador species?⁶¹

⁵⁹ See note 58.

⁶⁰ The gentlemen referred to were John William Weidemeyer (1819-?) and Stephen H. Calverly (-), well known Brooklyn, N. Y., entomologists. See dos Passos, (1951), p. 139.

⁶¹ Julius Lederer (1821-1870): "Die Noctuiden Europas" 252 pp. 4 pl. 1857.

If you have done with my copy of Kirby, please return as Ulke⁶² and Osten-Sacken⁶³ wish to refer to it.

I had not heard of your undertaking relative to Lepidopterous plates. I don't think the execution of the sample is very / extraordinary: though perhaps correct. Why don't you put more figures on a plate, and thus save on cost of printing?

Why not try an publish a larger edition . . .* Perhaps Prof. Henry would lend some aid. At any rate I think he would take a colored copy to keep here for reference.

What does the drawing cost per figure? You might make it a series of Smithsonian illustrations of Lepidoptera: we to publish only plain copies and by distributing them create a demand for colored ones to be furnished by some one to his profit.

Sincerely yours
S. F. Baird

W. H. Edwards
Newburgh

Do you keep the stones of your plates?

422

Newburgh, New York
Feby. 5 1862

Prof. Baird.

Dear Sir.

I have yours of 2nd and tomorrow shall send by express your Kirby, for which I am much obliged to you. I have had frequent occasion to refer to it lately. I also send with it 8 sheets of the Sphingidae, for *yourself*. I will see that you get the others when published. The coloring costs 50 cents a sheet, and is very well done indeed. I have had but one set colored. In every instance it is done from the specimen, when that can be obtained. I also send a sheet of the Theclas colored. Perhaps you will not think the coloring extraordinary (as you say of the lithographing, []) but as I did it / *myself* you must not be critical. This plate and one other same size lithographed, two colored copies of each, and 25 uncolored, cost me \$4.50.

The Sphingidae cost \$4 per plate to lithograph, and 50 cents each to color. We each had one colored plate made, and in all have struck off 100 copies, after which the stone has been cleaned. It was not our intention to make

⁶² Henry Ulke (1821-1910): a portrait painter who was also an entomologist. He was one of the men selected by Baird to handle Smithsonian material on the same basis as Edwards. His field was coleoptera. His fine portrait of Baird hangs in the secretary's office at the Smithsonian Institution.

⁶³ Charles Robert Osten-Sacken, (Karl Robert Romanovich, Baron von der Osten Sacken) (1828-1906) one-time Russian Consul at San Francisco and outstanding dipterist who worked up much of the material in the Smithsonian Institution at the time of this letter.

* I cannot decipher this word.

a book to be sold, for no bookseller would have treated with us on reasonable terms, but dividing the expense between three, it does not cost a great deal, and we mean to distribute the plates when done. There will be some short text with the plates. Several of these Sphinges have never been figured before, and three that / have been colored by the job, which we will not allow.

I had the small sheets made at my single expense, and of a size to bind into my Boisduval.⁶⁴ If the whole can be squeezed to pay me any money, I mean to continue printing off all the new species, at least of Butterflies.⁶⁵

I will write to Mr. Weidemeyer about Lederer. I don't know it.

I will write to Mrs. Ross and send you the letter to be forwarded. I will send her a net and pins also if you think she can receive them. They would have to go by private hand I suppose.

Yours truly
W. H. Edwards

197

341

Feb. 8 62

My Dear Mr. Edwards.

The package with Kirby and the plates of Sphingidae was duly received today. I am much obliged for the latter and shall prize them highly.

Would you have a set colored for the Smithsonian if Prof. Henry will pay for it. It would be very well to have one copy here for reference.

The price you pay for the lithographing is certainly very low.

By all means send the net and pins for Mrs. Ross. We can readily forward them. If you could send a nice book of insects it would be of service in stimulating her efforts.

Sincerely yours
S. F. Baird

W. H. Edwards
Newburgh
in left margin

How many impressions can be struck off from one of the stones?

423

Newburgh, New York
March 17, 1862

Prof. Baird
Smithsonian Ins
Washington, D. C.
Dear Sir.

⁶⁴Jean Baptiste Alphonse Dechauffour de Boisduval (1799-1879): A physician in Paris and one of the outstanding lepidopterists of all times. Edwards probably refers here to "Histoire Naturelle des Insectes. Species general des Lepidopteres. Tome premier. Roret, Paris. 1836." He may refer to Boisduval and Leconte (Major John Eatton Leconte, 1784-1860) "Histoire generale et iconographique des Lepidopteres et des Chenilles de l'Amerique septentrionale." Paris. 1833.

I enclose a letter which you may read for Mrs. Ross. I will send the box tomorrow or next day by express. The book is Rennie's *Insect Architecture*,⁶⁶ a fine copy.

I will see that the Smithsonian gets the Sphinges. It will be three months or more before we have all the sheets issued, after that one artist can have time to color extra plates.

Yours truly
W. H. Edwards

[on reverse]

The box is carefully packed and covered with canvass. This directed to you with my name on the corner. I think you may venture to ford. it to Mrs. R. without opening it & send the letter by mail.

I have a third paper on Butterflies ready for the Phila. Proceedings.⁶⁷ No. 2 is now in press. I have described about 24 new species.

425

Newburgh, New York
Apl. 27, 1862

Prof. Baird.

Dear Sir.

I have a letter from a correspondent in Bahia, Brazil, asking me to obtain for him at the Smithsonian "Directions for Meteorological Observations,"⁶⁸ "and some other of their interesting papers." What this last means I don't know, but as the gentleman is a naturalist and an educated man, it is well to send him whatever may be likely to interest him. His name is Sr. Antonio de Lacerda,⁶⁹ and / his father is one of the wealthiest citizens of Bahia.

⁶⁵ This seems to be the beginning of an idea with Edwards that led to the publication of his monumental "The Butterflies of North America."

⁶⁶ This book is number 14 in "The Library of Entertaining Knowledge" published by Charles Knight, London, in 1830, 420 pp. Miss Hazel Gay, librarian for the American Museum of Natural History, New York, supplied me with this information and told me that the title page carries no author's name. On their copy they have written in the author's name.

⁶⁷ See note 53.

⁶⁸ "Directions for Meteorological Observations and the Registry of Periodical Phenomena" Publ. No. 148. Miscellaneous Collections 1. 72 pp.; x 8 vo., 1860. Probably written by Joseph Henry and Arnold Guyot.

⁶⁹ Antonio de Lacerda (-): Through the good offices of Sr. Maury Gurgel Valente, Secretary in Charge of Cultural Affairs of the Brazilian Embassy in Washington, D. C., I was put in communication with Dr. Alvaro Barcelos Fagundes, Conselho de Desenvolvimento, Rio de Janeiro who wrote me as follows: "It is likely that the person to whom the great naturalist was asking the Secretary of the Smithsonian Institution to send some scientific papers was Comendador Antonia de Lacerda, son of the Visconde de Lacerda.

"Father and son were associated in the "Companhia de Vehiculos Economicos," devoted to public transportation in Bahia.

This gentleman was educated in this country and was made known to me by Mr. Thomas Say.⁷⁰

Send me whatever you can for him and I will forward them.

Yours truly

W. H. Edwards

692

687

May 3 62

Dear Sir.

I will have the pamphlet wanted by Senor Lacerda sent you soon.

Please ask him to collect reptiles for us in alcohol. We will send him plenty of books in return.

Truly yours

S. F. Baird

W. H. Edwards

Newburgh

N. Y.

426

Newburgh, New York

6 Oct. 1862

Prof. Baird.

Smithsonian Ins.

Dear Sir.

You wrote me in May that you would send for Mr. Lacerda, of Bahia, the "Directions for Meteorological Observations." He also added "and some other of their interesting papers." I had forgotten the matter till last week when I recd. a notification that a vessel was abt. sailing from Boston for Bahia and the Captain wd. take charge of anything for Mr. L. I got

"At the time the letter was written (1862) the son, Comendador Antonio de Lacerda, was probably studying the construction of the elevator which connects the upper and lower town in Salvador.

"Although not a technical graduate, he conceived the idea of drilling a shaft through the rock for the location of the elevator. The civil engineers of the time believed it would not be possible to follow this plan. They advocated an external construction involving a tower near the cliff and a bridge connecting it to the plateau.

". . . Mr. Lacerda went ahead with his project, the construction was started in 1869. . . . It is interesting to observe that in 1930, when the capacity of the old elevator had to be increased, the American company in charge of work developed the project along both conceptions. Thus, the present "Elevador Lacerda" consists of two units, a shaft in the rock and a tower, connected by a bridge on the top and a tunnel at the base.

"The information I am transmitting to you has been given by Dr. Pericles Madureira de Pinho, a scholar deeply devoted to the history of Bahia."

⁷⁰ Thomas Say (1787-1834): The Father of American Entomology. See Weiss, H. B. and Grace M. Ziegler "Thomas Say, Early American Naturalist." 260 pp. Baltimore, 1931.

this too late to apply to you. / But there may be another opportunity some day and we should be ready. Do send on therefore something for him.

What news from Kennicott?

Our plates of Sphinges have reached no. 15 and there are two more to issue. They make a beautiful series.

Yours truly
W. H. Edwards

427

Newburgh, New York
15th Oct. 1862

Prof. Baird.

Dear Sir.

I wrote you a few days ago about the books for Mr. Lacerda of Bahia. Since I wrote I have been notified that the vessel that was to have sailed on 1st inst. did not get off, and is now expected to leave 1st Nov. So that we can send the things to Mr. L. You desired me to write to him to send you Reptiles and some other things. This doubtless he will do, and if you like to, / add to the books "astronomical observations"⁷¹ he wants anything on these other subjects. He may be able to make good use of them.

Yours truly
W. H. Edwards

1417 [?]

261

Oct. 18 62

My Dear Sir:

Yours of Oct. 6 came to hand as I returned from the north⁷² and that of 15th is now here. I gladly avail myself of the opportunity to send a few things under frank.⁷³ Which please forward.

No news from Kennicott as the Indians got all our letters. No damage to collections I believe. He will probably be back this winter.⁷⁴

Truly yours
S. F. Baird

W. H. Edwards

Newburgh
N. Y.

⁷¹ At this time the Smithsonian was publishing as part of the Annual Report a summary of astronomical observations.

⁷² Baird often spent his summers in the Adirondacks or northern New England.

⁷³ Free carriage of mail accorded to the Smithsonian Institution as a government agency.

⁷⁴ Kennicott reached Chicago in October, 1862, the time these letters were being exchanged.

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Newburgh, New York
Oct. 27, 1862

Prof. S. F. Baird

Dear Sir.

The package for Mr. Lacerda came today, as well as a Report⁷⁵ to myself, for which I am obliged to you. I shall forward Mr. L's at once to Boston. They will be likely to please him.

I shall be in New York for the winter after November, of which I will duly advise you.

Yours truly
W. H. Edwards

429

Newburgh, New York
24th Nov. 1862

Prof. Baird.

Dear Sir.

I heard this morning from my horticultural neighbor, Chas. Downing,⁷⁶ that Kennicott had returned and was at Washington, which I am glad to hear. Give him my regards. I hope he has something good in my department. I go to New York for the winter this week, and hereafter my address will be at 40 Wall St. / as formerly. Send me any package to that direction.

Yours truly X
W. H. Edwards

⁷⁵ Edwards probably refers here to receiving a copy of the 1861 Annual Report of the Smithsonian Institution.

⁷⁶ Charles Downing (1802-1885): Pomologist and horticulturist living at Newburgh, New York. Not as well known as his younger brother Andrew Jackson Downing (1815-1852) whom he helped write "The Fruits and Fruit Trees of America" published in 1845. DAB 5: 418.

(continued from page 190)

A lively discussion period followed and the meeting was adjourned at 9:30 P.M.

EDWARD S. HODGSON, *Secretary*

MEETING OF FEBRUARY 19, 1957

A regular meeting of the Society was held at the American Museum of Natural History; President Treat presiding. Fifteen members and eight guests were present.

The Society voted unanimously to send a letter of greetings and moral support to Dr. and Mrs. Roman Vishniac.

President Treat read correspondence between himself and Mr. J. E. Hunsberger, who had applied for membership in the Society. The members present unanimously passed a resolution to suspend the provisions of the

By-laws regarding elections, and to postpone consideration of Mr. Hunsberger's application for membership at this time.

Dr. T. C. Schneirla of the American Museum of Natural History spoke on "Studies of Army Ants in Arizona". He briefly reviewed the basic pattern of nomadic and statary phases in the activities of *Eciton* in the tropics, and then raised the question of how such an activity pattern would be modified by the different climatic condition of a more northern area.

This matter was investigated by studying the behavior of army ants of the genus *Neivamyrmex* at the Southwest Research Station in Arizona. *Neivamyrmex* raids at dusk and emigration is the sequel of a raid, although the emigration may be carried out in two stages and not actually concluded until the second night. *Neivamyrmex* also has nomadic and statary phases, and the brood conditions "energizing" the raid are similar to those in *Eciton*. The larvae of *Neivamyrmex*, however, are not enclosed in cocoons and the stimuli from the larvae (probably chemical) keep the emigrations going longer than is true of *Eciton*.

The winter causes modifications of the behavioral pattern which had been previously observed in *Eciton*. As the summer season progresses, the phases of the activity cycle may get longer. At the particular locality of the study, a correlation was noted between the onset of cold weather and a reduction of colony activity. In the fall, the queen of *Neivamyrmex* lays small broods and then ceases reproductive functions completely. The colonies go more deeply into the ground in the fall and make only small raids during occasional warmer days of winter.

Dr. Schneirla illustrated his talk with a beautiful group of kodachromes of the Southwestern Research Station and the army ants themselves.

Discussion of Dr. Schneirla's observations continued until 10:00 P.M., when the meeting was adjourned.

EDWARD S. HODGSON, *Secretary*

MEETING OF MARCH 3, 1957

A regular meeting of the Society was held at the American Museum of Natural History; Dr. Treat presiding. Seven members and eight guests were present.

The members voted to approve the appointments to the publications committee suggested by the Executive Committee.

Dr. Daniel Ludwig of Fordham University, spoke on "Effects of temperature and parental age on the life cycle of the mealworm beetle."

Studies on the effects of aging on the progeny of invertebrate animals were initiated with work of Jennings and Lynch on rotifers. The reproductive capacity of rotifers depends upon the age of the mother giving rise to the generation being tested. Dr. Ludwig's work is an attempt to interpret similar results obtained with the mealworm *Tenebrio* in terms of differences in enzymatic activity. *Tenebrio* can be reared conveniently in the laboratory, the number of moults depending on the temperature. It was found that larvae from young parents reared at 30 degrees had a longer larval period than larvae from old parents reared at the same temperature. The adults also lived longer if from young parents.

Attempts are being made to relate these data to the level of cytochrome oxidase activity in the immature stages, since it is known that activity of this enzyme differs in the immature stages of Japanese beetles, depending upon the age of the parents. With *Tenebrio*, beginning at about 5 weeks of age, the cytochrome oxidase diminishes in the egg; the precise significance of this change is not known at the present time.

The meeting was adjourned at 9:30 P.M.

EDWARD S. HODGSON, *Secretary*

MEETING OF MARCH 19, 1957

A regular meeting of the Society was held at the American Museum of Natural History and was called to order at 8:00 P.M. by President Treat.

Mr. Nicholas Shoumatoff and Dr. John B. Schmitt were proposed for membership. The members voted to suspend the bylaws in order to elect these candidates at this meeting, and they were elected unanimously.

President Treat reported that the Society has found its purpose embodied in a certificate of incorporation. This purpose is to "advance the science of entomology in all its branches."

Dr. Ruckes called attention to the damage recently suffered by the Budapest Museum and the loss of the Coleoptera and part of the Hemiptera collections. Funds to aid the Museum are soon to be sought in this country.

Dr. William Creighton spoke on "Studies on Arboreal Ants in Deserts." Contrary to general opinion, there exists a varied fauna of ants in deserts, and among these ants he looked for peculiarities general to several genera found in the Southwestern United States, the object being to find common features produced by convergent evolution influenced by the selective factors in deserts.

He compared ground-dwelling, desert arboreal, and ordinary arboreal ants, with respect to seven general characteristics, including behavioral adjustments to temperature, possession or absence of psammophores, use of soil or plants as nest sites, storage of food, aestivation, marriage flights, diurnal and nocturnal foraging cycles. He presented evidence that most of these aspects of the natural history of ants are influenced by the special selective factors operative in arboreal desert environments. Certain data were tentatively interpreted as indicating that some arboreal ants eat exudates of trees at night. Dr. Creighton's presentation was illustrated by a series of beautiful kodachromes showing the study areas in the Southwest.

After a lively discussion period the meeting was adjourned at 9:40 P.M.

EDWARD S. HODGSON, *Secretary*

MEETING OF APRIL 2, 1957

A regular meeting of the Society was called to order by President Treat at the American Museum of Natural History. In the absence of the Secretary the minutes of the previous meeting were not read. Eleven members and three guests were present. The report of the Field Committee, Mrs. Hopf, Chairman, was read *in absentia*. A field trip to the Audubon sanctuary

near Greenwich, Connecticut, is proposed for Saturday, May 18th, to be conducted by Dr. A. B. Klots.

Assistant Secretary Robert G. Bloch introduced the speaker of the evening, Dr. Ralph E. Heal, Executive Secretary of the National Pest Control Association, who spoke on *Changing Patterns in Insect Control*. The organization represented by Dr. Heal is concerned primarily with "structural pests," chiefly insects and other arthropods in or around dwelling houses or other buildings occupied by man. Conventional ways of dealing with these pests are undergoing rapid change as the result of two main factors: (1) resistance of the pests to insecticides, and (2) prevalent practices in the location and construction of dwelling houses.

Resistance to insecticides, though reported by Melander in 1914 for the San Jose scale insect, did not become a serious problem until 1947, when in Italy and Sweden it appeared that house flies had acquired resistance to DDT. Resistant houseflies were found in the United States in the following year by George Barber of Rutgers University. Resistance of houseflies to the chlorinated hydrocarbons is now world-wide. The organic phosphate insecticides, used as bait components, were intensively tested in Public Health Service projects near Savannah, Georgia, and Orlando, Florida. In these areas a phenomenon which may be described as "behavioral resistance" has appeared in the fly populations, the insects showing an ability to recognize and avoid the poisoned baits. Such resistance is now reported by Dr. Philip Spear in house flies in Illinois. Drastic fly eradication programs in Corpus Christi, Texas, following epidemics of poliomyelitis and infant diarrhoea, has led to the development of highly resistant German cockroaches in that area. Similar resistance is evident in New York City roaches, doubling the cost of control measures. Certain other pests show similar trends, notably the bedbug and the brown dog tick.

Building practices which are bringing new problems in pest control include the increasing use of "hermetically sealed" air-conditioning, the location of new developments in areas with high populations of native insects, and the use of substandard lumber. The virtual sealing of air-conditioned houses often results in the trapping of moisture in walls and woodwork. This favors fungus growth and with it such insects as springtails, silverfish, psocids, and fungus beetles. Clover mites, millepedes, and termites become troublesome where new housing developments arise in areas already heavily populated with these animals. Concrete slab foundations in lieu of basements favor the invasion of houses and make control difficult. Inadequate seasoning of lumber and incomplete removal of the bark leads to infestations of more or less harmless but annoying insects such as bark beetles and cerambycids, for which remedies are not readily available.

Discussion of Dr. Heal's paper centered chiefly about the biological mechanism of resistance and problems of pest control in government housing. The meeting was adjourned at 9:45 P.M.

ASHER E. TREAT, *Secretary pro tem.*

MEETING OF APRIL 16, 1957

A regular meeting of the Society was called to order by President Treat at 8:00 P.M. in room 129 of the American Museum of Natural History.

The speaker of the evening, Dr. Leland G. Merrill, of Rutgers University spoke on "Some Little Known Insect Pests of New Jersey." The State of New Jersey has a 200 million dollar agricultural enterprise with an extremely high valuation of its agricultural land, leading to very serious conditions from insect pests that might be minor pests elsewhere. Some insects are also more or less peculiar to New Jersey because of the intensive agriculture there.

Dr. Merrill discussed and showed kodachrome slides of a large number of the New Jersey pests, beginning with the pepper maggot, the European corn borer and the carrot weevil. The corn borer has increased rapidly in the last year and transferred to tomatoes from corn or weeds in New Jersey. The sharp-nosed leaf hopper, found on cultivated blueberries has been indicated as the carrier of the virus disease "blueberry stunt." The cherry fruit-worm and the blueberry crown-girdler also attack cultivated blueberries in New Jersey. The pea aphid develops enormous populations on alfalfa, the principal component of the hay industry in the state. It has been calculated that 4,083 pounds of aphids (wet weight) may exist on a single acre of alfalfa.

Dr. Merrill described the procedure used to alert the growers to new pests, and the methods used to check on potentialities of new insect deprecations in the State.

The meeting was adjourned at 9:40 P.M. after the discussion period.

EDWARD S. HODGSON, *Secretary*

MEETING OF MAY 7, 1957

A regular meeting of the Society was held at the American Museum of Natural History, President Treat presiding.

The Society welcomed back Dr. and Mrs. Vishniac after their unfortunate and enforced absence. Dr. Treat expressed the sentiments of the entire Society in telling them how glad we were to see them.

Miss Campbell was proposed for membership, the by-laws being then suspended so that she could be elected to membership immediately.

Dr. Treat called attention to a new book published in France by our member, Dr. Klots, with excellent illustrations of butterflies done by Klots and some by our honorary member, Mrs. Swain. An English edition is expected in about one month.

Dr. Edward Hodgson, of Columbia University, spoke on "The Sensory World of Insects," centering his discussion on the electrophysiological methods of understanding the basis for insect behavior. By recording the nerve impulses originating in chemoreceptor cells, it is possible to show that many receptor organs of insects have mechanisms for discriminating between "acceptable" and "unacceptable" stimuli. Chemicals activating one cell of a receptor lead to a feeding or positive response, while activation of another cell of the same receptor organ mediates a rejection or negative response. The insects seem to conform in this way to a general situation prevailing among arthropods in which they integrate information in peripheral sense organs, rather than in the central nervous system, as with vertebrates.

The sensory physiology of arthropods occurring in caves was studied, because the lack of visual stimuli in such environments leads to hypertrophy of chemical and tactile senses. It was found that the receptor cells, particularly of cave species, exhibited a great deal of "spontaneous" activity, as would be expected for very sensitive receptors, and the "message" sent to the central nervous system consists of a change in the pattern of nerve impulses, rather than the mere presence of nerve impulses from the receptor cells. Kodachromes showing the cave collecting areas were shown.

After a period of discussion, the meeting adjourned at 10:00 P.M.

EDWARD S. HODGSON, *Secretary*

MEETING OF MAY 21, 1957

A regular meeting of the Society was held at the American Museum of Natural History; Dr. Treat presiding. Twenty-six persons were present.

The Society voted that a letter be sent to Charles Mohr of the Audubon Nature Camp, expressing thanks for his hospitality during the field trip to the Audubon Reservation. The field trip was judged to have been highly successful by everyone who attended.

Dr. Treat announced, with regrets, the resignations of Dr. Creighton as Vice-President, and Dr. Hodgson as Secretary. Both resignations have been necessitated by the pressure of other obligations.

The major part of the evening was devoted to a members' symposium. Dr. Treat reported on the Creighton's arduous trip to Mexico. Dr. Clausen reported on the "good old days" of the Society, with many humorous instances of field trips and meetings which she discovered during a recent search through the old minutes of the Society.

Dr. Vishniac reported that he is starting his photographic work again. Mr. Heineman described some recent collecting adventures in Jamaica. Mr. Soraci described the troubles associated with administration of the gypsy moth control program in New Jersey.

The meeting was formally adjourned at 9:20 P.M., but exchanges of information and other discussion continued long after formal adjournment.

EDWARD S. HODGSON, *Secretary*

MEMBERSHIP OF
NEW YORK ENTOMOLOGICAL SOCIETY

(JANUARY 1, 1958)

- Acosta, Jose T., Calle K, No. 317, Vibora, Habana, Cuba.
Alayo Dalmau, Pastor, Universidad de Oriente, Santiago,
Oriente, Cuba.
Ballou, Charles H., Apartado 2998, San Jose, Costa Rica.
Barber, Harry G., United States National Museum, Wash-
ington 25, D. C.
Becker, George G., 11 Hedges Avenue, Chatham, New Jersey.
**Bell, Ernest L., 150-17 Roosevelt Avenue, Flushing, New York.
*Bequaert, Joseph C., Museum of Comparative Zoology, Cam-
bridge, Massachusetts.
Bigelow, David M., Evansville Museum, 216 N.W. Two Street,
Evansville, Indiana.
*Bird, Henry L., 600 Milton Road, Rye, New York.
Blanton, Franklin S., University of Florida, Gainesville,
Florida.
Bloch, Robert G., 781 Ocean Avenue, Brooklyn 26, New York.
Boyd, William M., 171 Millerick Avenue, Trenton 8, New
Jersey.
Boyle, W. Wayne, Department of Zoology, Penn State Uni-
versity, University Park, Pennsylvania.
Brown, F. Martin, Fountain Valley School, Colorado Springs,
Colorado.
Buxbaum, Paul, 360 Central Park West, New York 25, New
York.
Campbell, Ruth G., 59 West Nine Street, New York 11, New
York.
Cazier, Mont A., American Museum of Natural History, New
York 24, New York.
Church, Frederic E., 655 Park Avenue, New York 21, New
York.
Clausen, Lucy W., Columbia University College of Pharmacy,
New York 23, New York.

* Life Member

** Honorary Member

- Creighton, William S., Department of Biology, College of the City of New York, New York 31, New York.
- Desmond, Thomas C., 94 Broadway, Newburgh, New York.
- *Detjen, Gustav, Skidmore Road, Freedom Plains, R. D. 1, Pleasant Valley, New York.
- Dietrich, Henry, Comstock Hall, Cornell University, Ithaca, New York.
- Dix, Peter H., 525 West 113 Street, New York 25, New York.
- Donohoe, Heber C., Mill Race Farm, Box 381, Clinton, New Jersey.
- dos Passos, Cyril F., Washington Corners, Mendham, New Jersey.
- Easton, Norman S., 458 High Street, Fall River, Massachusetts.
- Farb, Peter, 310 Riverside Drive, New York 25, New York.
- Farrelly, James T., 1507 Popham Avenue, Bronx, New York.
- Fluke, Charles L., Jr., Dept. Entomology, University of Wisconsin, Madison 6, Wisconsin.
- Forbes, James, Fordham University, New York 58, New York.
- Forbes, William T. M., Hotel Commander, Cambridge 38, Massachusetts.
- Franclemont, John C., Dept. Entomology, Cornell University, Ithaca, New York.
- Froeschner, Richard C., Montana State College, Bozeman, Montana.
- Frost, S. W., Dept. Zoology, State College, Pennsylvania.
- Fusselman, Mrs. E. R., 6 Robert Court, Eagle Rock Apt., West Orange, New Jersey.
- Gaul, Albro T., 28 Glenwood Lane, Levittown, Pennsylvania.
- Gemmell, Louis G., 290 Collins Avenue, Mt. Vernon, New York.
- Gertsch, Willis J., American Museum of Natural History, New York 24, New York.
- Granek, Irving, 100 President Street, Lynbrook, New York.
- Gray, Alice, American Museum of Natural History, New York 24, New York.
- Hagan, Harold R., Alma, Nebraska.
- Harriot, Samuel C., 200 West 58 Street, New York 19, New York.
- Hartzell, Albert, Boyce Thompson Institute, 1086 North Broadway, Yonkers 3, New York.
- Haskins, Caryl P., 1530 P Street, N.W., Washington 5, D. C.

- Heineman, Bernard, 175 West 72 Street, New York 23, New York.
- Heineman, Bernard, Jr., 15 Bank Street, New York 14, New York.
- Henry, Alexander S., P. O. Box 152, Westtown, New York.
- Hessel, Sidney A., Nettleton Hollow, Washington, Connecticut.
- Hodgson, Edward S., Dept. Zoology, Columbia University, New York 27, New York.
- Hood, J. Douglas, Roberts Hall, Cornell University, Ithaca, New York.
- Hopf, Mrs. Alice W., 136 West 16 Street, New York, New York.
- Huberman, Jacob, 1 East Fordham Road, Bronx 68, New York.
- Huckett, H. C., Box 38, R. F. D., Riverhead, New York.
- Huntington, E. Irving, 115 East 90 Street, New York 28, New York.
- Janvrin, Edmund R. P., 38 East 85 Street, New York 28, New York.
- Jones, Frank M., 2000 Riverview Avenue, Wilmington 47, Delaware.
- King, James C., Dept. Zoology, Columbia University, New York 27, New York.
- Klots, Alexander B., 215 Young Avenue, Pelham 65, New York.
- Lacey, Lionel, 485 Pelham Road, New Rochelle, New York.
- Lappano, Eleanor R., Development Branch, Rockefeller Institute, 550 First Avenue, New York 21, New York.
- Lowing, Mrs. Celia Smith, 370 Columbus Avenue, New York 24, New York.
- Marks, Louis S., 74 Main Street, Tuckahoe, New York.
- **McDunnough, James H., Nova Scotia Museum of Science, Halifax, Nova Scotia, Canada.
- **Melander, Axel L., 4670 Madera Lane, Riverside, California.
- Miller, A. C., Gulf Research & Development Co., P. O. Drawer 2038, Pittsburgh 30, Pennsylvania.
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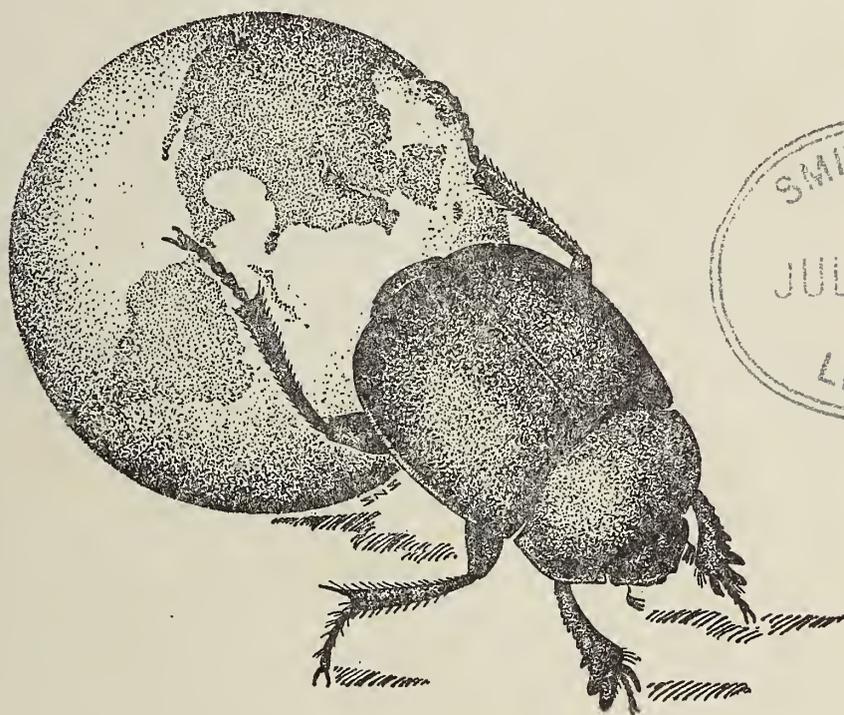
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Editor Emeritus HARRY B. WEISS



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VOL. LXVII

MARCH, 1959

No. 1

LIFE HISTORIES AND LARVAL BEHAVIOR OF ARRENURID WATER-MITES PARASITIZING ODONATA

BY RODGER MITCHELL

BIOLOGY DEPARTMENT, UNIVERSITY OF FLORIDA

Arrenurus all illustrate an unmodified life history pattern consisting of three active stages: the larva that is parasitic on an adult insect, followed by two free-living aquatic stages, the nymph and adult. The consistent life history pattern of the genus has been thoroughly established in the fine studies of Dr. Paul Münchberg, 1935 et. seq.), but there are many small differences in the details of each species life history that are considered to have great significance in the survival and success of the parasitic larvae and those related to larval attachment are taken up below.

Six life histories are reported and these were reared in the laboratory as a part of the studies of the water-mite fauna of the Edwin S. George Reserve, which is located 2 miles west of Pinckney, Livingston County, Michigan. Grants-In-Aid from the Edwin S. George Scholarship Fund provided support for this work and I am greatly indebted to the late J. Speed Rogers and to T. H. Hubbell who have been responsible for this continued assistance. Much was accomplished in these studies because I did not hesitate to take (and make my own) many suggestions and much labor generously offered by the Curator of the George Reserve, Irving J. Cantrall. Identifications of the dragonflies were checked by Edward J. Kormondy.

INTRODUCTION

Previous records of *Arrenurus* larvae parasitizing Odonata (Münchberg 1935 et. seq.) suggest that each *Arrenurus* has a limited attachment site preference but that species differ widely

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in their site selection. As the data reported below were collected, an increasing amount of attention was directed to the relation of attachment site to larval and host behavior. The fact that studies were based on parasites collected on the host, limited the approach to problems encountered by larvae during and after parasitism. Once a larva attaches itself to the host, successful completion of parasitism requires that the larva obtain adequate nutrition and water from the host and be finally reintroduced into a suitable aquatic habitat. Success in both these matters might be related to attachment position and it seems best to outline theoretical speculations as to site selection and then examine the data for correspondences with theory.

Larvae permanently attach themselves to the host by their mouthparts and withdraw nutrients and water through a tube produced in the host tissues (Marshall and Staley (1929; Miyazaki 1936). Any membrane and some sutures appear suitable as attachment sites for the larvae and the fact that extensive membranes of Odonata are ventrally located seems sufficient explanation for the occurrence of most mites on that surface.

Entering a suitable aquatic habitat after riding an odonate imago for several days is an event that may depend on the probability of the host's dying over or in water, in which case the mite larvae could be quite passive after attaching to the host. Some larvae may actively abandon their host but their small size and hydrophobic integument means that they will not easily pass through the surface film. Re-entering the water will be insured if some action of the host introduces into the water at least the part of the body to which the mites are attached, and under such conditions the larvae must be able to release.

Obviously the only predictable entrance of Odonata imagos into the water is during oviposition which occurs in only certain ways in certain Odonata. Immersion of the female, including in some cases the attached male, may be complete (as in some Coenagrionidae) or only the very tip of the abdomen may be dipped into the water (as typical of Libellulidae). Since larvae that abandon their host must be attached to a part of the host body that enters the water, the extent of attachment sites is a function of host behavior. Active larvae must select sites and suitable hosts. The possibility that pseudoviposition may be carried out by some male libelluline dragonflies (Moore, 1952;

Jacobs, 1955) suggests that sexual discrimination of hosts by larvae is not necessary in some cases.

Finally attached mites are quite likely subject to abrasion and injurious blows while attached to the host. Projecting appendages would protect thoracic attachment zones making them most secure, and it would appear that protection would be a factor in site selection.

On purely speculative grounds it is concluded that host and site selection by mite larvae would be influenced by the way larvae re-enter the water, by available nutrient, and by relative protection from injury. The first would require accurate host discrimination and attachment site correlated with host behavior. The last two factors would be nearly constant for all Odonata hosts as to favored sites and would not require host discrimination.

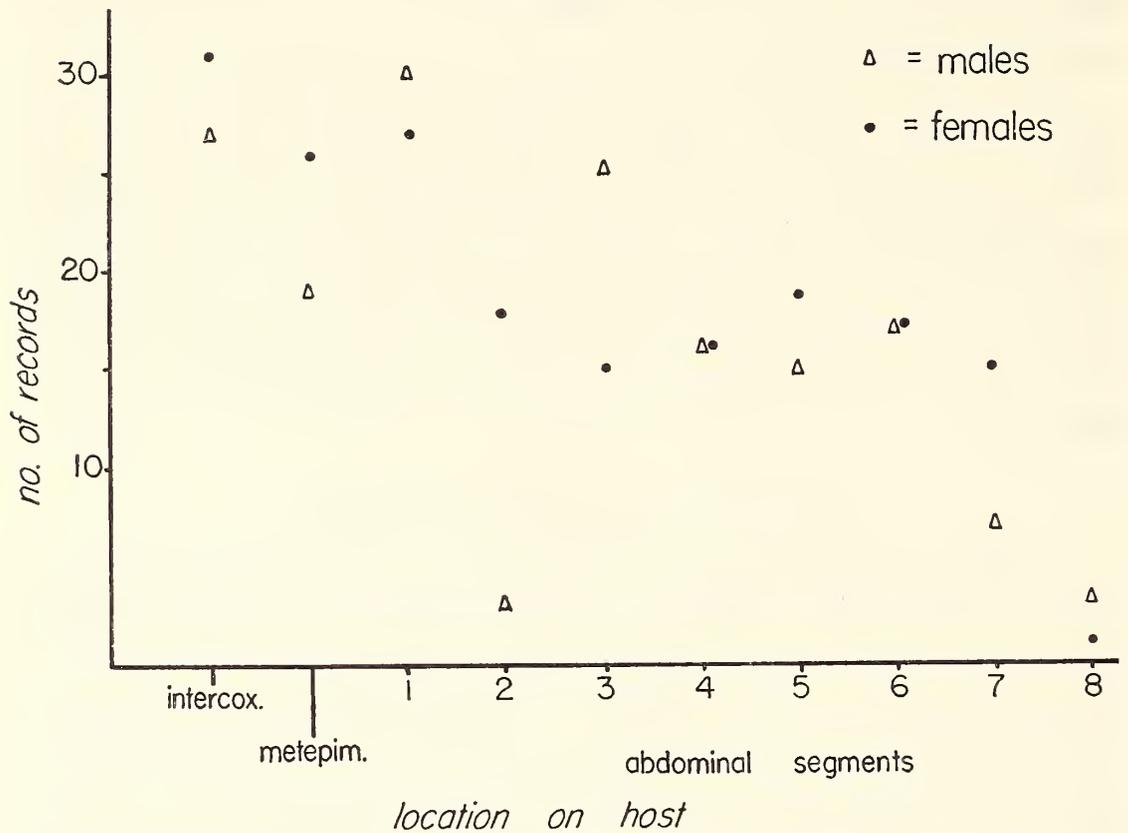
Arrenurus (A.) major Marshall

A. major is the most abundant species of *Arrenurus* and parasitizes a damselfly, *Ishnura verticalis* (Say) (Coenagrionidae), that is abundant and easily captured. Thus, observations on this parasite are the most complete. During the main flight period of the host, from early June to late August, 90 to 95 per cent of the *I. verticalis* are parasitized by an average of 13 larvae. Münchberg (1951) has already published an outline of this life history.

As long as the larvae are attached to the host and their integument is dry no activity was ever noted, but fully engorged larvae become active a few seconds after being dampened. Their legs move slowly at first but with greater speed and power as time passes, and whenever the legs strike a solid object the mite presses the legs firmly against the host, causing the body of the mite to be pushed back and forth on the attachment of the mouthparts. Evidently the mouthparts, once they are imbedded in the host integument, cannot be freed by their own action and loosen only as the mite larva twists about on that attachment. Most individuals are free of their attachment in ten to fifteen minutes, but a few larvae are never able to free themselves. Active unattached larvae are able to swim away from the host when it is dipped in water, but since their inefficient swimming is not enough to overcome their weight the larvae settle to the bottom where their

swimming movements propel them along the substrate at a speed of about a centimeter a second. The larvae can also crawl upon or cling to plants or algal strands. Activity persists until the nymphochrysalis is formed some 24 to 48 hours after release. If

GRAPH I.



The number of times a given site was found occupied by *A. major* larvae from a sample of 40 *I. verticalis* of each sex collected on July 21, 1957. The sites are the intercoxal membranes, the venter of the metepimeron, and the venter of the first eight abdominal segments.

possible the larvae will form the nymphochrysalis while grasping or in contact with some object.

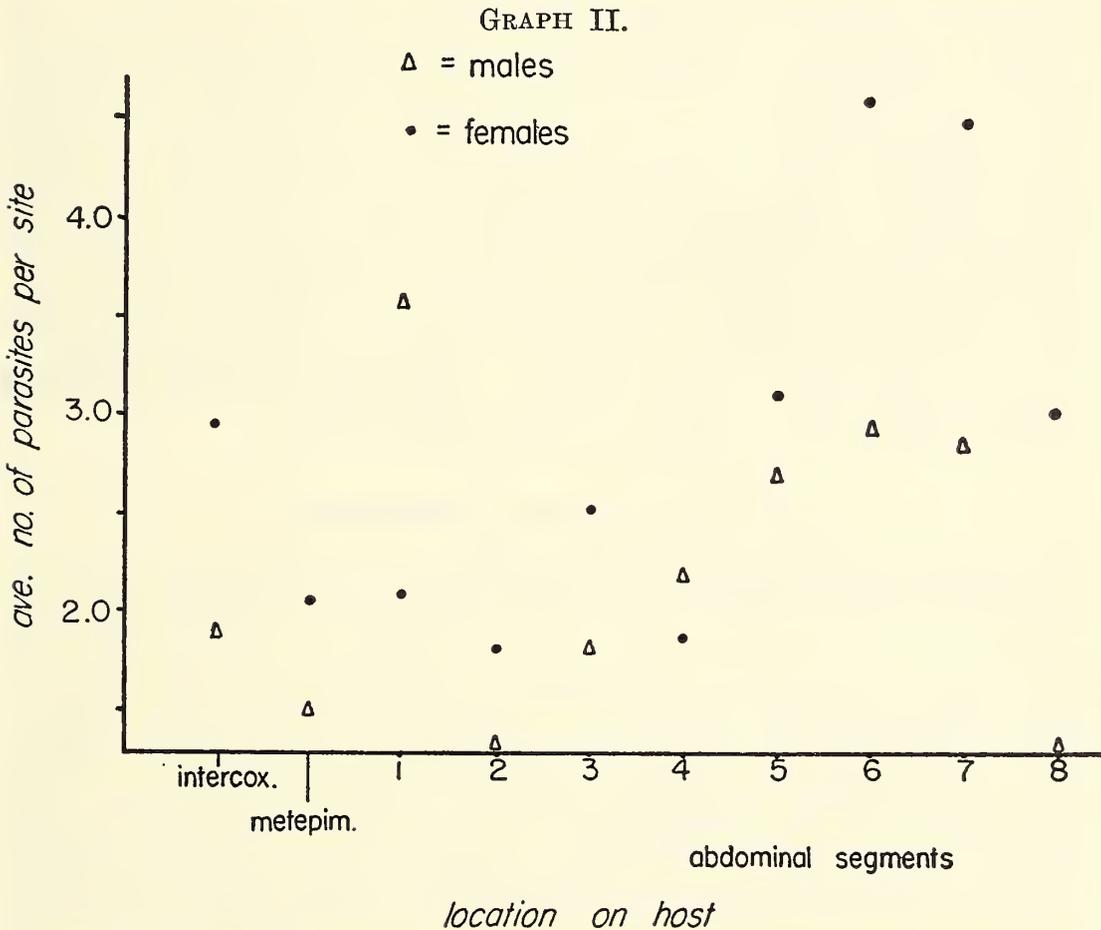
There is limited time during which larvae can drop off the host. Larvae not leaving during that time become more engorged and thicker skinned than average and do not become active when moistened, although they transform if the host is kept in water.

Oviposition by *Ishnura verticalis* involves both male and female. Females often go beneath the surface of the water. Males in tandem may enter the water far enough to wet the abdomen but usually no further (Grieve 1937). Larvae attached to the abdomen will be most likely to have an opportunity to re-enter the water.

Graph I shows the frequency with which larval mites are found

at a given location on the host. Graph II shows the average number found at individual sites for the entire sample. Sexual modifications of the second abdominal segment of the male make it an unsatisfactory site, but in all other respects the graphs indicate no site selection. This may be due to two nearly balanced pressures—one favoring larvae that re-enter the water from abdominal segments and the other favoring larvae that are protected at a thoracic attachment but have fewer opportunities to re-enter the water. A second explanation is that the ability of larvae to remain on the host as passive larvae may make site selection less important.

The nymphochrysalis, which is formed within 48 hours of release of the larva, is of short duration for the nymph emerges



Average number of larvae found at each parasitized site taken from the same sample as Graph I.

in two to six days to feed on ostracods or daphnia for a period of two to three weeks after which the teleiochrysalis is formed. Adults emerge from that stage in one to two weeks. Thus, post larval development can take place in just over a month.

Since parasitized *A. major* are found throughout the summer, it is likely that there must be at least two and possibly three overlapping generations each year. Field collections indicated that the adult is probably not a stage that overwinters.

Arrenurus bleptopetiolatus Cook

A. bleptopetiolatus was reared from ten green larvae attached to the venter of abdominal segments 8 and 9 of a male *Epicordulia princeps* Hagen (Libellulidae) collected on June 24, 1957. The response of these larvae to water and their activity was not determined. However, the location of the parasites at the tip of the abdomen suggests that they do drop off at oviposition. After being placed in water the larvae commenced transformation within two days and nymphs emerged in two more days. The nymphs readily ate ostracods and after feeding for just under a month transformed. A week or so later the adults emerged.

The concentration of larvae on the host is just where it would be expected if the parasite assumed an active role in re-entering the water for the oviposition habits of the host are given by Needham and Heywood (1929) as follows: "The female oviposits alone. She descends to touch the water at points wide apart, far out from shore in open water." The fate of mites attached to males would be to ride their host until it dies.

Arrenurus compactilis Marshall

In mid-June both sexes of *Enallagma ebrium* (Hagen) (Coenagrionidae) were often found with as many as ten greenish mite larvae attached to the venter of the metathorax and to the coxal membranes of legs II and III. Larvae taken from this host on June 16, 1957 later developed into adult *A. compactilis*. When these larvae were moistened the legs began to move, at first slowly and later quite vigorously. As the larvae pressed against the host with their legs their mouthparts were loosened so that the larvae were shortly freed from their hold to the host. Once in the water very vigorous activity of the legs propelled the larva slowly through the water. Within the next 24 hours the larva transformed into the nymphochrysalis from which the nymph emerged in as short a time as three days. Generally the nymphs fed on ostracods, although a few daphnia were taken, and after

three to four weeks' feeding the nymphs entered the teleiochrysalis from which the adult emerged a month later.

Larvae attached to female *E. ebrium* are assured of an opportunity to re-enter the water for the host females descend below the water to oviposit in plant stems (Walker, 1953). There are no reliable data as to how often the male is involved in oviposition or the part he normally takes in the process. In some species of *Enallagma* the male does partially enter the water according to Needham and Heywood (1929).

Owing to the fact that the host is often submerged during oviposition, *A. compactilis* can attach to areas of optimum stability and protection and the thorax appears to be just such a location.

Arrenurus fissicornis Marshall

Often as many as 100 larvae of this mite are found attached only to the venter of the terminal abdominal segments of both sexes of at least three dragonflies of the family Libellulidae, *Libellula incesta* Hagen, *L. luctuosa* Burm., and *Erythemis simplicicollis* (Say). Rearings were made from hosts collected from June 20 to 25, 1957 and during the latter part of June parasitism was nearly 100 per cent. Evidently these dark green larvae did drop off during oviposition, for several old females of *L. incesta* were found with very badly torn intersegmental membranes of the abdomen but with very few mite larvae remaining. In the laboratory, larvae attached to the host would loosen their grip if moistened, although complete release from the host was rarely achieved without some slight external pressure being applied to the mite larva.

Once off the host the larvae were active, but the movements of their legs were ineffectual in propulsion. In two to three days the nymphochrysalis was formed and the nymphs emerged to feed on ostracods for two to three weeks. The nymphs then entered the teleiochrysalis stage from which the adult emerged in about ten days.

Both laboratory observations and the condition of old host females confirm the fact that these mite larvae, which are always found attached to the venter of abdominal segments 5 through 9, must leave the host when the female oviposits. Since larvae did not entirely loosen themselves in the laboratory it might be as-

sumed that as the ovipositing host strikes the water with her abdomen, the larvae which have partially loosened their attachment are knocked off the host. Presumably all three hosts show the typical libellulid oviposition behavior as indicated by Walker (1953): Many species "oviposit by flying low over the water and striking the surface here and there with the end of the abdomen. . . ." Some pond species may "tap the water with abdomen rhythmically, about four times a second, and always rising between strokes to the same height, five inches."

Arrenurus pollictus Marshall

During most of June three species of *Lestes*, *L. disjunctus australis* Walker, *L. eurinus* Say and *L. forcipatus* Rambur (Lestidae) were found to be parasitized by reddish mite larvae that were attached to the ventral and lateral sutures of the thorax. *A. pollictus* was reared from these three host species collected from June 16 to 19, 1957. The heavily engorged larvae did not react when moistened and even when removed from the host and placed in water still showed no activity. Transformation commenced within 24 hours of removal of the larvae from the host and the nymphs emerged in 4 to 5 days to feed on both daphnia and ostracods. After a month of feeding the teleiochrysalis was formed from which the adult emerged in a few days.

Most species of *Lestes* oviposit in stems over the water (Walker 1953), although *L. forcipatus* is among the exceptions to the rule and oviposits at or under the water surface (Needham and Heywood 1929). Certainly the majority of the mites attached to these hosts only re-enter the water if the host dies over water. Larvae of this mite attach to the stable, well-protected venter of the thorax and, when engorged, lose all ability to move.

Arrenurus tetratumuli Münchberg

This species was described from undeveloped males reared by Münchberg from *Erythemis simplicicollis* (Say) and *Pachydiplax longipennis* (Burm.) (Libellulidae) collected at Point Pelee, Ontario. (Münchberg 1953). Features of the petiole were not developed in the type series and Dr. Münchberg has very kindly compared the male of *A. tetratumuli* with these specimens. Doctors Cook and Münchberg agree that *A. neosuperior* must

be synonymized with *A. tetratumuli*. Cook (1954) adequately illustrates and describes, under the name *A. neosuperior*, the differentiating characters of the entity that must go under the name *A. tetratumuli* Münchberg.

One parasitized specimen of *Pachydiplax longipennis* was collected on July 28, 1956 and found to have a few scattered very dark green larvae attached to the ventral region of the metathorax. On removal from the host the larvae showed no signs of activity in water but, within a few days, had transformed. The nymphs emerged in two weeks and fed on daphnia. On completion of the nymphal stage two males and four females emerged. These details of biology are in complete accord with the facts reported by Münchberg (1953).

Both the libelluline hosts reported for the species probably oviposit in the typical libellulid fashion with only the female involved. She merely dips the tip of the abdomen in the water during flight and releases eggs each time the abdomen strikes the water. Hence larvae attached to the thorax, as is the rule in *A. tetratumuli* will not be able to re-enter the water. Observations in the laboratory indicate that this larva does not respond to moistening and must passively depend on the host's drowning or dying over water in order to complete the life cycle.

Arrenurus wallensis Cook

Throughout late June and July, *Celithemis eponina* (Drury) and *C. elisa* (Hagen) (Libellulidae) are commonly parasitized by two types of larvae; a bright red larva that attaches to the lateral sutures of the meso- and meta-thorax, and a dark green larva that is almost always attached along the V-shaped suture of the ventral surface of the metepimeron where, if crowded, the mite larvae form two neat rows alternating with each other. Only the green larvae have been reared out. These are discussed below.

Arrenurus wallensis was reared from dark green larvae removed from the venter of the metathorax of *Celithemis eponina* collected on July 28, 1956. The larvae did not drop off the host when moistened. When removed and put in water they were inactive, and the nymphochrysalis was formed immediately. After ten days the nymphs emerged and readily fed upon daphnia until entering the brief teleiochrysalis stage some six weeks later.

About 20 fully engorged larvae occupy all the available space on the suture and only rarely attach to metepimeral sutures. Newly emerged dragonflies bear more than twenty mites, which suggests that the limited numbers and precise arrangement of engorged individuals is the result of competition that permits maturation of only those larvae that are properly placed on the suture. Since the limited attachment sites are not related to larval release, and occasional individuals attached to lateral thoracic sutures do feed and mature, it has not been possible to explain the limitations seen in the parasitism.

CONCLUSIONS

Odonata were found with mite larvae attached to ventral membranes from the mesothorax to the ninth abdominal segment with each mite species usually limited to one small area on the host. Protection is the only factor that need influence the attachment site of passive larvae which re-enter the water on the death of the host over or in the water. Inactive larvae such as *A. wallensis*, *A. pollictus*, and *A. tetratumuli* seek a thoracic attachment where the most protection is to be had.

The so-called active release of mite larvae from their attachment to the host may completely free the mite from its attachment or only loosen the attachment so that external forces easily free the larvae. This release was only seen after moistening and, unless moistened, attached larvae were quiescent. If an engorged mite did free itself from the host, directed locomotion was impossible and the mite either remained in place or dropped off the host. Thus, all mites that responded to wetting were found attached to parts of the host that were likely to be moistened. Parasites of hosts that dip the tip of the abdomen in water at oviposition must be concentrated on the tip of the abdomen as in *A. bleptopetiolatus* and *A. fissicornis*. Parasites of hosts that enter the water during oviposition have a wider range of potential attachment sites, but in these cases factors related to protection can restrict site selection by the larvae, as appeared to be the case in *A. compactilis*.

In its lack of any pronounced site selection, *A. major* represents an unsolved problem. Two possible explanations are offered above, both of which conform with the general views expressed here.

While *Arrenurus* are, for the most part, quite specific in their site of attachment they are often unspecific in their host selection. Many instances of apparent host specificity could be the result of only one potential host being available in the habitat. *A. planus*, a parasite on the thorax of both Anisoptera and Zygoptera (Münchberg 1952) is a most impressive case of wide latitude in host selection but restricted site selection. Larvae that take an active part in leaving the host are found to be limited to hosts of similar oviposition habits and it is noteworthy that there is no sex differentiation on the part of the larvae. The parasites on males may be lost, simulated oviposition by males may be common (Moore 1952, Jacobs 1955), or larvae may be able to live through the active life of the host and return to the water if the host dies over the water. Thus, the absence of sex selection in active parasites may mean that leaving the host at oviposition is only one of several ways by which parasites of one species may re-enter the water.

While only a few instances are considered here, it appears that host and site selection by *Arrenurus* larvae are best explained in terms of factors favoring the survival and re-entry of larvae into the water.

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THREE NEW GENERA OF IBIDIONINI (COLEOPTERA, CERAMBYCIDAE)¹

BY FREDERICO LANE²

Gourbeyrella, new genus

Ibidionini with a transverse frons; with short, blunt, widely separated antennal tubercles; with eyes reduced to a transverse lower lobe, lacking upper lobe. Antennae slightly longer than body length (♂), with a very long, slender, cylindrical scape; third segment shorter than scape; fourth segment slightly shorter than third; fifth segment nearly as long as scape; following segments decreasing in length up to tenth segment, the eleventh subequal to ninth; segments three and four somewhat nodose at apex; segments five to ten angulated at apex; segments rather compressed.

Prothorax longer than wide, subcylindrical, curved anteriorly, only very slightly constricted at sides on front; posteriorly with a somewhat abrupt, wide and strong constriction; sides subparallel; pronotum transversely rugose.

Elytra rather short, less than twice the length of prothorax; at base squarish with rounded humeri; at sides, after basal portion, slightly narrowed to apex; at apex acuminately rounded.

Legs with strongly clavate femora, unarmed at apex, the posterior pair reaching apex of elytra (♂); tibiae linear, slender; anterior tarsi with a rather long second segment, about subequal in length to first segment; third segment shorter, slightly narrower than the second at apex, the lobes rounded only at apex; distal or claw segment about length of third segment and one half of second taken together. Antennae and tibiae not carinate.

Genotype: *Neocorus romanowskii* Fleutiaux et Sallé, 1890.

This species, described from Basse-Terre, Island of Guadeloupe, does not seem to fit into any of the present genera of *Ibidionini*, and diverges widely from *Neocorus* Thomson, 1864. Compared with *Neocorus ibidionoides* (Serville, 1834), from Brasil and the type-species of the genus *Neocorus*, it shows striking differences. The head is short, without the neck-like constriction of *ibidionoides*; the eyes are more finely faceted and reduced to the lower lobe; the antennal tubercles are differently constructed, and the long and slender scape of the antennae surpasses the an-

¹ The present work was carried out in the American Museum of Natural History, and the United States National Museum, under a John Simon Guggenheim Memorial Foundation fellowship.

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terior border of the pronotum to some extent; the antennal formula shows the third segment slightly longer than the fourth; the shape of both prothorax and elytra is different, and the posterior femora slightly exceed the apex of elytra.

In *Neocorus ibidionoides* (Serville, 1834), the head is long and constricted behind; the eyes are more coarsely granulated, and do not lack the upper lobes, although these are distantly separated on the vertex of the head; the antennal tubercles are salient at apex; the scape of the antennae is more robust and does not surpass the anterior border of the pronotum to any extent; the third segment, although Lacordaire states it is subequal to the fourth, is really slightly shorter; the prothorax is constricted both anteriorly and posteriorly, and strongly globose at middle portion; the mesosternal process is narrower and more parallel-sided; the elytra are longer, about two and three-fourths the length of the prothorax, somewhat parallel-sided, pinched or narrowed at the middle, very convex posteriorly, the apices acuminate and dehiscent at suture; the posterior femora do not reach apex of elytra; the middle tibiae have a slender dorsal carina; the tarsal formula is different.

Gourbeyrella, new genus, would run closer to *Aphatum* Bates, 1870, having a similar posteriorly constricted prothorax, but *Aphatum*, according to Bates, does not exactly lack the upper eye lobes, although these are widely separated; it also is described as having each elytron bi-spinose, the spines long, and having the femora clavate and bidentate at apex.

Neocorus romanowskii Fleutiaux et Sallé, in both the Junk catalogue and Blackwelder checklist, figures as dating from 1889. Although Fleutiaux and Sallé's article is so dated on the first page (page 351), the correcting notice at the end of the article (page 484) is quite explicit: "Nota.—Les descriptions comprises dans ce mémoire n'ont paru qu'en 1890 : le 22 janvier, jusqu'à la page 424 inclusivement, et le 23 avril, de la page 425 à la fin."

The generic description in the present paper was based on a single male specimen, belonging to the American Museum of Natural History, and identified by W. S. Fisher as *Neocorus romanowskii* F. & S. It measures 6.25 mm. in length, with a humeral width of 1.75 mm., and was collected at Gourbeyre, Guadeloupe, very near the type locality. I here take the oppor-

tunity of warmly thanking Mr. Rudolph Schrammel for the fine photograph illustrating this specimen (PLATE I).

Xalitla, new genus

Ibidionini with a linear body; eyes transverse, prominent, very coarsely granulated, reduced to lower lobe; antennal tubercles short, wide, divergent, only slightly oblique from the horizontal, at apex projected into a slightly oblique, nearly vertical salient tooth. Head rather long, as seen from above, with a slanting convex vertex. Antennae with a moderately robust scape, reaching only a little beyond anterior margin of pronotum; third segment longer than scape, somewhat curved; fourth less than one-quarter length of third; following segments nearly subequal in length, slightly increasing up to sixth and slightly decreasing to ninth; tenth shorter and eleventh subequal to ninth.

Prothorax nearly twice as long as wide, subcylindrical, only slightly bent anteriorly, the sides subparallel, rounded posteriorly to a narrow constriction.

Scutellum oblique, rather longer than wide, rounded in a semicircle at apex.

Elytra slightly more than twice length of pronotum, convex, parallel-sided, rounded to apex, slightly dehiscent at suture.

Legs with strongly clavate femora, the posterior pair reaching to apex of third abdominal segment; first tarsal segment of posterior pair as long as second and third taken together; third segment about subequal to second and narrow lobed; claw segment subequal to first.

Genotype: *Xalitla azteca*, new species.

Xalitla azteca, new species

FEMALE. Tegumen reddish-brown, with exception of tips of mandibles, eyes, and posterior two-thirds of elytra, which are black; subopaque, the surface being very minutely granulate, covered with rather dense, uniform, large punctures, which are shallower on prothorax, sparser on under side, and very fine and sparse on abdomen; glabrous except for sparse, short, flying hairs.

Head rather densely punctate, but punctuations quite separate, not confluent, and uniformly distributed, especially on vertex. Gena short, forming a blunt jugular process. Underside of antennae with scattered long hairs.

Prothorax with larger, shallower, but close, punctuation, that gives a rather "crysidiid" appearance to surface.

Elytra with identical punctuation, but finer and deeper, slightly shallower and finer towards apex, but covering whole surface.

Underside of body sparsely punctate on abdomen.

Length, 6.25 mm.; humeral width, 1.25 mm.

Type Locality: Mexico, Guerrero, Xalitla, 4.VI.1946, J. & D. Pallister, collectors.



Neocorus romanowskii Fleutiaux & Sallé, 1890, genotype of **Gourbeyrella**, new genus.

Holotype, female, in the collection of the American Museum of Natural History.

This genus seems to run very close to *Aphatum* Bates, 1870, judging by Bates' description, but the apex of the elytra would easily separate it from *Aphatum* in which the apices are described as individually "longe bispinosa."

From *Gourbeyrella*, new genus, it diverges principally by the more cylindrical prothorax (not flattened on dorsal surface); the different elytral structure; the armed antennal tubercles, and differently shaped scape. But more than any of these characters, it diverges radically by the very coarse eyes, in contrast with the rather finely faceted eyes of *Gourbeyrella*. In relation to this last character, Bates' generic description of *Aphatum*, as well as White's description of the type species, *Ibidion rufulum*, are omissive, so that it is impossible to give a closer relationship discussion between the three genera without the examination of White's type.

***Acanthoibidion*, new genus**

Ibidionini with wide, low, antennal tubercles, rather thick on inner side, armed at apex with a sharp tubercle or tooth, and separated by an irregular groove; eyes finely granulated, with a triangular-oval lower lobe, and a long, bent, upper lobe, which has a uniform width from base to rounded distal end; upper eye lobes well separated on vertex of head, the distance between them about equal to distance between apices of antennal tubercles. Antennae setaceous, shorter than body length (♀); the scape only reaching to anterior border of pronotum; third segment subequal in length to scape; four to seven somewhat shorter than third; following segments decreasing slightly in length, the eleventh subequal to tenth; segments rather widened to apex, the third nodose, four and five only slightly; nine and ten somewhat angulated at apex.

Prothorax slightly transverse, subcylindrical, narrower anteriorly, armed near middle on each side of pronotum with a sharply pointed tubercle.

Elytra long, about four and one half times length of pronotum, moderately convex, sides subparallel, truncated at apex.

Protternal process rather narrowed between coxae; mesosternal process wide, about three-fourths diameter of coxae.

Legs with anterior femora clavate, middle and posterior femora more gradually widened to apex, the posterior pair reaching little beyond distal border of second abdominal segment; tibiae linear, not carinate; tarsi slender, with first segment longer than second and third conjointly. Abdomen with fifth segment rather short and rounded at apex.

Genotype: *Acanthoibidion venezuelensis*, new species.

This genus has very peculiar characters, but seems to run close to *Ibidion*.

***Acanthoibidion venezuelensis*, new species**

FEMALE. Tegumen of head (including scape), prothorax, mesothorax, anterior tip of metasternum, and legs (except apex of tibiae and all tarsi), red; underside of body and legs with paler red, more yellowish in tinge; tip of mandibles black; palpi brown; antennae blackish brown; apex of tibiae and all tarsal segments dark brown; elytra of a very dark blackish brown. Body clothed with sparse flying hairs, shorter and more regularly disposed on elytra.

Head confluent punctate, somewhat scabrose on frons, more sparsely punctate on vertex and sides; jugular process somewhat rounded at tip. Antennae with scape, second segment and base of third, shiny; following segments finely punctulate and clothed with short fine reddish pubescence; scape somewhat stout, gradually thickened to apex, rounded at apex, sparsely punctuated; segments three to six finely and not very distinctly keeled.

Prothorax with punctures on anterior and posterior borders, and along inner side of pronotal tubercles, and an impunctate longitudinal area at middle of pronotum; sides rather scabrose, unarmed but with a shallow, nearly obsolete, tubercle at middle.

Elytra densely punctate from base to apex, the punctures rather large and the surface elevated around them, resulting in an irregular rugulose surface; the punctures vaguely seriate, and the rugosities assuming in places a longitudinal vermicular aspect; humeri rounded, apex truncate.

Underside sparsely punctate; last abdominal segment very short, broadly rounded at apex; segments 1-3 long, decreasing very gradually in length; fourth shorter.

Length, 12.5 mm., humeral width, 3.5 mm.

Type Locality: Venezuela.

Holotype, female, in the collection of the U. S. National Museum.

This specimen, which belongs to the ex-Tippmann Collection, was placed under a box label as *Neocorus romanowskii* Fleut. & Sallé. It has a small locality label (Venez.), another with an indication "M. Germ.," and a third indicating it had previously belonged to the Cl. Müller collection.

A second specimen in the Tippmann Collection, under a box-label of *Neocorus diversipennis* Belon, is not this species. Structurally it is identical to the above described new species, but varies from it in color, having straw colored elytra with marginal and sutural lines and a stripe at apex brown; the sides of the frons and the apex of antennal tubercles are dark brown, and so is the scape of the antennae; the legs are darker. The elytra seem to be somewhat more finely punctate. This specimen measures 11 mm. in length, with a humeral width of 3.25 mm., and has the very same label indications of *Acanthoibidion venezuel-*

ensis, new species, which may be sufficiently variable in color pattern so as to include this second specimen.

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A MIXED MATING OF TWO SPECIES OF LIMENITIS FABRICIUS (LEPIDOPTERA, NYMPHALIDAE)

It seems worthwhile to record a very interesting case of inter-specific pairing that was brought to my attention some time ago. On 26 August 1957, In El Dorado, Ark., Mrs. H. E. Hanna noted a pair, consisting of a male *Limenitis archippus* (Cramer) and a female *L. arthemis astyanax* Fabricius, on a rubbish heap, joined in what seemed normal coition. On being caught, they separated. Mrs. Hanna sent the specimens to me, and very kindly presented them to the American Museum of Natural History, where they are now preserved in the collection.

Such mixed pairings in the wild are by no means unknown, but are very rarely reported properly, especially with preservation of both specimens. They are of great interest in studies of speciation, hybridization and behavior. Certainly all authentic records of this sort should be prominently published. Of even greater value would be to keep the specimens alive (when this is practicable), obtain a batch of eggs from the female and rear the offspring. Such facts should then be recorded as the number of eggs, the number of viable offspring, the numbers, appearances and food preferences of the larvae, pupae and adults, etc. Even more desirable would be to send the live female or eggs to someone versed in butterfly genetics.

The present instance is of particular interest because of the great color difference between the two species, *L. archippus* having departed radically from the coloration of its congeners to mimic *Danaus plexippus* L., the Monarch. We do not know, of course, what is the relative importance of this color difference in maintaining the normal segregation of the two species (which are very widely sympatric) as compared with their differences in genitalic structure, genetics, odor, courtship behavior and habitat.—ALEXANDER B. KLOTS, The City College of New York.

REMARKS ON DR. BREUNING'S REVISION OF THE LAMIIDS (COLEOPTERA, LAMIIDAE)¹

BY FREDERICO LANE²

Dr. Étienne de Breuning has undertaken a world wide revision of the lamiids, under the title of "Études sur les Lamiaires," begun in 1934 and continuing to the present. In the introduction to his work (p. 7), Dr. Breuning proposes dividing his articles according to Aurivillius' tribal classification, and points out that no broad study of the lamiids has been attempted since Lacordaire. For infra-specific classification he adopts the names subspecies, aberration, and "morpha," defining what he understands by these terms. His infra-specific concepts are not considered in the scope of this paper. Such infra-specific names generally mean little else than vague catalogue names for all sorts of forms that diverge, in variable degrees, from the originally described pattern, and seldom have any bearing on the real problems of subspeciation. A lot of irresponsible naming is carried out on a pseudo-scientific basis that could well be named "philatelic entomology."

As to his first proposal, Dr. Breuning has in many cases diverged widely from the Aurivillius model, introducing bold modifications in the systematics of the group. Some modifications should be expected, of course, for Lacordaire's famous work is certainly outdated and deficient, but the task requires a responsible approach. Aurivillius was the last world wide specialist to deal with the longicorn beetles, and without question the most competent entomologist for an extensive revision, conscious as he was of the many difficulties involved. However, he did not attempt such a revision beyond his catalogues, which display his group concepts and provide a solid foundation for research.

As to Dr. Breuning, Aurivillius' successor in this world wide approach, it could be questioned if his bold and dogmatic attempt will help or hinder present and future entomologists in their

¹ The present work was carried out in the American Museum of Natural History, under a John Simon Guggenheim Memorial Foundation Fellowship.

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research. This group of insects is reputedly difficult to study, and saddled with a very large number of obscure, sometimes chaotic, problems, pending an adequate solution. It can even be said that a very conscientious effort has to be made by researchers to avoid too many errors in their work, and consequent multiplication of such problems.

Necessarily, such a broad study not only requires a good morphological knowledge, with all pertinent information for establishing affinities and grouping in systematic units, but also obliges the student to acquire an adequate familiarity with the many nomenclatorial aspects. These can, of course, be treated independently in papers dealing with strictly nomenclatorial problems involving priority of names, etc. On the other hand, a serious study of insects can hardly be divorced from their nomenclature, and most certainly no revisional work could dispense with this foundation. One single example of Breuning's work illustrates the lack of consideration of these requirements.

In dealing with his twelfth tribe, AGNIINI (p. 137), Breuning credits it to Thomson, 1864, which is correct, but enlarges his concept of the tribe by including Lacordaire's LAMIDES, MONOCHAMIDES, and AGNIDES (1869), and adding POTE MNEMINI Aurivillius, 1921, all under what he calls "le nom ancien de Thomson." This would make one believe that he is binding his work on a strictly priority base, and that Thomson's AGNITAE really have precedence on the LAMIINI and MONOCHAMINI. Several genera are excluded and others included in this new tribal concept, which could of course be quite reasonable. The discussion of this concept, however, is not what I have in mind, and furthermore would require study by someone thoroughly familiar with the groups involved.

But, in his consideration of the LAMIINI, of the ten genera listed in the Junk catalogue, he removes all but *Lamia* Fabricius to the tribe PHRISSOMINI, innocently unconscious that by leaving *Lamia* in his AGNIINI he not only sinks the tribe LAMIINI, but the subfamily LAMIINAE as well, and that his "Études sur les Lami-aires" becomes hardly less than a ridiculous title. At first it seemed that some slight mistake had been committed in his generalities on the tribe AGNIINI, but the occurrence of *Lamia* in his generic keys (p. 138), as well as his treatment of *Lamia* as the first genus of the tribe (pp. 183-184), leaves no doubt as to

what he proposes. Fortunately, Dr. Breuning's procedure and his priority schedule are far from being correct, for he overlooked some important aspects:

1) It is evident that Breuning blindly followed Lacordaire and the Junk catalogue, in their minor category names. Judgment was not applied. Thus, "le nom ancien de Thomson" (AGNITAE) happens to be more recent than Lacordaire's LAMIDES and MONOCHAMIDES, referred to 1869. Resort to pertinent bibliography would have shown that not all of Lacordaire's group category names entitle him to their priority. He would also verify that Thomson, in 1864, used all three names in the following sequence:

14° Division.	LAMITAE VERAЕ.	(p. 66),
24° Division.	MONOCHAMITAE.	(p. 80),
26° Division.	AGNITAE.	(p. 83).

(Breuning's page reference to this last tribe should be corrected to 83, and not 36 as quoted by him).

If he went further, he would find that Thomson had previously used the name MONOCHAMITAE in 1860 (p. 93), which definitely rules out the supposed priority of "le nom ancien de Thomson," the AGNITAE.

But this is not all. The tribe LAMIINI is very much older than Lacordaire, 1869. In both the 1860 and 1864 Thomson publications, it is treated in a tribal concept (see Thomson, 1860, pp. VIII, XIII, XVI, 1; 1864, pp. 13, 14, 43) and not merely as minor group divisions, as the MONOCHAMITAE and AGNITAE. It does not matter that Thomson got his generic concept of *Lamia* all wrong, by taking Fabricius, 1792, as a reference, selecting *Lamia gigas* Fabricius, 1792, as the type of the genus, and reducing *Petrognatha* to a synonym of *Lamia*. Thomson overlooked the 1775 Fabrician reference, in which the name *Lamia* appeared for the first time, and so selected for a type a species of posterior date in relation to the originally included species. Among the thirty-three *Lamia* species listed in the 1775 title, *Cerambyx textor* L., 1758, figures as number 5 (p. 171), and as far back as 1810, Latreille selected this species for the type of the genus *Lamia* (p. 431), a selection that has never been questioned since Thomson (see the Junk catalogue, p. 70). The genus has also been reduced to its type species at least since Lacordaire, 1869 (p. 297), a point of view accepted by Breuning (pp. 183-184).

Lacordaire, 1869, in the treatment of his "Longicornes," divides them into three subfamilies: PRIONIDES, CERAMBYCIDES, and LAMIIDES. This last subfamily is characterized and divided into tribes (see pp. 238-242), one of which is his LAMIIDES VRAIES. These he further subdivides into divisions and sections (unnamed), and groups with names that correspond closely to the tribal concepts in the Junk catalogue. Dr. Breuning's page reference to Lacordaire's LAMIIDES (p. 293) refers to the minor tautonymic group in Lacordaire's system. The discussion of the validity of the name LAMIINI is superfluous, for it is of unquestionably old vintage and one of the cornerstones in the classification of the longicorn beetles. It has even been used, over a hundred years, as a family name with a proper modern suffix designation (LAMIIDAE), as can be seen in Newman, 1842, p. 275, and White, 1855, p. 347. Pascoe, 1864, not only used it as a family name, but divided his LAMIIDAE into subfamilies, with their distinguishing characters (pp. 6-9), and the LAMIINAE (p. 7) is one of them. This subfamily division was transcribed in the first volume of the Zoological Record, 1864.

2) No taxonomist should forget that there is always a stable core and main stems and branches in systematics, which avoids the chaotic situation that would follow in a system admitting all sorts of divergent personal opinions. Thus, a genus is primarily defined by its type species or genotype, which once recognized in any form, original or subsequent, is the cornerstone for any generic concept. This concept can be enlarged, and characters emended to admit other species, but in the reverse procedure, all can be taken out except this cornerstone single species which is the type of the genus. Of course, a genus can be synonymized, or in a lumping process this type can be superseded on a priority scale, but if revalidation or splitting should later occur, the type species has to be acknowledged again. A genus can lend its name to higher level groups, in such a manner that the genus *Lamia* can be, and in this case is, the type genus of a tribe (LAMIINI), and this in turn can be the stable tribe of a subfamily (LAMIINAE), which can be the main subfamily of the family LAMIIDAE, if the group is considered in this rank.

Dr. Breuning has to accept this arrangement for the LAMIIDAE (admitted by many, including the Zoological Record, with a family rank), through the LAMIINAE, the LAMIINI, right down to

the genus *Lamia* Fabricius, 1775, with its type species, *Lamia textor* (L., 1758). Many ancient genera, as in this case, have grown up to a status of present day families or subfamilies, with a tautonymic linking from generic to family or subfamily name.

Thus, Dr. Breuning's tribal concept could be an enlargement of the tribe LAMIINI, to include the MONOCHAMINI, the AGNIINI, and the POTESNEMIINI, but could in no manner of means take the name AGNIINI, except if he deliberately wishes to sink the subfamily name LAMIINAE (or family name LAMIIDAE). But to do this he would have to supply very convincing arguments and until such arguments are produced, the name of his twelfth tribe (AGNIINI) will have to revert to "le nom le plus ancien": LAMIINI.

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BUCHHOLZ LEPIDOPTERA COLLECTION

The Department of Insects and Spiders of the American Museum of Natural History proudly announces the accession of the Lepidoptera collection of the late Otto Buchholz of Roselle Park, New Jersey. This outstanding collection was purchased on January 7, 1959, for the American Museum of Natural History through the generosity of several friends. It consists of 124,985 specimens, including five holotypes, three allotypes and 551 paratypes. This is one of the largest, most complete and best prepared collections of Macrolepidoptera from North America north of Mexico ever built up by a private collector. It contains practically all the described species of butterflies, skippers and moths included in Part I of the 1938 McDunnough Check List. All specimens are to receive an O. Buchholz collection label.

The accession of this beautiful collection, following the John L. Sperry collection of 181,002 specimens, and the John B. Smith and George D. Hulst collections from Rutgers University of 32,022 specimens, gives the American Museum of Natural History one of the best and most complete study collections of North American butterflies, skippers, and macro-moths in existence. In most of these groups the collection is unexcelled.—FREDERICK H. RINDGE, The American Museum of Natural History.

DISDERIA INORNATA, A NEW SPECIES OF
PENTATOMID FROM MEXICO
(HETEROPTERA, PENTATOMIDAE)

BY HERBERT RUCKES¹

In 1910, Bergroth (Ent. News, vol. 21, pp. 18-21) erected the generic name *Disderia* in order to correct an error of identification made by Distant (Biol. Cent. Amer., Heteroptera, vol. 1, p. 83, pl. 7, fig. 9) who placed a Mexican species which he called *decorata* in Stal's genus *Phalaecus*. As Bergroth pointed out no relationship exists between *Phalaecus* and *Disderia*; indeed, as far as the latter is concerned, there is no other American genus related to it. The genotype automatically became *Disderia decorata* (Distant).

Until the present writing no other species of this genus seems to have been described. In 1933, while collecting in southern Mexico, R. L. Usinger and H. E. Hinton took a number of pentatomid specimens which up to the present have remained unidentified. I had the privilege of borrowing these from Doctor Usinger during my last visit to his laboratory in 1958. In his collection they were intermixed with a number of examples of *Banasa* with which they could readily be confused since, in superficial appearance, they have the same general build of some species of that genus. These form the type series for the accompanying description.

Bergroth, in setting up *Disderia*, was apparently overly precise in enumerating basic characteristics for his genus, using some that I feel are of a specific rather than of a generic status. If we discount the relative lengths of antennal segments II and III, the localized reflexion of the lateral pronotal margin, the number and arrangement of punctures on the embolium (exocorium of Bergroth) and the asulcate tibiae, then the species described below falls into this genus, for all the characters specified by Bergroth fit.

The one principal feature that makes me hesitate to put this new species in the genus *Disderia* is the very great discrepancy

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shown in the composition of the external male genitalia of *D. decorata* and those of the new species. Through the kindness of Mr. R. J. Izzard, of the British Museum, I was permitted to borrow one of Distant's male co-types to compare with the males of my proposed species. The figures (Fig. 1 and 2) included in this article are camera lucida drawings made of that specimen. Comparison of the figures with those of the proposed species will show, far better than a lengthy description, wherein the significant differences lie. In spite of these great differences I am loathe to erect a new genus primarily on the construction of the external male genitalia.

Whereas *Disderia decorata* (Distant) is contrastingly marked in dark and light colors, the proposed new species is concolorous brownish; to emphasize this difference I am calling the latter *Disderia inornata*.

***Disderia inornata*, new species**

Elongate ovate; intermediate in size, 10.0 mm–12.0 mm. long; fulvous, generously overlain with piceous, fuscous and ferruginous punctures, which are rather dense, especially on the hemelytra; those on the head, anterior lateral portions of the pronotum, embolium and connexivum tending to be dark bronzy green. Overall color medium brown.

Head two-thirds of the medial length of the pronotum (60/90) and five-sixths as wide between the eyes as long (50/60); antecular margins moderately sinuate, hardly reflexed, juga and tylus subequal, apex moderately rounded; disc mildly impressed, punctures piceous with a bronzy green tone, moderately dense and evenly spaced; ocelli red, about two and one-fourth times as far apart as distant from the eyes; eyes castaneous to medium brown. Antennae light orange fulvous, segments I, II, and III lightly stippled with fuscous dots; segmental ratios: 20/50/40/70/75, i.e. segment II slightly longer than III and two-thirds as long as V.

Pronotum two and a half times as wide across the humeri as long medially (230/90); anterior margin broadly and shallowly excavated to receive the head, truncated behind the eyes, barely surpassing them laterally and terminating in a minute extrorse apical tooth; anterolateral margins acute, essentially straight, not reflexed; humeri rounded and not at all produced; posterolateral margins straight, each about half as long as the width of the very weakly arcuate (subtruncate) posterior margin; disc rather evenly punctured, the punctures of the central portion ferruginous to fuscous, those near the lateral margins denser and darker, bronzy green; surface rather evenly convex, no rugae evident; cicatrices quite well defined.

Scutellum one-fourth longer than wide at the base (180/145); punctures fuscous, largest and most widespread centrally near the base, those nearer the margins and on the postfrenal portion denser and finer; the frenum ends two-thirds of the distance from the base, the margins from there onward subparallel to mildly convergent, apex moderately rounded, basal

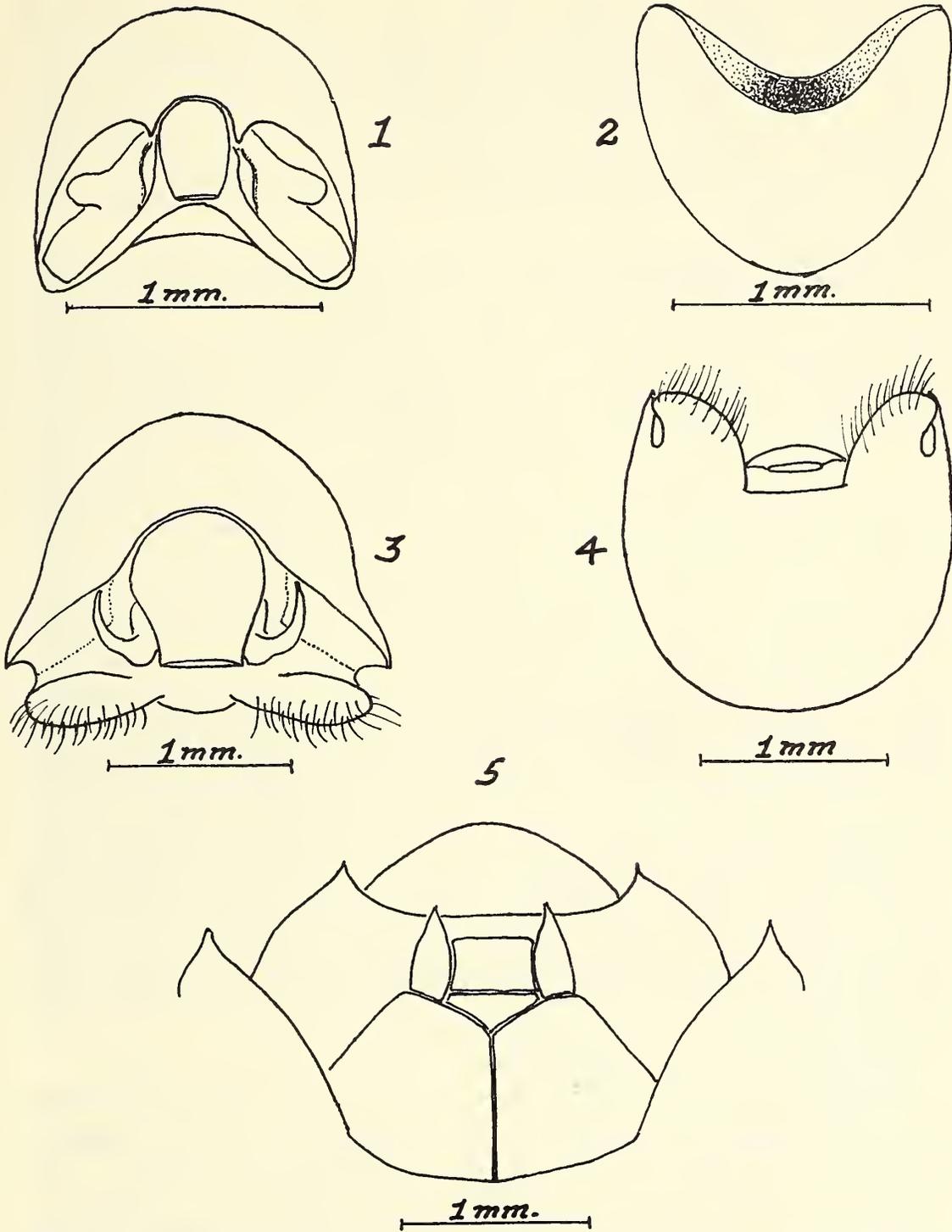


Fig. 1. Dorsal aspect of the male genital segment of *Disderia decorata* (Distant). Note the mitten-like parameres in this species.

Fig. 2. Ventral aspect of the same.

Fig. 3. Dorsal aspect of the male genital segment of *Disderia inornata* n. sp. Note the lateral apical notches and claw-like parameres in this species.

Fig. 4. Ventral aspect of the same.

Fig. 5. Ventral aspect of the female genital plates of *Disderia inornata* n. sp.

angles neither calloused nor pitted. Hemelytra densely and evenly punctured, punctures on the embolium darker, some tending to coalesce but not arranged in longitudinal rows; apical margin essentially straight, external angle roundly acute; membrane pale fulvous, slightly surpassing the apex of the abdomen, with about ten subparallel darker veins. Connexivum ochraceous to fulvous with a broad band of piceous or greenish black coalescing punctures each side of the incisures; apical segmental angles piceous, rectilinear, somewhat produced, those on the sixth segment acute, almost apiculate.

Ventral side ochraceous to pale fulvous; punctures moderate in size, fuscous to ferruginous, rather evenly distributed on the pleura, more shallow and wide spaced on the broad lateral portions of the abdomen; central portion of abdominal disc, the thoracic sterna and underside of the head essentially impunctate. Median abdominal spine reaching between the procoxae in the female but not attaining them in the male; its compressed laminate apex not broadly bent dorsally as in *D. decorata*, rather feebly curved and continued forward. Rostrum fulvous, the apex alone piceous, attaining the mesocoxae; segment I not quite reaching the prosternum; segment II twice as long as I; segment IV shorter than III; segmental ratios: 20/40/35/25. Legs darker fulvous, femora and tibiae lightly stippled with wide spaced piceous or fuscous dots; tarsi concolorous.

Male genital segment (Figs. 3 and 4) deeply U-shaped emarginate apically; each lateral apical process consisting of two superimposed short lobes, separated by a horseshoe-shaped, piceous-bordered notch; the upper lobe is flat-faced internally and fuscous there, feebly convex externally, fulvous and apically acute; the ventral lobe is strongly setigerous, stoutly subcylindrical with its apex obtusely rounded; the inner surfaces of the lower lobes form the lateral borders of the U-shaped emargination mentioned above. Parameres piceous, claw-shaped, their tips reaching the dorsal margin of the capsule. Basal plates of the female genital valves (Fig. 5) as broad as long, their apical margins subtruncate; the apical lobes are narrowly triangular, slightly tumid, their tips apiculate; both basal and apical plates lightly fusco-punctate.

Described from 14 specimens.

Holotype: Male: 10.0 mm. long to the apex of the membrane; 5.5 mm. wide across the humeri; Tejupilco, Temescaltepec, Mexico; June 24, 1933. Usinger and Hinton, collectors. Deposited in the California Academy of Sciences, San Francisco.

Allotype: Female: 11.5 mm. long to the apex of the membrane; 6.0 mm. wide across the humeri; Tejupilco, Temescaltepec, Mexico; June 26, 1933. Usinger and Hinton, collectors. Deposited in the California Academy of Sciences, San Francisco.

Paratypes: Males (7): Tejupilco, Temescaltepec, Mexico; June 22-28, 1933. Four deposited in the Usinger collection three retained in the American Museum collection. Females: (5) same data as above. Two deposited in the Usinger collection; three retained in the American Museum collection.

THE THAUMALEIDAE (DIPTERA) OF THE APPALACHIAN MOUNTAINS

BY FRANÇOIS VAILLANT

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A family of Diptera Nematocera, the Thaumaleidae, comprises only a small number of species, scattered all over the world. We know at present four genera and 54 species of Thaumaleidae:

	<i>Austrothaumalea</i> Tonnoir	<i>Trichothaumalea</i> Edwards	<i>Thaumalea</i> Ruthé	<i>Androprosopa</i> Mik
Oceania	2			
America	5	1	4	
Asia			3	
Africa			3	
Europe			35	1

Nearly all the species of Thaumaleidae have a small distribution area and no one of them seems to be shared by two continents.

The Thaumaleidae are clearly distinct from all other Nematocera. All having the same appearance, they form a very homogeneous family. Slight structural differences of the wings and of the palpi enable us to separate the four genera of Thaumaleidae. Within each genus, species can be distinguished from one another only by the characters of the last abdominal segment and of the genital armature; this is true for both sexes.

In North America, only five species have been described at present; they are:

- Trichothaumalea pluvialis* (Dyar and Shannon 1924),
- Thaumalea americana* Bezzi 1913,
- Thaumalea elnora* Dyar and Shannon 1924,
- Thaumalea johannis* Dyar and Shannon 1924,
- Thaumalea fusca* Garret 1925.

The first of these five species differs from the others by the covering of the wings; there are macrotrichia not only on the veins, but also on the membrane of the wings. In all species of *Thaumalea*, there are macrotrichia only on the veins. The taxonomic characters of the four North American species of *Thau-*

malea are the length and ornamentation of the dististyles and the form of the parameres in the male.

Larvae of at least ten species of *Thaumalea*, from North America, Europe and North-Africa, were identified. All were collected in the same kind of habitat. They live exclusively on dripping rocks and are to be found only in places where the substrate is covered with a film of water. The ensemble of the animals that live in similar conditions has been defined by A. Thienemann in 1909 as the "Fauna hygropetrica." The body of a *Thaumalea* larva is not entirely covered with water and it usually touches the substrate only at its two extremities; that is why a *Thaumalea* larva, when disturbed, is able to glide swiftly on the water film, as well as a *Dixa* larva.¹ On a clear day, *Thaumalea* larvae, when undisturbed, move slowly, from time to time, seeking a shady place. In fact, they are cold water stenothermes and are not found, at low altitude, in hygropetric biotopes entirely exposed to sunshine. *Thaumalea* larvae belong to the trophic group of the "substrate eaters"; their mouth parts collect mud and particles of organic matter in the crevices of the rock. Only when they are ready to pupate do *Thaumalea* larvae leave the hygropetric habitat; then they hide in wet moss or bury themselves in mud. After emergence, the flies, rather clumsy and unable to travel far, stay in the daytime on bushes at a short distance from dripping rocks.

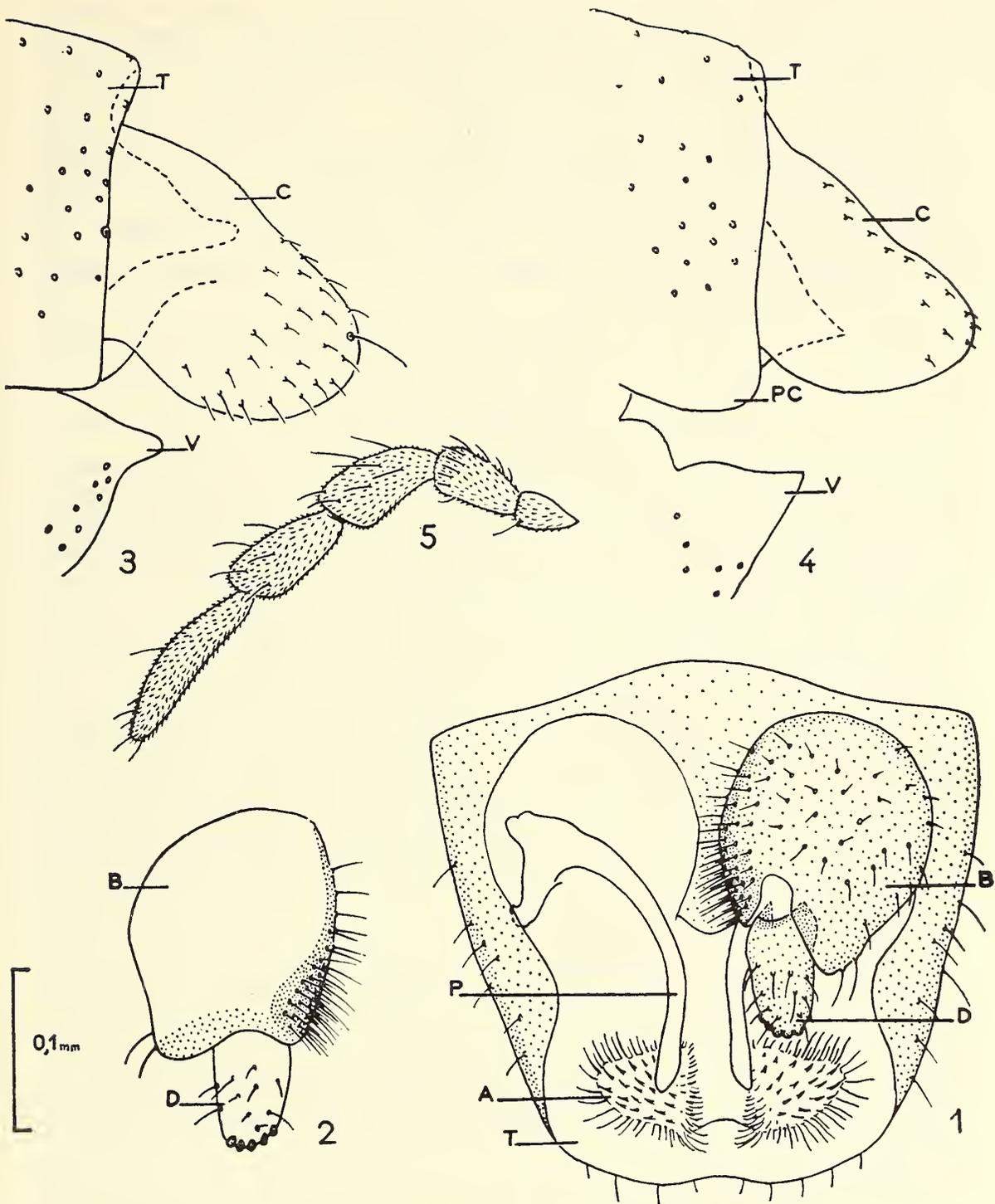
During the month of August, 1955, visiting the Great Smoky Mountains, I observed, in different hygropetric biotopes, numerous larvae of Thaumaleidae. I collected some of them and kept them alive. Finally I obtained males and females of two species of *Thaumalea*. One of the species is probably *T. americana* Bezzi; the other one is new.

Thaumalea americana Bezzi

Figures 1-3

Thaumalea americana was described by M. Bezzi in 1913, but the Italian entomologist did not give any figure of the fly and his description of the male genital parts of *T. americana* would fit just as well for specimens of many other species of *Thaumalea*. The type, collected by Dr. Johannsen in Ithaca, remained in M. Bezzi's collection.

¹ The way of progression of *Thaumalea* larvae has been thoroughly explained by A. Thienemann.



Figures 1-3: *Thaumalea americana* Bezzi. 1-2: male. 1: ninth tergite and genital parts, on ventral side; the right forceps is supposed to have been cut off. 2: left forceps, on dorsal side. 3: female, posterior extremity of the abdomen, side view.

Figures 4-5: *Thaumalea thornburghi*, new species. 4: female, posterior extremity of the abdomen, side view. 5: male, left maxillary palpus.

A: anal flap. B: basistyle or side piece. C: cercus. D: dististyle or clasper. P: paramere. PC: posterior corner of the ninth tergite. T: ninth tergite. V: valve.

All the figures on the same scale.

In 1924, H. J. Dyar and R. C. Shannon captured, in Pennsylvania and in Virginia, specimens of *Thaumalea*, which they considered to belong to the same species *T. americana*; they described the male, but did not figure it. One of the most important taxonomic characters they mentioned is the number of terminal spines on each dististyle; this number is only two. The American species of *Thaumalea* nearest allied to *T. americana* is *T. johannis*; the male of the latter species has about six apical spines on each dististyle.

Five years later, F. W. Edwards collected in Ithaca numerous males and females of *Thaumalea*; he believed they could be considered as specimens of *T. americana*, though he was able to compare them neither with the type, nor with Dyar and Shannon's samples of *T. americana*. Edwards's male specimens had about six small terminal spines on each dististyle and the English entomologist believed some of the spines of the dististyles had been overlooked on Dyar and Shannon's samples.

Edwards was able to compare, with the male type of *T. johannis*, the male samples of *T. americana* he collected. As the forceps are quite similar in both species, the characters Edwards used to distinguish *T. americana* and *T. johannis* are the color of the halteres—yellowish in the first species, dark in the second—and the shape of the parameres; these have parallel sides and are rounded at their tip in *T. americana*; they are spatulate at their tip in *T. johannis*.

Edwards's short description of *T. americana* and his figures of the genital parts of the male and of the female fit quite perfectly with the specimens I collected at Clingmans Dome, in the Smoky Mountains. I believe nevertheless it is better to give a precise description of these flies, and especially of their genital parts.

MALE: Thorax dark brown. Abdomen of a deeper shade. Antennae 12 segmented. Proportions of segments of an antenna are 15-37-28-9-9-9-13-15-11-13-19-24. The flagellar segments 1, 2, 4 and 8 bear on their dorsal side a long and stout seta. There are also two long setae at the tip of the last segment of the antenna. Wings of a uniform light brown tinge, quite similar to those of *T. thornburghi*, (Figure 8), though larger. Transverse nerve R_2 very faint; macrotrichia only on veins C, R and R_1 ; 25 macrotrichia on the vein R_1 . Halteres ochraceous. Ninth tergite without any projection of its edge. Basistyle of each forceps slightly longer than wide. Dististyle with hairs on its dorsal side as well as on its ventral side; at its tip, 5 dorsal directed teeth in a single row. Parameres only slightly broader at their distal end.

Measurements: length of the body: 2.8 mm. Antenna length: 0.28 mm. Wing length: 2.7 mm. Wing width: 1.1 mm.

FEMALE: The ninth tergite is devoid of lateral processes. Its posterior corners are at right angle.

Habitat: I obtained a male and a female specimen from larvae collected on August 26, 1955 at Cingmans Dome. The biotope was a dripping cliff on the roadside, at a short distance from the parking area, and at an elevation of about 6200 feet. Larvae of *Thaumalea americana* collected in Ithaca, New York, were described by O. A. Johannsen.

***Thaumalea thornburghi*, new species**

Figures 4-12

MALE: Thorax dark brown. Abdomen of a deeper shade. The number of segments of the antennae is most variable, which is unusual in Diptera; antennae of the holotype specimen are both 10 segmented, but a second specimen has antennae different from one another, though of the same length; one antenna is 10 segmented, while the other is only 7 segmented. In this abnormal antenna, some flagellar segments are fused. One antenna of a third specimen of *T. thornburghi* has 9 segments. Wings are of a uniform light brown tinge and have macrotrichia only on the veins C, R and R₁. There are only 10-12 macrotrichia on the vein R₁. The ventral edge of the ninth tergite projects backwards on each side. The basistyles are slightly wider than long. On their dorsal side, the dististyles have only three hairs and they bear, at their distal end, usually three brown blunt teeth in a single row; sometimes, the three teeth are not in a row or there are only two of them. At the tip of each dististyle is an ochraceous tooth truncate at its apex. On each dististyle, between the more distal of the brown teeth and the truncate one, there is a long seta. The parameres have a sharp tip. A posterior lobe of each anal flap projects between the parameres.

Measurements: length of the body: 2.0-2.1 mm. Antenna length: 0.28 mm. Wing length: 1.9-2.0 mm. Wing width: 0.75-0.8 mm.

FEMALE: In the two specimens examined, antennae are 9-segmented. The ninth tergite is rounded on both its posterior corners and is devoid of lateral processes. The valves of the genital plate are short.

Habitat: the male holotype was obtained from a larva collected on August 20, 1955, on Dripping Rock Cliff, beside Roaring Fork Creek, at about 2000 feet, with the same data for the female allotype, two male paratypes and a female paratype.

It is with pleasure that I name this species in honor of my friend, the writer Miss Laura Thornburgh, who kindly enabled me to pay a long visit to the Smoky Mountains and helped me in every possible way.

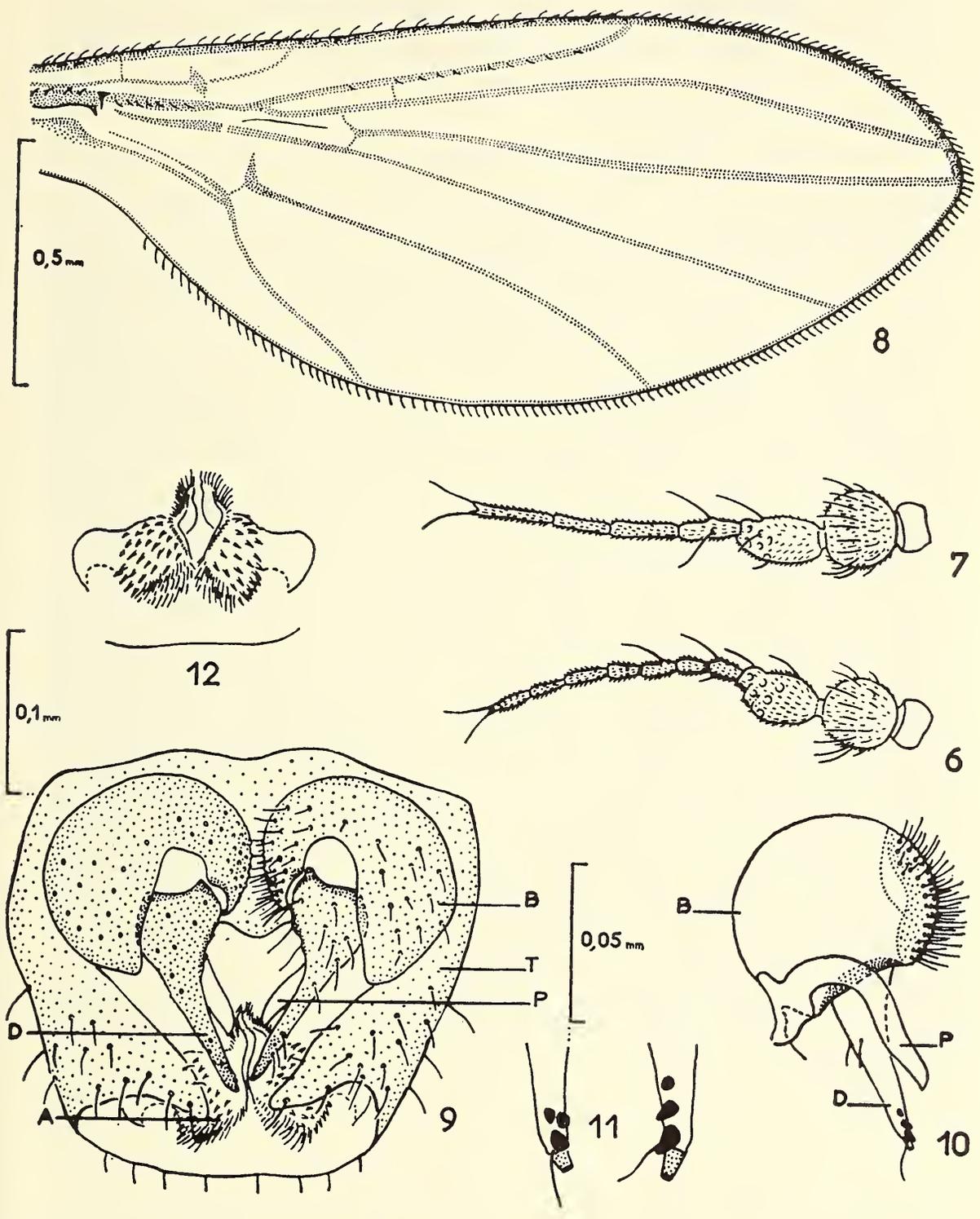
In 1913, the Italian entomologist, M. Bezzi, divided the dif-

ferent species of the genus *Thaumalea* into three distinct groups. The divisions were based solely upon differences of the male genitalia.

The male *Thaumalea* of Bezzi's first and second groups have forceps too long to be hidden dorsally by the ninth tergite, but the male flies of Bezzi's third group, or group C, have short forceps hidden dorsally by the ninth tergite. All North American species of *Thaumalea*, with the exception of *T. fusca*, belong to the group C. Both species of *Thaumalea* from Japan, *T. japonica* Okada and *T. striata* Okada, are in the same group C. So are two species from Europe, *T. nigra* Loew and *T. tarda* Loew, and one from Africa, *T. algira* Vaillant. But all the *Thaumalea* of the group C from Europe, Africa and Japan differ from the North American species of *Thaumalea* in their dististyles entirely devoid of teeth and of spines.

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Figures 6-12: *Thaumalea thornburghi*, new species, male. 6: left antenna of the holotype. 7: left antenna of a paratype. 8: wing. 9: ninth tergite and genital parts, on ventral side; the hairs of the right forceps have not been figured. 10: left forceps and left paramere, on dorsal side. 11: distal parts of both dististyles, dorsal view. 12: anal flaps, on dorsal side.

A: anal flap. B: basistyle or side piece. D: dististyle or clasper. P: paramere. T: ninth tergite.

The figures 6, 7, 9, 10 and 12 on the same scale.

UNUSUAL DIET FOR *TENEBRIO MOLITOR* LINN.

The common tenebrionid beetle, *Tenebrio molitor* Linn., which is found in many biology laboratories, can be reared with a minimum of care. It is useful as a food supply for most terraria and aquaria inhabitants.

These beetles customarily feed upon plant materials. According to the U.S.D.A., Tech. Bul., 95, 1929 and the recent entomological textbook, *An Introduction to the Study of Insects* by Borrer and DeLong, they are often found in stored grains and have been known to infest the stored cereal used to feed caged birds. The female lays the whitish, oval eggs singly or in clusters within the food material on hand. These food materials serve as nutriment for the larvae. The eggs hatch from within four to eighteen days into white larvae which become yellow in color as they grow. They are one to one and one-half inches in length when fully grown, and they are commonly known as mealworms.

While raising these beetles for various experiments, a few wandering larvae were observed to have left the culture and were feeding on a preserved grasshopper, *Dissosteira carolina* Linn., which was in a corked vial. This unusual meal had been reached by the larvae by tunnelling through the cork, as was evident from fine cork dust within and just outside the vial. These larvae were left with their strange diet and observed for several weeks. The grasshopper was gradually eaten away, and finally two pupae were seen in the vial. These pupae, upon becoming adult, trod the original route and left the vial. Thus, we have this unusual circumstance of a beetle commonly regarded as herbivorous only, consuming dried, preserved, insect material.—JAMES A. MULLEN, Department of Biology, Fordham University.

THE LARVAE OF THREE NEARCTIC DIPTERA OF THE FAMILY PSYCHODIDAE

BY FRANÇOIS VAILLANT

UNIVERSITY OF GRENOBLE (FRANCE)

The *Pericoma* and the *Telmatoscopus* are hairy winged gnats, that are quite common in shady places, near a spring or a stream. The larvae of most species of these flies have a marginal habitat, at the limit between ground and water; they are found on a substrate covered only by a very thin layer of water; the substrate can be a stone, or earth, or a dead leaf soaked in water, or live moss. These larvae are "substrate eaters" and scrape the substrate in front of them as they move; they feed on organic particles; some devour tissues of decayed leaves.

Extensive work has been done on the imaginal stages of North American species of *Pericoma* and *Telmatoscopus*; they have been revised lately by L. W. Quate. But very incomplete is our knowledge concerning the immature stages, and especially the larval stages of these flies. Indeed the larvae of only 2 identified species of *Pericoma* have been described, those of *P. albitarsis* (Banks) by O. A. Johannsen in 1934, and those of *P. truncata* Kincaid by L. W. Quate in 1955; characters of the larvae of 7 unidentified species have also been given by O. A. Johannsen. At present we know the larvae of 2 nearctic species of *Telmatoscopus*; they are those of the cosmopolitan species *T. albipunctatus* (Williston), which is common to North and South America, to Europe, to Africa and to Asia; larvae of this species have been described successively by H. F. Efflatoun, E. Zavattari, S. Mukerji, O. A. Johannsen and F. X. Williams. Larvae of *T. superbus* (Banks) were found in the water of a hollow stump; one of them was figured by L. W. Quate.

The German entomologist H. J. Feuerborn showed that the best taxonomical characters, that can be used to distinguish the larvae of the different species of *Pericoma* and *Telmatoscopus*, are the number and position of setae on the body of these larvae. He discovered that the setae of Psychodid larvae are of two kinds, according to their base of insertion and to their constancy. Some of these setae, called "true setae," are movable and attached to

a sclerotized ring; the number of true setae is constant for all species of *Pericoma* and of *Telmatoscopus*, sensu stricto. The other setae, called "accessory setae," are not movable; they are not attached to a ring, but directly to the body wall, and their diameter decreases progressively from their base to their tip; their number and position, quite the same in all the specimens of a same species, differ from one species to another.

Later on, G. H. Satchell established a nomenclature of sclerotized plates and of setae that may be applied to all larvae of *Pericoma* and of *Telmatoscopus*. He described the larvae, new to science, of 9 European species of these two genera.

Recently, H. F. Jung, in his excellent revision of both immature and mature stages of European Psychodids, continued Satchell's work. Having assembled the larvae of many other species of *Pericoma* and *Telmatoscopus*, he was able to point out new and important taxonomical characters, such as the shape of the hypostomium.

In August 1955, in the Great Smoky Mountains, I collected larvae of two species of *Pericoma*, *P. marginalis* (Banks) and *P. albitarsis* (Banks), and those of a species of *Telmatoscopus*, sensu stricto. Unfortunately, I was not able to obtain imagos of this last species and it is therefore unidentified. I thought it might be useful to compare these larvae with those of the species of the Old World, so I describe them here in some detail, using the terms chosen by G. H. Satchell. First are given the characters common to all the larvae of *Pericoma* and to those of *Telmatoscopus*, sensu stricto, then those peculiar to each of the three species *Pericoma marginalis* (Banks), *Pericoma albitarsis* (Banks) and *Telmatoscopus* (*Telmatoscopus*) species I. Characters that are of no taxonomic value have been intentionally omitted.

At the start, I wish to express my thanks to Mr. E. A. Hummel, Superintendent of the Smoky Mountains National Park, who kindly permitted me to collect water midges, and also to Mr. A. Stupka, Park Naturalist, who in many ways helped me to secure those midges.

The head of a *Pericoma* larva is protected by a chitinous capsule, divided by a U shaped epicranial suture, into three parts: the mediodorsal frons, and the two genae on the sides.

The body is divided into three thoracic and eight abdominal

segments; each of these, with the exception of the eighth abdominal segment, is in turn divided by superficial constrictions into secondary segments or annuli. The first four segments of the body comprise only two annuli each, while the six following segments are divided into three annuli each. The last abdominal segment is not constricted; according to H. J. Feuerborn, it comprises three metameres fused together.

Each of the six thoracic annuli and of the twenty abdominal annuli is protected on its dorsal side by a large tergal plate. Some of them have also a small pleural plate on each pleurite, and two or four small sternal plates on their ventral side. Only the anterior annulus of each thoracic segment has a pair of pleural plates. The first and the last annuli of each of the first seven abdominal segments bear also a pair of pleural plates.

The last two annuli of each abdominal segment, save the eighth one, bear one or two pairs of sternal plates.

The three tergal plates of each of the abdominal segments, from II to VII inclusive, are conventionally called—in antero-posterior order—protergal plate, mesotergal plate and metatergal plate. For reasons, which I have given in a previous paper, I came to consider the anterior tergal plate of each thoracic segment and of the first abdominal segment as being the homologue of the mesotergal plate of each of the abdominal segments from II to VII; so I give it also the name of mesotergal plate. The first annulus of each of the four anterior segments of the body would be the homologue of the first two annuli of each of the abdominal segments from II to VII.

The last abdominal segment is protected dorsally and laterally by a large siphonal plate, which surrounds completely the segment on its distal part.

The anus opens on the ventral part of the last abdominal segment; it is surrounded by three plates, an anterior one, the preanal plate, and two posterior ones, the adanal plates.

All the plates we have mentioned, save the protergal plates of the abdomen, bear true setae. Some of these are small and usually ramose; they are probably sensory in function; we shall call them setulae. The other true setae are much larger and are usually unbranched. In many species, they retain around them either lime or particles of mud and that is why we shall call them tectorial true setae. Accessory setae of the tergal plates have

usually the same length and shape as the tectorial true setae and have probably the same function and though their origin is different, they are considered as tectorial also. Some larvae of *Pericoma* and *Telmatoscopus* have not the slightest coat of lime or mud, but have nevertheless long tectorial setae, true and accessory. As those larvae live in moss and in places where sometimes a swift current occurs, we can suppose that tectorial setae are used here to anchor the larvae to the moss. Indeed *Pericoma* larvae, that live on naked substrate and are covered with neither lime nor mud, have very short tectorial setae.

The basic arrangement of true setae on the head capsule and on the plates of the body is the same for all the larvae of *Pericoma* and *Telmatoscopus*, sensu stricto we know. The mesotergal plate of the first thoracic segment and the metatergal plates of both the second and the third thoracic segments each have seven pairs of true setae. The metatergal plate of the first thoracic segment and those of the first seven abdominal segments all bear six pairs of true setae. All the mesotergal plates of the body, save that of the first thoracic segment, have only three pairs of true setae.¹

Each pleural plate of the thorax bears four true setae. The two anterior pleural plates of the first seven abdominal segments have each only one true seta, while the two posterior pleural plates of these same segments have each three true setae.

One or two true setae are inserted on each of the abdominal sternal plates.²

As for the siphonal plate of the last segment, it has six pairs of true setae. The preanal plate has two pairs and each adanal plate has two pairs.

A *Pericoma* larva is amphipneustic. Its anterior spiracles are prothoracic and open on each side of the posterior annulus, at the end of a projection of the body. The posterior spiracles

¹ In two European species of *Pericoma*, *P. calcilega* Feuerborn and *P. viperina* Vaillant, each abdominal mesotergal plate bears only two pairs of true setae; those of the third pair are not missing, but are inserted outside the plate.

² In addition to setae fixed on the plates, the first 10 segments of the body of a *Pericoma* or a *Telmatoscopus* larva have a few setulae and sensillae inserted on the body between the plates. As they have the same position in all larvae of *Pericoma* and *Telmatoscopus* and have no taxonomic value, I shall not insist upon them here.

open close to one another on the siphon, that is the distal part of the eighth abdominal segment; the spiracle-openings are surrounded by two dorsal and two ventral chitinous clubs, called flabellar processes. Each of these bears a row of long accessory setae, that are unwettable. The unwettable surface extending over the posterior spiracles, a small area of skin around them, and the accessory setae of the four flabellar processes, are called the flabellum.

The principal taxonomic characters used to distinguish larvae of the different species of *Pericoma* and *Telmatoscopus* are:

1—the shape of the head, the respective positions of its different true setae and of its callous places devoid of spines³;

2—the ornamentation of the hypostomium;

3—the respective positions of the true setae on the tergal plates and the different shapes of these setae;

4—the number, shapes, and respective positions of the accessory setae on the tergal plates;

5—the number and respective positions of the setae on the siphonal plate;

6—The respective lengths of the dorsal flabellar processes and of the ventral flabellar processes.

I shall now give the characters peculiar to each of the three species; the larvae described are all at the last instar. I shall also give some details concerning the habitat of the larvae of each species.

Pericoma marginalis (Banks)

Figures 1-7

Description: the head is about as long as wide; there are numerous stout spines behind each eye. The hypostomium has 25 to 30 teeth set in an irregular way.

The anterior spiracles are on long projection.

There are three pairs of setulae on the mesotergal plate of the first thoracic segment and on all the mesotergal plates of the abdomen; there are only two pairs of setulae on the mesotergal plates of the second and of the third thoracic segments and on all the metatergal plates of the body. All the other true setae of the tergal plates are tectorial; but they are of two kinds; some are leaf-shaped; the others are typical setae, circular in section. There is one pair of leaf-shaped true setae on each of the following plates: the second and third metatergal plates of the thorax and all the metatergal plates of the abdomen.

³ On the figures, the surface of the head-capsule of a larva, between the callous places, is dotted, the callous places are not.

As for the accessory setae, they are of only one kind; they are all leaf-shaped; there is one pair of them on each of the second and third thoracic mesotergal plates, on each of the second and third thoracic metatergal plates, and also on each of the abdominal protergal plates; there are two pairs of leaf-shaped accessory setae on each mesotergal plate of the abdomen.

On the mid annulus of each abdominal segment, save the last one, each sternal plate bears two ramose setae.

The siphonal plate has no accessory setae, but only the usual six pairs of true ones; the dorsal true setae of the siphonal plate are small; the lateral ones are much larger.

The preanal plate has four long slender true setae, that are unbranched.

On each side of the preanal plate, there are two small lateral plates, each with two paranal setae. Similar lateral plates are found in all species of *Pericoma* known at present.

The ventral flabellar processes are more than twice as long as the dorsal flabellar processes.

Length of the larva, when extended: 4.5–4.9 mm.

The tectorial setae retain under them and around them a layer of mud particles, so that the larva is entirely hidden under a thick covering of dirt, which absorbs water and keeps the animal from getting dry. Even the head and the sides of the larva are concealed under the coat of mud, so that it is difficult to catch sight of the animal.

A very special feature of the larva of *Pericoma marginalis* is its set of leaf-shaped setae. Similar setae are found in no *Pericoma* larva of the old world. It is most interesting to ascertain that leaf-shaped setae have exactly the same size and the same shape, whether they are true or accessory. Feuerborn's expressed opinion that true setae are sensory in function is therefore indefensible.

Habitat: many larvae of *Pericoma marginalis* have been found on Dripping Rock Cliff, beside Roaring Fork Creek, at an elevation of about 2000 feet; some have been found also in other parts of the Smoky Mountains National Park. All were on vertical wet cliffs, either on a naked substrate or on rock covered by a thin coat of mud; all were in a shady place.

Pericoma albitarsis (Banks)

Figures 8–15

Description: The larva of this species has already been described by O. A. Johannsen, but it is better to give more details in order to compare it with the larva of *Pericoma marginalis* and with larvae of other species.

The head, longer than wide, is especially broad behind the eyes; it is devoid of large spines. The hypostomium has two rows of sharp teeth; there are about 13 in the first row and 8 or more in the second row.

The projections bearing the anterior spiracles are short.

The number of true and accessory setae and their position is the same as for *Pericoma marginalis*.

All the accessory setae of the tergal plates are leaf-shaped. There is one pair more of leaf-shaped true setae than for *Pericoma marginalis*; it replaces a pair of typical setae and is on the metatergal plate of the first thoracic segment. The leaf-shaped setae are longer and narrower than those of the larva of *Pericoma marginalis*. All the true setae of the mesotergal plates, on the two posterior thoracic segments, are setulae. The sternal plates of the abdomen are quite similar to those of the first species.

The dorsal setae of the siphonal plate are small; the lateral ones are long and strong. The true setae of the preanal plate are flattened dorso-ventrally and are plumose on their sides.

Length of the larva, when extended: 4.7–5.0 mm.

The body is covered with mud, retained under the tectorial setae, but the coat is never as thick as it is in the larvae of *Pericoma marginalis* and it never hides the head, nor the sides of the body. On a few specimens collected in moss, there was hardly any mud at all.

Habitat: A few larvae were collected on Dripping Rock Cliff, but not in the same biotope as the larvae of *Pericoma marginalis*; they were in moss or on dripping rocks covered with a thin layer of diatoms. In several lotic biotopes on the roadside between Gatlingburg and Cades Cove, I found numerous larvae of the same species. Some were in the sun, creeping on wet rock covered with algae; others were in dripping moss.

Telmatoscopus (Telmatoscopus) species I.

Figures 16–24

Description: The head is about as long as wide and has no large spines. The hypostomium has several rows of long and slender teeth; the first row is composed of about 30 elements.

The processes bearing the anterior spiracles are short.

The number of setulae on each tergal plate of the body is the same as for the larvae of *Pericoma albitarsis*; all the other true setae of the tergal plates are typical tectorial setae. There are 2 pairs of accessory setae on all the mesotergal plates of the body, save the anterior one, and on all the protergal plates of the abdomen. There is only 1 pair of accessory setae on the last 2 metatergal plates of the thorax. The first 2 tergal plates of the body and all the metatergal plates of the abdomen are devoid of accessory setae. The sternal plates of the abdomen are similar to those of the larvae of *Pericoma marginalis* and of *Pericoma albitarsis*.

The siphonal plate has 3 pairs of small true setae, 3 pairs of stout lateral true setae, and dorsally a pair of long accessory setae. The anal plate is separated transversally into 2 parts; its 4 true setae are unbranched and curved backwards; the hind part of the preanal plate has, on its posterior edge, a row of accessory setae, that are ramose. There are no lateral plates, but 2 pairs of paraanal setae, each on a small individual plate.

Length of the larva, when extended: 4.5–4.7 mm.

Habitat: Some larvae were found near Dripping Rock Cliff, at about 10 feet from the biotope, where the larvae of *Pericoma marginalis* were collected. There were a few larvae of *Pericoma albitarsis* among them. All were in dripping moss, and entirely clean.

Telmatoscopus (Telmatoscopus) albipunctatus (Williston)

I shall now complete the description of the larvae of *Telmatoscopus albipunctatus* (Williston)⁴, so that it may be compared to the diagnoses of the larvae of other American *Telmatoscopus*.

The head-capsule, quite smooth, is much longer than wide; it is widest at three fourths of its length. The hypostomium has only 3 large teeth, the medioventral one being the largest.

The thoracic respiratory horns are short.

The metatergal plates of the second and third thoracic segments have each 3 pairs of setulae; the metatergal plates of the abdomen have 2 pairs, and the mesotergal plates of the abdomen have only one pair. All the other true setae of the tergal plates are tectorial. There are accessory setae—1 pair—only on each protergal plate of the abdomen. On the abdomen, the mid-annulus of each segment has 2 pairs of sternal plates, with a seta on each one.

There are two pairs of accessory setae on the siphonal plate; they are anterior to the 4 dorsal true setae of this plate; all the setae of the siphonal plate are almost of the same size. The preanal plate is very conspicuous; it has the shape of an arrow-head pointed backwards; on its posterior edge, it is lined with long accessory setae flat and unbranched; its 4 slender unbranched true setae are near its posterior end and close to one another. The paraanal setae of the eighth abdominal segment are not inserted on plates, but on articular membranes.

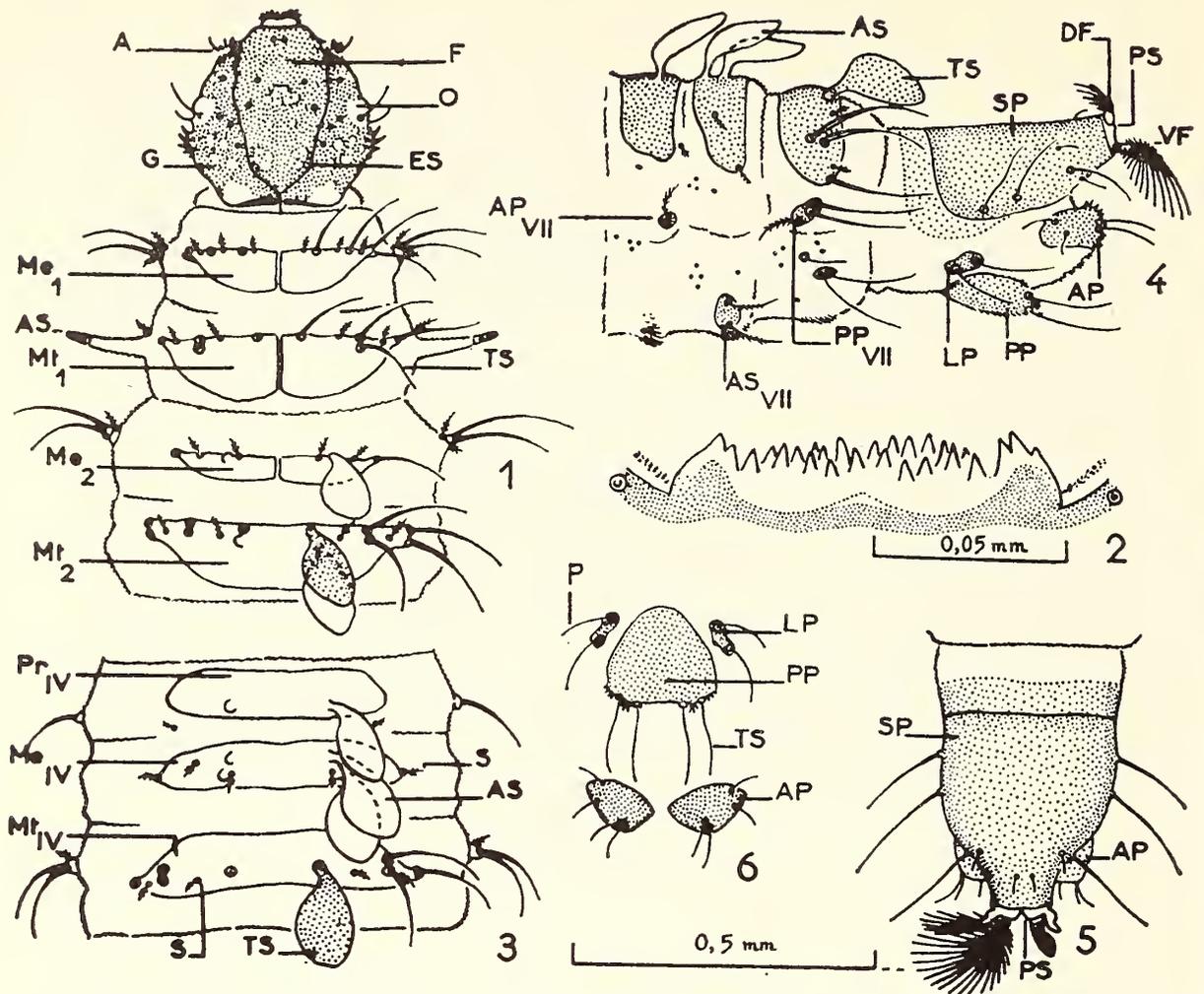
Length of the larva, when extended: 8.5–9.0 mm.

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⁴The larvae of *Telmatoscopus albipunctatus* described here were not found in America, but in small irrigation basins of a garden in Algiers, North Africa; they were collected October 3, 1948.

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Figures 1-6: larva of *Pericoma marginalis* (Banks). 1: head and two first thoracic segments, dorsal view. 2: hypostomium, ventral view. 3: fourth abdominal segment, dorsal view. 4: seventh and eighth abdominal segments, side view. 5: eighth abdominal segment, dorsal view; the setae of the right flabellar processes have not been figured. 6: plates surrounding the anus slit, outspread.

Conventionally, on figures 1 and 3, tectorial setae of the tergal plates have been omitted on the left side; only the basal ring of each tectorial true seta has been figured; only a bump has been figured at the location of each tectorial accessory seta. On figures 1, 3 and 4, leaf-shaped true setae are dotted, leaf-shaped accessory setae are not.

Figures 1, 3, 4 and 5 are on the same scale, indicated for figure 5.

A: antenna. AP: adanal plate. AP_{VII}: anterior pleural plate of the seventh abdominal segment. AS: accessory seta. AS_{VII}: anterior sternal plate of the seventh abdominal segment. DF: dorsal flabellar process. ES: epicranial suture. F: frons. FS: anterior spiracle or fore spiracle. G: gena. LP: lateral plate. Me₁: mesotergal plate of the first thoracic segment. Me₂: mesotergal plate of the second thoracic segment. Me_{IV}: mesotergal plate of the fourth abdominal segment. Mt₁: metatergal plate of the first thoracic segment. Mt₂: metatergal plate of the second thoracic segment. Mt_{IV}: metatergal plate of the fourth abdominal segment. O: ocellus. P: paraanal setae. PP: preanal plate. PP_{VII}: posterior pleural plate of the seventh abdominal segment. Pr_{IV}: protergal plate of the fourth abdominal segment. PS: posterior spiracle. PS_{VII}: posterior sternal plate of the seventh abdominal segment. SP: siphonal plate or dorsal plate. TS: true seta. VF: ventral flabellar process.

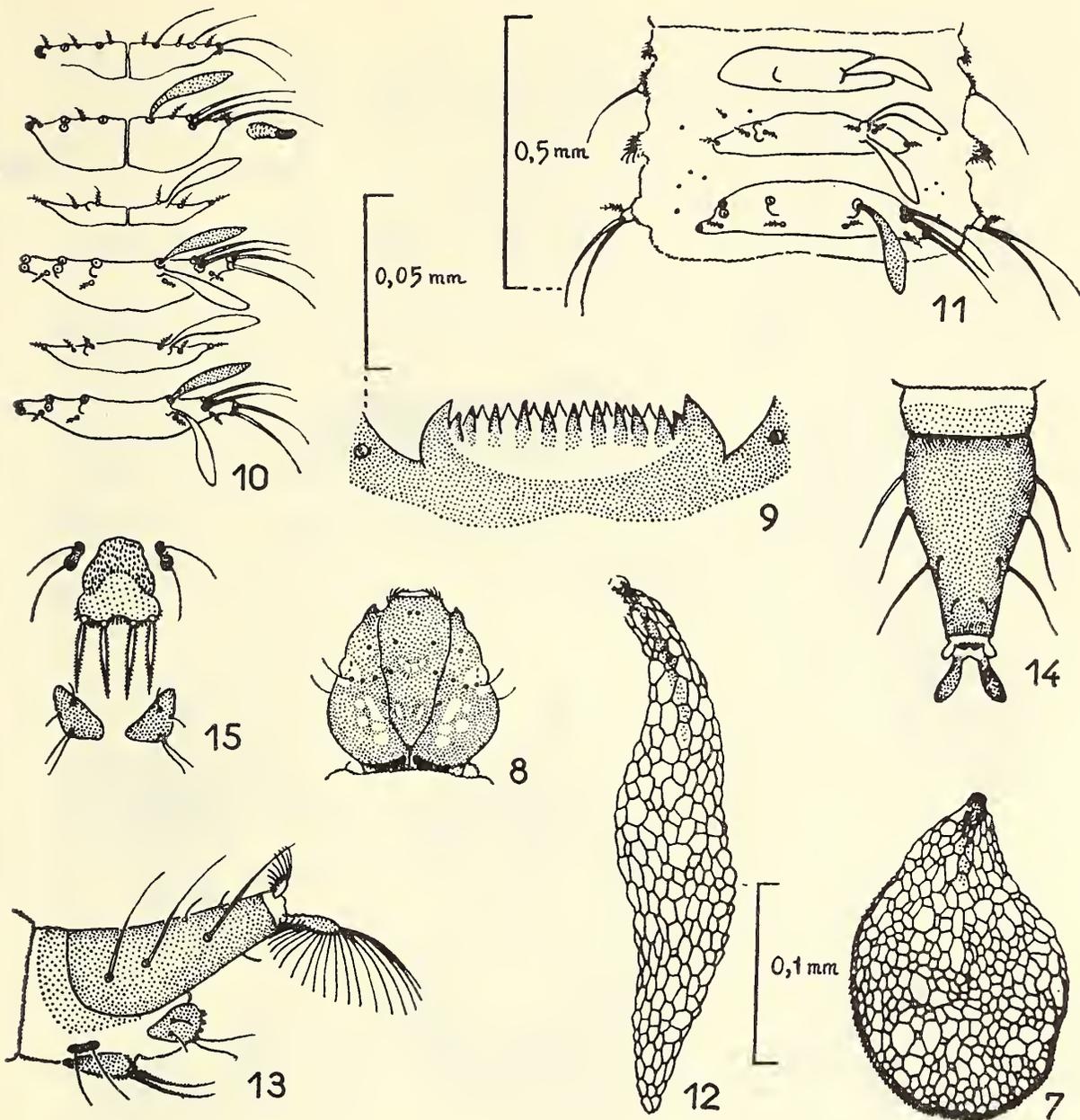
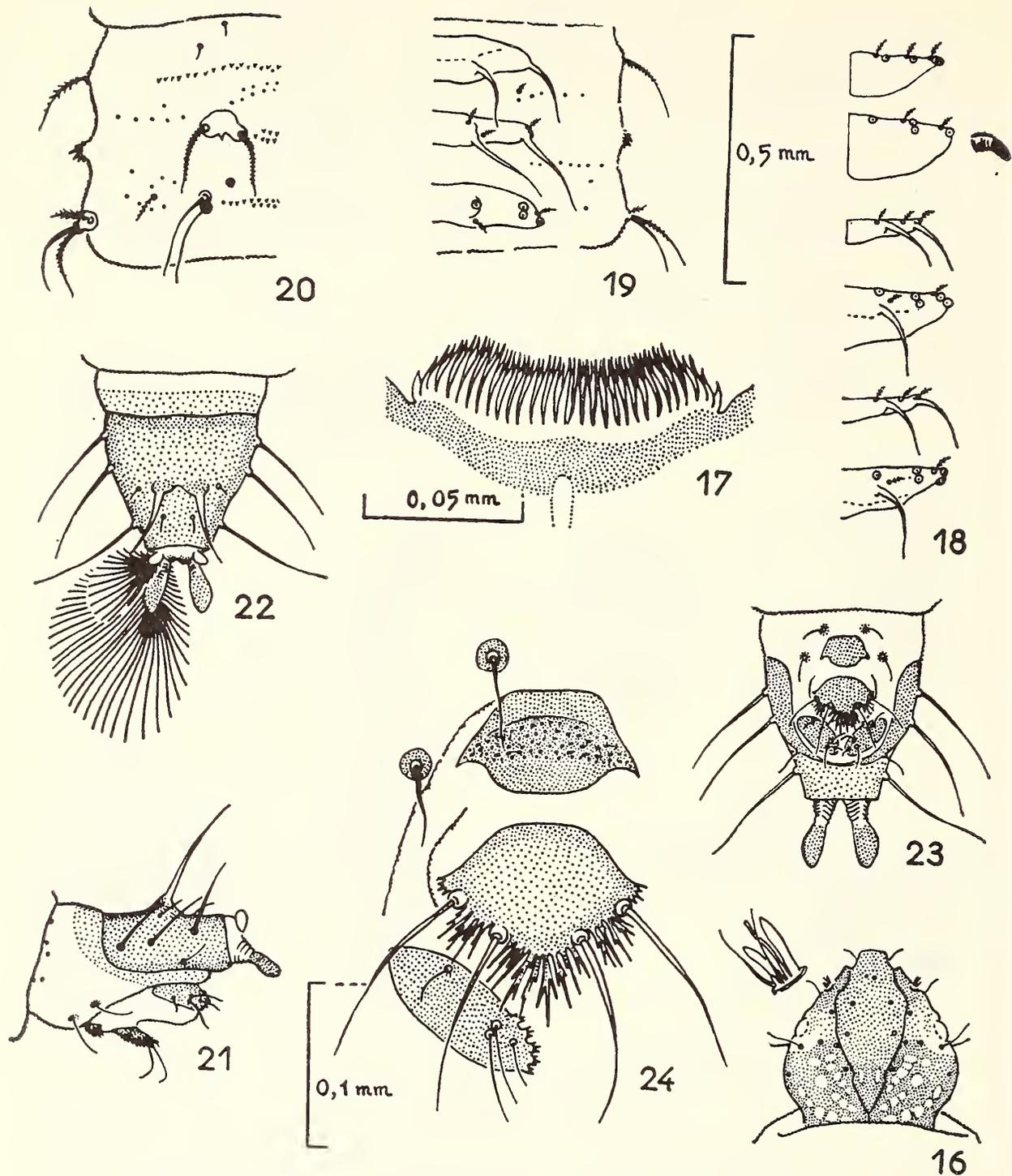


Figure 7: larva of *Pericoma marginalis* (Banks); true, leaf-shaped seta from the left side of the fourth abdominal segment.

Figures 8–15: larva of *Pericoma albitarsis* (Banks). 8: head, dorsal view. 9: hypostomium, ventral view. 10: thoracic tergal plates and right spiracle. 11: fourth abdominal segment, dorsal view. 12: true, leaf-shaped seta from the right side of the fourth abdominal segment. 13: eighth abdominal segment, side view. 14: eighth abdominal segment, dorsal view. 15: plates surrounding the anus slit, outspread.

On figures 10 and 11, tectorial setae of the tergal plates have been omitted on the left side; only the basal ring of each tectorial true seta has been figured; only a bump has been figured at the location of each accessory seta. Leaf-shaped true setae are dotted, leaf-shaped accessory setae are not.

Figures 7 and 12 are on the same scale. So are figures 8, 10, 11, 13, 14 and 15.



Figures 16-24: larva of *Telmatoscopus (Telmatoscopus) species I*. 16: dorsal view of the head, and left antenna enlarged. 17: hypostomium, ventral view. 18: right halves of the thoracic tergal plates and right spiracle. 19: right half of the fourth abdominal segment, dorsal view. 20: right half of the fourth abdominal segment, ventral view. 21: eighth abdominal segment, side view. 22: eighth abdominal segment, dorsal view; the setae of the right flabellar processes have not been figured. 23: eighth abdominal segment, ventral view. 24: plates surrounding the anus slit; the left adanal plate and lateral setae have not been figured.

On figures 18 and 19, tectorial true setae have been omitted; only their basal rings have been figured.

All the figures are on the same scale, save figure 17 and figure 24.

NOTES ON NORTH AMERICAN SPECIES OF NYCTEOLA (LEPIDOPTERA, NOCTUIDAE)

BY D. S. FLETCHER

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Recent revisionary work on the genus *Nycteola* (Hübner 1822) has involved the dissection of a number of Walker types of North America origin; as a result, four species of the *revayana* group have been separated and the existing synonymy modified.

The aedeagi of three of the four species were illustrated by McDunnough (1943, *Canad. Ent.*, 75: 61, figs. 1-3); the aedeagus of the fourth species, *N. scriptana* Walker, and the female genitalia of all four species are figured below. In *scriptana* the medial cornutus varies in the degree of development; this is true also of *cinereana*.

Listed below is the revised synonymy of the North American species of *Nycteola*, together with the localities from which the author has studied material.

Nycteola frigidana (Walker) (Fig. 5)

Tortrix frigidana Walker, 1863, *List Lep. Ins. B.M.*, 28: 323.

Holotype ♂ in B.M.

Tortrix favillana Walker, 1863, *tom. cit.*, p. 334.

Holotype ♂ in B.M.

Subrita latifasciella Walker, 1866, *op. cit.*, 35: 1746, **Syn. nov.**

Holotype ♀ in B.M.

?? *Sarothripus lintnerana* Speyer, 1875, *Stettin. ent. Ztg.*, 36: 170. Type not located in Zool. Mus., Berlin or Albany Mus., New York.

Nycteola frigidana Walker, McDunnough, 1943, *Canad. Ent.*, 75: 61, fig. 1.

Parrsboro, Nova Scotia; St. Martin's Falls (Albany River), Renfrew Co. and Blackburn, Ontario; Red Rock Lake, Manitoba; Franconia, New Hampshire.

Nycteola columbiana (H. Edwards) (Fig. 2)

Sarothripa columbiana H. Edwards, 1874, *Proc. Calif. Acad. Nat. Sci.*, (1) 5: 184. Holotype ♂ in Amer. Mus. Nat. Hist.

Nycteola columbiana H. Edwards, McDunnough, 1943, loc. cit., fig. 2.

Nycteola cinereana Neumoegen & Dyar (Fig. 4)

Nycteola revayana Scopoli var. *cinereana* Neumoegen & Dyar, 1893, J. N. Yk. ent. Soc., 1: 117.

Nycteola cinereana Neumoegen & Dyar, McDunnough, 1943, loc. cit., fig. 3.

Lectotype ♂ with the following data and selected by Dr. E. L. Todd is in the U. S. National Museum in Washington D. C.:—
 “6797 (Out at Yosemite, Aug. 15, 1891 (BB 305) = 5787)”
 “TYPE” “var. cinereana N. & D.” “Collection Dr. H. G. Dyar.” “♂ genitalia on slides Nov. 4, 1957 E.L.T. 724”
 “U.S.N.M. type 64109.”

Red Rock Lake, Manitoba; Baker Co., California; Nevada; Moab, Utah; Tiscaloosa Co. and Glenwood Springs, Colorado.

Nycteola scriptana (Walker) (Figs. 1, 3)

Tortrix scriptana Walker, 1863, List Lep. Ins. B.M., 28: 324.

Holotype ♀ in B.M.

Subrita ?metaspilella Walker, 1866, op. cit., 35: 1746. **Syn. nov.**

Holotype ♀ in B.M.

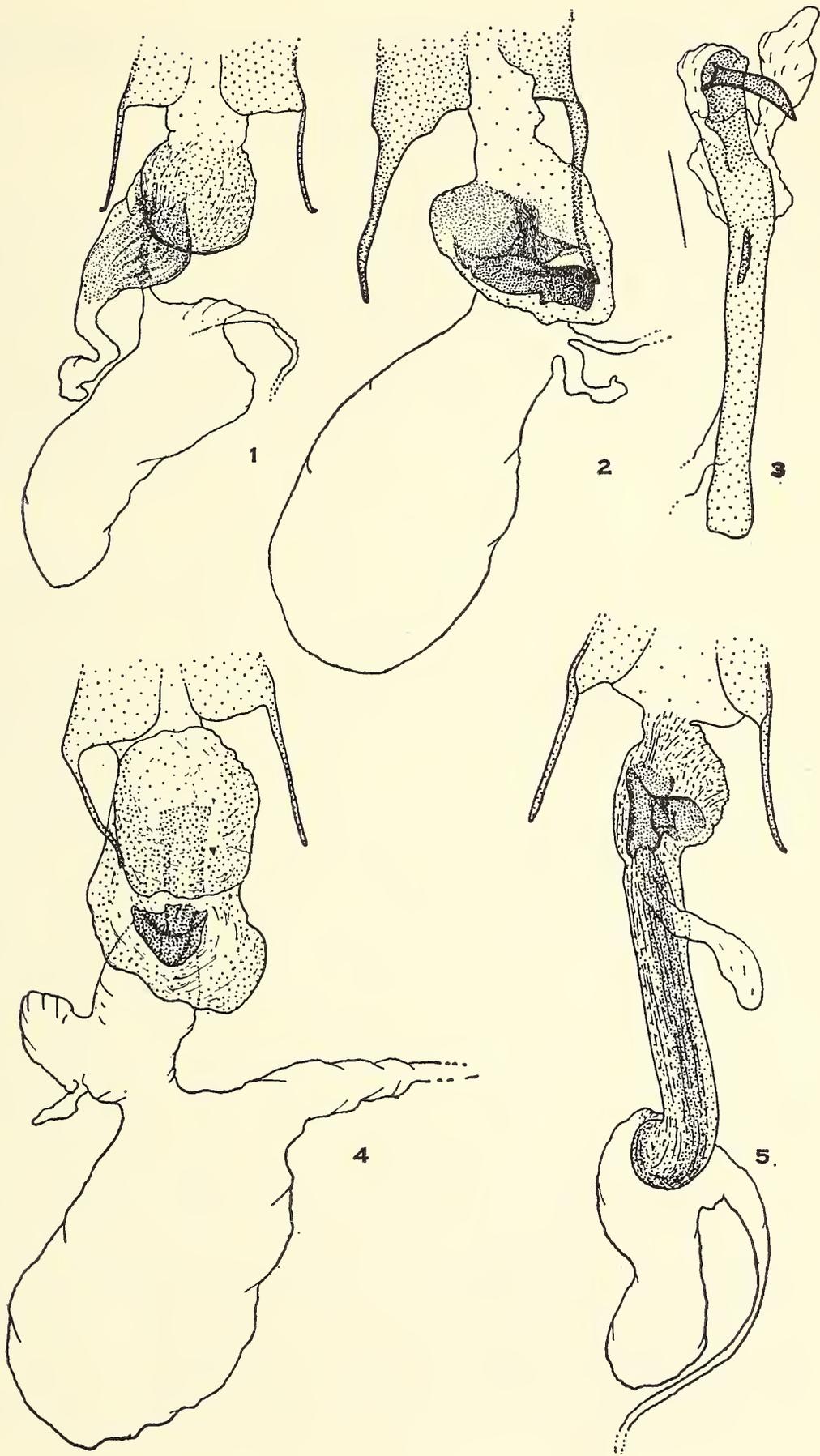
Massachusetts; New York; New Jersey; Ohio; North Carolina; Iowa; Texas.

A fifth species represented in the American Museum of Natural History by five female specimens from Portal in Cochise Co., Arizona and in the British Museum by one female from Santa Monica, California resembles closely *N. cinereana*, differing superficially in the almost uniformly drab hind wing and structurally in the ductus bursae. Until male specimens can be studied, the species is best left unnamed.

Thanks are here offered to Dr. F. Rindge of the American Museum of Natural History and to Dr. E. L. Todd of the U. S. National Museum for their ready help and co-operation.

Explanation of Plate

1. <i>Nycteola scriptana</i> Walker	♀ genitalia × 25
2. <i>N. columbiana</i> H. Edwards	♀ genitalia × 25
3. <i>N. scriptana</i> Walker	aedeagus × 30
4. <i>N. cinereana</i> Neumoegen & Dyar	♀ genitalia × 25
5. <i>N. frigidana</i> Walker	♀ genitalia × 25



A NEW SPECIES OF ODMALEA BERGROTH FROM BRAZIL

BY HERBERT RUCKES¹

The following description is founded on a number of specimens that conform to the requirements set forth by Bergroth for his genus *Odmalea* in 1915, with the exception of the construction of the head which is essentially a counterpart of that found in the genus *Dendrocoris* Bergroth. By this fact the new species might be considered an intermediate between these two genera but should be placed closer to *Odmalea* since more characteristics of that genus are evident.

Odmalea olivacea, new species

Small, about the size of *Dendrocoris humeralis* Uhler, with about the same degree of convexity as that species. Over-all appearance, above olivaceous, produced by a stramineous background overlain with medium green from the transhumeral area backward and with ferruginous to fuscous punctures, moderately fine and rather regularly and closely spaced, the coarsest ones on the pronotum; below stramineous centrally, olivaceous laterally, the punctures concolorous with the background. Head and anterior two-thirds of the pronotum rather declivous.

Head five-sixths of the medial length of the pronotum (50 × 60), disc more or less flattish, irregularly and feebly rugose; punctures for the most part concolorous, those toward the apical portions of the juga, fuscous; margins before the eyes abruptly sinuate, then parallel to a broadly rounded apex with a minute central V-shaped apical sinus there, the extreme edge of the juga narrowly fuscous; juga longer than the tylus and contiguous anteriorly; head slightly wider through the eyes than long medially (55 × 50); ocelli large and three times as far apart as each is from its eye; antennae short, not reaching the base of the pronotum, fulvous basally, then darkening apically; segmental ratios: 10/13/15/20/27, i.e., segments II and III subequal, II about half of the length of V which is fusiform.

Pronotum moderately excavated anteriorly to receive the head up to the eyes, margins behind the eyes truncate; disc about two and two-thirds as wide across the humeral angles as long medially (160 × 60); humeri produced into short, stout, acute conical processes, directed obliquely forward with the stubby acute apical angles directed laterally; anterolateral margins essentially straight before the antehumeral sinuses, coarsely denticulate

¹ Research Associate, Department of Insects and Spiders, the American Museum of Natural History, and Professor Emeritus, the City College of New York.

with three or four small subconical teeth; posterior margin very feebly bisinuate and as wide as the base of the scutellum; posterolateral margins each about one-third of the length of the posterior margin; disc somewhat transversely rugose before the transhumeral diameter, there ferruginous punctate on a stramineous background; smooth behind the transhumeral diameter and there tinted green with fuscous punctures; posterior margin of each humerus provided with a short piceous stripe.

Scutellum very slightly longer than wide at the base (105×100), the frenum ending about one-third of the distance from the base, the lateral margins from there onward gradually converging to a moderately rounded apex; disc stramineous and transversely rugose at the base, olivaceous apically and smoother there; punctures ferruginous, darkening somewhat apically and more widely spaced than those on the pronotum; an inconspicuous fuscous to piceous dash-like mark on each margin at the point where the frenum ends. Hemelytra olivaceous, punctures ferruginous becoming fuscous laterally, the coriaceous portion not quite reaching the apex of the scutellum, the external apical angle obtusely rounded; membrane hyaline with concolorous veins, just reaching the abdominal apex in the female and slightly exceeding it in the male. Connexivum moderately exposed, concolorous olivaceous. Apical segmental angles roundly rectilinear, not produced, and narrowly piceous.

Venter stramineous, somewhat pale greenish laterally. Head and pronotum provided with a longitudinal, piceous, submarginal stripe in line with the eyes. Punctures for the most part concolorous with the background, densest and coarsest on the thoracic pleura and more restricted to the broad lateral portions of the abdomen; a small piceous spot on the lateral apical angle of each mesopleuron. Rostrum reaching between the meso- and meta-coxae, the segmental ratios as given by Bergroth for the genus. Legs stramineous, the femora and tibiae sparsely stippled with small fuscous spots, the dorsal apical spine on the femora fuscous to piceous and minutely triangular, tarsi and apices of tibiae fulvous. Spine of second abdominal segment stout and reaching almost to the mesocoxae. Each spiracle broadly surrounded by a subcalloused, ivory ring. Apical angles of the abdominal segments with a triangular piceous patch.

Male genital segment subglobular; posterior-ventral face deeply impressed, the medial area produced, leaving the apical margins protruding as if pinched together (somewhat as in *Dendrocoris*, but more pronounced than there), the margins converging dorsally so that the hiatus between them is subpyriform in outline; dorsal-posterior face of segment lying at right angles to the posterior-ventral with a triangular hiatus between the mesal margins; parameres (claspers) styliform at their bases, then dilating to stubby, bi-lobed heads which are fuscous; visible surface of the proctiger evenly convex. Basal plates of the female valves withdrawn into the body and obscured by the sixth abdominal sternite; apical plates visible, these stout and acutely angled at their apices.

Described from seven specimens.

Holotype: Male: 5.5 mm. long; 4.0 mm. across the humeral

angles; Rio Vermelho, Santa Catarina, Brazil, November, 1945. A. Maller, collector, Frank Johnson, donor. Deposited in the American Museum of Natural History.

Allotype: Female: 6.7 mm. long; 4.4 mm. wide across the humeral angles; Pinhal, Santa Catarina, Brazil; December, 1947. A. Maller, collector, Frank Johnson, donor. Deposited in the American Museum of Natural History.

Paratypes: Males (4): Cauna, Santa Catarina, Brazil; December, 1945 (2); Pinhal, Santa Catarina, Brazil, December, 1947 (2). Female (1): Pinhal, Santa Catarina, Brazil; December, 1947. All deposited in the American Museum of Natural History.

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VOL. LXVII

JUNE, 1959

No. 2

AN ANNOTATED LIST OF THE LYCAENIDAE (LEPIDOPTERA, RHOPALOCERA) OF THE WESTERN HEMISPHERE

BY WILLIAM PHILLIPS COMSTOCK AND EDGAR IRVING HUNTINGTON

[CONTINUED FROM VOL. LXVI, P. 118]

PART II: SPECIES

abnormis Clench, Harry K., *Thecla acaste* form

Type Locality: La Rioja, Argentina.

Location of Type: British Museum (Natural History).

Original Description: 1946 (August), *Entomologist*, vol. 79, p. 189.

acadica Edwards, William H., *Thecla*

Type Locality: London, Ontario.

Location of Type:

Original Description: 1862 (February), *Proc. Acad. Nat. Sci. Philadelphia*, p. 55 (Philadelphia, Pa.).

Synonym: *muskoka* Watson and Comstock.

Subspecies: *coolinensis* Watson and Comstock, *montanensis* Watson and Comstock, *watrini* Dufrane, *souhegan* Whitney.

acameda Hewitson, W. C., *Thecla*

Type Locality: Amazon (Pará).

Location of Type: British Museum (Natural History).

Original Description: 1867, *Illus. of Diurnal Lepidoptera*, vol. 1, p. 101, vol. 2, pl. 41, figs. 151, 152 ♂ (London).

Synonym: *paulina* Draudt.

acaste Prittwitz, O. V., *Thecla*

Type Locality: Corcovado, Rio de Janeiro, Brazil.

Location of Type:

Original Description: 1865, *Stettin Ent. Zeit.*, vol. 26, p. 318 (Stettin).

Additional Reference: Clench, H. K., 1944 (July), *Bull. Mus. Comp. Zool.*, vol. 94, p. 241 (Cambridge, Mass.).

Synonym: *lycimna* Hewitson.

Subspecies: *abnormis* Clench.

acastoides Berg, Carlos, *Thecla*

Type Locality: Argentina.

Location of Type:

Original Description: 1882, Ann. de la Soc. Científica Argentina, p. 169 (Buenos Aires).

acis Drury, Dru, *Papilio*

Type Locality: "New York . . . 31st August."

Location of Type:

Original Description: 1770, Illus. of Natural History, vol. 1, p. 2, pl. 1, fig. 2 (London).

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 62 (New York). (Discuss localities.)

Subspecies: *mars* Fabricius, *armouri* Clench, *bartrami* Comstock and Huntington, *casasi* Comstock and Huntington, *gossei* Comstock and Huntington, *petioni* Comstock and Huntington.

acmenis Morris, John G., *Thecla* ? (not Hübner)

Type Locality: North America.

Location of Type:

Original Description: 1860 (May), Catalogue of the Described Lepidoptera of North America, p. 12 (Washington, D. C.).

Note: This is a misidentification of *Megisto acmenis* Hübner in Satyridae.

acmon Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1775, Papillons exotique des trois parties du monde, vol. 1, p. 81, pl. 51, figs. C, D (Amsterdam).

Additional Reference: Godman, F. D. and Osbert Salvin, 1887, Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 17. (Make *acmon* a synonym of *hemon* Cramer.)

acmon Westwood, John Obadiah, *Lycaena*

Type Locality: California.

Location of Type: British Museum (Natural History).

Original Description: 1852, Genera of Diurnal Lepidoptera, vol. 2, p. 494, pl. 76, fig. 2 (London).

Synonyms: *antaegon* Boisduval, *kelseyi* Wright.

Subspecies: *cottlei* Grinnell, *labecula* Watson and Comstock, *lutzi* dos Passos.

acontius Goodson, F. W., *Thecla*

Type Locality: "1 ♂. Nouvelle Grenada Etat Cundinamarca, Canancha (M. de Mathan), 1st Sem., 1900. ex. Oberthür Coll., 2 ♂ Colombia, Env. Bogota (Frère Apollinaire-Marie), 1918."

Location of Type: British Museum (Natural History).

Original Description: 1945 (December), Entomologist, vol. 78, p. 184 (London).

actaegon Morris, John G. *Lycaena* ? (not Boisduval)

Type Locality: California.

Location of Type:

Original Description: 1860 (May), Catalogue of the Described Lepidoptera of North America, p. 12 (Washington, D. C.).

Note: Misspelling of *antaegon* Boisduval.

actaeon Fabricius, Johann Christian

Type Locality:

Location of Type:

Original Description: 1775, Entomologica Systematica, appendix p. 829 (Flensburgi).

adamsi Druce, Hamilton H., *Thecla*

Type Locality: Pichis Road, Peru, 3,000 ft.

Location of Type: H. J. Adams Collection.

Original Description: 1909 (September), Trans. Ent. Soc. London, p. 432, pl. 11, fig. ♂ 2 (London).

adela Staudinger, Otto, *Thecla*

Type Locality: Amazon, Pará to Jurimaguas.

Location of Type: Staudinger Collection.

Original Description: 1888, Exotische Tagfalter, vol. 1, p. 287, vol. 2, pl. 97 ♂ (Bayern).

adenostoma Scudder, Samuel H., *Thecla* (not Henry Edwards)

Type Locality:

Location of Type:

Original Description: 1876 (May), Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 111 (Buffalo, N. Y.).

Note: Misspelling of *adenostomatis* Henry Edwards.

adenostomatis Edwards, Henry, *Thecla*

Type Locality: Tehachepi Pass, Southern California, July, 1875.

Location of Type: The American Museum of Natural History.

Original Description: 1877, Proc. Calif. Acad. Sci., vol. 7, p. 144 (San Francisco, California).

adria Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1873 (February), Illus. of Diurnal Lepidoptera, vol. 1, p. 142, vol. 2, pl. 56, figs. ♂ 345, 346 (London).

Additional Reference: Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 620 (London). (Makes *adria* a synonym of *megacles* Cramer.)

Note: We doubt this.

adrienne Maynard, Charles J., *Chrysophanus hypophlaeas*

Type Locality: Eastern Massachusetts.

Location of Type:

Original Description: 1891, Manual of North American Butterflies, p. 153 (Boston, Mass.).

Note: An aberration of *hypophlaeas* Boisduval.

adunca Draudt, Max, *Thecla*

Type Locality: Monte Tolima, Colombia, 3,200 meters.

Location of Type: Fassl Collection, now in Naturhistorisches Museum, Basle.

Original Description: 1919, The Macrolepidoptera of the World, vol. 5, p. 759, pl. 153-g (underside ♀) (Stuttgart).

aegides Felder, Cajetan and Rudolf Felder, *Pseudolycaena*

Type Locality: Venezuela and New Granada, Bogotá.

Location of Type:

Original Description: 1864-1867, Reise der Osterreichischen Fregatte "Novara" um die Erde, vol. 2, p. 246, pl. 31, figs. 3, 4 (Wien).

Subspecies: *amplitudo* Druce, *furina* Godman and Salvin.

aeaja Behr, Hermann, *Lycaena*

Type Locality: Alpine regions, headwaters Tuolumne River, California.

Location of Type:

Original Description: 1867 (January), Proc. Calif. Acad. Nat. Sci., vol. 3, p. 280 (San Francisco, California).

Additional Reference: McDunnough, J. H., 1938, Check list, part 1, p. 27, no. 453 (Los Angeles, California). (Places *aeaja* Behr as an altitude form of *saepiolus* Boisduval.)

aeolus Fabricius, Johann Christian, *Papilio*

Type Locality: "In Indiis".

Location of Type:

Original Description: 1775, Entomologica Systematica, p. 522 (Flensburgi).

Additional Reference: Kirby, W. F., 1871, A Synonymic Catalogue of Diurnal Lepidoptera, p. 389, no. 154 (London). (Places *aeolus* as a synonym of *pelion* Cramer.)

aepea Hewitson, W. C., *Thecla*

Type Locality: Ecuador.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, p. 165, pl. 65, figs. ♀ 457, 458 (London).

aepeona Draudt, Max, *Thecla*

Type Locality: Peru, Colombia.

Location of Type:

Original Description: 1920 (February), The Macrolepidoptera of the World, vol. 5, p. 793, pl. 157-h (Stuttgart).

aethesa Hewitson, W. C., *Thecla*

Type Locality: Bahia.

Location of Type: British Museum (Natural History).

Original Description: 1867, *Illus. of Diurnal Lepidoptera*, vol. 1, p. 86, vol. 2, pl. 33, fig. ♀ 57 (London).

aethesa Hewitson, W. C., *Thecla*

Type Locality: Bolivia.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 172, vol. 2, pl. 68, figs. ♀ 493, 494 (London).

Note: Hewitson, *ibid.*, makes *aethesa* (homonym) a synonym of *theia*.

aetolus Sulzer, Johann Heinrich, *Papilio*

Type Locality: "Cape of Good Hope".

Location of Type:

Original Description: 1776, *Abgekürzte Geschichte der Insecten*, vol. 1, p. 147, vol. 2, pl. 19, figs. 10, 11 (Winterthur).

Additional References: Cramer, Pierre, 1781, *Papillons exotiques des trois parties du monde*, vol. 4, p. 97, pl. 340, figs. F, G, H (Amsterdam). (Corrects locality to Surinam.) Hübner, Jacob, 1807, *Sammlung exotischer Schmettlinge*, vol. 1, pl. (102) (Augsburg).

Synonyms: *linus* Fabricius, *lincus* Fabricius, *amelia* Herbst.

Subspecies: *paraguayensis* Lathy, *separata* Lathy.

affinis Edwards, William H., *Thecla*

Type Locality: Utah.

Location of Type:

Original Description: 1862 (April), *Proc. Acad. Nat. Sci. Philadelphia*, p. 223 (Philadelphia, Pa.).

Subspecies: *washingtonia* Clench.

afra Edwards, William H., *Lycaena*

Type Locality: Deer River Country.

Location of Type:

Original Description: 1883 (November), *Can. Ent.*, vol. 15, p. 211 (London, Ontario).

Additional Reference: McDunnough, J. H., 1938, Check list, part 1, p. 28, no. 473-a (Los Angeles, California). (Places (♀) *afra* as a synonym of *couperi* Grote.)

aganippe Goodson, F. W., *Thecla*

Type Locality: Santa Catherina (♂), Leopoldina (♀), Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1945 (November), *Entomologist*, vol. 78, p. 170 (London).

agis Drury, Dru, *Papilio*

Type Locality: Brazil.

Location of Type:

Original Description: 1872. *Illus. of Natural History*, vol. 3, p. 34, pl. 26, figs. 3, 4 (London).

Additional Reference: Kirby, W. F., 1871, A Synonymic Catalogue of Diurnal Lepidoptera, p. 384 (London). (Makes *agis* a synonym of *phaleros* Linnaeus.)

agra Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1868, Specimen of a Catalogue of Lycaenidae in the British Museum, p. 30 (London).

Additional References: Hewitson, W. C., 1873 (February), Illus. of Diurnal Lepidoptera, vol. 1, p. 147, vol. 2, pl. 58, figs. 369, 370 ♂ (London). Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 88 (New York). (Made *agra* synonym of *bazochii* Godart.)

agricolor Butler, A. G. and Herbert Druce, *Strymon*

Type Locality: Cartago, Costa Rica.

Location of Type: British Museum (Natural History).

Original Description: 1872 (July), Cist. Ent., vol. 1, p. 105 (London).

Additional References: Butler, A. G., 1873 (October), Lepidoptera Exot., p. 158, pl. 57, fig. 4 ♂ (London). Godman, F. D. and O. Salvin, 1887 (May), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 34, vol. 3, pl. 52, figs. 11, 12 ♂ (London).

Subspecies: *bañosensis* Clench.

agrippa Fabricius. Johann Christian, *Hesperia*

Type Locality: "In America".

Location of Type:

Original Description: 1793, Entomologica Systematica, vol. 3, pt. 1, p. 259 (Hafniae).

Additional References: Butler, A. G., 1870, Catalogue of Diurnal Lepidoptera Described by Fabricius in the Collection of the British Museum, p. 187 (London). (Determined specimens from Pará, Brazil presumably from Jones' drawings.) Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 568 (London). (Mentions specimens determined by A. G. Butler labelled Honduras in British Museum.)

Note: There are no means of determining this species except by examination of Jones' figures.)

aguaca Draudt, Max, *Thecla*

Type Locality: Río Aguaca Valley, Colombia.

Location of Type:

Original Description: 1920 (February), The Macrolepidoptera of the World, vol. 5, p. 799, pl. 158-f (underside) (Stuttgart).

ahola Hewitson, W. C., *Thecla*

Type Locality: Mexico and New Granada.

Location of Type: British Museum (Natural History).

Original Description: 1867, *Illus. of Diurnal Lepidoptera*, vol. 1, p. 82, vol. 2, pl. 35, figs. 73, 74 ♂ (London).

Synonym: *cordelia* Hewitson.

aholiba Hewitson, W. C., *Thecla*

Type Locality: New Granada.

Location of Type: British Museum (Natural History).

Original Description: 1867, *Illus. of Diurnal Lepidoptera*, vol. 1, p. 82, vol. 2, pl. 35, figs. 76, 77 ♂ (London).

Synonyms: *artides* Schaus, *aratus* Schaus.

aibonito Comstock, W. P. and E. I. Huntington, *Thecla celida*

Type Locality: Aibonito, Puerto Rico, July 14-17, 1914.

Location of Type: The American Museum of Natural History.

Original Description: 1943 (December), *Ann. New York Acad. Sci.*, vol. 45, p. 76 (New York).

Additional Reference: Comstock, W. P., 1944 (October), *Sci. Survey Puerto Rico and Virgin Islands*, vol. 12, pt. 4, p. 489, pl. 9, figs. 2, 3 ♂ (New York).

alaskensis Chermock, F. H., *Plebeius scudderi*

Type Locality: Fort Yukon, Alaska, June 27, 1916.

Location of Type: Author's collection.

Original Description: 1944 (November), *Can. Ent.*, vol. 76, p. 213 (Guelph, Ontario).

alatus Druce, Hamilton, H., *Thecla*

Type Locality: Cajamarca, North Peru, 11,500 ft.

Location of Type: British Museum (Natural History), (Godman Collection).

Original Description: 1907 (June), *Proc. Zool. Soc. London*, p. 579 (London).

Additional Reference: Druce, H. H., 1909 (September), *Trans. Ent. Soc. London*, p. 434, pl. 11, fig. 13 ♂ (London).

albata Felder, Cajetan and Rudolf Felder, *Thecla*

Type Locality: Venezuela and New Granada, Bogotá.

Location of Type:

Original Description: 1864-1867, *Reise der Osterreichischen Fregatte "Novara" um die Erde*, vol. 2, p. 261, pl. 32, figs. 17, 18 ♀ (Wien).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (September), *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 2, p. 94 (London). (Say that Felder's types came from Venezuela and give localities of Panamá City, Taboga Island and Colombia.)

albineata Lathy, Percy I., *Thecla*

Type Locality: Rio Aquatal.

Location of Type: Fournier Collection (Paris).

Original Description: 1936, *Livre jubilaire de M. Eugene-Louis Bouvier*, p. 230, pl. 8, fig. 5 (Paris).

albrighti Clench, Harry K., *Everes comyntas* subsp.

Type Locality: Kings Hill, Montana, July 9, 1939.

Location of Type: Museum of Comparative Zoology, Cambridge, Massachusetts.

Original Description: 1944 (March), Jour. New York Ent. Soc., vol. 52, p. 60 (Lancaster, Pa.)

alce Edwards, William H., *Lycaena*

Type Locality: Colorado (♂)

Location of Type:

Original Description: 1871 (March), Trans. Amer. Ent. Soc., vol. 3, p. 272 (Philadelphia, Pa.)

Additional References: McDunnough, J. H., 1938, Check list, pt. 1, p. 27, no. 446 (Los Angeles, Calif.). (Places *alce* as a synonym of *isola* Reakirt.) Field, W. D., 1942 (January), Jour. Kansas Ent. Soc., vol. 15, no. 1, p. 36. (Maintains *alce* is a subspecies.)

alcestis Edwards, William H., *Thecla*

Type Locality: Dallas, Texas (♀).

Location of Type:

Original Description: 1871 (March), Trans. Amer. Ent. Soc., vol. 3, p. 271 (Philadelphia, Pa.).

Subspecies: *oslari* Dyar.

alda Hewitson, W. C., *Thecla*

Type Locality. Amazon (Pará).

Location of Type: British Museum (Natural History).

Original Description: 1868, Specimen of a Catalogue of Lycaenidae in the British Museum, p. 25 (London).

Additional Reference: Hewitson, W. C., 1873 (February), Illus. of Diurnal Lepidoptera, vol. 1, p. 144, vol. 2, pl. 57, figs. 355, 356 ♂ (London).

alea Godman, F. D. and O. Salvin, *Thecla*

Type Locality: Tres Marias Islands, Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1887 (September), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 95, vol. 3, pl. 58, figs. 10, 11 ♂ (London).

Note: Near *avalona* Wright.

alihoba Staudinger, Otto, *Thecla*

Type Locality: Cocapata, Bolivia.

Location of Type:

Original Description: 1894, Deutsche Ent. Zeit. (Iris), vol. 7, p. 81 (Dresden).

aliparops Michener, Charles D. and Cyril F. dos Passos, *Strymon strigosus*

Type Locality. Glenwood Springs, Colorado, July.

Location of Type: The American Museum of Natural History.

Original Description: 1942 (November), Amer. Mus. Novitates, no. 1210, p. 3 (New York, New York).

alticola Dyar, Harrison, *Lycaena* (not Godman and Salvin ?)

Type Locality: Cantas, Peru, 2,000 ft., Nov., 1911; Coropuna, Peru, 14,500 ft., Oct., 1911.

Location of Type: United States National Museum.

Original Description: 1913, Proc. U. S. Natl. Mus., vol. 45, p. 638 (Washington, D. C.).

Note: We have been unable to find a description of this species by Godman and Salvin. Dyar's name is nomen nudum.

amatista Dognin, Paul, *Thecla*

Type Locality: Loja and El Monje, Ecuador.

Location of Type:

Original Description: 1895, Ann. Soc. Ent. Belgique, vol. 39, p. 106 (Bruxelles).

ambrax, Westwood, John Obadiah, *Thecla*

Type Locality: Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1852, Genera of Diurnal Lepidoptera, vol. 2, p. 485, pl. 75, fig. 7 (London). (Figure only.)

Additional Reference: Godman, F. D. and O. Salvin, 1887 (August), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 57, vol. 3, pl. 55, figs. 5, 6 ♂ (London).

Subspecies: *septentrionalis* Lathy.

amelia Herbst, Johann Friedrich Wilhelm, *Papilio*

Type Locality:

Location of Type:

Original Description: 1804, Natursystem aller bekannten in und ausländischen Insekten, vol. 11, p. ?, pl. 300, figs. 3, 4 (Berlin).

Note: The name *amelia* Herbst is a synonym of *aetolus* Sulzer.

americana D'Urban, W. S. M., *Lycaena* (not Harris) See *americana* Harris

Type Locality: River Rouge Valley, Canada, Aug.

Location of Type:

Original Description: 1860 (April), Canadian Nat. and Geol., vol. 5, p. 91 (Montreal, Canada). (Nomen nudum.)

Additional Reference: D'Urban, W. S. M., 1860 (August), Canadian Nat. and Geol., vol. 5, p. 246 (Montreal, Canada). Nomen nudum. (Placed in genus *Chrysophanus*.)

americana Harris, Thaddeus William, *Lycaena*

Type Locality: Massachusetts.

Location of Type:

Original Description: 1862, Insects Injurious to Vegetation, 3rd Edition (Flint), p. 273, fig. 104 (Boston, Mass.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 26, no. 245 (Los Angeles, Calif.). (Places *americana* in synonymy of *hypophlaeas* Boisduval.)

americensis Blanchard, E., *Thecla*

Type Locality: Coquimbo, Chile.

Location of Type:

Original Description: 1852, Historia Física y Política de Chile, Zoologica, vol. 7, p. 38 (Paris), (Gay's Fauna of Chile).

Additional Reference: Hewitson, W. C., 1877, Illus. of Diurnal Lepidoptera, vol. 1, p. 207, pl. 83, figs. 693, 694 (London). Subspecies: *tucumana* Druce.

amethystina Hayward, Kenneth, J., *Thecla*

Type Locality: Villa Nougues, Tucumán, Argentina; January 21, 1921, January, 1929.

Location of Type: Fundación Miguel Lillo, Tucumán. (Several specimens in the British Museum (Natural History).)

Original Description: 1949, Acta Zool. Lilloana, vol. 8, p. 567, pl., fig. 3 (Tucuman, Argentina).

amica Edwards, William H., *Lycaena*

Type Locality: Mackenzie River, Canada.

Location of Type:

Original Description: 1863 (July), Proc. Ent. Soc. Phila., vol. 2, p. 80 (Philadelphia, Pa.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 27, no. 453 (Los Angeles, Calif.). (Places *amica* as a subspecies of *saepiolus* Boisduval.)

amicetus Doubleday, Edward, *Polyommatus* (Boisduval MS) Nomen nudum

Type Locality: Newfoundland.

Location of Type: British Museum (Natural History).

Original Description: 1847, List of the specimens of lepidopterous insects in the collection of the British Museum, pt. 2, p. 55 (London).

Additional References: Scudder, Samuel H., 1876 (May), Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 128 (Buffalo, N. Y.). (Places *amicetus* as a synonym of *epixanthe* Boisduval and LeConte.) Klots, A. B., 1936 (October), Bull. Brooklyn Ent. Soc., vol. 31, p. 166 (Brooklyn, N. Y.). (Endeavored to resurrect the name *amicetus* but failed to recognize that it was a nomen nudum.)

ammon Lucas, P. H., *Lycaena*

Type Locality: Havana, Cuba. "Also from Yucatan".

Location of Type:

Original Description: 1857, in Sagra, Historie physique, politique et naturelle de l'île de Cuba, vol. 7, p. 612, pl. 16, figs. 7 ♂, 7a ♀, 7b (Paris).

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 95, pl. 1, fig. 22 ♂ (New York, N. Y.).

Subspecies: *thomasi* Clench, *bethune-bakeri* Comstock and Huntington, *noëli* Comstock and Huntington, *woodruffi* Comstock and Huntington.

amphrade Schaus, William, *Thecla*

Type Locality: Guapiles, Costa Rica.

Location of Type: British Museum (Natural History).

Original Description: 1913 (September), Proc. Zool. Soc. London, p. 355, pl. 52, fig. 10 ♀ (London).

Synonyms: *posetta* Dyar.

ampia Hewitson, W. C., *Thecla*

Type Locality: Nicaragua (Chontales).

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 195, vol. 2, pl. 77, figs. 621, 622 (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (September), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 75, vol. 3, pl. 57, figs. 7 ♂, 8 (London).

amplitudo Druce, Hamilton H., *Thecla*

Type Locality: St. Jago, Ecuador.

Location of Type: Godman Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 575, pl. 32, fig. 6 ♂ (London).

Additional Reference: Draudt, Max, 1919, The Macrolepidoptera of the World, vol. 5, p. 753, pl. 149-b (Stuttgart). (Calls *amplitudo* a form of *aegides* Felder and Felder.)

amplus Druce, Hamilton H., *Thecla*

Type Locality: Cucuta, Venezuela.

Location of Type: Druce Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 582, pl. 33, fig. 13 ♂ (London).

amyntor Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1775, Papillons exotiques des trois parties du monde, vol. 1, p. 76, pl. 48, fig. E (Amsterdam).

Synonyms: *menalcas* Cramer.

Subspecies: *distractus* Clench.

amyntula Boisduval, Jean A., *Lycaena*

Type Locality: California.

Location of Type: United States National Museum?

Original Description: 1852, Ann. Soc. Ent. France, Series 2, vol. 10, p. 294 (Paris).

Additional Reference: Oberthür, Charles, 1913 (October), Etudes de Lepidopterologie Comparee, fasc. 9, pt. 1, p. 41, pl. 237, fig. 1938 ♂ (Rennes).

Synonyms: *dodgei* Gunder.

anacreon Fabricius, Johann Christian, *Hesperia*

Type Locality: "In India".

Location of Type: Lost (H. H. Druce).

Original Description: 1793, *Entomologica Systematica*, vol. 3, pt. 1, p. 268 (Hafniae).

Additional Reference: Druce, H. H., 1907, *Proc. Zool. Soc. London*, p. 568 (London).

Note: Neither Butler nor Druce recognized *anacreon*, but it might be determined from Jones' drawings.

anastomosis Draudt, Max, *Thecla mecrida* form

Type Locality: Guiana to the Amazon.

Location of Type:

Original Description: 1919 (December), *The Macrolepidoptera of the World*, vol. 5, p. 766, pl. 151-b (underside), (Stuttgart).

ancilla Barnes, William and James H. McDunnough, *Philotes enoptes*

Type Locality: Eureka, Utah, July 1-7.

Location of Type: United States National Museum.

Original Description: 1918, *Contributions to the natural history of the Lepidoptera of North America*, vol. 4, no. 2, p. 79 (Decatur, Illinois).

Additional Reference: Barnes, W. and J. H. McDunnough, 1916, *Contributions to the natural history of the Lepidoptera of North America*, vol. 3, no. 2, pl. 11, figs. 2, 5 (as *glaucon*), (Decatur, Illinois).

andicola Godman, Frederick D. and Osbert Salvin, *Lycaena*

Type Locality: Guallabamba (7,500 ft.); Quito (9,400 ft.); Cayambe to Otovalo (9,500 ft.); Machachi (9,800 ft.); Cotocachi (12,000 ft.). 10 examples.

Location of Type: British Museum (Natural History)?

Original Description: 1891, *Supplementary Appendix to Travels Amongst the Great Andes of the Equator*, by Edward Whymper, p. 104 (London).

Note: Has a lectotype been selected?

anfracta Druce, Hamilton H., *Thecla*

Type Locality: Chanchamayo, Peru.

Location of Type: Godman Collection.

Original Description: 1907 (June), *Proc. Zool. Soc. London*, p. 609 (London).

Additional Reference: Draudt, Max, 1920 (February), *The Macrolepidoptera of the World*, vol. 5, p. 794 (Stuttgart). (Considers *anfracta* a subspecies of *vitruvia* Hewitson.)

angelia Hewitson, W. C., *Thecla*

Type Locality: Cuba and Jamaica.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 162, vol. 2, pl. 63, figs. 439 ♂, 440 (London).

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (De-

ember), Ann. New York Acad. Sci., vol. 45, p. 68 (New York, N. Y.).
(Accept fig. 439 as type of *angelia* from Cuba.)

Subspecies: *dowi* Clench, *boyeri* Comstock and Huntington, *pantoni* Comstock and Huntington.

angelus Gunder, Jean D., *Plebeius acmon* tr. f.

Type Locality: Los Angeles, California, June 10, 1920.

Location of Type:

Original Description: 1929 (December), Bull. Brooklyn Ent. Soc., vol. 24, p. 326, pl. 31, fig. 4 (Brooklyn, N. Y.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 28, no. 461 (Los Angeles, Calif.). (Places *angelus* as an aberration for *monticola* Clémence.)

angerona Godman, F. D. and O. Salvin, *Thecla*

Type Locality: St. Vincent, Grenadines and Grenada.

Location of Type: British Museum (Natural History).

Original Description: 1896, Proc. Zool. Soc. London, p. 516 (London).

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 76 (New York, N. Y.).

Synonyms: *burdi* Kaye.

angusta Lathy, Percy I., *Thecla*

Type Locality: Paraguay (1 ♀).

Location of Type: Fournier Collection (Paris).

Original Description: 1936, Livre jubilaire de M. Eugene-Louis Bouvier, p. 232, pl. 8, fig. 17 (Paris).

Note: Resembles *T. picentia* Hewitson on upperside.

anina Druce, Hamilton H., *Thecla* (Mispelling of *aunia* Hewitson)

Type Locality:

Location of Type:

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 603 (London).

Note: Druce's name *anina* is, obviously, a typographical error for *aunia* Hewitson. The name *anina* should be listed in the synonymy of *orcynia* Hewitson.

anna Edwards, William H., *Lycaena*

Type Locality: California.

Location of Type:

Original Description: 1861 (July), Proc. Acad. Nat. Sci. Philadelphia, p. 163 (Philadelphia, Pa.).

Synonyms: *argyrotoæus* Behr, *cajona* Reakirt, *philemon* Boisduval, *ricei* Cross.

anna Druce, Hamilton H., *Thecla*

Type Locality: Interior of Colombia.

Location of Type: Godman Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 577, pl. 33, fig. 2 ♂ (London).

annetta Edwards, William H., *Lycaena*

Type Locality: Salt Lake, Utah, 1878.

Location of Type:

Original Description: 1882 (March), Papilio, vol. 2, p. 48, (New York, N. Y.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 27, no. 449 (Los Angeles, California). (Places *annetta* as a subspecies of *scudderi* Edwards.)

annettae dos Passos, Cyril F., *Incisalia iroides*

Type Locality: New Mexico, April 13, 1937.

Location of Type: The American Museum of Natural History.

Original Description: 1943 (June), Amer. Mus. Novitates, no. 1230, p. 3 (New York, N. Y.).

annulatus Gmelin, Johann Friederich *Papilio*

Type Locality:

Location of Type:

Original Description: Caroli a Linné, 1788, Syst. Nat., 13th ed., p. 2359, no. 896 (Leipsig.)

Additional Reference: Draudt, Max, 1920 (January), The Macrolepidoptera of the World, vol. 5, p. 769 (Stuttgart). Makes *annulatus* a synonym of *cupentus* Cramer.)

anosma Draudt, Max, *Thecla*

Type Locality: Bogotá, Colombia, 3,000 meters.

Location of Type: Fassel Collection, now in Naturhistorisches Museum, Basle.

Original Description: 1919 (December), The Macrolepidoptera of the World, vol. 5, p. 760, pl. 153-h (underside), (Stuttgart).

Additional Reference: Draudt, Max, 1921 (January), The Macrolepidoptera of the World, vol. 5, p. 823 (Stuttgart). (Said: "for *anosma* place: *oribata* Weymer.")

Note: Apparently the above indicates synonymy.

antaegon Boisduval, Jean A., *Lycaena*

Type Locality: California.

Location of Type: United States National Museum?

Original Description: 1852, Ann. Soc. Ent. France, Series 2, vol. 10, p. 295 (Paris).

Additional References: Oberthür, Charles, 1913 (October), Etudes de Lepidopterologie Comparee, fasc. 9, pt. 1, p. 41, pl. 236, fig. 1936 ♂, 1937 ♀ (Rennes). McDunnough, J. H., 1938, Check list, pt. 1, p. 28, no. 459 (Los Angeles, California). (Places *antaegon* as a synonym of *acmon* Westwood.)

Note: Boisduval associates *antaegon* with *acmon* Westwood, of which it is a synonym.

anthelle Doubleday, Edward, *Polyommatus* (Boisduval MS) Nomen nudum

Type Locality:

Location of Type:

Original Description: 1847, List of the specimens of lepidopterous insects in the collection of the British Museum, pt. 2, p. 55 (London).

Additional Reference: Scudder, Samuel H., 1876 (May), Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 128 (Buffalo, N. Y.). (Places the name in the synonymy of *dorcas* Kirby.)

anthora Hewitson, W. C., *Thecla*

Type Locality: Amazon, Cayenne.

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 191, vol. 2, pl. 76, figs. 604 ♂, 605, 606 (London).

anthracia Hewitson, W. C., *Thecla*

Type Locality: Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 166, vol. 2, pl. 65, figs. 462 ♂, 461, 463 ♀ (London).

Additional Reference: Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 603 (London). (Makes *anthracia* a synonym of *orcynia* Hewitson.)

antiacis Boisduval, Jean A., *Lycaena*.

Type Locality: San Francisco, California.

Location of Type: United States National Museum?

Original Description: 1852, Ann. Soc. Ent. France, Series 2, vol. 10, p. 300 (Paris).

Additional References: Oberthür, Charles, 1913 (October), Etudes de Lepidopterologie Comparee, fasc. 9, pt. 1, p. 41, pl. 237, fig. 1951 ♂ (Rennes). McDunnough, J. H., 1938, Check list, pt. 1, p. 28, no. 474 (Los Angeles, California). (Places *antiacis* as a form of *xerces* Boisduval.)

Synonyms: *intermedia* Chermock.

antibubastus Hübner, Jacob, *Hemiargus*

Type Locality: Georgia.

Location of Type:

Original Description: 1818, Beiträge zur Sammlung exotischer Schmetterlinge, vol. 1, p. 19, pl. (18), figs. 99, 100 (Augsburg).

Note: Erste Zutr. as *Rusticus bubastus*; Augsburg, 1808; plates published 1809–1813.

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 109 (New York, N. Y.). (Makes *antibubastus* a subspecies of *hanno* Stoll.)

Synonyms: *pseudoptiletetes* Boisduval and LeConte.

antigua Comstock, W. P. and E. I. Huntington, *Thecla*

Type Locality: St. John, Antigua, B. W. I., June 5, 1911.

Location of Type: The American Museum of Natural History.

Original Description: 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 83, pl. 1, fig. 16 ♀ (New York, N. Y.).

antinous Felder, Cajetan and Rudolf Felder, *Pseudolycaena*

Type Locality: New Granada, Bogotá.

Location of Type:

Original Description: 1864–1867, Reise der Osterreichischen Fregatte "Novara" um die Erde, vol. 2, p. 244, pl. 28, figs. 8, 9 (Wien).

Additional Reference: Draudt, Max, 1919 (November), The Macrolepidoptera of the World, vol. 5, p. 747 (Stuttgart). (Makes *antinous* a synonym of *telemus* Cramer.)

aon Lucas, P. H., *Thecla*

Type Locality: Havana, Cuba; also Yucatan.

Location of Type:

Original Description: 1857, in Sagra, Historie physique, politique et naturelle de l'ile de Cuba, vol. 7, p. 610, pl. 16, figs. 6 ♂, 6a, 6b ♀ (Paris).

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 56 (New York, N. Y.). (Did not recognize this species.)

apama Edwards, William H., *Thecla*

Type Locality: Fort Grant and in Graham Mts., Arizona.

Location of Type: Carnegie Museum, Pittsburgh, Pennsylvania.

Original Description: 1882 (October), Papilio, vol. 2, p. 137 (New York, N. Y.).

Subspecies: *homoperplexa* Barnes and Benjamin.

aphaca Hewitson, W. C., *Thecla*

Type Locality: Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1867, Illus. of Diurnal Lepidoptera, vol. 1, p. 105, vol. 2, pl. 36, fig. 90 ♀ (London).

Additional Reference: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 182, pl. 72, fig. 552 ♂ (London).

appula Hewitson, W. C., *Thecla*

Type Locality: Bolivia and Venezuela.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 163, vol. 2, pl. 64, figs. 447, 448 ♂ (London).

aprica Möschler, H. B., *Thecla*

Type Locality: Paramaribo, Surinam (1 ♂).

Location of Type:

Original Description: 1883, Verh. zool.-bot Ges., vol. 32, p. 310, pl. 17, fig. 6 (Wien).

aquilo Boisduval, Jean A., *Argus*

Type Locality: Cape North, Siberia upon the Altai and Labrador.

Location of Type:

Original Description: 1832, *Icones Hist. Lep. d'Europe*, vol. 1, p. 62, pl. 12, figs. 7, 8 ♀ (Paris).

Synonyms: *franklinii* Curtis, *kohlsaati* Gunder, *suttoni* Holland.

Subspecies: *bryanti* Leussler, *lacustris* Freeman, *megalo* McDunnough, *podarce* Felder and Felder, *cilla* Behr syn., *nestos* Boisduval syn., *tehama* Reakirt syn., *rustica* Edwards.

arachne Goodson, F. W., *Thecla*

Type Locality: Chapada, ?, April.

Location of Type: British Museum (Natural History) (1 ♂).

Original Description: 1945 (November), *Entomologist*, vol. 78, p. 170 (London).

aratus Schaus, William, *Thecla*

Type Locality:

Location of Type:

Original Description: 1902, *Proc U. S. Natl. Mus.*, vol. 24, p. 417 (Washington, D. C.).

Note: Schaus mentioned the name *aratus* Moritz ms. in connection with *aritides* Schaus of which it is a synonym.

archias Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1777, *Papillons exotiques des trois parties du monde*, vol. 2, p. 129, pl. 181, Fig. C. (Amsterdam).

arcula Druce, Hamilton H., *Thecla*

Type Locality: Tucumán, Argentina.

Location of Type: Druce Collection.

Original Description: 1907 (June), *Proc. Zool. Soc. London*, p. 629, pl. 36, fig. 27 ♂ (London).

ardea Edwards, William H., *Lycaena*

Type Locality: Virginia City, Nevada (♂).

Location of Type: The American Museum of Natural History.

Original Description: 1871 (January), *Trans. Amer. Ent. Soc.*, vol. 3, p. 209 (Philadelphia, Pa.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 27, no. 455 (Los Angeles, Calif.). (Places *ardea* as a subspecies of *icarioides* Boisduval.)

arecibo Comstock, W. P. and E. I. Huntington, *Thecla columella*

Type Locality: Guayanilla, Puerto Rico, July 22, 1914.

Location of Type: The American Museum of Natural History.

Original Description: 1943 (December), *Ann. New York Acad. Sci.*, vol. 45, p. 81, pl. 1, fig. 14 ♂ (New York, N. Y.).

arene Goodson, F. W., *Thecla*

Type Locality: River Tabaconas, N. Peru, 6,000 ft. (3 ♂♂); Upper R. Toro, La Merced, Aug. Sept. 1901 (1 ♀).

Location of Type: British Museum (Natural History).

Original Description: 1945 (November), *Entomologist*, vol. 78, p. 171 (London).

ares Godman, F. D. and O. Salvin, *Thecla*

Type Locality: Ega (Teffé), Amagonas, Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1887 (August), *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 2, p. 61, vol. 3, pl. 55, figs. 23, 24 ♂ (London).

arethusa Wolley Dod, F. H., *Chrysophanus*

Type Locality: Near Calgary, Alberta, July 5-20.

Location of Type: United States National Museum.

Original Description: 1907 (May), *Can. Ent.*, vol. 39, p. 169 (London, Ontario).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 26, no. 435 (Los Angeles, Calif.). (Places *arethusa* as a subspecies of *hypophlaeas* Boisduval.)

argentata Fletcher, James, *Lycaena pseudargiolus* var.

Type Locality: Cartwright, Southern Manitoba, Canada.

Location of Type: United States National Museum.

Original Description: 1903, *Trans. Royal Soc. Canada, Section 4*, p. 213, figs. (Ottawa).

Additional References: Fletcher, James, 1904 (May), *Can. Ent.*, vol. 36, p. 127, pl. (London, Ontario). McDunnough, J. H., 1938 Check list, pt. 1, p. 29, no. 475 (Los Angeles, Calif.). (Makes *argentata* a subspecies of *pseudargiolus* Boisduval and LeConte.)

argentinensis Clench, Harry K., *Thecla*

Type Locality: Tucumán, Argentina.

Location of Type: British Museum (Natural History).

Original Description: 1946 (August), *Entomologist*, vol. 79, p. 185 (London).

argerona Hewitson, W. C., *Thecla*

Type Locality: Minas Geraes.

Location of Type: British Museum (Natural History).

Original Description: 1878 (November), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 209, vol. 2, pl. 83, figs. 705, 706 (London).

argiolus Abbot, John and James Edward Smith, *Papilio* (Not Linnaeus)

Type Locality: Georgia.

Location of Type:

Original Description: 1797, *Insects of Georgia*, vol. 1, p. 29, pl. 15 (London).

Note: See *pseudargiolus* Boisduval and LeConte.

argiva Hewitson, W. C., *Thecla*

Type Locality: Venezuela.

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 208, vol. 2, pl. 83, figs. 702 ♂, 700, 701 ♀ (London).

Additional Reference: Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 630 (London). (Makes *argiva* a synonym of *dumenilii* Godart.)

argona Hewitson, W. C., *Thecla*

Type Locality: Uruguay.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 162, vol. 2, pl. 63, figs. 441, 442 ♂ (London).

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 87 (New York, N. Y.). (Made *argona* a synonym of *eurytulus* Hübner as did Lathy.)

argyrognomon Bergsträsser, J. A. B., *Lycaena*

Type Locality: Hanau-Münzenberg, Germany.

Location of Type: Gerning Collection, Frankfurt (F).

Original Description: 1779, Nomenclatur . . . der Insecten, vol. 2, p. 76, pl. 46, figs. 1, 2 (Hanau).

Note: Nabokov (1949 (February), Bull. Mus. Comp. Zool., vol. 101, no. 4, p. 479 (Cambridge, Mass.) uses the name *argyrognomon* to denote a North American species; heretofore, this name has been used for a palearctic species only.)

argyrotoxus Behr, Hermann, *Lycaena*

Type Locality: Sierra Nevada, California.

Location of Type:

Original Description: 1867 (January), Proc. Calif. Acad. Nat. Sci., vol. 3, p. 281 (San Francisco, Calif.)

Additional Reference. McDunnough, J. H., 1938, Check list, pt. 1, p. 27, no. 451 (Los Angeles, Calif.). (Places *argyrotoxus* as an aberration of *anna* Edwards.)

arindela Hewitson, W. C., *Thecla*

Type Locality: Chontales, Nicaragua.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 172, vol. 2, pl. 67, figs. 491, 492 ♂ (London).

Subspecies: *rinde* Dyar.

aritides Schaus, William, *Thecla*

Type Locality: Merida, Venezuela.

Location of Type: United States National Museum, no. 5945 ♂.

Original Description: 1902, Proc. U. S. Natl. Mus., vol. 24, p. 417 (Washington, D. C.).

Additional References: Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 605 (London). (Makes *aritides* a synonym of *aholiba* Hewitson.)

Draudt, Max, 1920 (February), *The Macrolepidoptera of the World*, vol. 5, p. 790 (Stuttgart). (Makes *aritides* a synonym of *aholiba* Hewitson.)

arizonensis Edwards, William H., *Lycaena pseudargiolus* var.

Type Locality: Arizona.

Location of Type:

Original Description: 1884 (June), *The Butterflies of North America*, 2nd series, vol. 2, *Lycaena* II, p. 5, paragraph 5, pl. II, figs. 18, 19 (Boston, Mass.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 29, no. 475 (Los Angeles, Calif.). (Places *arizonensis* as a summer form of *pseudargiolus cinerea* Edwards.)

arizonensis Gunder, Jean D., *Everes comyntas herrii* tr. f.

Type Locality: Santa Rita Mts., Arizona, April 18, 1910.

Location of Type: Los Angeles Museum.

Original Description: 1927 (December), *Can. Ent.*, vol. 59, p. 284, pl. A, fig. 10 (Orillia, Ontario).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 27, no. 447 (Los Angeles, Calif.). (Places *arizonensis* as an aberration of *herrii* Grinnell.)

arizonensis McDunnough, James H., *Glaucopsyche lygdamus* var.

Type Locality: White Mts., Arizona, May 27, 1934.

Location of Type: Canadian National Collection, Ottawa, no. 4089. (Paratype in the American Museum of Natural History.)

Original Description: 1936 (May), *Can. Ent.*, vol. 68, p. 113 (Orillia, Ontario).

armilla Druce, Hamilton H., *Thecla*

Type Locality: Rio de Janeiro, Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1907 (June), *Proc. Zool. Soc. London*, p. 583 (London).

armouri Clench, Harry K., *Strymon acis*

Type Locality: Rum Cay, Bahamas, February–March, 1934.

Location of Type: Museum of Comparative Zoology (no. 25,848).

Original Description: 1943 (February), *Psyche*, vol. 49, p. 53 (Cambridge, Mass.).

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), *Ann. New York Acad. Sci.*, vol. 45, p. 66 (New York, N. Y.).

arogeus Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1780, *Papillons exotiques des trois parties du monde*, vol. 4, p. 85, pl. 333, figs. A, B (Amsterdam).

Additional Reference: Druce, H. H., 1907, *Proc. Zool. Soc. London*, p. 568 (London). (Did not recognize the species.)

arola Hewitson, W. C., *Thecla*

Type Locality: Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1868, Specimen of a Catalogue of Lycaenidae in the British Museum, p. 28 (London).

Additional Reference: Hewitson, W. C., 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 151, vol. 2, pl. 60, figs. 392, 393 ♂ (London).

arota Boisduval, Jean A., *Polyommatus*

Type Locality: Juba Mountains, California, May and June.

Location of Type: United States National Museum?

Original Description: 1852, Ann. Soc. Ent. France, Series 2, vol. 10, p. 293 (Paris).

Additional Reference: Oberthür, Charles, 1913 (October), Etudes de Lepidopterologie Comparee, fasc. 9, pt. 1, p. 41, pl. 236, figs. 1933 ♂, 1934 ♀ (Rennes).

Subspecies: *nubila* Comstock.

arpoxis Godman, F. D. and O. Salvin, *Thecla*

Type Locality: Chitra, Panamá.

Location of Type: British Museum (Natural History).

Original Description: 1887 (August), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 49, vol. 3, pl. 55, figs. 25, 26 ♂ (London).

arpoxida Draudt, Max, *Thecla*

Type Locality: Río Songo, Bolivia.

Location of Type: Fassl Collection (now in Naturhistorisches Museum, Basle).

Original Description: 1920 (January), The Macrolepidoptera of the World, vol. 5, p. 775, pl. 155-a (underside ♂), (Stuttgart).

arria Hewitson, W. C., *Thecla*

Type Locality: Canelos, Ecuador.

Location of Type: British Museum (Natural History).

Original Description: 1870 (March), Equatorial Lepidoptera, Buckley, p. 68 (London).

Additional Reference: Hewitson, W. C., 1878 (November), Illus. of Diurnal Lepidoptera, vol. 1, p. 213, vol. 2, pl. 85, figs. 729, 730 ♂ (London).

arsace Boisduval, Jean A. and John LeConte, *Thecla*

Type Locality: Virginia and Georgia.

Location of Type:

Original Description: 1833, Histoire Générale et iconographie des Lépidoptères et des chenilles de l'Amérique Septentrionale, p. 103, pl. 32 (Paris).

Additional References: Dyar, H. G., 1902, Bull. U. S. Natl. Mus., no. 52, p. 39 (Washington, D. C.). (Makes *arsace* a variety of *irus* Godart.) Oberthür, Charles, 1920, Etudes de Lepidopterologie Comparee, fasc. 17,

p. 19, pls. p. 7, pl. DV, figs. 4209, 4210 (Rennes). McDunnough, J. H., 1938, Check list, pt. 1, p. 25, no. 405 (Los Angeles, Calif.). (Places *arsace* as a synonym of *irus* Godart.)

aruma Hewitson, W. C., *Thecla*

Type Locality: Brazil (Espiritu Santo).

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 192, vol. 2, pl. 76, figs. 609, 610 ♂ (London).

arza Hewitson, W. C., *Thecla*

Type Locality: Nicaragua (Chontales).

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 178, vol. 2, pl. 70, figs. 523, 524 (London).

asa Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1873 (February), Illus. of Diurnal Lepidoptera, vol. 1, p. 143, vol. 2, pl. 57, figs. 353, 354 ♂ (London). Amazon (Ega).

assula Draudt, Max, *Thecla*

Type Locality: Bogotá, Colombia (♀).

Location of Type: Fassel Collection. (Now in Naturhistorisches Museum, Basle.)

Original Description: 1919 (November), The Macrolepidoptera of the World, vol. 5, p. 748, pl. 153-a (underside ♀) (Stuttgart).

astenidas Lucas, P. H., *Lycaena*

Type Locality: Cuba.

Location of Type:

Original Description: 1857, in Sagra, Historie physique, politique et naturelle de l'île de Cuba, vol. 7, p. 613 (Paris).

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci. vol. 45, p. 57 (New York, N. Y.). (Suggested that *astenidas* is a synonym of *filenus* Poey.)

astenidia Draudt, Max, *Hemiargus* (not Boisduval)

Type Locality:

Location of Type:

Original Description: 1921 (January), The Macrolepidoptera of the World, vol. 5, p. 819 (Stuttgart).

Note: Misspelling of *astenidas* Lucas.

aster Edwards, William H., *Lycaena*

Type Locality: Southern Newfoundland.

Original Description: 1882 (October), Can. Ent., vol. 14, p. 194 (London, Ontario).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 27, no. 449 (Los Angeles, Calif.). (Places *aster* as a subspecies of *scudderii* Edwards.)

astiocha Prittwitz, O. V., *Lycaena*

Type Locality: Corcovado, Rio de Janeiro, Brazil.

Location of Type:

Original Description: 1865, Stettin Ent. Zeit., vol. 26, p. 324 (Stettin).

astragala Wright, William Greenwood, *Lycaena*

Type Locality: San Bernardino, California, August 2, 1889.

Location of Type:

Original Description: 1906, Butterflies of the West Coast, 2nd edition, p. 232, pl. 30, fig. 401 ♂ (San Bernardino, Calif.).

Note: The date of the species is 1905, from 1st edition published by the Whitaker and Ray Company, San Francisco, California.

Additional Reference: Barnes, William and J. H. McDunnough, 1917 (February), Check list of the Lepidoptera of Boreal America, p. 16, no. 421 (Decatur, Ill.). (Place *astragala* as a synonym of *gyas* Edwards.)

atahualpa Wallengrén, H. D. J., *Polyommatus*

Type Locality: Valparaiso, Chile, February.

Location of Type: Stockholm Museum.

Original Description: 1860, Wiener Ent. Monat., vol. 4, p. 37, no. 18 (Wien).

Additional Reference: Draudt, Max, 1921 (January), The Macrolepidoptera of the World, vol. 5, p. 822 (Stuttgart). (Places *atahualpa* as a synonym of *Chilensis* Blanchard.)

atala Poey, Felipe, *Eumenia*

Type Locality: Havana, Cuba.

Location of Type:

Original Description: 1832 (April), Centurie de Lépidoptères de l'île de Cuba (Paris). (No pagination and not plate numbers.)

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 59 (New York, N. Y.).

Synonyms: *toxea* Gray, *Toxia* Gray synonym.

Subspecies: *grayi* Comstock and Huntington.

atena Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1867, Illus. of Diurnal Lepidoptera, vol. 1, p. 92, vol. 2, pl. 36, fig. 93 ♂, pl. 37, fig. 101 ♂ (London).

atesa Hewitson, W. C., *Thecla*

Type Locality: Amazon (Tapajos).

Location of Type: British Museum (Natural History).

Original Description: 1867, Illus. of Diurnal Lepidoptera, vol. 1, p. 79, vol. 2, pl. 31, figs. 31, 32 ♂ (London).

athymbra Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1867, *Illus. of Diurnal Lepidoptera*, vol. 1, p. 92, vol. 2, pl. 36, figs. 91, 92 ♂ (London).

atnius Kirby, William F., *Thecla* (not Herrich-Schäffer)

Type Locality:

Location of Type:

Original Description: 1871, *A Synonymic Catalogue of Diurnal Lepidoptera*, p. 399, no. 333 (London).

Note: Misspelling of *atrius* Herrich-Schäffer.

atrana Schaus, William, *Thecla*

Type Locality: Castro, Paraná, Brazil.

Location of Type: United States National Museum, no. 5925.

Original Description: 1902, *Proc. U. S. Natl. Mus.*, vol. 24, p. 409 (Washington, D. C.).

Additional Reference: Draudt, Max, 1920 (December), *The Macrolepidoptera of the World*, vol. 5, p. 810, pl. 145-k (Stuttgart).

atrapraetextus Field, William D., *Plebejus*

Type Locality: Priest River, Idaho, July 20.

Location of Type: W. D. Field Collection.

Original Description: 1939, *Jour. Kansas Ent. Soc.*, vol. 12, p. 135 (McPherson, Kansas).

atrius Herrich-Schäffer, G. A. W., *Thecla*

Type Locality: Surinam.

Location of Type:

Original Description: 1853, *Sammlung aussereuropäischer Schmetterlinge*, p. 55, pl. 14, figs. 53, 54 (Regensburg).

Synonyms: *atnius* Kirby, *clitumnus* Butler.

atrofasciata McDunnough, James H., *Strymon melinus* var. n.

Type Locality: Wellington, B. C.

Location of Type: Canadian National Collection, Ottawa.

Original Description: 1921 (February), *Can. Ent.*, vol. 53, p. 47 (Orillia, Ontario).

atrox Butler, Arthur G., *Tmolus*

Type Locality: Pedroso, Río Puras, September 25, 1876.

Location of Type:

Original Description: 1877 (June), *Trans. Ent. Soc. London*, p. 140 (London).

Synonyms: *gentilla* Schaus.

attalion Godman, F. D. and O. Salvin, *Thecla*

Type Locality: Orizaba, Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1887 (August), *Biologia Centrali-Americana*, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 60, vol. 3, pl. 55. figs. 19, 20 ♂ (London).

atymna Hewitson, W. C., *Thecla*

Type Locality: Riobamba, Ecuador.

Location of Type: British Museum (Natural History).

Original Description: 1870 (March), *Equatorial Lepidoptera*, Buckley, p. 59 (London).

Additional Reference: Hewitson, W. C., 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 174, vol. 2, pl. 68, figs. 501 ♂, 499, 500 ♀ (London).

atymnides Draudt, Max, *Thecla loxurina* form

Type Locality: Quindiu Pass (3,800 meters) Colombian Central Cordillera.

Location of Type:

Original Description: 1919 (December), *The Macrolepidoptera of the World*, vol. 5, p. 758, pl. 153-e (Stuttgart).

atys Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1779, *Papillons exotiques des trois parties du monde*, vol. 3, p. 117, pl. 259, figs. E, F, G, H (Amsterdam).

Additional Reference: Hewitson, W. C., 1869 (April), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 78 (London). (Makes Cramer's figures E and F *Thecla polybe* Johansson.)

Synonyms: *scamander* Hübner.

aubumiana Harris, Thaddeus William, *Thecla*

Type Locality: Massachusetts.

Location of Type:

Original Description: In Morris, John G., 1862 (February), *Synopsis of the Lepidoptera of North America*, Smithsonian Misc. Coll., p. 101 (Washington, D. C.).

Note: This is obviously a misspelling of *auburniana* Harris, which is a synonym of *damon* Cramer.

auburniana Harris, Thaddeus William, *Thecla*

Type Locality: Sweet Auburn, near Cambridge, Massachusetts.

Location of Type:

Original Description: 1862, *Insects Injurious to Vegetation*, 3rd Edition (Flint), p. 277 (Boston, Mass.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 25, no. 401 (Los Angeles, Calif.). Places *auburniana* as a synonym of *damon* Cramer.)

auda Hewitson, W. C., *Thecla*

Type Locality: New Grenada.

Location of Type: British Museum (Natural History).

Original Description: 1867, Illus. of Diurnal Lepidoptera, vol. 1, p. 81, vol. 2, pl. 35, figs. 78, 79 ♀ (London).

aufidena Hewitson, W. C., *Thecla*

Type Locality: Nicaragua.

Location of Type: British Museum (Natural History).

Original Description: 1869 (April), Illus. of Diurnal Lepidoptera, vol. 1, p. 117, vol. 2, pl. 47, figs. 213, 214 ♂ (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (May), Biologia Central-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 22 (London). (Indicate that *aufidena* is a synonym of *jalan* Reakirt. They also associate *aufidena* with *battus* Cramer.)

augustinula Strand, Embrik, *Thecla augustula* ab.?

Type Locality: Costa Rica (1 ♂).

Location of Type: Niepelt Collection.

Original Description: 1916 (December), Lepidoptera Niepeltiana, pt. 2, p. 18, pl. 16, fig. 22 (Berlin).

Additional Reference: Goodson, F. W., 1945 (November), Entomologist, vol. 78, p. 170 (London). (Considers *augustinula* to be a good species.)

augustinus Westwood, John Obadiah, *Thecla*

Type Locality:

Location of Type:

Original Description: 1852, Genera of Diurnal Lepidoptera, vol. 2, p. 486 (London).

Note: New name proposed for *Thecla augustus* Kirby, of which it is a synonym.

augustinus Butler, A. G. and Herbert Druce, *Mithras*

Type Locality: Cartago, Costa Rica.

Location of Type: British Museum (Natural History) (Coll. Druce).

Original Description: 1872 (July), Cistula Entomologica, vol. 1, p. 106 (London).

Additional References: Butler, A. G., 1873 (October), Lepid. Exot., p. 159, pl. 57, fig. 8 (London). Godman, F. D. and O. Salvin, 1887 (May), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 16, vol. 3, pl. 50, figs. 21, 22 ♂ (London). Goodson, F. W. 1945 (November), Entomologist, vol. 78, p. 171 (London). (Says *augustinus* is pre-occupied by *Thecla augustinus* (Westwood, 1852) and further, that it is the female of *monica* Hewitson.)

augustula Kirby, W. F., *Thecla*

Type Locality: Costa Rica.

Location of Type: British Museum (Natural History).

Original Description: 1877, A Synonymic Catalogue of Diurnal Lepidoptera, Supplement, p. 777 (London).

Note: This is a new name proposed for *Mithras augustinus* Butler and Druce.

Additional Reference: Goodson, F. W., 1945 (November), *Entomologist*, vol. 78, p. 171 (London). (Says that *augustula* is female of *monica* Hewitson.)

augustus Fabricius, Johann Christian, *Hesperia*

Type Locality: "In America".

Location of Type:

Original Description: 1793, *Entomologica Systematica*, vol. 3, p. 275 (Hafniae).

Additional Reference: Kirby, W. F., 1871, *A Synonymic Catalogue of Diurnal Lepidoptera*, p. 385 (London). (Places *augustus* as a synonym of *meton* Cramer.)

augustus Kirby, William (Rev.), *Thecla*

Type Locality: "Taken in latitude 54 deg." (Cumberland-house ?)

Location of Type:

Original Description: 1837, *Fauna Boreali-Americana; Zoology, British America* (by Dr. John Richardson), pt. 4, *Insects* (by Rev. William Kirby), p. 298, pl. 3, figs. 4, 5 (Norwich, England).

Synonyms: *augustinus* Westwood.

Subspecies: *croesioides* Scudder, *helenae* dos Passos.

aunia Hewitson, W. C., *Thecla*

Type Locality: Venezuela.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 167, vol. 2, pl. 65, figs. 464, 465 ♂ (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (August), *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 2, p. 64 (London). (Places *aunia* ♂ as a synonym of *orcynia* Hewitson ♂).

aunus Cramer, Pierre, *Papilio*

Type Locality: "Il vient de l'isle Araba près de Curacao".

Location of Type:

Original Description: 1775, *Papillons exotiques des trois parties du monde*, vol. 1, p. 36, pl. 23, figs. E, F (Amsterdam).

Additional Reference: Hewitson, W. C., 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 184, pl. 73, figs. 567, 568 ♂ (London).

aura Godman, F. D. and O. Salvin, *Thecla*

Type Locality: Irazú, Costa Rica.

Location of Type: British Museum (Natural History).

Original Description: 1887 (August), *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 2, p. 60, vol. 3, pl. 55, figs. 21, 22 ♂ (London).

auretorum Boisduval, Jean A., *Thecla*

Type Locality: Northern California.

Location of Type: United States National Museum?

Original Description: 1852, Ann. Soc. Ent. France, 2nd Series, vol. 10, p. 288 (Paris).

Additional Reference: Oberthür, Charles, 1913 (October), Etudes de Lepidopterologie Comparee, fasc. 9, pt. 1, p. 40, pl. 235, fig. 1921 (Rennes).

Synonyms: *tacita* Edwards, *tetra* Edwards.

Subspecies: *spadix* Edwards.

aurora Druce, Hamilton H., *Thecla*

Type Locality: Espiritu Santo and Río Grande, Brazil.

Location of Type: Druce Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 583 (London).

Additional Reference: Draudt, Max, 1919 (December), The Macrolepidoptera of the World, vol. 5, p. 766, pl. 151-a (Stuttgart).

aurorina Draudt, Max, *Thecla*

Type Locality: Canon del Tolima, Quindiu Pass, Colombia.

Location of Type: Fassl Collection. (Now in Naturhistorisches Museum, Basle.)

Original Description: 1919 (December), The Macrolepidoptera of the World, vol. 5, p. 755, pl. 159-a (Stuttgart).

aurugo Draudt, Max, *Thecla*

Type Locality: Cuzco, Peru.

Location of Type: Fassl Collection. (Now in Naturhistorisches Museum, Basle.)

Original Description: 1919 (December), The Macrolepidoptera of the World, vol. 5, p. 759, pl. 153-g ♂ (Stuttgart).

australis Grinnell, Fordyce, Jr., *Glaucopsyche behri*

Type Locality: Pasadena, California, May 20, 1907.

Location of Type: Grinnell Collection (1 ♂).

Original Description: 1917 (October), Can. Ent., vol. 49, p. 350 (London, Ontario).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 28, no. 473 (Los Angeles, Calif.). (Places *australis* as a subspecies of *lygdamus* Doubleday.)

Synonyms: *sinepunctata* Comstock, *sinepuncta* McDunnough syn.

autoclea Hewitson, W. C., *Thecla*

Type Locality: Nicaragua (Chontales).

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 194, vol. 2, pl. 77, figs. 616, 617 (London).

Additional References: Godman, F. D. and O. Salvin, 1887 (September), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 76, vol. 3, pl. 57, figs. 9, 10 (sex?) (London). Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 610 (London). (Considers *autoclea* a synonym of *sangala* Hewitson.)

Synonyms: *callides* Dyar.

autolytus Edwards, William H., *Thecla*

Type Locality: Dallas, Texas (♂ ♂).

Location of Type:

Original Description: 1871 (March), Trans. Amer. Ent. Soc., vol. 3, p. 271 (Philadelphia, Pa.).

Subspecies: *ilavia* Beutenmiller, *mirabelle* Barnes syn.

avalona Wright, William Greenwood, *Thecla*

Type Locality: Avalon, Catalina Island, California, summer 1885.

Location of Type:

Original Description: 1906, Butterflies of the West Coast, 2nd edition, p. 209, pl. 28, figs. 328, 328-c ♂, 328-b ♀ (San Bernardino, Calif.).

Note: The date of the species is 1905, from 1st edition published by the Whitaker and Ray Company, San Francisco, California.

avoca Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1867, Illus. of Diurnal Lepidoptera, vol. 1, p. 96, vol. 2, pl. 37, figs. 94, 95 ♂ (London).

azaria Hewitson, W. C., *Thecla*

Type Locality:

Location of Type: British Museum (Natural History).

Original Description: 1867, Illus. of Diurnal Lepidoptera, vol. 1, p. 87, vol. 2, p. 34, figs. 65, 66 (London).

Additional Reference: Lathy, Percy I., 1932, Ann. Mag. Nat. Hist., Series 10, vol. 9, p. 182 (London). (Describes the male of *azaria* and says that Hewitson figured a female, not a male.)

Synonyms: *decyanea* Lathy.

azia Hewitson, W. C., *Thecla*

Type Locality: Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1873 (February), Illus. of Diurnal Lepidoptera, vol. 1, p. 144, vol. 2, pl. 57, figs. 357, 358 ♂ (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (September), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 91 (London). (Give additional localities in Central America and South America.)

azuba Hewitson, W. C., *Thecla*

Type Locality: Rio Grande.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 154, vol. 2, pl. 61, figs. 408, 409 ♀ (London).

Additional Reference: Draudt, Max, 1920, The Macrolepidoptera of the World, vol. 5, p. 807 (Stuttgart). (Gives locality "Brazil Rio Grande, Sao Paulo.")

azurinus Butler, A. G. and Herbert Druce, *Bithys*

Type Locality: Cartago, Costa Rica.

Location of Type: British Museum (Natural History) (Coll. Druce).

Original Description: 1872 (July), *Cistula Entomologica*, vol. 1, p. 107 (London).

Additional References: Butler, A. G., 1873 (October), *Lepid. Exot.*, p. 159, pl. 57, fig. 11 ♂ (London). Godman, F. D. and O. Salvin, 1887 (June), *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 2, p. 45, vol. 3, pl. 53, figs. 18, 19 ♂ (type) (London).

babhru Weeks, A. G., Jr., *Lycaena*

Type Locality: Sicasia, Bolivia, October, 1899.

Location of Type: Museum of Comparative Zoology.

Original Description: 1901 (December), *Trans. Amer. Ent. Soc.*, vol. 27, p. 357 (Philadelphia, Pa.).

Additional Reference: Weeks, A. G., Jr., 1905, *Illus. of Diurnal Lepidoptera*, p. 98, pl. 43, fig. 1 (Boston).

bacchus Scudder, Samuel H., *Lycaena* (Harris MS).

Type Locality:

Location of Type:

Original Description: 1889, *The Butterflies of the eastern United States and Canada with special reference to New England*, vol. 2, p. 998 (Cambridge, Mass.).

Additional Reference: McDunnough, J. H., 1938, *Check list pt. 1*, p. 26, no. 435 (Los Angeles, Calif.). (Places *bacchus* as a synonym of *hypophlaeas* Boisduval.)

bacis Godman, F. D. and O. Salvin, *Thecla*

Type Locality: Chiriquí, Panamá.

Location of Type: Staudinger Collection.

Original Description: 1887 (May), *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 2, p. 21, vol. 3, pl. 49, figs. 20, 21 ♂, 22 ♀ (London).

Subspecies: *vulnerata* Staudinger.

baetra Hewitson, W. C., *Thecla*

Type Locality: Nicaragua.

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 194, vol. 2, pl. 77, figs. 619, 620 (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (September), *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 2, p. 74 (London). (Make *baetra* a synonym of *beon* Cramer.)

bactriana Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1868, *Specimen of a Catalogue of Lycaenidae in the British Museum*, p. 11 (London).

Additional Reference: Hewitson, W. C., 1869 (April), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 118, vol. 2, pl. 50, figs. 252, 253 ♂ (London).

badaca Hewitson, W. C., *Thecla*

Type Locality: Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1868, Specimen of a Catalogue of Lycaenidae in the British Museum, p. 12 (London).

Additional Reference: Hewitson, W. C., 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 184, vol. 2, pl. 73, figs. 569, 570 ♂ (London).

Synonyms: *collucia* Hewitson.

badeta Hewitson, W. C., *Thecla*

Type Locality: Cayenne.

Location of Type: British Museum (Natural History).

Original Description: 1873 (February), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 146, vol. 2, pl. 58, figs. 365, 366 ♀ (London).

Synonyms: *melba* Hewitson.

baeton Sepp, Jan. *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1828-1848, *Surinaamsche Vlinders*, vol. 1, p. 23, pl. 8 (Amsterdam).

Additional Reference: Hewitson, W. C., 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 183 (London). (Makes *baeton* synonym of *inachus* Cramer.)

bagrada Hewitson, W. C., *Thecla*

Type Locality: Villa Nova (Amazon).

Location of Type: British Museum (Natural History).

Original Description: 1868, Specimen of a Catalogue of Lycaenidae in the British Museum, p. 22 (London).

Additional Reference: Hewitson, W. C., 1873 (February), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 137, vol. 2, pl. 55, figs. 324, 325 ♂ (London).

bahamensis Clench, Harry K., *Hemiargus*

Type Locality: Crooked Island, Bahamas, March 1, 1934.

Location of Type: Museum of Comparative Zoology (no. 25,737).

Original Description: 1943 (February), *Psyche*, vol. 49, p. 57 (Cambridge, Mass.).

bakeri Clench, Harry K., *Lycaenopsis pseudargiolus*

Type Locality: Baker, Oregon, April 20, 1941.

Location of Type: Museum of Comparative Zoology.

Original Description: 1944, *Jour. New York Ent. Soc.*, vol. 52, p. 274 (Lancaster, Pa.).

baldyensis Gunder, J. D., *Philotes battoides* var. *bernardino* ab. ♀

Type Locality: Camp Baldy, San Bernardino County, California.

Location of Type: American Museum of Natural History.

Original Description: 1925 (January), Ent. News, vol. 36, p. 3, pl. I, fig. M (Philadelphia, Pa.).

balius Godman, F. D. and O. Salvin, *Thecla*

Type Locality: "Interior of Colombia" (also from Polochic Valley, Guatemala).

Location of Type: British Museum (Natural History).

Original Description: 1887 (September), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 65, vol. 3, pl. 56, figs. 6, 7 ♂ (London).

Additional Reference: Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 604 (London). (Makes *balius* a synonym of *gabatha* Hewitson and adds Belize, British Honduras as new locality.)

balliston Hübner, Jacob, *Lampides*

Type Locality: Georgia.

Location of Type:

Original Description: 1823, Zuträge zur Sammlung exotischer Schmetterlinge, vol. 2, p. 11, pl. (40), figs. 229, 230 (Augsburg).

Note: Probably not American.

balteata Scudder, Samuel H., *Incisalia irus* var.

Type Locality: Centre, New York, May (♀).

Location of Type:

Original Description: 1889, The Butterflies of the eastern United States and Canada with special reference to New England, vol. 2, p. 837 (Cambridge, Mass.).

Additional Reference: McDunnough, J. H., 1938, Check List, pt. 1, p. 25, no. 405 (Los Angeles, Calif.). (Places *balteata* as an aberration of *irus* Godart.)

balzapamba Goodson, F. W., *Thecla*

Type Locality: "1 ♂. Merida, Venezuela, 1897. 1 ♂. Balzapamba, Prov. de Bolivar (M. de Mathan), III, IV, 1894. Both ex coll. Oberthür."

Location of Type: British Museum (Natural History).

Original Description: 1945 (December), Entomologist, vol. 78, p. 187 (London).

banksi Watson, Frank E. and William P. Comstock, *Heodes hypophlaeas hypophlaeas* ab.

Type Locality: Lexington, Massachusetts.

Location of Type: Museum of Comparative Zoology. (Paratype American Museum of Natural History.)

Original Description: 1920, Bull. Amer. Mus. Nat. Hist., vol. 42, p. 454 (New York, N. Y.).

bañosensis Clench, Harry K., *Thecla agricolor*

Type Locality: San Pablo, Río Pastaza, vic. Baños, Ecuador, 2,200 meters. ♀

Location of Type: American Museum of Natural History.

Original Description: 1944 (July), Bull. Mus. Comp. Zool., vol. 94, p. 233 (Cambridge, Mass.).

barajo Reakirt, Tryon, *Thecla*

Type Locality: Near Vera Cruz, Mexico.

Location of Type:

Original Description: 1866 (November), Proc. Acad. Nat. Sci. Phila., p. 333 (Philadelphia, Pa.).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (May), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 30, vol. 3, pl. 51, figs. 22, 23 ♂, 24 ♀ (London).

Synonyms: *desdemona* Hewitson.

barba Druce, Hamilton H., *Thecla*

Type Locality: Río Minero, Muzo, Colombia, 2,500 ft.

Location of Type: Godman Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 575, pl. 32, fig. 3 ♂ (London).

barbouri Clench, Harry K., *Brephidium*

Type Locality: Great Inagua Island, Bahamas, Feb. 1934.

Location of Type: Museum of Comparative Zoology (no. 25,738).

Original Description: 1943 (February), Psyche, vol. 49, p. 58 (Cambridge, Mass.).

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci. vol. 45, p. 111 (New York, N. Y.).

barnesi Gunder, Jean D., *Glaucopsyche xerces* f. *mertila* tr. f.

Type Locality: San Francisco, California, April, 1923.

Location of Type: Barnes Collection, U. S. National Museum, Washington, D. C.

Original Description: 1927 (December), Can. Ent., vol. 59, p. 282, pl. A, figs. 2, 2a (Orilla, Ontario).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 28, no. 474 (Los Angeles, Calif.). (Places *barnesi* as an aberration of *xerces* form *mertila* Edwards.)

barrensis Rosa, Mario, *Thecla melibaeus* ♀ var.

Type Locality: S. Joao da Barra, Brazil.

Location of Type: Author's Collection?

Original Description: 1936 (June), Bol. Mus. Natl., vol. 12, no. 2, p. 82 (Rio de Janeiro).

bartrami Comstock, W. P. and E. I. Huntington, *Thecla acis*

Type Locality: Miami, Florida.

Location of Type: American Museum of Natural History.

Original Description: 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 65, pl. 1, fig. 2 ♀ (New York, N. Y.).

basalides Westwood, J. O., *Thecla*. See *basilides* Geyer, Carl, *Tmolus*

Type Locality:

Location of Type:

Original Description: 1852, *Genera of Diurnal Lepidoptera*, vol. 2, p. 485 (London).

Note: This is probably the first use of the misspelling *basalides*.

basilides Geyer, Carl, *Tmolus*

Type Locality: Brazil.

Location of Type:

Original Description: 1837, *Zuträge zur Sammlung exotischer Schmetterlinge*, vol. 5, p. 42, figs. 977, 978 ♂ (Augsburg).

Additional References: Hewitson, W. C., 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 155, vol. 2, pl. 61, figs. 414, 415 ♂, 412, 413 ♀ (London). (As *basalides*.) Godman, F. D. and O. Salvin, 1887 (September), *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 2, p. 93 (London). (As *basalides*, give Central American and South American localities.)

Synonyms: *basalides* Westwood, *ziba* Hewitson, *thulia* Hewitson syn.

bassania Hewitson, W. C., *Thecla*

Type Locality: Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1868, *Specimen of a Catalogue of Lycaenidae in the British Museum*, p. 14.

Additional Reference: Hewitson, W. C., 1869 (April), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 117, vol. 2, pl. 47, figs. 217, 218 ♂ (London).

batesii Hewitson, W. C., *Thecla*

Type Locality: Rio de Janeiro.

Location of Type: British Museum (Natural History).

Original Description: 1865, *Illus. of Diurnal Lepidoptera*, vol. 1, p. 72, vol. 2, pl. 27, fig. 6 ♂ (London).

bathildis Felder, Cajetan and Rudolf Felder, *Pseudolycaena*

Type Locality: Venezuela.

Location of Type:

Original Description: 1864–1867, *Reise der Osterreichischen Fregatte "Novara" um die Erde*, vol. 2, p. 245, pl. 31, figs. 19, 20 (Wien).

Additional Reference: Draudt, Max, 1919 (November), *The Macrolepidoptera of the World*, vol. 5, p. 752 (Stuttgart). (Places *bathildis* as a synonym of *battus* Cramer.)

bathis Fabricius, Johann Christian, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1781, *Species Insectorum*, vol. 2, p. 116 (Hamburgi).

Note: Synonym of *battus* Cramer.

bathyllos Tessmann, Günter, *Leptotes*

Type Locality: Montealegre, mittl. Pachitea, Eastern Peru.

Location of Type:

Original Description: 1928, Mitt. Zool. Museum, vol. 14, Heft 1, p. 126 (Berlin).

battoides Behr, Hermann, *Lycaena*

Type Locality: San Joaquin River, California, elev. 11,000 ft.

Location of Type: Destroyed in San Francisco, California fire in 1906.

Original Description: 1867 (January), Proc. Calif. Acad. Nat. Sci., vol. 3, pt. 1, p. 282 (San Francisco, Calif.).

Additional Reference: Barnes, William and J. H. McDunnough, 1917 (March), Contributions to the natural history of the Lepidoptera of North America, vol. 3, no. 4, p. 213 and vol. 3, no. 2, p. 116, pl. 11, figs. 7, 8, 10 (Decatur, Illinois). (Consider specimens from Mineral King, Tulare County, California, to be typical *battoides* Behr.)

Synonyms: *glaucon* Edwards.

Subspecies: *bernardino* Barnes and McDunnough, *baldyensis* Gunder syn., *oregonensis* Barnes and McDunnough, *martini* Mattoni.

battus Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1775, Papillons exotiques des trois parties du monde, vol. 1, p. 81, pl. 51, figs. E, F (Amsterdam).

Synonyms: *bathildis* Felder and Felder, *bathis* Fabricius.

Subspecies: *jalan* Reakirt, *aufidena* Hewitson syn.

bazochii Godart, Jean B., *Poloymmatus*

Type Locality: Brazil.

Location of Type: Paris Museum.

Original Description: 1822, Encyclopédie Méthodique, vol. 9, p. 681 (Paris.)

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 88 (New York, N. Y.).

Synonyms: *thius* Geyer, *agra* Hewitson.

Subspecies: *gundlachianus* Bates.

bebrycia Hewitson, W. C., *Thecla*

Type Locality: Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1868, Specimen of a Catalogue of Lycaenidae in the British Museum, p. 13.

Additional References: Hewitson, W. C., 1869 (April), Illus. of Diurnal Lepidoptera, vol. 1, p. 119, vol. 2, pl. 50, figs. 258, 259 ♂ (London). Godman, F. D. and O. Salvin, 1887 (September), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 93 (London). (Give Polochie Valley, Guatemala.)

beera Hewitson, W. C., *Thecla*

Type Locality: Curaray, Ecuador.

Location of Type: British Museum (Natural History).

Original Description: 1870 (March), Equatorial Lepidoptera, Buckley, p. 65, (London).

Additional Reference: Hewitson, W. C., 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 151, vol. 2, pl. 59, figs. 390, 391 ♂ (London).

behrii Edwards, William H., *Lycaena*

Type Locality: California.

Location of Type:

Original Description: 1862 (April), Proc. Acad. Nat. Sci. Phila., p. 224 (Philadelphia, Pa.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 28, no. 473 (Los Angeles, Calif.). (Places *behrii* as a subspecies of *lygdamus* Doubleday.)

behrii Edwards, William H., *Thecla*

Type Locality: Lake Mono, California.

Location of Type:

Original Description: 1870 (January), Trans. Amer. Ent. Soc., vol. 3, p. 18 (Philadelphia, Pa.).

Synonyms: *kali* Strecker, *nigroinita* Gunder.

Subspecies: *columbia* McDunnough, *crossi* Field.

belleri Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 194, vol. 2, pl. 77, fig. 618 ♀ (London).

Additional Reference: Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 609 (London). (Considers *belleri* a synonym of *beon* Cramer.)

bennetti Dyar, Harrison G., *Thecla*

Type Locality: Pampaconas River, Peru, August, 1911.

Location of Type: United States National Museum, no. 15,621.

Original Description: 1913, Proc. U. S. Natl. Mus., vol. 45, p. 636 (Washington, D. C.).

beon Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1780, Papillons exotiques des trois parties du monde, vol. 4, p. 61, pl. 319, figs. B, C (Amsterdam).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (September), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 74, vol. 3, pl. 57, figs. 4, 5 ♂, 6 ♀ (London).

Synonyms: *baetra* Hewitson, *belleri* Hewitson, *caulonia* Hewitson, *isobeaon* Butler and Druce, *jeneirica* Felder, *vibulena* Hewitson.

Subspecies: *chacona* Jörgensen.

bernardino Barnes, William and James H. Dunnough, *Philotes battoides*

Type Locality: Camp Baldy, San Bernardino Mts., California.

Location of Type: United States National Museum.

Original Description: 1916, Contributions to the natural history of the Lepidoptera of North America, vol. 3, no. 2, p. 116, pl. 11, figs. 9, 11, 13 (Decatur, Illinois).

Synonyms: *baldyensis* Gunder.

beroea Hewitson, W. C., *Thecla*

Type Locality: Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1868, Specimen of a Catalogue of Lycaenidae in the British Museum, p. 14 (London).

Additional Reference: Hewitson, W. C., 1874, Illus. of Diurnal Lepidoptera, vol. 1, p. 158 (London). (Synonym of *yojoa* Reakirt.)

bertha Jones, E. Dukinfield, *Thecla*

Type Locality: Castro, Paraná, Brazil.

Location of Type: Jones Collection.

Original Description: 1912, Proc. Zool. Soc. London, p. 897, pl. 97, fig. 4 (London).

besidia Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1868, Specimen of a Catalogue of Lycaenidae in the British Museum, p. 24 (London).

Additional References: Hewitson, W. C., 1869 (April), Illus. of Diurnal Lepidoptera, vol. 1, p. 136, vol. 2, pl. 54, figs. 318, 319 ♀ (London). Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 587 (London). (Describes male, gives habitat as Chapada Campo, Brazil and says Hewitson's type is in the Godman Collection.)

(To Be Continued)

BOOK NOTICE

Living Earth. By Peter Farb. Harper & Brothers, New York, 1959. $5\frac{3}{4} \times 8\frac{1}{2}$ inches, illustrated, 178 pp., \$3.75.

Peter Farb has undertaken the task of compressing the living element of the earth's crust into a book of 178 pages, and he has done a thoroughly creditable job. This little book's unbroken theme is the multitude of living forms and countless individuals inhabiting the soil, and that these living creatures are responsible for the character of the soil in no small degree. After a general review of the processes of soil formation and the part played by the lower organisms in this formation, the book broadly covers three great soil types. The characteristic differences and the types of life associations found in the forest, grassland, and desert soils are presented. Some representative soil dwellers, from bacteriophages through plants, insects, and burrowing mammals are given in typical locales. A fair balance between plant and animal life has been maintained, and a considerable portion of the book deals with the fascinating world of microorganisms inhabiting the earth's crust. The lives of soil inhabiting insects and their near relatives are interwoven throughout, constituting perhaps a third of the subject matter. An especially commendable feature of the work is a strong emphasis on ecology and mutualism in the various soil societies.

The book is unusually readable and interest sustaining, while adhering closely to the facts of the several scientific specialties involved. The seventeen halftone illustrations by Roman Vishniac are considerably superior to the usual printed rendition. A number of illustrative line drawings by Louise Katz are included. Aside from the obvious stimulation to the imagination and understanding of the younger reader, the more mature professional scientist can profit by an evening or so with such a book. We all become somewhat encysted in our specialties, and it is refreshing to occasionally broadly review the complex interrelationships of life we tend to forget.—E. E. McCoy, Jr.

STUDIES ON ANTENNAL CONTACT
CHEMORECEPTION BY THE WOOD NYMPH
BUTTERFLY, *CERCYONIS PEGALA*¹

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In previous work on the locations of trophic contact chemoreceptors of Lepidoptera (Frings and Frings, 1956), we found antennal receptors in two species of moths, the only Lepidoptera for which these were reported up to then. These receptors were discovered, however, only after removal of the tarsal contact chemoreceptors. Earlier work (Frings and Frings, 1949) had indicated that butterflies did not possess contact chemoreceptors on the antennae, but the tests had been made mostly with intact animals. The question naturally arose as to whether butterflies might also have antennal receptors which could be revealed only by removal of the tarsal receptors. We have found that this is actually the case for the Wood Nymph Butterfly, *Cercyonis pegala* (Satyridae), and the work is reported in this paper.

MATERIALS AND METHODS

Two sets of experiments were performed—preliminary tests in July and August, 1956, and a quantitative study in July and August, 1957. In the tests of 1956, 21 individuals (16 males and 5 females) were used. In the study of 1957, 39 individuals (21 males and 18 females) were used. In both cases, these were captured in the field in Maine and were of unknown antecedents. The insects were immobilized for testing by clamping the wings between spring clothes-pins, as described by Minnich (1921).

The preliminary tests utilized the methods detailed in our

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We are happy to express our appreciation to Carl Frings, who captured and cared for most of the butterflies during 1956, and to James Clegg, a student assistant, who carried out the routine testing during 1957.

previous papers. Series of tests of variable duration and number were made at 24 hour intervals. The insects were given all the water they would drink before each day's tests, and their lack of response to water was determined before each trial with the experimental solution. A 1M sucrose solution was used as an acceptable material, and extension of the proboscis when this was brought in contact with a receptive area was the index of reception. Water and the sugar solution were presented to the suspected loci of receptors either on artists' brushes or on fine glass needles. Tests were made with intact animals and with animals variously operated upon. The operations, which will be enumerated in the section on results, were carried out without anaesthesia, using fine dissecting scissors.

For the quantitative study, the tarsi or antennae of similarly immobilized individuals were dipped first into water in a small watch-glass to test for lack of response to this and then into 1M sucrose solution in a similar watch-glass. Five seconds were allowed for a response in each case. Extension of the proboscis was used as the index of reception. The insects were given all the water they would drink before each testing period. They were not allowed to feed during the trials, but were fed at the end of each day's tests. After tests with intact animals, various combinations of legs were removed to produce individuals with mesothoracic legs only, with metathoracic legs only, with mesothoracic and metathoracic legs on either side only, or with one mesothoracic or metathoracic leg on either side only. The prothoracic legs, in this species, are rudimentary. Following the testing of these insects one day later, the segments of the remaining tarsi were removed one by one on successive days and the animals' reactions to tarsal and antennal stimulation were tested one day after each operation.

Laboratory temperatures were uncontrolled, but were continuously recorded on a thermograph. For the preliminary tests of 1956, which were carried out over a period of 10 days, the temperature extremes between the testing periods were 17°–24° C.; for more than three-fourths of the time the temperatures were 21°–23° C. The daily tests were carried out at 21°–23° C. For the study of 1957, which was carried out over a period of 29 days, the extreme range between testing sessions was 16°–24° C.;

for more than three-fourths of the time the temperatures were 20°–23° C. The tests were carried out at 21°–24° C. Only when the temperature fell below about 18° for some hours was there any noticeable effect on the hunger of the insects. In every case, the animals were tested before each day's trials to be sure that they were responsive to the sucrose solution, and the temperatures at which the tests were made were well within the limits for normal proboscis response.

RESULTS

The first of the preliminary tests were carried out to determine whether contact chemoreceptors were present on the second segment of the metathoracic tarsi or not. Our previous work (1956) had indicated that receptors were present on the third segment and not on the first (basal) segment of the metathoracic tarsi, but did not allow us to draw conclusions about the situation with respect to the second segment. For these tests, 8 individuals were used in 136 paired tests (water vs. sucrose solution), using artists' brushes and glass micro-needles, with or without removal of tarsal segments. The receptors were found to be present on the distal one-third of the second segment, but probably not on the proximal one-half. More exact localization was not possible with these methods.

The second series of tests were made to determine whether these butterflies had antennal contact chemoreceptors which could be demonstrated by this technique only after removal of some or all of the tarsal receptors. For these tests, 21 individuals were used in 675 paired tests over a period of 11 days. With all the tarsi intact, there were responses about 5% of the times when the antennae were stimulated with sucrose solution. This was the typical situation observed earlier. In cases in which a response was given, repeat tests were negative, or the insect drank water after uncoiling the proboscis, thus indicating non-satiety with respect to water. As before, the indication was that antennal receptors were lacking, with some residual question left in the mind of the observer. With all the legs removed, however, the situation changed radically. Now the insects responded quite regularly (70%–80%) to stimulation of the antennal tips with the sugar solution, just as in the moths previously studied. Thus

stimulation of the antennal receptors elicited proboscis extension only when the tarsal receptors were removed or reduced in number.

With animals from which all the tarsi were removed it was found that only the tips of the antennal clubs were sensitive. Here there are a number of trichoid sensilla which seem to be the actual receptors (Fig. 1). When the tips of the clubs were removed from responsive individuals, the response disappeared. Three of the individuals tested had sustained unilateral injury to the antennal clubs before capture. These injuries were discovered when tests, after tarsal removal, showed no reception with the damaged antennae. If a glass microneedle were used to move a droplet of sugar solution along the antenna, no response was obtained until the droplet reached the tip of the club. Part of the apparent lack of reception in our earlier tests may have been due to failure to touch these specific areas. Repetition of tests with intact animals, however, showed no more than 5%–8% response even when these were touched.

Tests were next made with insects having reduction in numbers of tarsal receptors, rather than total removal of the tarsi, to see whether the degree of response to antennal stimulation was proportional to the degree of removal or was an all-or-none phenomenon appearing when some critical number of receptors was removed. Only limited time and experimental subjects were available, therefore only preliminary tests could be made. It was obvious, however, that the degree of response from antennal stimulation was related to the number of tarsal receptors removed.

A possible hypothesis to account for the lack of response on antennal stimulation when the tarsi were intact would be a reverse form of the familiar tarsal inhibition of flight. The mounted insects were suspended in mid-air, without having the tarsi in contact with a substrate. It is conceivable that this state of affairs might inhibit the normal proboscis response, when the antennal tips were stimulated. Accordingly, mounted butterflies were given small pieces (4 cm. square) of mosquito-netting or plastic fly-screening to hold with the tarsi. With these being held, the antennal tips were stimulated with artists' brushes moistened with water or sugar-water. The results were essen-

tially the same as when the insects had no pieces to stand on. Touching the tarsi with sugar solution through the squares of netting brought about immediate uncoiling of the proboscis. In all, 85 paired tests were made. Thus the presence of tarsal contact had no measurable effect on the response.

In our earlier work, we found no evidence for the presence of receptors sensitive to sugar solutions on the rudimentary prothoracic legs or on the palpi in this species and in other nymphaloids. In view of the appearance of responses from antennal stimulation only after the tarsi were operated upon, it seemed worthwhile to test these other possible receptive areas with the tarsi, or antennae, or both removed. Twenty-one butterflies were used, 195 tests being made over a period of 7 days. At no time was there any indication of reception by either the rudimentary prothoracic legs or the palpi, while concurrent tests in which the tip of the proboscis was touched (Fig. 2) showed that the insects were fully responsive to stimulation. In this species, the palpi are ordinarily covered with a coat of scales. This, however, had been worn off by some individuals and was removed in others, so that the surface of the palpi could be reached, but this did not change the negative results.

The results of these tests may be summarized as follows. Trophic contact chemoreceptors were found to be present on the ventral surface of the second segment of the metathoracic tarsi, but probably not on the basal segment. The tips of the antennal clubs could be stimulated by sugar solutions, but proboscis extensions were elicited only when some of the tarsal contact chemoreceptors were removed. This did not seem to be a special case of tarsal inhibition. Even with the tarsi and antennae completely removed, stimulation of the palpi or rudimentary prothoracic legs with sucrose solution did not elicit proboscis extensions.

The quantitative study of 1957 described in the previous section was made to determine more precisely the relationship between removal of tarsal receptors and degree of response elicited by antennal stimulation. The results of these experiments are summarized in Table 1.

These results confirm our earlier report that receptors are present on the second segment of the metathoracic tarsus, but

Table 1. Results of tests of contact chemoreception by the tarsi and antennal tips of *C. pegala*. Following tests with unoperated animals, various sets of legs were removed, after which tarsal segments were removed one by one. Symbols: No. = number of individuals tested in each group; Pt. = part stimulated by sucrose solution; T = tarsi; A = antennae; N = number of tests performed; + = number of positive responses (dropping of the proboscis) obtained in the tests; % = percentage of positive responses.

Legs Present	No.	Pt.	Number of Segments Present on Each Tarsus						
			5	4	3	2	1	0	
			N + %	N + %	N + %	N + %	N + %	N + %	N + %
Unoperated	39	T	236 228 97						
		A	233 21 9						
Left & Right	13	T	78 74 95	60 55 92	55 53 97	55 40 73	85 31 36	80 3 4	
Meso & Meta		A	60 13 22	59 24 41	55 27 49	55 31 56	85 48 55	80 62 78	
Left & Right	6	T	45 45 100	30 30 100	25 25 100	25 23 92	30 26 86	30 2 6	
Meso only		A	35 9 26	30 13 43	25 13 52	25 14 56	32 18 56	25 19 76	
Left & Right	7	T	40 33 83	30 23 77	35 19 54	30 20 67	45 2 4	50 0 0	
Meta only		A	30 13 43	30 19 63	35 16 46	35 20 57	50 28 56	50 37 74	
Left or Right	7	T	50 35 70	30 15 50	35 28 80	35 26 74	40 14 35	40 1 2	
Meso only		A	30 8 27	35 22 63	35 25 71	35 24 69	40 34 85	40 34 85	
Left or Right	5	T	45 16 36	25 8 32	25 9 36	25 2 8	20 0 0	20 0 0	
Meta only		A	25 7 28	25 10 40	25 19 76	21 17 81	22 19 86	20 18 90	

not on the proximal segment. The 4% response obtained when only the first segment was present on both metathoracic legs is not significantly different at the 5% level from 0%. All but two of the positive responses obtained with the mesothoracic tarsi completely removed were marked as questionable, meaning that the extension of the proboscis was slight. It is probable, therefore, that the receptors are limited to the tarsi. The insects definitely have contact chemoreceptors on the basal segment of the mesothoracic leg. This corrects our earlier report based on local stimulation tests.

It is obvious that the rise in response on antennal stimulation roughly paralleled the drop in response on tarsal stimulation as tarsal segments were removed. A difference between the mesothoracic and metathoracic tarsi was also clearly indicated. More segments had to be removed from the mesothoracic tarsi than from the metathoracic to produce an equivalent result. The difference between the normal response level (9%) on antennal stimulation and response when two or three of the four functional legs were removed (22%–43%) is highly significant. Thus the development of responsiveness to antennal stimulation was graded and not all-or-none.

A behavioral observation made during these tests is worthy of note. When the tarsi of intact animals touched a liquid surface, the antennae were only occasionally dipped toward the surface. When, on the other hand, the tarsi of animals from which two or more terminal segments of the tarsi had been removed were similarly touched to a liquid surface, the antennae were almost invariably drawn to the surface. This reaction again suggested the substitution of one set of end-organs for another when the latter were injured or removed.

DISCUSSION

These results show that this butterfly has receptors on the tips of the antennal clubs which, when stimulated by sucrose solutions, mediate proboscis extensions only when the tarsal receptors are partially or wholly removed. Until proved absent in other species of butterflies, it would seem best to assume the presence of these receptors.

Most important, this study shows that the conditions of the

tests for locations and properties of the contact chemoreceptors are of critical importance. While electrophysiological experiments would undoubtedly discover these receptors, they would give no indication of the differential use by the insects. Behavioral tests, on the other hand, introduce the complication of often unpredictable behavior patterns. In both cases, conclusions about the role of the experimentally discovered receptors in the life of the insect must be drawn with caution. Negative results in behavioral studies particularly must be regarded as only an indication of lack of reception.

One is bound to ask why highly specialized contact chemoreceptors should be present on the antennae if they do not mediate an appropriate response when appropriately stimulated unless the tarsi are absent. Certainly under normal conditions the tarsi are present, and one might expect that the antennal receptors would thus be rendered non-functional. This, however, is not necessarily true. The conditions under which these tests were made, like any laboratory conditions, are artificial. In nature, for instance, the antennal receptors on the tips would be used while the butterfly stood on the corolla of a flower and extended the antennae into the flower. The insect would thus be stimulated simultaneously by odors as well as other stimuli which might facilitate responses. Perhaps the receptors are distance chemoreceptors under ordinary conditions which can act as contact chemoreceptors under the special conditions produced by the operations. Only by field studies with normal butterflies can the place of these antennal chemoreceptors in the normal lives of the butterflies be determined.

SUMMARY

When the tips of the antennal clubs of immobilized but otherwise normal butterflies were touched with 1M sucrose solution, the proboscis was only rarely extended. When the same procedure was followed with individuals from which the tarsi, which bear contact chemoreceptors, were removed, the response rose to 70%–90%.

Removal of the segments of the tarsi one by one showed that, as the tarsal receptors were removed, the increase in response as a result of stimulation of the antennae paralleled the drop in response as a result of stimulation of the tarsi.

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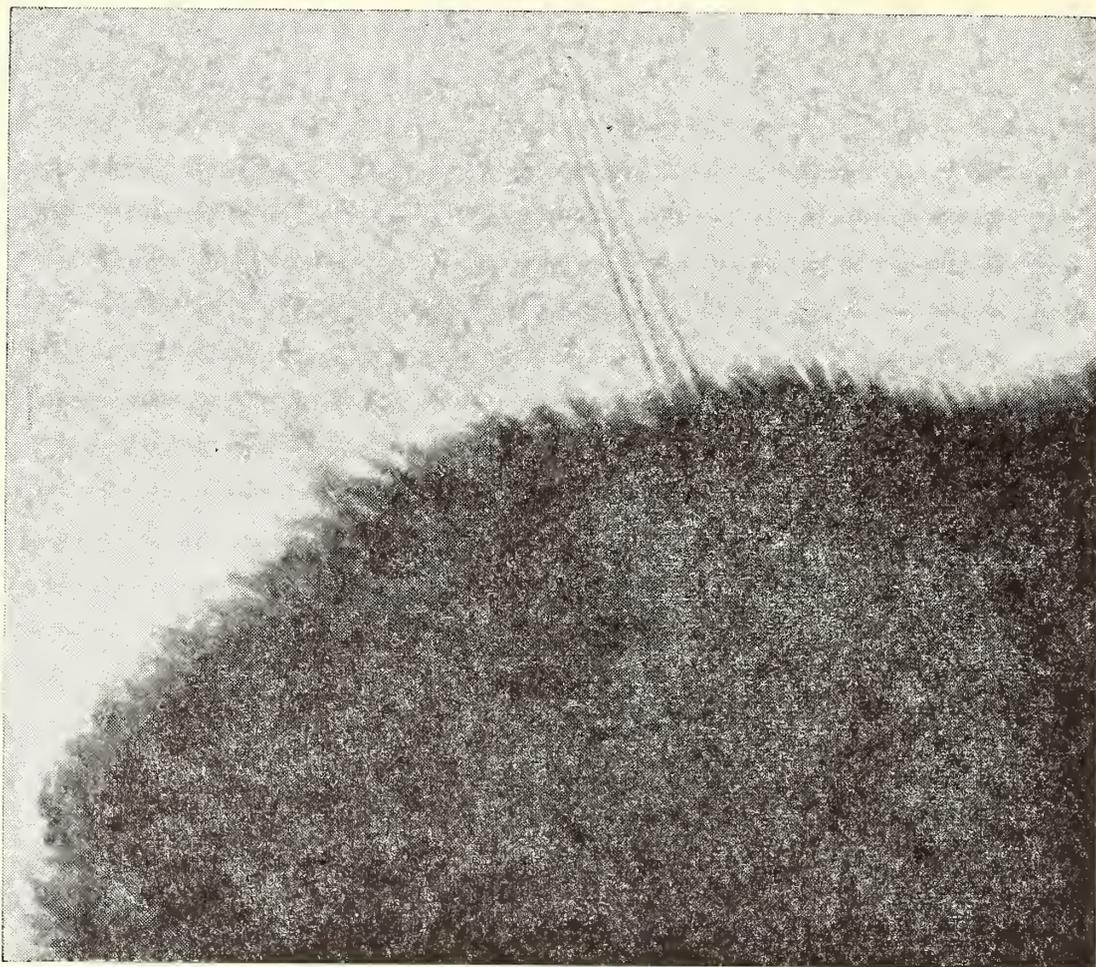


FIGURE 1. Photomicrograph of terminal segment of antenna of *C. pegala*, showing probable chemoreceptive sensillum ($\times 400$).

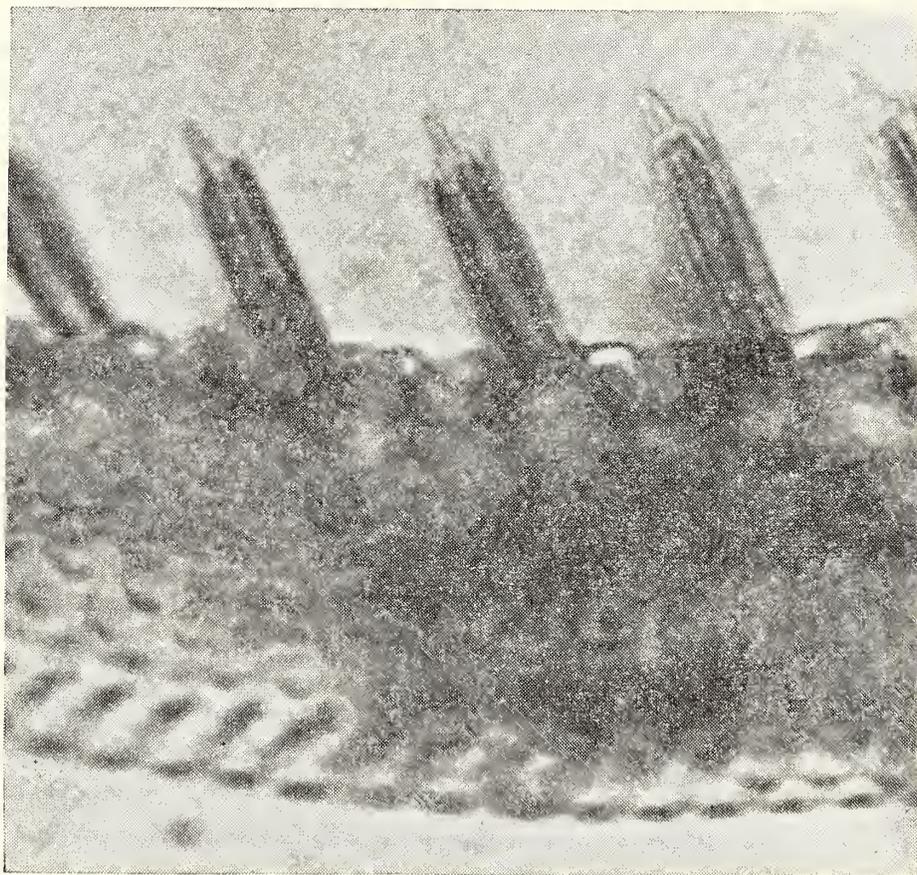


FIGURE 2. Photomicrograph of terminal portion of proboscis of *C. pegala*, with probable chemoreceptive sensilla ($\times 400$).

THE CORRESPONDENCE BETWEEN
WILLIAM HENRY EDWARDS AND
SPENCER FULLERTON BAIRD. PART II

ANNOTATED BY F. MARTIN BROWN

Two papers published by Edwards during 1862 are not noted in the correspondence he held with Baird. It seems likely that since neither one dealt with new species Edwards felt that Baird would have little interest in them. The first of the papers appeared in the March 1862 issue of the Proceedings of the Entomological Society of Philadelphia, vol. 1, pp. 182-184. It is titled "Notes on GRAPTA COMMA, Harris, and GRAPTA FAUNUS, Edwards." In it Edwards stoutly defended the identity of *faunus* distinct from European *c-album* Linnaeus. It started a long series of discussions in the literature that ultimately led to the acceptance of Edwards' argument that the American species of this genus were distinct from the Old World species.

The second paper appeared in the July issue of the same journal on pages 221-224. It is entitled "Descriptions of certain species of DIURNAL LEPIDOPTERA found within the United States, figured in Doubleday's Genera but undescribed." The four species noted are these:

1. *Argynnis astarte* Doubleday. Edwards confused Doubleday's species, a *Boloria* from the Canadian Rocky Mountains, with a form of *Speyeria mormonia* Boisduval. Dos Passos and Grey (American Museum Novitates, no. 1370, 1947, p. 23) settled the question of the forms by selecting Edwards "California" citation for the "type", thus making *astarte* Edwards *nec* Doubleday 1862 a synonym of *arge* Strecker. The "Oregon" material probably referred to what Edwards later described as *erinna*, another subspecies of *mormonia*.
2. *Melitaea chalcedon* Doubleday. Edwards named two areas from which he had material that he considered to be Doubleday's species: "Rocky Mountains; California." The California material probably reached Edwards from Behr or may have been among the specimens he received from Ménétriés (see Dos Passos, Jour. N. Y. Ent. Soc., vol. 59, p. 138). The Rocky Mountain material probably came from the Mullen expedition (see note 12) and was collected in the Bitterroot Mountains by John Pearceall. If so it represented what Gunder later called *wallacensis*.
3. *Melitaea anicia* Doubleday. Edwards cited three localities for this

species: "Kansas; Rocky Mountains; California." The "Kansas" material probably was collected by William S. Wood in 1859 during his trip to what is now Colorado but was then Kansas. An *anicia*-like form of the species, later called *brucei* by Edwards, is not rare in the Front Range west of Denver, where we know Wood collected. The "California" material may well have been supplied by Behr and it may have represented what Behr later called *nubigena*, an insect that was frequently confused with high-altitude *anicia* from Colorado.

4. *Timetes coresia* Doubleday. Edwards specimen probably came to him from Lincecum and less probably from the Mexican Boundary Survey naturalists.

New York, 40 Wall St.
5 Jan. '63

Prof. Baird.

Dear Sir.

I intend going to Washington next week. If you will write me how many plates of the Sphingidae I sent you I will take on those since published. We have reached 14 or 15. I seem to have no memorandum of what I sent you. I hope to see Kennicott.

Yours truly
W. H. Edwards

1886

37

Jan 9 63

My Dear Mr. E.

I find record of four plates of Sphingidae only. We will be very glad to have rest [and]* to see you.

Truly yours
S. F. Baird

W. H. Edwards
40 Wall St.
N. Y.

9

New York, 40 Wall St.
10th Feby. 1863

Prof. Baird.

Dear Sir.

I have heard somewhere that a shipment of insects from Xanthus⁷⁷ (I * a large blot obscures this word.

⁷⁷ Xánthus János (Louis John Xantus "de Vesey") (1825-1894): Hungarian adventurer-naturalist, later director of the Hungarian National Museum. At this time he was a tidal observer at Cape San Lucas,—near Manzanillo, Colima,—on the west coast of Mexico. The "de Vesey" portion of his Anglicized name was assumed. He was a fantastically prolific collector of all sorts of natural history objects. See Hume, Edgar Erskine (*Ornithologists of the United States Army Medical Corps*. Publ. Institute

believe that the name) from Mexico, is expected by you. If such an one arrives, don't forget our Sphinges. Let me have any he sends for our plates. Can't I write to Mr. X. and request him to pay especial attention to *this family* and the *Butterflies*? If you approve, give me his address. If he would like to be paid for / what he sends I will pay him. I don't know what sort of arrangement you have with him, whether he collects exclusively with the Smithsonian or not.

I have sent to the British Museum for drawings of all the Sphinges in that collection that are not to be had in this country.

Yours truly
W. H. Edwards

2082

159

Feb. 13 63

My Dear Mr. E.

Write to Xantus and enclose your letter to me. I forward to him about the 5th of every month. Offer to name his butterflies and in return for a series to label all and add from your own collection of N. American specimens for him. I don't think he would care to be otherwise paid. We only expect a series: he can do what he pleases with the rest. He stipulates that the 2nd best set of everything shall go to the Hungarian National Museum.

Kennicotts things are not here yet.

Truly yours
S. F. Baird

W. H. Edwards
40 Wall St.

2139

192

Feb. 21 63

My Dear Mr Edwards.

Can you go \$100.00 towards Butterflies of Mr. Xantus expedition? I have just had long letters from him detailing in glowing colors the richness* animal especially, insect life about Colima, and announcing already a large collection of specimens. He had made arrangements to make a very thorough explorations in 200 miles radius in various directions to do which he had to incur much expense in purchase of horses, etc. He drew on me for 250.00 which I paid but had great difficulty in borrowing the money and

of Hist. of Medicine. The Johns Hopkins University. First Series. Monographs. Volume I. Baltimore, Maryland, 1942) Chapter XXXV, pp. 510-532; and, Madden, Henry "*Xantus—Hungarian Naturalist in the pioneer West.*" W. P. Wreden, Burlingame, California, 1949.

* My reading of this word is uncertain. Mr John Franklin Jameson, archivist at the Smithsonian, successor to De Atley, wrote to me on December 17, 1958, ". . . the word you read as "richness" is not distinct and could well be some other word; however, we cannot suggest a more likely candidate."

if you will furnish the sum above mentioned toward making it up you shall have the first series of Lepidoptera and I will ask Xantus to take particular pains to complete the collection. You know he expects to thoroughly explore the Three Marias, a group of tropical / islands off the Mexican coast at Mazatlan: having an entirely independent fauna like the Galapagos.⁷⁸

Xantus has all necessary apparatus for catching Lepidoptera and could easily assign a native to the express purpose of collecting these beauties.

Let me know at once what you think of the matter.

Sincerely yours

S. F. Baird

W. H. Edwards
40 Wall St.
N. Y.

10

New York 23 Feb.
40 Wall St.

Dear Sir.

I enclose a line for Xanthus or Xantus as his name may be. The former is classical I believe.⁷⁹

Do what you can for me. Especially let us have the Sphinges before they go to Europe.

Yours truly

W. H. Edwards

Prof. Baird

11

New York, 40 Wall St.
26 Feby. 1863

Prof. Baird.

Smithsonian Ins.

Washington, D. C.

Dear Sir.

I received yours of 21st the day after I wrote you respecting Xantus. I hardly know how to spare \$100 now, but I have determined to make the venture and save it some other way. When I am able to do anything of this sort, it gives me pleasure. We will hope for better times and money plentier some day to come.

I shall trust to you to make it plain to Mr. Xantus / that I am to have *at least* a complete series of the Butterflies he takes, and the Sphinges and the family *Catocala* or *underwing* moths, which is the only family of moths

⁷⁸ The Tres Marias Islands (approx. 21° 30' N. Lat., 106° 30' W. Long.) lie about 70 miles off the coast of the state of Nyarit, Mexico. Baird was a little too enthusiastic about the isolation of the islands. The biota is only slightly modified Mexican.

⁷⁹ Both Xanthus and Xantus are classical Greek. The former meaning yellow the latter having to do with carding wool.

I care about. I am now working them up and wish much to get the Mexican species, of course. I shall be glad of duplicates when any are to be spared—but the above series I wish and it is to be for my own private collection. If you wish one preserved for the Smithsonian, I will take care of it.

Especially call his attention to the Sphinges, for we want all the material / we can get while our work on the Sphinges is in progress. In the 3 Marias he certainly must get some new species of this family, and any where in Mexico there must be rare ones even if they be described, that we need in order to give truthful colorings.

Yours truly
W. H. Edwards

The check is certified.

2186

223

Feb 28 63

My Dear Mr. Edwards.

Yours of 26th is just to hand with its enclosure. Many thanks in Xantus name for the advance: it will aid in enableing him to increase the scope of his operations: and I am sure will yield you good returns.

I will see that you get the butterflies as you want and hope you may be well repaid: though you I know are willing to use your means to advance science in general: care of the results in your own department be secondary.*

Keenicotts things not yet arrived, though early expected.

Truly yours
S. F. Baird

W. H. Edwards
40 Wall St.
N. Y.

2186**

223

Feb 28 63

W. H. Edwards, 40 Wall St. N. Y.

has sent me check on Manhattan Company for 100.00 for Xantus exploration.

He stipulates for one full series of Butterflies: Sphinges, and *Catocala* or underwing moths.

S. F. Baird

See letter of Feb 26, 63.

Edwards made no reference in any of the letters he wrote to Baird at this time of the first of his series of descriptive papers

* The part of the sentence from the second colon onward is archaic. I understand it to mean that Baird believes Edwards will put the general advance of science before his own gain of butterflies.

** This is the same number as the letter to Edwards written the same date. It seems to be a memorandum for file acknowledging the debt to Edwards, or, a receipt for the money and sent to Edwards.

published in the Proceedings of the Entomological Society of Philadelphia, vol. 2, pp. 14–22, bearing the title “Descriptions of certain species of DIURNAL LEPIDOPTERA found within the limits of the United States and British America.”, published in March 1863. The paper was illustrated with three plates of black and white drawings and was primarily devoted to the descriptions of new Skippers.

1. *Colias alexandra*, nov. sp. “From Pike’s Peak; in the Society’s collection; 6 males, 1 female. The second female is from the collection of Mr. George Newman and was taken among the Rocky Mountains, some years ago, by Mr. Wood.” The Newman specimen was collected in the area west of Denver in 1859 by William S. Wood. The Pike’s Peak material probably was collected between 1860 and 1862 by Winslow J Howard. (See Brown, *Entomological News*, vol. 68, pp. 41–47, 1957.)
2. *Thecla clothilde*, nov. sp. “Taken near Quebec, C.E., [Canada East] by Rev. Mr. Provancher.” (1820–1892) See Carpenter, 1945, p. 81; 1953, p. 323. Edwards later recognized that he had created a synonym of his earlier species *laeta* (1862) and listed *clothilde* as such in his 1877 catalogue.
3. *Hesperia mystic*, nov. sp. “Connecticut; Michigan; Canada West.” Here is a puzzle! Recent use of the name *mystic* associates it with Scudder, not Edwards. Apparently both Edwards and Scudder used *mystic* for the same insect and both published the name at about the same time, claiming it for a new species. Scudder’s name was published on page 172 of volume 3 of Proceedings of the Essex Institute. This volume spanned four years, 1860–1863.

The problem is the precise date of publication for the pages involved in the Proceedings of the Essex Institute. Various cataloguers use dates ranging from 1862 (Edwards, 1872; Strecker, 1878) to 1865 (Evans, 1955). The two men who should know best, Edwards and Scudder, disagree and each credited the name to the other! In the “Synopsis of North American Butterflies” published by Edwards in the Supplement to volume 1 of “Butterflies of North America” in January, 1872, page 46, this is found: “1. MYSTIC Scudder, Proc. Essex Inst. 1862. Edw. Proc. Ent. Soc. Phila. 1863, pl. 1.” At the head of his article upon the species in “Butterflies of Eastern United States and Canada” volume 2, p. 1705, 1889, Scudder wrote: “*Hesperia mystic* Edw., Scudd. Proc. Ess. Inst. iii: 172–173 (1863); Proc. entom. soc. Philad., ii: 15–16, pl. 1, fig. 3, 4 (1863); . . .”

I inquired of my good friend Mr. Cyril F. Dos Passos his opinion upon this matter. He wrote to me on December 18, 1958 as follows: “*Hesperia mystic* should be referred to Scudder with the date April 1863. This information is taken from my separate of his paper at the top of which is printed ‘(From the Proceeding of the Essex Institute, Salem, Mass. Vol. III., Read at the Meeting of March 10, 1862.—

Published April, 1863.)' This was a *mss.* name of Edwards and doubtless he had Scudder corresponded about it, hence its use by the latter"

My own inquiry suggests that the March issue of the Proceedings of the Entomological Society of Philadelphia for 1863 may have been released as late as April of that year. It is evident from Edwards letter dated March 17, 1862, that the February 1862 issue was in press a month later than the date on the signatures.

"Michigan" material possibly from Mr. M. Miles, of Lansing, Mich. "Canada West" probably from Kennicott collected on Red River of the North (1857) or vicinity of Lake Winnipeg (1859). "Connecticut" material may have been caught by Edwards himself.

4. *Hesperia huron*, nov. sp. "Illinois; Georgia; Texas; Washington, D. C." The sources of material probably were: Illinois—possibly Benjami D Walsh; Georgia—possibly Jas. Ridings, nr Atlanta; Texas—probably Gideon Lincecum, Washington Co.; Washington, D. C.—Drexler.
5. *Hesperia conspicua*, nov. sp. "Lansing, Michigan, from Mr. Miles."
6. *Hesperia pontiac*, nov. sp. "Lansing, Michigan, from Mr. Miles."
7. *Hesperia logan*, nov. sp. "Lansing, Michigan, from Mr. Miles. Philadelphia, from Mr. George Newman."
8. *Hesperia delaware*, nov. sp. "Philadelphia, from Mr. George Newman." This is the male of *logan* which was described from females.
9. *Hesperia uncus*, nov. sp. "Philadelphia, from Mr. George Newman." Apparently this specimen was improperly ticketed by Mr. Newman. The species is not known east of Kansas. Since Newman received some of the material collected by William S. Wood in what is now Colorado it seems very likely that the true type locality for *uncus* is the vicinity of Denver, Colo.
10. *Hesperia ocala*, nov. sp. "Georgia; Florida; Texas." The probable sources of material are: Georgia—possibly James Ridings, nr. Atlanta; Florida—possibly A. W. Chapman; Texas—probably Gideon Lincecum, Washington, Co.
11. *Hesperia mandan*, nov. sp. "Lake Winnipeg, from Mr. R. W. Kennicott." Probably collected in 1859.
12. *Hesperia omaha*, nov. sp. "Taken at Pike's Peak; from the collection of Mr. Newman." This is another improperly labelled specimen from Newman's collection. Edwards' *omaha* is a synonym of *palaemon* Pallas, as is *mandan* Edwards. The species has never been taken in Colorado and certainly is not found in the Pikes Peak region, an area in which I have collected for almost thirty years.
13. *Hesperia wyandot*, nov. sp. "Taken on Long Island by Mr. Calverley; at Washington, D. C. by Mr. Drexler."

12

New York, 40 Wall St.
7 Apl. 1863

Prof. Baird.

Dear Sir.

I have just ret'd. from West Virginia⁸⁰ where I have been these five

weeks past. I heard in Phila. that Kennicott's things had arrived. If you get leisure send me the butterflies. I am impatient to see what the Yucon produces.

Truly yours

W. H. Edwards

Walker^{s1} of the B. [British] Museum has undertaken to get us figures printer [printed?] their coll. of Sphinges in the Museum.*

1924**

cf. 22

13

New York, 40 Wall St.
20th Apl. 1863

Prof. Baird.

Dear Sir.

Yours of 18th is recd.^{s2} I shall move to Newburgh next week Monday and soon after will send you the eggs you covet. If Kennicott sends the butterflies tell him to direct them to Newburgh. I probably shall not be there after 1st June, as I am planning to spend the summer in West Virginia and other foreign parts.

Ross called and left a few butterflies in not remarkably good order. Nothing new, I think. He seems a jolly fellow and I was glad to meet him.

If Mr. Osbert Salvin^{s3} has gone to London with his butterflies, I fear he is lost to us, except in so far as he may wish some species and will

^{s0} Western Virginia did not cede from the Union during the Civil War. It was loyal to the Government and as a reward was granted statehood on June 20, 1863. However Congressional action during December, 1862, and signed by President Lincoln on the last day of the year, assured statehood.

^{s1} Francis Walker (1809-1874): famous lepidopterist at the British Museum known for his enormous contribution to the study of Heterocera. (See Carpenter, 1945, p. 108; 1953; p. 342).

* Much of this postscript is difficult to read.

** This reference number in the upper left hand corner of the letter means nothing to me. I can see no connection between this letter and No. 22.

^{s2} There is an hiatus in Baird's copy-books. The letter referred to is among those missing. So far no letter to Edwards has been found between those dated Feb. 28 '63 and Dec. 23 '63, and Jan. 16 '64 and May 15 '64. Edwards' letters to Baird for the latter period are some what tangled. See my note to his letter of 18 May 1864.

^{s3} Osbert Salvin (1835-1898): co-author of "Biologia Centrali-Americana. Rhopalocera" with Frederick DuCane Godman (1834-1919). Salvin did not live to see the entire three volumes completed. He and Godman were in Guatemala in 1861. The introduction in the first volume of the Rhopalocera noted above tells us that on p. xxviii, but does not mention any trip of Salvin in 1862 or 1863. Possibly this refers to his return from Guatemala. (See Carpenter, 1945, p. 89; 1953, p. 329).

exchange for them. Hewitson,⁸⁴ Saunders⁸⁵ and Walker are so assiduous in London, that they would at once get the choice of any collection. He may have some new Sphinges at any rate and I will write him.

Yours truly
W. H. Edwards

14

Newburgh, New York
4th May 1863

Dear Sir.

Much obliged to you for the list of Mr. Kerr, which I return. They are named from obsolete names throughout. There are several I would like and hope the gentleman will exchange us those.

I sent you the two eggs you especially wanted. Hereafter I will either send you my collection or I will make out a list from which you can determine what you wish. But just now, what with moving here from New York, and getting settled, making garden or, and lots of back work with butterflies, I am hard driven. Hurry up Kennicott. I shall be off to Virginia again in June, and would like to do up any new work before I go.

Yours truly
W. H. Edwards

15

Newburgh, New York
11 May 1863

Prof. S. F. Baird

Dear Sir.

The box of butterflies from Kennicott came safely on 9th inst. The contents were interesting, though I think there is no new species there. They are the same as Mrs. Ross sent last year with exception of one *Colias* which Mr. Ross brought in a few weeks ago, and which I think may be new.⁸⁶

⁸⁴ William Chapman Hewitson (1806-1878): gentleman-lepidopterist, author of many fine works on butterflies. His collections were willed to the British Museum and were the finest in existence at the time. (See Carpenter, 1945 p. 45).

⁸⁵ William Wilson Saunder (1809-1879): gentleman-lepidopterist; Hewitson drew upon his fine collections for some of the material figured in *Exotic Lepidoptera*. (See Carpenter, 1945, p. 90).

⁸⁶ I have found no reference by Edwards in his correspondence with Baird of his second paper entitled "Descriptions of certain species of DIURNAL LEPIDOPTERA found within the limits of the United States and British America." published in the Proceedings of the Entomological Society of Philadelphia, vol. 2, pp. 78-82, July 1863. The species treated were these:

1. *Parnassius sayi*, nov. sp. "From the Society's collection. Taken at Pike's Peak." The type probably was captured by Winslow J. Howard in 1860-1862.

There is also an *Argynnis* that I have not seen before.

It is curious that among the few ($\frac{1}{2}$ dozen) from Yucon River we should have our common *Antiopa*, and certain Californian / species which I have not seen from this side of the Mountains. I am sorry that Kennicott could not have taken a few more as travellers are so scarce in the region.

I am glad you like the eggs I sent you. I had but these two left. Hereafter—say next winter—I will make out a list of what I have* but I doubt if I have anything that will be rare to you. Give my regards to Mr. Kennicott.

Yours truly
W. H. Edwards

Smithsonian**
Dec 23
1863
Institution

Newburgh, New York
21 Dec. 1863

Prof. Baird.

Dear Sir.

Do you get any insects from Xantus? I hear he was expected home in November.

We have received from London three sheets of *Sphinges* drawn for our book under the superintendance of Mr. Walker from B. Museum collection,

-
2. *Colias christina*, nov. sp. "Taken at the portage of Slave River, by Mrs. Bernard C. Ross, late of Fort Simpson, for whom I have the honor to name this fine species."
 3. *Colias helena*, nov. sp. "From Mackenzie's River taken by Mrs. Ross." I believe this is the *Colias* referred to by Edwards as among the butterflies collected by Kennicott in Edwards' letter to Baird dated 11 May 1863.
 4. *Lycaena amica*, nov. sp. "From Mackenzie's River taken by Mrs. Ross."
 5. *Melitaea texana*, nov. sp. "Texas." Probably captured by Geideon Lincecum (1792-1874). (See Carpenter 1945, p. 60; and Geiser, S. W., "Naturalists of the Frontier").
 6. *Anthocharis ausonides*, Boisduval. "California from Dr. H. Behr; Youcon River, from Mr. R. W. Kennicott; Pike's Peak, in the Society's collection."
 7. *Chionobas chryxus* Doubleday. "Taken near Pike's Peak; from the Society's Collection." The Pike's Peak specimens of *ausonides* and *chryxus* probably were collected by Winslow J. Howard in 1860-1862. The three species noted, suggest that the Pikes Peak collection was made somewhere between 7000 and 9000 feet elevation, probably in the Ute Pass area.

* I cannot read this word.

** This inscription is in the form of an horizontal oval hand-stamped in the upper left corner of the letter below which Baird had scrawled Dec 23. Hereafter the notation Red *date* indicates this or a similar stamped date.

in all containing about 20 species never before figured. This brings us to plate 20 and I dont know if we have material enough to complete that. I relied on Xantus to get us a few new species.

What is Kennicott doing?

Yours truly
W. H. Edwards

4160

321

[Dec] 23 63

My Dear Mr. Edwards

Xantus is still at Manzanillo and I hope will remain some months longer. Six boxes of his collections are long over due.

Kennicott will be here next week.

Do you remain all winter in Newburg.

Yours truly
S. F. Baird

W. H. Edwards

Newburgh

H. W. Bates is now publishing the new species of Butterflies from the Isthmus & Central Am. collected by Salvin. The 1st paper Pr. Zoo. Soc. June [?]* 23, 1863 describes 6 new species all from the Isthmus Panama of 31 in all.⁸⁷

4323

41

January 16 64

My Dear Mr. Edwards

Yrs. of 15 just to hand. If the eggs from Para⁸⁸ are accompanied by the parents in any of these I would be glad to have them and give others for them. but if not so being capable of determination, they will be of comparatively little value.

Sincerely yours
S. F. Baird

W. H. Edwards

Newburgh

3974

Red May 10 (*sic*) 1864

Newburgh, New York
10th May 1864

My Dear Sir.

Do you expect anything for me from Xantus. I have heard that he was

* The month name did not transfer to the copy-book page.

⁸⁷ "On a Collection of Butterflies Brought by Messers Salvin and Godman from Panama, with Remarks on Geographical Distribution."

⁸⁸ The letter from Edwards has not been found. It seems very likely that the eggs refered to here are some that Edwards collected or purchased during his stay at Para and on the Amazon in 1846. This is described by him in his first publication "A Voyage up the River Amazon, including a residence at Para." New York, 1847, 16 mo, 256 pp.

not intending to return to this country and that his collections would not come here. Is that so? I send you by this mail a paper of mine on butterflies.⁸⁹ You will see that the tribe [is] not yet exhausted.

Yours truly

W. H. Edwards

What is Kennicott doing?

⁸⁹This probably refers to his "Descriptions of certain species of DIURNAL LEPIDOPTERA found within the limits of the United States and British America, No. 3" published in the Proceedings of the Entomological Society, Philadelphia, 2: 501-507, March 1864. The species described in this paper are the following:

1. *Pieris nasturtii* Boisduval *in litt.* "San Francisco; from Dr. Behr . . ."
2. *Pieris vernalis*, nov. sp. "In the collection of Mr. Geo. Newman and Mr. Wilt are several specimens, taken, as I am informed, at Red Bank, New Jersey, in the month of May . . ."
3. *Eresia cincta*, nov. sp. "Texas. Florida." The Texan material may have been collected by Gideon Lincecum. See my note 40, under *Melitaea minuta*. I do not know the source of the Florida material. Possibly it was collected by A. W. Chapman. Edwards later considered *cincta* to be a synonym of *texana* and so placed it in his Catalogue of 1877.
4. *Argynnis hesperis*, nov. sp. "From the Rocky Mountains" This may have been collected by William Wood or Winslow Howard (see Brown, Entomological News, vol 68, pp 41-47, 1957) Edwards suggestion in *Butterflies of North America*, vol 1, *Argynnis* VII that James Ridings was the collector cannot readily be accepted. Ridings did not collect in Colorado until the season of 1864, after this paper was published. The actual month of issue for the Proceedings of the Entomological Society of Philadelphia probably are given accurately on the signatures.
5. *Argynnis epithore* Boisduval *in litt.* "From a male sent me from California." Probably sent by Behr.
6. *Melitaea mylitta* Edwards 1861 (see note 40), additional notes and statement that *collina* Behr is a synonym.
7. *Melitaea pallida*, nov. sp. "Texas, Kansas" See *Eresia cincta* above for "Texas." The Kansas material may have been collected by Wood when eastern Colorado was part of Kansas. See the reference given under *Argynnis hesperia* above.
8. *Melitaea phaon*, nov. sp. "From St. Simon's Island, Georgia; Northern Georgia."
9. *Lycaena echo*, nov. sp. "California from Dr. Behr"
10. *Lycaena lycea*, nov. sp. "Rocky Mountains" See the note under *Argynnis hesperis* above. Both of these species are common in the Front Range directly west of Denver, Colorado.
11. *Hesperia nemoris*, nov. sp. "Taken at Portsmouth, Ohio, by Mr. John Bolton." Cresson, 1909, p. 52 lists Bolton as a member of the Entomological Society of Philadelphia (American Intomological Society) elected August 11, 1862 and living in Portsmouth, Ohio.

5349

40

May 15 64

My Dear Mr. Edwards.

Yours making inquiry about Xantus was duly received. He is now in Washington and has been here for several weeks recovering from his fever. He will leave in a few weeks for Hungary.

About the Butterflies he tells me that for want of pins he could do but little, and that the collection made is of trifling account, not worth any money. He has accordingly paid back to me the \$100.00 you sent, and it is subject to your order. Will you trust it to mail, or how shall I send it.

Sincerely yours

Spencer F. Baird

W. H. Edwards

Newburgh

N. Y.

4052

Rcd May 20 1864

22⁹⁰

Another numbering series was begun for 1865. It appears as though there are two Edwards' letters missing, probably written before 10 May and after the first of the year.

Newburgh, New York

18 May 1864

Prof. Baird.

Washington

D. C.

Dear Sir.

I am sorry to hear by your letter of 15 that Xantus made me no collections. I would rather have had the butterflies than the money, but as it falls out otherwise, you may send me money by mail unless you can readily get me a draft on New York.

Yours truly

W. H. Edwards

5440

93

May 20 64

My Dear Mr. Edwards

I send the 100.00 of Xantus in registered letter by mail. Please send me receipt.

Truly yours

S. F. Baird

W. H. Edwards

Newburgh

⁹⁰ The "paging" numbers of these letters of Edwards are somewhat confused at this point. A concordance of numbers and dates is this:

No. 15 (u.l.) 11 May 1863 from Newburgh

No number 21 December 1863 from Newburgh

No number 10 May 1864 from Newburgh

5489

104

May 24 64

My Dear Mr. Edwards

I sent yesterday in a registered letter a 100.00 bill the return by Mr. Xantus of your subscription. Please acknowledge.

Truly Yours
S. F. Baird

W. H. Edwards
Newburgh
N. Y.

17

Newburgh, New York
25th May 1864

Prof. Baird.

Dear Sir.

The letter with \$100 enclosed from Xantus came today. Much obliged to you for your trouble in the matter.

I also received from Mr. Uhler⁹¹ by your direction a day or two since, a lot of butterflies from Cuba. They were in wretched order and I threw out most of them, but a few were interesting. It is a pity Mr. Wright⁹² shd. take so much trouble in collecting only to have the specimens spoiled for want of good manipulation or packing. I would be very glad to pay him, if he wishes remuneration, for a lot of good specimens. You can tell me what I could do in the case with him. His boxes contain ½ or more specimens over and above what they ought. They are damaged by crowding and all sorts of ragged specimens are sent, even when a dozen of a species are sent. Where the / species is rare, a poor specimen is better than none, but where it is common, he would do well to reject any but literally perfect ones.

Yours truly
W. H. Edwards

6209

380

Oct 21 64

Dear Sir:

We have just received from our correspondent Carmiol⁹³ in the interior

No. 22 (l.r.)	18 May 1864 from Newburgh
No. 17 (l.r.)	25 May 1864 from Newburgh
No. 18 (l.r.)	24 November 1864 from Newburgh

⁹¹ Philip Reese Uhler (1835–1913): librarian of the Peabody Institute, Baltimore, Maryland; interested in economic entomology and hemiptera; Edwards named *Oeneis uhleri* in his honor. (see Carpenter, 1945, p. 106; 1953, p. 339).

⁹² —see note 51.

⁹³ Julian Carmiol (—): I can find nothing about this man. He shipped various kinds of natural history specimens, especially bird skins,

of Costa Rica a lot of 200 or more Lepidoptera in apparent good condition in folded papers. They are for sale to the highest bidder. Shall I send them on for you to look at and appraise.

If there are duplicates in the lot, I would be glad to have them saved for Mr. Salvin of England, unless you greatly prefer to keep the whole. He will pay good prices for anything sent but I think you ought to have the refusal of the collection.

Sincerely yours
S. F. Baird

W. H. Edwards
Newburgh
N. Y.

6287

435

Oct. 30 64

Dear Mr. E.

Did you get a letter I wrote you about a lot of butterflies from Costa Rica. Let me know if you want them or whether I shall send to Salvin in a week or two.

Yours truly
S. F. Baird

W. H. Edwards
Newburgh
N. Y.

6391

497

Nov 6 64

My Dear Mr Edwards.

I wrote you twice to Newburgh [(]is not this your present address) respecting a collection of some 200 Costa Rican Butterflies we have for sale to highest bidder but as yet without reply. I now send this to Cresson⁹⁴ asking him to forward to you. Please let me know soon as I must send to Osbert Salvin if you dont care for them.

Truly yours
S. F. Baird

W. H. Edwards

to the Smithsonian Institution about this time. That Salvin purchased some material from Carmiol is witnessed by the type of *Dismorphia cinerascens* Salvin (Ann. & Mag. N. H. ser. 4, 7: 415. 1871). Since Godman made no mention of Carmiol among the regular collectors for Godman and Salvin in connection with the "Biologia" (see Lepidoptera-Rhopalocera vol. 1, p. xxi of the "Biologia") I take it that this lot in Baird's hands may have been the source of some Carmiol material noted in the "Biologia."

⁹⁴ Ezra Townsend Cresson (1838-1926): a founder, with James Ridings and George Newman, of the Entomological Society, Philadelphia, later called the American Entomological Society, in 1859. Cresson was Corresponding Secretary of the Society at the time of this letter. He played a large part in producing Edwards "Butterflies of North America," Vol. 1. (see Carpenter, 1945, p. 20; 1953, p. 278).

18

Newburgh, New York
24th Nov. 1864

My dear Sir.

I returned home last evening after seven weeks in coal and oil in West Va. I found three letters from you respecting the Costa Rica Butterflies. I do not think I will make an offer for them. They are not strictly in my line. I am obliged to you for the opportunity. If there is / Sphinx among them I beg you to reserve it for our publication. By the way we have reached the 20th plate.

I have made fine collections in Va. the past summer. Especially in taking the ♀ of *Argynnis Diana*, not before known. It is black while the ♂ is fulvous and differs in markings. It is the most singular variation we have in our fauna. Pap. Turnus has black ♀ also, / but then it has yellow ones, while there appear to be only black ♀ of *Diana*. I saw 100 I suppose of them. We may expect to find fine things in the Southern States. When we are at liberty to explore them. H. W. Bates⁹⁵ (Amazonian) to whom I sent one of the ♀ has sent me an essay for publication on this curious variation in the / sexes. I am absent from home more than half the time now. My address is Charleston, W. Va. when not here. If you ever write me here again and get no answer, direct to the other place.

Yours truly
W. H. Edwards

Prof Baird
Washington, D. C.

It is curious that Edwards did not mention in this letter that he was publishing an article about the female of *diana* and another about the *Argynnids* of California. These are successive articles in the third volume of Proceedings of the Entomological Society of Philadelphia, pp. 431-434 and 434-436 respectively in the November issue. Although the first article is titled "Description of the Female of ARGYNNIS DIANA." it is much more. In it Edwards related in detail the habits of both sexes of the species and concluded the brief paper with a summary of the butterflies he found in the Kanawha region. It

⁹⁵ Henry Walter Bates (1825-1892): Coleopterist and general entomologist and naturalist of renown. His classic, "A Naturalist on the Amazon," written after many years residence upon the river, is a mine of information for the tropical biologist. He and Wallace conceived the idea of their Amazonian venture after reading Edwards' "A Voyage up the River Amazon, including a residence at Para." New York, 1847, and a meeting in London with Edwards. (see Carpenter, 1945, p. 6; 1953, p. 263)

would have been better if Edwards had not published the second paper "Notes on the ARGYNNIDES of California." In it he summarized two papers of Behr read before the Lyceum of Natural History of San Francisco, and further confused the situation.

Bates' paper alluded to in the letter, "Notes upon the variation of sexes in ARGYNNIS DIANA." appeared on pages 204-207 of the January, 1865, issue of the Proceedings, and is an interesting discussion of sexual dichromism.

The
New York Entomological Society

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Nos. 3, 4

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September, December, 1959

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of the
New York Entomological Society

Devoted to Entomology in General

Editor Emeritus HARRY B. WEISS



Edited by FRANK A. SORACI

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Journal of the New York Entomological Society

VOL. LXVII

SEPTEMBER-DECEMBER

Nos. 3, 4

THE CORRESPONDENCE BETWEEN WILLIAM HENRY EDWARDS AND SPENCER FULLERTON BAIRD. PART III.

ANNOTATED BY F. MARTIN BROWN

A fire at the Smithsonian Institution on January 24, 1865, destroyed the upper floor of the building and there was considerable water damage done on the lower floors. Just how much of Baird's correspondence was destroyed or made useless by this catastrophe is not clear. Very fortunately Baird kept most of his records at home. Thus only that portion in his office may have been affected. The last letter from Edwards in 1864 that is now preserved in Baird's files is dated November 24. The first letter in the files for 1865 bears the date April 13 and the statement that he, Edwards, had just returned from three months in West Virginia. The tenor of the letter suggests that he had not been in correspondence with Baird during his absence from the East. Thus it seems likely that little or no correspondence between the two was lost in the fire or because of it.

During this period Edwards published his fourth paper devoted to new species in the Proceedings of the Entomological Society of Philadelphia ("Descriptions of certain species of DIURNAL LEPIDOPTERA found within the limits of the United States and British America No. 4." vol. 4, pp. 201-204, January 1865.). Seven species were described for the first time.

1. *Melitaea picta*, nov. sp. "From six specimens taken by Mr. Ridings in Nebraska Territory." The specimens were taken on the plains along the old wagon road to Denver in the summer of 1864. According to Dr. Eric G. De Flon of Chadron, Nebraska, in a letter (15 Jan. 1959) describing the old wagon routes westward in Nebraska ". . . a Stage from Omaha to Denver and the Rockies would have followed much the

same route from Kearney, to North Platte, to Julesburg, Sterling, Fort Lupton and Denver." The route in Nebraska paralleled the Platte River to North Platte and then the South Platte River to Julesburg and the Colorado towns.

2. *Satyrus ridingsii*, nov. sp. "From four females taken by Mr. Ridings at Burlington, Boulder Co., Colorado." Burlington, Boulder Co., is not to be confused with the present city of Burlington, Kit Carson Co., near the Kansas border. It is an old and abandoned name for the present city of Longmont, Boulder Co.
3. *Hesperia napa*, nov. sp. "Taken at Empire City, Colorado Territory." Empire, Clear Creek Co., now is almost a ghost town at the eastern foot of Berthoud Pass on Colorado Highway 281 about a mile west of the junction of 281 and U. S. Highway 6. The collector was Ridings.
4. *Hesperia maculata*, nov. sp. "Taken at New Orleans by Mr. Norton." Edward Norton (1823-1894) of Farmington, Connecticut, was long a friend of Edwards and a specialist on Hymenoptera. (see Carpenter, 1945, p. 74)
5. *Hesperia viator*, nov. sp. "From a male taken by Mr. Arthur Christie, in Northern, Illinois. The female in my possession was sent by Mr. E. Norton from New Orleans." Christie is not listed in Miss Carpenter's Bibliography (1945) nor the supplement (1953).
6. *Hesperia ricaria*, nov. sp. "From six specimens taken by Mr. Ridings at Empire City, Colorado Territory." The species is a synonym of *Pyrgus ruralis* Boisduval.
7. *Lycaena rustica*, nov. sp. "From two males, one female, taken at Pike's Peak by Mr. Ridings." The species is abundant in the Pikes Peak region above 9,000 feet elevation.

[Red. April 16, 1865]

304

New Haven, Conn.

Apl. 13, 1865

Prof Baird,

Dear Sir.

I returned home this day after a three months absence in W. Va. I found a letter from Dr. H. Behr⁹⁶ of San Francisco dated 28th Feby. saying he had sent for me to the Smithsonian a box of insects. If you have recd. this forward it to me at this place, and please be very careful to have it enclosed in a secure box with straw about it. Direct it to 203 Orange St. New Haven. I took a furnished / house here last fall, and shall not return to Newburgh before 1st May.

I enclose you a proof of a drawing of *Argynnis Diana* ♀ that Cassin⁹⁷

⁹⁶ Dr. Hans Herman Behr (1818-1904): a physician-naturalist living at the time in San Francisco. (See Carpenter, 1945, p. 7; 1953, p. 264.) In his "Reminiscences", (dosPassos, 1951, p. 138), Edwards states that he first communicated with Behr in the early 1860's. This must have been before April, 1862, since in the paper he published then (see note 58) he described several specimens received from Behr.

has made for me. It is a remarkable case that the ♀ of *Diana* shd. be black while the ♂ is brown yellow. You can see the ♂ in Say's works.⁹⁸

I propose publishing a monograph of the *Argynnides*⁹⁹ of this country after the style of Hewitson's *Exotics*,¹⁰⁰ quarto. Cassin has drawn *A. Atlantis*¹⁰¹ / also, and I will follow it up as I have leisure. We have nearly 30 species, many very large sized ones, Californian mostly, and such a work will be handsome as well as useful to entomologists.

I have to spend most of my time now in West Virginia, among the coal mines

Yours truly
W. H. Edwards

7767

7

Ap. 16 (?) 63

My Dear Mr. Edwards.

Yours of the 13 is to hand. Nothing has been received from Dr. Behr for you, but as soon as any has arrived I will forward it. If I understand aright I send to Newburgh after May 1.

Your monograph of *Argynnis* will be very interesting and acceptable. I hope it will be regularly published¹⁰² so as to be available to science. Dont fail to send us a copy.

Sincerely yours
S. F. Baird

⁹⁷ John Cassin (1813-1869): printer-ornithologist, with side interest in insects. (See Carpenter, 1945, p. 16; 1953, p. 274) At this time Cassin was associated with Bowen & Company, lithographers, in Philadelphia. (See dosPassos, 1951, pp. 143-144.)

⁹⁸ Thomas Say (1787-1834) (See note 70) (see Carpenter, 1945, pp. 90-91; 1953, p. 329.) "American Entomology, or Descriptions of the Insects of North America. Illustrated by Coloured Figures from Original Drawings executed from nature." Three volumes containing 54 plates, 1824-1828. S. A. Mitchell, Philadelphia, Pennsylvania. The figure referred to is plate 17 in volume 1 (1824).

⁹⁹ Although Edwards did not know it at the time this was the beginning of his "Butterflies of North America."

¹⁰⁰ "Illustrations of new species of Exotic Butterflies, selected chiefly from the Collections of William Wilson Saunders and William G. Hewitson." Four volumes. 1851-1871. Van Voorst. London, England. (See notes 84 and 85)

¹⁰¹ Edwards had considerable trouble finding artists to work on the stones for his illustrations, see letter dated "10 Dec 1866". This trial of *A. atlantis* may well be the one accepted and ultimately published (1868). It does not carry the name of the lithographic artist. (See dosPassos, 1951, p. 143 and footnote on p. 144.)

¹⁰² The Edwards, Weidemeyer and Calverly work on the Sphingidae was not truly published. (See letter January 30, 1862, *et. seq.*)

W. H. Edwards
203 Orange St.
N. Hav.

7997

27

April 17 65

My Dear Mr Edwards.

We have just heard from Orizaba, Mex. Six or seven boxes of lepidoptera prepared by Botteri¹⁰³ which I presume he wishes to sell. If you say so I will send on to you for examination and you can make an offer for them. If the specimens are numbered can you send me names to be returned to Botteri.

Truly yours
S. F. Baird

W. H. Edwards
New Haven
203 Orange St.
Recd Apr. 22, 1865
305

New Haven 203 Orange St.
20 Apl 65

My Dear Sir.

Yours of the 17th just recd. I shall be glad to see the Mexican butterflies you speak of, and if you will send them to me at Newburgh, I will look at them, and if I see what I like, will make you an offer for them. I shall move to Newburgh next Monday, and the following Monday shall go to West Va. Therefore send them as early as possible. You said nothing about the / box which Dr. Behr writes me he sent to me, care of the Smithsonian, and about which I wrote you last week. I should be sorry to lose that box. Write me whether you have sent it.

Yours truly
W. H. Edwards

Prof. Baird.
Smithsonian
Washington

I have just received from my brother¹⁰⁴ in Manila a snake in alcohol, quite a handsome fellow for a snake, also a / fancy fellow of the lobster family, well preserved in alcohol also.

If you wish them I will send them to you.

W. H. E.

¹⁰³ ——— Botteri (—) Cresson listed as a member, "M. Boteri, Mexico, March 12, 1866", on p. 52 of "A history of the American Entomological Society, Philadelphia, 1859-1909". published by the Society. Baird and Edwards use a spelling Botteri.

¹⁰⁴ ——— ——— Edwards (—): The best account of the Edwards family is not available to me. It is "Timothy and Rhoda Ogden Edwards of Stockbridge, Mass., and their Descendants" by W. H. Edwards, published in 1903. There is a note on the back of the last page of this letter, possibly written in pencil, reading: "The snake etc are from Manila —sent by my brother who lives there."

7857

71

April 22 65

My Dear Mr Edwards.

Yours of the 20th is to hand and the six or seven boxes of butterflies have already gone forward to you by Adams.¹⁰⁵

If the specimens are not numbered, please label a series and label it for returning.

Truly yours
S. F. Baird

W. H. Edwards
Newburgh

We will be very glad of the snake and crab. What part of the world does /*
7880 84

Ap. 26 65

My Dear Mr Edwards

We sent off today a box to your address from Dr. Behr.

Truly yours
S. F. Baird

W. H. Edwards
Newburgh

red. Apr. 29, 1865
306

Newburgh, 27 Apl. 1865

Prof. S. F. Baird
Dear Sir.

You still do not reply to my question repeated in two letters, whether the Smithsonian has recd. from Dr. Herman Behr of San Francisco a box insects for me. He says he sent it in Feby.

Excuse me writing again about this as I have but few days more at home, and am / anxious to know where this box of Behr's is.

Your Mexican boxes may arrive today.

Answer this to 40 Wall St. But if you have the box I write of, and have not sent it, forward it to Newburgh.

Yours truly
W. H. Edwards

7921

107

April 29 65

My Dear Mr Edwards.

The box of butterflies from Dr. Behr has I hope before this reached you. It arrived the very day I sent it.

Truly yours
S. F. Baird

W. H. Edwards
40 Wall St.
N. Y.

[Post script] ? Frank Leslie was luckily Jan. '65.....
Postpaid if possible and to 40 Wall Street
[all very illegible]

¹⁰⁵ The Adams Express Company.

* The postscript is incomplete.

3976?

[Red. May 7 1865]

308

Newburgh, New York

2 May 65

Prof. S. F. Baird
Washington
D. C.

Dear Sir.

The box from Dr. Behr arrived yesterday, but the other box, which I understand was sent on 21st or 22nd ult. has not reached me. Perhaps it was not forwarded as you supposed at that date.

Yours truly

W. H. Edwards

5966

Red May 12 1865

307

Phila 11 May

Prof. Baird
Dr. Sir.

I am on my way to Charleston, W. Va., where I shall be for a month. The Mexican butterflies had not reached Newburgh up to when I left yesterday. Hope to have them when I return. Probably I have arranged to sell them / all for you.

Yours truly

W. H. Edwards

8044

184

Washington, May 16 65

My Dear Sir.

I find on examination of our books that the box of butterflies was sent to your address at Newburgh April 22, not to N. Hav.

Truly yours

S. F. Baird

W. H. Edwards
Newburgh
N. Y.

In June of this year Edwards published a brief note "Notes upon PAPILIO ASTERIAS and SATURNIA PROMETHEA hermaphrodites" in the Proceedings of the Entomological Society of Philadelphia (4:390, 1865).

[Red July 11 1865]

309

Newburgh, New York

8 July 1865

Prof. S. F. Baird
Dear Sir.

I returned yesterday from West. Va. where I have been since 1st May.

I found three letters of yours here, and the box of Mexican butterflies. On examining them, I find them in very bad order, a good many were broken with the bodies lying loose about the boxes, tending to damage the legs antennae etc. I have removed all such. There are scarcely any specimens I want, / principally because none of them are perfect. All are rubbed or broken, and most of this damage either occurred before the insects were caught, or from the way they were crowded into the boxes.

I have taken 24 specimens altogether. What ought I to pay for them? and what do you wish me to do with the rest of the collection? I can send it to some collectors in Phila and New York, and let them select some things if you say so, or I can / send them to Akhurst¹⁰⁶ in Brooklyn, with orders to sell off what he can. Write me what to do.

These old collections¹⁰⁷ are good for very little. I have, through some of them, introduced the *dermestes* into my duplicate boxes and for two seasons have lost a great number of specimens, many of them valuable.

Good lepidoptera, well put up, would readily sell at 10 to 25 cents each. We have many students in this line who / would gladly buy good specimens from Mexico or elsewhere. But poor ones are not wanted at all.

Let me hear from you soon.

Yours truly

W. H. Edwards

644-*

Aug 15

310

. . . / send them to John Akurst, 9 Prospect St. Brooklyn, who will sell them under my direction.

I go to West Va. next Weds. to be there till 1st Oct. If you wish to write me, do so to "Charleston, Kanawha Co., W. Va."

I send in the box for yourself a col'd plate¹⁰⁸ of A Diana ♀ which will

¹⁰⁶ John Akhurst (1816-1902): collector-taxidermist, long established in Brooklyn, N. Y., as a dealer in objects of natural history and suppliers for collectors. There are many accessions in his name on the Smithsonian books. Whether any of the tropical material was collected by Akhurst or whether all of it was bought from native and visiting collectors I do not know.

¹⁰⁷ Apparently this refers to the old collections, such as the Herndon material, transferred from the U. S. Patent Office to the Smithsonian in 1852 and forwarded to Edwards for safe-keeping in 1861.

* This is the last leaf of a letter the first of which has been lost. In the upper left hand corner there is a notation consisting of a four (?) digit number beginning with 644 under which a line is drawn and "Aug 15" written. In the lower right hand corner is "310". The latter and the part of the letter preserved suggest that this is the proper chronological position for the fragment. However, reference to the plate of *diana* when taken in connection with Edwards' letter of February 23, 1866 is a bit puzzling.

¹⁰⁸ This cannot be either of the plates of *Argynnis diana* used in the "Butterflies of North America" but a forerunner of them. The plate of the species issued in June 1868 was drawn by Weist and figured both sexes.

please you. I intend publishing the N. A. / species of *Argynnis* in this style. About 30 species, mostly not figured.

Yours truly
W. H. Edwards

The September issue of the Proceedings of the Entomological Society of Philadelphia for 1865 contains on page 148 "Description of a new species of *Limenitis*" by Edwards. The butterfly described is *Limenitis proserpina*. Edwards himself collected the types, a male from Mountain House, Greene Co, New York, collected in 1863 and another of the same sex collected about six miles away at Stony Clove, Greene Co, New York, on August 2, 1865.

[Red. Dec 29, 1865]
311

40 Wall St., New York
28 Dec 1865

Prof Baird.

Washn D C

Dear Sir.

I am about starting for West Va. to be absent till 1st Feby. If the Mexican butterflies come during the winter, send them to John Akhurst, No 9 Prospect St. Brooklyn, with whom I have made arrange / ments to spread them and sell all but the ones saved for me.

My address in W. Va. is Charleston.

Kanawha Co.
W. Va.
Yours truly
W. H. Edwards

The next letter in this correspondence suggests very strongly that an exchange of letters is missing.

[Red Feb 19 1866]
260

Baltimore 18 Feby 66

Prof. S. F. Baird
Smithsonian

Dear Sir.

Sorry I cant go on to Washington. I am obliged to return to New York tonight.

Later this plate was withdrawn and a new one prepared by Mrs Peart was included in the Supplement to volume 1, issued in January 1873. (See letter dated July 25, 1872.)

Is there anything new or interesting in the insect way? Do you never get butterflies now from correspondents in British Ama. or the far West?¹⁰⁹ You used to have plenty of good things.

What about your Mexican friend you / wrote me of last summer? Write me at 40 Wall.

Yours truly
W. H. Edwards

P. S.

I intend to publish a monograph of the Argynnides, in quarto, drawn and colored in the best style. Have 3 plates now printed, and when I get 2 more, will issue the first part.¹¹⁰ There are abt. 35 species of this family in Ama., many Californian, and most unfigured.

Yours truly
W. H. E.

9965

577

Wash. Feb. 20 1866

My Dear Sir.

I believe nothing new has been turned up in the butterfly way since my last, although we are advised of a lot of 257 specimens from Costa Rica for sale which will be here probably in a week or less. The first lot which I offered you I sent to Mr. Salvin who found some fine new Species. I am sorry you did not take them. Sumichrast* of Orizaba¹¹¹ promises us butterflies for you after a while.

¹⁰⁹ Throughout the period of the Civil War Edwards' letters to Baird are singularly free of reference to the conflict. Here is another example of his apparent unawareness of the national, and international, situation. Although the War between the States was ended for all practical purposes in late February, 1865, the last Confederate force did not surrender until May 26th. The U. S. Army parties upon whom Baird depended for so much of the material from the West were not thinking of butterflies during the summer of 1865! To the north in British America there were equally stirring, but peaceful, changes in motion. The "Hudson's Bay Company" was fighting to hold its empire. The Dominion of Canada was about to be formed. Few people realize that a vast portion of what is today our neighbor to the north was privately held by the Hudson's Bay Company and really not an integral part of the British Empire. During the 1860s the Honourable Company of Adventurers founded under the patronage of Prince Rupert in 1670 was drastically changed and ultimately lost its sovereign rights to nearly half a continent. See Douglas MacKays "The Honourable Company", The Musson Book Co., Ltd., Toronto, Canada, new edition. 1938, especially Chaps. XVII-XVIII.

¹¹⁰ The first part was issued in June 1868. It contained the plates for *diana*, *cybele*, *aphrodite*, *nokomis* and *atlantis*. This was the first fascicle of "Butterflies of North America".

* According to the published record in the Annual Reports for 1866 *et seq*

We have not had any Lepidoptera for some time from British America although there are here several boxes very much preferred, from Kennicott expedition collected in California and probably Vancouver Island.¹¹² These might perhaps go to you for safe keeping if you want them.

Your memoir will doubtless be very interesting. Dont fail to send us a copy. Could you spare one for Salvin?

Sincerely yours
S. F. Baird

W. H. Edwards
Newburgh

[Red Feb 24 1866]

261

40 Wall St. New York
Feb 23rd 1866

Prof. S. F. Baird

Dear Sir

Yours of 20th is just received. Do let me have the keeping at least of the Califn & Vancouver spees you speak of, with the privilege of describing any new species. There is no one as familiar as I am with the Califn species, and as I am publishing the Argynnides, many of which are found / in California and are unfigured as yet, I am especially interested in having every species of that genus that can be found. I therefore look at every new collection bro't thence with great interest.

this is the proper spelling for the "hieroglyphics" in Baird's letter. Edwards read it as "Summerheart", see his letter of 17 July 1866. My first reading was "Summerhead"! Cresson (see note 103) lists "Sumichrast, Francois, Mexico, March 12, 1866." Carpenter (1945, 1953) does not list the man.

¹¹¹ Orizaba is a small town in the state of Vera Cruz, Mexico, approximately 18° 25' N. Lat., 96° 30' W. Long. It is about 3000 feet above sea level and situated about 20 miles southeast of Volcano Orizaba, 18,546 feet altitude at its crest. The region has an extraordinarily rich flora and fauna, embracing everything from the tropical rain forest to the tropical equivalent of arctic-alpine grasslands. The volcano is the southernmost outpost for many north temperate species and genera, although a few do range south to the above-tree-line crests in southern Costa Rica.

¹¹² The Annual Report of the Smithsonian Institution for 1865 notes the arrival of collections from Col. Charles S. Bulkley, director of the Russian Telegraph Expedition. These were made by Kennicott in Nicaragua and California. Baird may have confused here future plans with past accomplishments. I suspect that this omission of Nicaragua as one of the areas represented in this collection lead Tryon Reakirt, to whom Edwards sent tropical material, to assign a southern Californian type locality to several species really collected in Nicaragua. Kennicott's route in Nicaragua was up the San Juan River from the east coast to Lake Nicaragua, Lake Managua and the Pacific Ocean.

Send them to me at 40 Wall. I will retain them under whatever restrictions or conditions you impose.

This evening I / will mail you 2 plates showing the style of the work I intend to publish. I am sorry Diana ♀ is not colored — By the way perhaps I can find a col'd specimen to send you.

Do what you can for me.

Yours truly
W. H. Edwards

10—

609

Washington, Feb. 25, 1866

Dear Sir:

In compliance with Mr. Kennicott desire and your wish we send you by Adams Express the Lepidoptera thus far received from the Russian Telegraph Expedition.¹¹³ Any new species you find you are at liberty to describe, giving full credit to the direction to Col. Bulkley and to Mr. Kennicott and retaining the collection in good condition until Mr. Kennicott's return, or until it is reclaimed by us, but do not make any dispositions to be made of the specimens until Mr. / Kennicott returns, who will take charge of them.

Additional* of lepidoptera from the same expedition will be sent you for safe keeping under similar conditions.

no signature

W. H. Edwards
40 Wall St.
N. Y.

This is Baird's draft of the official letter of transmittal for the material. Such a letter, of course, would be signed by Prof. Henry, Secretary of the Institution.

¹¹³ This was a grandiose plan to construct a telegraph line from Moscow, Russia, to Chicago, Illinois! The expedition sometimes is called the Western Union Telegraph Expedition. Kennicott was the chief of the Scientific Corps, one of his assistants being Ferdinand Bischoff. Kennicott died in Alaska and his place was taken by W. H. Dall. The information gathered by the American members of the expedition played a major part in the decision of the United States to buy Alaska. The plan was abandoned when the trans-Atlantic cable proved successful. See James Alton James (1864- ?) "The First Scientific Exploration of Russian America and the Purchase of Alaska" Northwestern University Studies in the Social Sciences, No. 4., Evanston, Illinois, 1942.

* The copy-book press of the draft is very much blurred and difficult to read. The lacuna is either one or two words and nothing that I can suggest from the strokes makes sense.

262

Cincinnati, 36 Walnut St.
9 March 1866

Prof Baird.

Smithsonian
Washington

Dear Sir

I have mailed a letter to Mr. Ross and was about writing one to Govr McTavish¹¹⁴ when it occurred to me that he might know nothing about taking butterflies, and would need instructions about it, as well as net, pins etc. Therefore I have delayed writing until I hear from you about this. Write me, directing to care of R. C. Lovell,¹¹⁵ 36 Walnut St. Cine.

Tell Mr Uhlke that in W. Va. the other day I went into the woods and filled a little bottle with *Coleopa* for him. I have laid in a qt of alcohol and am about going back there. Doubtless I will secure a good lot of the animals. / Has not he facilities for obtaining butterflies in Texas among the Germans there. Before the war there used to be many collectors. I recollect some in the vicinity of New Braunfels.¹¹⁶ If Mr Uhlke can get any one to collect for me I will buy or exchange, and shall take it as a favor.

Yours truly

W. H. Edwards

10—.

681

Wash. Mar. 12 1866

My Dear Mr. E.

Gov. MacTavish probably knows how to prepare Lepidoptera but it could do no harm to tell him.

¹¹⁴ William Mactavish (1815–1870): at the time Chief Factor and governor of Assiniboia and Rupert's Land, which position he held from 1864 to 1870. His headquarters were at Fort Garry, now within the city of Winnipeg, Manitoba.

¹¹⁵ R. C. Lovell () was the agent for Edwards' company, The Kanawha and Ohio Coal Company, in Cincinnati. Later the office of the company moved to 52 Walnut Street.

¹¹⁶ This letter suggests that Edwards himself had no earlier contact with the New Braunfels, or Texan, naturalists. He may have received material through Uhlke (see note 57). For excellent accounts of the German naturalists in Texas see Samuel Wood Geiser, "Naturalists of the Frontier." University Press in Dallas, Texas. Second edition, revised and enlarged, 1948. Two New Braunfels collectors that Edwards may have had in mind are these. F. S. Lindheimer a resident of New Braunfels, Texas, who joined the Entomological Society of Philadelphia on November 14, 1859, possibly was the son of Ferdinand Jakob Lindheimer (1801–1879) although not mentioned in Geiser's account of the naturalist (l. c. pp. 132–149) nor in Appendix B. DAB. (11:273–274. 1933) does not mention any son of F. J. Lindheimer. It is possible that F. S. Lindheimer is an erratum for F. J. Lindheimer of New Braunfels. Otto Friedrich (1800–1880) lived near the site of the present town of Greune in the vicinity of New Braunfels from 1850 to the time of his death.

We have just had warm offers of service of some Germans in Texas who collect and can talk Lepidoptera to them. How much per dozen or hundred shall we offer.

Yours
S. F. Baird

W. H. Edwards
care R. C. Lovell
36 Walnut St
Cincinnati

[Red Mar. 25 1866]
263

Coalburgh, Kanawha Co.
W. Va., Mar. 19, 66

Prof. Baird
Smithsonian Ins.
Washn.

Dear Sir.

Yours of 12th recd here, forwarded from Cinc. I hardly know what to say about the German collectors in Texas. So many of their butterflies are common here also, that if we paid by the piece we should get a lot of worthless material. I cannot indicate such as are rare. All such and new species, are valuable and worth paying / for. I would be willing to pay 50 cents each for new species and 15 cents each for all others that I retained. I would rather do this than offer 5 cents each for everything.

If they will send you one shipment I can tell what the average is worth, and show them what are worth collecting & what not.

The better way to put them up is in papers. They break less and cost less to carry.

Yours truly
W. H. Edwards

10172

27

Wash. Mar 20 66

My Dear Mr. Edwards

I have received 250 Lepidoptera in paper from Costa Rica. Do you want them and what are they worth to the collector (Carmioli). I have written to Texas to some Germans for Butterflies.

Botteri is sending more Butterflies to be named. We return the enclosed names from the other lot as undecipherable. Please write out legibly and return to me soon as possible.

Truly yours
S. F. Baird

W. H. Edwards
Cincinnati

[Red Apr. 6 1866]
264

Coalburgh, Kanawha Co.
West Va., 29 Mar. 66

Prof. S. F. Baird
Smithsonian
Washn. D. C.

Dear Sir

Yours of the 20th via Cine came up on the boat this morning. I return the names for Botteri, printed carefully.

I will take the Costa Rica butterflies¹¹⁷ you speak of, at venture. The price being 10 cents. I shall leave this for home about 5th April. If I can do so, I will take / the Balte & O road and stop over in Washington.

It occurs to me that I may be able to get more than 10 cents for the Costa Rica specimens, such as I do not wish to retain. If they are in good order I could get 15 or 20 doubtless, and whatever I did get for them shd go to the collector. I do not speculate on him. I know two collectors here who would pay 15 or 20 for good / specimens. I presume there would be several duplicates.

This season is not so early as last by two weeks. I saw butterflies then on 17th Mar. and as yet have seen none this year.

Yours truly
W. H. Edwards

[Red. Apr. 10, 1866]
265

SWANN HOUSE
I. William Dent
Proprietor
Parkersburgh, West Va.

8 Apl. 1866

Prof. S. F. Baird
Smithsonian
Washn.

Dear Sir.

I thought I could go home via Washn but cannot now. Will try and return that way as I did before.

If you will send the Costa Rica butterflies to me, 40 Wall St., I will soon dispose of them & forward you the money. For what I retain I will pay 10 cents, and what I dispose of I will put at 15 or more. If they / are in good condition I can dispose of them at a good price.

When you write the Germans in Texas, please direct them to inform you when they send insects, in what locality they were taken, so that we may not get Mexican species mixed with those of the U.S. I wrote you¹¹⁸ that

¹¹⁷ These were shipped by Julian Carmiol to Baird for disposal.

¹¹⁸ This may be "I write you" but I do not think so. Although the sequence of letters does not seem to be interrupted there may be one missing here. Apparently these specimens were given to Edwards upon a visit to Baird in Washington.

the few Colorado specimens you gave me contained three or four new, or at least, unknown to me, species. One is a fine *Papilio*,¹¹⁹ which I am pleased to add / to our Fauna.

Send me any other butterflies that come from any quarter.

Yours truly
W. H. Edwards

10329 (?)

160

Washington April 1—, 1866

My Dear Mr Edwards

Yours from Parkersburg is just to hand. I will send the Costa Rica butterflies to 40 Wall St.

Please make your payment for them drafts in gold as I have to remit same [?] to Carmiol, the collector.

Will send a small lot of Numbered butterflies deposited [?] with me [?] by Dr. C. Champion.¹²⁰

Yours ever
S. F. Baird

W. H. Edwards
40 Wall St
N. Y.

This is a very much blurred transfer and difficult to decipher.

7691

[Recd. Apr. 14, 1866]

Law Office of Waldo Hutchins
No. 40 Wall Street
New York
Apl. 13th 1866

Prof Baird

Washn.

Dear Sir

I have just received the Costa Rican butterflies. Will remit you the money

¹¹⁹ This is *Papilio bairdii* Edwards which he described in the October 1866 issue of the Proceedings of the Entomological Society of Philadelphia on page 200 of volume 6. (see comments following the letter dated October 25, 1866.) Edwards was mistaken about the source of the material in this letter but he is correct in the original description. See also Edwards' letter of May 30, 1866.

¹²⁰ Champion was one of Godman and Salvin's regularly employed collectors in Central America. In the "Introduction" to the first volume devoted to butterflies of "Biologia Centrali—Americana," on p. XXVIII, there is an extended account of the areas in Guatemala and Panama where Champion collected. After Salvin's death in 1898 Champion helped Godman complete the second volume devoted to butterflies and was of especial help completing the studies of Hesperiidæ (*l.c.* p. XXIX). There is no listing for C. Champion in Carpenter, 1945 or 1953.

as desired in a few days. I found the Califn. butterflies¹²¹ that you sent a month ago.

Whoever packs the boxes of insects for you does not take sufficient care to have tow or hay between the inner & outer box. In this case one side of the inner boxes rested against the wood of the outer one and in one box the pins had shaken loose with damage to antennae etc.

I have just recd the proof of the 4th plate of my *Argynnides*.¹²²

Yours truly

W. H. Edwards

772-

[Recd Apr. 21, 1866]

267

New York, 40 Wall St.
20 Apl. 66

Prof. Baird

Washn D. C.

Dear Sir.

I took the Costa Rican butterflies over to Akhurst and opened them with him. They prove to be a very poor lot, such a one as a man could take in half a day, if he caught everything he saw, good or bad. There were 50 or 60 of one species of *Agraulis* that is as common there as *Colias Philodice* in our meadows, and out of the whole number scarcely one really perfect one. Just so of the others. Instead of being of many species there were 10 to 30 of several, all of which were common, and in the entire number there was not one I cared to have. This being so I told Akhurst to offer them in a lot to Mrs Bridgham¹²³ for \$25, and tell her he could

¹²¹ These probably were the butterflies collected by Kennicott and Bischoff while in California. See draft of letter for Henry's signature, February 25, 1866. In the paper alluded to in note 119 and p. — there are described three butterflies from California. Of these, one is credited to Behr and the other two are without collector credit. It is possible that the types of *Lycaena mertilla* (p. 206) and *Hesperia yreka* (p. 207-208) are from this lot. If so the type locality for *mertilla* is in the vicinity of San Francisco as well as that for *yreka*.

¹²² The fourth plate of *Argynnis* is *nokomis*. It would be very interesting to see this proof. Is it the withdrawn plate prepared by Wiest or is it a forerunner of that plate? Edwards did not consider what Wiest had drawn a good representation of the species. Mrs. Peart re-drew it and the re-drawn plate was made from material collected in 1871, not the type which had been the model for Wiest's plate (and this one). This has caused no end of trouble among those students of the genus who try to discover just what the name *nokomis* represents. A search for these plates at the Smithsonian Institution has been without success.

¹²³ Mrs. E. F. Bridgham (—): Cresson (see note 103) listed "Bridgham, Mrs. E. F., New York, N. Y., September 11, 1865" and "Bridgham, Joseph, Jr., New York, N. Y., March 9, 1863" as members of the American Entomological Society—The Entomological Society of Philadelphia at the time of their enrollment. Neither is noted by Carpenter, 1945, 1953.

not divide the lot. He did / so, and she told me last night, that there were less than a dozen she wanted and the rest were so poor that she could not buy the lot for the sake of these few.

I have told Akhurst to put them up again, not taking one out, and I will return them to you, next week.

The collectors ought to be informed that unless they send good specimens, carefully put up, you do not want them at all. To send you a lot like this is an imposition on your good nature. The commonest species and 10 to 50 of a species is rather too much.¹²⁴

I am sorry this has turned out so, for if they had been fair species, of a proper variety, I could have disposed of all & would have retained some myself.

Yours truly
W. H. Edwards

7762

[Red Apr. 28, 1866]

268

New York, 40 Wall St.
27th April 1866

Prof. S. F. Baird
Smithsonian
Washington
D. C.

Dear Sir.

I was considerably astonished this morning in going to Akhurst's to see him hand over \$25 proceeds of the sale of the Costa Rica butterflies. I had gone to get them to return to you, thinking them a miserable lot and of scarcely any value. / It seems he called on an enthusiastic German collector a few days ago and almost without examination, said German took the lot. We had offered them to Mrs. Bridgham for the same—in green backs¹²⁵ of course—for I had not the face to ask more, hardly even that.

This will encourage your Costa Rican correspondent, but assure him, it is the last lot / of that poor description that will find a sale here. Where

¹²⁴ This plaint of Edwards holds true today in many instances. If Carmiol shipped material of little variety and some abundance I suspect that it came from the uplands west of the mountains, the high plateau upon which stands San Jose, the capital of Costa Rica. My own collecting there was dreary, a dozen species or so in abundance and little else.

¹²⁵ "Greenbacks" was applied as a nickname to the legal tender notes issued by the United States government during the Civil War (from 1862 and current until 1879). Since they were not valid for payment of taxes nor convertible to specie and there was at the time of this letter considerable doubt upon their availability for payment of debts incurred before the National Banking Act of 1864 no one was anxious to hold them and they were used as currency at discount. At one time a "greenback" dollar was worth only 35¢ gold. Greenbacks had their worst reputation in Wall Street among Edwards' peers!

beautiful and rare species may be had for the taking it is a shame to send you such trash as the most of these were. I enclose a certified check for \$25 to your order.

Yours truly
W. H. Edwards

P. S. Yours just in of yesterday. I will send the check next week as I have been interrupted and I have not a moment left before I go to Newbg.

10461

233

Washington Apr 29 66

Dear Mr. Edwards

We send two boxes of Botteri—Orizaba Lepidoptera of which please return the names soon as possible and keep specimens as Smithsonian Mus deposit, taking series duplicated for yourself.

A third box from Sumichrast contains Diptera & Hymenoptera. Ask Ostensacken to pick out and name the Diptera and then send the Hymenoptera to Norton.

Yours truly
S. F. Baird

W. H. Edwards
40 Wall St
N. Y.

What great luck with Costa Rica butterflies.

The squeeze of this letter is very badly blurred and difficult to read. The only really readable part of the postscript is "Costa Rica".

7906

[Red. May 23 1866]

269

Newburgh, New York
May 21 1866

Prof. S. F. Baird
Smithsonian Ins.
Washington
D. C.

Dear Sir.

I enclose you the \$25 reed from the sale of the Costa Rica butterflies, as I before advised you.

I have been so engaged in packing up my collections & books & furniture these three last weeks that I have not written you, and I waited to get the name of such of the Mexican butterflies, / Sphinges & moths as I could not myself determine. I have reed but a part of these as yet, and will give what I now can. In a few weeks the most of the others will be forwarded to you. Grote¹²⁶ has the moths. Most unfortunately I have mislaid the

¹²⁶ August Radcliffe Grote (1841–1903): one of the leading lepidopterists of his time specializing in moths, particularly Noctuids, who described over 2000 species of lepidoptera. At the time of this letter he was living in

list of Sphinges, all but one of which I was able to name from the plates of our work. That one was a new one. But I have packed up the originals and cannot now lay my hands on them. I / regret this exceedingly. I had named the Sphinges on a separate paper from the butterflies. The latter I found, but not the other. All I can say is this, several of the Sphinges were common, as Cingulata, Carolina, Jerson, & others. But about half were rare, some of them very rare and one plain brown one a new species, that will be described by Grote, & figured in our work.

If the collector of those will send on perfect specimens of all the Sphinges he can collect, for every / new species I will give \$3 per pair, for 4 pairs, and for those not new, but rare, and not found in the U. S. \$2 per pair, for those that are rare but found in the States \$1 per pair, & for almost any good specimen, even if not rare, 25 to 50 cents could be had. I can sell several sets of these insects. They are worth more than butterflies and as new species are desirable for our work, I am anxious to get all the Sphinges found.

If the specimens are not perfect, but are in *fair condition*, I will pay $\frac{1}{2}$ of the above rates. Please so write the collector. The names of the new species I will try & send you after I go West, next week, (about 28th).

Yours truly

W. H. Edwards

10738

410

Washington May 24 1866

My Dear Mr Edwards

Yours of the 21 with enclosure of 25.00 was received: so also the list of named Lepidoptera. This I have sent to Sumichrast with your offer. A recent letter mentioned that in the fall he would have a large collection for you.

I suppose of course the offers are at gold as foreigners know nothing of our paper currency.

Truly yours

S. F. Baird

W. H. Edwards
Newburgh
N. Y.

[Red May 31 1866]

272

Baltimore, 30th May

Prof. Baird.

Dear Sir.

I am on the way to Kanawha again, going on to night. Shall be there till 1st July.

I discovered today in Phila that the Papilio among these Arizona speci-
Buffalo, New York. He became curator of the Buffalo Society of Natural History in 1873. In 1884 he left America and lived the rest of his life in Germany. See DAB 8:27.

mens was a new and undescribed species. Among that small lot of butterflies were 5 or 6 new species. That shows that Arizona is worth looking after. I hope you write the gentleman who collects there, to do more of the same. I trust the Apaches have / not scalped him.

Tell Ulke I will bring him on some Coleoptera. He must keep watch for any butterflies for me.

Yours truly
W. H. Edwards

There is an excellent young man at Lyme, Conn. who has a small school, & where boys are devoured with a zeal for birds eggs. (My own boy is with him) I told him to write for [sic] you if he got anxious about naming there [sic] collections. They can get fish hawks & some other good ones. / His name is Wm. A. Magill.¹²⁷

W. H. E.

When I return I shall have a number more of names of the Mexican moths to send you.

[Red July 12 1866]

273

New York, 11 July

Prof. Baird.

Dear Sir.

I am just in from Kanawha. Have you any butterflies for me? Tell Mr. Ulke I will send him some few Coleoptera from Kana which I have with me here. Write me at / Newburgh.

Yours truly
W. H. Edwards

11120

642

Washington July 13 66

Dear Mr Edwards

Yours of 11 to hand. We send a lot of boxes butterflies. Some for you from Sumichrast: others from Botteri for S. I. to be named. With them are some Diptera for Ostensacken, and Hymenoptera for Norton. Address the latter direct to Farmington, Conn.

Yours ever
S. F. Baird

¹²⁷ William A. Magill (-). In answer to my letter of 18 December 1958 addressed to the Town Clerk of Lyme, Connecticut, Mr. Joseph S. Dunn the librarian of the Phoebe Griffin Noyes Library wrote to me "There was a school in Old Lyme (formerly Lyme) conducted by William A. Magill. It was known as the Boys Boarding School and was located in a house on 'The Street' erected by Captain Daniel Chadwick. The name of the school, its location, and the name of William A. Magill, as principal are shown on a map dated 1868. The house still stands and is owned by Captain Guy Chadwick, who is out of town for the Winter. Miss Mary Chadwick and Miss Ellin Noyes, both related to the Captain Daniel Chadwick confirm the fact of the school but did not know how long it operated."

W. H. Edwards
Newburgh
N. Y.

[Red. July 19, 1866]
274

Newburgh, New York
17 July 1866

Prof. Baird.
Smithsonian
Washington, D. C.

Dear Sir.

I enclose you a list of butterflies from those sent me to be named in May, and of which invoice I have before sent you many times.

In a few days I will send part of those reed yesterday.

Yours truly
W. H. Edwards

[Red July 19, 1866]
275

Newburgh, New York
17 July 1866

Prof Baird
Smithsonian
Washn.
D. C.

Dear Sir

The box by express came yesterday, contents in good order. I will get names for Botteri Butterflies as I can. But relying on correspondents who are in the country for part of the names, I cannot get them till September.

Summerhearts [Sumichrast] (Cant say if I get this name right / as I never could decipher it in your letters) specimens are good ones, nearly all of them, and well put up. A few are broken, and a few had dermestes in. He ought to put camphor in the boxes. I will have no difficulty in disposing of them or any other small lot as well preserved.

By count, after rejecting a very few damaged ones I make

242 butterflies:

20 moths

10 Aegerians [Megathymidae?]

I will let you know what I do with these in a few days.

Yours truly
W. H. Edwards

11174

674
Washington July 19, 66

Dear Mr Edwards

Yours of July 17 with continuation of list of Botteri butterflies duly received. I dont think you write your names legibly enough for foreigners. The authorities also should be given.

I enclose catalogue of a collection of Lepidoptera and letter which we had some time ago. Which explains itself. Will you take the specimens for yourself or others and return such an equivalent as is desired. The collection is in our hands.

Yours truly
S. F. Baird

W. H. Edwards
Newburgh
Return the enclosures.

8722

1

[Rcd July 23 1866]

Newburgh, New York
22 July 66

Prof. Baird, Smithsonian
Washn. D. C.

Dear Sir.

Yours of 19th is recd. I can do nothing with the European Lepa, such quantities being sent to this country. I return the list of them.

I have re-written the list of names of the invoices of Botteri of April & July as far as I have had names, with the authorities. I shall have the names of the moths of Apl. invoice in a day or two.

Yours truly
W. H. Edwards

8877

[Rcd Sept 27 1866]

277

Newburgh, New York
25th Sept. 1866

Prof. S. F. Baird
Smithsonian
Washn.

Dear Sir.

Yours of 22nd just recd. The butterflies you had better direct to be forwarded to me here, as any day after this week I may have to go to Kanawha, to be absent a month.

I left the butterflies last sent with Akhurst / to sell, and I will see him tomorrow to know the results. He found on opening the papers that there was too little variety—too many yellow & white ones of a kind—and too few showy or large species. This prevented his selling to two persons either of whom would have taken them otherwise. I put him in correspondence with a third and hope he / has sold them. If so, the proceeds will be sent you at once. I will try the lot now to come and if they do not go off favorably, will discontinue the arrangement. There is no complaint about the *condition* of the last lot. They are generally good specimens. I am inclined to think that the best species get sent to Europe and we take the residue.

Ask Dr. Brewer¹²⁸ abt. / that Frigate Pelican egg. My respects to him.

Yours truly

W. H. Edwards

This sentence suggests that there may be a letter missing as this is the first mention of the egg in the letters I have seen. It is possible that Edwards wrote directly to Brewer about it. Another possibility is that Edwards told Baird about it personally on a visit to Washington although there is nothing in the letters to suggest that he visited there in the summer of 1866. This would be unlikely since Baird generally spent his summers in New England.

8617

[Red Sept 28, 1866]

278

Newburgh, New York.

26th Sept. 1866

Prof. Baird.

Washn.

Dear Sir

I learn that the butterflies were sold by Akhurst. There were 272 specimens, at 10 c makes 27.20 in gold. I will send this to you shortly. The lot now expected may be of more value and go off better.

Yours truly

W. H. Edwards

P. S.

Yesterday I saw Dr. Livingston,¹²⁹ of Honduras, who obtd the eggs I wrote you of, & had them here. He says he got them himself. They were Frigate Pelican, surely, as in one of the nests were 2 young birds besides an egg or two, which eggs were same as all the rest. They got 14 eggs but 10 were spoiled by hvg. young birds in them.

8645

[Red Oct 13 1866]

279

Newburgh 8 Oct

Dear Sir.

Send the insects to 40 Wall, office of W. Hutchins,¹³⁰ 3rd floor.

¹²⁸ Thomas Mayo Brewer (1814-1880): one of the leading ornithologists of his time. He graduated from Harvard in 1835. In 1857 the Smithsonian published his "North American Oölogy" and he collaborated with Baird and Ridgeway upon "A History of North American Birds," Little Brown & Co., Boston, 5 vol. 1874-1884. See DAB 3:24.

¹²⁹ Dr. ————— Livingston (— —): The port of Livingston, about 11 miles from Puerto Barrios, Guatemala was named after him and until the establishment of Puerto Barrios was the main Caribbean port for Guatemala.

¹³⁰ Waldo Hutchins (— — -ca. 1892): lawyer. The next and numerous

I write you at Washn. Have been looking for the Mexican insects. Send them when you reach Wn.

I write in haste from a news shop on train.

I will see that Sommercheast [Sumichrast] gets the money now due & any this month.

Yours truly
W. H. Edwards

280

[Red Oct 25 1866]

Law Offices
Slosson, Hutchinson & Platt
40 Wall Street
New York

Oct 23, 1866

Prof S. F. Baird
Smithsonian
Washn,
Dear Sir

I found yours of 22 in the office at Newburgh as I passed thru' this

following letters from Edwards to Baird are written on the letterhead of the firm "Slosson, Hutchins & Platt" at 40 Wall Street, New York City. Mr. Lionel J. Coen, librarian of the Library of the New York Law Institute, very graciously searched the Legal Directories for me and traced the firm to 1959.

1876: Hutchins & Platt—40 Wall Street.

1887: Augustus S. Hutchins, Waldo Hutchins, and Waldo Hutchins, Jr.—

1892: A. S. Hutchins & Waldo Hutchins, Jr.—69 Wall Street.

1910: A. S. and W. Hutchins—84 Williams Street.

1925: moved to 110 Williams Street.

At no time is Edwards noted as a member of the firm in the directories (in letter Jan. 28, 1959).

In reply to a letter directed to the firm I received a cordial reply (Jan. 29, 1959) from Mr. Waldo Hutchins, Jr. He wrote in part ". . . Most of the old records have been destroyed.

"I remember my father, who died in 1933, telling me once that the old firm at one time represented the Kanawa (*sic*) Valley Coal Company. I never heard of William Henry Edwards as having been mentioned as a member of the old firm, so the relationship probably was that of lawyer and client."

After graduating from Williams College in 1842 Edwards studied law in New York City. He apparently practiced in New York City and Newburgh, New York, until his interests in the coal fields pre-empted his time. It is possible that he had a law office of his own at 40 Wall Street before giving up the profession.

The three law partners at the time of Edward's letters were John Slosson, Waldo Hutchins and John H. Platt. I have tried, unsuccessfully, to find a connection between Mrs. Annie Trumbull Slosson (1838-1926), a very active New York lepidopterist, and John Slosson.

morn'g. I have started for Kanawha. The box you now send, therefore, will have to wait till / I return (15th Nov.). I send you check for \$38.95 the sum due Sumichrast on last invoice.

Yours truly
W. H. Edwards

11658

112

Washington Oct 21, 66

Dear Mr Edwards

I send tomorrow by Express the Lepidoptera just received from Sumichrast.

Yours ever
S. F. Baird

W. H. Edwards

Newburgh

I left the Botteri butterflies out. [three undecipherable words].

11732

152

Oct 25, 1866

Dear Sir

Yours of 23 enclosing your check for 38.95 was duly received today and will be sent Prof. Sumichrast.

Yours truly
S. F. Baird

W. H. Edwards

Newburgh.

281*

Mr. Sommercheast [Sumichrast]

with W. H. Edwards

Recd 272 specimens

of butterflies

Sold 172 for \$25 currency

100 at 10 a 147 14.70

39.70

less express 75

\$38.95

Sent check for same

to Prof. Baird 23 Oct

1866

= 26.32 Mexican*

Wm. H. Edwards*

* This apparently is a statement of the account sent with letter 280. It is in Edwards hand except for the asterisked entries. These seem to be in Baird's hand. If the equation at the bottom of the sheet is to Mexican pesos the exchange was much in their favor \$1.48 to P1.00. It may be the conversion from "greenbacks."

[To be continued]

PROCEEDINGS OF THE NEW YORK ENTOMOLOGICAL
SOCIETY

MEETING OF OCTOBER 1, 1957

A regular meeting was held at the American Museum of Natural History and was called to order by President Treat. Fourteen members and two guests were present. Mr. Robert Bloch was appointed Secretary Protem.

Dr. Ruckes reported on the Executive Committee meeting held prior to the regular meeting. Dr. James Mullen was appointed Vice President and Mr. Peter Farb, Secretary for the duration of the terms. The Committee resolved, in effect, to constitute itself, together with the Publications Committee, an Interim Editorial Board with Mr. Soraci retaining the office of Editor, and to take the initiative in promptly restoring the Journal of the Society to full quarter publication. Mr. Boyd reported that the 1956 volume of the Journal would be out by December 1, 1957. The Committee voted that authors should no longer be required to pay the full cost of plates for articles accepted. It was voted to accept the report of the Executive Committee.

The report of the Committee on By-Laws was read by the President. Action will be taken at a later meeting.

Dr. Roy Whelden of Haskins Laboratory, Union College, Schenectady, New York, was proposed for membership by Dr. Clausen. Dr. Schneirla moved that the by-laws be suspended in order to elect Dr. Whelden at this meeting. It was so voted and he was elected unanimously. The President proposed for membership Mr. Tony Roberts and Mr. Bryan Treat.

The members of the Society reported on their summer activities. Mr. Bloch and Mr. Huberman told of their efforts to combat resistance to insecticides in pests. Trips reported on were Mrs. Hopf's to Nova Scotia, Mrs. Campbell's to Vermont, Dr. Treat's to Maine, Dr. Schneirla's to the southeast for the study of Army ants and Dr. Schmitt's to New Hampshire to collect insects for studying their neuro-muscular mechanisms.

Dr. Pohl spent three months in Europe and presented the Society with two postcards commemorating J. H. Fabre. He brought greetings to the Society from the French Entomological Society and presented a menu of the 33rd Annual Banquet of the Société d'Acclimatation et de Protection de la Nature.

In the absence of Mr. Soraci who was in Nova Scotia, Mr. Boyd reported that the gypsy moth spraying campaign was very successful and that it controlled other insects as well.

The meeting was adjourned at 9:50 P.M.

PETER FARB, *Secretary*

MEETING OF OCTOBER 15, 1957

A regular meeting of the Society was held at the American Museum of

(continued on page 156)

ACTIVITIES OF RESPIRATORY ENZYMES DURING THE METAMORPHOSIS OF THE HOUSEFLY, *MUSCA DOMESTICA LINNAEUS**

BY DANIEL LUDWIG AND MARY C. BARSA

DEPARTMENT OF BIOLOGY, FORDHAM UNIVERSITY

Agrell (1949) described total dehydrogenase activity and the specific activities of malic, citric, succinic and glutamic dehydrogenases as U-shaped during the metamorphosis of the blowfly, *Calliphora erythrocephala*. However, Ludwig and Barsa (1958) found that only malic and succinic dehydrogenases and the malic enzyme have U-shaped activity curves during this period in the mealworm, *Tenebrio molitor*.

In the present investigations, a study was made of the dehydrogenase respiratory enzymes of the housefly to compare their activities with those of other insects during metamorphosis.

MATERIAL AND METHODS

The insects used in this study were DDT-sensitive houseflies obtained from the Boyce Thompson Institute for Plant Research. The adults were kept at room temperature (approximately 25° C.) and fed diluted milk and sugar water. The eggs were laid on filter paper placed in the milk. They were removed daily and placed in the larval medium which consisted of animal pellets which had been powdered and soaked in tap water. The larvae were reared at room temperature and when they began to leave the food, they were placed on a piece of filter paper in a large petri dish. Insects, within 6 hours of puparium formation, were placed in labelled beakers and kept at 25° C. Immediately following puparium formation, they were designated as 0-day pupae, although they were probably in the prepupal stage.

The houseflies were washed in an alcohol solution, according to the procedure followed by Cotty (1956), to remove surface bacteria before homogenization. They were homogenized by means of a motor-driven glass homogenizer for 1 minute in the

* This work was supported in part by the Medical Research and Development Board, Office of the Surgeon General, Department of the Army, under Contract No. DA-49-007-MD-444.

proper buffer. In all cases the buffers were adjusted to a pH of 7.4. The activities of succinic, malic, glucose, glutamic, alpha-glycerophosphate, lactic and isocitric dehydrogenases and the malic enzyme were determined by the Thunberg technique as given by Umbreit, Burris and Stauffer (1945, p. 126). Details of substrates, coenzymes, buffers and salts used in each enzymatic determination, as well as the procedure followed in preparing the Thunberg tubes are given by Ludwig and Barsa (1958). Samples of the same homogenate were used in the experimental tube and in the control. The rates of enzyme activity (1/time in minutes for 90 per cent decoloration of the methylene blue) were measured at 30° C. Activity values were obtained by subtracting the rate of the control from that of the experimental tube. Throughout all experiments, a minimum of 10 determinations were made.

OBSERVATIONS

Changes in the activities of the dehydrogenase enzymes during the metamorphosis of the housefly are shown in Table 1 and

TABLE 1.

DEHYDROGENASE ACTIVITY DURING THE METAMORPHOSIS OF THE HOUSEFLY. ACTIVITY IS EXPRESSED AS 1/TIME IN MINUTES FOR 90 PER CENT DECOLORATION OF METHYLENE BLUE. READINGS WERE MADE AT 30°C. (GPD IS ALPHA-GLYCEROPHOSPHATE DEHYDROGENASE).

Stages	Alco- hol	Glu- cose	GPD I	Dehydrogenase					
				GPD II	Iso- citric	Lactic (total)	Malic	Malic enzyme	Suc- cinic
Larva	0.041	0.004	0.047	.....	0.402	0.048	0.333	0.097	0.008
Puparium just formed	0.042	.....	0.013	.....	0.282	0.012	0.337	0.047	0.006
Pupa, 1-day	0.037	0.014	0.011	.....	0.255	0.018	0.312	0.061	0.004
Pupa, 2-day	0.024	0.013	0.004	.....	0.220	0.006	0.204	0.056	0.002
Pupa, 3-day	0.027	0.013	0.005	.....	0.197	0.005	0.179	0.063	0.004
Pupa, 4-day	0.025	0.013	0.003	0.004	0.194	0.002	0.262	0.060	0.005
Pupa, 5-day	0.024	0.013	0.015	0.009	0.158	0.004	0.461	0.058	0.013
Adult, just emerged	0.043	0.003	0.043	0.030	0.180	0.005	0.897	0.086	0.028

Figure 1. The activities of succinic, malic, total alpha-glycerophosphate and alcohol dehydrogenases and of the malic enzyme

followed U-shaped curves. Alpha-glycerophosphate II (enzyme not requiring DPN) was absent until the 4-day pupa and its activity greatly increased in the adult. The activity of lactic dehydrogenase was high (0.048) in the larva but it decreased rapidly and very little activity was observed in the latter part

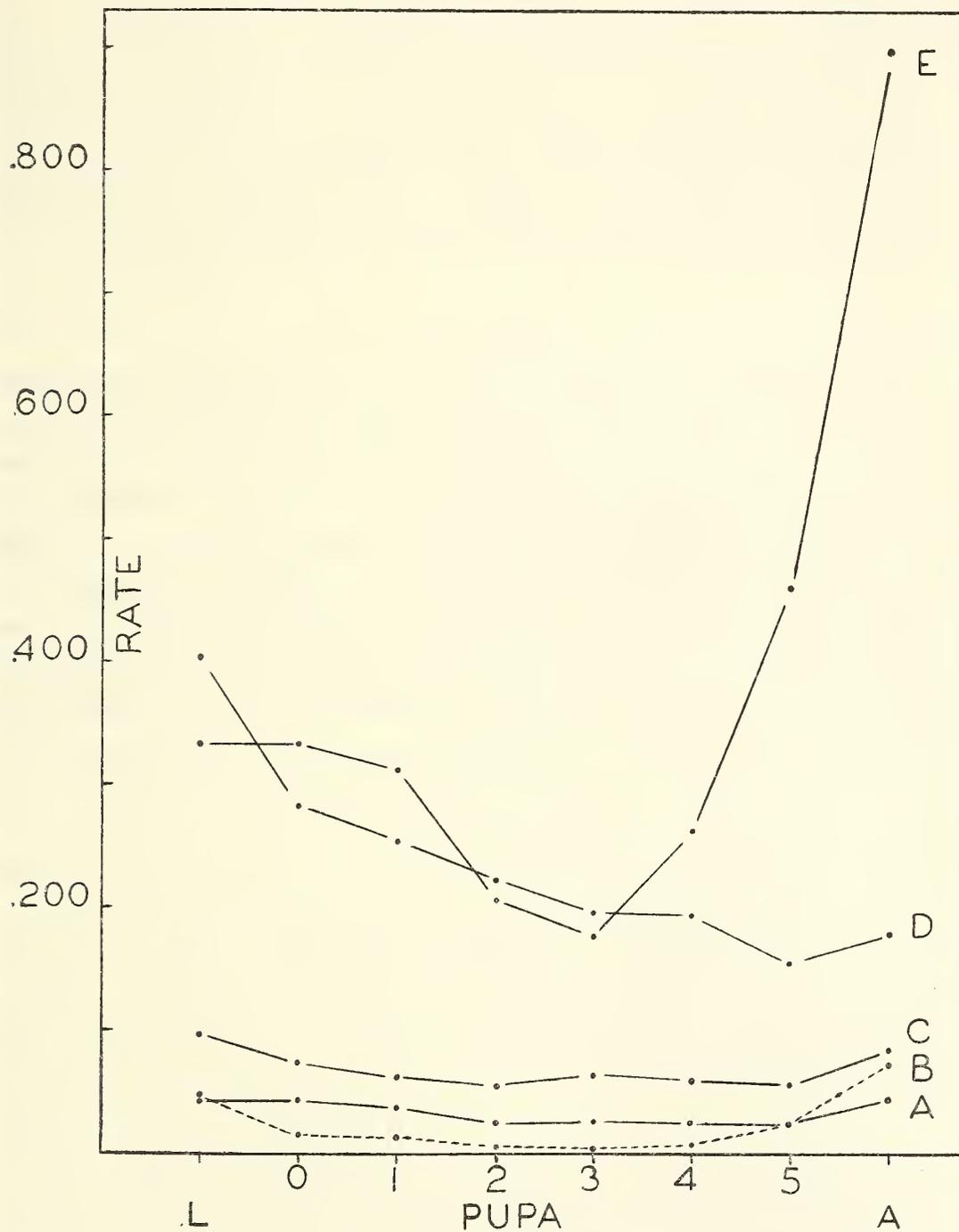


FIGURE 1. Changes in the activity of dehydrogenase enzymes during the metamorphosis of the housefly. Rate is expressed at 1/time in minutes for 90 per cent decoloration of methylene blue. Graph A, alcohol dehydrogenase; Graph B, alpha-glycerophosphate dehydrogenase; Graph C, malic enzyme; Graph D, isocitric dehydrogenase; Graph E, malic dehydrogenase. L, larva; A, newly emerged adult.

of the pupal stage or in the adult. A lactic dehydrogenase not requiring DPN was observed only in the larva. Its activity amounted to about one-fourth the total lactic dehydrogenase activity of this stage. A very low glucose dehydrogenase activity was observed during the prepupal and adult stages. However, this enzyme showed a constant value of 0.013 throughout the pupal stage. A low activity of glutamic dehydrogenase was obtained in the larva but it disappeared early in the pupal stage. Isocitric dehydrogenase activity was high at the beginning, but decreased steadily during the remainder of metamorphosis. The activities of malic and isocitric dehydrogenases were much greater than those of any of the other enzymes studied.

DISCUSSION

The activities of succinic, isocitric and malic dehydrogenases and the malic enzyme of the housefly are similar to those reported for these enzymes during the metamorphosis of the mealworm, *Tenebrio molitor*, by Ludwig and Barsa (1958). However, the malic dehydrogenase of the adult housefly is more active than that reported in the previous work for the adult mealworm. The activity curves for alcohol and alpha-glycerophosphate I (requiring DPN) dehydrogenases are U-shaped during the metamorphosis of the housefly but remained constant in the mealworm. Alpha-glycerophosphate II dehydrogenase (not requiring DPN) was not found until near the end of metamorphosis in the housefly but was present throughout this process in the mealworm. Glutamic dehydrogenase was found in the larva of the housefly but this enzyme does not appear until near the end of metamorphosis in the mealworm. In both species the activity of lactic dehydrogenase is very low throughout metamorphosis. These results differ from those of Agrell (1949) for the blowfly, *Calliphora erythrocephala*, in that the activity curves for glutamic and isocitric dehydrogenases of the housefly are not U-shaped. The activity curve for succinic dehydrogenase has been found to be U-shaped during the metamorphosis of the following species: *Drosophila melanogaster*, Wolsky (1941); *Calliphora erythrocephala*, Agrell (1949); *Bombyx mori*, Ito (1955); *Popillia japonica*, Ludwig and Barsa (1955); *Tenebrio molitor*, Ludwig and Barsa (1958); *Ephestia kühniella*, Diamantis (1959); and *Musca*

domestica, (the present work). Since the activity of this enzyme is very low, it could be a determining factor in the U-shaped respiratory curve characteristic of insect metamorphosis.

SUMMARY

A study was made of the activities of the dehydrogenase enzymes during the metamorphosis of the housefly using the Thunberg technique.

The activities of succinic, malic, total alpha-glycerophosphate and alcohol dehydrogenases and of the malic enzyme follow U-shaped curves during metamorphosis. Alpha-glycerophosphate II (not requiring DPN) was absent until the 4-day pupa and its activity greatly increased in the adult. Lactic and glutamic dehydrogenases were present in the larva but disappeared early in the pupal stage. Isocitric dehydrogenase activity was high at the beginning but decreased steadily during the remainder of metamorphosis. There was a low activity of glucose dehydrogenase in both the larval and adult stages. However, this enzyme showed a constant higher value throughout the pupal stage.

The activity curve for succinic dehydrogenase has been found to be U-shaped during metamorphosis in all insects studied. Since the activity of this enzyme is very low, it could be a determining factor in the U-shaped respiratory curve characteristic of insect metamorphosis.

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(continued from page 150)

Natural History. The meeting was called to order by President Treat. Thirteen members and two guests were present.

The President reported on the publication schedule of the Journal, as discussed at the meeting of the Executive Committee. The first issue of 1957 will be out the middle of January, combined issues two and three by April, and the last issue by the middle of June.

Two new members—Master Tony Roberts, aged 14, and Master Bryan Treat, age 9—were unanimously elected to membership.

The President was about to bring the proposed changes in the By-laws to a vote when Dr. Forbes raised the point that they must first be advertised to the membership. It was agreed that a copy of the changes would be sent to each member previous to the meeting of November 19th. At that time they will be voted upon.

Dr. T. C. Schneirla of the American Museum of Natural History spoke on "Field Studies of Army Ants in Southeastern United States." This report on his summer's extension of the Arizona work with Doryline ants was illustrated by a series of kodachromes. Dr. Schneirla first reviewed his previous reports to the Society on the nomadic and statary phases of activity in these ants, and his work with the genus *Neiramyrme* at the Museum's Southwestern Research Station in Arizona.

His summer's work was devoted to studying *Neiramyrme nigrescens* in the Southeast, a common species extending to the Atlantic Coast. The study was made at the Bankhead National Forest in Alabama and the Sumter National Forest in South Carolina.

In Arizona Dr. Schneirla had always been able to physically follow the colony under observation. Not so in the Southeast. The "Tallulah" colony, at the end of the statary curve with a large oncoming pupal brood, was located in a stump and a cordon thrown around the bivouac. After five nights the colony was lost. It was again located and promptly lost. The colony had passed from statary to nomadic phase because of the stimulation of the maturing brood.

Next studied was the "Mound" colony and, like "Tallulah," was difficult to follow. However a method of tracery was used without keeping actual physical continuity with the colony. It was found that in the Southeast, colonies were better observed during the statary phase since at this time they selected stumps, while in Arizona they became subterranean. As with the Arizona observations of *nigrescens*, it was seen that the colony was unstable during the first few days of the 18-day statary phase, and that the queen became physogastric early and late in this phase.

(continued on page 162)

ESTIMATION OF ANT COLONY SIZE BY THE LINCOLN INDEX METHOD¹

BY ROBERT M. CHEW

DEPT. OF BIOLOGY, UNIV. SOUTHERN CALIFORNIA, LOS ANGELES

Apparently the only method used in the past for estimating the size of ant colonies has been to excavate the colony completely and count all individuals unearthed. The uncertainty and difficulty of this method is well illustrated by the history of *Myrmecocystus melliger* Forel. Wheeler (1908) felt that this species forms small colonies of hardly more than 300–500 individuals with chambers that do not descend more than a foot or so into the soil. He thought that he had completely excavated such colonies. That this may not have been true is obvious from the report of Creighton and Crandall (1954) on the excavation of one colony near Tucson. At the beginning of excavation, the vertical extent of this colony was apparently going to be limited by a rock-like layer of caliche, eighteen inches below the soil surface. However, careful following of a single small lead descending vertically through the caliche led to the discovery of new chambers at a depth of thirty inches. After penetration of five to six feet of caliche, the excavation was completed at a depth of sixteen feet, where the queen's chamber was found. Over 1500 repletes and hundreds of normal workers were found in the many chambers of this colony. Previously this species was thought not to have repletes. Tevis (1958) followed colonies of *Veromessor pergandei* (Mayr) as deeply as eleven feet without completely excavating any colony.

While certain biological information, such as the occurrence of repletes in *M. melliger*, can be obtained only by laborious digging, the present author has found that the number of foraging workers can be estimated much more simply, by the use of the Lincoln Index method, or the mark-release-recapture method. This method has been widely used in censusing populations of different vertebrate animals.

As used by the author, this method is as follows: (1) 100–400 worker ants are collected from a colony entrance with an aspirator; (2) these individuals are etherized in several batches and each ant is marked on the dorsum with a spot of Testors colored

¹ Contribution from Southwestern Research Station, American Museum of Natural History, Portal, Arizona. Work carried out under the support of National Science Foundation Grant G-5570.

dope; (3) the marked ants are counted and then released at the colony entrance after they have revived (the few ants whose legs have become bound up by dried dope are removed); (4) a second sample of ants is collected 24 hours later, and the marked and unmarked individuals counted; (5) the total number of foraging workers in the colony is calculated by the formula:

$$\text{total no. workers} = \frac{(\text{No. ants in 2nd sample}) \times (\text{total no. marked})}{\text{Number of marked ants recaptured}}$$

The use of this method is based on several assumptions: (a) any individual in the colony is susceptible of being captured and marked; (b) the marked individuals mix thoroughly with unmarked before resampling; (c) marking is permanent during the length of the sampling period, and does not adversely influence the behavior or survival of marked individuals. Considering these assumptions with regard to ants:

(a) As far as is known, all normal worker ants that are beyond the callow stage participate in foraging and carrying materials out of the nest. The situation in bees, where younger workers limit themselves to duties inside the nest, while only older workers forage outside, is not known to occur in ants (W. S. Creighton, personal communication). Therefore, any individual worker is susceptible of being captured outside the nest and marked or counted.

Certain special types of workers do not normally leave the nest, and these would not be captured or enter into the estimation of colony size. Repletes, such as found in some species of the genus *Myrmecocystus*, do not leave the nest, but full repletes are not found in any other North American genus. The major workers of many species of *Pheidole* do not forage, and the majors of *Cryptocerus* and *Camponotus* probably do not forage. These exceptions are few and they do not limit the application of the Lincoln Index method to most species of ants.

(b) The thoroughness with which marked and unmarked workers mix within the colony in 24 hours is not yet certain. When there are several openings to a colony, several feet apart, marked individuals released at one entrance are not necessarily captured in equal ratios at all entrances 24 hours later. This indicates incomplete mixing.

(c) Spots of Testors colored dope are not permanent markings. The dope flakes off in a matter of one to several days.

Counting of marked individuals in the recapture sample is best done under magnification, in order to detect those ants that have only a small fleck of dope still adhering to a hair or bristle. When a colony is resampled at 24-hour intervals, the calculated colony size shows a gradual increase. This indicates inversely the rate at which marked individuals are losing their identification. If such data are plotted, as in Figure 1, the curve can be interpolated to zero time, i.e. no loss of markings, for a possibly more accurate estimation of colony size. The loss of markings in the first 24 hours for *Pogonomyrmex occidentalis* is within the range of variability of different samples taken at 24 hours after release. It should be possible to find a more adherent marking material, which would allow a sampling interval of more than 24 hours and thus more thorough mixing in of marked individuals.

There is no evidence that this method of marking results in the death of marked individuals.

Table 1 gives preliminary data on colony size of three species of ants in Cochise County, Arizona. As expected, there is a

TABLE 1.

NUMBER OF FORAGING WORKERS IN COLONIES OF THREE SPECIES OF ANTS IN COCHISE CO., ARIZONA.

Colony #	Date	Foraging Workers	Mound Size
<i>Novomessor cockerelli</i> (E. Andre)			
A13	Oct. 3	236	52 cu. in.*
A8	Oct. 13	570	254 cu. in.
A4	Oct. 13	648	221 cu. in.
A1a	Oct. 13	570	—
<i>Myrmecocystus mimicus</i> Wheeler			
A25	Oct. 22	650	39 sq. in.**
A26	Oct. 23	1280	29 sq. in.
<i>Pogonomyrmex occidentalis</i> (Cresson)			
P1	Sept. 21	1320	302 cu. in.*
P2	Sept. 21	435	74 cu. in.
P3	Oct. 8	2100	1470 cu. in.

* mound size figured as volume of cone; ** basal area of crater-like mound.

N. cockerelli and *M. mimicus* colonies were located in a creosote bush community, 4500' elevation, 6 mi. north of Portal, Arizona; *P. occidentalis* colonies were in pine-oak woodland, 5400' Southwestern Research Station, Portal.

range of sizes for a particular species. A relationship between colony size and surface mound size is suggested.

The marking of ants with colored spots is also highly useful in determining whether adjacent mounds and entrances are parts of a single colony or separate colonies. Tèvis (1958) found that *Veromessor pergandei* colonies change their entrance hole about 10 times a year. One entrance is abandoned and another opened up. In the course of a year these different entrances of the same colony cover an area approximately 50 feet in diameter. Similar shifts of activity, and also simultaneous use of several entrances, have been observed by the

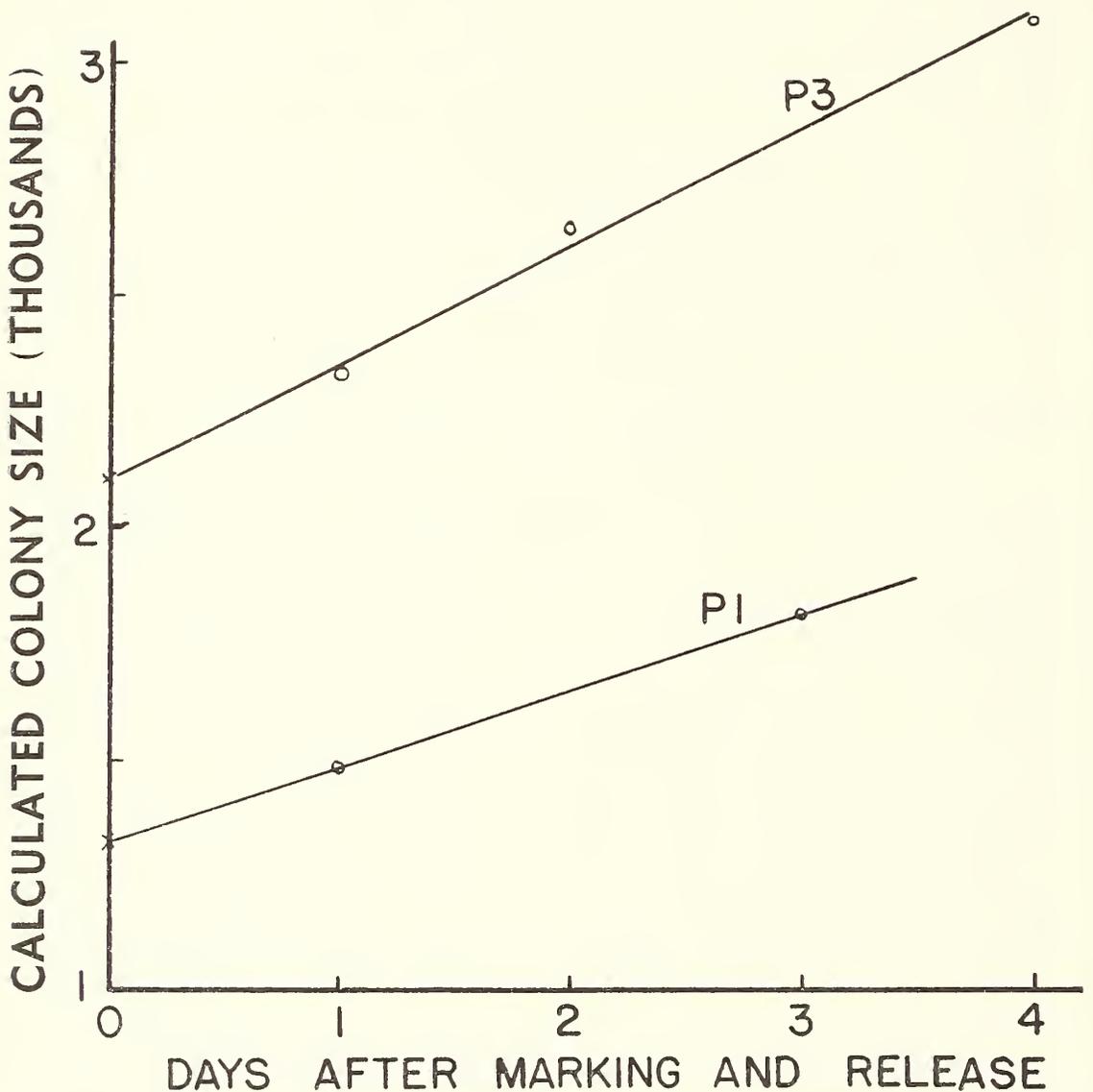


FIGURE 1. Estimation of number of foraging workers in colony of *Pogonomyrmex occidentalis*. True colony size is taken as value of line extrapolated to zero time, i.e. before any marking on ants had flaked off.

present author for *Novomessor cockerelli*. Colony A4 in Table 1 had three openings in a triangular arrangement 6 to 10 feet apart. Two of these openings had relatively high mounds, while the third was marked only by a circle of fine angular gravel. In the initial test to determine whether these openings were all part of a single colony, 100 individuals were marked green at entrance A, 118 were marked blue at entrance B, and none were marked at entrance C. Resampling at all entrances 24 hours later showed: A—115 unmarked, 45 green, 11 blue; B—62 unmarked, 49 blue, 2 green; C—48 unmarked, 4 blue, 3 green. While the three entrances are indicated as part of one colony, there was an obvious tendency for recapture of a particular color marking predominantly at the entrance where it was used.

The present paper is presented in the hope of stimulating further testing, development and use of the Lincoln Index method in ant work. Data easily obtained on size of colonies can be the bases for different kinds of ecological studies. The author is using the method to follow seasonal changes in colony sizes and as a basis for the calculation of the energy requirements of colonies, i.e. (colony size) \times (measured metabolism of individual ants) = total energy requirement for colony. The method can also be used to follow growth of colonies from year to year. The mark-release-recapture method has the great advantage that it can be used repeatedly on the same colony, while the digging method destroys a colony at first use.

Literature Cited

- CREIGHTON, W. S. AND R. H. CRANDALL. 1954. New data on the habits of *Myrmecocystus melliger* Forel. The Biol. Rev., C.C.N.Y. 16 (1): 2-6.
- TEVIS, L. 1958. Interrelations between the harvester ant *Veromessor pergandei* (Mayr) and some desert ephemerals. Ecology 39(4): 695-704.
- WHEELER, W. M. 1908. Honey ants with a revision of the American *Myrmecocysti*. Bull. Amer. Mus. Nat. Hist. 24: 345-397.

(continued from page 156)

These observations emerged from the summer's work: *N. nigrescens* operates on a nomadic-statory pattern in the Southeast throughout its summer cycle, much as in the Arizona studies. The statory phase lasts about 18 days both in Arizona and the Southeast. Differences noted were that the Southeast colonies were not so numerous and they worked more in the leaf-mold and animal burrows, often following subterranean tree roots, than in Arizona.

The discussion of Dr. Schneirla's studies continued until 9:55 P.M., when the meeting was adjourned.

PETER FARB, *Secretary*

MEETING OF NOVEMBER 19, 1957

President Treat called to order a regular meeting of the Society in Room 419 of the American Museum of Natural History at 8:10 P.M. Eighteen members and six guests were present.

Mr. Bloch read a letter informing the Society of the death of Mr. Isaiah Cooper, formerly Curator of the Staten Island Museum and a member for many years of the Society. The Society unanimously passed a resolution of sympathy and the Secretary was directed to send this on behalf of the Society to his daughter.

Dr. Treat reported on an informal meeting held in Mr. Heineman's home on November 5th. He announced donations made to the Society by Messrs. Heineman, Schwarz and Dos Passos, and the Inwood Foundation. These additional funds now make possible the new meeting room, more attractive notices sent before each meeting, and the ability to obtain out-of-town speakers.

In the absence of Vice President Mullen, Dr. Forbes announced the programs for the rest of the 1957-8 year.

Mr. Bloch proposed that consideration be given to an annual dinner. The President stated that it would be taken under advisement by the Executive Committee.

The Amendments to the By-laws were passed as follows: (Deletions are enclosed in parentheses; additions are in italics).

Article II

All candidates for membership must be proposed by an active member of the Society at a regular *or annual* meeting. . . .

Article III

2. . . . The Executive Committee shall be composed of the President (Chairman), and four active members, all entitled to vote. The Editor, *Vice-President*, Associate Editor, Secretary, and Treasurer shall also be members of the Executive Committee but not entitled to vote. . . .

3. Standing Committees of the Society to be appointed by the President, shall consist of an Auditing Committee, composed of three active members; *a Program Committee*, and a Field Committee, *each* composed of two active members.

(continued on page 212)

AN ANNOTATED LIST OF THE LYCAENIDAE
(LEPIDOPTERA, RHOPALOCERA) OF THE
WESTERN HEMISPHERE

BY WILLIAM PHILLIPS COMSTOCK AND EDGAR IRVING HUNTINGTON

[CONTINUED FROM LXVII (2), P. 95]

bethulia Hewitson, W. C., *Thecla*

Type Locality: Amazon (Pará).

Location of Type: British Museum (Natural History).

Original Description: 1869 (April), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 128, vol. 2, pl. 51, figs. 278, 279 ♂ (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (August), *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 2, p. 61 (London). (Makes *bethulia* a synonym of *empusa* Hewitson.)

Note: This should be checked.

bethune-bakeri Comstock, W. P. and E. I. Huntington, *Hemiargus ammon*

Type Locality: Miami, Florida, January 26, 1932.

Location of Type: American Museum of Natural History.

Original Description: 1943 (December), *Ann. New York Acad. Sci.*, vol. 45, p. 97, pl. 1, fig. 25 ♂ (New York, N. Y.).

bianca Möschler, H. B., *Thecla*

Type Locality: Interior of Surinam.

Location of Type:

Original Description: 1883, *Verh. zool.-bot. Ges.*, vol. 32, p. 310, pl. 17, fig. 5 (Wien).

Additional Reference: Draudt, Max, 1921 (January), *The Macrolepidoptera of the World*, vol. 5, p. 823 (Stuttgart). (Said: "P. 766, line 9 from below; cancel *bianca* Mschlr.")

Note: Referring to p. 766, this might mean that Draudt considered *bianca* to be the female of *malvania* Hewitson. See *ostrinus* Druce.

Synonyms: *ostrinus* Druce.

biblia Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1868, *Specimen of a Catalogue of Lycaenidae in the British Museum*, p. 12 (London).

Additional Reference: Hewitson, W. C., 1873 (February), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 150, vol. 2, pl. 59, figs. 384, 385 ♂ (London). Amazon (Tapajos).

bicolor Philippi, R. A., *Lycaena*?

Type Locality: Santiago, Chile.

Location of Type:

Original Description: 1860, *Linnaea Entomologica Zeitschrift*, vol. 14, p. 269 (Berlin).

Additional Reference: Hewitson, W. C., 1877, *Illus. of Diurnal Lepidoptera*, vol. 1, p. 208, vol. 2, pl. 83, figs. 697 ♂, 695, 696 ♀ (London).

bilix Draudt, Max, *Thecla*

Type Locality: Río Aguaca Valley, Colombia.

Location of Type: Fassl Collection. Now in Naturhistorisches Museum, Basle.

Original Description: 1919 (December), *The Macrolepidoptera of the World*, vol. 5, p. 759, pl. 153-g ♂ (Stuttgart).

bimaculata Möschler, H. B., *Thecla*

Type Locality: Inner Surinam (2 ♂ ♂, 1 ♀).

Location of Type:

Original Description: 1876, *Verh. zool.-bot. Ges.*, vol. 26, p. 299, pl. 3, fig. 3 (Wien).

Addition Reference: Draudt, Max, 1919, *The Macrolepidoptera of the World*, vol. 5, 747 (Stuttgart). (Considers *bimaculata* a synonym of *nobilis* Herrich-Schäffer.)

binangula Schaus, William, *Thecla*

Type Locality: Peru.

Location of Type: United States National Museum, no. 5941 ♂.

Original Description: 1902, *Proc. U. S. Natl. Mus.*, vol. 24, p. 415 (Washington, D. C.).

biston Möschler, H. B., *Thecla*

Type Locality: Inner Surinam (1 ♂, 1 ♀).

Location of Type:

Original Description: 1876, *Verh. zool.-bot. Ges.*, vol. 26, p. 302, pl. 3, fig. 5 (Wien.).

bitias Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1777, *Papillons exotiques des trois parties du monde*, vol. 2, p. 12, pl. 104, fig. E (Amsterdam).

Additional Reference: Draudt, Max, 1920 (February), *The Macrolepidoptera of the World*, vol. 5, p. 779 (Stuttgart). (Says *bitias* is probably a synonym of *syncellus* Cramer.)

blackmorei Barnes, William and J. H. McDunnough, *Plebeius icarioides* var. nov.

Type Locality: Goldstream, Vancouver Island, B. C.

Location of Type: United States National Museum, Barnes Collection.

(Paratype in American Museum of Natural History.)

Original Description: 1919 (April), Can. Ent., vol. 51, p. 92 (London, Ontario).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 27, no. 455 (Los Angeles, Calif.). (Places *blackmorei* as a subspecies of *icarioides* Boisduval.)

blenina Hewitson, W. C., *Thecla*

Type Locality: Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1868, Specimen of a Catalogue of Lycaenidae in the British Museum, p. 12 (London).

Additional References: Hewitson, W. C., 1869 (April), Illus. of Diurnal Lepidoptera, vol. 1, p. 127, vol. 2, pl. 50, figs. 256, 257 ♂ (London). Godman, F. D. and O. Salvin, 1887 (June), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 48, (London). (Makes *blenina* a synonym of *xami* Reakirt.)

boeonides Capronnier, J. B., *Thecla* Nomen nudum

Type Locality: Copa Cabana, Brazil.

Location of Type:

Original Description: 1874, Ann. Soc. Ent. Belgique, vol. 17, p. 15 (Bruxelles).

bogotana Draudt, Max, *Hemiargus hanno* form

Type Locality: Bogotá, Colombia.

Location of Type:

Original Description: 1921 (January), The Macrolepidoptera of the World, vol. 5, p. 819 (Stuttgart).

boharti Gunder, Jean D., *Plebeius saepiolus* tr. f.

Type Locality: Yosemite National Park, California, July 24, 1931.

Location of Type: American Museum of Natural History.

Original Description: 1932 (January), Pan-Pacific Entomologist, vol. 8, p. 127 (San Francisco, Calif.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 27, no. 453 (Los Angeles, Calif.). (Places *boharti* as an aberration of *saepiolus* Boisduval.)

bolima Schaus, William, *Thecla*

Type Locality: Castro, Parana, Brazil.

Location of Type: United States National Museum, no. 5942 ♂.

Original Description: 1902, Proc. U. S. Natl. Mus., vol. 24, p. 416 (Washington, D. C.).

borealis Ureta R., *Leptotes trigemmatius*

Type Locality: Azapa, Chile; December 24, 1938.

Location of Type: Museo Nacional de Historia Natural, Santiago, Chile.

Original Description: 1949, Boletín del Museo Nacional de Historia Natural, vol. 24, p. 112, pl. 2, fig. 11 (Santiago, Chile).

boreas Felder, Cajetan and Rudolf Felder, *Pseudolycaena*

Type Locality: New Granada, Bogotá.

Location of Type:

Original Description: 1864–1876, Reise der Osterreichischen Fregatte "Novara" um die Erde, vol. 2, p. 244, pl. 31, fig. 12 (Wien).

bornoi Comstock, W. P. and E. I. Huntington, *Hemiargus*

Type Locality: Port Beudet, Haiti, March 3–4, 1922.

Location of Type: American Museum of Natural History.

Original Description: 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 102, pl. 1, figs. 18, 19 ♀ (New York, N. Y.).

borus Boisduval, Jean A., *Thecla*

Type Locality: California, May.

Location of Type: United States National Museum?

Original Description: 1869, Ann. Soc. Ent. Belgique, vol. 12, p. 43 (Bruxelles).

Additional References: Kirby, W. F., 1871, A Synonymic Catalogue of Diurnal Lepidoptera, p. 396 (London). (Makes *borus* a synonym of *californica* Edwards.) Oberthür, Charles, 1913 (October), Etudes de Lepidopterologie Comparee, fasc. 9, pt. 1, p. 42, pl. 238, fig. 1953 (Rennes).

bosora Hewitson, W. C., *Thecla*

Type Locality: Curaray, Ecuador.

Location of Type: British Museum (Natural History).

Original Description: 1870 (March), Equatorial Lepidoptera, Buckley, p. 66 (London).

Additional References: Hewitson, W. C., 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 166, vol. 2, pl. 65, figs. 459, 460 ♂ (London). Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 616 (London). (Said: "has a large discal spot on the upperside of the fore wing, and a narrow white line closing the cell of the same wing below which is not mentioned by Hewitson and is not shown in his figure.") Allied to *thespia* Hewitson and *photismos* Druce.

bourkei Kaye, W. J., *Thecla*

Type Locality: Jamaica, B. W. I. (1 ♀).

Location of Type: Bourke Collection, Oxford Museum. (Bernard Heine- man says type was not in Oxford Museum according to Prof. Valary on May 15, 1953.)

Original Description: "1924" (1925), Trans. Ent. Soc. London, p. 416 (London).

Additional References: Kaye, W. J., 1931, Trans. Ent. Soc. London, vol. 79, p. 536, pl. 39, fig. 8 ♂ (London). Comstock, W. P. and E. I. Hunt- ington, 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 61 (New York, N. Y.).

bouvieri Lathy, Percy I., *Thecla*

Type Locality: Ecuador.

Location of Type: Fournier Collection (Paris).

Original Description: 1936, Livre jubilaire de M. Eugène-Louis Bouvier, p. 231, pl. 8, fig. 13 (Paris).

boyeri Comstock, W. P. and E. I. Huntington, *Thecla angelia*

Type Locality: Pétionville, Haiti, May.

Location of Type: American Museum of Natural History.

Original Description: 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 70 (New York, N. Y.).

Additional Reference: Comstock, W. P., 1944 (October), Scientific Survey of Puerto Rico and the Virgin Islands, vol. 12, pt. 4, 487, pl. 9, fig. 4 ♂ (New York, N. Y.),

boyi Röber, J., *Thecla*

Type Locality: Uypiranga, Rio Negro.

Location of Type:

Original Description: 1931, Intern. Ent. Zeit., vol. 24, p. 391 (Guben).

Note: Near *gabriela* Cramer.

brasiliensis Draudt, Max, *Eumaeus minyas* form

Type Locality: Amazon.

Location of Type:

Original Description: 1919 (November), The Macrolepidoptera of the World, vol. 5, p. 745 (Stuttgart).

Additional Reference: Lathy, Percy I., 1926, Ann. Mag. Nat. Hist., 9th Series, vol. 17, p. 39 (London). (Believes *brasiliensis* to be a synonym of *toxana* Boisduval.)

brasiliensis Talbot, George, *Thecla*

Type Locality: Urucum, 15 miles south of Corumba, Matto Grosso, Brazil.

Location of Type: Hill Museum (Brit. Mus.).

Original Description: 1928, Bull. Hill Museum, vol. 2, pt. 3, p. 218 (London).

brehmei Barnes, William and F. H. Benjamin, *Mitoura gryneus* race *castalis* form

Type Locality: Shovel Mountain, Texas.

Location of Type: Barnes Collection, United States National Museum.

Original Description: 1923, Contributions to the natural history of the Lepidoptera of North America, vol. 5, p. 64 (Decatur, Illinois).

brescia Hewitson, W. C., *Thecla*

Type Locality: Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1868, Specimen of a Catalogue of Lycaenidae in the British Museum, p. 13 (London).

Additional References: Hewitson, W. C., 1869 (April), Illus. of Diurnal Lepidoptera, vol. 1, p. 119, vol. 2, pl. 50, figs. 260, 261 ♂ (London). Godman, F. D. and O. Salvin, 1887 (June), Biologia Centrali-Americana, In-

secta, Lepidoptera-Rhopalocera, vol. 2, p. 43, vol. 3, pl. 53, figs. 8, 9 ♂, 10 ♀ (London).

Synonyms: *thoana* Hewitson.

brocela Dyar, Harrison, G., *Thecla*

Type Locality: Cotahuasi, Peru, 9,000 ft., October, 1911.

Location of Type: United States National Museum, no. 15,622.

Original Description: 1913, Proc. U. S. Natl. Mus., vol. 45, p. 637. (Washington, D. C.).

browni dos Passos, Cyril F., *Lycaena nivalis*

Type Locality: Snowslide Canyon, 8 miles from Montpelier, Idaho, July 10, 1929.

Location of Type: American Museum of Natural History.

Original Description: 1938 (March), Can. Ent., vol. 70, no. 3, p. 45, pl. 2, figs. 1, 2, 3, 4 (Orillia, Canada).

brunnea Tutt, J. W., *Celastrina argiolus* ab.

Type Locality: Brooklyn, New York.

Location of Type:

Original Description: 1908, Nat. Hist. Brit. Lepid., vol. 9, p. 413 (London).

Additional References: Edwards, W. H., 1884, The Butterflies of North America, vol. 2, *Lycaena*, p. 10, pl. 2, fig. 25 (Boston, Mass.). McDunnough, J. H., 1938, Check list, pt. 1, p. 28, no. 475 (Los Angeles, Calif.). (Places *brunnea* as an aberration of *pseudargiolus* Boisduval and LeConte.)

bryanti Leussler, R. A., *Plebejus aquilo* race

Type Locality: Black Mountain, 30 miles Southwest of Aklavik, Northwest Territory, 68 deg. No. Lat.

Location of Type: American Museum of Natural History.

Original Description: 1935 (April), Bull. Brooklyn Ent. Soc., vol. 30, p. 58 (Brooklyn, N. Y.).

bubastus Cramer, Pierre, *Papilio*

Type Locality: "Cap de Bonne Esperance."

Location of Type:

Original Description: 1780, Papillons exotiques des trois parties du monde, vol. 4, p. 84, pl. 332, figs. G, H (Amsterdam).

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 78 (New York, N. Y.).

Synonyms: *salona* Hewitson.

Subspecies: *ponce* Comstock and Huntington.

buccina Druce, Hamilton H., *Thecla*

Type Locality: Chapada, Tapajos, Brazil.

Location of Type: Godman Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 585, pl. 34, fig. 4 ♂ (London).

buchholzi dos Passos, Cyril F., *Plebeius icarioides*

Type Locality: White Mountains, Arizona, 8500 ft., June 25, 1937.

Location of Type: American Museum of Natural History.

Original Description: 1938 (March), Can. Ent., vol. 70, no. 3, p. 47, pl. 2, figs. 13, 14, 15, 16 (Orillia, Canada).

buchholzi Freeman, H. A., *Strymon*

Type Locality: Pharr, Texas, November 24, 1946 and October 14, 1944.

Location of Type: H. A. Freeman Collection.

Original Description: 1950 (January), Field and Laboratory, vol. 18, no. 1, p. 12 (Southern Methodist, Univ., Dallas, Texas).

bulvus—, *Heodes hypophlaeas* ab. Misspelling of *fulvus*

Type Locality:

Location of Type:

Original Description: 1929. Zool. Record, vol. 65, Insecta, p. 240.

bunnirae Dyar, Harrison G., *Thecla*

Type Locality: Sierra de Guerrero, Mexico, February, 1913.

Location of Type: United States National Museum, no. 21, 199.

Original Description: 1919, Proc. U. S. Natl. Mus., vol. 54, p. 336 (Washington, D. C.).

Additional Reference: Schaus, William, 1920, Ent. News, vol. 31, p. 176 (Philadelphia, Pa.). (Makes *bunnirae* Dyar a synonym of *canus* Druce.)

buphonia Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1868, Specimen of a Catalogue of Lycaenidae in the British Museum, p. 25 (London).

Additional Reference: Hewitson, W. C., 1873 (February), Illus. of Diurnal Lepidoptera, vol. 1, p. 148, vol. 2, pl. 58, fig. 374 ♂ (London). Amazon (Obydos).

burdi Kaye, W. J., *Thecla*

Type Locality: St. Vincent, B. W. I.

Location of Type:

Original Description: 1923, Entomologist, vol. 56, p. 277 (London).

Additional Reference: Huntington, E. I., 1944 (December), Jour. New York Ent. Soc., vol. 52, p. 328 (Lancaster, Pa.). ("*Thecla burdi* Kaye a Synonym").

Note: Synonym of *Thecla angerona* Godman and Salvin.

burdicki Henne, C., *Leptotes marina* form

Type Locality: Lennox, Los Angeles County, California, October 10, 1932.

Location of Type: Burdick Collection, Lennox, Los Angeles County, California. (Paratype United States National Museum.)

Original Description: 1935 (April), Ent. News, vol. 46, no. 4, p. 100, fig. 1 (Philadelphia, Pa.).

burica Dyar, Harrison, G., *Thecla*

Type Locality: Trinidad River, Panama.

Location of Type: United States National Museum, no. 15,757.

Original Description: 1915, Proc. U. S. Natl. Mus., vol. 47, p. 150 (Washington, D. C.).

buris Druce, Hamilton H., *Thecla*

Type Locality: Ega, Amazonas, Brazil.

Location of Type: Godman Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 590, pl. 34, fig. 18 ♂ (London).

busa Godman, F. D. and O. Salvin, *Thecla*

Type Locality: Chontales, Nicaragua.

Location of Type: British Museum (Natural History).

Original Description: 1887 (May), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 26, vol. 3, pl. 51, figs. 1, 2 ♂ (London).

cabiria Hewitson, W. C., *Thecla*

Type Locality: Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 195, vol. 2, pl. 77, figs. 623, 624 ♀ (London).

Additional Reference: Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 607 (London). (Makes *cabiria* a synonym of *hesperitis* Butler and Druce.)

Note: If *lugubris* Möschler is recognized as the southern race of *hesperitis* Butler and Druce, *cabiria* Hewitson would be a synonym of *lugubris*.

cadmus Felder, Cajetan and Rudolf Felder, *Pseudolycaena*

Type Locality: Venezuela.

Original Description: 1864–1867, Reise der Osterreichischen Fregatte "Novara" um die Erde, vol. 2, p. 247, pl. 31, fig. 5 (Wien).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (May), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 27, vol. 3, pl. 51, figs. 8, 9 ♂, 10 ♀ (London).

caeca Reiff, William, *Heodes*

Type Locality: Blue Hills, Massachusetts, May 26, 1912.

Location of Type: Reiff Collection.

Original Description: 1913 (July), Ent. News, vol. 24, p. 306, pl. 10, figs. 3, 4 (Philadelphia, Pa.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 26, no. 435 (Los Angeles, Calif.). (Places *caeca* as a synonym of *Lycaena hypophaeas* ab. *obliterata* Scudder.)

caesaries Druce, Hamilton H., *Thecla*

Type Locality: Bartica, British Guiana.

Location of Type: Druce Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 617, pl. 36, fig. 19 ♂ (London).

caespes Druce, Hamilton H., *Thecla*

Type Locality: La Paz, Bolivia.

Location of Type: Druce Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 614, pl. 36, fig. 18 ♀ (London).

caeus Godman, F. D. and O. Salvin, *Theclopsis*

Type Locality: Calobre, Panamá.

Location of Type: British Museum (Natural History).

Original Description: 1887 (October), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 101, vol. 3, pl. 58, figs. 24, 25 ♂ (London).

Additional Reference: Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 631 (London).

cajona Reakirt, Tyron, *Lycaena*

Type Locality: California.

Location of Type: Strecker Collection (1 ♂, 1 ♀).

Original Description: 1866 (June), Proc. Ent. Soc. Phila., vol. 6, p. 147 (Philadelphia, Pa.).

Additional Reference: Strecker, Herman, 1900 (March), Lepidoptera, Rhopaloceres and Heteroceres, Supplement no. 3, p. 20 (Reading, Pa.). (Makes *cajona* a synonym of *anna* Edwards.)

calanus Auctorum (= *falacer* Godart)

Type Locality:

Location of Type:

Original Description:

calanus Hübner, Jacob, *Rusticus armatus*

Type Locality:

Location of Type:

Original Description: 1809, Sammlung exotischer Schmettlinge, vol. 1, pl. (100) (Augsburg).

Note: Boisduval and LeConte (1833, Histoire Générale et iconographie des Lépidoptères et des chenilles de l'Amérique Septentrionale, p. 92) make *calanus* Hübner a synonym of *falacer* Godart, which was a mistake.)

Synonyms: *wittfeldi* Edwards.

calatia Hewitson, W. C., *Thecla*

Type Locality: Nicaragua (Chontales).

Location of Type: British Museum (Natural History).

Original Description: 1873 (February), Illus. of Diurnal Lepidoptera, vol. 1, p. 148, vol. 2, pl. 58, fig. 375 ♀ (London).

calcas McDunnough, James H., *plebeius* (not Behr). See *calchas* Behr

Type Locality:

Location of Type:

Original Description: 1938, Check list, pt. 1, p. 27, no. 458 (Los Angeles, Calif.). (Misspelled *calchas* as *calcas*.)

calchas Behr, Herman, *Lycaena*

Type Locality: Mono Lake, California.

Location of Type:

Original Description: 1867 (January), Proc. Calif. Acad. Nat. Sci., vol. 3, pt. 1, p. 281 (San Francisco, Calif.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 27, no. 458 (Los Angeles, Calif.). (Places *calchas* (as *calcas*) as a synonym of *shasta* Edwards.)

Synonyms: *calcas* McDunnough.

calchinia Hewitson, W. C., *Thecla*

Type Locality: Amazons.

Location of Type: British Museum (Natural History).

Original Description: 1868, Specimen of a Catalogue of Lycaenidae in the British Museum, p. 21 (London).

Additional Reference: Hewitson, W. C., 1973 (February), Illus. of Diurnal Lepidoptera, vol. 1, p. 145, vol. 2, pl. 57, figs. 359, 360 ♂ (London). Amazon (Ega).

calena Hewitson, W. C., *Thecla*

Type Locality: Nicaragua (Chontales).

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 187, vol. 2, pl. 74, figs. 581, 582 ♂ (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (September), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 77 (London). (Make *calena* a synonym of *denarius* Butler and Druce.)

calesia Hewitson, W. C., *Thecla*

Type Locality: Curaray, Ecuador.

Location of Type: British Museum (Natural History).

Original Description: 1870 (March), Equatorial Lepidoptera, Buckley, p. 67 (London).

Additional Reference: Hewitson, W. C., 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 163, vol. 2, pl. 64, figs. 445, 446 (London).

californica Edwards, William H., *Thecla*

Type Locality: California.

Location of Type:

Original Description: 1862 (April), Proc. Acad. Nat. Sci. Phila., p. 223 (Philadelphia, Pa.).

Synonyms: *borus* Boisduval, *cygnus* Edwards, *cygnus* Scudder.

callanga Dyar, Harrison G., *Lycaena* (Staudinger MS ?)

Type Locality: San Miguel, Peru, 6,000 ft., July 24, 1911; Urubamba, Peru, 9,500 ft., July 15, 1901.

Location of Type: United States National Museum.

Original Description: 1913, Proc. U. S. Natl. Mus., vol. 45, p. 638 (Washington, D. C.).

callao Druce, Hamilton H., *Thecla*

Type Locality: Callao, Peru.

Location of Type: British Museum (Natural History).

Original Description: 1907, Proc. Zool. Soc. London, p. 611, pl. 36, fig. 11 ♂ (London).

Additional Reference: Druce, H. H., 1909 (September), Trans. Ent. Soc. London, p. 437 (London). (Makes *callao* a synonym of *joya* Dognin.)

callides Dyar, Harrison G., *Thecla*

Type Locality: La Chorrera, April, 1912; Trinidad River, March, 1912, Panamá.

Location of Type: United States National Museum, no. 15,760.

Original Description: 1915, Proc. U. S. Natl. Mus., vol. 47, p. 151 (Washington, D. C.)

Additional Reference: Schaus, William, 1920, Ent. News, vol. 31, p. 176 (Philadelphia, Pa.). (Makes *callides* Dyar a synonym of *autoctea* Hewitson.)

callirrhoe Goodson, F. W., *Thecla*

Type Locality: "1 ♀ (no locality), ex coll. Semper. Unfortunately the body is missing."

Location of Type: British Museum (Natural History).

Original Description: 1945 (December), Entomologist, vol. 78, p. 185 (London).

calor Druce, Hamilton H., *Thecla*

Type Locality: Tapajos River, Brazil; Chapada Campo, Brazil, November-December.

Location of Type: Druce Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 163 (London).

Additional Reference: Draudt, Max, 1920 (February), The Macrolepidoptera of the World, vol. 5, p. 798, pl. 158-e (Stuttgart).

caltha Druce, Hamilton H., *Thecla*

Type Locality: Santarem, Amazonas, Brazil.

Location of Type: Druce Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 591, pl. 34, fig. 19 ♂ (London).

calus Godart, Jean B., *Polyommatus*

Type Locality: America.

Location of Type:

Original Description: 1822 Encyclopédie Méthodique, vol. 9, p. 640 (Paris).

Additional Reference: Hewitson, W. C., 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 188, vol. 2, pl. 75, figs. 585, 586 ♂ (London).

cambes Godman, F. D. and O. Salvin, *Thecla*

Type Locality: Cordova, Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1887 (August), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 53, vol. 3, pl. 54, figs. 16, 17 ♂; 18 ♀ (London).

Note: Godman and Salvin say that the female figured is associated with some doubt.

Synonyms: *syvia* Dyar.

camissa Hewitson, W. C., *Thecla*

Type Locality: Sarayaco, Ecuador.

Location of Type: British Museum (Natural History).

Original Description: 1870 (March), Equatorial Lepidoptera, Buckley, p. 66 (London).

Additional Reference: 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 189, vol. 2, pl. 75, figs. 595, 596 ♂ (London). Additional locality: Nicaragua (Chontales).

Synonyms: *charichlorus* Butler and Druce, *vespasianus* Butler and Druce.

campa Jones, E. Dukinfield, *Thecla*

Type Locality: Castro, Paraná, Brazil.

Location of Type: Jones Collection.

Original Description: 1912, Proc. Zool. Soc. London, p. 901, pl. 97, fig. 14 (London).

cana Hayward, Kenneth J., *Thecla*

Type Locality: Villa Nogués, Tucumán, Argentina.

Location of Type: Fundación Miguel Lillo, Tucumán.

Original Description: 1949, Acta Zool. Lilloana, vol. 8, p. 571, pl., fig. 7 (Tucumán, Argentina).

canacha Hewitson, W. C., *Thecla*

Type Locality: Venezuela.

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 187, vol. 2, pl. 74, figs. 583, 584 ♂ (London).

candar Dyar, Harrison G., *Thecla* (not Druce) Nomen nudum. See *candor* Druce

Type Locality: Tincochaca, Peru, 7,000 ft., August 9, 1911.

Location of Type:

Original Description: 1913, Proc. U. S. Natl. Mus., vol. 45, p. 636 (Washington, D. C.).

Note: This is a misspelling of *candor* Druce.

candidus Druce, Hamilton H., *Thecla*

Type Locality: Río Minero, Muzo, Colombia, 2,500 ft.

Location of Type: Godman Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 571, pl. 31, figs. 1 ♂, 2 ♀ (London).

candor Druce, Hamilton H., *Thecla*

Type Locality: Huancabamba, North Peru, 6,000–10,000 ft.

Location of Type: Druce Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 578, pl. 33, fig. 1 ♂ (London).

Additional Reference: Druce, H. H., 1909 (September), Trans. Ent. Soc. London, p. 433 (London). (Makes *candor* a synonym of *amatista* Dognin.)

Synonyms: *candar* Dyar.

caninius Druce, Hamilton H., *Thecla*

Type Locality: Venezuela.

Location of Type: Godman Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 585, (London).

Additional Reference: Draudt, Max, 1920 (January), The Macrolepidoptera of the World, vol. 5, p. 770, pl. 154-e (Stuttgart).

canitus Druce, Hamilton H., *Thecla*

Type Locality: Paraguay.

Location of Type: Druce Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 604, pl. 36, fig. 8 ♂ (London).

canus Druce, Hamilton H., *Thecla*

Type Locality: Chilpancingo, Guerrero, Mexico, 4,600 ft., June.

Location of Type: Godman Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 624 (London).

Additional Reference: Draudt, Max, 1920 (February), The Macrolepidoptera of the World, vol. 5, p. 806, pl. 159-g (Stuttgart).

Synonyms: *bunnirae* Dyar.

capeta Hewitson, W. C., *Thecla*

Type Locality: Nicaragua.

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 193, vol. 2, pl. 77, figs. 614, 615 ♀ (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (September), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 75 (London). (Think that the type is a male and not a female.)

caramba Clench, Harry K., *Thecla*

Type Locality: Massaranduba-Blumenau, Sta. Cartharina, Brazil.

Location of Type: American Museum of Natural History.

Original Description: 1944 (September), Jour. New York Ent. Soc., vol. 52, p. 255 (New York, N. Y.).

ceranus Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1780, Papillons exotiques des trois parties du monde, vol. 4, p. 84, pl. 332, figs. C, D (Amsterdam).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (May), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 24, vol. 3, pl. 50, figs. 13, 13a, 14 ♂, 15 ♀ (London).

Synonyms: *ceranus* Fabricius.

cardus Hewitson, W. C., *Thecla*

Type Locality: Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 151, vol. 2, pl. 60, figs. 395, 396 ♂, 394 ♀ (London).

carla Schaus, William, *Thecla*

Type Locality: Colombia.

Location of Type: United States National Museum, no. 5923.

Original Description: 1902, *Proc. U. S. Natl. Mus.*, vol. 24, p. 408 (Washington, D. C.).

carnica Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1873 (February), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 143, vol. 2, pl. 57, fig. 352 ♂ (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (September), *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 2, p. 86 (London). (Give Central American localities.)

carolyna Comstok, John A., *Plebeius*

Type Locality. Tehachapi Mountains, California.

Location of Type: Southwest Museum.

Original Description: 1922, *Bull. So. Calif. Acad. Sci.*, vol. 21, p. 46, pl. 3 (Los Angeles, Calif.).

Additional Reference: McDunnough, J. H., 1938, *Check list*, pt. 1, p. 28, no. 462 (Los Angeles, Calif.). (Places *carolyna* as a form male of *chlorina* Skinner.)

carpasia Hewitson, W. C., *Thecla*

Type Locality: Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1868, *Specimen of a Catalogue of Lycaenidae in the British Museum*, p. 15 (London).

Additional Reference: Hewitson, W. C., 1869 (April), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 116, vol. 2, pl. 47, figs. 223, 224 (London).

carpophora Hewitson, W. C., *Thecla*

Type Locality: Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1868, *Specimen of a Catalogue of Lycaenidae in the British Museum*, p. 16 (London).

Additional References: Hewitson, W. C., 1869 (April), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 116, vol. 2, pl. 47, figs. 221, 222 ♂; 1874 (December), *op. cit.*, vol. 1, p. 182, vol. 2, pl. 72, fig. 547 ♀ (London). Draudt, Max, 1919 (November), *The Macrolepidoptera of the World*, vol. 5, p. 750 (Stuttgart). (Makes *carpophora* a subspecies of *inachus* Cramer.)

carteia Hewitson, W. C., *Thecla*

Type Locality: Canelos, Ecuador.

Location of Type: British Museum (Natural History).

Original Description: 1870 (March), *Equatorial Lepidoptera*, Buckley, p. 64 (London).

Additional Reference: Hewitson, W. C., 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 164, vol. 2, pl. 64, figs. 451, 452 ♂ (London).

carteri Weeks, A. G., Jr., *Thecla*

Type Locality: Suapure, Venezuela.

Location of Type: Museum of Comparative Zoology.

Original Description: 1906 (June), *Ent. News*, vol. 17, p. 197 (Philadelphia, Pa.).

Additional Reference: Weeks, A. G., Jr., 1911, *Illus. of Diurnal Lepidoptera*, vol. 2, p. 4, pl. 3, fig. 2 (Boston, Mass.).

carthaea Hewitson, W. C., *Thecla*

Type Locality: Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1868, *Specimen of a Catalogue of Lycaenidae in the British Museum*, p. 15 (London).

Additional Reference: Hewitson, W. C., 1869 (April), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 116, vol. 2, pl. 47, figs. 215, 216 ♂ (London).

caryaevorus McDunnough, James H., *Strymon*

Type Locality: Merivale, Ontario, June 12, 1941.

Location of Type: Canadian National Collection, no. 5262.

Original Description: 1942 (January), *Can. Ent.*, vol. 74, p. 1 (Guelph, Ontario).

Additional Reference: Michener, C. D. and C. F. dos Passos, 1942, *Amer. Mus. Novitates*, no. 1210, p. 5, fig. 3 (New York, N. Y.).

casasi Comstock, W. P. and E. I. Huntington, *Thecla acis*

Type Locality: Santiago de Cuba.

Location of Type: American Museum of Natural History.

Original Description: 1943 (December), *Ann. New York Acad. Sci.*, vol. 45, p. 66, pl. 1, fig. 1 ♀ (New York, N. Y.).

casmilla Hewitson, W. C., *Thecla*

Type Locality: Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 177, vol. 2, pl. 70, figs. 521, 522 ♀ (London).

cassidula Boisduval, Jean A., *Lycaena*

Type Locality: Honduras.

Location of Type:

Original Description: 1870, *Considérations sur des Lépidoptères Envoyés du Guatemala a M. de l'Orza*, p. 16 (Rennes).

Additional Reference: Draudt, Max, 1921, *The Macrolepidoptera of the World*, vol. 5, p. 820 (Stuttgart). (Makes *cassidula* a form of *marina* Reakirt.)

cassioides Boisduval, Jean A., *Lycaena*

Type Locality: Honduras and Mexico.

Location of Type:

Original Description: 1870, *Considérations sur des Lépidoptères Envoyés du Guatemala à M. de l'Orza*, p. 16 (Rennes).

Additional Reference: Draudt, Max, 1921, *The Macrolepidoptera of the World*, vol. 5, p. 820 (Stuttgart). (Makes *cassioides* a synonym of *marina* Reakirt.)

cassius Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1775, *Papillons exotiques des trois parties du monde*, vol. 1, p. 36, pl. 23, figs. C, D (Amsterdam).

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), *Ann. New York Acad. Sci.*, vol. 45, p. 89, pl. 1, fig. 21 ♀ (New York, N. Y.).

Subspecies: *striata* Edwards, *catilina* Fabricius, *theonus* Lucas, *floridensis* Morrison syn., *chadwicki* Comstock and Huntington.

castalis Edwards, William H., *Thecla*

Type Locality: Waco, Texas.

Location of Type:

Original Description: 1871 (January), *Trans. Amer. Ent. Soc.*, vol. 3, p. 208 (Philadelphia, Pa.).

Additional Reference: McDunnough, J. H., 1938, *Check list*, pt. 1, p. 25, no. 401 (Los Angeles, Calif.). (Places *castalis* as a subspecies of *damon* Cramer.)

Synonyms: *brehmei* Barnes and Benjamin, *discoidalis* Skinner.

castimonia Druce, Hamilton H., *Thecla*

Type Locality: Interior of Colombia.

Location of Type: Druce Collection.

Original Description: 1907 (June), *Proc. Zool. Soc. London*, p. 580, pl. 33, fig. 6 ♂ (London).

castitas Druce, Hamilton H., *Thecla talayra* var.

Type Locality: Pará, Espiritu Santo, Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1907 (June), *Proc. Zool. Soc. London*, p. 579 (London).

Additional Reference: Draudt, Max, 1919 (December), *The Macrolepidoptera of the World*, vol. 5, p. 763, pl. 154-c (Stuttgart). (Makes *castitas* a form of *talayra* Hewitson.)

castrena Jones, E. Dukinfield, *Thecla*

Type Locality: Castro, Paraná, Brazil.

Location of Type: Jones Collection.

Original Description: 1912, *Proc. Zool. Soc. London*, p. 900, pl. 97, figs. 12, 13 (London).

Additional Reference: Schaus, William, 1920, Ent. News, vol. 31, p. 176 (Philadelphia, Pa.). (Places *castrena* Jones female as a synonym of *tella* Schaus.)

castro Reakirt, Tryon, *Polyommatus*

Type Locality: Rocky Mountains, Colorado.

Location of Type: Strecker Collection (2 ♀♀), Field Museum, Chicago, Illinois.

Original Description: 1866 (June), Proc. Ent. Soc. Phila., vol. 6, p. 148 (Philadelphia, Pa.).

Additional Reference: Barnes, William and J. H. McDunnough, 1917 (February), Check list of the Lepidoptera of Boreal America, p. 15, no. 407 (Decatur, Illinois). (Places *castro* as a synonym of *helloides* Boisduval.)

catadupa Hewitson, W. C., *Thecla*

Type Locality: Ecuador.

Location of Type: British Museum (Natural History).

Original Description: 1869 (April), Illus. of Diurnal Lepidoptera, vol. 1, p. 117, vol. 2, pl. 47, figs. 219, 220 ♂ (London).

catalina Reakirt, Tryon, *Lycaena*

Type Locality: California.

Location of Type: Strecker Collection (1 ♂, 1 ♀), Field Museum, Chicago, Illinois.

Original Description: 1866 (June), Proc. Acad. Nat. Sci., Phila., vol. 6, p. 244 (Philadelphia, Pa.).

Additional Reference: Barnes, William, and J. H. McDunnough, 1917 (February), Check list of the Lepidoptera of Boreal America, p. 16, no. 448 (Decatur, Illinois). (Places *catalina* as a race of *piasus* Boisduval.)

Synonyms: *gorgonioi* Gunder, *rhaea* Boisduval.

catharina Draudt, Max, *Thecla*

Type Locality: Santa Catharina, Brazil.

Location of Type: Wernicke Collection.

Original Description: 1920 (February), The Macrolepidoptera of the World, vol. 5, p. 788, pl. 156-k (Stuttgart).

catharinae Capronnier, J. B., *Thecla* Nomen nudum

Type Locality: Botafogo, Brazil.

Location of Type:

Original Description: 1874, Ann. Soc. Ent. Belgique, vol. 17, p. 15 (Bruxelles).

catharinensis Clench, Harry K., *Thecla acaste*

Type Locality: Santa Catharina, Brazil.

Location of Type: Museum of Comparative Zoology, no. 26,226.

Original Description: 1944 (July), Bull. Mus. Comp. Zool., vol. 94, p. 242 (Cambridge, Mass.).

catilina Fabricius, Johann Christian, *Hesperia*

Type Locality: "Americae meridionalis Insulis".

Location of Type:

Original Description: 1793, *Entomologica Systematica*, vol. 3, pt. 1, p. 304 (Hafniae).

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), *Ann. New York Acad. Sci.*, vol. 45, p. 91, pt. 1, figs. 29, 30 ♀ (New York, N. Y.). (Make *catilina* a subspecies of *cassius* Cramer.)

catrea Hewitson, W. C., *Thecla*

Type Locality: Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 181, vol. 2, pl. 71, figs. 545, 546 ♂ (London).

caulonia Hewitson, W. C., *Thecla*

Type Locality: Rio de Janeiro.

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 188, vol. 2, pl. 75, figs. 587, 588 ♀ (London).

Additional Reference: Druce, H. H., 1907 (June), *Proc. Zool. Soc. London*, p. 609 (London). (Makes *caulonia* a synonym of *beon* Cramer.)

cauter Druce, Hamilton H., *Thecla*

Type Locality: Chapada Campo, Brazil, September–November, male and female.

Location of Type: Godman Collection.

Original Description: 1907 (June), *Proc. Zool. Soc. London*, p. 589, pl. 34, fig. 15 ♂ (London).

cecina Hewitson, W. C., *Thecla*

Type Locality: Guatemala (Poloehic Valley).

Location of Type: Salvin and Godman Collection. British Museum?

Original Description: 1868, *Specimen of a Catalogue of Lycaenidae in the British Museum*, p. 34, (London).

Additional Reference: Hewitson, W. C., 1877 (January), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 202 (London). (Makes *cecina* Hewitson synonym of "*janais*" Cramer.)

cecrops Fabricius, Johann Christian, *Hesperia*

Type Locality: "In Indiis".

Location of Type:

Original Description: 1793, *Entomologica Systematica*, vol. 3, p. 270 (Hafniae).

Synonyms: *poeas* Hübner, *gottschalki* Clark.

ceglusa Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1868, *Specimen of a Catalogue of Lycaenidae in the British Museum*, p. 22 (London).

Additional Reference: Hewitson, W. C., 1873 (February), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 138, vol. 2, pl. 55, figs. 330, 331 ♂ (London).

celestata Hewitson, W. C., *Thecla*

Type Locality: Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 181, pl. 71, figs. 543, 544 ♀ (London).

celida Lucas, P. H., *Thecla*

Type Locality: Cuba.

Location of Type: British Museum (Natural History)?

Original Description: 1857, *in* Sagra, *Historie physique, politique et naturelle de l'île de Cuba*, vol. 7, p. 610 (Paris).

Additional Reference: Hewitson, W. C., 1869 (April), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 125, vol. 2, pl. 49, figs. 246, 247 ♂ (London).

Subspecies: *shoumatoffi* Comstock and Huntington, *aibonito* Comstock and Huntington.

celmus Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1775, *Papillons exotiques des trois parties du monde*, vol. 1, p. 87, pl. 55, figs. G, H (Amsterdam).

Additional References: Hewitson, W. C., 1873 (February), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 140, vol. 2, pl. 56, figs. 338, 339 ♂ (London). Amazon, Venezuela, Nicaragua, Rio de Janeiro. Godman, F. D. and O. Salvin, 1887 (September), *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 2, p. 85 (London). (Give additional localities.)

Synonyms: *pereza* Butler.

celona Hewitson, W. C., *Thecla*

Type Locality: Espiritu Santo.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 179, vol. 2, pl. 70, figs. 529, 530 ♂ (London).

centoripa Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1868, *Specimen of a Catalogue of Lycaenidae in the British Museum*, p. 23 (London).

Additional Reference: Hewitson, W. C., 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 183, vol. 2, pl. 73, figs. 562, 563 ♂ (London).

Synonyms: *hahneli* Staudinger.

centralis Barnes, William and James H. McDunnough, *Philotes battoides*

Type Locality: Salida, Colorado, July 1-7.

Location of Type: United States National Museum (Barnes Collection). Paratype in American Museum of Natural History.

Original Description: 1917 (March), Contributions to the natural history of the Lepidoptera of North America, vol. 3, no. 4, p. 215, pl. 16, figs. 7, 8 (Decatur, Illinois).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 28, no. 466 (Los Angeles, Calif.). (Places *centralis* as a subspecies of *glaucon* Edwards.)

centuncula Draudt, Max, *Thecla*

Type Locality: Sao Paulo, Brazil.

Location of Type:

Original Description: 1920 (February), The Macrolepidoptera of the World, vol. 5, p. 805, pl. 159-f (underside female) (Stuttgart).

ceranus Fabricius, Johann Christian, *Hesperia* Rurales (not Cramer)

Misspelling of *caranus* Cramer

Type Locality: "India".

Location of Type:

Original Description: 1793, Entomologica Systematica, vol. 3, pt. 1, p. 276, no. 66 (Hafniae).

Additional Reference: Goodson, F. W., 1945 (December), Entomologist, vol. 78, p. 186 (London). (Calls attention to the misspelling of *ceranus* Cramer by Fabricius, and repeated by Godart and Butler.)

cerata Hewitson, W. C., *Thecla*

Type Locality: Pará.

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 191, vol. 2, pl. 76, figs. 607, 608 ♂ (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (September), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 84 (London). (Give Central American localities.)

Subspecies: *palumbes* Druce.

ceraunus Fabricius, Johann Christian, *Hesperia*

Type Locality: "Americae meridionalis Insulis".

Location of Type:

Original Description: 1793, Entomologica Systematica, vol. 3, pt. 1, p. 303 (Hafniae).

Additional Reference: 1943 (December), Comstock, W. P. and E. I. Huntington, Ann. New York Acad. Sci., vol. 45, p. 107 (New York, N. Y.). (Make *ceraunus* a subspecies of *hanno* Stoll.)

Subspecies: *ramon* Dognin.

ceromia Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 185, vol. 2, pl. 74, figs. 573, 574 ♂ (London).

Synonyms: *suada* Hewitson.

cestri Reakirt, Tryon, *Thecla*

Type Locality: Near Vera Cruz, Mexico.

Location of Type:

Original Description: 1866 (November), Proc. Acad. Nat. Sci. Phila., p. 338 (Philadelphia, Pa.).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (September), *Biologia Centrali-Americana*, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 96, vol. 3, pl. 58, figs. 12, 13 ♂ (London). (Give Central American localities.)

Subspecies: *peruensis* Dufrane.

cethegus Stoll, Caspar, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1790, *Papillons exotiques des trois parties du monde*, Supplement, p. 168, pl. 38, figs. 5, 5E (Amsterdam).

Additional References: Sepp, Jan. 1855, *Surinaamsche Vlinders*, vol. 2, p. 195, pl. 86 (Amsterdam). Druce, H. H., 1907, Proc. Zool. Soc. London, p. 568 (London). (Does not recognize the species.)

cetra Draudt, Max, *Thecla*

Type Locality: Muzo, Colombia.

Location of Type: Fassl Collection (now in Naturhistorisches Museum, Basle).

Original Description: 1920 (January), *The Macrolepidoptera of the World*, vol. 5, p. 776, pl. 155-c (Stuttgart) (underside male).

chacona Jörgensen, Pedro, *Thecla cecrops* form

Type Locality: Formosa, Argentina.

Location of Type: Jörgensen Collection.

Original Description: 1932, *Deutsche Ent. Zeit. (Iris)*, vol. 46, p. 45 (Dresden).

Note: Probably a form of *beon* Cramer and not of *cecrops* Fabricius.

chadwicki Comstock, W. P. and E. I. Huntington, *Leptotes cassius*

Type Locality: Roseau Valley, Dominica, B. W. I., April 11, 1929.

Original Description: 1943 (December), *Ann. New York Acad. Sci.*, vol. 45, p. 93, pl. 1, fig. 28 ♀ (New York, N. Y.).

chalcis Edwards, William H., *Thecla*

Type Locality. California (1 ♂).

Location of Type:

Original Description: 1869 (September), *Trans. Amer. Ent. Soc.*, vol. 2, p. 376 (Philadelphia, Pa.).

chaluma Schaus, William, *Thecla*

Type Locality: St. Catherina, Brazil.

Location of Type: United States National Museum, no. 5937 ♀.

Original Description: 1902, *Proc. U. S. Natl. Mus.*, vol. 24, p. 414 (Washington, D. C.).

charichlorus Butler, A. G. and Herbert Druce, *Tmolus*

Type Locality: Cartago, Costa Rica.

Location of Type: British Museum (Natural History).

Original Description: 1872 (July), *Cistula Entomologica*, vol. 1, p. 109 (London).

Additional References: Butler, A. G., 1873 (October), *Lepid. Exot.*, p. 162, pl. 57, fig. 10 (London). Hewitson, W. C., 1877 (January), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 189 (London). (Makes *charichlorus* a synonym of *T. camissa* Hewitson.)

charlottensis Holland, William J., *Chrysophanus*

Type Locality: Queen Charlotte Island, British Columbia, August 1, 1912.

Location of Type: Carnegie Museum, Pittsburgh, Pennsylvania.

Original Description: 1930, *Ann. Carnegie Mus.*, vol. 20, p. 6 (Pittsburgh, Pa.).

chilensis Blanchard, E., *Lycaena*

Type Locality: Coquimbo, Chile.

Location of Type:

Original Description: 1852, *Historia Física y Política de Chile, Zoologica*, vol. 7, p. 37; 1854, *op. cit.*, *Atlas*, vol. 2, pl. 2 (3), figs. 4a, 4b (Paris) (Gay's Fauna of Chile).

Synonyms: *atahualpa* Wallengren.

chilica Schaus, William, *Thecla*

Type Locality: Castro, Parana, Brazil.

Location of Type: United States National Museum, no. 5956 ♂.

Original Description: 1902, *Proc. U. S. Natl. Mus.*, vol. 24, p. 422 (Washington, D. C.).

chione Goodson, F. W., *Thecla*

Type Locality: "Cauca Valley, Torne, August, '07, Colombia" (1 ♂). Amazon (Bates), ex coll. Felder (1 ♂).

Location of Type: British Museum (Natural History).

Original Description: 1945 (December), *Entomologist*, vol. 78, p. 185 (London).

chiriquensis Niepelt, W., *Theorema*

Type Locality: Chiriqui, Panama, 1 male.

Location of Type: Niepelt Collection.

Original Description: 1927, *Intern. Ent. Zeit.*, vol. 21, p. 51, pl. opp. p. 182, fig. 6 ♂ type (Guben).

chiton Fabricius, Johann Christian, *Hesperia*

Type Locality: "Habitat in India".

Location of Type: Lost (H. H. Druce).

Original Description: 1793, *Entomologica Systematica*, vol. 3, p. 262 (Hafniae).

Additional References: Donovan, Edward, 1800, *Ins. India*, p. 41, pl. 39, fig. 1 (London). Godman, F. D. and O. Salvin, 1887 (May), *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 2, p. 23 (London). (Make *chiton* a synonym of *phaleros* Linnaeus.) Druce, H. H., 1907, *Proc. Zool. Soc. London*, p. 567 (London).

chlamydem Druce, Hamilton H., *Thecla*

Type Locality: Pozuzo, Peru, 5,000-6,000 ft.

Location of Type: Druce Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 577, pl. 32, fig. 10 ♂ (London).

chlamys Druce, Hamilton H., *Thecla*

Type Locality: South Paraguay.

Location of Type: Godman Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 584, pl. 34, fig. 3 ♂ (London).

chlorina Skinner, Henry, *Lycaena*

Type Locality: Tehachapi, California, July 6.

Location of Type: Academy of Natural Sciences, Philadelphia, Pennsylvania.

Original Description: 1892 (January), Ent. News, vol. 13, p. 15 (Philadelphia, Pa.).

Synonyms: *carolyne* Comstock.

chloris Hewitson, W. C., *Thecla*

Type Locality: Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 202, vol. 2, pl. 80, figs. 659, 660 ♀ (London).

chloris Field, William D., *Habrodias grunus lorquini* form

Type Locality: Mount Diablo, Contra Costa County, California, June 17, 1931.

Location of Type: F. Martin Brown Collection, Colorado Springs, Colorado.

Original Description: 1938, Bull. So. Calif. Acad. Sci., vol. 37, pt. 1, p. 28 (Los Angeles, Calif.).

chlorophora Watson, Frank E. and William P. Comstock, *Strymon saepium*

Type Locality: San Diego, California, June 14, 1913 (Collector W. S. Wright).

Location of Type: American Museum of Natural History.

Original Description: 1920 (December), Bull. Amer. Mus. Nat. Hist., vol. 42, art. 10, p. 452 (New York, N. Y.).

chonida Hewitson, W. C., *Thecla*

Type Locality: Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1874, Ent. Mo. Mag., vol. 11, p. 105 (London).

Additional References: Hewitson, W. C., 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 197, vol. 2, pl. 78, figs. 635, 636 (London). Mexico. Godman, F. D. and O. Salvin, 1887 (September), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 90 (London). (Say that the type is a female and give locality as Jalapa, Mexico.)

christophe Comstock, W. P. and E. I. Huntington, *Thecla*

Type Locality: Port-au-Prince, Haiti, January 1-6, 1922.

Location of Type: American Museum of Natural History.

Original Description: 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 85, pl. 1, figs. 9, 10 ♀ (New York, N. Y.).

chrysalus Scudder, Samuel H., *Hypaurotis* (not Edwards)

Misspelling of *chrysalus* Edwards

Type Locality:

Location of Type:

Original Description: 1876 (May), Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 113 (Buffalo, N. Y.).

cilla Behr, Hermann, *Lycaena*

Type Locality: Headwaters Tuolumne River, California, elev. 11,000 ft.

Original Description: 1867 (January), Proc. Calif. Acad. Nat. Sci., vol. 3, p. 281 (San Francisco, Calif.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 27, no. 452 (Los Angeles, Calif.). Places *cilla* as a synonym of *aquilo podarce* C. and R. Felder.)

cillutincarae Draudt, Max, *Thecla loxurina* form

Type Locality: Bolivia, 3,000 meters.

Location of Type:

Original Description: 1919 (December), The Macrolepidoptera of the World, vol. 5, p. 758, pl. 153-e (Stuttgart).

cimelum Gosse, Philip Henry, *Thecla*

Type Locality: Paraguay, December-February.

Location of Type: British Museum (Natural History).

Original Description: 1880 (September), Entomologist, vol. 13, p. 203, pl. 2, fig. 2 ♂ (London).

Additional Reference: Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 593 (London).

cinerea Edwards, William H., *Lycaena pseudargiolus* form *violacae* var.

Type Locality: Arizona.

Location of Type:

Original Description: 1883 (January), Papilio, vol. 3, p. 8 (New York, N. Y.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 29, no. 475 (Los Angeles, Calif.). Places *cinerea* as a subspecies of *pseudargiolus* Boisduval and LeConte.)

Synonyms: *arizonensis* Edwards.

cinerea Lathy, Percy I., *Thecla*

Type Locality: Rio Grande do Sul, Brazil.

Location of Type: Fournier Collection (Paris).

Original Description: 1936, Livre Jubilaire de M. Eugene-Louis Bouvier, p. 231, pl. 8, fig. 11 (Paris).

cinniana Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 189, vol. 2, pl. 75, figs. 593, 594 ♀ (London).

circinata Hewitson, W. C., *Thecla*

Type Locality: Bolivia.

Location of Type: British Museum (Natural History).

Original Description: 1874 (November), *Bolivian Butterflies Collected by Mr. Buckley*, p. 19 (London).

Additional Reference: 1877 (January), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 199, vol. 2, pl. 79, figs. 645, 646 ♂ (London).

cissusa Hewitson, W. C., *Thecla*

Type Locality: Pará.

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 188, vol. 2, pl. 75, figs. 589, 590 ♂ (London).

cithonius Godart, Jean B., *Polyommatus*

Type Locality: Guiana.

Location of Type:

Original Description: 1822, *Encyclopédie Méthodique*, vol. 9, p. 633 (Paris).

citima Edwards, Henry, *Thecla crysalus* var.

Type Locality: Mount Nebo, Utah, August, 1875.

Location of Type: American Museum of Natural History (1 ♀).

Original Description: 1881 (April), *Papilio*, vol. 1, p. 53 (New York, N. Y.).

clara Kirby, W. F., *Cupido* (not Edwards) *Nomen nudum*

Type Locality:

Location of Type:

Original Description: 1871, *A Synonymic Catalogue of Diurnal Lepidoptera*, p. 376, no. 306 (London).

Additional Reference: Scudder, Samuel H., 1876 (May), *Bull. Buffalo Soc. Nat. Sci.*, vol. 3, p. 124 (Buffalo, N. Y.). (Says there is no description of *clara* Edwards.)

clara Edwards, Henry, *Lycaena*

Type Locality: Colorado and the mountains of California.

Location of Type: American Museum of Natural History (3 females from Tehachepi, California).

Original Description: 1880, *Pacific Coast Lepidoptera*, no. 26, 1 page (New York, N. Y.).

Note: *Pacific Coast Lepidoptera*, nos. 1-22, are reprints from *Proc. Calif. Acad. Sci.*; nos. 23-30 are reprints as the 1877-1878 volumes of the *Proceedings* were never published.

clarina Hewitson, W. C., *Thecla*

Type Locality: Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 173, vol. 2, pl. 68, figs. 497, 498 ♂ (London).

clarionensis Van Duzee, E. P., *Thecla melinus* (Heid, Graham H. MS)

Type Locality: Clarion Island, Mexico, April 30, 1925.

Location of Type: California Academy of Science Museum, no. 3749 ♂.

Original Description: 1933, Proc. Calif. Acad. Sci., Series 4, vol. 21, p. 143.

clarissa Draudt, Max, *Thecla*

Type Locality: Sao Paulo, Brazil.

Location of Type:

Original Description: 1920 (February), The Macrolepidoptera of the World, vol. 5, p. 797, pl. 158-d (underside male) (Stuttgart).

clarki Freeman, T. N., *Incisalia nippon* var.

Type Locality: Constance Bay, Ottawa Region, Ontario, Canada, June 4, 1938.

Location of Type: Canadian National Collection, Ottawa, no. 4430.

Original Description: 1938 (December), Can. Ent., vol. 70, p. 247 (Orillia, Ontario).

claytoni Brower, A. E., *Lycaena dorcas*

Type Locality: Springfield, Maine, July 27, 1938.

Location of Type: United States National Museum (Paratype in American Museum of Natural History).

Original Description: 1940, Bull. Brooklyn Ent. Soc., vol. 35, p. 138 (Brooklyn, N. Y.).

clenchi Comstock, W. P. and E. I. Huntington, *Thecla maesites*

Type Locality: Roseau Valley, Dominica, B. W. I., April.

Location of Type: American Museum of Natural History.

Original Description: 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 72, pl. 1, fig. 8 ♂ (New York, N. Y.).

cleocha Hewitson, W. C., *Thecla*

Type Locality: Curaray, Ecuador.

Location of Type: British Museum (Natural History).

Original Description: 1870 (March), Equatorial Lepidoptera, Buckley, p. 62 (London).

Additional Reference: Hewitson, W. C., 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 169, vol. 2, pl. 66, figs. 475, 476 (London).

cleon Fabricius, Johann Christian, *Papilio*

Type Locality: Brazil.

Location of Type: Banksian Collection, British Museum (Natural History).

Original Description: 1775, Systema Entomologia, p. 522, (Flensburgi).

Additional References: Butler, A. G., 1869, Catalogue of Diurnal Lepi-

doptera Described by Fabricius in the Collection of the British Museum, p. 188, pl. 2, figs. 4, 6 (London). Hewitson, W. C., 1873 (February), Illus. of Diurnal Lepidoptera, vol. 1, p. 142, vol. 2, pl. 56, figs. 347, 348, 349 ♂ (London). (Rio de Janeiro.)

Synonyms: *ecbatana* Hewitson.

clepsydra Druce, Hamilton H., *Thecla*

Type Locality: Bogotá, Colombia.

Location of Type: British Museum (Natural History).

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 607, pl. 36, fig. 10 ♂ (London).

Additional Reference: Draudt, Max, 1920 (January), The Macrolepidoptera of the World, vol. 5, p. 775 (Stuttgart). (Includes *clepsydra* as a synonym of *arpoaxis* Godman and Salvin.)

Note: Draudt's figure is poor, the synonymy is questionable.

climicles Dyar, Harrison G., *Thecla*

Type Locality: Taboga Island, Panama.

Location of Type: United States National Museum, no. 15,758.

Original Description: 1915, Proc. U. S. Natl. Mus., vol. 47, p. 150 (Washington, D. C.).

Additional Reference: Schaus, William, 1920, Ent. News, vol. 31, p. 176 (Philadelphia, Pa.). (Makes *climicles* a synonym of *proba* Godman and Salvin.)

clitumnus Butler, A. G., *Tmolus*

Type Locality: Prainha, Brazil, December 6, 1874.

Location of Type: British Museum (Natural History).

Original Description: 1877 (June), Trans. Ent. Soc. London, p. 140, pl. 3, fig. 6 (London).

Additional Reference. Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 613 (London). (Makes *clitumnus* a synonym of *atrius* Herrich-Schäffer.)

clothilde Edwards, William H., *Thecla*

Type Locality: Quebec, C. E.

Location of Type:

Original Description: "1863" [1864], Proc. Ent. Soc. Phila., vol. 2, p. 15 (Philadelphia, Pa.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 25, no. 418 (Los Angeles, Calif.). (Places *clothilde* as a synonym of female *laeta* Edwards.)

clytie Edwards, William H., *Thecla*

Type Locality: San Antonio, Texas.

Location of Type:

Original Description: 1877 (November), Field and Forest, vol. 3, p. 88 (Washington, D. C.).

Additional References: Edwards, W. H., 1882 (February), Papilio, vol. 2, p. 24 (New York, N. Y.). Holland, W. J., 1931, The Butterfly Book, Rev. Ed., p. 241, pl. 30, fig. 6 ♀ type (Garden City, N. Y.). Barnes, W. and

J. H. McDunnough, 1912 (July), Contributions to the natural history of the Lepidoptera of North America, vol. 1, no. 4, p. 57, pl. 27, fig. 3 (Decatur, Illinois).

Synonyms: *maevia* Godman and Salvin (winter form).

coccineifrons Godman, F. D. and O. Salvin, *Thecla*

Type Locality: Nicaragua (Chontales), also Santa Marta, Colombia.

Location of Type: British Museum (Natural History).

Original Description: 1887 (May), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 23, vol. 3, pl. 50, figs. 7, 8 ♂, 9 ♀ (London).

cockaynei Goodson, F. W., *Thecla*

Type Locality: "1 ♂ (no locality), ex Hewitson Coll. 1 ♂, British Museum Coll., Venezuela."

Location of Type: British Museum (Natural History).

Original Description: 1945 (December), Entomologist, vol. 78, p. 187 (London).

coelebs Herrich-Schäffer, G. A. W., *Thecla*

Type Locality: Cuba.

Location of Type:

Original Description: 1862, Corresp.-Blatt. Zool.-Min. Ver., vol. 16, p. 142 (Regensburg).

Additional References: Hewitson, W. C., 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 156, vol. 2, pl. 62, figs. 416, 417 (London). Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 61 (New York, N. Y.).

coelicolor Butler, A. G. and Herbert Druce, *Strymon*

Type Locality: Cartago, Costa Rica.

Location of Type: Coll. Druce (British Museum).

Original Description: 1872, Cistula Entomologica, vol. 1, p. 106 (London).

Additional Reference: Butler, A. G., 1873 (October), Lepid. Exot., p. 158, pl. 57, fig. 6 (London).

Synonyms: *hena* Hewitson.

cogina Schaus, William, *Lycaena*

Type Locality: Castro, Parana, Brazil.

Location of Type: United States National Museum, no. 5920.

Original Description: 1902, Proc. U. S. Natl. Mus., vol. 24, p. 407 (Washington, D. C.).

collina Philippi, R. A., *Lycaena*

Type Locality: Santiago, Chile.

Location of Type:

Original Description: 1860, Linnaea Entomologica Zeitschrift, vol. 14, p. 270 (Berlin).

Synonyms: *lyrnessa* Hewitson.

collucia Hewitson, W. C., *Thecla*

Type Locality:

Location of Type: British Museum (Natural History).

Original Description: 1877 (January), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 186, vol. 2, pl. 74, figs. 577, 578 ♀ (London).

Additional Reference: Druce, H. H., 1907 (June), *Proc. Zool. Soc. London*, p. 624 (London). (Makes *collucia* a synonym of *badaca* Hewitson.)

collustra Druce, Hamilton H., *Thecla*

Type Locality: Caparo, Trinidad, B. W. I.

Location of Type: Druce Collection.

Original Description: 1907 (June), *Proc. Zool. Soc. London*, p. 600, pl. 35, fig. 15 ♂ (London).

color Druce, Hamilton H., *Thecla*

Type Locality: British Guiana.

Location of Type: Druce Collection.

Original Description: 1907 (June), *Proc. Zool. Soc. London*, p. 582, pl. 33, fig. 11 ♂ (London).

coloradensis Gunder, J. D., *Heodes heteronea* ab. ♂

Type Locality: Plain View, Colorado, July 1924.

Location of Type: American Museum of Natural History.

Original Description: 1925 (July), *Ent. News*, vol. 36, p. 194, pl. V, fig. 1 (Philadelphia, Pa.).

columbia Skinner, Henry, *Lycaena lygdamus*

Type Locality: Fort Columbia, Washington, April 25, 1916.

Location of Type: Academy of Natural Sciences, Philadelphia, Pennsylvania.

Original Description: 1917 (May), *Ent. News*, vol. 28, p. 213 (Philadelphia, Pa.).

columbia McDunnough, James H., *Callipsyche behrii* var. nov.

Type Locality: Fairview, British Columbia, June 12, 1919.

Location of Type: Canadian National Collection, Ottawa, no. 5474 ♂.

Original Description: 1944 (September), *Can. Ent.*, vol. 76, no. 9, p. 190 (Guelph, Canada).

columbiae Mattoni, R. H. T., *Philotes enoptes*

Type Locality: Columbia River near Brewster, Okanogan County, Washington, May 5, 1947.

Location of Type: United States National Museum.

Original Description: 1954 (December), *Bull. Southern Calif. Acad. Sciences*, vol. 53, pt. 3, p. 162, pl. 43, figs. 7, 11 (Los Angeles, Calif.).

columbicola Strand, Embrik, *Thecla*

Type Locality: Colombia (2 ♂ ♂).

Location of Type: Niepelt Collection.

Original Description: 1916 (December), *Lepidoptera Niepeltiana*, pt. 2, p. 16, pl. 14, figs. 27, 28 (Berlin).

columbinia Strand, Embrik, *Thecla*

Type Locality: Colombia (1 ♂).

Location of Type: Niepelt Collection.

Original Description: 1916 (December), *Lepidoptera Niepeltiana*, pt. 2, p. 17, pl. 14, figs. 25, 26 (Berlin).

columella Fabricius, Johann Christian, *Hesperia*

Type Locality: "Americae meridionalis Insulis".

Location of Type:

Original Description: 1793, *Entomologica Systematica*, vol. 3, pt. 1, p. 282 (Hafniae).

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), *Ann. New York Acad. Sci.*, vol. 45, p. 79, pl. 1, fig. 13 ♀ (New York, N. Y.). (Fix the type locality as Hispaniola.)

Synonyms: *erytalus* Butler.

Subspecies: *modesta* Maynard, *ocellifera* Grote syn., *cybira* Hewitson, *arecibo* Comstock and Huntington, *istapa* Reakirt.

comae Druce, Hamilton H., *Thecla*

Type Locality: Río Minero, Muzo, Colombia, 2,500 ft.

Location of Type: Godman Collection.

Original Description: 1907 (June), *Proc. Zool. Soc. London*, p. 576, pl. 32, figs. 8 ♂, 9 ♀ (London).

Synonyms: *cornae* (Zool. Record).

comana Hewitson, W. C., *Thecla*

Type Locality: Amazon (Tapajos).

Location of Type: British Museum (Natural History).

Original Description: 1867, *Illus. of Diurnal Lepidoptera*, vol. 1, p. 97, vol. 2, pl. 36, figs. 87, 88 ♂ (London).

Synonyms: *peralta* Moschler.

commodus Felder, Cajetan and Rudolf Felder, *Thecla*

Type Locality: Venezuela and New Granada, Bogotá.

Location of Type:

Original Description: 1864-1867, *Reise der Osterreichischen Fregatte "Novara" um die Erde*, vol. 2, p. 262, pl. 32, figs. 19, 20 ♂ (Wien).

comstocki Fox, Charles L., *Plebeius shasta* n. var.

Type Locality: Glacier Point, Yosemite National Park, California, June 11, 1923.

Location of Type: American Museum of Natural History. Paratypes: California Academy of Sciences (San Francisco, Calif.), Southwest Museum (Los Angeles, Calif.).

Original Description: 1924 (April), *Ent. News*, vol. 35, p. 140 (Philadelphia, Pa.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 28, no. 458 (Los Angeles, Calif.). (Places *comstocki* as a subspecies of *shasta* Edwards.)

comstocki Gunder, J. D., *Philotes sonorensis* form

Type Locality: San Gabriel River, Duarte, Los Angeles County, California, March 15, 1922.

Location of Type: American Museum of Natural History.

Original Description: 1925 (January), Ent. News, vol. 36, p. 6, pl. I, figs. 1, 2, 3 (Philadelphia, Pa.).

comstocki Henne, Christopher, *Callophrys*

Type Locality: Providence Mountains, San Bernardino County, California, April 20, 1938.

Location of Type: Collection Los Angeles County Museum.

Original Description: 1940, Bull. So. Calif. Acad. Sci., vol. 39, pt. 1, p. 71 (Los Angeles, Calif.).

comyntas Godart, Jean B., *Polyommatus*

Type Locality: North America.

Location of Type: Paris Museum.

Original Description: 1822, Encyclopedie Methodique, vol. 9, p. 660 (Paris).

Additional Reference: Boisduval and LeConte, 1833, Lep. Septentrionalé, p. 120, pl. 36, figs. 6, 7, 8, 9 (Paris).

Synonyms: *meinersi* Field, *sissona* Wright, *watermani* Nakahara.

Subspecies: *albrighti* Clench, *herrii* Grinnell, *arizonensis* Gunder syn., *herii* (Zool. Record) syn., *valeriae* Clench.

conchylium Druce, Hamilton H., *Thecla*

Type Locality: Castro, Parana, Brazil and Paraguay.

Location of Type: Druce Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 598, pl. 35, fig. 12 ♂ (London).

confusa Lathy, Percy I., *Thecla*

Type Locality: Peru.

Location of Type: Fournier Collection (Paris).

Original Description: 1936, Livre jubilaire de M. Eugene-Louis Bouvier, p. 231 (Paris).

Note: Lathy said this was the butterfly figured as a female by Hewitson on pl. 66, fig. 472 in Illus. of Diurnal Lepidoptera under *epopea*. He claims figure is of male of another species and names it *confusa*.

conoveria Schaus, William, *Thecla*

Type Locality: Petropolis, Brazil.

Location of Type: United States National Museum, no. 5934 ♂.

Original Description: 1902, Proc. U. S. Natl. Mus., vol. 24, p. 413 (Washington, D. C.).

coolidgei Gunder, Jean D., *Brephidium exilis* ♀ ab.

Type Locality: Los Angeles, Los Angeles County, California.

Location of Type: American Museum of Natural History.

Original Description: 1925 (January), Ent. News, vol. 36, p. 2, pl. 1, fig. L (Philadelphia, Pa.).

coolinensis Watson, Frank E. and William P. Comstock, *Strymon acadica*

Type Locality: Coolin, Idaho.

Location of Type: American Museum of Natural History.

Original Description: 1920 (December), Bull. Amer. Mus. Nat. Hist., vol. 42, art. 10, p. 451 (New York, N. Y.).

corcorani Gunder, Jean D., *Atlides halesus* tr. f.

Type Locality: Riverside, Riverside County, California, September 2, 1933.

Location of Type: American Museum of Natural History.

Original Description: 1934 (June), Can. Ent., vol. 66, p. 131 (Orillia, Ontario).

cordelia Hewitson, W. C., *Thecla*

Type Locality: Curaray, Ecuador.

Location of Type: British Museum (Natural History).

Original Description: 1870 (March), Equatorial Lepidoptera, Buckley, p. 64 (London).

Additional References: Hewitson, W. C., 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 165, vol. 2, pl. 65, figs. 453, 454 ♀ (London). Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 604 (London). (Makes *cordelia* (♀) a synonym of *ahola* Hewitson (♂).

cornae—, *Thecla* Misspelling of *comae* Druce

Type Locality:

Location of Type:

Original Description: 1908, Zool. Record, vol. 44, p. (Insecta) 301 (London).

corolena Hewitson, W. C., *Thecla*

Type Locality: Cayenne.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 175, vol. 2, pl. 69, figs. 506, 507 ♂ (London).

coronata Hewitson, W. C., *Thecla*

Type Locality: Bogotá and Guatemala.

Location of Type: British Museum (Natural History).

Original Description: 1865, Illus. of Diurnal Lepidoptera, vol. 1, p. 70, vol. 2, pl. 27, figs. 3, 5 ♂, 4 ♀ (London).

Subspecies: *watkinsi* Lathy.

coronta Hewitson, W. C., *Thecla*

Type Locality: Cayenne.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 157, vol. 2, pl. 62, figs. 422, 423 ♂ (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (September), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 89 (London). (Give also Mexico and Guatemala.)

cos Druce, Hamilton H., *Thecla*

Type Locality: Bartica, British Guiana.

Location of Type: Druce Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 613, pl. 36, fig. 13 ♂ (London).

cosa Hewitson, W. C., *Thecla*

Type Locality: None.

Location of Type: British Museum (Natural History).

Original Description: 1867, Illus. of Diurnal Lepidoptera, vol. 1, p. 78, pl. 31, fig. 36 ♂ (London).

cosmophila Tessmann, Günter, *Thecla orobiana* f. ♀.

Type Locality: Between La Paz and La Salud, Eastern Peru, 1800 m.

Location of Type:

Original Description: 1928, Mitt. Zool. Museum, vol. 14, Heft 1, p. 125, pl. 5, fig. 8 (Berlin).

costaricensis Draudt, Max, *Eumaeus minyas* form

Type Locality: Costa Rica.

Location of Type:

Original Description: 1919 (November), The Macrolepidoptera of the World, vol. 5, p. 745, pl. 146-b (Stuttgart).

Additional Reference: Lathy, Percy I., 1926, Ann. Mag. Nat. Hist., 9th Series, vol. 17, p. 38 (London). (Places *costaricensis* as a synonym of *godartii* Boisduval.)

cottlei Grinnell, Fordyce, Jr., *Rusticus acmon*

Type Locality: Baker's Beach, San Francisco, California, March, 1915.

Location of Type: American Museum of Natural History.

Original Description: 1916, Jour. Ent. Zool., vol. 8, p. 83, six figs. (Pomona College, Claremont, Calif.).

Synonyms: *labecula* Watson and Comstock.

couperi Grote, Augustus R., *Glaucopsyche*

Type Locality: Anticosti Island, Canada.

Location of Type:

Original Description: 1873 (November), Bull. Buffalo Soc. Nat. Sci., vol. 1, p. 185 (Buffalo, N. Y.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 28, no. 473 (Los Angeles, Calif.). (Places *couperi* as a subspecies of *lygdamus* Doubleday.)

Synonyms: *leussleri* Gunder, *mcdunnoughi* Gunder.

couperii Draudt, Max, *Lycaena* (not Grote) See *couperi* Grote

Type Locality:

Location of Type:

Original Description: 1920 (December), The Macrolepidoptera of the World, vol. 5, p. 816, pl. 144-d (Stuttgart).

crambusa Hewitson, W. C., *Thecla*

Type Locality: Bolivia.

Location of Type: British Museum (Natural History).

Original Description: 1874 (November), Bolivian Butterflies Collected by Mr. Buckley, p. 20 (London).

Additional Reference: Hewitson, W. C., 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 205, vol. 2, pl. 81, figs. 678, 679 ♂ (London).

crataegi Boisduval, Jean A. and John LeConte, *Polyommatus*

Type Locality: Georgia.

Location of Type:

Original Description: 1833, Histoire Générale et iconographie des Lépidoptères et des chenilles de l'Amérique Septentrionale, p. 128, pl. 37, figs. 1, 2, 3, 4, 5 (Paris).

Additional Reference: Kirby, W. F., 1871, A Synonymic Catalogue of Diurnal Lepidoptera, p. 345 (London). (Makes *crataegi* a synonym of *tarquinius* Fabricius.)

crepundia Druce, Hamilton H., *Thecla*

Type Locality: Río Colorado, Peru, 2,500 ft.

Location of Type: H. J. Adams Collection.

Original Description: 1909 (September), Trans. Ent. Soc. London, p. 435, pl. 11, fig. 6 ♂ (London).

crethona Hewitson, W. C., *Thecla*

Type Locality: Jamaica.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 157, vol. 2, pl. 62, figs. 420, 421 ♂ (London).

crines Druce, Hamilton H., *Thecla*

Type Locality: Río Minero, Muzo, Colombia, 2,500 ft. Bogotá, Colombia.

Location of Type: Godman Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 573, pl. 32, figs. 1 ♂, 2 ♀ (London).

crispisulcans Draudt, Max, *Thecla*

Type Locality: Santa Catharina, Brazil.

Location of Type:

Original Description: 1920 (February), The Macrolepidoptera of the World, vol. 5, p. 799, pl. 158-g (Stuttgart).

critola Hewitson, W. C., *Thecla*

Type Locality: Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1874, Ent. Mo. Mag., vol. 11, p. 105 (London).

Additional Reference: Hewitson, W. C. 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 197, vol. 2, pl. 78, figs. 633, 634 ♂ (London).

croesioides Seudder, Samuel H., *Incisalia augustus*

Type Locality: Eastern United States.

Location of Type:

Original Description: 1876 (April), Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 104 (Buffalo, N. Y.).

Additional References: McDunnough, J. H., 1938, Check list, pt. 1, p. 25, no. 403 (Los Angeles, Calif.). (Places *croesioides* as a synonym of *augustus* Kirby.) dos Passos, C. F., 1943 (June), Amer. Mus. Novitates, no. 1230, p. 2 (New York, N. Y.). (Places *croesioides* as a subspecies of *augustus* Kirby.)

crolinus Butler, A. G. and Herbert Druce, *Tmolus*

Type Locality: Cartago, Costa Rica.

Location of Type: British Museum (Natural History) (Druce Collection).

Original Description: 1872 (July), *Cistula Entomologica*, vol. 1, p. 107 (London).

Additional References: Butler, A. G., 1873 (October), *Lepid. Exot.*, p. 160, pl. 57, fig. 13 (London). Godman, F. D. and O. Salvin, 1887 (August), *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 2, p. 63, vol. 3, pl. 55, figs. 31, 32 ♂, 33 ♀ type (London).

crolus Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1780, *Papillons exotiques des trois parties du monde*, vol. 4, p. 85, pl. 333, figs. G, H (Amsterdam).

Additional Reference: Hewitson, W. C., 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 155 (London). (Determines *crolus* Cramer as a male of *echion* Linnaeus.)

crossaea Draudt, Max, *Thecla* (not Hewitson) See *crossoea* Hewitson

Type Locality:

Location of Type:

Original Description: 1920 (December), *The Macrolepidoptera of the World*, vol. 5, p. 809, pl. 159-1 (Stuttgart).

crossi Field, William D., *Callipsyche behrii*

Type Locality: Nederland, Colorado, July 19, 1936.

Location of Type: Collection William D. Field (United States National Museum?).

Original Description: 1938 (October), *Jour. Kansas Ent. Soc.*, vol. 11, no. 4, p. 130 (McPherson, Kansas).

crossoea Hewitson, W. C., *Thecla*

Type Locality: ?

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 158, vol. 2, pl. 62, fig. 427 (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (September), *Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera*, vol. 2, p. 95 (London). (Make *crossoea* a synonym of *mulucha* Hewitson.)

Synonyms: *crossaea* Draudt.

cruenta Gosse, Philip Henry, *Thecla*

Type Locality: Corrientes, Argentina, April.

Location of Type: British Museum (Natural History)?

Original Description: 1880 (September), *Entomologist*, vol. 13, p. 204, pl. 2, fig. 4 ♂ (London).

crysalus Edwards, William H., *Thecla*

Type Locality: Lake Paso, August 7, 1871.

Location of Type: Museum of Comparative Zoology.

Original Description: 1873 (March), Trans. Amer. Ent. Soc., vol. 4, p. 344 (Philadelphia, Pa.).

Synonyms: *chrysalus* Scudder.

Subspecies: *citima* Henry Edwards.

culminicola Staudinger, Otto, *Thecla*?

Type Locality: Huallatani, Bolivia, 4,000-4,500 meters.

Location of Type:

Original Description: 1894, Deutsche Ent. Zeit. (Iris), vol. 7, p. 80, pl. 2, fig. 6 (Dresden).

cupa Druce, Hamilton H., *Thecla*

Type Locality: Rio Grande, Brazil.

Location of Type: Druce Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 612, pl. 36, fig. 12 ♂ (London).

cupentus Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1781, Papillons exotiques des trois parties du monde, vol. 4, p. 93, pl. 337, figs. F, G ♂ (Amsterdam).

Synonyms: *annulatus* Gmelin.

cuprea Lathy, Percy I., *Thecla*

Type Locality: Macas, Ecuador.

Location of Type: Fournier Collection (Paris).

Original Description: 1930 (June), Trans. Ent. Soc. London, p. 134, pl. 9, fig. 6 (London).

cupreus Edwards, William H., *Chrysophanus*

Type Locality: Oregon (1 ♂, 1 ♀).

Location of Type:

Original Description: 1870 (January), Trans. Amer. Ent. Soc., vol. 3, p. 20 (Philadelphia, Pa.).

Synonyms: *maculinita* Gunder.

curtira Schaus, William, *Thecla*

Type Locality: Aroa, Venezuela.

Location of Type: United States National Museum, no. 5935 ♂.

Original Description: 1902, Proc. U. S. Natl. Mus., vol. 24, p. 413 (Washington, D. C.).

Additional Reference: Draudt, Max, 1920 (December), The Macrolepidoptera of the World, vol. 5, p. 811, pl. 145-g (Stuttgart). (Places *curtira* in the genus *Theclopsis*.)

cuyamaca Wright, W. S., *Miltoura spinetorum*

Type Locality: Julian, San Diego County, California, August 4, 1917.

Location of Type: W. S. Wright Collection.

Original Description: 1922 (October), Bull. So. Calif. Acad. Sci., vol. 21,

no. 2, p. 19, pls. C, D (Los Angeles, Calif.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 25, no. 396 (Los Angeles, Calif.). (Places *cuyamaca* as a synonym of *spinetorum* Hewitson.)

cyanus Draudt, Max, *Thecla*

Type Locality: Bolivia.

Location of Type:

Original Description: 1920 (February), The Macrolepidoptera of the World, vol. 5, p. 796, pl. 158-c (Stuttgart).

cybele Godman, F. D. and O. Salvin, *Thecla*

Type Locality: St. Vincent, B. W. I.

Location of Type: British Museum (Natural History).

Original Description: 1896, Proc. Zool. Soc. London, p. 516 (London).

Additional Reference: Draudt, Max, 1919, The Macrolepidoptera of the World, vol. 5, p. 748 (Stuttgart). (Makes *cybele* a subspecies of *marsyas* Linnaeus.)

cybira Hewitson, W. C., *Thecla*

Type Locality: Cuba and Jamaica.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 161, vol. 2, pl. 63, figs. 435, 436 ♀ (London).

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 81, pl. 1, fig. 15 (New York, N. Y.). (Make *cybira* a subspecies of *columella* Fabricius.)

cygnus Scudder, Samuel H., *Thecla* (not Edwards) Misspelling of *cygnus* Edw.

Type Locality:

Location of Type:

Original Description: 1876 (May), Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 109 (Buffalo, N. Y.).

cyda Godman, F. D. and O. Salvin, *Thecla*

Type Locality: Irazú, Costa Rica.

Location of Type: British Museum (Natural History).

Original Description: 1887 (May), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 28, vol. 3, pl. 51, figs. 15, 16 ♀ (London).

cydia Hewitson, W. C., *Thecla*

Type Locality: Rio de Janeiro.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 160, vol. 2, pl. 63, figs. 433, 434 ♀ (London).

cydonia Druce, Hamilton H., *Thecla*

Type Locality: Interior of Colombia.

Location of Type: Druce Collection (♂).

Original Description: 1890, Ent. Mo. Mag., Series 2, vol. 1, p. 152 (London).

Additional Reference: Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 583, pl. 33, fig. 14 ♂ type (London).

cydrara Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1868, Specimen of a Catalogue of Lycaenidae in the British Museum, p. 17 (London).

Additional Reference: Hewitson, W. C., 1869 (April), Illus. of Diurnal Lepidoptera, vol. 1, p. 133, vol. 2, pl. 53, figs. 295, 296 ♂ (London).

cygnus Edwards, William H., *Thecla*

Type Locality: Nevada (♀).

Location of Type:

Original Description: 1871 (January), Trans. Amer. Ent. Soc., vol. 3, p. 207 (Philadelphia, Pa.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 24, no. 382 (Los Angeles, Calif.). (Places *cygnus* as a synonym of *californica* Edwards.)

Synonyms: *cygnus* Seudder.

cyllarissus Herbst, Johann Friedrich Wilhelm, *Papilio*

Type Locality:

Location of Type:

Original Description: 1800, Natursystem aller bekannten in und ausländischen Insekten, vol. 10, p. 297, pl. 291, figs. 3, 4 (Berlin).

Additional References: Kirby, W. F., 1877, A Synonymic Catalogue of Diurnal Lepidoptera, Supplement, p. 774, no. 162 (London). (Places *cyllarissus* in synonymy of *cyllarus* Cramer.) (Draudt, Max, 1920 (February), The Macrolepidoptera of the World, vol. 5, p. 780 (Stuttgart). (Places *cyllarissus* in synonymy of *cyllarus* Cramer.)

cyllarus Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1775, Papillons exotiques des trois parties du monde, vol. 1, p. 43, pl. 27, figs. C, D (Amsterdam).

Synonyms: *cyllarissus* Herbst, *xanthica* Lathy.

Subspecies: *deliciae* Druce, *reducta* Lathy.

cymon Capronnier, J. B., *Thecla* Nomen nudum

Type Locality: Rio de Janeiro, Brazil.

Location of Type:

Original Description: 1874, Ann. Soc. Ent. Belgique, vol. 17, p. 14 (Bruxelles).

cyna Edwards, William H., *Lycaena*

Type Locality: San Antonio, Texas (♀).

Location of Type:

Original Description: 1881 (February), Trans. Amer. Ent. Soc., vol. 9, p. 3 (Philadelphia, Pa.).

Synonyms: *mela* Strecker.

cynara Godman, F. D. and O. Salvin, *Thecla*

Type Locality: Oaxaca, Mexico.

Location of Type: British Museum (Natural History).

Original Description: 1887 (May), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 19, vol. 3, pl. 49, figs. 9, 10 ♂, 11 ♀ (London).

cyphara Hewitson, W. C., *Thecla*

Type Locality: Panamá.

Location of Type: British Museum (Natural History).

Original Description: 1874, Ent. Mo. Mag., vol. 11, p. 106 (London).

Additional Reference: Hewitson, W. C., 1877, Illus. of Diurnal Lepidoptera, vol. 1, p. 186, vol. 2, pl. 74, figs. 579, 580 ♂ (London).

cypria Geyer, Carl, *Theritas*

Type Locality: Yucatán.

Location of Type:

Original Description: 1837, Zutrage zur Sammlung exotischer Schmetlinge, vol. 5, p. 36, figs. 945, 946 ♀ (Augsburg).

Subspecies: *paphia* Felder and Felder.

cyrriana Hewitson, W. C., *Thecla*

Type Locality: Peru.

Location of Type: British Museum (Natural History).

Original Description: 1874, Ent. Mo. Mag., vol. 11, p. 105 (London).

Additional Reference: Hewitson, W. C., 1877 (January), Illus. of Diurnal Lepidoptera, vol. 1, p. 195, vol. 2, pl. 78, figs. 625, 626 ♂ (London). Peru.

daedalus Behr, Hermann, *Lycaena*

Type Locality: Alpine regions, headwaters Tuolumne River, California.

Location of Type:

Original Description: 1867, Proc. Calif. Acad. Nat. Sci., vol. 3, p. 280 (San Francisco, Calif.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 27, no. 455 (Los Angeles, Calif.). (Places *daedalus* Behr as an aberration of *icarioides* Boisduval.)

damastus Godart, Jean B., *Polyommatus*

Type Locality: Virginia.

Location of Type: Paris Museum.

Original Description: 1822, Encyclopédie Méthodique, vol. 9, p. 640 (Paris).

Note: Godart gave this new name for *Papilio damon* Cramer of which it is a synonym by reference.

dammersi Comstock, John A. and Christopher Henne, *Philotes enoptes*

Type Locality: Snow Creek, Riverside County, California.

Location of Type: Christopher Henne Collection (United States National Museum?). Paratype in American Museum of Natural History.

Original Description: 1933 (January-April), Bull. So. Calif. Acad. Sci., vol. 32, pt. 1, p. 24 (Los Angeles, Calif.), March.

damo Druce, Herbert, *Thecla*

Type Locality: Calobre, Panamá.

Location of Type: British Museum (Natural History).

Original Description: 1875 (May), Cistula Entomologica, vol. 1, p. 362 (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (May), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 15, vol. 3, pl. 49, figs. 1, 2 ♂, 3 ♀ (London).

Subspecies: *dorcas* Druce.

damon Cramer, Pierre, *Papilio*

Type Locality: Virginia, U. S. A.

Location of Type:

Original Description: 1784, Papilons exotiques des trios parties du monde, vol. 4, p. 208, pl. 390, figs. C, D (Amsterdam).

Synonyms: *aubumiana* Harris, *auburniana* Harris, *damastus* Godart, *gryneus* Hübner, *smilacis* Boisduval and LeConte, *patersonia* Brehme syn.

Subspecies: *castalis* Edwards, *brehmei* Barnes and Benjamin syn.

danaus Felder, Cajetan and Rudolf Felder, *Pseudolycaena*

Type Locality: Venezuela.

Location of Type:

Original Description: 1864-1867, Reise der Osterreichischen Fregatte "Novara" um die Erde, vol. 2, p. 248, pl. 31, figs. 6, 7 (Wien).

daraba Hewitson, W. C., *Thecla*

Type Locality: Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1867, Illus. of Diurnal Lepidoptera, vol. 1, p. 105, vol. 2, pl. 36, fig. 89 ♂ (London).

Additional Reference: Hewitson, W. C., 1874 (December), *op. cit.*, vol. 1, p. 158, vol. 2, pl. 62, figs. 425, 426 ♂, 424 ♀. (Makes *daraba* a synonym of *yojoa*, which is incorrect; fig. 426 is a female not a male.)

datitia Jones, E. Dukinfield, *Thecla*

Type Locality: Fernandes Pinheiro, Paraná, Brazil.

Location of Type: Jones Collection.

Original Description: 1912, Proc. Zool. Soc. London, p. 901, pl. 97, fig. 15 (London).

daunia Edwards, William H., *Lycaena*

Type Locality: Colorado (♂).

Location of Type:

Original Description: 1871 (March), Trans. Amer. Ent. Soc., vol. 3, p. 272 (Philadelphia, Pa.).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 28, no. 472 (Los Angeles, Calif.). (Places *daunia* as a subspecies of *piasus* Boisduval.)

davara Hewitson, W. C., *Thecla*

Type Locality: None given.

Location of Type: British Museum (Natural History).

Original Description: 1868, Specimen of a Catalogue of Lycaenidae in the British Museum, p. 31 (London).

Additional Reference: Hewitson, W. C., 1873 (February), Illus. of Diurnal Lepidoptera, vol. 1, p. 147, vol. 2, pl. 58, fig. 371 (London).

Subspecies: *joannisi* Dufrane.

davisi Watson, Frank E. and William P. Comstock, *Incisalia polios* ab.

Type locality: Lakehurst, New Jersey, April 29 (Collector W. T. Davis).

Location of Type: American Museum of Natural History.

Original Description: 1920 (December), Bull. Amer. Mus. Nat. Hist., vol. 42, art. 10, p. 453 (New York, N. Y.).

dealbata Draudt, Max, *Thecla phydela* form

Type locality: Brazil.

Location of Type:

Original Description: 1919 (November), The Macrolepidoptera of the World, vol. 5, p. 752, pl. 149-g (Stuttgart).

deborae Geyer, Carl, *Eumaea*

Type locality:

Location of Type:

Original Description: 1834, Sammlung exotischer Schmetterlinge, vol. 3, pl. (18) (Augsburg).

deborrei Capronnier, J. B., *Thecla*

Type Locality: Botafogo, Brazil, November 27.

Location of Type:

Original Description: 1874, Ann. Soc. Ent. Belgique, vol. 17, p. 17, pl. 1, fig. 4 (Bruxelles).

Additional Reference: Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 630 (London). (Makes *deborrei* (♀) a synonym of *faunalia* Hewitson).

decorata Lathy, Percy I., *Lamprospilus*

Type Locality: Oxapampa, Peru (1 ♂).

Location of Type: Fournier Collection, Paris.

Original Description: 1926, Ann. Mag. Nat. Hist., Series 9, vol. 17, p. 47 (London).

Additional Reference: Lathy, P. I., 1930 (June), Trans. Ent. Soc. London, pl. 9, fig. 17 ♂ (London).

decyanea Lathy, Percy I., *Lamprospilus azaria* ♀ ab.

Type Locality: Petropolis, Brazil (1 ♀).

Location of Type: Fournier Collection, Paris.

Original Description: 1932, Ann. Mag. Nat. Hist., Series 10, vol. 9, p. 182 (London).

deidamia Burmeister, H., *Thecla*

Type Locality: Las Conchas, north of Buenos Aires, Argentina.

Location of Type:

Original Description: 1879, Atlas Desc. Physique République Argentine, vol. 5, Lép., pt. 2, p. 24 (Buenos Aires).

Additional Reference: Clench, H. K., 1944 (July), Bull. Mus. Comp. Zool., vol. 94, p. 234 (Cambridge, Mass.). (Makes *deidamia* a synonym of *remus* Hewitson.)

deliciae Druce, Hamilton H., *Thecla*

Type Locality: Maranhão, North Brazil.

Location of Type: Godman Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 595, pl. 35, fig. 3 ♂ (London).

Additional Reference: Draudt, Max, 1920 (February), The Macrolepidoptera of the World, vol. 5, p. 780, pl. 151-i (Stuttgart). (Makes *deliciae* a subspecies of *cyllarus* Cramer.)

del sud Wright, William Greenwood, *Chrysophanus*

Type Locality: San Diego, California.

Location of Type:

Original Description: 1906, Butterflies of the West Coast, 2nd edit., p. 215, pl. 28, figs. 347, 347-b ♀ (San Bernardino, Calif.).

Note: The date of the species is 1905, from 1st edition published by the Whitaker and Ray Co., San Francisco, California.

Additional Reference: Skinner, Henry, 1905 (December), Ent. News, vol. 16, p. 337 (Philadelphia, Pa.). (Makes *del sud* a synonym of *hermes* Edwards.)

delus Capronnier, J. B., *Thecla* Nomen nudum

Type Locality: Botafogo, Brazil.

Location of Type:

Original Description: 1874, Ann. Soc. Ent. Belgique, vol. 17, p. 17 (Bruxelles).

demea Hewitson, W. C., *Thecla*

Type Locality: Nicaragua (Chontales).

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 180, vol. 2, pl. 70, figs. 533, 534 ♂ (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (October), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 100 (London). (Places *demea* in genus *Theclopsis*.)

demilineata Lathy, Percy I., *Thecla*

Type Locality: Paraguay.

Location of Type: Fournier Collection, Paris.

Original Description: 1936, Livre Jubilaire de M. Eugene-Louis Bouvier, p. 231, pl. 8, fig. 16 (Paris).

demonassa Hewitson, W. C., *Thecla*

Type Locality: Venezuela and Amazon.

Location of Type: British Museum (Natural History).

Original Description: 1868, Specimen of a Catalogue of Lycaenidae in the British Museum, p. 25 (London).

Additional Reference: Hewitson, W. C., 1873 (February), Illus. of Diurnal Lepidoptera, vol. 1, p. 148, vol. 2, pl. 58, figs. 376, 378 ♂, 377 ♀ (London).

denarius Butler, A. G. and Herbert Druce, *Tmolus*

Type Locality: Cartago, Costa Rica.

Location of Type: British Museum (Natural History).

Original Description: 1872 (July), Cistula Entomologica, vol. 1, p. 109 (London).

Additional Reference: Butler, A. G., 1873 (October), Lepid. Exot., p. 162, pl. 57, fig. 3, (London).

Synonyms: *calena* Hewitson, *renarius* Butler.

deniva Hewitson, W. C., *Thecla*

Type Locality: Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 180, vol. 2, pl. 71, figs. 535, 536 ♀ (London).

derus Capronnier, J. B., *Thecla* Nomen nudum

Type Locality: Botafogo, Brazil

Location of Type:

Original Description: 1874, Ann. Soc. Ent. Belgique, vol. 17, p. 18 (Bruxelles).

desdemona Hewitson, W. C., *Thecla*

Type Locality: Guatemala (Poloche Valley.)

Location of Type: British Museum (Natural History).

Original Description: 1867, Illus. of Diurnal Lepidoptera, vol. 1, p. 79, vol. 2, pl. 45, figs. 189, 190 ♂ (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (May), Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 30 (London). (Make *desdemona* a synonym of *barajo* Reakirt.)

deserta Draudt, Max, *Thecla syncellus* form

Type Locality: Guerrero, Mexico.

Location of Type:

Original Description: 1920 (February), The Macrolepidoptera of the World, vol. 5, p. 779, pl. 151-k (Stuttgart).

Additional Reference: Draudt, Max, 1921 (January), *op. cit.*, vol. 5, p. 823. (Said: "for *deserta* insert: *sierrae* Dyar.")

Note: Draudt means that *deserta* is a synonym of *sierrae*.

desertorum Grinnell, Fordyce, Jr., *Strymon sylvinus*

Type Locality: Oak Creek, Kern County, California, June 29, 1905.

Location of Type: American Museum of Natural History.

Original Description: 1917 (October), Can. Ent., vol. 49, p. 349 (London, Ontario).

detesta Clench, Harry K., *Thecla*

Type Locality: St. Fé de Bogotá, Colombia.

Location of Type: British Museum (Natural History).

Original Description: 1946 (July), Entomologist, vol. 79, p. 155 (London).

deutargiolus Scudder, Samuel H., *Cyaniris*

Type Locality:

Location of Type:

Original Description: 1876 (May), Bull. Buffalo Soc. Nat. Sci., vol. 3, p. 115 (Buffalo, N. Y.)

Note: Scudder attributes this name to Harris, "MSS., Harr. Ent. Cor., 165 (Polyommatus)," and places it as a synonym of *neglecta* Edwards.

devia Möschler, H. B., *Thecla*

Type Locality: Surinam?

Location of Type:

Original Description: 1883, Verh. zool.-bot. Ges., vol. 32, p. 311, pl. 17, fig. 7 (Wien).

Additional Reference: Schaus, William, 1920, Ent. News, vol. 31, p. 176 (Philadelphia, Pa.). (Makes *devia* a synonym of *xeneta* Hewitson.)

diaguita Hayward, Kenneth J., *Thecla*

Type Locality: Villa Nagues, Tucumán, Argentina (1100 meters, January 12, 1931).

Location of Type: Fundación Miguel Lillo, Tucumán.

Original Description: 1949, Acta Zool. Lilloana, vol. 8, p. 576, pl., fig. 4 (Tucumán, Argentina).

dicaea Hewitson, W. C., *Thecla*

Type Locality:

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 179, vol. 2, pl. 70, figs. 531, 532 ♂ (London).

Additional Reference: Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 1619 (London). (Give locality as Castro, Parana, Brazil.)

Synonyms: *farmina* Schaus.

dicaeoides Lathy, Percy I., *Thecla*

Type Locality: Paraguay (♀).

Location of Type: Fournier Collection, Paris.

Original Description: 1936, Livre jubilaire de M. Eugene-Louis Bouvier, p. 229, pl. 8, fig. 1 ♀ (Paris).

dicina Draudt, Max, *Thecla*

Type Locality: Colombia.

Location of Type:

Original Description: 1920 (February), *The Macrolepidoptera of the World*, vol. 5, p. 803, pl. 159-b (Stuttgart).

dickiei Weeks, A. G., Jr., *Thecla*

Type Locality: Coroico, Bolivia, May, 1889.

Location of Type: Museum of Comparative Zoology.

Original Description: 1901, *Ent. News*, vol. 12, p. 266 (Philadelphia, Pa.).

Additional Reference: Weeks, A. G., Jr., 1905, *Illus. of Diurnal Lepidoptera*, p. 49, pl. 14, fig. 1 (Boston, Mass.).

didymaon Auct., *Thecla* See *dydimaon* Cramer

Type Locality:

Location of Type:

Original Description:

dignota Draudt, Max, *Thecla*

Type Locality: Bogotá, Colombia (1 ♂).

Location of Type: Fassi Collection. (Now in Naturhistorisches Museum, Basle.)

Original Description: 1919 (December), *The Macrolepidoptera of the World*, vol. 5, p. 754, pl. 153-b (Stuttgart).

dindus Fabricius, Johann Christian, *Hesperia*

Type Locality: "In India."

Location of Type: Lost (H. H. Druce).

Original Description: 1793, *Entomologica Systematica*, vol. 3, p. 269 (Hafniae).

Additional References: Butler, A. G., 1870, *Catalogue of Diurnal Lepidoptera Described by Fabricius in the Collection of the British Museum*, p. 189 (London). (Mentions Jones' figure as near *T. mulucha* Hewitson or *T. olbia* Hewitson.) Druce, H. H., 1907, *Proc. Zool. Soc. London*, p. 568 (London).

dindymus Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1775, *Papillons exotiques des trois parties du monde*, vol. 1, p. 73, pl. 46, figs. F, G (Amsterdam).

Additional Reference: Hewitson, W. C., 1869 (April), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 107, vol. 2, pl. 39, fig. 126 ♂ (London).

Synonyms: *sphinx* Fabricius.

dinus Hewitson, W. C., *Thecla*

Type Locality: Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1867, *Illus. of Diurnal Lepidoptera*, vol. 1, p. 114, vol. 2, pl. 43, figs. 174, 175 ♀ (London).

dion Schallers, J. G., *Papilio* (*Plebejus Rurales*)

Type Locality: Unknown.

Location of Type:

Original Description: 1788, *Der Naturforscher*, vol. 23, p. 9 (Halle).

Note: Figure reference given as plate 1, figs. 9, 10.

Additional Reference: Draudt, Max, 1920 (February), *The Macrolepidoptera of the World*, vol. 5, p. 808 (Stuttgart. (Said "*dion* Schaller is a species not to be identified, perhaps allied to *faunalia*."))

dione Scudder, Samuel H., *Chrysophanus*

Type Locality: Dennison, Iowa, July; New Jefferson, Iowa, July 24.

Location of Type:

Original Description: 1868, *Proc. Boston Soc. Nat. Hist.*, vol. 11, p. 401 (Boston, Mass.).

Additional Reference: Scudder, Samuel H., 1869, *Trans. Chicago Acad. Sci.*, vol 1, p. 330 (Chicago, Illinois).

Subspecies: *gibboni* Gunder.

discoidalis Skinner, Henry, *Thecla damon* var.

Type Locality: Round Mountain, Blanco County, Texas, February 10 and August 16.

Location of Type: Academy of Natural Sciences, Philadelphia, Pennsylvania. (Paratype in American Museum of Natural History.)

Original Description: 1897 (June), *Can. Ent.*, vol. 29, p. 156 (London, Ontario).

Additional Reference: McDonnough, J. H., 1938, Check list, pt. 1, p. 25 (Los Angeles, Calif.). (Places *discoidalis* as a synonym of *castalis* Edwards.)

dissentanea Draudt, Max, *Thecla*

Type Locality: Cuzco, Peru (2 ♂ ♂).

Location of Type: Fassl Collection (now in Naturhistorisches Museum, Basle).

Original Description: 1919 (December), *The Macrolepidoptera of the World*, vol. 5, p. 758, pl. 153-e (Stuttgart).

Additional Reference: Ureta R, Emiles, 1949, *Boletin del Museo Nacional de Historia Natural*, vol. 24, p. 97 (Santiago, Chile). (Gives description and figure of female.)

distractus Clench, Harry K., *Thecla amyntor*

Type Locality: Río Minero, Muzo Colombia, 2,500 ft.

Location of Type: British Museum (Natural History).

Original Description: 1946 (July), *Entomologist*, vol. 79, p. 153 (London).

dodava Hewitson, W. C., *Thecla*

Type Locality: Chiriquí, Panamá.

Location of Type: Staudinger Collection.

Original Description: 1877 (January), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 200, vol. 2, pl. 79, figs. 647, 648 (London).

Additional Reference: Godman, F. D. and O. Salvin, 1887 (September),

Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera, vol. 2, p. 71, vol. 3, pl. 56, figs. 28, 29 ♂ (London).

dodgei Gunder, Jean D., *Everes amyntula* tr. f.

Type Locality: Santa Cruz, California, April 20, 1918.

Location of Type: American Museum of Natural History.

Original Description: 1927 (December), Can. Ent., vol. 59, p. 283, pl. A, fig. 7 (Orillia, Ontario).

Additional Reference: McDunnough, J. H., 1938, Check list, pt. 1, p. 27, no. 448 (Los Angeles, Calif.). (Places *dodgei* as an aberration of *amyntula* Boisduval.)

dolichos Hübner, Jacob, *Atlides*

Type Locality: Georgia.

Location of Type:

Original Description: 1823, Zuträge zur Sammlung exotischer Schmettlinge, vol. 2, p. 9, pl. (39), figs. 219, 220 (Augsburg).

Additional Reference: Kirby, W. F., 1871, A Synonymic Catalogue of Diurnal Lepidoptera, p. 383, (London). (Makes *dolichos* a synonym of *halesus* Cramer.)

dolichus Hübner, Jacob, *Atlides*. See *dolichos* Hübner Nomen nudum

Type locality:

Location of Type:

Original Description: 1819, Verzeichniss bekannter Schmettlinge, p. 80, no. 815 (Augsburg).

dolium Druce, Hamilton H., *Thecla*

Type Locality: Honduras.

Location of Type: British Museum (Natural History).

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 619 (London).

dolosa Staudinger, Otto, *Thecla*

Type Locality: Puerto Cabello and Mérida, Venezuela.

Location of Type: Staudinger Collection.

Original Description: 1888, Exotische Tagfalter, vol. 1, p. 286, vol. 2, pl. 97, (Bayern).

Additional Reference: Druce, H. H., 1907 (June), Proc. Zool. Soc. London, p. 579 (London). (Makes *dolosa* a synonym of *spurius* Felder and Felder.)

dolyllas Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1777, Papillons exotiques des trois parties du monde, vol. 2, p. 22, pl. 111, figs. B, C (Amsterdam).

Subspecies: *pallida* Lathy.

dominica Möschler, Heinrich Benno, *Lycaena*

Type Locality: Jamaica, B. W. I.

Location of Type:

Original Description: 1886, Abhandl. Senckenberg. Naturf. Gesselsch., vol. 14, p. 26, fig. 10 (Frankfurt).

Additional References: Kaye, W. J., 1931, Trans. Ent. Soc. London, vol. 79, p. 534, pl. 39, figs. 1, 4, 7 (London). Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 101 (New York, N. Y.). (Consider *dominica* a good species.)

dominicana Lathy, Percy I., *Thecla*

Type Locality: Dominica, B. W. I.

Location of Type: H. J Adams Collection, 15 males (type).

Original Description: 1904 (March), Proc. Zool. Soc. London, p. 452 (London).

Additional Reference: Comstock, W. P. and E. I. Huntington, 1943 (December), Ann. New York Acad. Sci., vol. 45, p. 76 (New York, N. Y.).

Synonyms: *otoheba* Dyar.

dorcas Kirby, William (Rev.), *Lycaena*

Type Locality: "Taken in Latitude 54 deg." (Cumberland-house?)

Location of Type:

Original Description: 1837, Fauna Boreali-Americana; Zoology, British America (by Dr. John Richardson), pt. 4, Insects (By Rev. William Kirby), p. 299, pl. 4, fig. 1 (Norwich, England).

Synonyms: *anthelle* Doubleday.

Subspecies: *claytoni* Brower, *dospassosi* McDunnough.

dorcas Druce, Hamilton H., *Thecla*

Type Locality: Vina, Northwest Peru, 5,500 ft.

Location of Type: Godman Collection.

Original Description: 1907 (June), Proc. Zool. Soc. London, p. 572 (London).

Additional Reference: Draudt, Max 1919 (November), The Macrolepidoptera of the World, vol. 5, p. 748 (Stuttgart). (Makes *dorcas* a subspecies of *damo* Druce.)

doryasa Hewitson, W. C., *Thecla*

Type Locality: Amazon (Pará).

Location of Type: British Museum (Natural History).

Original Description: 1874 (December), Illus. of Diurnal Lepidoptera, vol. 1, p. 179, vol. 2, pl. 70, figs. 527, 528 ♂ (London).

Subspecies: *epidius* Godman and Salvin.

dospassosi McDunnough, J. H., *Lycaena dorcas* var.

Type Locality: Bathurst, New Brunswick, August 6, 1939.

Location of Type: Canadian National Collection Ottawa, no. 5290.

Original Description: 1940, Can. Ent., vol. 72, p. 130 (Guelph, Ontario).

doudoroffi dos Passos, Cyril F., *Incisalia*

Type Locality: Big Sur, Monterey County, California, June 9, 1939.

Location of Type: American Museum of Natural History.

Original Description: 1940 (August), Can. Ent., vol. 72, p. 168 (Guelph, Ontario).

Subspecies: *windi* Clench.

dowi Clench, Harry K., *Strymon angelia*

Type locality: Arthurs Town, Cat Island, Bahamas, July 15, 1935.

Location of Type: Museum of Comparative Zoology, no. 25,451.

Original Description: 1941 (March), Rev. Torreia, Univ. Havana, no. 7, p. 4 (Havana, Cuba).

draudti Lathy Percy I., *Thecla*

Type Locality: Colombia and Central America.

Location of Type: Fournier Collection, Paris.

Original Description: 1926, Ann. Mag. Nat. Hist., Series 9, vol. 17, p. 40 (London).

Additional Reference: Lathy, Percy I., 1930, Trans. Ent. Soc., London, pl. 9, fig. 10 ♂ (London).

draudti Lathy, Percy I., *Lamprospilus*

Type Locality: Río Aquatal, Colombia, November 1908, 1800 m. (1 ♂).

Location of Type: Fournier Collection, Paris.

Original Description: 1932, Ann. Mag. Nat. Hist., Series 10, vol. 9, p. 181 (London).

drucei Lathy, Percy I., *Thecla*

Type Locality: Santa Catherina, Brazil.

Location of Type: Fournier Collection, Paris.

Original Description: 1926, Ann. Mag. Nat. Hist., Series 9, vol. 17, p. 41 (London).

dryope Edwards, William H., *Thecla*

Type Locality: Plain County, Colorado (1 ♂).

Location of Type:

Original Description: 1870 (January), Trans. Amer. Ent. Soc., vol. 3, p. 19 (Philadelphia, Pa.).

Additional Reference: Edwards, William H., 1870 (November), Trans. Amer. Ent. Soc., vol. 3, p. 193 (Philadelphia, Pa.). (Describes the male.)

dubiosa Lathy, Percy I., *Thecla*

Type Locality: "Patria ignota." (1 ♀).

Location of Type: Fournier Collection, Paris.

Original Description: 1936, Livre jubilaire de M. Eugene-Louis Bouvier, p. 232, pl. 8, fig. 20 (Paris).

ducalis Westwood, John Obadiah, *Thecla*

Type Locality: Brazil.

Location of Type: British Museum (Natural History).

Original Description: 1852, Genera of Diurnal Lepidoptera, vol. 2, p. 483, pl. 77, fig. 1 (London). (Figure only.)

Additional Reference: Lathy, Percy I., 1930 (June), Trans. Ent. Soc. London, vol. 78, p. 133, pl. 9, figs. 3 ♂, 4 ♀ (London).

duma Hewitson, W. C., *Thecla*

Type Locality: Bogotá.

Location of Type: Staudinger Collection.

Original Description: 1878 (November), *Illus. of Diurnal Lepidoptera*, vol. 1, p. 211, vol. 2, pl. 84, fig. 713 (London).

dumenilii Godart, Jean B., *Polyommatus*

Type Locality: Antilles?

Location of Type:

Original Description: 1822, *Encyclopédie Méthodique*, vol. 9, p. 677 (Paris).

Synonyms: *argiva* Hewitson, *obscura* Staudinger.

dumetorum Boisduval, Jean A., *Thecla*

Type Locality: California.

Location of Type: United States National Museum?

Original Description: 1852, *Ann. Soc. Ent. France*, Series 2, vol. 10, p. 291 (Paris).

Additional Reference: Oberthür, Charles, 1913 (October), *Etudes de Lepidopterologie Comparee*, fasc. 9, pt. 1, p. 40, pl. 236, fig. 1926 (Rennes).

Subspecies: *perplexa* Barnes and Benjamin.

dydimæon Cramer, Pierre, *Papilio*

Type Locality: Surinam.

Location of Type:

Original Description: 1777, *Papillons exotiques des trois parties du monde*, vol. 2, p. 59, pl. 134, fig. A (Amsterdam).

Synonyms: *didymæon* Auct.

dysmenia Draudt, Max, *Theorema*

Type Locality: Upper Río Negro, Colombia.

Location of Type: Fassel Collection. (Now in Naturhistorisches Museum, Basle.)

Original Description: 1919 (November), *The Macrolepidoptera of the World*, vol. 5, p. 745, pl. 153-a (Stuttgart).

[To be continued]

(continued from page 162)

Article V

3. . . . *At the expiration of his term of office the Secretary shall deliver to his successor all papers, books, and other records belonging to the Society.*

Article IX

1. The subscription price of the Journal (and), the price of single numbers (to active members), (and discounts allowed to subscription agencies and on sales) *and the price of sets shall be determined by the Executive Committee.*

Article X

6. Whenever notice of any meeting is required by these by-laws it shall be deemed sufficient if published in the *Bulletin of the New York Academy of Sciences or the Calendar of the American Museum of Natural History. . . .*

(continued on page 222)

CHANGES IN THE FAT CONTENT DURING METAMORPHOSIS OF THE MEALWORM, *TENEBRIO MOLITOR* LINNAEUS¹

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In the physiological studies of insects, the role of fats is of great importance. In many instances, fats have been claimed as a source of energy during metamorphosis due to its decrease throughout this period. This has been shown by Rudolfs (1932) with the tent caterpillar, *Malacosoma americana*; Becker (1934) with the mealworm, *Tenebrio molitor* and by Hitchcock and Haub (1941) with the blowfly, *Phormia regina*. However, Ludwig and Rothstein (1949) working with the Japanese beetle, *Popillia japonica* and Rousell (1955) with the mealworm, *T. molitor* have shown that glycogen is utilized during metamorphosis and may serve as a source of energy. Ludwig and Rothstein (1949) also believed that the supply of glycogen may be replenished at the expense of lipids. Because of the importance of fat either for oxidation or as a source of glycogen which may in turn be used as an energy source, an understanding of the energetics of metamorphosis require observations of the fate of fats at each day of this process.

MATERIAL AND METHODS

Cultures were maintained at room temperature (approximately 25° C.) in chick growing mash. Water was provided by wetting the cloth covers of the cultures weekly. Mature larvae and prepupae were weighed and vacuum desiccated over anhydrous CaCl₂. Prepupae were also collected and placed in an incubator maintained at 30° C. Upon pupation the insects were placed in dated beakers and kept at 30° C. In this manner, pupae timed to within 24 hours, were obtained. At the desired stage of

¹ From a thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Fordham University. The author wishes to express sincerest gratitude for the stimulation, interest and critical guidance of Dr. Daniel Ludwig.

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metamorphosis, they were weighed and vacuum desiccated. All material was kept in desiccators until ready for use.

Free lipid determinations were made by filtered anhydrous ether and bound lipids by ether-alcohol (3 parts of 95 per cent ethyl alcohol to 1 part of anhydrous ethyl ether) extractions on the same insect in a Soxhlet apparatus. Extractions were continued for a minimum of seven and one-half hours and at the end of this period, the solvent was carefully poured from the Soxhlet flask into a beaker desiccated to a constant weight. The solvent was allowed to evaporate and the beaker was then dried to constant weight under vacuum desiccation. The difference between the final weight of the beaker with fat, and its initial weight without fat, represents the milligrams of free or bound lipid extracted.

OBSERVATIONS

Table I shows the free, bound and total lipid content of the insect at different stages of metamorphosis. Each value is ex-

TABLE I

PER CENT OF FREE LIPIDS, BOUND LIPIDS AND TOTAL LIPIDS DURING THE STAGES OF METAMORPHOSIS OF THE MEALWORM. EACH VALUE IS EXPRESSED AS PER CENT WET WEIGHT.

Stage	No. of Readings	Free Lipid	Bound Lipid	Total Lipid
Larva	10	12.59	4.76	17.35
Prepupa	10	10.68	4.73	15.41
Newly molted pupa	20	10.20	5.40	15.60
1-day pupa	20	10.46	4.46	14.92
2-day pupa	10	9.05	4.19	13.24
3-day pupa	10	8.35	3.91	12.26
4-day pupa	10	7.87	3.47	11.34
5-day pupa	10	8.22	5.08	13.30
Newly emerged adult	10	7.84	5.03	12.87

pressed as per cent wet weight. Free lipid decreased irregularly from 12.95 in the larva to 7.84 per cent in the newly emerged adult. On the other hand, bound lipid showed no consistent shifts but remained relatively constant throughout metamorphosis. These changes are shown graphically in figure 1.

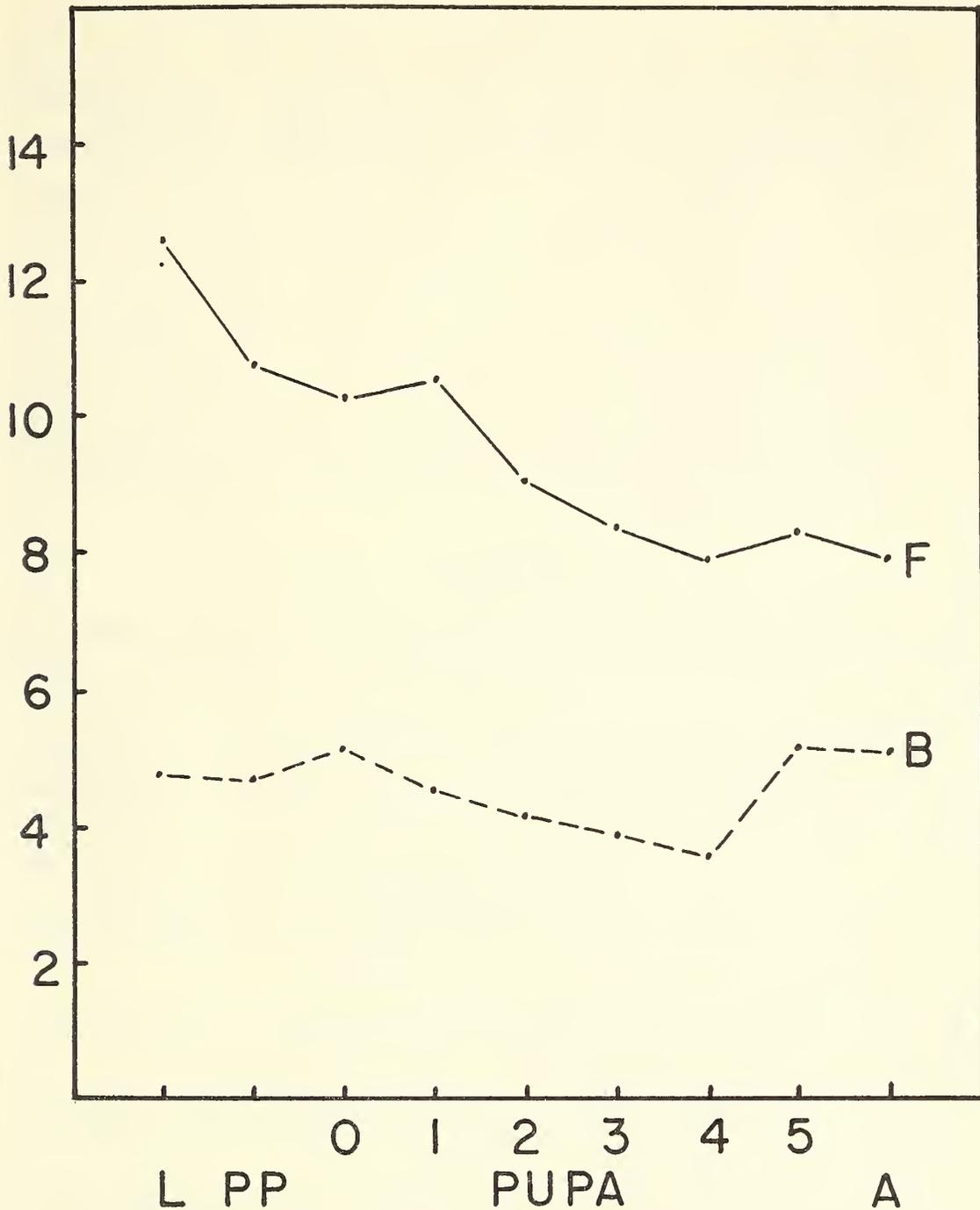


FIG. 1. Changes in the content of free lipid and bound lipid during the metamorphosis of the mealworm at 30° C. F denotes free lipid and B denotes bound lipid. L, larva; PP, prepupa; 0, newly molted pupa; 1 through 5 represents days of the pupal stage; A, newly emerged adult.

DISCUSSION

The decrease in free lipids during metamorphosis may be due to their utilization as an energy source. Battista (1954), working with the Japanese beetle, *P. japonica*, showed a marked decrease in the fatty acid content during the fifth and sixth days of the pupal stage. This decrease coincided with an increase in

glycogen at 25° C reported by Ludwig and Rothstein (1949) for this species. They showed that the free fat content also decreased sharply on the fifth and sixth days. They believed that this increase in the glycogen content occurs at the expense of the fats. Rousell (1955) working with *T. molitor* demonstrated an increase in the glycogen content during the early days of metamorphosis after which it decreased steadily throughout the remainder of the life cycle. He claimed that energy may be stored in the form of glycogen built up during the larval period from stored fats and later used as an energy source during metamorphosis. Hence, in the mealworm the energy required for metamorphosis is obtained from the utilization of both fats and glycogen.

SUMMARY

Lipid determinations were made on the mealworm, *Tenebrio molitor*, collected at 24 hour intervals during metamorphosis at 30° C.

Free lipids decreased irregularly while bound lipids remained relatively constant. Thus, free fats may be used as an energy source.

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CHANGES IN THE DISTRIBUTION OF NITROGEN DURING METAMORPHOSIS OF THE MEAL- WORM, *TENEBRIO MOLITOR* LINNAEUS¹

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Needham (1929) stated that during insect metamorphosis when larval tissues are histolyzed there should be a breakdown of the insoluble protein with a simultaneous increase in the soluble protein fractions. As the adult tissues are formed this process should be reversed. This hypothesis was verified by Evans (1932) with the sheep blowfly, *Lucilia sericata*; Anderson (1948) with the Japanese beetle *Popillia japonica*; and by Del Vecchio (1955) with the housefly, *Musca domestica*. However, Evans (1934) found no changes in the various nitrogen fractions during the metamorphosis of the mealworm, *Tenebrio molitor*.

Since this insect is also holometabolic, it seemed improbable that there would be no major changes in the nitrogenous fractions during its metamorphosis. The present study is a reinvestigation of the distribution of nitrogen during each day of metamorphosis in the mealworm, *T. molitor* at 30° C.

MATERIAL AND METHODS

Cultures were maintained at room temperature (approximately 25° C.) in chick growing mash. Water was provided by wetting the cloth covers of the cultures weekly. Mature larvae and prepupae were weighed and vacuum desiccated over anhydrous CaCl₂. Prepupae were also collected and placed in an incubator maintained at 30° C. Upon pupation the insects were placed in dated beakers and kept at 30° C. In this manner pupae, timed to within 24 hours, were obtained. At the desired stage of metamorphosis, they were weighed and vacuum desiccated. All material was kept in desiccators until ready for use.

¹ From a thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Fordham University. The author wishes to express sincerest gratitude for the stimulation, interest and critical guidance of Dr. Daniel Ludwig.

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Fractionation was accomplished by the technique of Del Vecchio (1955). Each insect was pulverized and thoroughly mixed with 10 ml. of distilled water. To the supernate were added 1 ml. of $\frac{2}{3}$ N H_2SO_4 and 1 ml. of 10 per cent sodium tungstate to separate fraction B (water soluble protein not precipitated by tungstic acid) from fraction C (water soluble protein precipitated by tungstic acid). The residue remaining after the previous extractions was treated with a solution of ether-alcohol (1 ml. of distilled water, 4.5 ml. of absolute ethyl alcohol and 4.5 ml. of absolute ethyl ether) to remove fraction A (lipid nitrogen) from fraction D (water insoluble nitrogen). These fractions are given letters of designation so as to correspond with similar fractions obtained by Ludwig and Rothstein (1952) and Del Vecchio (1955). The Kjeldahl procedure was employed to make the nitrogen determinations on each fraction.

OBSERVATIONS

No loss in the percentage of nitrogen occurred during the change from larva to adult. However, there was an increase in the total nitrogen percentage of the adult.

The changes in the distribution of nitrogen for each day of metamorphosis are given in table I. Each fraction is expressed

TABLE I

CHANGES IN THE DISTRIBUTION OF NITROGEN DURING THE METAMORPHOSIS OF THE MEALWORM. NITROGEN VALUES ARE GIVEN AS PER CENT TOTAL NITROGEN WITH THEIR STANDARD ERRORS.

	Fraction A	Fraction B	Fraction C	Fraction D
Larva	1.82 ± 0.23	13.41 ± 2.08	17.18 ± 1.75	67.59 ± 1.3
Prepupa	1.92 ± 0.12	11.57 ± 0.80	10.60 ± 0.63	75.96 ± 1.0
Newly molted pupa	2.97 ± 0.19	15.75 ± 0.41	12.85 ± 0.37	68.52 ± 0.52
1-day pupa	2.15 ± 0.13	15.28 ± 0.86	12.06 ± 0.43	70.54 ± 0.74
2-day pupa	2.00 ± 0.11	13.98 ± 0.51	11.33 ± 0.38	72.77 ± 0.87
3-day pupa	1.98 ± 0.11	15.74 ± 0.80	12.31 ± 0.59	70.04 ± 0.91
4-day pupa	1.65 ± 0.12	14.80 ± 0.80	11.66 ± 0.64	72.21 ± 0.90
5-day pupa	1.32 ± 0.33	16.14 ± 0.79	11.36 ± 0.31	70.73 ± 0.77
Newly emerged adult	1.40 ± 0.11	18.64 ± 0.46	11.91 ± 0.68	68.04 ± 0.77

as per cent total nitrogen. Fraction A (lipid nitrogen) remained constant during the larval and prepupal stages and then increased to 2.97 per cent in the newly molted pupa. This increase was followed by a decrease to 2.15 in the 1-day pupa and then a steady decrease to 1.40 per cent in the newly emerged adult. Fraction B decreased from 13.41 in the larva to 11.57 per cent in the prepupa. This decrease was followed by an increase to approximately 15 per cent in the early pupa and it remained at approximately this value until the last day of the pupal stage. Upon emergence it increased to 18.64 per cent. Fraction C decreased from a high of 17.18 per cent in the larval stage to 10.60 in the prepupal stage. This fraction remained between 11 and 13 per cent throughout the remainder of the life cycle. Fraction D was 67.59 per cent in the larva and increased to 75.96 in the prepupa. This increase was followed by a decrease to 68.52 per cent in the newly molted pupa. This fraction then increased to 70.54 per cent in the 1-day pupa and remained at approximately this value throughout the remainder of the pupal stages. Upon emergence of the adult it decreased to 68.04 per cent. These changes are shown graphically in figure 1. Fraction D (insoluble nitrogen) showed a marked decrease in the newly molted pupa and then gradually increased until the 2-day pupa. The graph shows that nitrogen from fraction D is transferred to A, B and C in the newly molted pupa. Reciprocal shifts are shown between fractions D and B. All of these shifts were shown to be statistically significant.

DISCUSSION

The constancy of the nitrogen percentages are in agreement with those of other workers (Evans 1932, for the blowfly, *Lucilia sericata*, Anderson 1948, for the Japanese beetle, *Popillia japonica*, and Del Vecchio 1955, for the housefly, *Musca domestica*). The increase in the percentage of total nitrogen obtained upon emergence of the adult may be associated with the shedding of the cuticle and a loss of water which occurs at this time. The results of the present study on the distribution of nitrogen are in accordance with other work on holometabolous insects. The shifts in nitrogen obtained during the metamorphosis from prepupa to pupa indicate a breakdown of larval protein and an increase in the decomposition products. During the early pupal

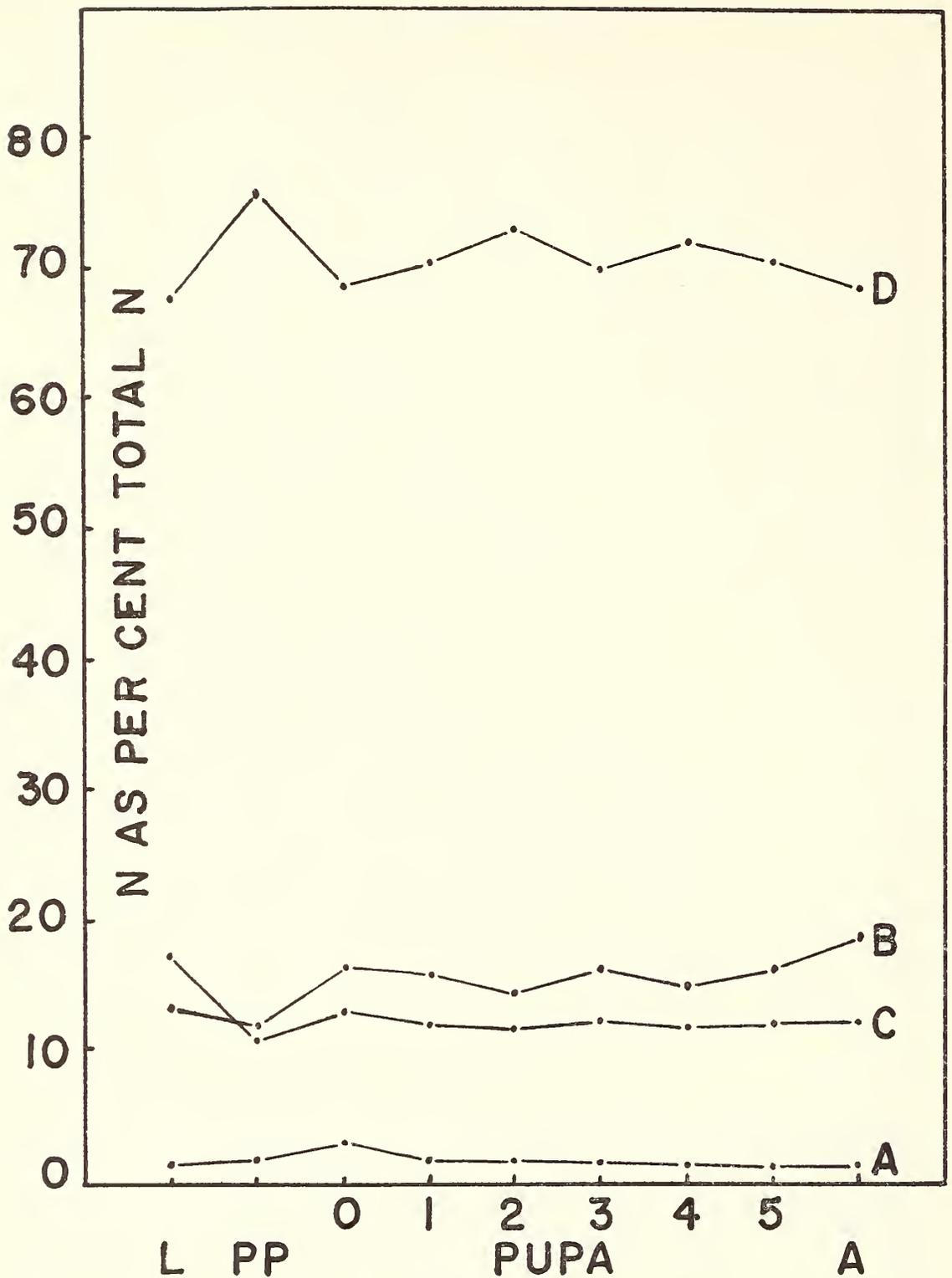


FIG. 1. Changes in the per cent of total nitrogen of the various fractions during the metamorphosis of the mealworm at 30° C. L, larva; PP, prepupa; O, newly molted pupa; 1 through 5 represent days of the pupal stage; A, newly emerged adult.

stages there is an utilization of these products for the synthesis of adult tissues. If the processes of histolysis and histogenesis occur simultaneously during the change from the prepupa to newly molted pupa, the process of histolysis is dominant while

the process of histogenesis is dominant during the early pupal stages. Evans (1934) studied the distribution of nitrogen in the mealworm, *T. molitor* on alternate days during metamorphosis at 25° C. from larva to adult. He obtained the insoluble protein fraction by the addition of distilled water to the powdered material. Soluble proteins were precipitated by the addition of trichloroacetic acid to the filtrate, while proteoses and peptones were precipitated with sulphuric acid and sodium tungstate. He failed to show any major shifts and concluded that histolysis and histogenesis are not as clearly defined in Coleoptera as in the higher Diptera. The work of Anderson (1948) on the Japanese beetle has shown the inaccuracy of this generalization since a large decrease in the insoluble and an increase in the soluble nitrogen occurred at pupation. In the present study, complimentary shifts between the nitrogenous fractions were obtained also during the transition from prepupa to pupa but were not as pronounced as those found by Anderson (1948) for the Japanese beetle or by Del Vecchio (1955) for the housefly.

SUMMARY

Nitrogen fractionations were made on the mealworm, *Tenebrio molitor*, collected at 24 hour intervals during metamorphosis at 30° C.

The change from larva to adult showed no loss in the percentage of nitrogen but a slight increase occurred upon the emergence of the adult.

During metamorphosis the insoluble proteins (fraction D) decreased sharply from 76.0 in the prepupa to 68.5 in the newly molted pupa. It then increased to 72.8 per cent in the 2-day pupa and remained at approximately this value during the remainder of the pupal stage. Upon emergence of the adult it decreased to 68.04 per cent. Reciprocal shifts are shown in fraction B. Nitrogen from fraction D was transferred to A, B and C in the newly molted pupa.

The complimentary shifts between the nitrogenous fractions may indicate the breakdown of the larval protein during the transition from prepupa to pupa and the synthesis of adult protein during the remainder of the pupal period. However, these shifts were not as pronounced in this species as in some other holometabolous insects.

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(continued from page 212)

Mr. Farb proposed that Mr. Tony Roberts be appointed to report to the Executive Committee on the possibilities of forming a Junior Entomological Society under the sponsorship of the Society. A substitute motion was made and passed that Miss Alice Gray and Mr. Roberts be invited to the December 3rd meeting of the Executive Committee to report on possibilities of such a move.

Dr. M. J. Ramsey, Training Officer of the Plant Quarantine Division, U. S. Department of Agriculture spoke on "Insects In International Commerce." He reported that 5000 years ago the granary weevil was found in the tombs of the Pharaohs and was probably the first insect transported around the known world in commerce. In the recent book *Faunal Connections Between Europe and North America*, Lindroth delves into the records of early explorers of the New World and concludes that since their ballast was soil, many insects were carried with them. And the second voyage of Columbus might very well have been the means of bringing European insects to this country, since he was carrying plants to propagate in the New World.

It is in cargo shipments that we today find the bulk of insects entering international commerce, said Dr. Ramsey. The mails, too, can be a means of dissemination; for example, USDA recently found the Khapra beetle in rice seeds mailed from Asia. One of plant quarantine's major problems is shamrocks sent from Ireland, since golden nematode cysts are often found in the soil accompanying them. The increase in international air travel increases the problem of quarantine, since serious pests can survive the short flights.

Of our present pests, records kept between 1854 and 1904, before there was a federal quarantine, show that 100 pests of agriculture became established here from abroad. Since then, there have been very few. To show the magnitude of the job in keeping foreign injurious insects from our borders, Dr. Ramsey said that the yearly average for the last decade has been the interception of 6763 shipments that contained pests not yet established in this country.

(continued on page 235)

UNDESCRIBED SPECIES OF CRANE-FLIES FROM
THE HIMALAYA MOUNTAINS (TIPULIDAE,
DIPTERA), IV*

BY CHARLES P. ALEXANDER

AMHERST, MASSACHUSETTS

The preceding part under this general title was published in the JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY, 66: 161–170. As was the case with the preceding three instalments, materials discussed at this time are from Nepal where they were taken in 1957 by Dr. Edward I. Coher and assistants. A single species from the Darjeeling District, north India, taken by Father Aloysius Camilleri, is included. All types are included in the author's collection of crane-flies.

Tipula (Vestiplex) bhutia new species

Belongs to the *himalayensis* group; mesonotum gray, the praescutum with four brownish gray stripes that are narrowly bordered by blackish, the interspaces narrow; antennae relatively long, basal three segments yellow, the remainder black, first flagellar segment short; legs black, only the femoral bases yellow, claws of male toothed; wings conspicuously marbled brown and creamy yellow; abdomen yellow basally, the outer five segments black; male hypopygium with the tergal lobes broadly rounded; apex of basistyle terminating in two short black teeth or spines; outer dististyle darkened; appendage of ninth sternite simple, relatively short, from an enlarged base; aedeagus stout, narrowed to an acute point.

MALE. Length about 13 mm.; wing 15 mm.; antenna about 5 mm.

Frontal prolongation of head gray, nasus elongate, yellowed at tip; palpi black. Antennae of male relatively long; scape and pedicel brownish yellow, first flagellar segment a little darker, remainder of organ black; first flagellar segment short, only slightly more than one-half the second; outer segments somewhat incised, longer than the verticils. Head gray on the anterior vertex, with a capillary brown central vitta extending from the small vertical tubercle backward; posterior half of head, including the genae, more fulvous.

Pronotum dark gray, vaguely patterned with darker. Mesonotal praescutum with the very restricted ground gray, with four dark brownish gray stripes that are narrowly bordered by blackish, the interspaces narrowly obscured; scutal lobes each with two dark gray areas that are narrowly bordered by darker, central area brownish yellow; scutellum gray, with a

* Contribution from the Entomological Laboratory, University of Massachusetts.

brown central line; mediotergite yellow pollinose, darker on sides and behind, with indications of a capillary darkened vitta, pleurotergite yellow. Pleura chiefly gray, more or less variegated with darker; dorsopleural region brown, metapleura yellow. Halteres with stem yellow, knob dark brown. Legs with fore coxae gray, remaining coxae somewhat more buffy; trochanters yellow; femora black, the bases yellow, narrowly so on the posterior legs; no yellow subterminal ring as is common in the group; tibiae and tarsi black; claws of male with a small basal tooth. Wings brown, conspicuously marbled with cream yellow areas, the ground more extensive than the pale areas, the latter in all cells before cord, including two or more areas each in cells *R*, *M*, *Cu* and the Anals; beyond the cord the yellow is chiefly restricted to a short poststigmatal band extending from costa into cell R_5 ; a small slightly more whitened area across base of cell 1st M_2 , including also small parts of cells *R* and M_3 ; prearcular field conspicuously yellowed, costal region more obscurely so; veins brown, yellow in the brightened fields, including the outer radial cells. Venation: R_{1+2} strongly upcurved; petiole of cell M_1 subequal to or shorter than the oblique *m*; *m-cu* at fork of M_{5+4} or beyond this on vein M_4 .

Abdomen with the basal sternites yellow, the tergites with three narrow stripes, the median one paler; fifth and succeeding segments, including the hypopygium, brownish black. Male hypopygium with the tergite transverse, narrowed outwardly, the posterior border with a narrow V-shaped median notch forming broad rounded lobes that are provided with abundant relatively short setae except on the lateral parts; tergite apparently without further ventral armature, as in several allied species. Outer margin of basistyle at apex produced into a short stout black spine, in cases with a second similar spine or point. Appendage of ninth sternite a short relatively stout rod from an enlarged darkened base, the latter with strong setae from conspicuous pale punctures; outer rod very gently curved, narrowed to an acute spine, surface with strong setae. Outer dististyle an elongated darkened club with strong retrorse setae at outer end; inner style with beak relatively stout, slightly upcurved, apex obtuse; lower beak and other lobes blackened. Aedeagus stout, narrowed to an acute point, with distinct lateral shoulders.

Holotype, ♂, Simbhanjang Pass, Nepal, 8650 feet, April 16, 1957 (Coher). Paratopotypes, 2 ♂♂, with the type.

While generally similar to various other Himalayan members of the group in its conspicuously marbled wings and appearance, the present fly differs from all in the coloration, structure of the antennae and particularly in features of the male hypopygium, including the tergite, basistyle, dististyles and appendage of the ninth sternite. The lack of a yellow subterminal ring on the femora is noteworthy.

***Tipula (Vestiplex) malla* new species**

Belongs to the *himalayensis* group; size relatively large (wing of male

16 mm.); mesonotal praescutum with four brownish gray stripes; scutellum and mediotergite with a central brown vitta; antennae relatively long, basal flagellar segments bicolored; legs black, femoral bases and a narrow subterminal ring yellowed; wings marbled light brown and creamy yellow; R_{1+2} preserved; basal abdominal segments yellow, the lateral tergal borders narrowly gray, outer segments more uniformly blackened; male hypopygium with the posterior border of tergite produced into two broad blackened lobes, their margins obliquely truncated and microscopically roughened; inner dististyle with the beak long and slender; appendage of ninth sternite a gently curved simple rod from an expanded base, its tip acute.

MALE. Length about 16 mm.; wing 16 mm.; antenna about 5 mm.

Frontal prolongation of head brownish yellow; nasus distinct, relatively stout; palpi black. Antennae of male relatively long; scape and pedicel yellow, first flagellar segment obscure yellow, the central half swollen and slightly darker; succeeding two or three segments bicolored, the small basal enlargements black, the remainder brownish yellow, passing through brown to black, the segments beyond midlength of the organ almost uniformly darkened; segments feebly incised, much longer than the verticils. Head brownish yellow, the orbits more pruinose; a narrow darkened central stripe on vertex, beginning on the entire vertical tubercle.

Pronotum brownish gray, the scutum with three blackened areas, scutellum more yellowed. Mesonotal praescutum with the restricted ground brownish yellow, with four brownish gray stripes, the lateral pair slightly darker, especially on their inner border; median interspace very narrow and more obscured than the lateral ones; intermediate stripes confluent on extreme anterior ends and here with very restricted darkened borders; scutum grayish yellow; stigma small, pale brown; yellow areas before cord subequal in mediotergite grayish yellow with a clearly defined brown central vitta; pleurotergite more yellowed. Pleura gray, slightly patterned with darker; dorsopleural membrane dusky. Halteres with stem yellow, knob brownish black. Legs with fore coxae gray, remaining coxae more yellowed; trochanters yellow; femora black, bases restrictedly yellowed, with a narrow obscure brownish yellow subterminal ring, the blackened tips more extensive; tibiae and tarsi black; claws small, simple. Wings light brown, conspicuously marbled with pale creamy yellow areas; prearcular field and cell *Sc* deeper yellow; stigma small, pale brown; yellow areas before cord subequal in extent to the dark pattern, most extensive in cells *R* and *M* where they form a major V-shaped mark; cell *Cu*, base and angles of *1st A*, and much of cell *2nd A* yellowed; beyond the cord the yellow color appears chiefly as an incomplete poststigmatal band extending from costa into the base of cell R_5 ; a single isolated whitish yellow area in cell *1st M*₂ and bases of cells M_3 and M_4 ; veins of anterior half of wing yellowed, of posterior half, from *M* backward, darker. Venation: R_{1+2} preserved, upcurved at tip, widening the cell; *Rs* moderately long, about one-half longer than *m-cu*; cell M_1 about three times its petiole; cell *1st M*₂ pointed at its inner end; *m-cu* shortly before the fork of M_{3+4} .

Basal abdominal segments yellow, the lateral tergal borders narrowly

gray, margined internally by a vague darker line, more evident on cephalic part of the individual segments; outer end of abdomen more uniformly blackened; styli yellowed. Male hypopygium with the tergite small, transverse, its posterior border produced into two broad blackened lobes that are separated by a very narrow notch; lobes blackened, their margins obliquely truncated and microscopically serrulated or roughened, the inner angle produced into a more definite tooth; immediately beneath the dorsal lobes is a second one, its surface with numerous microscopic spicules. Basistyle without blackened armature, the outer apical part produced into a weak pale triangular blade. Appendage of ninth sternite a gently curved rod from an expanded base, relatively short, its tip acute; surface with long pale setae that are more abundant at base. Two dististyles, the outer elongate, narrow, entirely pale, its inner face provided with abundant very long erect to slightly retrorse setae; inner style with the beak long and slender, its lower margin heavily blackened, provided with short setae; outer basal lobe relatively large. Phallosome broad at base, the outer third more narrowed but without a distinct shoulder. Eighth sternite relatively large, posterior border convexly rounded, with relatively few setae.

Holotype, ♂, Simbhanjang Pass, Nepal, 8197 feet, June 24, 1957 (Coher).

Allied and generally similar to other species of the *himalayensis* group, such as *Tipula (Vestiplex) distifurca* Alexander, *T. (V.) subtincta* Brunetti, and others, differing especially in the structure of the male hypopygium, particularly the tergite, appendage of the ninth sternite, and the dististyles.

***Tipula (Vestiplex) rana* new species**

Belongs to the *himalayensis* group; size relatively large (wing of male 16 mm.); general coloration of praescutum yellow with four entire brown stripes; antennae relatively long, scape and pedicel yellow, flagellum brown; femora black with a broad brownish yellow subterminal ring; claws of male toothed; wings variegated yellow and pale brown; R_{1+2} entire; basal abdominal segments yellow, tergites with three black stripes, outer four segments brownish black; male hypopygium with the posterior border of tergite four-lobed; inner dististyle broad; appendage of ninth sternite broad at base, narrowed into a slender spine, surface with unusually long pale setae.

MALE. Length about 15 mm.; wing 16 mm.; antenna about 4.3 mm.

Frontal prolongation of head about equal in length to the remainder, light brown, restrictedly gray pruinose at base above; nasus slender; basal segment of palpi brownish yellow, remainder black. Antennae of male relatively long; scape and pedicel yellow, first flagellar segment light brown, the remainder dark brown; segments feebly incised, longer than the verticils. Head above yellow medially, brightest in front, chestnut brown on orbits and genae; vertex with a more darkened central stripe that deepens to dark brown on the entire vertical tubercle.

Pronotum variegated brown and yellow. Mesonotal praescutum with the restricted ground yellow, with four entire brown stripes, the intermediate pair narrowly separated by a ground vitta, posterior interspaces narrow and obscured; humeral region impressed, dark brown; a vague sublateral brown spot before suture, visible only in certain lights; scutum yellow, each lobe with two brown areas, the anterior one oval, about one-third the size of the posterior mark; scutellum and mediotergite yellow pollinose, with a narrow central brown stripe; pleurotergite yellow. Pleura olive yellow, patterned with brown, including areas on the anepisternum and a longitudinal line near the dorsal margin of the sternopleurite; dorsopleural membrane brown. Halteres with stem yellow, knob infuscated. Legs with the coxae olive yellow; trochanters yellow; femora black, with a broad brownish yellow ring before the narrower intensely black apex; tibiae and tarsi brownish black; claws with basal tooth. Wings with the prearcular and costal regions saturated yellow; disk variegated with pale brown and light yellow, the former more extensive; beyond the cord the yellow pattern appears as a short poststigmatal band extending from costa into cell R_5 ; before cord the yellow pattern more extensive, subequal in amount to the brown, with two areas in cells R and M and others in the Anal cells, most restricted in cell Cu ; veins brown, more yellowed in the brightened basal and costal parts. Venation: R_{1+2} entire; petiole of cell M_1 longer than m ; M_{3+4} shorter than basal section of M_{1+2} .

Basal abdominal segments yellow, the tergites trivittate with dark brown, the stripes narrow; sixth and succeeding segments brownish black, hypopygium black. Male hypopygium distinctive; ninth tergite fused basally with the sternite, transverse, posterior border with a very broad U-shaped emargination, the lateral lobes relatively small, obtuse at tips; immediately beneath these a large flattened oval lobe or blade, its mesal edge blackened. Outer dististyle relatively long; inner style large, broad, beak small. Appendage of ninth sternite distinctive, broad at base, at near midlength narrowed into a long acute spine, surface of lobe with relatively few but very long and conspicuous pale setae. Aedeagus triangular in outline, without lateral shoulders.

Holotype, ♂, Simbhanjang Pass, Nepal, 8197 feet, June 24, 1957 (Coher).

Other somewhat similar regional species include, besides *Tipula (Vestiplex) himalayensis* Brunetti, *T. (V.) distifurca* Alexander, *T. (V.) inaequidentata* Alexander, *T. (V.) nigroapicalis* Brunetti, *T. (V.) stylicera* Alexander, *T. (V.) subtinctoria* Brunetti, and others more recently described by the writer. The present fly is quite distinct from all in the structure of the male hypopygium, particularly the tergite, inner dististyle and appendage of the ninth sternite. In its general appearance it most resembles *inaequidentata*.

Tipula (Oreomyza) camillerii new species

Size small (wing of male 10 mm.); general coloration brownish gray, praescutum with three slightly darker brown stripes; antennae with scape and pedicel yellow, first flagellar segment yellow, its tip blackened, remaining segments black; first flagellar segment elongate; legs black, femoral bases narrowly obscure yellow, claws of male simple; wings brown, variegated by yellow areas that form vague crossbands; R_{1+2} atrophied, cell 1st M_2 small, pentagonal; abdomen yellow basally, outer segments black; male hypopygium with the ventral part of the basistyle produced into a strong lobe that is tipped with spines; gonapophysis bearing a strong tooth on mesal edge; aedeagus trifid at apex.

MALE. Length about 8.5 mm.; wing 10 mm.; antenna about 3 mm.

Frontal prolongation of head yellowed above, darkened beneath; nasus short; palpi black throughout, terminal segment more than twice the length of the penultimate. Antennae of male of moderate length; scape and pedicel yellow, first flagellar segment yellow, the outer fourth blackened, remainder of organ black; first flagellar segment long-cylindrical, about equal to the succeeding two combined; flagellar segments beyond the first with the basal enlargement scarcely indicated, segments longer than their verticils, terminal segment very small. Head gray, more buffy in front; a capillary impressed darkened line extending from the low vertical tubercle backward; setigerous punctures of vertex conspicuous.

Pronotum brownish gray. Mesonotal praescutum brownish gray, with three slightly darker brown stripes, the median one more or less bordered and divided by dusky, the anterior end vaguely brightened; posterior sclerites of notum brownish gray, scutal lobes more or less darkened; scutellum and mediotergite with a central darker vitta; scutellum and postnotum with long pale setae, katapleurotergite vaguely more brightened. Pleura dark brownish gray; dorsopleural membrane yellow. Halteres with stem light yellow, knob infuscated. Legs with coxae and trochanters brownish yellow; remainder of legs black, femoral bases restrictedly obscure yellow; claws simple. Wings brown, variegated by yellow areas, as follows: At areulus, before and beyond origin of R_s in cell R , near outer end of cell M and as a crossband beyond the cord, extending from costa into cell M_3 ; a further brightening before midlength of cell 1st A ; cell C brown. Sc more yellowed; stigma small, brown, scarcely differentiated from the ground; veins brown, more yellowed in the subcostal field. Macrotrichia on veins beyond cord and on outer ends of M , Cu and most of 2nd A , lacking on R_s and 1st A . Venation: R_s long, nearly twice R_{2+3} , the latter forming an angle at the end of R_s ; R_{1+2} atrophied, vaguely persistent as a pale line; cell M_1 about twice its petiole; cell 1st M_2 small, pentagonal, m being the shortest element; $m-cu$ near outer end of M_{3+4} ; cell M_4 deep, distal section of Cu_1 about twice $m-cu$.

Abdomen with basal five segments obscure yellow, the tergites narrowly darkened medially, the extreme posterior borders of the sternites narrowly suffused; outer segments, including hypopygium, black, the sixth sternite yellowed on basal part. Male hypopygium with the tergite narrowed

outwardly, posterior border with a broad U-shaped emargination, with a further tiny notch at the base, lobes broadly rounded. Region of ninth sternite produced mesad and caudad into a strong lobe that is tipped with six or seven strong spines arranged in a compact group. Outer dististyle broadest across outer end, apex obliquely truncated; inner style unusually broad, beak obtuse, lower beak still more obtuse, its margin corrugated, outer basal lobe obtuse, unmodified. Aedeagus relatively short and stout, terminating in three stout pale filaments; gonapophyses appearing as yellow blades, the tips acute, on mesal edge beyond midlength with a strong spine. Eighth sternite with posterior border convexly rounded, without lobes or modified setae.

Holotype, alcoholic ♂, Kurseong, Darjeeling District, India, August 1957 (Aloysius Camilleri).

This interesting species is named in honor of the collector, Father Aloysius Camilleri, S.J., who has collected numerous interesting Diptera in the vicinity of Kurseong. The most similar regional ally is *Tipula (Oreomyza) gnoma* Alexander, of northeastern Burma, which differs especially in the structure of the antennae and male hypopygium. *T. (O.) striatipennis* Brunetti is more distantly related. All three species agree in the atrophy of vein R_{1+2} , thereby differing from the numerous other species of *Tipula* in the eastern Himalayan fauna.

***Dolichopeza (Nesopeza) longisetosa* new species**

General coloration of head and thorax yellow; legs with tarsi and tips of tibiae white; wings weakly tinged with brown, stigma dark brown; male hypopygium with the posterior border of tergite conspicuously trilobed; ninth sternite with two pencils of very long setae; inner dististyle complex.

MALE. Length about 9 mm.; wing 9mm.; antenna about 3.5 mm.

Frontal prolongation of head obscure yellow; palpi dark brown. Antennae of male relatively long, as shown by the measurements, exceeding one-third the length of wing; scape and pedicel pale yellow, flagellum brownish black; verticils much shorter than the segments; in addition to the sparse verticils, segments with a dense very short pubescence. Head obscure yellow; vertical tubercle lacking.

Pronotum testaceous yellow. Mesonotal praescutum chiefly covered by three yellow stripes, the interspaces vaguely more obscured; scutal lobes yellow, the median region more obscured; scutellum and mediotergite brownish yellow, the latter clearer yellow behind. Pleura light yellow throughout. Halteres elongate, stem dusky, knob infuscated. Legs with the coxae and trochanters testaceous; femora obscure yellow basally, passing into brown outwardly; tibiae brown, the tips whitened; involving about the outer sixth to eighth; tarsi white. Wings weakly tinged with brown; stigma oval, dark brown; a vague paler brown seam at anterior cord; veins brown. Venation: R_s arcuated, longer than R_{2+3} ; R_{1+2} at-

rophied; R_3 long and straight, about one-half longer than R_{2+3} ; medial forks relatively shallow, cell M_1 about one-half longer than its petiole; $m-cu$ about three-fourths to four-fifths its length before the fork of M ; cell $2nd\ A$ narrow.

Basal abdominal segments light brown, the tergites more darkened outwardly, outer three or four segments dark brown. Male hypopygium with the posterior border of tergite conspicuously trilobed, including large lateral flattened scoops, their outer surface with blackened spicules, the most cephalic one a powerful spine; central tergal lobe blackened, base broad, apex gently convex, on either side with a shorter and paler obtuse hairy lobe. Ninth sternite on either side with a slender pencil of very long setae. Outer dististyle a long flattened blade, the outer setae longest; inner style with outer part of beak heavily blackened, connected with the pale lower or inner section by pale membrane, the latter, together with the extensive outer basal lobe, with abundant microscopic setulae.

Holotype, ♂, Simbhanjang Pass, Nepal, 8197 feet, June 24, 1957 (Coher).

The most similar described regional species include *Dolichopeza* (*Nesopeza*) *lacteipes* Alexander and *D. (N.) orientalis* Brunetti, both differing evidently in the coloration of the body and appendages and in the structure of the male hypopygium. Attention is called to the exceedingly long hair pencils on the ninth sternite of the present fly.

***Limonia (Limonia) cnephosa* new species**

Allied to *globithorax*; general coloration of body dark brown to brownish black; antennae with basal flagellar segments subglobular, outer ones with short glabrous necks; halteres and legs dark brown; wings relatively broad, very strongly blackened; cell $1st\ M_2$, nearly square, shorter than vein M_4 ; $m-cu$ at or beyond the fork of M .

FEMALE. Length about 5 mm.; wing 5 mm.

Rostrum and palpi black. Antennae black throughout; flagellar segments subglobular, the outer ones more oval; segments with short glabrous necks; terminal segment subequal in length to the penultimate, its outer end pointed; verticils longer than the segments. Head dull brownish black.

Pronotal scutum brownish black, scutellum restrictedly obscure yellow. Mesonotum large, moderately gibbous, dark brown, posterior sclerites more yellowed, especially the scutellum. Pleura brown, sternopleurite paler. Halteres brownish black, base of stem restrictedly yellowed. Legs with coxae and trochanters brownish yellow; remainder of legs dark brown; claws long and slender, with spines at extreme base only. Wings relatively broad, very strongly blackened; veins brown. Venation: Sc_1 ending opposite midlength of Rs , Sc_2 at its tip; free tip of Sc_2 lying some distance before level of R_2 ; cell $1st\ M_2$ nearly square, slightly widened outwardly, shorter than vein M_4 ; $m-cu$ subequal in length to distal section of Cu_1 , placed at or shortly beyond the fork of M .

Abdomen dark brown; both the cerci and hypovalvae blackened at bases, outer ends more horn colored.

Holotype, ♀, Kathmandu Road, Mile 65.5, Nepal, June 24, 1957 (Coher).

Although it is quite distinct from all other regional members of the genus, the present fly is closely related to the Japanese *Limonia* (*Limonia*) *globulithorax* (Alexander), differing especially in slight details of the antennae and in the broader wings, with the venational details distinct. There seems to be no question of the validity of the present fly despite the present lack of the more distinctive male sex.

***Limonia* (*Limonia*) *decurvans* new species**

Size small (wing of male about 6 mm.); general coloration of thorax obscure yellow; mouthparts very reduced to virtually lacking; basal flagellar segments subglobular, the outer ones elongate; wings strongly tinged with brown, virtually unpatterned; *Sc* and cell *1st M*₂ long; male hypopygium with two dististyles, rostral prolongation of ventral style with two spines on lower margin near base.

MALE. Length about 4.5–5 mm.; wing 5.5–6 mm.; antenna about 1 mm.

Rostrum and palpi very reduced to virtually lacking. Antennae with scape brown, the remainder black; basal flagellar segments subglobular, with short abrupt apical pedicels, beyond midlength of the organ the segments becoming progressively much longer; terminal segment nearly equal to the preceding two taken together; verticils shorter than the segments. Head blackened, paler on occipital region; eyes small; anterior vertex very broad, exceeding four times the diameter of scape.

Pronotum obscure yellow. Mesonotum obscure yellow, the central region of praescutum and the scutal lobes vaguely darker. Pleura obscure yellow. Halteres with stem dusky, knob infuscated. Legs with coxae and trochanters yellow; remainder of legs yellowish brown to brown, tarsi scarcely darker; claws long, with a strong basal spine and a capillary subappressed spine at near midlength. Wings strongly tinged with brown, virtually unpatterned, even the stigma scarcely apparent; veins light brown. Veins of outer half of wing with relatively short and inconspicuous macrotrichia. Venation: *Sc* long, *Sc*₁ ending about opposite or beyond three-fifths the length of *Rs*, in cases *Sc*₂ longer than *Sc*₁; free tip of *Sc*₂ and *R*₂ in transverse alignment; cell *1st M*₂ large, subequal to or longer than distal section of vein *M*₁₊₂; *m-cu* at or before fork of *M*, in cases to one-fourth its own length.

Abdominal tergites brown, sternites a trifle paler; hypopygium brownish yellow. Male hypopygium with the tergite transverse, the posterior border subtruncate to very feebly emarginate, cephalic margin more strongly convex; setae sparse, about eight or nine on either lobe, removed from the thickened margin; surface of tergal plate with abundant microscopic setulae. Basistyle with the ventromesal lobe stout, setae numerous, grouped

on apical half. Two dististyles, the outer one a pale straight rod, its outer half strongly narrowed; inner style small, its area about two-thirds that of the basistyle; rostral prolongation a compressed blade, its tip decurved; two rostral spines, large and pale, closely approximated on lower margin of prolongation near base, curved to the acute tips. Gonapophysis appearing as a pale blade, the apical lobe a direct posterior extension of the base of the style. Aedeagus broad, pale, tip bifid, slightly decurved; genital tubes approximated at midline.

Holotype ♂, Simbhanjang Pass, Nepal, 8197 feet, June 24, 1957 (Coher). Paratopotypes, 3 ♂♂.

Limonia (*Limonia*) *decurvans* is readily told from all other regional members of the subgenus having unpatterned wings by the extremely reduced mouthparts and the structure of the male hypopygium, especially the presence of two dististyles and the decurved rostral spines of the ventral style.

***Limonia* (*Metalimnobia*) *hedone* new species**

Size relatively large (wing of female 10 mm.); mesonotal praescutum brownish yellow with three brownish black stripes, the median one narrow, laterals broad, reaching the margin; posterior sclerites of notum black, mediotergite yellowed on posterior half; pleura black; knobs of halteres black; femora yellow, with two black rings, the more basal one broader, especially on middle and posterior legs, femoral tips broadly yellow; wings light yellow, heavily patterned with pale and darker brown, cell *M* along vein *Cu* with a series of about six dark brown spots; *m-cu* before fork of *M*; abdomen obscure yellow, lateral borders broadly blackened.

FEMALE. Length about 8.5 mm.; wing 10 mm.

Rostrum and palpi black, the former relatively long. Antennae with the scape brownish yellow, pedicel light yellow, flagellum dark brown to brownish black; basal flagellar segments short-oval, outer ones elongate, terminal segment longest, about one-half longer than the penultimate; outer verticils very long. Head dull black, sparsely pruinose; anterior vertex narrow, about equal in width to two rows of ommatidia.

Pronotum brown. Mesonotal praescutum brownish yellow, with three brownish black stripes, the median one narrow, slightly widened behind, lateral stripes broad, reaching the outer border, the interspaces thus very wide; scutum narrowly silvery medially, the lobes extensively polished black; scutellum brownish black, parascutella obscure yellow; mediotergite brownish black on anterior half, sending a median point backward, the remainder obscure yellow or testaceous yellow. Pleura and pleurotergite brownish black, only the ventral sternopleurite paler. Halteres with stem yellow, knob black. Legs with the coxae brown; trochanters obscure yellow; femora yellow, each with two brownish black rings, the outer one narrow, subequal on all legs, less than the yellow apex, basal dark ring narrowest on fore legs, very broad on middle and hind pairs, including about one-third the length of the segment; tibiae yellow, tips very narrowly blackened;

tarsi black; claws of female with about five teeth, the outermost largest. Wings light yellow, heavily patterned with brown, costal border more saturated yellow; heaviest darkened areas include four in cell *R*, the third at origin of *Rs*, fourth at fork, confluent with the stigma; narrower dark brown areas at fork of *Sc*, cord and outer end of cell 1st *M*₂; paler brown washes in outer radial field, at ends of longitudinal veins and as conspicuous washes in cells *Cu* and 1st *A* and 2nd *A*; cell *M* with more than the anterior half washed with pale brown, the clear posterior border adjoining vein *Cu* with about six small dark brown spots; veins brown, yellowed in the costal and areular regions. Venation: *Sc*₁ ending beyond midlength of the sinuous *Rs*, *Sc*₂ near its tip; *Sc*₂ and *R*₂ subequal and in virtual transverse alignment; *r-m* lying just before the level of *R*₂; inner end of cell 1st *M*₂ arcuated; *m-cu* about one-third to nearly one-half its length before the fork of *M*.

Abdomen obscure brownish yellow, darker laterally, sternites clearer yellow with broader lateral margins; outer segments with posterior borders more narrowly darkened. Ovipositor with cerci slender, gently upcurved to the acute tips; hypovalvae deep, blackened basally.

Holotype, ♀, Simbhanjang Pass, Nepal, 8197 feet, June 24, 1957 (Coher).

The most similar regional species include *Limonia* (*Metalmnobia*) *biannulata* (Brunetti), *L. (M.) vajra* Alexander and *L. (M.) jactator* new species, all of which have patterned wings, differing among themselves chiefly in the coloration of the body and especially of the legs.

***Limonia* (*Metalmnobia*) *jactator* new species**

Size medium (wing of female 8.5 mm.); mesonotal praescutum with the brownish yellow ground very restricted, heavily patterned with black; mediotergite chiefly obscure yellow; legs black, femora with base and sub-terminal ring yellow; wings pale yellow, patterned with brown, including three major areas in cell *R*; cell 1st *M*₂ small, about one-half the distal section of vein *M*₁₊₂; *m-cu* more than three-fourths its length before the fork of *M*.

FEMALE. Length about 8 mm; wing 8.5 mm.

Rostrum and palpi black, the former relatively long, about one-third the remainder of head. Antennae with scape light brown, pedicel yellow, flagellum brownish black; flagellar segments short-oval, passing into more elongate-oval; verticils considerably longer than the segments. Head dull black, more pruinose on the anterior vertex, less so on the genae; anterior vertex narrow, about one-third the diameter of scape.

Pronotum brownish black, pretergites paler brown. Mesonotal praescutum with the restricted ground brownish yellow, the extensive pattern black, including a relatively narrow median stripe, slightly wider sublateral stripes and broad lateral margins, all these areas confluent at the suture; median region of scutum silvery, lobes brownish black; scutellum brownish black,

parascutella light yellow; mediotergite chiefly obscure yellow, weakly darkened on anterior half of central part; pleurotergite obscure yellow dorsally, the ventral part infuscated. Pleura chiefly brownish black, the ventral sclerites yellowed, including the ventral sternopleurite and meron; dorso-pleural membrane dusky. Halteres with stem yellow, knob brown. Legs with coxae and trochanters yellow, fore coxae weakly darkened; remainder of legs black, femora with the basal fourth and a conspicuous subterminal ring light yellow, the latter narrower than the black tip; claws with three or four teeth, the outermost larger. Wings pale yellow, the costal and pre-arcular fields more saturated yellow; a heavy brown pattern, arranged as follows: Three major areas in cell *R*, including the origin and fork of *Rs*, the latter confluent with the stigma; cord and outer end of cell 1st *M*₂ narrowly seamed; paler washes in base of cell *C* and at ends of longitudinal veins, very extensive in the Anal field; all marginal darkenings enclosing yellow submarginal spots; still paler brown washes in outer radial cells; veins brown. Venation: *Sc*₁ ending about opposite midlength of *Rs*, *Sc*₂ near its tip; cell 1st *M*₂ unusually small, about one-half the distal section of vein *M*₁₊₂; *m-cu* more than three-fourths its length before the fork of *M*.

Abdomen obscure brownish yellow, sternites clearer yellow, pleural membrane dusky; genital segment and valves of ovipositor horn-yellow; cerci relatively small, gently upcurved.

Holotype, ♀, Simbhanjang Pass, Nepal, 8197 feet, June 24, 1957 (Coher).

As indicated under the account of *Limonia* (*Metalimnobia*) *hedone* new species, this latter fly and the present species are generally similar to one another and apparently closely allied, differing evidently in the pattern of the body and wings but especially of the legs.

***Limonia* (*Rhipidia*) *coheriana* new species**

Belongs to the *morionella* group; general coloration polished black; size small (wing of male under 4 mm.); antennae of male bipectinate, the pedicels of the segments elongate; legs brownish black, outer tarsal segments paling to creamy white; wings pale grayish subhyaline, unpatterned; male hypopygium with the tergite narrowly transverse; rostral spines two, long, from a common elongate basal tubercle.

MALE. Length about 3.5 mm.; wing 3.8 mm.; antenna about 1.9 mm.

Rostrum and palpi black, the former of moderate length. Antennae of male black throughout, bipectinate, elongate, especially the pedicels of the flagellar segments which are approximately three-fourths as long as the longest branches; segments with the pedicels progressively shorter outwardly; apparently two simple terminal segments. Head black.

Thorax uniformly polished brownish black to black. Halteres with stem dirty white, knob infuscated. Legs with the coxae dark brown to brownish black; trochanters brown; remainder of legs brownish black, the outer tarsal segments paling to creamy white. Wings pale grayish subhyaline, without pattern, even the stigma lacking; veins pale brown. Venation: *Sc*₁ ending

opposite origin of *Rs*, *Sc*₂ far retracted; *Rs* only a little longer than the basal section of *R*₄₊₅; cell *M*₂ open by atrophy of *m*; *m-cu* about one-fifth its length beyond the fork of *M*; cell 2nd *A* broad.

Abdomen brownish black. Male hypopygium with the tergite narrowly transverse, posterior border shallowly emarginate. Basistyle with the ventromesal lobe relatively small. Dorsal dististyle stout, gently curved, tip abruptly acute; ventral style subequal in area to the basistyle; rostral prolongation small, spines two, from a common tubercle. Gonapophysis with mesal-apical lobe relatively slender, the acute tip narrowly blackened.

Holotype, ♂, Jhawani, Nepal, March 19, 1957 (Coher).

I take unusual pleasure in naming this interesting fly for the collector, my long-time friend Dr. Edward I. Coher. The most similar regional species is *Limonia (Rhipidia) morionella* (Edwards), which is well-distinguished by the darkened stigma and structure of the antennae of the male. There are relatively numerous species of the group in the Oriental and Ethiopian regions, including Mauritius and Madagascar.

(continued from page 222)

Dr. Ramsey presented a series of kodachromes showing the vast numbers of pests intercepted at our ports-of-entry, and the methods of detection used. The meeting adjourned at 10:00 P.M.

PETER FARB, *Secretary*

MEETING OF DECEMBER 3, 1957

President Treat called to order a regular meeting of the Society in Room 419 of the American Museum of Natural History at 8:00 P.M. Twenty-five members and ten guests were present.

Dr. Treat greeted the visitors. Mr. Bernard Heineman introduced his guest, Mr. Raymond Brush, an amateur lepidopterist, and Dr. James Mullen introduced Mr. Daniel J. Sullivan, S.J., a graduate student at the Fordham University Biological Laboratory. A belated announcement was made that Edwin Way Teale had been honored last June by Earlham College, his alma mater, with an honorary degree of Doctor of Letters.

Dr. Treat reported that the Executive Committee heard the report of Miss Alice Gray and Mr. Tony Roberts on the proposed Junior Entomological Society; concrete proposals on membership will be submitted at the next meeting.

The President asked Dr. Creighton, Chairman of the Nominating Committee which also consisted of Dr. Klots and Dr. Schneirla, to read the tentative slate of officers to be voted on at the Annual Meeting. Dr. Creighton stated that the Committee felt that the present officers have done an admirable job of conducting Society affairs, and they wished to return them to office. A few changes were suggested for the Publications Committee, however. Candidates nominated were: Dr. Treat, President; Dr. Mullen, Vice-President; Mr. Farb, Secretary; Mr. Bloch, Assist. Secy.; Mr. Huberman, Treasurer; Mrs. Vaurie, Asst. Treasurer.

For the Executive Committee: Mr. E. Irving Huntington, Mr. Bernard Heineman, Dr. Herbert Ruckes, Dr. Alexander B. Klots. For the Publications Committee: Mr. Frank Soraci, Editor, and Mr. Schwarz, Mr. Farb, Dr. Creighton.

Miss Gray nominated the following for membership in the Society: Miss Jeanette Berger and Mr. Peter Paul Watsky.

President Treat commented for the Executive Committee with reference to Mr. Bloch's proposal at the last meeting for an annual Society dinner. It was felt that there was not sufficient time in this year's program, but that the proposal should be taken under advisement in next year's programming.

Dr. Creighton introduced the speaker of the evening, Dr. Edward O. Wilson of Harvard University, a myrmecologist who recently completed a ten months' trip through the Australasian and Melanesian regions. Dr. Wilson explained that he had three purposes for his trip: to collect insects in areas where ants have not previously been collected or where collections are meager; to examine the available collections in the museums in this region; to study the zoogeography and distribution of the ant fauna there. Dr. Wilson commented that the ants found in New Guinea are more closely related to those of southeastern Asia than to those found in the islands to the east. The talk was illustrated with very interesting slides.

The meeting was adjourned at 10:00 P.M. after a brief discussion.

JAMES FORBES, *Secretary Pro. Tem.*

MEETING OF JANUARY 7, 1958

The 66th Annual Meeting of the Society was called to order at 8:10 P.M. by President Treat in Room 419 of the American Museum of Natural History. Fourteen members and four guests were present.

Mr. Huberman reported on the periodic financial difficulties of the Society. Mr. Soraci reported on the progress in bringing publication of the Journal up to schedule.

The President announced that there has been a change in the list of candidates for office read to the Society at the previous meeting. Dr. Mullen found himself unable to accept the nomination for Vice-President, but Mr. Nicholas Schoumatoff has agreed to his name being proposed. No further nominations were made from the floor, and Dr. Clausen moved that the Secretary be empowered to cast one ballot for the entire slate. The motion was passed and the Secretary so voted.

Dr. Treat reported on a meeting of the Executive Committee at which plans for the Junior Entomological Society were further discussed. Under Miss Gray's direction, an organizational meeting of the young people will be held on February 8th to draw up plans which will then be submitted to the Society at the following meeting. Dr. Treat pointed out that Society members should be prepared to give their backing to the Junior group, and that annual charges to the Society would be about \$20 for liability insurance. Miss Gray was warmly thanked for her efforts and authorized by the Society to proceed.

Miss Jeanette Berger and Mr. Paul Watsky were unanimously elected to membership. Dr. Vishniac announced that Dr. Treat has been elected a Fellow of the N. Y. Academy of Sciences.

Speaker of the evening was Dr. Morris Rockstein of NYU Medical School who addressed the Society on "Aging In Insects." Dr. Rockstein pointed out that there are many compelling reasons for using insects to study the physiology of aging: they are every bit as complex and interesting as higher forms; they are short-lived and the researcher can obtain many offspring (sometimes as many as 4000 bees a day from a single queen). Also, they are extremely inexpensive to keep in the laboratory: a colony of only 375 rats costs \$7.50 a day, while for only a dollar he can have 50-100,000 flies.

Dr. Rockstein reported on his work in aging of adult houseflies and honeybees. Characteristics of old-age are seen in the skin, locomotion, senescence of nerves and brain. He located a key section of the brain which he used for comparison counts of cells in the tissue. A 35% loss of brain cells during life was found in some honeybees.

In a study of the possible enzymes concerned with aging in insects, Dr. Rockstein discovered the cholinesterase activity rose for the first 7 to 10 days and then remained on the same level for the rest of the life-span; this is a brain enzyme and seems concerned with the maturing of the brain rather than actual aging. He also studied the organic phosphate enzymes which trigger activity, and it was seen that they followed the same pattern as cholinesterase. However, alkaline phosphatase dropped during the first few days and was seen to be related to flight ability. Dr. Rockstein concluded that enzyme activity was not directly related to the problem under consideration.

While working on the resistance to DDT by houseflies in Korea, he observed that males have a shorter life-span than females. He experimented by keeping five cages of males and females, starting with about 150 flies in each cage. At the end of 21 days, no males survived while there were still many females alive. This was confirmed by mortality studies which showed that two-thirds of male houseflies died at the end of three weeks. When Dr. Rockstein included milk in the diet of the colonies, the females lived much longer than when they were just eating sugar and water. Not so with the males which had the same longevity in spite of the enriched diet. Thus, male houseflies are seen to have an immutable aging factor.

Dr. Rockstein gave statistics on longevity of various forms of life, based on sex differences. Examples were man, white rat, *Daphnia*, black-widow spider, mealworm and housefly—in all cases, the female of the species lived much longer.

Does the age at which the female lay eggs affect the longevity of the offspring? Dr. Rockstein's experiments to answer this question showed that 50% of female offspring from a four-day-old mother died. Mortality increased as age of the mother increased, until at parental age 27 days, 92% of the female offspring died. Yet, the male longevity remained about the same, regardless of age of the parent. Thus, again, we see that the male longevity factor is not affected. Dr. Rockstein is now attempting to learn

the part that the age of the male parent's sperm plays in these longevity figures.

After the interesting discussion period, the members adjourned to the foyer where refreshments were served. The meeting was adjourned at 10:10 P.M.

PETER FARB, *Secretary*

MEETING OF JANUARY 21, 1958

A regular meeting of the Society was held in room 419 of the American Museum of Natural History, President Treat presiding. Sixteen members and three guests were present.

Because the guest speaker presented two films, the President reversed the procedure of the meeting and delayed business matters until the conclusion of the speaker's talk.

Dr. George S. Tulloch of Brooklyn College spoke on "Schistosomiasis"—a disease caused by a deadly, parasitic worm. Dr. Tulloch stated that five percent of the world's population suffers from it, and evidence of it has been found in Egyptian mummies.

A Public Health Service film described the life-history of a form of *Schistosoma* that occurs in Central America and the Caribbean. Known as Manson's blood fluke, it lives inside the intestinal veins of humans, resulting in a lethal accumulation of fluids in the body. The intermediate host of the sporocysts is a tiny freshwater snail.

Schistosomes are widespread. Practically every gull in our area is loaded with a species of them, and "clam-diggers itch" is caused by a schistosome that parasitizes birds.

Dr. Tulloch showed his slides taken in China where, in certain areas, 95 percent of the population suffers from schistosomiasis. Discussion brought out the fact occurrence of the disease is even worse in Japan—100 percent in some places.

A Public Health Service training film on tapeworm, common in our area, was also shown.

At the conclusion of the talk, Dr. Treat announced the new members of the Society's standing committees. They are:

Auditing Committee: Sidney Hessel, Bernard Heineman, Herbert Schwarz. Program Committee: Nicholas Shoumatoff, Bernard Heineman. Field Committee: Dr. Alexander Klots, Nicholas Shoumatoff. Photographic Sales Committee: Dr. Klots, Dr. Lucy Clausen. Delegate to the N.Y. Academy of Sciences: Dr. Clausen.

Mr. Huberman reported that after payment of expenses on the current issue of the Journal, the treasury will be disturbingly low. Our financial plight is caused by annual income of \$1800 and expenses of \$2600. The President pointed out to the members that this indicates a probable rise in dues. He announced that his investigations revealed that the possibilities of income from Journal advertising were not good.

Mr. Soraci proposed Mr. William W. Metterhouse of 57 Sunset Boulevard, Hamilton Square, New Jersey, for membership.

The meeting adjourned at 9:45 P.M.

PETER FARB, *Secretary*

MEETING OF FEBRUARY 4, 1958

The regular meeting of the Society was held in room 419 of the Museum of Natural History.

The meeting was opened at 8:15 P.M. by Dr. Treat. The minutes of the previous meeting were read by Dr. Treat, who also greeted the guests; Mr. Devlin of the New York Times, Mr. Watsky and Mr. Rex.

A report on the field trip was made by Mr. Shoumatoff. The trip is to be held near Bedford, N. Y. on grounds consisting of about 350 acres. On the grounds is a lake, a bog, trails, large fields, hemlock groves, lovely rock gorge, and a brook. The trip should be fruitful collecting for everyone who attends. The date for the trip is May 17.

Mr. William W. Metterhouse was elected to membership, unanimously.

The sympathy of the Society was extended to Mr. Dix on the loss of his father.

The speaker of the evening, Dr. Charles C. Doane was introduced by Dr. Treat. An abstract of his paper, "Some Relationships of Fungi and Bacteria to Vectors of Dutch Elm Disease," follows:

A study of some of the bacteria and fungi associated with the smaller European elm bark beetle, *Scolytus multistriatus* is in progress. Most of the work to date has been done on the microorganisms that are pathogenic to the beetles. A preliminary survey indicates that the most common pathogen is a fungus, *Beauveria bassiana* (Bals.) Vuill. Although the larvae, pupae and adults are about equal in susceptibility, the larval stage is most frequently attacked in nature.

Preliminary field observations indicated that the fungus infects only a low percentage of larvae (less than 10%) in trees in open sunny areas but may kill up to 98% of the larvae infesting trees in shaded or semi-shaded areas. This fungus may be a limiting factor for populations attempting to establish in shaded or semi-shaded areas.

While counts were made of larvae killed in shaded bark a number of confirmatory isolations were made by placing the mummified larvae on artificial media. Growth from these dead larvae was consistently a combination of *Beauveria* and a red-pigmenting bacteria, *Serratia* spp., probably *Serratia marcescens*. Isolation of these two microorganisms is of interest since a number of workers have found *Serratia* associated with *Beauveria* in infected silkworm cultures and have speculated on a possible symbiotic relationship between the two microorganisms. Further study will be made of this association.

Laboratory tests with *Serratia* in pure culture show that it will kill 70% to 80% of the larvae exposed to it on treated bark. The pathogenicity of the bacterium decreases considerably if it is grown for a prolonged period on artificial media.

Two new species of bacteria, *Aerobacter scolyti* and *Escherichia klebsiellaeformis* were reported pathogenic to bark beetles in France in 1955. Cultures of these bacteria were received from M. Pesson and the Institut Pasteur and their pathogenicity is being studied in laboratory cultures. Reports show that 100% kill of exposed larvae should occur within 72 hours but these bacteria have produced no more than 17% kill of beetle larvae in 5

days. The bacteria have apparently become attenuated from continued growth on artificial media and it is hoped that pathogenicity may be recovered by successive passage through larvae of the lesser European elm bark beetle. These bacteria have not been found to date in the beetle populations in Connecticut.

After Dr. Doane presented his paper an interesting discussion took place. The meeting was adjourned at 9:55 P.M.

ROBERT G. BLOCH, *Assistant Secretary*

MEETING OF FEBRUARY 18, 1958

A regular meeting of the Society was held at the American Museum of Natural History; President Treat presiding. The meeting was opened at 8:15 P.M.

Doctor Treat read the minutes of the February 4 meeting and same were accepted. He also welcomed the guests and announced that several speakers had been invited to participate in an anticipated Forum on Gypsy Moth Control. Also, Doctor Vishniac will speak March 21, at the New York Academy of Science.

William H. Loery, M.D., and Raymond Brush were proposed for membership.

The president introduced the speaker of the evening, Dr. James C. King. An abstract of his paper follows:

WHAT HAS THE POPULATION GENETICIST TO OFFER THE ENTOMOLOGIST?

The entomologist is concerned with characters—morphological, physiological, behavioral. All taxonomy is based on them. There are differences in characters between species, between populations within species and between individuals within populations. These characters are all under genetic influence and the population geneticist is concerned with the processes which result in a given population having a given set of characters and which account for persistence or change in the set.

Genetically, characters may be produced by single genes or by polygenic complexes. The same characters may sometimes be produced by one, sometimes by the other; and where a polygenic complex is responsible, different complexes may produce the same result. Experimental selection for a polygenic character (resistance to DDT in *D. melanogaster*) has been shown to produce the same phenotypic result in two lines, identical in origin but independently selected. Genetic analysis of the two lines, however, disclosed that two very different gene complexes had been built up.

In any cross-breeding population which is reasonably near equilibrium the means and variances for any number of characters are definite and predictable. There is a modal phenotype: the great majority of individuals lie within definite phenotypic limits. This situation obtains because the gene pool of the population is an integrated system. The modal phenotype is produced by the random pairing of the chromosomes at fertilization. Artificially produced homozygotes deviate from the modal phenotype. Selection acts not on genes or chromosomes but on individuals—diploid sets of

chromosomes. Chromosomes which, when paired at random, give the nearest approach to the modal phenotype have the best chance of survival. The survival value of a chromosome (or gene) depends quite as much on the genetic milieu in which it is found as on its own makeup. The modal phenotype is produced by many interesting polygenic complexes; "switch" genes and extreme phenodeviants are exceptional phenomena.

Selection acts in a fluctuating and capricious manner. Hence no population ever achieves a perfectly integrated genetic system. Any change produced in a genetic system by selection sets in motion a complex readjustment involving compensatory changes leading toward a new integration. The whole process is continuously dynamic and kaleidoscopic. Since different local populations of the same species differ in such complex ways, the notion sometimes expressed that two species may differ in only one or a small number of genes is fantastic.

Doctor King recommended as bibliographical material The Cold Spring Harbor (1955) Symposium and the Journal of Evolution.

After many questions and a lively discussion period, the meeting was adjourned at 10:00 P.M.

ROMAN VISHNIAC, *Secretary pro tem.*

MEETING OF MARCH 4, 1958

The regular meeting of the Society was called to order by President Treat at 8:05 P.M. in Room 419 of the American Museum of Natural History. Seventeen members and seventeen guests were present. Mrs. Vaurie was appointed Secretary *pro tempore*. Minutes of the meeting of 18 February were read and approved. The President read an excerpt from a letter from Mr. Soraci, Editor of the Society's Journal, stating that all copy for the 1957 volume was in the hands of the printer, and that material is accumulating for the first issue of 1958. There were no reports of other officers.

In the absence of Mr. Hessel, the report of the Auditing Committee for 1957 was read by Mr. Heineman, who had served with Mr. Hessel and Mr. Schwarz. The report was accepted by unanimous vote of the Society.

William H. Loery, M.D., and Raymond Brush were unanimously elected to membership. There were no proposals for new membership. Miss Alice Gray reported that the Junior Entomological Society, under her direction, has requested the senior Society to supply speakers on the following subjects: (1) How to tackle a taxonomic research problem; (2) Insect photography; (3) Tropical butterflies; (4) The ecology of the pine barrens; (5) Fossil insects. Mr. Shoumatoff agreed to speak on topics 1 and 3, Dr. Elsie Klots on topic 5, Dr. Clausen on 2, and Dr. A. B. Klots on 4.

The paper of the evening was given by Mary H. Loveless, M.D., of New York Hospital. It was entitled *The hazard of insect stings*. An abstract follows:

Despite the importance to man of plant pollination and honey, bees and especially wasps at times comprise a serious hazard when a state of allergy toward venom exists in the victim of stinging. The reaction to the sting is in this instance not restricted to the usual hivelike redness and

swelling that occurs at the site of inoculation but involves the whole body with such responses as a rash, acute drop in bloodpressure followed by unconsciousness, suffocation due to swellings in the airways, and other serious disturbances. All these reactions are dependent on the presence of allergic antibodies which combine immediately with any venom in their vicinity to give rise to acute inflammation.

There is, fortunately, a means of protection. It consists of a series of cautious injections of the patient each spring with venom which has been taken from a healthy, lively insect of the type that has induced his allergic antibodies. These graduated injections can, we find, be completed during 2½ hours without untoward reactions. They cause the body to build up antibodies of another variety, the so-called blocking antibodies. The latter combine with any venom the patient may receive through the sting of an insect in the field. The venom is promptly "neutralized" and inactivated by this combination and fortunately the antibody-venom complex is nonirritating to the host. Furthermore the blocking antibody has a greater avidity for the venom than has the allergic antibody in the body. The result of this competition between the two types of antibody is that only the blocking type unites with the venom. Thus, the allergic reaction is forestalled and prevented. In short, the patient tolerates the venom which had formerly produced a serious allergic reaction in him. He is immune because of his possession of the blocking, or protective, antibodies.

It is unfortunate that the blocking antibody is produced only for a period of some six months after the course of venom injections. Thus the patient must be immunized each year prior to the time of appearance of the wasps in summer. The allergic antibody, on the other hand, seems to be formed for years once they have been made by the body.

During the past decade, while we were working out the method of immunization with venom, we have introduced the planned stingtest to discover whether the treated patient could indeed tolerate the sting of a lively insect which had formerly caused him to become seriously ill. We have found that all patients, with the possible exception of one man who had also a blood disorder, can take the sting of from one to four insects without any adverse affect. It is, of course, necessary to have all equipment at hand for immediate use should allergic reactions ever be encountered during these challenges. They have clearly established the safety and efficacy of venom-immunization, and thus man has now a means of defense against this unusual hazard.

A prolonged and very lively discussion followed the presentation of Dr. Loveless, and continued for some time after formal adjournment at 9:45 P.M.

MRS. PATRICIA VAURIE, *Secretary pro tem.*

MEETING OF MARCH 18, 1958

A regular meeting of the Society was called to order by the President, A. E. Treat, at 8:10 P.M. in Room 419 of the American Museum of Natural History. Thirteen members and five guests were present. The president read the minutes of the previous meeting which were approved as read. Announcements were made of the forthcoming meeting of the New York Acad-

emy of Science at which Dr. Vishniac will speak; of the coming N. Y. A. S. Conference on Axenic Culture of Invertebrate Metazoa; of a recent publication on *Papilio nise* by Trustees Klots and Heineman; and of a new journal *Entomologia* scheduled for early appearance in the Netherlands.

A meeting of the Interim Editorial Board (Executive and Publications Committees) held on 17 March at the home of Mr. Heineman was briefly reported by the President. Miss Gray reported upon the progress of the newly formed Junior Division of the New York Entomological Society. Organization of this group, with Miss Alice Gray as Senior Advisor, was recently completed, with the following officers: President, Tony Roberts; Vice President, A. Clifton Hooks; Corresponding Secretary, Maureen O'Connor; Recording Secretary, Paul Watsky; Treasurer, Joel Hallam. Membership is up to the present limit of 15, with a considerable waiting list. Dues of \$1.50 payable in two installments in April and October have been voted. Meetings are scheduled for 10:30 A.M. to 1:00 P.M. on the first and third Saturdays of each month, the year around. Liability insurance covering the group's activities has been purchased through the generosity of Mr. Bernard Heineman. Several successful and well-attended meetings have already been held, at one of which Dr. Klots spoke on the Ecology of the Pine Barrens. Joint activities with the senior Society are contemplated.

There being no further business, the President introduced the speaker of the evening, Mr. A. L. Taylor, Head Nematologist of the Crops Production Research Division of the Agricultural Research Service, United States Department of Agriculture. Mr. Taylor spoke on *Recent Research in Nematology*. An abstract follows:

The word nematology as used in the title refers to the study of the plant parasitic and soil nematodes, with occasional contacts with the insect parasites, marine and freshwater nematodes. This includes some 5,000 known species, probably only a fraction of those existing. Plant parasitic and soil nematodes occur in hundreds of millions per acre in all soils where anything can grow and some are important economic parasites of crop and ornamental plants. In general, these nematodes are less than a millimeter long and only about 20 microns wide, too small to be seen easily without a microscope, but large enough to be seen easily when separated from the soil. These tiny bodies have a complete digestive system, a nervous system, reproductive organs, muscles and an excretory system. Reproduction is by eggs and the nematode passes through 4 larval stages, separated by moults, before reaching the adult stage. Plant parasitic nematodes feed on living plants, mostly on the roots, but sometimes also on the above ground parts, and if food is available, may develop to adult stage in a few weeks. If food is not available, as during the winter in cultivated fields, or conditions are unfavorable some species remain indefinitely in the second larval stage. Larvae of the golden nematode of potatoes may remain alive in cysts in soil for as long as ten years, and larvae of the wheat nematode have been found alive after 28 years of storage in dried galls.

Since nematodes are somewhat specialized parasites, able to reproduce on certain plants but not on others, they can be controlled by crop rotation; perhaps one of the chief advantages of crop rotation is nematode control. Another method is trap cropping, the modern improvement of this old

method being the use of trap plants which the nematodes can invade, but in which it cannot complete its development and reproduce. In the past ten years, most progress has been made in the popularization of nematocides which are used for killing nematodes in the soil before the crop is planted. These are mostly fumigants which are applied by injection into the soil and are being used with notable success in increasing crop yields by pineapple growers in Hawaii, tobacco growers in the southern states and vegetable growers in many parts of the country.

Mr. Taylor's remarks excited much interest and many questions. The meeting was adjourned at 10:10 P.M.

ASHER E. TREAT, *Secretary pro tem.*

MEETING OF APRIL 1, 1958

A regular meeting of the Society was held at the American Museum of Natural History. The President called the meeting to order at 8:10 P.M. Twelve members and eight guests were present.

It was announced that the *Zoological Record* of London has appealed for a contribution from the Society. The membership felt that the Society was not presently in a financial position to give any donations; however, several members have given individual donations and a few members offered to make up the difference between these and \$100. A contribution will thus be mailed in the name of the Society.

Mr. Soraci reported on the publication of the *Journal* and appealed for more filler material. Mr. Shoumatoff reported on plans for the Field Trip on May 17th.

Mrs. Edward R. Fusselman, 6 Robert Court, West Orange, New Jersey was proposed for membership.

Dr. Daniel Ludwig of Fordham University spoke on "Metabolism In The Insect Egg." He described the changes in carbohydrate, fat, various nitrogen and phosphorus fractions, activity of the succin-oxidase system, and the rate of O₂ consumption which occur during the embryonic development of the Japanese beetle. This development requires eight days at 30 degrees C. Reducing substances increase during early embryogenesis and then decrease on the fourth day. Oxidation of glycogen furnishes the main source of energy during the first four days, followed by the utilization of fat. During the first four days there are pronounced shifts in nitrogen and phosphorus from fraction C (water soluble, precipitated by tungstic acid or trichloroacetic acid) to other fractions which include lipid, acid soluble and the insoluble fractions.

Similar changes occur to a more limited extent during the latter part of the embryonic period. The activities of cytochrome oxidase and succinic dehydrogenase decrease rapidly during the first four days, associated with the imbibation of water and an increase in weight. During the latter part of the embryonic period the activities of these enzymes increase rapidly although weight remains constant. These observations suggest a change in the mechanism of embryogenesis at the fifth day. A study of embryonic development of carefully timed eggs has shown that blastokinesis occurs between the fourth and fifth days. Prior to this process, organ formation occurs; and following it, differentiation predominates. The energy for blasto-

kinesis may be obtained from the oxidation of reducing compounds.

The meeting adjourned at 9:30 P.M.

ROBERT G. BLOCH, *Assistant Secretary*

MEETING OF APRIL 15, 1958

President Treat called a regular meeting to order at 8:05 P.M. in room 419 of the American Museum of Natural History. Twenty-seven members and 19 guests were present.

The President announced that Drs. Klots and Dos Passos were planning to attend the International Congress of Entomology; a motion was passed electing them official delegates of the Society to the Congress. The Society voted to dispense with the regular order of business to allow more time for the program.

The program was a forum on the question: Is aerial application of insecticides a desirable means of controlling the gypsy moth? The moderator, Mr. A. A. Miller, an attorney, introduced the three speakers: Frank A. Soraci, Director of the Division of Plant Industry, New Jersey Department of Agriculture; Dr. Robert Cushman Murphy, Curator Emeritus of Birds, American Museum of Natural History; Dr. John L. George, Associate Curator of Mammals, New York Zoological Society.

Mr. Soraci described the life-history of the moth and the early attempts to battle the pest in Massachusetts. To date, about \$100 million of public funds has been spent only to control the moth. Yet, the worst defoliation in history took place in 1953 and the insect continues to spread. As a result of this breakthrough of the moth, an additional 100 million acres of important hardwood forests are threatened. We now have a material, DDT, and an aerial method of application which give hope of eradication, said Mr. Soraci. The current eradication program of the states and U.S. Department of Agriculture got underway to a limited extent in 1956, and the large-scale program began in 1957 with the spraying of three million acres. These are the results: an isolated outbreak of the moth around Lansing, Michigan, has been eradicated; there have been no recoveries of moths in areas sprayed in Pennsylvania and New Jersey; excellent results have been achieved in New York State, except on Long Island where some live moths have been trapped. The gypsy moth campaign, stated Mr. Soraci, is in the public interest, and eradication is being achieved. No damage to humans, plants, fish, bees, animal life has occurred that would indicate discontinuance of the program.

Dr. Murphy stated that control of some insect pests was needed. The best example, he feels, is the campaign against the Japanese beetle in the 1930's. But the current gypsy moth program is in sad contrast. And the USDA fire ant program in the South he regards as being even more flagrant because: no research was done on the ant between 1953 and 1957, few investigations were made of possible parasites, there is no knowing whether the current outbreak is a cyclic peak. Dr. Murphy doubts that it is possible to eradicate any insect by chemical means, and states that no example of an insect so eradicated can be found. Between 1949 and 1953, New England was sprayed from the air to control gypsy moth; yet the worst outbreak in history took place in 1953. Dr. Murphy objects to trespass by the federal government and states upon private property, and he objects to irresponsible statements

on the program of USDA. The situation on Long Island is that there have been 37 centers of gypsy moth outbreak of long standing and that in spite of the spraying, the moth will still be there in future years. And, because of insect resistance to pesticides, the dosage will continually have to be increased.

Mr. Soraci, in rebuttal, questioned the success of the Japanese beetle campaign since the pest is still doing much damage in ever increasing areas. As for the possibilities of eradicating an insect by chemical means, Mr. Soraci stated that it now appears eradication of the Medfly in Florida has been achieved. This is the most recent example, but there are others. The aerial spraying with DDT in New England in 1949 was not aimed at eradication, stated Mr. Soraci, but was a local effort to alleviate defoliation. Regarding Dr. Murphy's statement about the gypsy moth program being a trespass on private property, Mr. Soraci said that at least in New Jersey, the state has right of entry to alleviate a public nuisance. DDT, Mr. Soraci concluded, has been a boon to mankind in controlling many human diseases and insect pests.

Dr. Murphy described the effects of the 1957 spray program on Long Island. He believes it wiped out the balance of nature. Some areas were sprayed as many as 15 times. There were dangerous concentrations of DDT in milk. An analysis of peas from the sprayed area showed they contained 14-20 parts per million of DDT, thus making them unfit for human consumption. He had tissues and livers from dead birds analyzed and found they contained high proportions of DDT.

Dr. George stated that his position was nearly midway between the two previous speakers. He said that the gypsy moth is an exotic, introduced species that will at first have cyclic populations, eventually hit a balance and decline in numbers. Dr. George said that not all trees are susceptible to moth attacks and that the hardwoods can be defoliated for a number of years without dying. He has hopes for control of the moth if more work were done in biological control; for example, there is a disease attacking the moths that makes rearing them in the laboratories very difficult. Dr. George's recommendations for a good gypsy moth program would be: no mass spraying but rather spot spraying in outbreak areas. Also, more biological control research should be undertaken.

In discussions from the floor, it was brought out by Dr. Klots that the moth disappeared from Putnam, Connecticut, around 1940 without any chemical control being used; he believes that ecological factors will eventually take over to reduce populations. In response to a question, Mr. Soraci gave figures on the economy and efficiency of the current spray program: to eradicate the moth (requiring spray of about 23,000 acres) in New Jersey in the 1920's, took 11 years and cost 2½ million dollars. Eleven hundred man years of labor were expended in the whole control operation. Today, a single airplane in only four hours, at a cost of less than \$23,000, can spray the same acreage with the same results.

Dr. George said that the effect of sub-lethal doses of pesticides should be investigated for their cumulative effect. On the question of biological control, it was stated from the floor that for two decades USDA and the states spent \$2 million to release well over 100 million parasites and predators;

also, the polyhedrosis virus has been known for 50 years, yet gives biological control of the moths only at high population levels.

The meeting was adjourned at 10:05 P.M.

PETER FARB, *Secretary*

MEETING OF MAY 6, 1958

President Treat called the regular meeting to order at 8:10 P.M. at the Museum of Natural History. Twenty-five members and seven guests were present. Because of the length of the minutes on the gypsy-moth forum of April 15, it was voted to dispense with their reading.

Dr. Treat announced that there had been much favorable response to the gypsy-moth forum; he also stated that contributions to the *Zoological Record* fund exceeded expectations and a check has been mailed in behalf of the Society.

Mr. Shoumatoff reported that Drs. Klots and Teale will participate in the traditional Members' Symposium on May 20th. He also gave the highlights of some of next season's programs.

Mr. Soraci reported that he wished to publish an up-to-date membership list in the first issue of the Journal for 1958, but that he does not have the specialties of all the members. The time necessary to obtain them would delay publication of the list. A motion was made and passed to dispense with the specialties.

Mr. Schoumatoff reported on the plans for the Field Trip, and attempted to arrange transportation for members.

Miss Alice Gray told the Society that the Junior Division has grown to approximately 20 members and that Dr. Klots gave a talk on fossil insects which was enthusiastically received. The Society passed a motion to pay the transportation expenses of Junior members who could not otherwise afford to go on the Field Trip.

Mrs. Edward R. Fusselman of 6 Robert Court, West Orange, N.J., was elected to membership.

The speaker of the evening, Dr. Thomas Eisner of Cornell University, gave an illustrated talk on "Food Economy in Ant Societies." Dr. Eisner first discussed the food economy of the Australian honey ants. Selected workers in these colonies become repletes and a special compartment of their digestive tract becomes gorged with liquid food. The repletes are little more than living storage casks to maintain the supply of food during times of shortage.

The transmission of food by regurgitation is extremely rapid. Dr. Eisner developed an experiment with Dr. E. O. Wilson of Harvard to determine to what extent food transmission can be figured quantitatively. They first removed a worker from a colony, and allowed her to feed on radioactive honey. The worker was then returned to the nest and time was allowed for the honey to be passed around the colony by regurgitation. The radioactivity was then measured. One of the nests experimented with became uniformly radioactive within only 24 hours; seventy percent of another nest became radioactive in three hours.

Dr. Eisner illustrated the digestive tract of the ants, emphasizing the crop which is the "social" stomach and the mid-gut which is the gut proper. Liq-

uid food is first stored in the crop which becomes swollen, and tremendous pressure is built up. What prevents the liquid from leaking out of the crop into the mid-gut? Dr. Eisner stated that there is an intermediate structure between the crop and the mid-gut—the proventriculus—which acts like a valve. This organ is different in various genera of ants, while it is monotonously the same in other Hymenoptera. Dr. Eisner traced the development of this organ, from the primitive organ of the Australian Bull Ant up to the higher ants, illustrating the many variations in structure. Since feeding by regurgitation is important in the social life of ants, Dr. Eisner stated that the incredible complexity of this one small organ has influenced the evolution of ant societies. Because of the proventriculus, when there is little food available every ant in the colony still has a share of that little; when lots of food is available, each ant equally has a good supply in its crop.

Following a lengthy discussion period, the meeting was adjourned at 9:45 P.M.

PETER FARB, *Secretary*

MEETING OF MAY 20, 1958

A regular meeting of the Society was held at the American Museum of Natural History. President Treat called the meeting to order at 8:05 P.M. Eighteen members and five guests were present.

Mr. Soraci announced delivery of a file of Society archives to the President. He also reported that the page proofs of the last issue of the Journal for 1957 were on hand and indexed, and that all material for the 1958 volume had been received.

Chairman Klots of the Field Trip Committee reported on the highly successful visit of the Society to the Butler and Westmoreland Sanctuaries in Bedford, N.Y. on May 17th. About 40 members and guests attended, including junior entomologists.

Miss Gray reported that the Junior Entomological Society consists of 17 members and 12 interested persons, of whom 14 attended the field trip. Because Miss Gray will be returning to California next fall to continue her doctoral studies, the question of replacing her as sponsor of the Junior Society was discussed. A motion was made and passed expressing appreciation to Miss Gray for her work in guiding and building up the Junior Society.

The program of the evening was the traditional Members' Symposium. The first contributor was Dr. A. B. Klots, who showed a series of slides of excellent color photographs he had made in New Mexico, Connecticut and Pelham, N.Y., illustrating various orders of insects at close range. They included *Culex* mosquitos, the white-faced hornet and a group picture of a bee, crab spider and two ambush bugs in a chain of predation and reproduction.

Dr. Teale showed a group of colored slides recording his field explorations from the St. Lawrence to the Rio Grande and including both entomological and ornithological topics.

Following a discussion by each of the members present on his plans for the summer, which covered a wide range of geographical and entomological interests, the meeting adjourned at 9:55 P.M.

NICHOLAS SHOUMATOFF, *Secretary pro tem.*

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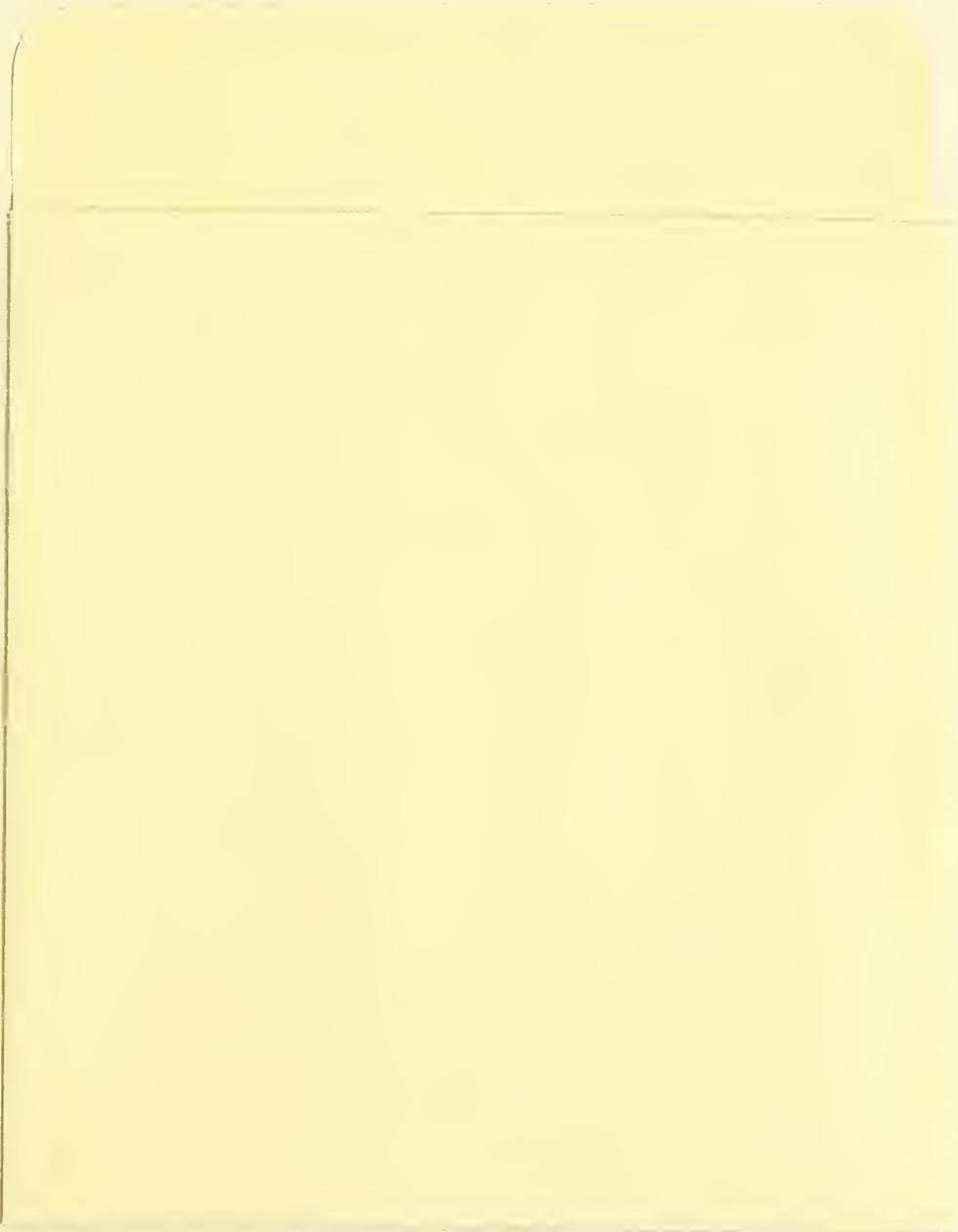
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