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NOTES ON AFRICAN MYRMELEONIDÆ.

By Nathan Banks.

The following article is based largely on the collection of African Myrmeleonidæ of the Berlin Museum, which the curator, Dr. R. Heymons, wished me to work out for them. Mr. Esben Petersen has kindly loaned me his collection of Abyssinian Myrmeleonidæ, which contains several species previously unknown to me. My own collection contains a number of species, principally from South Africa from Dr. H. Brauns' duplicates from the Petersen collection, and material purchased from dealers.

There are many other species recorded from Africa. Some of these are probably synonyms of well-known species. I have made a new arrangement of the genera, and given tables to species as far as possible.

Much of the Berlin Museum material is from German East Africa (D. O. Afrika), but many valuable specimens are from German Southwest Africa (D. S. W. Afrika), from Kamerun and Togoland.

The types of the new species, except where otherwise indicated are in the Berlin Museum.

TABLE OF GENERA OF AFRICAN MYRMELEONIDÆ.

1. In the hind wings but one (rarely two) cross-veins before the origin of the radial sector; the anal usually ends in the margin (Dendroleoninæ)....11
   In the hind wings four or more cross-veins before the origin of the radial sector; the anal often runs into the cubital fork (Myrmeleoninæ)...... 2
2. In the hind wings the anal is not connected directly to the hind margin by cross-veins, but to the post-anal by a series of cross veins; wings heavily marked; pronotum very much broader than long (Palparini)........ 3
   In hind-wings the anal vein is connected directly to the hind-margin by several cross-veins (Myrmeleonini)........ 6
3. Two or more series of costal cells nearly to the base of wing.......Stenares
   But one series of costals, except near the stigma........ 4
4. Apex of subcosta incrassate........ Pamexis
   Apex of subcosta not incrassate........ 5

5. Antennæ not their diameter apart at base; the basal joint with long bristles **Palpares**
   Antennæ more than diameter of basal joint apart; smaller species. . **Tomatares**
6. Spurs longer than the basal joint of tarsus, which is very short............ 7
   Spurs not longer than the basal joint of tarsus, which is longer than the second joint.. 9
7. Body very hairy; legs very short; spurs much curved.................... 8
   Body but little hairy; legs more slender; spurs nearly straight; a line through the apical part of wings.........................**Myrmecælurus**
8. Costal series double..**Syngenes**
   Costal series single...**Acanthaclisis**
9. The branches of radial sector are bent to form a straight line through the middle of the apical part of the wing; basal joint of the tarsus about as long as the apical...**Nesoleon**
   No such line through the wings...10
10. In fore wings the radial sector arises before the cubital fork; many costals before the stigma are crossed...........................**Hagenomyia**
   In fore-wings the radial sector arises much beyond the cubital fork; costals are mostly simple..**Myrmeleon**
   (a) A series of cross-veins before the radial sector are crossed; very large species..subgenus **Macroleon**
11. Spurs present and distinct..12
   No spurs:
   Legs very slender......................................**Gymnocnemia**
   Legs of usual length...................................**Gymnoleon**
12. The forks of cubitus in the fore-wing are parallel for a distance, and the anal is also parallel to them......................................**Creagris**
   The forks of cubitus diverge, and the anal is not parallel to the upper branch, and to the lower only for a short distance...........................13
13. Joints 2, 3, and 4 of tarsus very long, each as long as basal joint....**Megistopus**
   Joints 2 and 3 very short, but little longer than broad....................14
14. Legs very slender; the tibiæ I and II as long or longer than femora I and II; basal tarsal joint nearly as long as apical; spurs as long as two joints; antennæ very slender; wings broad and much marked (Dendroleoni)....15
   Legs shorter; the tibiæ I and II shorter than femora I and II, the basal tarsal joint plainly shorter than the apical (Nemoleonini)...................16
15. Wings especially hind pair very strongly falcate at tip; first joint of tarsus longer than the last.......................................**Cymothales**
   Wings hardly falcate; the branches of radial sector bent to form a straight line through the middle of apical half of wings..............**Dendroleon**
16. In hind-wings the anal does not run directly to the margin but bends upward making a long curve; the radial sector arises before cubital fork in both wings..**Echthromyrmex**
   In hind-wing the anal runs directly to the hind margin...................17
17. Spurs but little longer than the long first joint of tarsus; first branch of radial sector arises beyond end of the anal vein......................**Nemoleon**
   Spurs longer than the first tarsal joint, which is short....................18
18. Spurs as long as three or four joints of tarsus....................**Formicaleon**
   Spurs not so long, about as long as two tarsal joints...........**Macronemurus**

Under *Stenares* I have placed *Crambomorphus*. Both are hardly more than subgenera of *Palpares*. *Symmathetes* is united with *Palpares*. A species of *Glenurus* is described from Africa, but from the figure it is a *Dendroleon;* the genus *Palparidius*, lately described by Peringuey, appears to be identical with *Echthromyrmex*. The *Centroclisis* of Navas I consider the same as *Acanthaclisis*.

Palpares Rambur.

Of this genus there are about forty named species from Africa; doubtless there are several more. They are the grandest and most beautiful insects of the family, if not of the entire Neuropteroid series. Their marking are however, variable, as may be easily seen from even a small series of specimens.

I have tabulated thirty-four of the species, but a few are perhaps synonyms.

Type—*P. libelluloides.*

SYNOPSIS OF SPECIES.

1\. Hind-wings black, except seven or eight small spots 2
Hind-wings much more pale, only with dark bands 3

2\. Hind-wings very narrow, lanceolate .... **karrooanus**
Hind-wings broad, not lanceolate .... **voeltzkowi**

3\. Fore-wings with a complete band across before middle 4
Fore-wings without complete band before middle, outer margin of wings scarcely sinuate 6

4\. Outer margin of wings sinuate; very large species (Symmathetes) 5
Outer margin of wings not sinuate, rather small species .... **ovampoanus**

5\. Basal band of fore-wings reaches hind margin, apical spot divided; hind-wings with the stigmal spot furcate in front, apical spot divided .... **gigas**
Basal band of fore-wings does not reach hind margin, apical spot not divided; hind-wings with the stigmal spot not furcate in front, apical spot not divided, but emarginate .... **mœstus**

6\. A large dark spot over the cubitus in the hind wings 21
Not more than a dot over the forking of cubitus, although a dark spot may be near by 7

7\. Hind wings with complete bands 8
Hind wings without complete bands 13

8\. Fore-wings densely reticulate with black, but leaving three clear yellow bands. **flavofaciatus** and **genialis**
Fore-wings without three clear yellow bands 9

9\. Median band with a projection toward the cubital fork, or else a separated spot near by, the stigmal band with an upward projection as well as one behind 10
Not so marked 11

10\. Median band of hind-wings connected to the stigmal, and median has a projection toward cubital fork .... **latipennis**
Median band well separated from stigmal, and a spot near cubital fork separate from the median band .... **inclemens**

11\. Median and stigmal bands of hind wings well separated .... **insularis**
Median and stigmal bands connected or nearly so 12

12\. Apical spots of both wings divided so as to form an anterior and posterior apical streaks .... **elegantulus**
Apical spots not so divided .... **amitinus**

13\. Wings with all small spots, no large ones; legs yellow .... **sparsus**
Wings with some large spots 14

14\. Outer margin of both wings very narrowly black; no marks between median and stigmal spots in fore-wings 15
Outer margin of wings with dots or spots; some marks between median and stigmal spots in the fore-wings 16

15\. A black band below antennæ .... **ægrotus** (**tessellatus**)
No black band below antennæ .... **tigris**

16\. Median spot of hind-wings not reaching one-half way across wing; in fore-wings the median and stigmal spots are small 17
Median spot of hind-wings reaches one-half way across wing 18

17. Legs yellowish; few small spots in fore-wings; (female)........ **submaculatus**
    Legs blackish, more small spots in fore-wings, (male, probably same as submaculatus)... **nyicanus**
18. In fore-wings the median spot is barely larger than the numerous other spots. **pardaloides**
    In fore-wings the median spot is much larger than the many small spots....19
19. Many small spots in the basal part of the hind-wings............. **furfuraceus**
    Few, if any, small spots in the basal part of the hind wings...............20
20. Larger; spots not broken up much.................................. **tristis**
    Smaller, wings shorter, and appendages shorter, stigmal spot of hind-wings more broken up... **interioris**
21. Basal spot of hind-wings reaches nearly to base of wings.................22
    Basal spot of hind-wings not reaching toward base 23
22. Basal spot large and angulate, also large stigmal spot.......... **immensus**
    Basal spot in form of a streak, also other streaks.................. **radiatus**
23. Median band of fore-wings very small, reticulate, with darker edges, fore-wings often yellowish..24
    Median band of fore-wings distinct, reaching one-half way across wing....27
24. Median and stigmal spots of hind-wings connected; but few small spots in the fore-wings.. **stuhlmanni**
    Median and stigmal spots not connected, more small spots in the fore-wings. 25
25. Hind part of fore-wings not tessellate with dark spots............ **dubiosus**
    Hind part of fore-wing tessellate with dark spots........................26
26. Fore-wings not very yellowish................................. **speciosus**
    Fore-wings plainly yellowish..................................... **caffer**
27. Median band of hind-wings bent inward behind; stigmal spot broader behind than in front, and reaches hind margin.............................28
    Median band not bent inward at tip; stigmal spot not reaching hind margin and narrow behind...32
28. Wings broad; median band of hind-wings does not reach the hind margin. **hispanus**
    Wings usually narrow, median band of hind-wings reaches hind-margin....29
29. Apical mark of hind wings connected to the stigmal.......................30
    Apical mark of hind-wings not connected to stigmal; two yellowish spots on front of the pronotum...31
30. But lightly marked, stigmal spot of fore-wings larger, from Madagascar.. **martini**
    More heavily marked, stigmal spot smaller; from South Africa (may be same) **cataractae**
31. No small spots between median and stigmal spots in fore-wings.... **damarensis**
    Many small spots between median and stigmal spots in the fore-wings.... **formosus**
32. Stigmal spot of hind-wings connected to a large spot just before it ... **cephalotes**
    Stigmal spot of hind-wings without a spot just before it..................33
33. Stigmal spot of hind wings reaches across wing, in fore-wings nearly across; median spot of fore-wings very narrow.................... **percheroni**
    Stigmal spot of hind-wings and fore-wings not near across wing... **libelluloides**

Palpares formosus n. sp.

Head black, clypeus yellow; pronotum black, with two yellow spots in front; rest of the thorax black, with several pale spots through the middle; legs black; abdomen pale, darker toward tip. Wings very slender; forewings densely spotted with small brown dots, but a narrow angulate median band crosses the wing, the stigmal spots small, and a rather large preapical spot. Hindwings with a large spot over the fork of the cubitus, an angulate median band crosses the wing to the hind margin, leaving two small hyaline spots on the hind margin; a stigmal band crosses the wing, leaving one hyaline spot on the hind margin, and it has an inner projection toward the median band; a transverse, preapical band, connected each side around the tip and thus enclosing a hyaline spot.

Expanse 80 mm.

From Willowmore, Cape Colony, 20 Febr. (Dr. Brauns). Similar to *P. damarensis* McLach., but with more slender wings; the forepair with spots all over the surface, not clear between the median and stigmal bands. (Banks coll.)

Acanthaclisis Rambur.

This genus is related to *Myrmeleon*, but distinguished by the very heavy legs, and the much curved or rather geniculate spurs; the body and legs are extremely hairy; the antennæ are rather close together at base; the wings in most forms have a line through the apical part of the wings formed by the bending of the branches of the radial sector, and there is a similar line through the cubital area formed by the bending of the branches of the upper cubitus.

Type—*A. occitanica.*

The genus *Syngenes* formed for *A. debilis* Gerst, is scarcely more than a subgenus; it has many of the costal crossveins crossed.* The genus *Centroclisis* is, I think, a synonym of *Acanthaclisis*, its type species agreeing closely with my specimens of *A. distincta.*

Quite a number of species have been described from Africa; Dr. Van der Weele examined Gerstaecker's types and placed most of them as synonyms of other forms; I have seen only a few of the species, and the following table is based partly on the descriptions.

1. Costal area with many of cross veins crossed (Syngenes) .... **longicornis**
   Costal area with most of cross-veins simple or forked........................2
2. A black streak through middle of fore-wings .... .**lineatipennis**
   No black streak in fore-wings............ . 3
3. Spurs evenly curved.................. **dasymalla**
   Spurs geniculate..... 4
4. Fork of cubitus with a distinct spot................ ..**mashunensis**
   Fork of cubitus unmarked.................... 5
5. Various patches of white cross-veins in both wings; many small dark dots; larger ones along upper edge of cubitus, especially at end...........**gulo**
   Few patches of white cross-veins; less marked with dark, wings rather more acute at tips..6
6.—Costal series almost all simple; pronotum not so plainly lineate with black.. **distincta**
   Costal series mostly forked; pronotum very distinctly lineate with black.. **baetica**

**A. americana*, *A. fallax* have many costals forked; *A. japonica*, *A. horrida*, and some Australian species have many costals crossed.

Acanthaclisis bætica Rambur.

Not before recorded from Africa; in the Petersen coll. a specimen from Oran, Algeria agrees with Spanish specimens.

Myrmecælurus Costa.

This genus is related most closely to *Nesoleon*, but separated from that as well as from *Myrmeleon* by the longer spurs; there is a line through the apical part of the wing.

There are several species recorded from Africa, but I have seen but one which is new. The *Myrmeleon tristis* has been referred to this genus, but is nearer to *Myrmeleon*, and is better placed in a new genus.

Type—*M. flavus* (=*trigrammus*).

Myrmecælurus subcostatus n. sp.

Pale yellow; no mark between antennæ, and only very faintly on each side on the anterior part of vertex; antennæ pale brownish; pronotum with a black line each side not reaching either margin, and a median black dot on front margin; three black lines on rest of thorax, the median one nearly complete (single on the scutelli), the lateral ones interrupted, some dark lines over base of coxæ I and II; abdomen with a dark median stripe from base to tip, and a dark stripe each side on the venter. Wings hyaline, venation yellowish, the subcosta very strongly marked with black nearly to the stigma; the black extending up on each costal crossvein; the radial sector much marked with black, and at tip with a black streak extending out over the end of radius toward the tip of wing; some dark dots on origin of branches of cubitus, and a few others near middle of wing. In the hind-wings the subcosta and radius are marked near base, and to a lesser degree on the radial sector and cubitus, and a few veins near middle of wing. Pronotum much broader than long, rounded in front. Wings rather broad near tip; about seven or eight crossveins before radial sector, and about ten branches to the radial sector; costals simple; hind-wings a little narrower but scarcely more acute than the fore-wings.

Expanse 58 mm.

From Erythraea (Kristensen coll.); types in coll. Banks and Petersen.

Nesoleon Banks.

This genus is near *Myrmeleon*, having several crossveins before origin of the radial fork in hind wings, but a single costal series, and the spurs no longer than basal tarsal joint. There are from 6 to 10 crossveins before radial sector (more than in *Myrmeleon*, and the spurs or one of them is much shorter than the basal tarsal joint, which is nearly as long as the apical joint; the antennæ are wide apart at base. The wings are broad and subfalcate at tip, and differ at once from *Myrmeleon* in having a line through the apical part of each wing, partly formed by the bent branches of the radial sector.

Type—*N. braunsi* Bks.

1. Wings with large black spots 2
   Wings with only small black marks 3
2. Wings almost all black, more than apical half of hind-wings black, only the stigma and an apical spot pale .... **braunsi**
   Wings mostly pale, less than apical half of hind-wings black, large stigmal and apical spots pale .... **boschimanus**
3. No interantennal mark 4
   Interantennal mark distinct 5
4. Pronotum with three dark stripes (unnamed species from Kamerun, but one specimen) .... sp.
5. Pronotal stripes slender and broken; wings rather narrow; a dark spot at the base of the stigma, one at end of the cubital fork, and one over cubitus and median near their ends; elsewhere but little marked .... **trivirgatus**
   Pronotal stripes plain and complete 6
6. Wings rather evenly marked all over with small blackish spots at the forks of the veins; the outer gradates not more prominent than other veins, nor a mark at the end of the cubital fork .... **punctatissimus**
   Wings not evenly marked all over 7
7. Wings almost all hyaline, only faintly marked and then most noticeable near the outer apical margin; stigma darker at base .... **pallens**
   Wings unevenly marked, the stigma with a prominent dark spot at base, the outer gradates marked, and a pale unmarked streak beyond it, no prominent spot at end of cubital fork .... **mysteriosus**
   Similar to N. mysteriosus, but the wings not much marked, except at the gradate series, and near the end of the anal vein, thus two oblique lines on each fore-wing; stigma dark at base; longitudinal veins of wings strongly marked .... **variegatus**

Nesoleon braunsi Banks.

I have seen only the types from Willowmore, Cape Colony, (Dr. Brauns).

Nesoleon boschimanus (Peringuey).

Head black; a large pale spot each side on face; vertex pale, with black dots, three in each of three rows, median spots sometimes connected; pronotum with broad median black, and two narrower stripes each side, the median continued back over the thorax, and the lateral also continued, but in a broken and branched form; abdomen black, some of the segments beyond middle are pale at tip; femora brown; tibiæ pale, with a black tip, and on front and middle pair a median band also; tarsi, except basal joint, mostly black; spurs weak, hardly more than one-half the length of the basal tarsal joint. Wings moderately broad, about as in N. mysteriosus; apex acute; venation interrupted black and white; forewings with larger spots along hind and outer margin, a sub-basal spot, a larger oblique median spot, a larger stigmal spot, sloping inward, a spot behind this one; hind wings pale on basal three-fifths; two small spots near disc of wing, then a broad prestigmal band, narrowed in the middle, and broadened behind and reaching outward to near tip of wing, a prominent spot beyond the stigma, nearly connected to the large black spot behind it. Seven cross-veins before radial sector in hind wings; eight branches to radial sector in both pairs; abdomen shorter than wings.

Expanse 40–45 mm.

From Deutsch Sud. W. Afrika; Grootfontein, Okahandya, and Gr. Namalaut.

Nesoleon mysteriosus (Gerst.).

From various places in D. O. Afrika (Berlin Museum); and Mt. Algego, Uganda (Banks coll.)

Nesoleon variegatus (Klug).

From Harrar, Abyssinia (Petersen and Banks coll.)

Nesoleon trivirgatus (Gerst.)

From Grootfontein, D. S. W. Afrika. This may be but a pale form of *N. variegatus.*

Nesoleon punctatissimus (Gerst.)

From Windhock, Reitfontein and Reheboth, D. S. W., Afrika, and Lindi, D. O. Afrika. This may be the *Myrmeleon lanceolatus* Rambr.

Nesoleon pallens, (Klug).

Several specimens collected by Kristensen in Erythræa I believe are this species; there is some variation in length and breadth of wing and one specimen has the wings about as Klug figures, but the abdomen does not show the transverse dark marks, nor does Klug's description mention them, so I presume the figure is too highly colored in this respect. Klug's species is surely a *Nesoleon* as he shows plainly in his figure the fine line in the apical venation of the forewings.

Hagenomyia new genus.

This genus agrees in general with *Myrmeleon*; there are several crossveins before the radial sector in the hind wings; the spurs are no longer than the first tarsal joint; which is longer than the second; the antennæ are wide apart at base; and there is no line through the apical part of the wings; it differs from *Myrmeleon* in the much broader wings, in having the radial sector of forewings arising before the cubital fork, and in having many costals before the stigma crossed.

Type—*Myrmeleon tristis* Hagen.

Hagenomyia tristis (Hagen).

This is very common in many parts of Africa; I have seen specimens from Argabba, Tewe, N. Usambara, Kamerun, Togo, Kongo, Tanganjika, Sansibar, Angola, Madagascar, and various places in D. O. Afrika (Berlin Museum), Erythraea, Abyssinia, and Abutshi, Niger (Banks coll.)

Myrmeleon Linnaeus.

In this genus there are several crossveins before the radial sector in both wings, the anal is connected to margin; there is no straight line through the apical part of the wings, the basal joint of tarsus is much shorter than the apical joint and the spurs are not or but a little longer than the basal joint; the costals are simple, the cubital forks diverge, and the wings are usually narrow.

Type.—*Myrmeleon formicarium* Linn.

There are two subgenera; *Myrmeleon* and *Macroleon*, the latter with large species, mostly broader wings, and with several of the crossveins before the radial sector crossed; the type of this subgenus is *M.* (*Myrmeleon*) *validus* McLach.

Many species have been described from Africa, several of which probably do not belong to the genus as here restricted, and others are perhaps synonyms of some of the common species. Those that I have seen are tabulated below.

1. Fore-wings with an oblique dark mark up from the end of the anal vein, and dark spots on the cubitus and median near the tip; pronotum dark.... **alcestris**
   No such marks.......... 2
2. Outer apical margin of both wings narrowly dark; pronotum dark........ **formicaroides**
   Outer apical margins not dark.......... 3
3. A large dark cloud before and beyond the large white stigma.........**lynceus**
   No such cloud.......... 4
4. Abdomen plainly banded with pale; pronotum dark, indistinctly marked.. 6
   Abdomen not plainly banded with pale; pronotum pale yellowish, at least on sides.......... 5
5. A simple, narrow median dark stripe on the pronotum............**medialis**
   A simple median, and a lateral stripe for most of the distance on pronotum.. **doralice**
   A broad median stripe furcate in front on the pronotum...........**furcatus**
   A broad median dark stripe on pronotum, serrate on the sides and occupying most of the surface..........**lethifer**
6. Size small, stigma barely distinct; no series of crossed veins before radial sector in fore-wings, cubitus marked with black and white.......**obscurus**
   Size very large, stigma plainly white; a series of crossed veins before radial sector in fore-wings (Macroleon).......... 7
7. Wing tinged throughout with a vinous color.......... **validus**
   Wings not tinged with vinous 8
8. Interantennal mark includes a pale spot below antennæ; black on clypeus; pronotum with five pale spots.......................**quinquemaculatus**
   Interantennal mark not complete below, but with a deep median indentation of pale; hardly black on clypeus; larger and with narrower wings......**atlas**

Myrmeleon obscurus Rambur.

Widely distributed in tropical and South Africa. Specimens have been examined from Harrar, Abyssinia (Petersen coll.); Tamatave and Vohemar, Madagascar, (Banks coll.) and Erythræa; from Bagamoyo and Lindi, D. O. Afrika, Windhoek, D. S. W. Afrika, Livingstone, S. Afrika, and Kamerum (Berlin Mus.).

Myrmeleon lethifer Walker.

From White River, Transvaal, Kibwezi, Brit. O. Afrika, and Kwidjwi, Ost Afrika. *M. nigridorsis* Kolbe is the same species.

Myrmeleon doralice n. sp.

Face yellow, a large shining black interantennal mark, curving evenly downward on the face, and above reaching to middle of vertex, with a median extension on vertex, and a black streak each side; antennæ rather long, blackish, tip paler, pronotum longer than broad, narrowed in front, pale yellow, a median black stripe, widest in front, and a curved black streak each side from behind the transverse furrow; rest of thorax with middle black spot, and oblong spots over the base of wings, a basal median black spot on the scutelli; pleura black through the middle; abdomen shorter than wings, black, tips of segments narrowly pale, sides pale; legs pale yellowish, tips of tibiæ rather darker, tip of last tarsal joint black; spurs not as long as basal tarsal joint, which is much shorter than the apical joint. Wings hyaline; venation pale yellowish, subcosta, radius, and cubitus marked with dark, stigma hardly distinct. Wings rather slender, acute at tips; about 10 cross-veins in forewings before radial sector, 6 in hind wings, 10 branches of radial sector; in the forewings the first fork of radial sector is so connected up to the radius as to appear as a distinct sector of the radius, thus apparently two radial sectors.

Expanse 60 mm.

From Windhoek, D. S. W. Afrika.

Myrmeleon alcestris n. sp.

Head mostly black, margin of face yellow, a median yellow spot on the clypeus, two dots between the antennæ, and the orbits yellowish; a pale stripe across vertex in front, a large yellow spot each side, and three longitudinal submedian lines on the vertex pale, a spot each side on occiput pale; basal joints of antennæ pale, with dark rings, rest dark brown; pronotum short, a median dark streak, a spot near each anterior corner, and a larger spot in each hind corner, dark; rest of thorax dark, with indistinct black marks, and the hind margins of the segments pale; coxæ black, femora black, except pale base, tibiæ pale, heavily spotted or streaked with dark; tarsi pale brownish, tip of last joint black; spurs not as long as basal tarsal joint, which is about two thirds as long as the apical joint. Wings hyaline; venation black and white, the crossveins with black dots, the longitudinal veins with longer black streaks, a black spot at the base of the stigma, an oblique blackish cloud up from the end of the anal vein, and a spot over cubitus and median at the usual point for such spot. Wings slender, acute at tips; 7 cross-veins before radial sector in forewings, 5 in hind wings; 10 branches of radial sector in both pairs.

Expanse 54 mm.

From Reitfontein, D. S. W. Afrika.

Myrmeleon medialis n. sp.

Head with a large black interantennal mark reaching down over most of the face and up to the vertex, a dark mark on clypeus, in middle connected upward to the interantennal mark; vertex with a double median spot in front, a small median one behind, and a long one each side, black; antennæ dark brown, short; pronotum but little longer than wide, pale, with a broad median brown stripe; thorax pale, with some large median black spots, and one over base of each wing, pleura with a broad broken black streak; abdomen black, with short white hairs, not as long as wings; legs pale, rather more brownish toward tips, with black bristles, tarsi quite long, first joint hardly as long as second and third together, fifth one and a half times as long as the first, spurs not as long as the first joint. Wings hyaline, venation pale yellowish, subcosta slightly marked with black, stigma barely distinct. Wings long and slender, forewings sub-falcate at tip, about 9 crossveins before radial sector in forewings, and 6 in hindwings; 10 branches of radial sector in both wings.

Expanse 60–68 mm.

From Natal and Georgetown, Cape Colony.

Myrmeleon furcatus n. sp.

Head pale yellow, a black mark at base of each antennæ, and a median vertical line; a broad, dark band above antennæ; vertex with a pair of broken submedian stripes, a broader short stripe each side behind, with lateral projections toward eyes, and a lateral spot in front; antennæ with a brown mark on basal joint; a narrow brown ring on second joint, beyond that brown; pronotum pale, with a broad median dark stripe, furcate in front; a short dark stripe on each hind corner; rest of thorax dark, with hind margin of meso- and meta-thorax pale, a narrow pale line on each lateral lobe of the mesothorax, a spot on each lateral lobe of the metathorax, and the scutelli with a pale dot each side, and sometimes other spots; abdomen dark, pale at tip; legs pale, a dark line on the tibiæ, and a streak near tip of femora; spurs as long as the first tarsal joint, which is not as long as the next three together, and shorter than the last joint. Wings hyaline; venation pale, subcosta, radius and cubitus interrupted with dark, also slightly on the radial sector, stigma dark, with a darker spot at base. Wings long, acute at tips, the hind pair almost subfalcate at tip; about eleven crossveins before the radial sector in forewings, six in hind wings; about twelve branches to radial sector in each wing.

Expanse 73 to 90 mm.

From Erythræa (Kristensen coll.). Types in collections of Banks and Petersen.

Myrmeleon lynceus Fabr.

From Victoria, Kamerun, and a smaller specimen from Togo. The *M. leucostigmatus* Weele, from Kamerun, is a synonym.

Myrmeleon formicaroides Weele.

One specimen from Misahohe, Togo.

Myrmeleon quinquemaculatus Hagen.

A common African species, specimens from Ginda (Petersen coll.), Kilimandjaro (Banks coll.) and various places in Togo and D. O. Afrika. *M. polyzones* Gerst. and *M. rapax* Kolbe are synonyms as already stated by Van der Weele.

Myrmeleon validus McLachlan.

From Tamatave, Madagascar (Banks coll.).

Myrmeleon atlas n. sp.

Similar to M. 5-maculatus, but much larger. Face yellow, with a median black spot below, the interantennal mark is not complete below, but indented with the pale reaching up between antennæ, and the mark is not continued all around the lower edge of the antennal socket; marks of vertex similar to those of M. 5-maculatus; the pronotum shows a large pale median spot in front, and at each upper corner, with a narrow extension backward; the abdominal segments are pale only near middle (not to base as in 5-maculatus); the legs yellowish brown, not plainly marked. Wings much more slender than in M. 5-maculatus, especially the hind pair, and more falcate at tip; venation mostly dark, subcosta and radius plainly interrupted with pale; stigma not very distinct; there is a longer series of crossed veinlets before the radial sector in forewings than in M. 5-maculatus.

Expanse 126 mm.

From Kwidjwi, Ost Afrika.

Gymnoleon new genus.

But one crossvein before radial sector in the hindwings, several in forewings; costal series simple, cubital forks not very much divergent; antennæ rather close together at base; pronotum slender; no spurs; legs of moderate length, the last joint of tarsus as long as the basal joint.

Type—*G. exilis* n. sp.

By absence of spurs it is related to the genus *Gymnocnemia*, but differs at once in the very much shorter and stouter legs.

Gymnoleon exilis n. sp.

Face pale yellow, a large black interantennal mark, a row of spots across the vertex, the middle one the largest; pronotum pale yellowish, a pair of black submedian stripes, not quite parallel, and a lateral stripe each side; rest of thorax pale, with a pair of dark submedian lines, broken, but extending over the scutelli, a lateral dark line over base of wings; abdomen rather pale, with dark stripe on each upper side; legs pale, middle and apical mark on tibiæ, except the hind tibiæ have only the apical mark, tips of tarsal joints black. Wings hyaline, venation mostly brown, but the longitudinal veins are interrupted with pale, many of the cross-veins with a pale dot or space; many of the forks in posterior and outer part of fore-wings have a black dot, a larger spot near end of anal vein, and faintly dark at anastomosis of cubitus and median, this last mark is more prominent in the hind-wings, often elongate. Wings rather slender, acute at tips, the hind pair plainly longer than the forewings, narrower and subfalcate at tips; about seven crossveins before radial sector in forewings, about 8 branches of radial sector in each wing, in forewings the anal vein ends before the origin of first branch of radial sector, and the forks of cubitus are plainly divergent. The pronotum is longer than broad, and broadest behind; the abdomen is much shorter than the wings.

Expanse 45 mm.

From Ari Ugri, Erythræa (Kristensen coll.) and from Lindi, D. O. Africa (Berlin Mus.). Type in coll. Banks; cotypes in coll. Petersen and in Berlin Museum.

Gymnoleon elizabethæ n. sp.

Face yellow, a black band below the antennæ reaching above them, the vertex broadly rounded in front and dark brown, back of vertex gray, with two rows of blackish dots, front of vertex with a median furrow making the front plainly bilobed; antennæ brown, tip paler, pronotum short, dull blackish, a faint paler spot each side in front, and one or two in the middle; thorax brown, indistinctly marked with pale; a deep black band on metanotum; abdomen blackish; legs short, yellow-brown, with black marks on tibiæ, hind tibia only at tip, tarsi mostly dark brown, except the basal joint of hind tarsus which is yellow; no spurs; basal joint of tarsus as long as second and third together. Wings with black and white venation, on radius the black and white are in long streaks, elsewhere in short spots, along cubitus and its fork are several small clouds of brown, and a longer oblique mark on cubitus and median near their tip, stigma dark at base, and a cloud near end of anal and cubital fork. Wings slender, subfalcate at tips, anal and cubital fork in forewings run parallel for a distance longer than width of wing, the cubital fork nearly parallel to the cubitus; twelve branches of radial sector in each wing; in apical part of wings the longitudinal veins are very close together.

Expanse 52 mm.

From Port Elizabeth, Cape Colony, 25 Jan., (Brauns), (coll. Banks).

Creagris Hagen.

This genus is known by the parallel forks of the cubitus in the anterior wings; there are but two rows of cells between the forks and these are separated by a nearly straight vein; the anal vein also runs parallel to the cubital forks for some distance.

Type—*C. plumbeus* Oliv.

Many species are known by the names, but several of these names apply to variations of *C. plumbeus*. Whether these forms should be kept distinct or all united under the one name must be determined by larger collections from representative parts of Africa.

The forms I have examined are distinguished as follows:

1. Venation pale, unmarked.......... 2
   Venation marked with black and white.......... 5
2. Apex of hind-wings with a fuscous streak.......... 3
   Apex of hind wings unmarked.......... 4
3. Very large species.......... **diana**
   Species of moderate size.......... **nubifer**
4. Pronotum with indications of two narrow submedian lines; femora dotted with black.......... **murinus**
   Pronotum with a median stripe or absent; femora scarcely dotted with black. **africanus**
5. Wings with black longitudinal streaks.......... **nigrostrigatus**
   Wings without streaks.......... 6
6. Four large black spots along the radial sector in the fore-wings.... **pretiosa**
   No such large spots.......... 7
7. No black band below antennæ.......... 8
   A black band below antennæ, vertex with a frontal ridge, venation strongly marked with black and white.......... **aegyptiacus**
8. An oblique dark mark at end of anal vein in fore-wings; venation very plainly marked with black and white.......... **mortifer**
   No marks on wings; venation only faintly marked with dark and pale.... **plumbeus**

Creagris pretiosa n. sp.

Face pale, a median vertical black line, and a brown spot under each antenna; antennæ brown, base yellowish; vertex with a black band in front, a row of connected black dots, and behind are six separated black dots, the submedian ones being longitudinal; pronotum gray, black on the sides and a submedian pair of black stripes, broadest in front; thorax gray, black marks on the lateral lobes and the usual black band on the mesonotum; abdomen black above, pale beneath. Legs brown, with much gray hair, femur I black on inner tip, tibia I black in middle and near tip, middle leg similar, hind legs paler, the tibiæ black only at tip, all tarsi black, except yellow on basal and most of apical joint of tarsus I. Wings hyaline, venation black, interrupted with pale, the cross-veins mostly wholly black; four large black spots along the radial sector of forewings, another smaller at base of the stigma, a black streak along base of the cubital vein, small black spots at forking of cubitus and farther out on cubitus, one on a crossvein connecting median to the first branch of the radial sector, and one at end of the anal vein, the outer gradate veins form a black line parallel to the outer margin; hindwings with a black spot at the base of the stigma one on a crossvein below and a little before it, and two faint ones on other crossveins from radial sector to radius, another near the end of the cubitus. Forewings broad, acute at tip, almost falcate, the costal margin at base plainly concave, the anal runs parallel to the fork of cubitus for much less than the width of the wings. Hind wings narrow, subfalcate at tip; eleven branches of radial sector in both pairs.

Expanse 78 mm.

From Deutsch Ost Afrika, Bex Lindi. (Berlin Museum).

Creagris diana Kolbe.

Of this magnificent species there are specimens from Lindi, and Mohorovi, D. O. Afrika. Peringuey's recent species, *C. inclitus*, seems to be the same form; his description agrees with the East African specimens.

Creagris nubifer Kolbe.

Specimens from Lindi, D. O. Afrika; Bismarcksburg, Togo, and from Harrar, Abyssinia (Petersen coll.). Peringuey's recent *C. proximus* from South Africa agrees with these specimens.

Creagris plumbeus (Oliv.)

Specimens from Morocco, agree with the European form; they have a median dark stripe on the pronotum, and the longitudinal veins are faintly marked with dark. Also known from Algeria.

Creagris murinus (Klug).

Egypt (Petersen coll.). The median marks on the pronotum are in form of two approximate dark lines; the venation is wholly yellowish. On Klug's plates it is figured as *M. syriacus*, but in text described as *M. murinus*.

Creagris africanus (Rambur).

From D. O. Afrika, Sansibar, Victoria Nyanza, and D. S. W. Afrika (Outyo). The legs are less marked than in *C. murinus*, the median stripe on the pronotum is often absent, and the wings are plainly more acuminate at tips than in *C. murinus*. Peringuey's species, *C. pseudoplumbeus* from South Africa seems to be the same species. It is probable that this and *C. murinus* are but varieties of *C. plumbeus; C. luteipennis*, *C. lanceolatus* Rbr., and *C. lupinus* Oliv., are also closely related if not identical, and McLachlan suggests that several of Walker's Indian species also belong to *C. plumbeus*.

Creagris mortifer (Walk.)

From Daressalam; Reitfontein, D. S. W. Afrika (at light), and Abyssinia. Probab y occurs over most of Africa.

Creagris ægyptiacus (Rambur).

From Egypt (Petersen coll.); Bagamoyo and Korogue, D. O. Afrika, also Madagascar. Also widely spread in Africa.

Peringuey has recently described four other species from South Africa. One, *C. angustipennis*, may belong to the genus, but the three other species (*C. damarinus. C. mashunus* and *C. bechuanus*) are said to have the spurs no longer than the first joint of tarsi; since all the species of *Creagris* known to me have spurs as long as three or four joints, I can hardly believe that these three species really belong to *Creagris.*

Formicaleon n. gen.

This genus, of the general appearance of *Myrmeleon*, is at once distingiushed therefrom by having but one crossvein before the radial sector in the hindwings, and by the antennæ being close together at base; from the allied genera, *Nemoleon* and *Macronemurus*, it is separated by the longer spurs.

The genus *Formicaleo* Leach was made for *Myrmeleon formicarius*, which was already the type of *Myrmeleon;* therefore, I am compelled to make a new name for the *Formicaleo* that is used by Hagen and Brauer.

The type is *Myrmeleon tetragrammicus* Fabr.

There are many species in the African fauna, the few I have seen may be separated as follows:

1. Two broad black stripes on the yellow pronotum, and the lower sides black, antennæ long and slender, wings rather broad, most of the cross-veins brown . . . 2
   Not two broad black stripes on a yellow pronotum . . . 3
2. Two cross-veins before radial sector in the hind-wings, stigma rosy. . **idoneus**
   But one cross-vein before radial sector in the hind-wings; stigma white. . . . **lethalis**
3. Hind-wings with a dark streak in apical part; pronotum pale, with incomplete dark lines . . . **harpalyce**
   No streak in the hind-wings . . . 4
4. Four dark spots just behind the radius in each fore-wing . . . **hesione**
   No such spots . . . 5
5. Hind part of fore-wings with many small dark spots; pronotum dark, with two darker stripes; antennæ short . . . **lepidus**
   Not so . . . 6
6. Pronotum with a broad median black stripe, and oblique black line in apical part of the fore-wings . . . **ilione**
   Pronotum and wings not so marked . . . 7
7. Gradates in fore-wings margined with brown; larger species, expanse 80 mm. **alcione**
   Gradates of fore-wings not margined; smaller species, expanse about 50 mm. **persephone**

Formicaleon harpalyce n. sp.

Head yellow, a black mark under each antenna, a large interantennal mark, mostly above the antennæ, two bands across vertex made up of spots, a median spot behind and one each side on occiput; antennæ yellowish, tip darker, basal joint with dark mark below; pronotum broad, yellowish (or reddish), two black marks on front margin, a submedian pair of stripes behind, the posterior side margins broadly behind, and a spot each side on the transverse furrow black; rest of thorax pale, with black marks, mostly over base of wings, metascutellum with a pale median line; abdomen shorter than wings, dull black; legs pale reddish yellow, spurs curved, the first pair as long as four joints. Wings hyaline, venation pale, longitudinal veins not interrupted with dark, or very faintly so, some crossveins, especially costals partly dark, stigma yellowish (or reddish); hind wings with a long brown streak from the anastomosis of cubitus and median outward toward tip of wing. Wings slender, acute at tips, hind wings falcate at tip; about 8 crossveins before radial sector in forewings, 12 or 13 branches of radial sector in both pairs.

Expanse 70 to 80 mm.

From West Africa, Bismarcksburg, Togo.

Formicaleon alcione n. sp.

Face pale yellowish, black band below and above antennæ, a transverse frontal band on vertex, and spots more or less connected in a row behind; antennæ pale, annulate with brown, tip dark; pronotum broader than long, dark, three ill-defined pale stripes, the median more narrow; thorax pale, marked with dark, scutelli with a double dark spot; abdomen shorter than wings, blackish, pale each side near tip; legs pale, femora spotted with black, especially near the tip, tibia with bands above near base and tip, tips of tarsi black; the tarsi short, last joint nearly as long as other joints together, spurs as long as four joints. Wings hyaline, venation black and white, not dotted, but in long streaks, a spot at base of stigma, and two spots (smaller) beyond on the radius, the outer gradates very irregularly, but plainly dark, and a faint dark streak up from end of anal vein; hind wings with stigmal spot, and two beyond dark, also one on the anastomosis of cubitus and median. Wings very long and slender, acute at tips, hind wings falcate at tip, 7 or 8 crossveins before radial sector in forewings, 14 or 15 branches of radial sector in both pairs.

Expanse 75 mm.

From Mohorovi, D. O. Afrika, and one marked "Key. Frustorpher."

Formicaleon idoneus n. sp.

Face pale, a large black interantennal mark, reaching below the antennæ where it is deep and shining, paler above toward vertex, two rows of transverse spots on the vertex, the hind row with a projection each side behind; antennæ long, pale on base, and annulate with brown, beyond and at tip darker brown; pronotum broader than long, yellowish, with two broad black stripes and the lower margins black; rest of thorax pale, striped and spotted with black, scutelli mostly pale, the mark over base of the forewings includes two pale spots; abdomen shorter than wings, brownish, paler on basal half and there with lateral black line; legs pale, anterior femora and tibiæ dotted with black, tip of tarsi black, apical joint of tarsus nearly as long as others together, spurs about as long as four joints. Wings hyaline, stigma rosy, longitudinal veins black and white, radial sector and branches and most of the crossveins black. Wings rather broad beyond middle, tips acute, hind wings subfalcate; 8 crossveins before radial sector in forewing, two in hindwing, 13 branches of radial sector in both wings.

Expanse 85 mm.

From Langenburg, D. O. Afrika. In general similar to *F. lethalis*, having broad wings and slender antennæ, but the two crossveins before radial sector in hindwing distinguish it.

Formicaleon ilione n. sp.

Face pale, a vertical black line between bases of antennæ; a broad deep black band above antennæ; two, rather curved, bands on the vertex, connected in middle by dark, and the posterior one extended behind in middle; pronotum with a broad black median stripe, broken up behind into lateral projections, a spot each side near front on the transverse groove, and the posterior sides black; rest of thorax mostly black, with a broad pale stripe each side, sides of scutelli pale; abdomen black, each segment (beyond the basal) with a pale stripe each side, connected in front of the dorsum, venter rather pale, the pleuræ of thorax heavily streaked with black, leg short, hairy; femora thick, with many white hairs and bristles and a few black ones, anterior femora mostly black, others paler, especially below, front and middle tibiæ with two black bands, hardly visible in hind tibiæ, tarsal joints tipped with black, very short, the basal especially so, the fifth as long as all others together, spurs longer than three joints. Wings with the longitudinal veins heavily marked with black and white, the costals and many crossveins mostly black, black spot at base of stigma, a long curved prominent black stripe over the gradates toward tip of wing, and a short, oblique mark upward from near the end of the anal vein; hindwings less marked, the anal vein wholly, and the median vein on the basal third very pale yellowish, other veins marked slightly with black. Wings not very long, quite broad at stigma, hind pair much narrower, both pairs acute and subfalcate at tip, the outer margin being slightly concave, seven cross-veins before origin of the radial sector in the forewings, ten to eleven branches of the radial sector in each wing.

Expanse 60 to 65 mm.

From Harrar, Abyssinia (Kristensen collector), types in collections Banks and Petersen.

Formicaleon persephone n. sp.

Face pale yellow, a black band below antennæ and one above, two transverse rows of spots on the vertex; antennæ pale, annulate with with brown; pronotum broader than long, dull blackish, a faint median pale line and an indistinct outer pale stripe each side; rest of thorax dark, marked a little with pale, posterior margin of anterior lobe of mesothorax pale; abdomen blackish, a pale spot above before middle of each segment; legs pale, hind femora and tibiæ with blackish dots, front femora darker, tibiæ with basal and apical dark mark, and tips of tarsi black; apical joint of tarsus not as long as the others together, spurs as long as four joints, curved. Wings extremely slender, fully six times as long as broad, acute at tips; venation mostly black, the radius mostly pale, the subcosta interrupted black and white, cubitus with longer streaks of black and white, cross-veins on large patches are pale, the gradates black, a black spot at base of stigma and over union of subcosta and radius; 7 crossveins before radial sector in forewings, about 11 branches of radial sector in each wing.

Expanse 50 mm.

From Thies, Senegal. Its small size and very narrow wings separate it from all others.

Formicaleon hesione n. sp.

Face pale, a black band below and one above antennæ, pale between, vertex brown, three double black spots behind in a transverse row, and in front of these are two others, submedian; antennæ pale, annulate with brown; pronotum broader than long, dark, a median pale line, and a large anterior spot each side, not clearly outlined, but reaching backward; rest of thorax dark, marked with pale, especially on the scutelli; legs short, pale, tibiæ marked with brown above near base and at tip, tips of tarsi dark, dark dots on hind femora, black hairs below on femora and tibiæ I, tarsi short, apical joint about as long as others together, spurs as long as four joints, curved; abdomen shorter than wings, blackish, a pale spot above before the middle of each segment, apical segment with a pale spot each side near tip. Wings hyaline, venation black and white, some large patches of white veins, costals black at each end, four spots behind radius, one before radial sector, one on origin of radial sector, one on first branch of radial sector, and one near stigma, the stigma with basal black mark, and a spot on radius beyond, a short oblique mark over end of anal vein, and the outer gradates plainly black, also a spot over the first crossvein between cubitus and cubital fork; in hind wings a spot at base of stigma, one just behind radius near by, and one on radius beyond stigma. Wings very slender, acute at tips, 7 cross veins before radial sector in forewings, about 10 branches of radial sector in both pairs.

Expanse 58 mm.

From Nssanakang, Kamerun. In general appearance it is very much like *Nemoleon 4-maculatus* from East Africa, but the gradates are more plainly marked, and the tarsi are very different in structure.

Formicaleon lethalis (Walker.)

Specimens from Bagamoyo, Madagascar, Natal, and Mhonta, D. O. Afrika. Recorded from various places in East Africa.

The *F. leucospilos* Hagen is the same species.

Formicaleon lepidus (Kolbe).

From Langenburg, D. O. Afrika, and Erythræa, (Petersen coll.).

Nemoleon Navas.

This genus has but one crossvein before the radial sector in the hindwings; the antennæ are not their diameter apart at base; the first joint of tarsus is about as long as the last joint, and the spurs about as long as this first tarsal joint. The wings are slender, with a single costal series.

Type—*Myrmeleon arenarius.*

1. Wings with some dark spots 3
   Wings without dark spots 2
2. Spurs and claws black. .... **kituanus**
   Spurs and claws reddish .... **filiformis**
3. Outer gradates in fore-wings form a prominent oblique dark stripe .. **pardalice**
   Outer gradates do not form a prominent stripe 4
4. Four black spots just behind the radius in the fore-wings, and one at the stigma .... **quadrimaculatus**
   A black dot at end of anal vein in fore-wings, and one near end of median where it joins the cubitus .... **alcidice**

Nemoleon alcidice n. sp.

Face pale, a dark brown band over base of antennæ, and two narrow brown bands on the vertex, made up of conjoined spots; antennæ pale, the second joint dark above, the tip also dark; pronotum pale, a brown spot on each side margin; and two black dots on each side, one on the transverse groove, the other behind it on the hind margin; rest of thorax dark on sides, but only faintly marked in the middle, not plainly on the scutelli; abdomen dull black, last segment slightly paler at tip, all white haired. Legs slender, pale, distinctly dotted with black on the femora and tibiæ, and at tips of tarsal joints, claws long, reddish, as also the spurs, which are as long as the first tarsal joint, and this as long as the next three together, apical joint nearly as long as the basal, both black and white bristles on the legs. Wings hyaline; venation pale, interrupted with black, fore-wings with an oblique black mark near end of anal vein, a roundish, black spot near end of median at its connection with the cubitus, one black spot on the union of subcostal and radius, and two beyond on the radius, the outer one the larger; the anal vein pale, but its branches marked with black on the margin. Wings long and slender, acute at tips; seven crossveins before the radial sector in forewing, nine branches of the radial sector in each wing. Hindwings mostly unmarked.

Expanse 58 mm.

From Erythræa (Kristensen coll.). Type in coll. Petersen; (cotype in Banks coll.); a poor specimen from Duma, Kamerun, June (Berlin Museum).

Nemoleon pardalice n. sp.

Face pale, a dark band under and between antennæ, two narrow bands on the vertex, made up of black spots, and behind a pair of submedian marks; antennae brown, except the pale base; pronotum dark, with a pale spot each side in front, and a pale streak behind; thorax dark, a pale spot each side on the anterior lobes, and on scutelli, posterior margin of the anterior lobe and of the mesothorax pale, two pale marks on the metanotum; femora mostly dark, but white-haired, tibiæ with basal and preapical dark bands, and tips of tarsal joints dark; spurs not as long as the basal joint, which is about as long as the next two together, apical a little longer than the basal. Abdomen black, white-haired, tip pale. Wings hardly hyaline; venation mostly dark, the subcosta, radius, and cubitus, marked with white, some crossveins white, and some white on branches of the radial sector, median vein wholly black; many veins bordered with black, especially the crossveins in hind part of wings, also the outer gradates, which form a long oblique line, and the veinlets obliquely above the end of the anal vein, the origin of the radial sector, an oblique vein before it, one oblique vein connecting it to the radius, and where it bends up toward the radius near the stigma, also black; the stigma dark; some small cross-veins beyond the stigma in the costal area are bordered with black; in the hindwings the subcosta black and white, the other veins mostly black, the forks of veinlets near the outer hind margin are dark, and also above the radius near tip of wing with dark spots on the forks. Wings rather short, and broad; forewings hardly acute at tips, hindwings plainly so; six crossveins before origin of radial sector in the forewing, one of them oblique, about eight branches of radial sector in both pairs, all costals simple. Abdomen much shorter than wings; vertex high and convex in a ridge, pronotum about as long as broad.

Expanse 40 mm.

From Erythræa (coll. Kristensen), type in collection Petersen.

Nemoleon 4-maculatus n. sp.

Head pale, a black mark each side under antennæ along the side of the eyes, a black band above antennæ, emarginate above in middle, two rows of black spots on vertex, six in each row, more or less connected in pairs; antennæ pale, annulate with brown; pronotum slender, narrowed in front, dull black, a median pale stripe from before middle to tip, and a stripe each side pale; rest of thorax dull black, with a few yellowish spots; abdomen about as long as wings, black, with white hair, tips of segments with a yellow spot above; legs pale, marked with black, long black bristles and white hairs, tips of tibiæ and tarsi black, femora with black near middle, at least above; basal joint of tarsus as long as last, spurs a little longer than first joint. Wings hyaline, marked with black, venation black and white, forewings with four black spots behind radius, one before origin of radial sector, one on origin of radial sector, one a little beyond first branch of radial sector, and one near the stigma; base of stigma black, a narrow streak up from end of anal vein, spot at anastomosis of cubitus and median, and two dots on radius beyond stigma; many crossveins are black, but there are large patches where all are white, two of these near middle of wing and one oblique below the stigma; hind wings with spot at base of stigma, and a spot behind radius black, some of the same large patches of white crossveins as in the forewings. Wings very slender, acute at tips, 7 crossveins before radial sector in forewings, about 9 or 10 branches of radial sector in both pairs.

Expanse 58 mm.

One from Langenburg, Nyassa-See, and one from Zanzibar.

Nemoleon filiformis (Gerst.).

From Bismarckburg, Togo, and Nssanakand, Kamerun.

Nemoleon kituanus (Kolbe).

From Peleki, Kwidjwi, D. O. Afrika.

Macronemurus Costa.

This genus is similar to *Formicaleon*, but the spurs are shorter. The antennæ are close together at base; the pronotum is very narrow when compared with the head; and the antennæ are rather long and slender. There are two types of venation; one in which the forks of cubitus are much divergent, and the wings are broader, and the radial sector arises barely beyond the forking of cubitus. This is the typical section. The other group has narrower wings, the radial sector arises much beyond the forking of cubitus, and the cubital forks are nearly parallel approaching the condition of *Creagris;* the species *M. iolanthe*, and *M. melanthe* described below belong to this section.

Type of genus—*M. appendiculatus* Costa.

The species here recorded may be separated by the following table:

1. Hind-wings with an apical brown streak; cross-veins all dark; pronotum with dark stripes .... **striola**
   Hind-wings with the outer apical margin dark; a dot at end of anal and on anastomosis of cubitus and median in the fore-wings .... **iolanthe**
   Hind wings without streak or dark margin 2
2. Fore-wings with many large black spots (about 24) and four or five near apex of the hind-wings .... **pulchellus**
   Wings without large marks 3
3. Radius and subcosta unmarked; cross-veins nearly all pale; no spots on wings; pronotum mostly dark .... **melanthe**
   Radius and subcosta black and pale alternately 4
4. Pronotum pale, with three entire, black stripes; gradate veinlets marked; many cross-veins are margined with brown at their junction with the longitudinal veins .... **loranthe**
   Pronotum not so marked 5

5. All the cross-veins are margined with brown; pronotum pale, with lateral dark stripe, and three dark spots in the middle .... **ianthe**
All cross-veins not margined with brown.................................. 6
6. A median forked stripe on pronotum; cross-veins nearly all dark; stigma white .... **tinctus**
No median forked stripe on the pronotum 7
7. Pronotum yellow, with two spots at front margin and a median one behind, and a narrow stripe each side dark; nearly all cross-veins dark ... **euanthe**
Pronotum mostly dark.. 8
8. Pronotum dark with a narrow, pale, median line.................. **chloranthe**
Not so marked.. 9
9. A black dot at end of anal vein, and one at base of stigma; pronotum all dark (a broken specimen seen) .... sp.
No dots on wings; pronotum marked with pale, (a broken specimen seen)..sp.

Macronemurus striola Kolbe.

From Bagamoyo, and Lindi, D. O. Afrika; the former specimen is small, and slightly marked, but does not seem to differ in structure.

Macronemurus tinctus Kolbe.

From Peleki and Netron See, D. O. Afrika, and Kiiui, East Africa.

Macronemurus chloranthe n. sp.

Face yellow, a black band below and a broader one above antennæ, two rows of dots on the vertex, the hind one curved; antennæ slender, broadly annulate with brown; pronotum fully as long as broad, sides subparallel, dark, a narrow, median pale line, and a pale sinuate stripe each side, a black dot each side on the transverse furrow, thorax dark, black on middle of metanotum, and some faint pale marks in front; abdomen blackish, a pale yellowish streak each side above on middle of each segment, shorter than wings; legs pale, femora darker near tip, tibiæ with subbasal and apical marks brown, joints 2, 3, 4, and apical part of 5 black, legs white-haired, a few black bristles, apical joint of tarsus much longer than broad, spurs fully as long as two joints. Wings hyaline, venation black and white, usually in long streaks, especially prominent on subcosta, radius, and cubitus, a dark spot at base of stigma, and the crossvein below it black, outer gradates dark and spot at end of anal vein; in hind wings with spot at stigma; wings slender, acute at tips, 7 crossveins before radial sector in forewings, 8 branches to radial sector in both pairs.

Expanse 46 mm.

From Okahanda, S. W. Afrika.

Macronemurus iolanthe n. sp.

Face yellow, interantennal mark and the vertex all black; antennæ long, brown, tip darker; pronotum a little longer than broad, narrowed in front, dull blackish, with faint median pale line, and a broader pale mark on each side, indistinct in some lights; thorax and abdomen black, latter with white hairs, apical segment pale; abdomen of female shorter than wings; legs with mostly black femora, anterior pairs paler in front, tibiæ I and II blackish above, tarsi long, but apical joint much longer than basal, spurs about as long as two joints. Wings hyaline, outer margin near tip fumose, more prominent in hind wings, a spot on fork of cubitus, one below stigma, two on radius beyond stigma, one at anastomosis of cubitus and median, and an oblique one at end of anal vein, black, some small dots along anal vein beyond its middle; hind wings unmarked, venation mostly pale, the subcosta, radius, and cubitus faintly dotted with dark. Wings long and slender, acute at tips, 7 crossveins before radial sector, 10 or 11 branches of radial sector in both pairs; the anal (in forewings) runs parallel to cubital fork for some distance, six or seven cross-veins between them.

Expanse 64 mm.

From Bismarckburg, Togo.

Macronemurus melanthe n. sp.

Face yellowish, interantennal mark and vertex entirely black; antennæ brown, darker at tips; pronotum a little broader than long, dull yellowish brown, with indistinct dark marks, a pair in front, a pair behind, and the outer posterior edges black; thorax mostly black; abdomen blackish; legs pale, femora and tibiæ dotted with red brown, tarsi long and slender, last joint as long as the first three joints, spurs only a little longer than basal joint. Wings hyaline, venation pale, almost unmarked, stigma not distinct. Wings long and slender, acute at tips, 6 crossveins before radial sector in forewings, 11 branches of radial sector in both pairs; in forewings the anal vein runs parallel to the cubital fork farther than in other species (except iolanthe), there being five to seven crossveins between them. Male abdomen is longer than the wings, the appendages rather long, but not one-half as long as the penultimate joint.

Expanse 58 mm.

From Bismarckburg, Togo.

Macronemurus euanthe n. sp.

Head yellow, a black band above and below antennæ, a narrow transverse line across front of vertex, and a curved row of six small dark spots behind, behind this a median spot; antennæ rather long, pale, faintly annulate with brown, pronotum not much broader than long, pale yellowish, two submedian spots on front margin, a median spot behind, and a stripe each side, brown, the latter not reaching front margin; thorax yellow, spotted with dark, anterior lobe with two spots and the anterior margin dark, scutelli with median dark stripe, and dark streak over base of wings; abdomen shorter than wings, dark, pale on base, white-haired; legs pale, some dots on the hind femora, a sub-basal and apical mark above on tibiæ I and II, and tip of tarsus dark, long erect bristles on femora and tibiæ, last joint of tarsus nearly as long as the others together, spurs as long as three joints (leg I) or two joints (leg III). Wings hyaline, nearly all crossveins dark, and margined with pale brown, longitudinal veins pale, the radius and cubitus with dark dots; in hind wings the crossveins not margined, but some dark dots near apical margin. Wings rather slender, forewings acute at tips, hind wings subfalcate; 7 crossveins before radial sector in forewings, 9 branches of radial sector in both pairs. Male abdomen longer than wings very slender, appendages filiform, about as long as the penultimate joint.

Expanse 45 mm.

From Reitfontein, D. S. W. Afrika, (at light).

Macronemurus ianthe n. sp.

Very similar to M. euanthe, the same spotting of pronotum and thorax; the head has the interantennal mark reaching farther up on the vertex so there is no line across the vertex and in place of the row of spots is an anchor shaped mark, and a dot each side adjoining the eye; abdomen yellowish brown, white-haired; legs as in M. euanthe, the spurs hardly longer than two joints; wings as in M. euanthe, but all cross-veins are more heavily bordered with brown, the subcosta, radius, and cubitus are prominently white and black; in hind wings many crossveins, especially in the posterior part of wings, are margined with brown, the subcosta, radius, and cubitus white and brown; stigma yellowish. Wings slender acute at tips, 7 crossveins before radial sector in forewings, 10 branches of radial sector in both pairs.

Expanse 56 mm.

From Langenburg, D. O. Afrika.

Macronemurus loranthe n. sp.

Head yellow, a large black interantennal mark extending below antennæ and much above, and on middle above it is connected to a median dark stripe which extends to the back of head, a brown spot each side on vertex; antennae brown; pronotum much broader than long, yellow, a broad median and a lateral stripe each side dark brown, each continued back on the mesothorax, the lateral ones furcate behind; a median stripe on metanotum, and a furcate mark over base of wings; pleura with a broad interrupted brown streak. Abdomen slender, in male longer than wings, and with appendages nearly as long as last segment, pale brown, a faint pale mark each side near base of segments, sometimes in form of a streak. Legs pale yellow, the tibiæ with basal and apical dark spot above, tip of tarsus dark, and dark dots on femur, last tarsal joint nearly as long as the others together, the spurs nearly as long as three joints. Wings hyaline, venation pale, marked with brown at connection of all veins, thus making many small dots all over the wing, more prominent along cubitus and on outer gradates, stigma pale, no basal spot; hind wing with these small spots along the hind and apical margins; the subcosta and radius interrupted with brown. Wings rather broad at stigma, acute at tips, hind wings sub-falcate at tip; 5 to 7 crossveins before radial sector in forewing, 12 branches to radial sector in both pairs, in forewings a few of the costals before stigma are forked.

Expanse 50 to 57 mm.

From Bismarckburg, Togo, and the Togo Hinterland.

Macronemurus pulchellus n. sp.

Face pale, a black dot between antennæ, a dark band above antennæ, and a spot each side on posterior part of vertex; antennæ pale brownish; pronotum yellowish, unmarked, except a black dot each side on hind margin and a black mark in posterior corners; the outer part of pronotum before the groove is rather darker than the middle; rest of thorax pale yellow, black on sides, and across the anterior lobe, two spots on the metathorax black, scutelli wholly pale; abdomen black, segments broadly pale behind, tip and most of the second segment pale; legs long and slender, hind femora deep-black, tibia lined near the tip below, anterior femora with an outer black line, spurs as long as two tarsal joints, the basal joint very short, the apical nearly as long as all others together. Wings hyaline; forewings heavily maculate with many quite large black marks, and some near the apex of the hindwings; costal area of forewings unmarked, about 24 spots over rest of surface, mostly over a crossvein, and roundish or elongate in shape; the elongate ones mostly near and at right angles to the hind margin; hind-wings with four or five such spots near the apex and toward hind margin; venation mostly pale; stigma not very dark. Wings rather slender, acute at tip; forewing with about five crossveins before radial sector, nine branches to radial sector in each wing; abdomen shorter than wings.

Expanse 65 mm.

From Erythræa (Kristensen coll.); type in coll. Petersen.

Cymothales Gerst.

The radial sector of hind wings arises near base, with but one crossvein before it; the wings are rather broad in the stigmal region, and more or less falcate at tip, the hind pair usually strongly falcate; the cubitus in hind wings is scarcely forked, or the fork so weak as not differing from the other veinlets from cubitus to the margin; the anal also weak. The antennæ are very slender, and rather wide apart at base; the legs are extremely slender, the basal tarsal joint longer than the apical; spurs as long as two joints; the tibiæ longer than the femora; the prothorax is long and slender.

Type—*C. mirabilis* Gerst.

The species can be separated by this table:

1. Middle band of fore-wings plainly divided into two spots................. 2
   Middle band of fore-wings undivided, at least one connection............. 4
2. This band only narrowly divided; the apical mark of fore-wings is very broad, and hardly at all broken up by pale spots.....................**liberiensis**
   This band is broadly divided; the apical mark broken up by pale spots.... 3
3. Femur I black, and black-haired; antennæ mostly pale; a spot on fore-wings before the stigma, and one near middle of hind margin of each wing.... **speciosus**
   Femur I not black-haired; and only with a few pale dots......... **eccentros**

4. Thorax black, with narrow pale lines 5
   Thorax pale, with a median black stripe over meso and metathorax; the spot on hind margin of hind wings is connected along the margin to the apical spot .... **delicatus**
5. Antennæ pale, except basal joint and the tip .... **dulcis**
   Antennæ dark for one-third way out 6
6. Continental specimens .... **mirabilis**
   Madagascar specimens .... **bouvieri**

Cymothales liberiensis Weele.

From Longji and Victoria, Kamerun; I have one from Sierra Leone.

Cymothales mirabilis Gerst.

From Bismarckburg, Togo, and Abyssinia (Petersen coll.) Known from several other localities in Africa.

Cymothales speciosus Gerst.

One from Amani, D. O. Afrika.

Cymothales sp.

A broken specimen from Kongo, appears to be a new species related to *C. delicatus*.

Cymothales delicatus n. sp.

Face pale, a curved brown mark on each side, a band below antennæ, above brown and on the front part of the elevated portion, vertex with six brown spots in a transverse row in front, and three larger spots in a row behind, each of the latter are nearly double; antennæ with dark mark on basal joint, and a dot each side on the second joint, beyond black for about five or six joints, and then white for three joints, then brown to the tip; pronotum pale with a median stripe brown, and a brown curved line each side in front; rest of thorax dark brown, with a white stripe each side; abdomen pale brown; legs pale, femora mostly brown, especially above, tibiæ with brown dots. Wings hyaline, venation mostly pale, but the veins in dark spots are dark; forewings with a basal spot, with an outer extension behind; a median spot from radius to the median vein nearly square, and narrowly connected to a brown V-mark behind it; a long brown stigmal mark, extending obliquely inward, not so well defined, to near the median vein; slightly behind it begins an oblique, brown streak which extends to the hind margin and in front points toward the tip of the wing; around the tip are several dark spots, but not very distinct, the whole apical area is slightly fumose; the costal area has several of the crossveins marked with brown. Hind wings with a basal brown spot over origin of the radial sector, one on a crossvein from radius to radial sector, about seven crossveins beyond the basal one, another toward the stigma, and one under stigma, the apical part above radius mostly dark, but a narrow apical pale streak, hind margin toward tip has two well separated brown spots, the outer one is connected by brown along the hind margin to the brown at tip, the short veinlets along the hind margin are mostly dark. Wings broad; the forewings hardly falcate at tip; the hind pair but little longer than front wings, falcate at tip, but not as strongly so as in C. mirabilis; about four crossveins before the radial sector in the forewings, about eight branches to radial sector in each wing, the sixth branch is soon forked, otherwise venation much as in other species.

Expanse 68 mm.

From Kongo, West Africa, in coll. Banks.

Echthromyrmex McLach.
(Palparidius Peringuey.)

Antennæ hardly diameter of basal joint apart, not very long; legs rather short, basal joint short, apical as long as others together, the spurs nearly as long as two joints, tibiæ shorter than femora; pronotum very short; male appendages extremely long. Wings rather broad; costals simple, one crossvein before radial sector in the hind wing, in forewings the first branch of radial sector arises barely before the cubital fork. In hind wing the cubital bends upward and then downward to the anastomosis with the median, the anal parallels it so that the cubital fork is indistinct.

Type—*E. platypterus* McLach.

I have not seen the type species, and the above description is taken from the species described below which I believe is congeneric; at least it agrees with McLachlan's description, and is remarkable in having, as he said, the "postcosta simple" (= cubitus); in this feature it is related to the South American genus *Dimares*, and the markings of the wings are also similar to that genus. The genus, *Palparidius*, recently described by Peringuey is the same, without doubt; it has no very close relation to *Palpares*.

Echthromyrmex fascipennis n. sp.

Face yellowish; a transverse brown mark on face, a large brown interantennal mark slightly pointed below on the middle, and extending up in front of the vertex, which is bilobed; four pale brown marks on vertex in a curved row; antennæ dark brown; pronotum very short, nearly twice as broad behind as long, much narrowed in front, pale, with a median black stripe, and an oblique lateral one each side, many minute black points at base of bristles; rest of thorax black, a broad pale stripe over middle behind the anterior lobe, and including a median dark stripe; thorax at base of wings pale; abdomen dark, a pale median and a lower lateral stripe, all very narrow toward tip; appendages yellowish, blackish near base below; legs yellowish, rather short and heavy, not very hairy, basal tarsal joint barely longer than the second, apical as long as others together, spurs straight, nearly as long as two joints.

Wings hyaline, with large black marks; forewings with dots along the upper edge of the subcosta along both sides of the cubitus, to the fork, and along the lower branch of the fork; many dots near the posterior and outer margin; two oblique narrow black bands, both begin at the radius, one before the middle and one beyond the middle, this latter is broken near tip, and reaches in a line to the hind margin; an oblique apical streak black, and including several white crossveins, a dark mark before and one beyond the white stigma. Hind wings with some dots along the subcosta, a rather broad oblique dark band before the middle, beginning at the radius and with a curved tip, not reaching across wing; a large dark spot before the stigma, and behind it on the hind margin are two narrow upward streaks, the inner one forked, a short apical dark streak, and some dark dots along the outer margin; venation of both pairs mostly pale, except dark spots on the radial sector and cubitus. Wings rather broad, not very long, not acute at tips; three or four cross-veins before radial sector in forewing, about nine branches to radial sector in each wing, the anal region of both pairs is very broad, in the hind wing the post-anal extends out quite a long distance, and has five branches to the margin. Abdomen shorter than the wings (in the male), the male appendages are extremely long, fully one-half as long as the abdomen, curved downward, and parallel.

Expanse 76 mm.

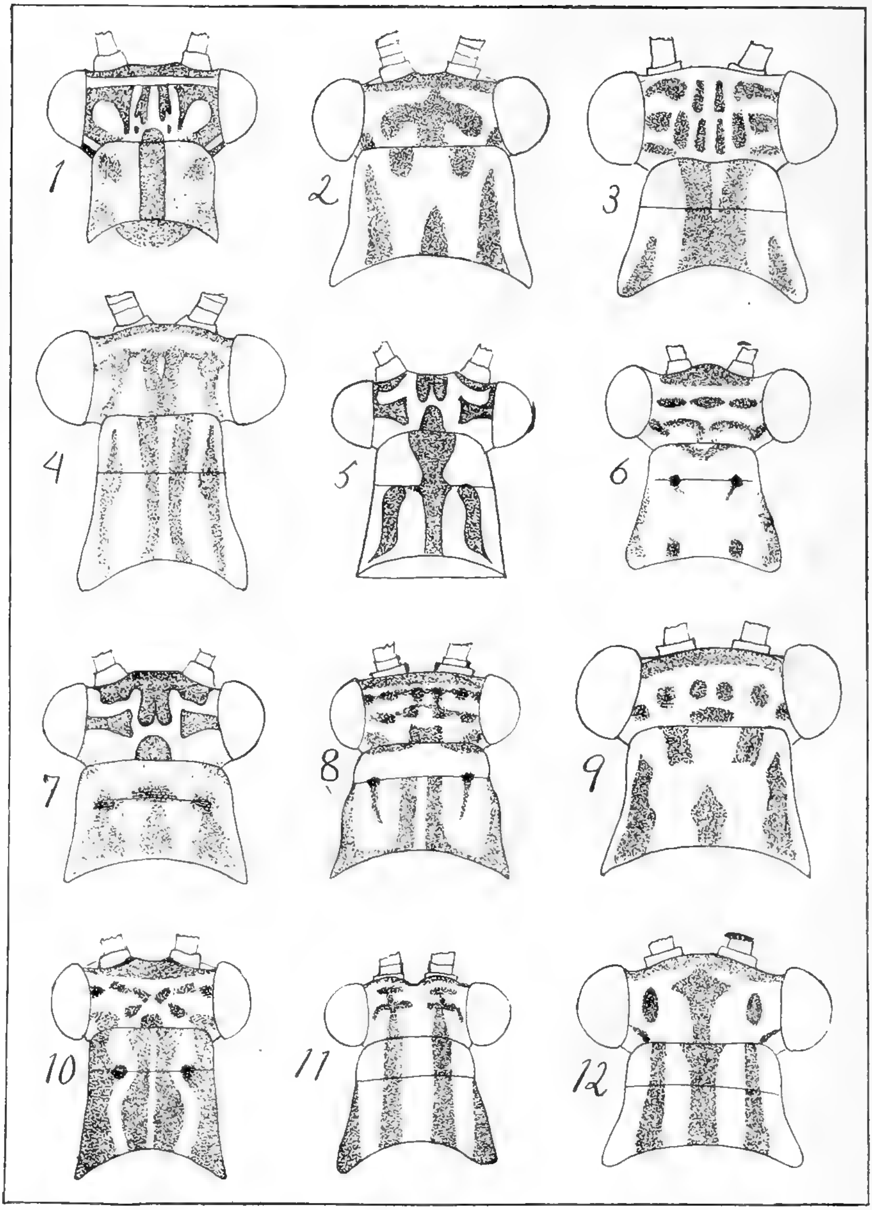
From Okahanda, Deutsch Sud-West Afrika, (Berlin Museum).

Peringuey has recently described* two species which are closely related to *E. fascipennis*. He made for them a new genus, *Palparidius*, but his figure shows it is the same as *Echthromyrmex*. His *P. capicola* has the stigmal mark of the hind wings entire, not broken up into three spots as in *E. fascipennis;* his *P. concinnus* has this stigmal mark broken up, but the median band is very narrow, and not hooked at end; there are several other differences in maculation. The male appendages of *E. fascipennis* appear to be much longer than in either of Peringuey's species.

EXPLANATION OF PLATES I AND II.

Fig. 1. Myrmeleon alcestris.
Fig. 2. Macronemurus ianthe.
Fig. 3. Myrmeleon furcatus.
Fig. 4. Gymnoleon exilis.
Fig. 5. Myrmeleon doralice.
Fig. 6. Nemoleon alcidice.
Fig. 7. Myrmeleon obscurus.
Fig. 8. Formicaleon harpalyce.
Fig. 9. Macronemurus euanthe.
Fig. 10. Macronemurus chloranthe.
Fig. 11. Formicaleon ideonus.
Fig. 12. Macronemurus loranthe.
Fig. 13. Nemoleon pardalice.
Fig. 14. Formicaleon ilione.
Fig. 15. Myrmeleon medialis.
Fig. 16. Nesoleon boschimanus.
Fig. 17. Nesoleon punctatissimus.
Fig. 18. Creagris pretiosa.
Fig. 19. Macronemurus melanthe.
Fig. 20. Nemoleon quadrimaculatus.
Fig. 21. Echthromyrmex fascipennis.
Fig. 22. Echthromyrmex fascipennis.
Fig. 23. Macronemurus loranthe.

* Annals South African Museum, V, p. 43, 1910.



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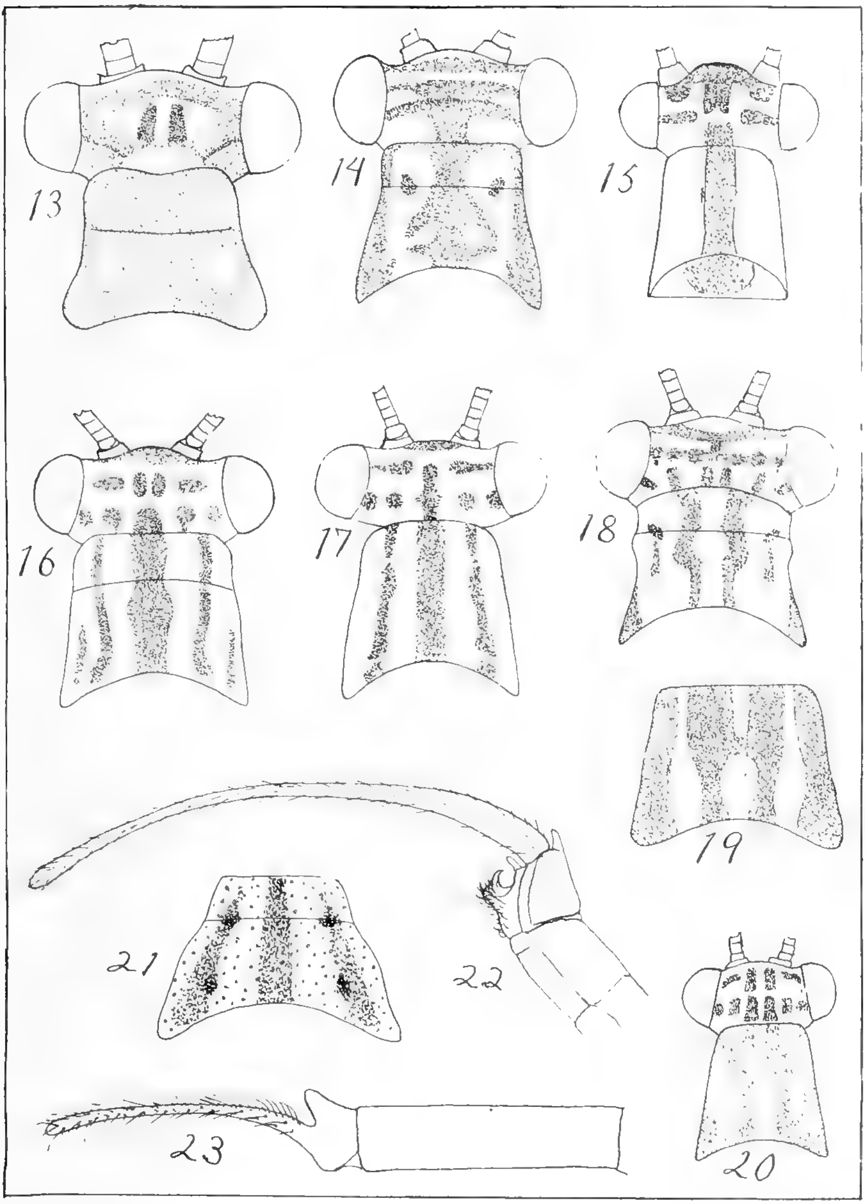


Nathan Banks.

THE LITHOBIOMORPHA OF THE SOUTHEASTERN STATES.

By Ralph V. Chamberlin,
Provo, Utah.

In this paper is summarized our present knowledge of the genera and species of the Lithobiomorpha occurring in the extensive region lying south from Kentucky and the Virginias and east of the Mississippi river. The great majority of the records given are based upon collections made by the author himself in the summer of 1910, during which season all of the states in the territory indicated, excepting Florida, were visited. The southern portion of Georgia and the coastal region of this state and of the Carolinas were not covered. Some species additional to those here listed are likely to be found in these sections. The season was favorable for members of this group; and it is felt that the great majority of the more widespread forms were secured. In this connection it may be noted that in the case of most of the species specimens were taken in a considerable number of localities and that all the species previously recorded were again found excepting two from southern Georgia and Florida, where, as before mentioned, collections were not made.

Of especial interest are the genera Buethobius and Watobius, here erected for the first time, and Zygethobius, previously established by the author for a species occurring in the high mountain ranges of the western Unites States. The finding of a second species of Zygethobius in the mountainous section of this southeastern region fulfills what had been anticipated as likely. The three genera named are annectant and must alter to a considerable degree some prevalent conceptions as to affinities within the suborder. The genera recognized in the present paper may be separated as follows:

KEY TO GENERA.

a. Legs bearing bristles only, no articular spines present excepting sometimes one at distal end of tibia of all but last pairs of legs but this usually replaced by an acutely pointed process.

b. First leg-bearing segment with a pair of spiracles.

c. A single pair of ocelli; tarsi of first thirteen pairs of legs undivided, those of the last two pairs biarticulate.... **Lamyctes** Meinert.

bb. First leg-bearing segment without spiracles.

c. Tarsi of first thirteen pairs of legs undivided, those of the last two pairs biarticulate; ocelli none. ....
Buethobius gen. nov.

cc. Tarsi of all legs biarticulate; ocelli present.
d. A single pair of ocelli present; an acutely pointed process at distal end of tibia; reproduction seemingly parthenogenetic, no males occurring.... **Zygethobius** Chamberlin.
dd. A number of pairs of ocelli present, forming a patch on each side of the head; a spine at distal end of tibia; males occurring .... **Watobius** gen.nov.
aa. Legs provided with articular spines as well as with bristles; no acute process at distal end of tibia on cephalic side.
b. Coxal pores in a single series .... **Lithobius** Leach.
bb. Coxal pores scattered or in several series........ **Bothropolys** Wood.

Genus **Lamyctes** Meinert.

1. **Lamyctes tivius** sp. nov.

Slender, widest at tenth dorsal plate, very gradually attenuated cephalad, more abruptly caudad.

Dorsum yellow to light brown, the head, prehensorial feet and ultimate segments darker; antennae and legs yellow.

Antennae of moderate length, composed of twenty-eight to thirty-one articles; first two articles long, the third and fourth very short, the fifth and sixth longer, the seventh and eighth again very short, the ninth longer, the tenth and eleventh in turn shorter, the twelfth and subsequent articles comparable to the ninth, or the thirteenth and fourteenth in some reduced; this alternation of pairs of shorter articles with longer ones in proximal portion of antennae apparently constant in this species.

A single pair of large ocelli.

Prosternal teeth 2+2, small, or 3+3, the outer one on each side smallest.

Angles of none of the dorsal plates produced.

Coxal pores small, round, 2, 3, 3, 3.

Anal legs long and slender, the joints of tarsus especially so; prefemur long, clearly more slender proximally than that of the penult pair, clavately enlarged distad; tibia of nearly uniform diameter throughout length, the first tarsal joint of similar shape and length but more slender. (See Pl. 3, fig. 2 cf. also figs. 1 and 3).

Claw of gonopods entire. Basal spines 2+2, rather stout, the inner considerably smaller.

Length 6–7.5 mm.

Localities.—Byram and Holly Springs, Miss.; New Orleans, La.; Jackson, Ala.; Atlanta, Ga.; Hot Springs, N. C.

2. **Lamyctes tivius** var. **pius,** var. nov.

Agreeing in general with the species as above described but conspicuously longer and more robust, the length of specimens examined lying between 9 and 9.5 mm. Color uniformly darker.

Locality.—Hot Springs, N. C.

Genus **Buethobius** gen. nov.

First leg-bearing segment without spiracles.

Ocelli none.

Tarsi of the first thirteen pairs of legs undivided, those of the fourteenth and fifteenth pairs biarticulate.

Legs without true spines. Tibiae of the first thirteen pairs of legs with an acutely pointed process at distal end on cephalic side like that of Lamyctes and Zygethobius. (See Pl. 4, fig. 1).

Apparently only females found and the reproduction parthenogenetic.

Type.—Buethobius oabitus sp. nov.

3. **Buethobius oabitus** sp. nov.

General color yellow or light yellowish brown; the head and prehensorial feet and in some the ultimate segments clear orange; antennae and legs clear yellow.

Rather slender, for most of length parallel sided. Narrowed over a few segments behind head and more abruptly at caudal end.

Antennae long, reaching the ninth body segment; composed of thirty-six articles of which those beyond the second are rather short, uniform.

Prosternal margin wide; teeth 3+3, very small.

Ocelli none.

Angles of none of the dorsal plates produced.

Coxal pores round, moderate in size; 3, 3, 3, 3—4, 4, 4, 4.

Legs of the first thirteen pairs each ending in three claws; those of the fourteenth and fifteenth pairs with the claws single. Anal legs long and slender.

Claws of gonopods undivided; basal spines 2+2.

Length 10–12 mm.; width at the tenth plate 1.3–1.4 mm.

Locality.—Byram and Canton, Miss.

Genus **Zygethobius** Chamberlin.

Sub-genus **Zantethobius** subgen. nov.

Angles of the sixth, seventh, ninth, eleventh and thirteenth dorsal plates produced.

Type.—Zygethobius pontis, sp. nov.

The previously described species, Z. dolichopus Chamb., the type of the genus, may be placed in a subgenus Zygethobius sens. str.

4. **Zygethobius pontis** sp. nov.

Moderately robust; strongly narrowed caudad and cephalad of the tenth dorsal plate, the first leg-bearing segment especially narrow.

Dorsum in color somewhat chestnut, with a narrow median longitudinal stripe blackish, the first segment darker than the others; head deep to blackish brown; prehensorial feet and antennae reddish, the latter becoming paler, yellowish, distad; venter yellowish to light brown, the caudal plates reddish; legs brown, paler proximally than distally; last pairs of legs darker, blackish proximally, pale distad.

Antennae very long; composed of forty-three articles which are short.

The ocelli of the single pair very large.

Prosternal teeth 3+3.

Angles of the sixth, seventh, ninth, eleventh and thirteenth dorsal plates produced.

Coxal pores 3, 4, 4, 4.

The process at distal end of anterior pairs of legs apically acutely spinescent. (See Pl. 4, fig. 2).

Anal legs long and slender.

Claw of gonopods entire; basal spines 2+2.

Length ad 10.5 mm.; width of tenth plate 1.6 mm.

Localities.—Johnson City, Tenn.; Natural Bridge, Va.

Genus **Watobius** gen. nov.

First leg-bearing segment without spiracles.

A number of pairs of ocelli present, these forming a patch on each side of the head as in Lithobius, a caudal one in the place of the so-called single ocellus in the latter genus and the others toward the base of the antenna.

Tarsi of all legs biarticulate.

Legs without true spines excepting one at distal end of tibia of anterior legs in place occupied by the process in the preceding genera.

Fifth joint in penult legs of male greatly enlarged, the anal (in type) not modified.

Both sexes occurring.

Type.—Watobius anderisus sp. nov.

5. **Watobius anderisus** sp. nov.

Slender, attenuated from the tenth dorsal plate cephalad; more abruptly caudad.

Brown, the ultimate segments often darker; head and prehensorial feet conspicuously darker, deep brown or brownish black; antennae brown, pale distad; legs light brown, the posterior pairs having a purplish tinge, the anal and penult pairs abruptly pale distad of the femur, the tibiae in the penult legs especially pale.

Angles of the ninth, eleventh and thirteenth dorsal plates produced.

Antennae short; in most composed of twenty-two articles, in some of but twenty; articles decreasing in length gradually and uniformly from the first to the penult.

Ocelli on each side composed of one large posterior one, in place of the single one in Zygethobius, etc., and of eight smaller ones in a patch arranged in three series; thus, 1+3, 3, 2.

Prosternal teeth 2+2.

Angles of the ninth, eleventh and thirteenth dorsal plates produced.

Coxal pores small, 2, 2, 2, 2.

All legs with three claws excepting those of the ultimate pair which seem to have the exterior accessory claw but to lack the inner one.

Anal legs of male moderately and uniformly crassate; the penult legs with the fifth joint strongly enlarged and somewhat flattened dorso-ventrally, complanate above or weakly depressed, complanate and weakly furrowed beneath. (See Pl. 3, figs. 4 and 5).

Claw of female gonopods tripartite; basal spines 2+2.

Length 7.5–9.5 mm.

Localities.—Thomasville and Anniston, Ala.; Tallulah Falls and Bremen, Ga.

Genus **Lithobius** Leach.

Several of the species listed under this genus below conform to Monotarsobius as defined by Verhoeff in having the anterior tarsi (those of the first thirteen pairs of legs) undivided whereas those of species belonging to Lithobius proper have the tarsi all biarticulate. However, this character seems variable to such an extent that it is difficult to place some species upon this basis; hence, it seems best not to maintain it until some correlated characters, if such exist, shall be worked out. Those species which have the anterior tarsi clearly undivided are specially indicated below.

6. **Lithobius coecus** Bollman.

1888. Lithobius coecus, Bollman, Ann. N. Y. Acad. Sci., p. 111.

Locality.—Saluda, N. C. The only other known locality for this species is that at which the types were collected, Beaver Creek, Tenn.

7. **Lithobius tuobukus** sp. nov.

Light brown to yellow, the posterior segments often darker; head concolorous with body or often a darker, reddish brown; antennae light brown proximally, paler distad; legs light brown, the posterior pairs yellow, especially bright distad.

Antennae short or moderate; articles 25-29, all except the first few moderate or short in length.

Prosternal teeth mostly 5+5 or 6+6, small, even.

Ocelli compactly arranged in an oblong patch in three series; thus 1+4, 5, 4, a total of 14.

None of the dorsal plates with the posterior angles produced.

Coxal pores rather small, round, 3, 4, 4, 3.

Last two pairs of coxae armed laterally, the last four pairs dorsally.

Spines of the first legs 2, 2, 1; of penult 1, 3, 3, 2, the claw single; of the anal 1, 3, 3, 2, the claw also single.

In the male the anal legs are moderately crassate, especially the third and fourth joints; the fourth joint is flattened or somewhat excavated dorso-mesally and is often produced at distal end into a lobe extending mesad and bearing at its apex a spine directed caudad, but in many this lobe is absent. (See Pl. 3, fig. 7).

Claw of the gonopods in female entire; spines 2+2.

Length 9.5–12 mm.

Localities.—Brown's Summit, N. C.; Natural Bridge, Chatham, and Lynchburg, Va.; White Suplhur, W. Va.; Hot Springs, Linville Falls, Asheville, N. C.; Greenville, S. C.; Russellville, Johnson City and Unaka Springs, Tenn.; Lexington, Ky.

Very close to species 12 but the penult legs with only one claw instead of with three. Mr. Bollman mentions no modification in the anal legs of the male of L. proridens nor does the specimen listed below under this species present such. The only course open at present, therefore, seems to be to separate the present species from proridens and possibly to assume, judging from localities given for proridens, that Bollman has included the two species under one name.

8. **Lithobius watovius** sp. nov.

General color yellow; head, prehensorial feet and posterior segments darker, orange; antennae and legs yellow.

Antennae short, composed of twenty articles which, excepting the first two and the ultimate, are moderately short.

Prosternal teeth 2+2 or 3+3, the outer tooth on each side weak or obsolete.

Ocelli about four, arranged in one or two series; thus 1+2, 1.

Angles of none of the dorsal plates produced.

Tarsi of the first thirteen pairs of legs undivided, those of the last two pairs biarticulate as usual (Monotarsobius).

Coxal pores 1 (2), 2, 2, 2.

Ultimate pair of coxae laterally armed, the last three pairs dorsally armed.

Spines of the first legs 0, 2, 1–1, 2, 1, (2); of penult 1, 3, 3, 0, without supplementary claw; of anal 1, 3, 1, 0, also without supplementary claw.

Anal and penult legs in the male uniformly crassate.

Length 6.7 mm. (larger specimen).

Locality.—Byram, Miss. Two males were taken.

9. **Lithobius paitius** sp. nov.

Dorsum pale brown; head and posterior segments darker, dark orange; legs greyish, except the caudal pairs which are bright yellow, with the brush of hairs on anal legs of male red proximally and yellow distad; antennae grey to dull yellow; venter pale grey to greyish yellow.

Antennae short, consisting mostly of twenty-four articles which are short excepting the first two and the ultimate.

Ocelli small, in a small patch; in number about seven, arranged thus, 1+3, 3.

Prosternal teeth 2+2.

Angles of none of the dorsal plates produced.

Coxal pores 2, 4, 4, 3, small.

Last pair of coxae laterally armed, last two pairs dorsally armed.

Tarsi of the first thirteen pairs of legs undivided (Monotatsobius).

Spines of the first legs 0, 1, 1; of the penult 1, 3, 2, 1, without supplementary claw; of anal 1, 3, 2, 0, also without supplementary claw.

In the anal legs of the male the fourth joint is strongly swollen and provided at proximal end with a lobe on dorso-mesal surface from the posterior surface of which springs a dense brush of very long hairs which projects beyond the caudal end of the joint. (See Pl. 3, fig. 6).

In the female the claw of the gonopods is bluntly tripartite, the lateral lobes being not much lower than the middle one; basal spines as usual, 2+2.

Length 6.5–7 mm.

Locality.—Catawba, N. C.; Unaka Springs, Tenn.

10. **Lithobius watsuitus** sp. nov.

Dorsum light brown; head much darker, reddish brown or chestnut; prosternum colored like head, but its feet pale distad; antennae dark brown, paler distad; venter with the anterior plates commonly with purplish tinge; most legs light yellowish brown, but the caudal pairs darker, brown, excepting tarsi which are light.

Antennae short; composed of thirty to thirty-two articles which, beyond the third are short and compactly united.

Ocelli about eight, arranged in two series; thus 1+4, 3.

Prosternal teeth, 2+2.

Angles of none of the dorsal plates produced.

Coxal pores small and round, 2, 3, 3, 3–3, 3, 3, 3.

Ultimate coxae laterally as well as dorsally armed.

Spines of the first legs 1, 2, 1; of penult 1, 3, 3, 1, one supplementary claw present; of anal 1, 3, 2, 0, the claw single.

Anal and penult legs in the male crassate, especially so the fourth joint which is somewhat flattened dorso-ventrally and is longitudinally weakly furrowed.

Length 7.5–9 mm.

Localities.—Atlanta, Ga.; Natural Bridge, Va. The specimen from Virginia differs in having the spines of the anal legs 1, 3, 2, 1, instead of 1, 3, 2, 0.

11. **Lithobius bilabiatus** Wood.

1867. Lithobius bilabiatus, Wood, Proc. Phil. Acad. Sci., p. 130.
1887. Lithobius tuber, Bollman, Proc. U. S. N. M., p. 256.

Localities.—Canton and Byram, Miss. This species is found in the states along the Mississippi river from the Gulf to Wisconsin and Minnesota. It seems to be most abundant in Illinois and Iowa.

12. **Lithobius proridens** Bollman.

1887. Lithobius proridens, Bollman, American Naturalist, p. 81.
1887. Lithobius proridens, Bollman, Proc. U. S. N. M., p. 258.

Locality.—Watervalley, Miss. One male agreeing fully with the original description. Previously reported from Indiana (type locality), Washington, D. C.; Arkansas, and Tennessee (Knoxville, Mossy Creek).

13. **Lithobius branneri** Bollman.

1888. Lithobius branneri, Bollman, Ann. N. Y. Acad. Sci., p. 107.
1888. Lithobius branneri, Bollman, Proc. U. S. N. M., p. 111, 112, 342.

Localities.—Brookhaven, Miss. (var. a); Maplesville, Ala.; Atlanta, Ga. (var. b); Catawba and Brown's Summit, N. C.; Asheville, N. C. (var. c); Russellville and Unaka Springs, Tenn. (author). Also Knoxville, Beaver Creek, and Mossy Creek, Tenn. (J. C. and C. B. Branner, seq. Bollman).

Several closely related varieties are represented in the material here referred to this species. The incompleteness of the original description must make it doubtful which variety is typical until the types are re-studied. The species has the anterior tarsi undivided (Monotarsobius).

14. **Lithobius lundii** Meinert.

1886. Lithobius lundii, Meinert, Myr. Mus. Haun., III p. 111.
1887. Lithobius lundii, Bollman, Proc. U. S. N. M., p. 111.

Localities.—Lula and Tallulah Falls, Ga.; Taylor's, S. C.; Asheville and Hot Springs, N. C.; Johnson City and Unaka Springs (and also Beaver and Mossy Creeks, seq. Bollman), Tenn.; Natural Bridge, Va.

This species, originally described from New York State, ranges into the southern states along the uplands.

15. **Lithobius exiguus** Meinert, var.

1886. Lithobius exiguus, Meinert, Myr. Mus. Haun, III, p. 110 (11).
1911. Lithobius exiguus, Chamberlin, Canad. Ent.

Localities.—Longbeach, Brookhaven, Canton, Jackson, and Holly Springs, Miss.; Selma (var. b), Thomasville, Morgan, and Birmingham, Ala.; Jackson, Tenn.; Lexington, Ky.; Lynchburg, Va.

A widespread species occurring commonly under leaves and sticks and among stones along streams in Wisconsin, Illinois, Iowa, and neighboring states as well as throughout the region covered in the present paper.

16. **Lithobius elattus** Bollman.

1888. Lithobius elattus, Bollman, Proc. U. S. N. M., XI, p. 348.

Localities.—Johnson City and Russellville, Tenn.; Chatham, Lynchburg, Natural Bridge, and Balcony Falls, Va. (also Marksville, Va., and Washington, D. C., seq. Bollman); White Sulphur, W. Va.

The specimens listed here differ somewhat from those described by Bollman in one or two particulars but probably represent the same species.

17. **Lithobius aureus** McNeil.

1887. Lithobius aureus, McNeil, Proc. U. S. N. M., p. 327.

Locality.—Pensacola, Fla. (seq. McNeil). The two specimens upon which this species was based lack the anal legs. As a result it is difficult to identify the species from the published description.

18. **Lithobius pinguis** Bollman.

1888. Lithobius pinguis, Bollman, Entom. Americana, IV, p. 7.

Localities.—Hudsonville, Miss.; (Little Rock, Ark., the type locality, seq. Bollman).

Because of the incompleteness of the original description and the fewness of the specimens upon which based the reference of the specimens in hand to this species is provisional. It is possible that the following species may have to be merged with the present one; but in view of the important differences between the specimens of L. euthus and Mr. Bollman's description, this union at present seems impossible.

19. **Lithobius euthus** Chamberlin.

1904. Lithobius euthus, Chamberlin, Proc. Acad. Sci. Phil., p. 652.

Localities.—Byram, Canton, and Gulfport, Miss.

20. **Lithobius cantabrigensis** Meinert.

1885. Lithobius cantabrigensis, Meinert, Proc. Amer. Phil. Soc., XXI, p. 177.
1888. Lithobius cantabrigensis, Bollman, Proc., U. S. N. M., XI, p. 342.

Localities.—Greenville, S. C.; Saluda, N. C.; Balcony Falls, Va.; Russellville, Tenn.; (also Beaver and Mossy Creeks, Tenn., seq. Bollman).

Described originally from Mass., the only other recorded locality.

The species seems to have a strong tendency toward the formation of local varieties.

21. **Lithobius cantabrigensis** var. **suitus,** var. nov.

Dorsum brown; the head and posterior segments darker, reddish; antennae pale distally; legs pale brown, the posterior pairs darker but with their distal joints distinctly lighter.

Antennae moderate, composed of from twenty-nine to thirty-two articles.

Ocelli about eight or nine arranged in two or three series; thus, 1+4, 4, or 1+3, 3, 1.

Prosternal teeth 2+2.

Angles of the eleventh and thirteenth dorsal plates produced or these in some nearly straight.

Coxal pores round, 3, 4, 4, 3.

Posterior coxae unarmed.

Spines of the first legs 0, 0, 1–0, 1, 1; of the penult 1, 3, 2, 1–1, 3, 3, 1, with two claws; of the anal, 1, 3, 2, 0, with two claws.

Gonopods in the female with the claw tripartite or almost bipartite in some through reduction of one lateral lobe.

Length 7–9 mm.

Localities.—Hot Springs, N. C.; Birmingham, Ala.

The anterior tarsi in part seem consolidated or undivided, but the form scarcely would conform to Monotarsobius.

22. **Lithobius cantabrigensis** var. **zinus** var. nov.

Color brown; head and posterior segments darker, not reddish; antennae dark, paler distally.

Antennae composed mostly of from twenty-eight to thirty-one articles, more rarely thirty five or even thirty-seven.

Ocelli eleven to sixteen, arranged in three or four series; thus, 1+4, 4, 4, 3-1+3, 4, 3.

Ultimate coxae laterally armed.

Spines of the first legs 1, 1, 1–1, 2, 1; of penult legs, 1, 3, 3, 1–1, 3, 3, 2, with two claws; of the anal legs 1, 3, 2, 0–1, 3, 2, 1, likewise with two claws.

In the male the anal and penult legs moderately crassate, the fourth joint in the anal ones larger and somewhat complanate dorsally.

Length 8-10 mm.

Localities.—Talapoosa and Bremen, Ga.; Anniston, Ala. (variant); Brown's Summit, N. C.; Chatham, Natural Bridge, and Lynchburg, Va.

24. **Lithobius atkinsoni** Bollman.

1887. Lithobius atkinsoni, Bollman, Proc. U. S. N. M., X, p. 625.
1888. Lithobius atkinsoni, Bollman, Proc. U. S. N. M., XI, p. 349.

Bremen, Atlanta, Lula, and Tallulah Falls, (also Macon, seq. Bollman), Ga.; Taylor's, Greenville and Seneca, S. C.; Saluda and Hot Springs (also Balsam seq. Bollman), N. C.

The localities here indicated are all those thus far recorded for this species.

24. **Lithobius naiwatus** sp. nov.

Brown; the head and posterior segments darker; antennae pale distad; legs yellowish to whitish brown; the anal and sometimes also the penult legs dark purplish brown or purplish black, with the distal joints pale.

Antennae of moderate length or short; composed of thirty-two to thirty-five articles of which most of the first ten are of medium length and those more distad short.

Ocelli about thirteen, compactly arranged in three straight series; thus, 1+5, 4, 3.

Prosternal teeth 2+2.

Posterior angles of the ninth, eleventh and thirteenth dorsal plates produced.

Coxal pores small, round, 4, 5, 5, 4.

Last two pairs of coxae armed laterally, last three pairs armed dorsally.

Spines of first legs, 1, 2, 1–2, 2, 1; of the penult legs 1, 3, 2, 1–1, 3, 2, 0, with two claws; of the anal legs 1, 3, 3, 2, with a single claw.

Anal and penult legs in male moderately crassate, without special lobes or processes.

Claw of the gonopods in the female tripartite; basal spines 2+2, conical, the inner smaller.

Length 11–13 mm.

Localities.—Saluda, Catawba, and Linnville Falls, N. C.; Landrum, S. C.; Tallulah Falls, Ga.; Unaka Springs, Tenn.; Lexington, Ky. (var.)

25. **Lithobius forficatus** (Linneus).

1758. Scolopendra forficata, Linneaus, Syst. Nat., I, p. 638.
1815. Lithobius forficatus, Leach, Tr. Linn. Soc., XI.
1821. nec Lithobius spinipes Say, Journ. Acad. Sci. Phil., II, p. 108.
1845. Lithobius americanus, Newport, Tr. Linn. Soc., XIX, p. 365.

Localities.—Greenville, S. C.; Asheville and Hot Springs, N. C.; Lynchburg and Balcony Falls, Va.; White Sulphur, W. Va.; Fulton and Lexington, Ky.

The range of this species, so abundant in the north, is carried southward into our present territory by the mountain ranges. It has not previously been reported from the Carolinas or other points so far south in this district.

26. **Lithobius celer** Bollman.

1888. Lithobius celer, Bollman, Entom. Amer., IV, p. 7.
1909. nec. Lithobius celer, Chamberlin, Ann. Ent. Soc. America, p. 190.

Locality.—Fulton, Ky.

27. **Lithobius oedipes** Bollman.

1888. Lithobius oedipes, Bollman, Entom. Amer., IV, p. 8.

Locality.—Mississippi.

28. **Lithobius manegitus** sp. nov.

Dorsum dark brown; head darker, nearly mahogany, the antennae similar proximally but becoming paler or rufous distad legs brown above, mostly paler ventrally, and the posterior pairs mostly pale distad.

Antennae moderate; composed of twenty articles which decrease in length from the second distad to the penultimate.

Ocelli in a patch situated apparently closer than usual to the base of antenna; in number about nine, arranged in three series; thus 1+3, 3, 2.

Prosternal teeth 2+2; a characteristic stout spine uniformly present on each side ectad of the outer tooth.

Angles of the ninth, eleventh and thirteenth dorsal plates produced.

Coxal pores round, in number 5, 5, 5, 4.

Last two pairs of coxae armed laterally; only the ultimate coxae armed dorsally.

Spines of the first legs 1, 2, 1–2, 2, 1; of the penult 1, 3, 3, 2, with two claws; of the anal 1, 3, 3, 1, provided also with two claws.

In the male the anal legs are crassate and the tibia or fifth joint is conspicuously furrowed lengthwise dorsally toward the exterior side, the furrow being fringed on each side by a dense growth of hair, the hair longest at posterior end (See Pl. 4, fig. 7). The penult legs more crassate than the anal, the fourth and fifth joints most enlarged; the fifth joint or tibia furrowed from end to end along the meso-ventral surface and excavated on this surface at the distal end where there is a process bearing a conspicuous brush of hairs which projects mesad (See Pl. 4, figs. 4, 5 and 6.)

The gonopods of female with the claw entire; basal spines 2+2, conical, the inner the smaller.

Length 15–17 mm.

Localities.—Hot Springs, Catawba, Saluda and Linville Falls, N. C.; Johnson City, Unaka Springs and Altapass, Tenn.

Very close to L. oedipes Boll., but differing markedly in characters of the anal and penult legs of the male.

29. **Lithobius tabius** sp. nov.

Brown; head and commonly also the first dorsal plate darker, chestnut; antennae dark, pale distad; legs a much paler brown, the posterior pairs darker with the distal joints pale.

Antennae short; composed of about thirty-three articles.

Ocelli sixteen, arranged in four series; thus, 1+4, 4, 4, 3.

Prosternal teeth 2+2.

Angles of the ninth, eleventh and thirteenth dorsal plates produced, those of the sixth and seventh excised or obliquely truncate.

Coxal pores round, 4, 4, 4, 3.

Last two pairs of coxae laterally armed, last four pairs armed dorsally.

Spines of first legs 1, 2, 1; of the penult 1, 3, 2, 1, with two claws; of the anal 1, 3, 3, 2, with two claws.

Claws of the gonopods in female tripartite.

Length 10.5 mm.; width at tenth dorsal plate 1.5 mm.

Locality.—Johnson City, Tenn.

In many points very similar to arienus, carolinae, etc., but the angles of the sixth and seventh dorsal plates not at all produced.

30. **Lithobius simitus** sp. nov.

Brown; the head and posterior plates reddish, the former paler cephalad of the frontal suture; antennae dark brown, pale distally; legs whitish brown, the tarsi clear yellow, the posterior pairs darker, the anal pair yellow distad of the femur; venter light brown, darker caudad, the anterior plates with purplish tinge.

Antennae short, composed of twenty-seven to thirty-two short articles.

Ocelli arranged in two series, about eight in number; thus, 1+4, 3.

Prosternal teeth 2+2.

Angles of the ninth, eleventh and thirteenth dorsal plates produced.

Coxal pores small, 2, 3, 3, 3.

Last two pairs of coxae armed laterally, last three pairs armed dorsally.

Tarsi of the first thirteen pairs of legs imperfectly divided in part but suture mostly plainly evident.

Spines of the first legs 0, 0, 0–0, 0, 1; of the penult 1, 3, 2, 0, with two claws; of the anal 1, 3, 2, 0, a supplementary claw likewise present.

Claw of the female gonopods bipartite; basal spines 2+2, conical.

Length 7–7.5 mm.

Locality.—Grenada, Miss. Two female specimens.

31. **Lithobius transmarinus** Koch.

1862. Lithobius transmarinus, Koch, Die Myriopodeongattung Lithobius, p. 31.
. Lithobius mordax, Koch, ibid. p. 34.
1872. Lithobius mordax, Meinert, Myr. Mus. Haun., II p. 294.
1875. Lithobius transmarinus, Stuxberg, Ofvers. af K. Vet. Akad. Forh. no. 3, pp. 26 and 32.
——. Lithobius mordax, Stuxberg, ibid., pp. 27 and 32.
1887. Lithobius mordax, Bollman, Proc. U. S. N. M., p. 263, etc.
. Lithobius transmarinus. Bollman, ibid., p. 626, etc.
1893. Lithobius spinipes, Bollman, (of Say??), Bull. U. S. N. M., 46, p. 146.
1896. Lithobius mordax var. Louisianae, Brölemann, Ann. Soc. Ent. de France, p. 48.
——. Lithobius transmarinus var. pennatus, Brölemann, ibid., p. 48.

Localities.—Brookhaven, Fernwood, Holly Springs, Byram, Canton, Biloxi, Ocean Springs, and Longbeach, Miss.; New Orleans, La.; Jackson, Mobile, and Salem, Ala.

Apparently Koch based his description of transmarinus upon a female while his description of mordax is clearly that of the male. The differences pointed out between the anal legs of these two forms are essentially secondary sexual characters as found in male and female of the present species, although the longitudinal furrows on the mesal surface of the sixth and seventh joints in the female vary in development and may be deeply impressed in some, in others evident upon one or the other of the joints alone, or may be quite absent as seems to be more commonly the case in the males. Similarly Brölemann (Ann. Ent. Soc. Fr., 1896, pp. 48-49) in arguing for the distinctness of transmarinus and mordax relies almost wholly upon secondary characters and does not inform us as to whether he is speaking of male or female. He says: "Pour ce qui est des deux espèces de Koch, il me semble qu'il ne peut y avoir de confusion, puisque le 4e article des pattes anales des mordax est trés court, trés renflè, parcouru en dessus par un profond et large sillon, ce qui n'est nullement le cas chez le transmarinus." But this is true only of males while the females conform to Brölemann's transmarinus, which must accordingly be regarded as the same species.

32. **Lithobius xenopus** Bollman.

1888. Lithobius xenopus, Bollman, Proc. U. S. N. M., XI. p. 350.

Locality.—Tallulah, Ga. (L. M. Underwood).

33. **Lithobius vorax** Meinert.

1872. Lithobius vorax, Meinert, Myr. Mus. Haun., II, p. 292.
1875. Lithobius vorax, Stuxberg, Ofvers. af k. Vet. Akad. Forh. no. 3, p. 26 and 32.
1885. Lithobius latzeli, Meinert, Proc. Am. Phil. Soc., XXI, p. 175.
1887. Lithobius clarus McNeil, Proc. U. S. N. M., X, p. 326.
——. Lithobius tyrannus, Bollman, ibid., p. 636.

Localities.—Byram, Fernwood, Watervalley, Canton, Holly Springs, Grenada, Jackson, Biloxi (type locality), Longbeach and Ocean Springs, Miss.; Pensacola, Fla. (clarus McNeil); Jackson and Birmingham, Ala.; Brown's Summit, N. C.; Crandall, Marksville and Luray, Va. (latzeli, seq. Meinert and Bollman.)

There is marked variation in this species in the development of the claws of the penult legs. There is a distinct anterior or third claw in the specimens from some localities (such as Holly Springs, Fernwood, Longbeach, Miss., and Jackson, Ala., etc.) which seems to be especially well developed in younger or smaller specimens (cf. clarus McNeil) but which is readily broken off and tends in older specimens to become relatively reduced, obsolete or absent. Because of this it would seem justifiable to regard clarus as having been based upon small specimens of this species since no other difference appears in the description given. Specimens from North Carolina and Virginia seem to show a tendency for the coxal pores to be round or oval rather than strongly transverse more frequently than in specimens from the Gulf region; but there are no constant differences in this respect and both extremes with intermediates are to be found in the more southern localities. Hence, no grounds in this direction appear why L. latzeli should be kept apart from vorax. The longitudinal sulcus which Meinert mentions as occurring on the ventral surface of the third and fourth joints of the anal legs in latzeli is present in all specimens of vorax. The sulcation on the mesal surface of the tarsal joints of anal and penult legs mentioned by Bollman as distinctive of his tyrannus is present in most specimens of vorax. The articles of the antennae vary greatly in number with the size of the individual, from twenty-six or twenty-seven in young specimens fourteen or fifteen millimeters in length to above forty in the largest adults. The average number in medium size adults would seem to be about thirty-five or thirty-six.

34. **Lithobius underwoodi** Bollman.

1888. Lithobius underwoodi, Bollman, Proc. U. S. N. M., XI, p. 350.

Localities.—Maplesville, Selma, Morgan, Thomasville, Jackson, and Anniston, Ala.; Atlanta, Tallulah Falls, (and Macon, type locality, seq. Bollman), Ga.; Landrum and Seneca, S. C.

Especially abundant in Alabama where it seems to be the most common of the larger species.

35. **Lithobius rex** Bollman.

1888. Lithobius rex, Bollman, Procl U. S. N. M., XI, p. 350.

Locality.—Tallulah, Ga. (L. M. Underwood).

36. **Lithobius carolinae** sp. nov.

Medium or slender.

Dorsum brown to brownish yellow; head much darker, chestnut; prosternum dark brown; antennae bark brown, pale or rufous distally; legs light brown or yellow, the posterior pairs darker but light distally; venter pale.

Antennae short; composed of thirty to thirty-five articles.

Ocelli about ten or twelve, arranged in three series; thus, 1+4, 3, 3.

Prosternal teeth 2+2.

Angles of the sixth, seventh, ninth, eleventh and thirteenth dorsal plates produced.

Coxal pores 3, 4, 4, 3, round.

Last two pairs of coxae laterally armed, last three pairs dorsally armed.

Spines of first legs 0, 0, 1; of penult 1, 3, 2, 1, with two claws; of the anal 1, 3, 2, 0, or rarely 1, 3, 2, 1, also with two claws.

Claws of gonopods in female tripartite; basal spines 2+2.

Length 8–9.5 mm.; width of tenth dorsal plate 1.2–1.5 mm.

Localities.—Asheville and Hot Springs, N. C.; Landrum and Taylor's (var.), S. C.; Russellville, Tenn.

This species would seem to be related to L. juventus of Bollman, but the sixth dorsal plate has the posterior angles more or less produced and the spining of the legs is constantly different.

37. **Lithobius arienus** sp. nov.

Robust.

Dorsum brown; head together with anterior and posterior plates darker, not reddish; antennae brown, darkened distad; legs pale yellow, the posterior pair darker; venter pale, the prosternum and posterior plates slightly darker.

Antennae moderately long; composed of thirty-four articles.

Ocelli compactly arranged in four longitudinal series; thus 1+4, 4, 3, 3, a total of fifteen; ocelli of the two upper rows larger.

Prosternal teeth 2+2.

Sixth, seventh, ninth, eleventh and thirteenth dorsal plates with the posterior angles produced.

Coxal pores ad 3, 4, 4, 3, round.

Last two pairs of coxae laterally armed, the last three pairs dorsally armed.

Spines of the first legs 0, 1, 1; of the penult 1, 3, 3, 2, armed with two claws; of the anal 1, 3, 2, 1, also armed with two claws.

Length 11.5 mm.; width of tenth plate 2 mm.

Locality.—Hot Springs, N. C.

One male. Very close to carolinae but conspicuously larger and more robust and differing in the spining of the legs, in the ocelli, in coloration, etc.

Genus **Bothropolys** Wood.

But one species of this genus occurs in the United States east of the Rocky Mountains.—B. multidentatus.

38. **Bothropolys multidentatus** Newport.

> 1845. Lithobius multidentatus, Newport, Tr. Linn. Soc., XIX, p. 365.
> 1862. Bothropolys nobilis, Wood, Journ. Acad. Sci. Phil. V, p. 15.
> 1865. Bothropolys multidentatus, Wood, Tr. Am. Phil. Soc., XIII, p. 152.
> 1875. Lithobius multidentatus, Stuxberg, Ofvers. af k. Vet. Akad. Forh.
> 1887. Lithobius multidentatus, Bollman, Proc. U. S. N. M., p. 263.

Localities.—Canton, Fernwood, and Byram, Miss.; Maplesville and Jackson, Ala.; Catawba, N. C.; Russellville, Tenn.; White Sulphur, W. Va.; Chatham and Balcony Falls, Va.

This species is widespread in the southern states though apparently not so common as farther north. In the section from Virginia to New York state, etc., it is abundant as it is also in corresponding latitudes farther west.

EXPLANATION OF PLATES.

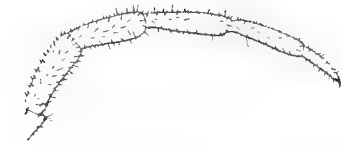
PLATE 3.

- FIG. 1. Left anal leg of Lamyctes fulvicornis from the exterior. From specimen 9.6 mm. in length taken at Haugen, Wisconsin.
- FIG. 2. Left anal leg of Lamyctes tivius sp. nov. From a specimen 6.6 mm. in length taken at Jackson, Ala. Same magnification as preceding.
- FIG. 3. Left anal leg of Lamyctes pinampus. From a specimen 8.6 mm. long taken at Claremont, Cal. Same magnification as the preceding.
- FIG. 4. Right anal leg of Watobius anderisus. Specimen from Thomasville, Ala.
- FIG. 5. Right penult legs of Watobius anderisus. Same specimen as preceding.
- FIG. 6. Left anal leg of Lithobius paitius sp. nov., dorsal aspect.
- FIG. 7. Left anal leg of Lithobius tuobukus sp. nov., dorsal aspect.

PLATE 4.

- FIG. 1. Right leg of the fifth pair of Buethobius oabitus sp. nov., cephalic aspect
- FIG. 2. Right leg of the fifth pair of Zygethobius pontis sp. nov.
- FIG. 3. Right leg of the fifth pair of Watobius anderisus sp. nov., cephalic aspect
- FIG. 4. Left penult leg of Lithobius manegitus sp. nov., ventral aspect.
- FIG. 5. Left penult leg of Lithobius manegitus sp. nov., dorsal aspect.
- Fig. 6. Left anal leg of Lithobius manegitus sp. nov., dorsal aspect.
- FIG. 7. Prosternum of Lithobius manegitus sp. nov., ventral aspect.

1



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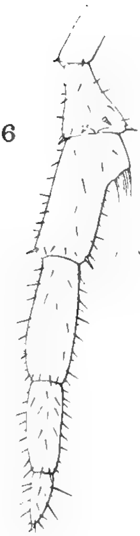

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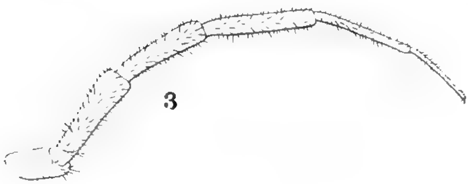

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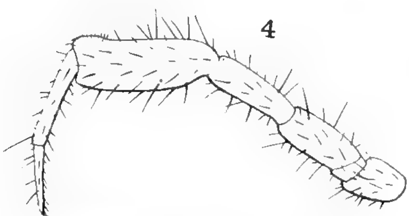

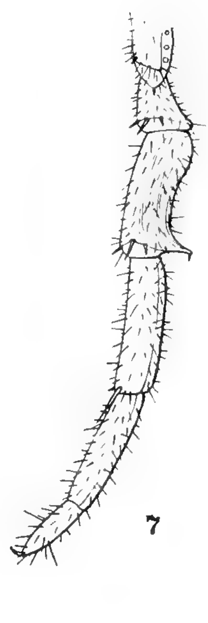

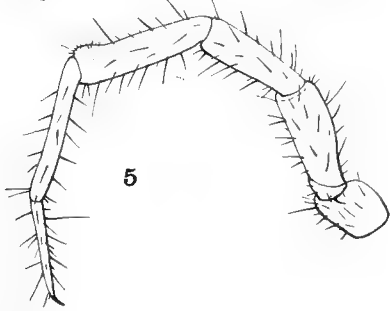

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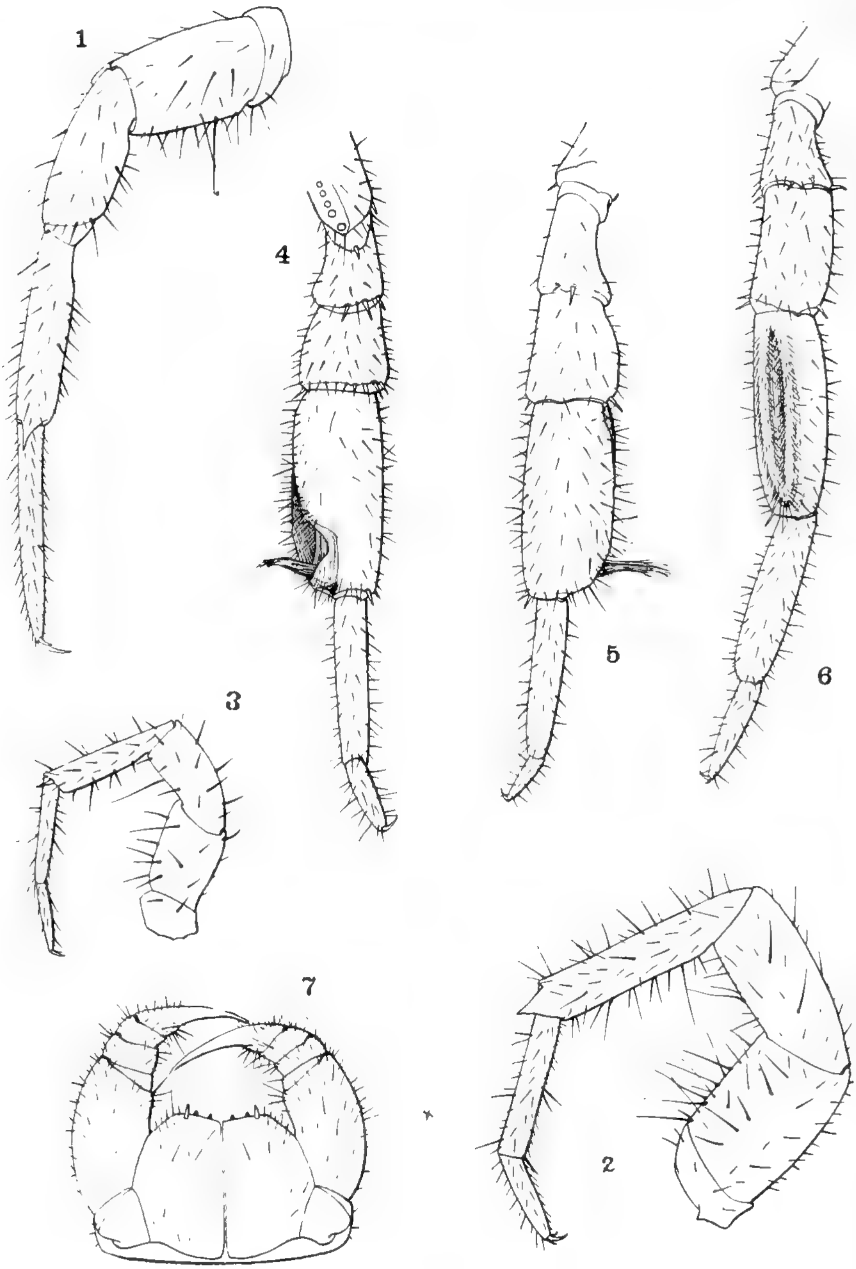
R. V. Chamberlin.



R. V. Chamberlin.

NOTES ON THE SYNONYMY OF THE GENERA INCLUDED IN THE TRIBE LACHNINI.

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In taking up the preliminary work on what I term the subfamily *Lachninae* it is very hard to ascertain the correct standing of several of the genera in the tribe *Lachnini* both from a standpoint of literature and classification.

Beginning with the original description of the genus *Lachnus* the author will discuss the later genera as erected and invites further discussion in order that the correct generic names may be used in the future.

The genus *Lachnus* Burmeister. Illiger is credited with the genus, but in reality it belongs to Burmeister and was published in 1835 in his Handbuch der Entomologie, p. 91.

"3 (13) Gatt Lachnus Ill.
Aphis autor.

Eh. Fuhler deutlich sechsgliederig, kurzer als der Leib. Das erste und zweite Glied kurz und dick, das dritte sehr lang, das vierte 2-3 kurzer, das funfte etwas langer als das dritte, das sechste klein, zugespitzt bei einigen Arten wie am Ende zusammen geschnurt und scheinbar ein eigenes Glied bildend. Flugel mit starker Randrippe. Hinterleib ohne Honigrohren hochstens mit zwei Hockern an deren Stelle."

Under this genus Burmeister gives seven species as follows:

1. *Lachnus lapidarius*, (Fab.), which appears to be an unrecognizable species.

2. *Lachnus fagi*, (Linn.), which is now the type of the genus *Phyllaphis* Koch.[1]

3. *Lachnus quercus*, (Linn.), which is now the type of the genus *Stomaphis* Walker.[2]

4. *Lachnus fasciatus*, Burmeister, which Del Guercio has recently placed in his Genus Lachniella.[3]

5. *Lachnus Punctatus*, Burmeister, which up to the present time has not been definitely recognized (may be viminalis Boyer).[4] (?)

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1. Koch, Die Pflanzenlause Aphiden, 1857, p. 248.
2. Walker, The Zoologist, 1870, Vol. 28, p. 2000.
3. "Redia," 1909, Vol. 5, fasc. 2, pp. 173-359.
4. Boyer, Ann's Ent. Soc. France, 1841, p. 184.

Then he mentions *Aphis pini* aut. and *Aphis betulae* autor to go in this genus but as no reference is made to any one author neither species can have a valid standing in this genus.

As one of the species originally cited under the genus must hold for the type of that genus then must one of the four valid species be that type.

Two of the four are unquestionably removed as types of the genera *Phyllaphis* and *Stomaphis*, thus leaving only two for the genus Lachnus.

Lachnus punctatus if found to be distinct is the only species which has not been definitely recognized and placed in a different genus by the later writers, and it is the only species left for the type of the genus.[5] Unless this species is located the genus *Lachnus* must revert to the group containing *L. fasciatus* Burm. as a type.

A careful study of *Lachnus viminalis* Boyer, Boyer's description of that species, and Burmeister's description may (?) show that *L. viminalis* Boyer is identical with *L. punctatus* Burm. In that case *Lachnus* will be definitely established with *L. fasciatus* as the type. If not then what is the genus and what species can we refer to that genus?

On the other hand in 1908 Mordilko[6] used L. viminalis Boyer to form a new genus *Tuberolachnus*. Should this species prove to be *L. punctatus* then *L. fasciatus* Burm. must be the type of the genus *Lachnus* Burm., as it is the only species of those cited by Burmeister left in that genus. Since *L. fasciatus*, according to Del Guercio at aut., is a valid species I hold that this species under the existing conditions must hold as the type.

The next genus taken up in this tribe was *Cinara* Curtis, as follows:

The genus *Cinara* Curtis.
type *A. pini* Linn.?
He includes *A. roboris* Linn.

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5. April, 1910. Entomological News. The author gave *Lachnus punctatus* as the type of the genus Lachnus because it seemed to be the only species which was left for that genus, and at that time I was unaware of the fact that Mordwilko (Annuaire Musie Zoologique de L'Academie Imperiale des Sciences, Vol. 13, 1908, p. 374) had used *Lachnus viminalis* as the type of his genus *Tuberolachnus*. It is impossible, however, with the present knowledge of the two above species to more than place *Lachnus punctatus* as a doubtful synonym of *L. viminalis* for *Lachnus punctatus* apparently cannot be clearly determined, and Boyer's description of *L. viminalis* is too clear to be put aside.

6. Annuaire Musie Zoologique de L'Academie Imperials des Sciences, vol. 13, 1908, p. 374.

This genus was formed in 1835 by Curtis, section 576, Vol. 12, of his British Entomology.

He places two species in the genus, *Aphis pini* Linn.?, and *Aphis roboris* Linn. The first he gives as the type, but as he places a question mark after Linn., the species is not valid, and *A. roboris* Linn. which he describes in full is the type of the genus? The generic names erected for that species since that time are synonyms?[7] He gives the figures of the adults, some of the parts, and also gives a good description.

The synonymy of this genus would then be

Cinara Curtis 1835
Pterochlorus Rondani 1848.[8]
Dryobius Koch 1855 Loc. cit.

Dryaphis Amyot[9] which Del Guercio Loc. cit. p. 262 has given genus rank never was a genus name until given that rank by Del Guercio. If we were to accept Amyot's names which were mononomials and in this case means "Oak Aphid" there would never be an end to the changing of names. The late workers on the *Hemiptera* refuse to look upon the work of Amyot except as a curiosity.

The next genus to be formed in the Lachnus group was Stomaphis Walker loc. cit. with *A. quercus* Linn. as the type and there is no discussion necessary on this genus name as it is well established.

Mordilko loc. cit. in 1908 deemed it necessary to erect two new genera in this group, Schizolachnus Mord. with *A. tomentosus* DeGeer as the type and *Tuberolachnus* Mord. with *Lachnus viminalis* Boyer as the type.

In 1909 Del Guercio loc. cit. has placed both of the above species in the genus *Lachnus* regardless of the fact that neither were in the original genus and he removes to other genera all of the original included species. If it is true that *L. viminalis* Boyer and *L. tomentosus* DeGeer are both in the same genus then must *Tuberolachnus* be the genus name with Schizolachnus as a synonym and *L. viminalis* Boyer as the type.

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7. The question of the validity of this genus rests upon the fact that Curtis did not give *roborus* as the type and the other species is questioned. The author then concludes that the genus is in question and cannot be placed as a valid genus.

8. Esapodi afidicidi in Nuove Ann. di Sci. Nat. Bologna, 1848.

9. Ann. Soc. Ent. France vol. 5, ser. 2, p. 481, 1847.

In 1909 five new genera were formed in this group, one of which must be a synonym and a second which would according to the reasoning of this article also be a synonym.

The genera are *Eulachnus* Del Guercio (loc. cit.), the type of which probably should be *E. Agilis* (Kalt.)

Lachniella Del Guercio (loc. cit.), the type of which is not set, and is, I consider, a synonym of Lachnus?

Essigella Del Guercio (loc. cit.) with *E. californicus* (Essig) as the type.

Davisia Del Guercio (loc. cit.) *L. longistigma* Monell as the type and which is a synonym of the following genus. (Nov. 13, 1909).

Longistigma Wilson [10], type *L. caryae* Harris which I have published as synonymous with *L. longistigma* Monell and L. *platinicola* Riley. (Nov. 1, 1909.)

According to the evidence shown here using Del Guercio's arrangement to generic characters, the correct synonymy is as follows:

1. *Trama* Heyden
   type *T. troglodytes* Heyd.
2. *Stomaphis* Walker
   type *S. Quercus* (Linn).
3. *Pterochlorus* Rondani
   Syn. *Cinara* Curtis?
   Syn. *Dryobius* Koch.
   Syn. *Dryaphis* Kirk
   type *P. roboris* (Linn.)
4. *Essigella* Del Guercio
   type *E. californicus* (Essig.)
5. *Longistigma* Wilson
   Syn. *Davisia* Del Guercio
   type *L. caryae* (Harris).
6. *Tuberolachnus* Mord.
   ? Syn. *Schizolachnus* Mord.
   type *T. viminalis* (Boyer).
7. *Lachnus* Burmeister.
   Syn. *Lachniella* Del Guercio
   Type *L. fasciatus* Burm.
8. *Eulachnus* Del Guercio
   type *E. Agilis* (Kalt).

In the December, 1910, issue of the ANNALS the author published a paper on the genera of the subfamily *Aphidinae* and wishes here to note two corrections.

The type of the genus Illinoia should read *m. liriodendri* Monell. The type of the genus *Hyalopterus* Koch should read *A. pruni* Fab. instead of *aurantiae* Koch.

10. Can. Ent., vol. 41, p. 385, 1907.

SUMMARY OF FOOD HABITS OF AMERICAN GALL MIDGES.

By E. P. Felt,
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Our understanding of this group will be much clearer if we recall that it is an offshoot from the Mycetophilidae, the species of which subsist largely upon decaying vegetable matter or low forms of vegetable life. The family Itonidae, better known as the Cecidomyiidae, has attained its present large proportions not by reason of strength, great resistant powers or unusual fecundity, but through an amazing adaptability. We find larvae in decaying vegetable matter, in dead wood, on fungus, affecting all parts of a very great variety of the higher plants and presenting thereupon almost every conceivable grade in the development of the gall, living as parasites at the expense of very small insects or even preying upon their near allies. Broadly speaking, taxonomic studies in this family show at least a moderately close relationship between specialization in structure and divergence in the food habits from those of ancestral forms.

We have no firsthand knowledge of the food habits of the tribe Lestremiinariae, though there is every reason to believe that there is substantial agreement in this regard with European species, which have been reared from decaying vegetable matter.

We can supply a little definite information respecting the food habits of the tribe Campylomyzariae, since representatives of several genera have been reared. Mycophila fungicola, an undescribed species, referable to a new genus was reared from fungus, while Monardia lignivora Felt was obtained in considerable numbers from the fungous-affected heartwood of white pine. Cordylomyia coprophila is an undescribed species referable to a genus which will be erected shortly. It was reared from manure. These few records show that this comparatively generalized tribe subsists upon fungi, fungous-affected wood and certain forms of vegetable matter. These food habits agree in general with those of European species, and further observations will doubtless show that members of the tribe as a whole, depend for nourishment on the lower plants or upon the tissues of the higher plants after invasion by fungi or the commencement of decay.

The subfamily Heteropezinae comprises a number of remarkable, and taxonomically speaking, ancient forms. The species live largely, if not exclusively, in ligneous tissues in the incipient stages of decay. Miastor larvae, presumably those of M. americana Felt were found in numbers in the moist, partially decayed inner bark and sapwood of chestnut. The majority of the European species studied, develop under practically similar conditions.

Our title implies a limitation to gall-making forms. This is true of the vast majority of the members of this family, though not applicable to the two subfamilies just discussed or to the lowest tribe of the Itonidinae now under consideration. The members of this tribe, the Epidosariae, distinctly allied with the more generalized forms in this family by the presence of a well developed crossvein and yet exhibiting a connection with the higher forms because of the universal presence of highly specialized circumfili, do not produce galls but live in dead, frequently dried, woody tissues. The detection of the larvae is consequently difficult and, as a result, rearings have been comparatively few. Winnertzia pinicorticis Felt was obtained by Mr. Pergande from the bark of Pinus inops. The genus Colpodia, with its remarkably long, narrow wings, probably lives in dead wood, a habit known to be true of Asynapta saliciperda Felt which was reared from old Rhabdophaga batatas O. S. galls on willow.

The most generalized of the true gall-making forms are probably found in the tribe Dasyneuriariae, the genus Rhabdophaga Westw. being the less specialized of this group. A study of this genus shows at once a marked partiality to Salix, a genus placed rather low in the series of flowering plants, and the production thereupon of a number of comparatively simple deformities such as bud and subcortical galls. It is pre-eminently a genus of the willow. Dasyneura Rond. comes next. An examination of the records shows that a large proportion of the species live in comparatively simple leaf and bud galls on various genera of the higher flowering plants, an interesting exception being the remarkable D. flavotibialis Felt which was reared from decaying wood, while D. rhois Coq. was obtained from a root gall on Sumac. The peculiar Lasiopteryx coryli Felt was reared from leaf folds on hazel, Corylus virginica. An undescribed species of Cystiphora Kieff. was reared from a very inconspicuous swelling on Viburnum leaves. A departure from the normal food habit in this tribe is seen in Coccidomyia pennsylvanica, an undescribed species belonging to a new genus and reared from Lecanium scales.

This series of generalized gall-making forms is continued in the tribe Oligotrophiariae, separated from the preceding only by the simple claws. The more generalized genus, Phytophaga Rond. exhibits a connection with the preceding tribe in the possession by P. destructor Say., of claws with rudimentary teeth. As is well known, it hardly makes a gall, depending for protection upon the leaf sheath. P. ulmi Beutm. occurs in the buds of elm, P. violicola Coq. curls the leaves of violet, while several species of this genus typified by P. rigidae O. S. live upon Salix, making galls similar to those produced by species of Rhabdophaga. Janetiella asplenifolia Felt was reared from a fleshy fold on the midvein of sweet fern, while J. brevicauda Felt was obtained from the typical gall of Lasioptera vitis O. S. on grape. The genus Oligotrophus Latr. is represented by the European O. betulae Winn., which affects the seeds of birch, while O. salicifolius, an undescribed species produces a flattish, ovoid gall on Salix leaves. The genus Rhopalomyia Rubs. contains a large number of species and exhibits a marked partiality for Solidago, producing upon various species of this plant genus a considerable number of flower and bud galls, the large rosette deformities of apical buds being characteristic. A few species of this genus also occur upon the allied aster and Artemisia. The larger species of Sackenomyia Felt are restricted to Salix, while one small species at least, has been reared from Viburnum. Walshomyia Felt is found in the fruit of Juniperus.

The tribe Lasiopterariae exhibits a high degree of specialization in venation at least, and we find in this group a marked restriction in food habits. The genera Lasioptera Meign. and Neolasioptera Felt live almost exclusively in subcortical stem galls, a large proportion of the species occurring upon Solidago, though a considerable variety of other plants are subject to attack. Asteromyia Felt, like the two preceding genera, exhibits a marked preference for Solidago, though a number of species occur upon aster. It is noteworthy that a large majority of the galls produced by this genus are of the apparently fungous-affected blister type. The highly specialized Clinorhyncha Loew is represented in America by several species probably restricted to the florets of Yarrow, Thoroughwort and presumably Chrysanthemum. The peculiar Camptoneuromyia adhesa Felt has been reared from oval, adherent galls between Solidago leaves, while C. rubifolia Felt was obtained from a marginal leaf roll on blackberry.

The tribe Asphondyliariae is a rather highly specialized group, the species living mostly in buds. This is particularly true of Asphondylia H. Lw., a genus practically confined to buds and apparently not closely restricted in food habits, since different species have been reared from a considerable variety of plants. Schizomyia Kieff. is allied to the preceding genus and the several species reared were obtained from buds; such as S. coryloides Walsh and Riley from an apical leaf bud gall on grape, and S. pomum Walsh and Riley from a nutlike polythalamous grape gall, evidently a modified bud. S. rivinae Felt was reared from bud galls on Rivina. Cincticornia Felt appears to be restricted to leaf galls on Quercus, the largest and perhaps most characteristic being that produced by C. pilulae Walsh. A series of rearings have resulted in obtaining a number of species, all from various leaf galls on this plant genus.

The tribe Itonidinariae comprises a large assemblage of highly specialized forms, easily divided by the circumfili into two groups, namely the bifili and trifili. The former is represented by Endaphis Kieff. first recorded as an endoparasite on Aphididae and reared by us from mite infested foliage. Contarinia Rond. also belongs in this subtribe and, as is well known, displays a marked preference for bud and fruit structures, C. johnsoni Sling., C. virginianeae Felt, C. rumicis H. Lw., C. sorghicola Coq. and C. pyrivora Riley, all being representative in food habit. Thecodiplosis Kieff. is closely allied to the preceding and is represented in America by T. quercifolia Felt reared from oak, T. ananassi Riley reared from a twig gall on Taxodium, and T. liriodenri O. S., inhabiting a blister gall on tulip leaves. Dentifibula Felt, also in this subtribe, has at least one species, D. cocci Felt, which is zoophagous.

The subtribe trifili comprises the remainder of the genera in the family. The genus Bremia Rond., representated by several American species, is probably phytophagous. Aphidoletes Kieff. contains several American species, a few of which at least are known to prey upon Aphididae. It is possible that our American species of Lobodiplosis Felt, Coquillettomyia Felt, and Karschomyia Felt have habits similar to those of the allied Mycodiplosis Rubs., the majority of the species of which appear to subsist upon fungi, though one, M. acarivora Felt preys upon Tetranychus. Youngomyia Felt displays a preference for the buds of various plants. Species of Clinodiplosis Kieff. have been reared from leaf galls on scrub oak, Spiraea, Carya, and from roots of Cattleya. It is probable that the species occurring on hickory leaves is an inquiline. The genus Caryomyia Felt comprises a number of homogeneous forms producing a considerable variety of galls on hickory leaves. We have yet to obtain undoubted evidence that members of this genus live upon any other plant. Prodiplosis floricola Felt has been reared from enlarged blossoms of spiraea and clematis. Arthrocnodax Rubs. is represented by several American forms, A. apifila Felt occurring in bee hives and probably subsisting upon organic debris, though subsequent investigations may show it to be predaceous. Hormomyia H. Lw. comprises a number of large forms usually found in the vicinity of swamps and presumably living mostly on sedges or allied vegetation. Four species, hardly typical of the genus, namely H. crataegifolia Felt, H. canadensis Felt, H. clarkei Felt and H. verruca Walsh have been reared from leaf galls respectively, on Crataegus, Amelanchier, Spiraea and Salix. The European Monarthropalpus buxi Lab., producing an oval swelling upon the leaves of Box has been recently detected in this country. Giardomyia menthae Felt was reared from a pustule-like gall in the axil of the leaf of Mentha canadensis. Lestodiplosis Kieff. is represented by a large series of mostly spotted-winged midges which have been reared from a considerable variety of plants. The larvae of some at least, are known to be zoophagous and it is probable that most of the reared American forms prey upon the larvae of gall-making midges. The genus Itonida Meign,. better known as Cecidomyia Meign., comprises a large number of forms inhabiting for the most part, flower, bud and leaf galls on the higher flowering plants, though I.

resinicola O. S. and I. resinicoloides Wlms. occur in exuded pitch masses on pine, while I. tritici Kirby is well known as a species of prime economic importance.

A study of our records from a botanical aspect reveals several facts of interest. We note first that American gall midges live at the expense of some 177 plant genera belonging to 66 plant families. They afford support to some 538 species of gall midges representing 44 genera. These forms are known to inhabit 44 fruit (botanically speaking), 146 bud, 218 leaf, 130 stem, and 4 root galls. The paucity of root galls must be attributed in a measure to the difficulty of finding them. In addition to the above some five species were reared from unknown plants and eleven zoophagous species belonging to three genera, making a total of 47 insect genera comprising some 554 species, 441 of these having been reared from either plants or animals. Reference to our records shows that the Compositae supports a very large fauna, 22 of its genera affording sustenance to 118 species of gall midges belonging to some 15 genera. The majority of these midges, 55 species occur in bud, 32 in leaf, 30 in stem, while 5 inhabit fruit galls. The Salicaceae, represented only by Salix and Populus, supports some 59 species of gall midges referable to 15 genera, by far the greater number occurring upon Salix. As in the Compositae, a large proportion, 21 species occur in bud, 15 in leaf and 21 in stem galls, only 1 living at the expense of the fruit. The Rosaceae appears to be the next plant family favored by gall midges, 10 genera being subject to attack by 43 species of midges, assignable to 14 genera, 3 species inhabiting fruit, 12 bud, 25 leaf and only 3, stem galls. The Gramineae, despite its numerous genera and wide distribution has but 18 genera at present known to support some 25 species of midges representing 12 insect genera, 8 species occurring in fruit and 17 in stem galls. This is probably only a small proportion of the forms occurring upon grasses. Our record for the Cyperaceae is even more unsatisfactory, only one species, presumably inhabiting a stem gall being known. The paucity of records in both of these families is probably due to the difficulty of finding the galls. There is a close parallelism between the Juglandaceae and the Fagaceae, two genera in each being affected by gall midges. Juglans and Castanea are known to be infested by one and three species respectively, while Carya and Quercus are subject to attack by 25 and 21 species, the former affording support to representatives of 5 and the latter to species belonging to 7 genera. These two trees are likewise comparable in that each supports but one species in the fruit, while by far the greater majority of the midges, namely 23 and 18 respectively, produce leaf galls. The large family Leguminosae has 13 genera which support some 5 genera of gall midges referable to 20 species, 3 living in fruit, 3 in bud, 6 in leaf and 8 in stem galls. Only 6 genera in the Urticaceae are attacked by gall midges belonging to 4 genera representing 8 species, 2 living in bud, 9 in leaf and 6 in stem galls. In the Vitaceae, Psedra, and Vitis support some 12 genera of gall midges representing 17 species; 4 inhabit bud, 12 leaf and 1 root galls. By far the great majority of the species, 15, occur upon Vitis. The large family of Labiatae supports some 6 genera representing only 13 species, the Caprifoliaceae, 8 genera comprising 14 species, and the important Pinaceae 6 genera and 14 species. The above record, while dealing with a much larger number of species than we have been accustomed to think occurred in this family, shows that in all probability there are many forms yet to be discovered.

Comparing the above data with recently summarized records* it will be seen that the food habits of some 420 European gall midges representing 43 genera are unknown. The Pinaceae afford sustenance to 11 species belonging to 4 genera, a condition closely paralleled in this country. The European Gramineae support some 20 gall midges representing 7 genera, a showing somewhat below what obtains in America. Conversely, the European records for the Cyperaceae include 4 genera and 9 species, while in this country but one species has been reared from Scirpus. The European Salicaceae supports some 30 species of midges belonging to 6 genera, 5 of these occurring on poplar. There appear to be no species affecting the Juglandaceae in Europe. There are nearly as many genera and species, 20 and 7 respectively, occurring upon the Fagaceae in Europe as in America, though the distribution is different, since Fagus supports 5 species referable to 3 genera and Quercus has only 14 species representing 4 genera, a marked contrast to conditions obtaining in this country. There is a pronounced differ-

*1909, Houard, C. Les Zoocecidies des Plantes d'Europe.

ence in the European Rosaceae, especially marked in Spiraea with its 2 genera and 5 species, contrasting strongly with our 8 genera representing 11 species. A still greater difference is found in the Vitaceae, the European Vitis supporting but 2 genera and 2 species, while our American vines afford sustenance to 12 genera represented by 15 species. The European fauna of the Compositae is also much less, namely some 67 species representing 10 genera as compared with our 118 species assignable to 15 genera. This large discrepancy is accounted for in great part by the enormous fauna of the Solidago and the numerous species occurring upon aster; plant genera which in Europe support only one genus and one species.

THE STRUCTURE AND SYSTEMATIC IMPORTANCE OF THE SPERMATOPHORES OF CRICKETS.

J. P. Jensen.

In several groups of animals, we find that the spermatozoa are held in packets or masses, and in some such as the Cephalopods, there is high specialization of the spermatophore, as the organ is called, in which the spermatozoa are contained. Among the insects, only representatives of a few groups form spermatophores, but when present they are beautiful and interesting structures and those formed by the gryllids or crickets are especially so.

While engaged in research work on crickets in the Entomological Laboratory of Cornell University, I noticed one day that a female Gryllus had a small pear-shaped organ attached between the ventral surface of the base of the ovipositor and the posterior end of the 8th abdominal sternite (Fig. 1). This structure did not seem to be part of her own body and as I did not at the time know anything about spermatophores, I was very much puzzled by it. After investigating the literature I found that I had happened to collect the specimen before the spermatophore had dropped off, and upon examining several males, I found a similar organ in situ in most of them, just outside of what was considered the genital opening and covered by the ends of the posterior sclerites.

Crickets, such as members of the genera Gryllus, Nemobius and Oecanthus are very difficult to classify and I had encountered considerable difficulty in obtaining good specific characters. More with a view of determining whether the spermatophores might not assist me in classifying them, than expecting to make any morphological discoveries, I commenced to study them somewhat thoroughly.

The literature was searched for accounts of copulation in these and related insects and five references were found. Serville stated that in copulation the female Gryllus mounts the body of the male, as in the Oecanthids. Peytoureau said that in the Locustidae the transfer of spermatozoa takes place by means of a pear-shaped spermatophore that is transferred to the female in copulation. Packard mentioned that in the two families of Gryllidae and Locustidae this was true and that especially Gryllus had been noticed to have this habit. Gillette in 1904 gave an excellent illustrated account of the structure and transfer of the spermatophores of the Western Cricket, Anabrus simplex, family Locustidae, and the most complete was found to be an account by Lespes in 1855, who not only noticed carefully the complete process of copulation but by dissection he determined how the spermatophores were developed and to some extent the function of the parts of the spermatophore.

After relaxing some of my specimens of Gryllus, I dissected out the spermatophores in several males to gain a good knowledge of their structure. The spermatophore proper (Fig. 2, A) is attached to a handle-shaped part (Fig. 2, B) possessing five lateral hooks, three in front and two behind. The function of these hooks was not understood at the time but will appear later. A long whip-like part (Fig. 2, C) is attached to the dorsal side of the handle. Many males were examined and a spermatophore was almost always found present. This is in accordance with Lespes' observations, who found that a new spermatophore was completely formed in about one hour and that each female copulated several times during the egg-laying season.

To determine the function of the parts, the female that had this organ still attached was after relaxation carefully dissected. The function of the hooks on the handle was readily found to be for attachment. The anterior part of the handle was found to be inside of the vaginal opening and the three anterior hooks held it firmly in place. The two at the posterior end also curve up and serve to hold it firmly in place by clasping to some extent the basal part of the ovipositor. After removing the bulb of the spermatophore, I attempted to remove the handle, but the anterior hooks held too firmly, part of it broke off but the whip-like structure remained attached and when pulled out, showed that it had extended a considerable distance up the passage and as will soon be shown this would indicate that the spermatheca is quite far removed from the external opening. By mounting in glycerine and using high power the true relation of the whip-like part to the handle was made out, and also the nature and function of the former structure. It is attached somewhat nearer the spermatophore body than the middle of the handle and is continued as a dorsal thickening of the handle into the narrow cylindrical attachment between the handle and the bulb. It is in fact a duct, whose cavity can be traced from a point some distance inside the bulb (Fig. 2, D) to its outlet at the end of the whip.

This was proven by embedding the tiny structure in paraffin and taking microtome sections of it (Fig. 3 and 4), from the farther end of the handle to almost the tip of the thread. The outside wall is rather gelatinous and soft, but a cylindrical, central core (Figs. 3 and 4, B) of very hard, apparently chitinous, material has the tiny duct in its center (Figs. 3 and 4, C) and in the sections this duct had not been flattened in the least. The very firm walls are no doubt for the purpose of preventing flattening or deformation, which might compress the duct and prevent the passage of the spermatozoa.

Last summer I again had opportunity to witness the courting and mating of Oecanthis fasciatus, and the process was very much the same as described by the writer in the *Canadian Entomologist*, Jan., '09. Then, however, I had missed the transfer of the spermatophore and after killing this female I removed the organ and mounted it in the usual way under a cover glass in canada balsam. Watching it under low power of the microscope I succeeded by judicious pressure, in causing the spermatozoa to flow out of the end of the "thread." This was final proof that this part of the organ is for conducting the spermatozoa to the spermatheca. Lespes in his account, somehow seems to have overlooked the fact that this thread-like structure is a duct, likely due to the minuteness of the duct itself, which when highly magnified, reminds one of a fine capillary tube. He calls it a horny thread, "file corné." In fact he does not attempt to explain the structure at all, nor how the spermatozoa enter the vagina of the female from the spermatophore after it has been placed in position.

As before mentioned, the various species of crickets are very difficult to determine and the spermatophores may in the future be of considerable importance for definitely defining the species. For instance, Minnesota specimens of Gryllus pennsylvanicus Burm. vary considerably in general coloration and size from the Eastern specimens, but the spermatophores examined were all exactly alike. Lespes described and figured the respective spermatophores of the common European species, Gryllus sylvestris, G. campestris and G. domesticus, and they differ very markedly from one another. Oecanthis fasciatus Fitch and O. quadripunctatus Beut. are the same species as gradations in the antennal markings show very nicely when one has considerable material. Whether the spermatophores further verify this, I have not as yet been able to definitely determine but it appears to me that the spermatophores of insects are worthy of considerable more attention than has been devoted to them in the past.

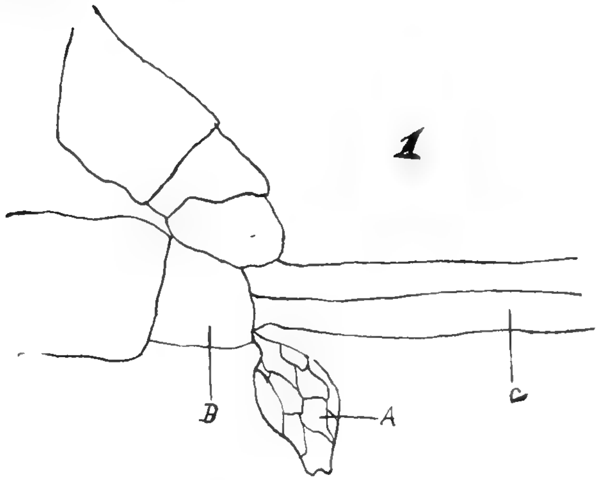
EXPLANATION OF PLATE V.

All figures magnified, 3 and 4 highly.

FIG. 1. Attachment of spermatophore to female Gryllus pennsylvanicus. A, bulb of spermatophore; B, 8th abdominal sternite; C, ovipositor.

FIG. 2. Spermatophore of G. pennsylvanicus, magnified. A, bulb; B. handle; C, thread-like part (Lespes "file corne"); D, duct; E, cross-section shown in Fig. 3; F, cross-section shown in Fig. 4.

FIGS. 3 and 4. Cross-sections of thread at E and F in Fig. 2. A, gelatinous outside wall; B, hard core; C, duct.



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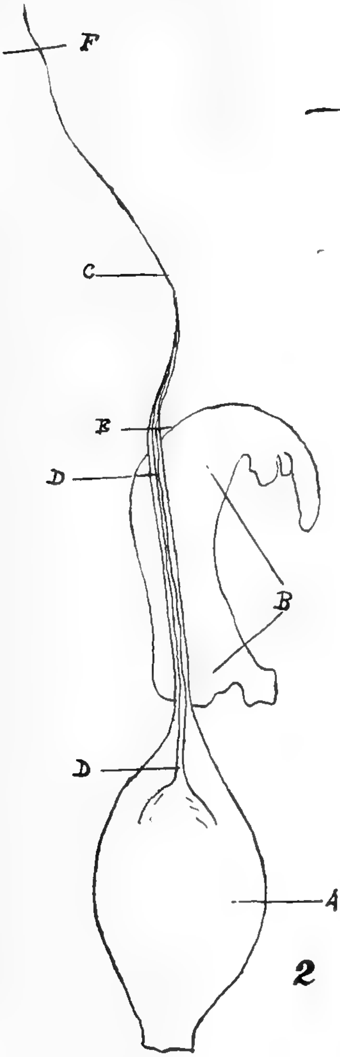

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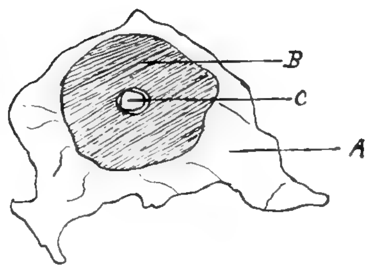

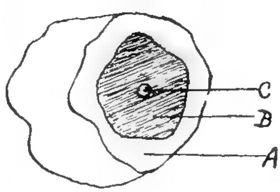

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J. P. Jensen.

NOTES ON THE LIFE-HISTORY OF THE LARCH CASE-BEARER (COLEOPHORA LARICELLA.)

Glenn W. Herrick.

This is an European insect that is gradually becoming quite widely distributed in the northeastern United States and parts of Canada. It is also evidently causing considerable injury to larch trees wherever it is present.

It was first noted in this country by Dr. Hagen, who, in 1886, recorded it as seriously injuring the European larches on an avenue in Northampton, Mass. In 1905, Dr. Fletcher recorded its injuries to larches in Canada and in 1906 Miss Patch says that the case-bearers have been present in certain counties in Maine and "although minute they have been present in such enormous numbers that larch trees have often been, during the past three summers, eaten bare of green early in the spring." The insect has been present on the larches in the vicinity of Ithaca for several years, and undoubtedly does considerable injury every season. The small green leaves are devoured in early spring as fast as they push out, and on many trees the green tissues are eaten out and the leaves left pale and bleached in early spring. As soon as the buds begin to break in the spring, the dark brown, cigar-like cases that have been lying quietly attached to the branches all winter, become suddenly animated and commence crawling to the tender green leaves. In the spring of 1910 we found them active and feeding by the 16th of April. Each larva selects a leaf and soon eats a circular hole through the epidermis, thus gaining access to the tender tissues within. Then holding its case at right angles to the leaf and never releasing hold of its case it mines to the right and left of the opening as far as it can reach. The mined portion of the leaf assumes a bleached appearance and the whole tree soon shows the effect of the injuries if the larvae are abundant. Observations would seem to indicate that the larvae molt just before leaving their winter quarters on the branches. This point, however, must await another season for definite determination. The cases of the larvae are enlarged after they have been feeding a few days by slitting the old case and inserting a piece of leaf in the slit and fastening it in with silk. One larva must attack a great number of the small young leaves, for in cases observed the larvae were not abundant enough to do the damage they did unless each case-bearer attacked and injured several leaves. As bearing on this point I selected a branch 6 inches long and found that it bore 24 whorls of leaves, one whorl, at this particular stage, containing 54 small leaves and other nascent ones in the center that could not be counted. If we take 54 leaves as the average, the branch bore 1296 leaves that were of a size to be attractive to the larvae. On this branch were 10 case-bearers. They had injured every leaf on the branch except those in the last whorl evidently having begun near the base of the branch and worked outward. These ten larvae had probably attacked and injured over a thousand leaves the majority of which, of course, were small.

On April, 26th I found the first pupa in the breeding cages. When ready to pupate, the larvae attach their cases securely to the branches or to the leaves often in clusters of 4 or 5. A favorite place for attachment seems to be the center of a whorl of leaves. The period of pupation, in the breeding cages at least, proved to be from two to three weeks. We found moths emerging in the insectary May 11, 13, 15, 16 and on.

The moths begin pairing in a few days after emergence and on May 31, their pinkish-red eggs were found deposited on leaves in the breedings jars. The eggs are shaped as though moulded in a tea-cup with many ridges radiating from the upper and smaller end, for they are glued to the leaves by their bases.

On June 6th, in the field, an abundance of moths were found and many of them were pairing. Some had probably emerged a few days earlier. On June 10th I found eggs on the leaves in abundance but there were still many pupae in cases showing that the moths emerge over a long period. The eggs are evidently placed indiscriminately on either side of the leaves.

On June 28th and 29th the eggs were found hatching in the field. The egg-shells remain glued to the leaf and show no rupture of any kind for the emergence of the larva. Investigation shows that the larva bores through the base of the egg-shell and goes directly through the epidermis into the leaf beneath the egg. Here the larvae live mining in the tissues of the leaf but growing very slowly. The excrement of the tiny larva is packed behind it in the mine. Here the larvae live until September. Owing to our absence from the University during the first part of September, we are unable to say at just what date the larvae first began to leave their mines and make their cases. On my return on the 15th of September many of them were found in their tiny cases feeding on the leaves. From this time on through September opportunity was given to observe them making their cases. In most instances, at least, they clean out their mines and pack the excrement in the outer end of it near the tip of the leaf. When the burrow is clean enough to suit them they cut off the tip of the leaf containing the excrement, which falls to the ground out of the way, and then they cut off enough of the leaf containing the clean part of the mine to make them a case of the desired length. The larvae now feed on the leaves of the larches until the latter part of October when they migrate to the branches and go into hibernation.

FURTHER BIOLOGICAL NOTES ON THE COLORADO POTATO BEETLE, LEPTINOTARSA 10-LINEATA* (SAY), INCLUDING OBSERVATIONS ON THE NUMBER OF GENERATIONS AND LENGTH OF THE PERIOD OF OVIPOSITION. II, ILLINOIS.

By A. A. Girault and James Zetek,
Office of the State Entomologist of Illinois.

In presenting for publication the results of a third successive year's observations on the biology of this insect made in the latitude of Urbana, Illinois and supplementing those made in Georgia in 1906 (Girault and Rosenfeld, 1907) and in Ohio in 1907 (Girault, 1908), it becomes necessary to state that little or no progress has been made in regard to the continuity of observation and experiment, so that they should still be classed as desultory. The observations were made in the open or east insectary of this office at Urbana under as normal conditions as possible, but during odd hours and without previous forethought or planning and subject to much neglect at a critical time toward the last.

They are presented, therefore, mainly to add to the sum of biological data on this insect, which in the end may lead to the discovery of important laws. At present, however, they form but a small beginning and cover but one or two biological factors; as they supplement to a large degree the observations made in Ohio (Girault, 1908), they are presented in the same general manner.

Those who gather data of this kind cannot help being impressed by our poverty in this respect and by the urgent necessity of accuracy in observation, to the minute as regards time and to the fraction of a degree as regards temperature, though it is true that such errors as occur should be chance errors, hence negligible. And most decidedly other factors should be taken into consideration, for in matters of this kind,

* This may seem a trivial matter but consistency demands that the specific name of this insect be written as it was originally by Say; I see no necessity for change or reason therefor and certainly stability in nomenclature is not aided by making one. See articles 15 and 19, The International Code of Zoological Nomenclature as Applied to Medicine (Stiles, 1905). If a change was necessary the form x-*lineata* would seem preferable to the other, being less radical. A. A. G.

we cannot foresee of what great importance the most trivial observations may become in the future and there is, doubtless, more than one cause for variability in periods of development.

SUMMARY.

The following paper merely contains additional biological data along the same lines as those presented previously, obtained during the season of 1908, together with an account of the breeding of adults in confinement which resulted in reproduction by the second generation of adults under adverse conditions. This reproduction by the second generation of adults apparently, was further hindered by actual starvation and was scanty, but the behavior of the beetles would lead to the belief that they were both willing and eager to reproduce. The fact is clearly shown that reproduction occurred with a pair of normal adults of the second generation, a result contrary to what we understand to be the meaning brought out by Tower (1906), discussed previously (Girault, 1908). We do not, however, make any claims, but the evidence is sufficient to establish the fact that *exceptionally* the adults of the second generation in normal beetles do develop the germ-cells before a period of hibernation.

THE EGG.

1. *Length of Stadium.**

The duration of embryonic development was determined for about nine hundred cases during the breeding season and the results are tabulated in Table I. The separate lots were confined as previously, in darkness. In every case recorded the time is actual, unless noted to the contrary. By comparing these records with those given by Girault (1908, Table I, p. 156), differences are noticeable in regard to the duration of the stage at the same approximate dates for the two latitudes; witness Lot I of the two tables. We should expect to find here a corresponding difference in the temperatures.

* This term is used in preference to *instar* which was originally proposed to designate the insect itself at any stage or period of development, as the egg instar, third larval instar and so on, just as we say the larva, caterpillar, pupa or imago.

TABLE I.

Duration of the Egg Stadium, Urbana, Ill., Season 1908.

Remarks.	Lot No.	No. eggs	Deposited Month	Deposited Day	Deposited Time	Hatched Month	Hatched Day	Hatched Time	Duration Days	Duration Hours	Effective Temp Daily Averages, Degrees Fahr.
Pair No. 3 Hib. adults ..	1	58	May	29	11:45 a. m.	June	5	9:45 a. m.	6	22	24.47°
" 3 " ..	2	49	"	30	1:30 p. m.	"	6	11:30 a. m.	6	22	25.41°
" 1 " ..	3	18	June	4	7:00 p. m.	"	9	7:00 p. m.	5	..	34.24°
" 1 " ..	4	48	"	8	10:45 a. m.	"	14	6:30 p. m.	6	$7\frac{3}{4}$	26.9°
" 1 " ..	5	43	"	9	3:00 p. m.	"	16	12:00 m.	7	9	24.4°
" 3 " ..	6	33	"	12	1:00 p. m.	"	18	5:45 p. m.	6	$4\frac{3}{4}$	26.25°
" 1 Gen. 1	7b	60	July	6	1:15 p. m.	July	11	7:00 p. m.	5	$5\frac{3}{4}$	32.40°
" 1 "	8c	58	"	8	3:00 p. m.	"	13	5:00 p. m.	5	2	37.67°
" 1 "	9d	43	"	8	4:30 p. m.	"	13	1:00 p. m.	4	$21\frac{1}{2}$	37.81°
" 1 "	10e	56	"	10	1:00 p. m.	"	14	9:00 p. m.	4	8	40.22°
" 3 Hib. adults ..	11	40	"	10	1:45 p. m.	"	15	11:30. a. m.	4	$21\frac{3}{4}$	39.54°
" 1 Gen. 1	12f	32	"	11	4:00 p. m.	"	16	9:00 p. m.	5	5	38.46°
" 3 Hib. adults ..	13	28	"	14	2:30 p. m.	"	19	7:00 p. m.	5	$4\frac{1}{2}$	37.74°
" 1 Gen. 1	14	80	"	14	2:30 p. m.	"	19	6:00 a. m.	4	$15\frac{1}{2}$	35.64°
" 1 "	15	83	"	18	3:15 p. m.	"	24	8:00 a. m.	5	$16\frac{3}{4}$	33.07°
" 3 Hib. adults ..	16	11	"	19	3:30 p. m.	"	25	6:00 a. m.	5	$14\frac{1}{2}$	34.05°
" 1 Gen. 1	17	53	"	19	12:30 p. m.	"	24	5:00 p. m.	5	$4\frac{1}{2}$	33.41°
" 3 Hib. adults ..	18	51	"	23	11:30 a. m.	"	27	12:00 m.	4	$12\frac{1}{2}$	38.43°
" 2 " ..	19	38	Aug.	4	10:00 a. m.	Aug.	9	9:00 a. m.	4	21	34.78°
" 2 " ..	20	26	"	5	10:30 a. m.	"	10	2:00 p. m.	5	$3\frac{1}{2}$	33.24°
" 3 " ..	21	41	"	5	10:30 a. m.	"	10	3:00 p. m.	5	$4\frac{1}{2}$	33.50°

But first attention should be drawn to the fact that there exists variation in the duration of embryonic development for batches of eggs deposited at the same time, hence subject to the same environmental factors including temperatures. Thus in lots 13 and 14 (Table I), from different parents, deposited at the same time on June 14 hatched at different times on June 19, lot 14 hatching 13 hours earlier than lot 13. And in lots 8 and 9; although there is a difference of an hour and a half between the times of deposition, the times of hatching diverge still more being separated by four hours and the lot deposited last hatched first. These lots were from the same parent. But contrary to this, in lots 10 and 11 deposited by different parents within 45 minutes of each other, the lot deposited first hatched first, the times of hatching being $14\frac{1}{2}$ hours apart. However, lots 20 and 21 deposited by different parents at the same time hatched within an hour of each other. The data are insufficient but parentage apparently does not account for the variation between batches of eggs deposited simultaneously and we must state tentatively that it is inherent and hence subject to the laws of chance or else there are factors involved which have escaped detection. We think this variation is inherent and hence limited or continuous and with sufficient data could be plotted in the same way as other continuous variations. It is of the same nature, apparently, as individual variations in the duration of postembryonic stadia, a matter of common observation and which are not controlled by temperature within certain time limits, nor by food.

As found previously, the daily average effective temperature increases as the period of embryonic development decreases and conversely. But for equal periods of development as shown in foregoing, equal amounts of temperature were not necessary, as witness lots 1 and 2, 7 and 12 and lots 13 and 21; also lots 9, 11 and 19. For a degree of temperature (effective) there appears to be a variable amount of growth or development, which as yet remains unpredictable; it is a specific, or maybe generic, characteristic.

2. *Number of Eggs Deposited.*

The data obtained on this point but serve to confirm what is stated by Girault (1908, p. 157 ff.) in a previous paper and also to increase the maximum number observed to be deposited by several hundred. The data were derived mainly by keeping in confinement three pairs of hibernated beetles captured early in the season while mating in a potato field and one or two pairs of the succeeding generations. The total number of eggs deposited, the rate of deposition and other related points for the pairs of the several generations are brought out in Table II presented herewith. The records fall short of what actually would have been the totals for the generations, as toward the second week in August the adult beetles were much neglected and finally died of starvation. The effect of this lack of nourishment on the second generation (or parents of the third generation) was especially noticeable, for although mating occurred freely throughout the different lots, oviposition occurred but once and most of the beetles disappeared into the soil for hibernation nearly as soon as their food was discontinued. The results indicate, however, that the first generation of adults are capable of as large an amount of reproduction as are the hibernated beetles and that the second generation of adults (or parents of the third generation) were willing or able to reproduce.

The three pairs of the hibernated beetles were obtained from a potato field in Urbana captured while mating at 11

TABLE II. NUMB

Mass No.	May
	Pair No. 1.
	Date
1	May 23, 7:00 p. m.
2	" 30, 7:00 p. m.
3	June 1, 2:00 p. m.
4	" 3, —:— a. m.
5	" 4, —:— a. m.
6	" 4, 7:00 p. m.
7	" 5, 12:00 M.
8	" 6, —:— a. m.
9	" 7, 11:00 a. m.
10	" 8, 10:45 a. m.
11	" 9, 3:00 p. m.
12	" 11, 3:30 p. m.
13	" 13 2:00 p. m.
14	" 14, 4-6 p. m.
15	" 17, 3:00 p. m.
16	" 22, 1:30 p. m.
17	" 23, 9:00 p. m.
18	" 24, 2:30 p. m.
19	" 26, 1:00 p. m.
20	" 26, 4:00 p. m.
21	" 28, 3:00 p. m.
22	" 30, 10:00 a. m.
23	July 1, 1:30 p. m.
24	" 3, 2:45 p. m.
25	" 4, 2:50 p. m.
26	
27	
28	
29	
30	
31	
32	
33	
34	
35	
36	
37	
38	
39	
40	
41	
42	
43	
44	
45	
46	
47	
48	
49	
50	
	Total
	No. of batches....
	Av. per batch......
	Daily av...

TABLE II. NUMBER OF EGGS DEPOSITED IN CONFINEMENT BY PAIRS OF DIFFERENT GENERATIONS, 1908.

Mass No.	Hibernated Adults. 1st Mating observed: May 23, 11 a. m.				May 27, 7:30 p. m.		Generation I. Parents 2d Gen. First mating observed June 23, 9 a. m.		Generation II. Parents 3d Gen. First mating observed Aug. 11, 3 p. m.	
	Pair No. 1. Date	No. Eggs	Pair No. 2. Date	No. Eggs	Pair No. 3. Date	No. Eggs	Pair No. 1 Date	No. Eggs	Pair No. 2 Date	No. Eggs
1	May 23, 7:00 p. m.	73	May 23-27	8	May 28, 1:30 p. m.	77	July 8, —:— a. m.	52	Aug. 11, 10.00 a. m.	3
2	" 30, 7:00 p. m.	27	" 30, 11:00 a. m.	25	" 29, 11:45 a. m.	58	" 8, 3:00 p. m.	58	" 12, —:— p. m.	9
3	June 1, 2:00 p. m.	50	" 30, 5:00 p. m.	22	" 29, 3:00 p. m.	11	" 8, 4:30 p. m.	43		
4	" 3, —:— a. m.	38	June 1, 1:00 p. m.	48	" 30, 1:30 p. m.	49	" 9, 2:00 p. m.	53		
5	" 4, —:— a. m.	62	" 2, 2:00 p. m.	46	June 1, 1:30 p. m.	64	" 10, 1:00 p. m.	56		
6	" 4, 7:00 p. m.	18	" 4, 12:00 M.	53	" 2, 2:30 p. m.	38	" 10, —:— p. m.	30		
7	" 5, 12:00 M.	29	" 5, 10:30 a. m.	43	" 4, 2:00 p. m.	47	" 11, 10:00 a. m.	44		
8	" 6, —:— a. m.	46	" 6, —:— a. m.	8	" 5, 10:00 a. m.	27	" 11, 4:00 p. m.	32		
9	" 7, 11:00 a. m.	49	" 6, —:— a. m.	23	" 6, 11:00 a. m.	36	" 12, —:— a. m.	41		
10	" 8, 10:45 a. m.	48	" 7, 11:30 a. m.	42	" 6, —:— p. m.	9	" 13, 1:00 p. m.	14		
11	" 9, 3:00 p. m.	43	" 8, 12 M.	57	" 7, 11:30 a. m.	45	" 14, 2:30 p. m.	80		
12	" 11, 3:30 p. m.	24	" 9, 3:30 p. m.	52	" 7, 7:30 p. m.	23	" 15, 12:30 p. m.	58		
13	" 13 2:00 p. m.	35	" 10, 3:00 p. m.	23	" 8, 12:30 p. m.	39	" 16, 8:00 p. m.	80		
14	" 14, 4-6 p. m.	34	" 12, 1:00 p. m.	51	" 9, 2:30-4:30 p.m	56	" 17, 12:00 M.	64		
15	" 17, 3:00 p. m.	1	" 13, 3:00 p. m.	32	" 10, 4:00 a. m.	48	" 18, 3:15 p. m.	83		
16	" 22, 1:30 p. m.	37	" 14, 10:00 a. m.	6	" 11, 3:45 p. m.	21	" 19, 12:30 p. m.	53		
17	" 23, 9:00 p. m.	39	" 20, 3:00 p. m.	13	" 12, 1:00 p. m.	33	" 21, 11:30 a. m.	88		
18	" 24, 2:30 p. m.	21	" 21, 1:20 p. m.	40	" 13, 2:45 p. m.	45	" 21-22, a. m.	40		
19	" 26, 1:00 p. m.	36	" 22, 1:30 p. m.	49	" 14, 4-6 p. m.	31	" 24, 2:00 p. m.	6		
20	" 26, 4:00 p. m.	32	" 23, 9:10 a. m.	36	" 16, 1:30 p. m.	33	" 25, 10:30 a. m.	9		
21	" 28, 3:00 p. m.	26	" 24, 1:30 p. m.	29	" 17,	1	" 26, 12:00 M.	30		
22	" 30, 10:00 a. m.	30	" 28, 2:20 p. m.	14	" 21, 1:30 p. m.	36	" 27, 10:00 a. m.	26		
23	July 1, 1:30 p. m.	42	" 29, 3:00 p. m.	24	" 22, 1:30 p. m.	21				
24	" 3, 2:45 p. m.	31	July 1, 10:00 a. m.	10	" 23, 1:10 p. m.	41				
25	" 4, 2:50 p. m.	31	" 2, —:— p. m.	30	" 26, 5:30 p. m.	8				
26			" 3, 2:40 p. m.	25	July 4, 3:30 p. m.	28				
27			" 6, 1:20 p. m.	44	" 6, 1:30 p. m.	33				
28			" 7, 3:00 p. m.	42	" 8, 2:00 p. m.	46				
29			" 9, 11:45 a. m.	41	" 9, 1:30 p. m.	34				
30			" 10, 1:00 p. m.	14	" 10, 1:45 p. m.	40				
31			" 12, 9:30 a. m.	14	" 11, 2:00 p. m.	29				
32			" 12, 1:00 p. m.	8	" 12, 9:00 a. m.	10				
33			" 14, 2:30 p. m.	28	" 14, 2:30 p. m.	28				
34			" 15, 12:00 M.	37	" 14, 5:00 p. m.	33				
35			" 17, 11:45 a. m.	45	" 15, 3:00 p. m.	32				
36			" 18, 10:30 a. m.	49	" 18, 10.00 a. m.	27				
37			" 19, 1:30 p. m.	24	" 19, 3:30 p. m.	11				
38			" 21, 1:00 p. m.	31	" 23, 11:30 a. m.	51				
39			" 25, 10:00 a. m.	10	" 25, —:— p. m.	70				
40			" 25, 10:30 a. m.	21	" 26, 4:00 p. m.	17				
41			Aug. 2,	19	" 29, —:— p. m.	34				
42			" 3,	16	" 30, 10:00 a. m.	10				
43			" 4, 10:00 a. m.	38	Aug. 2,	10				
44			" 5, 10:30 a. m.	26	" 3, —:— p. m.	17				
45			" 6, —:— p. m.	22	" 4, —:— p. m.	19				
46			" 7, 11:00 a. m.	19	" 5, 10:30 a. m.	11				
47			" 11, 10:00 a. m.	1	" 6, —:— p. m.	21				
48			" 16, —:— p. m.	4	" 8, —:— p. m.	12				
49					" 10, —:— p. m.	19				
50					" 12, —:— p. m.	9				
	Total	902	Total	1362	Total	1578	Total	[illegible]		
			Average, 1280.6							
	No. of batches	25	No. of batches	48	No. of batches	50	No. of batches	[illegible]		
	Av. per batch	36 08	Av. per batch	28 37	Av. per batch	31.6	Av. per batch	[illegible]		
	Daily av	21 47	Daily av	16 40	Daily av	20 76	Daily Av.	[illegible]		

A. M., May 23 (pairs No. 1 and 2) and at 7:30 P. M., May 27, 1908 (pair No. 3) and confined with food immediately after capture. The single pair of the first generation resulted from a mass of 60 eggs deposited by hibernated beetles and taken from the field on May 23, 1908 and the single reproducing pair of the second generation are direct descendants of the pair of the first generation.

In the case of an extra cage containing a large number of adults collected in the field during the latter part of July, a female was observed to deposit a mass of 103 eggs, the largest single mass of eggs yet recorded. In another case, the rate of oviposition was timed; a female deposited in succession in a single mass in the usual manner 64 eggs in a period of time occupying 3200 seconds or 53 1-3 minutes. The rate of deposition was regular, each single deposit requiring 50 seconds—40 seconds to pass the egg and to fasten it and about 10 seconds to obtain position for the next deposit.

Attention is called to the rapid deposition of the single pair of the first generation, having a daily rate of deposition of 52 eggs and on a single day (July 8) depositing as many as 153 eggs in three separate batches, averaging 51 eggs each.

THE LARVA.

1. *Duration of Larval Stadia.*

We were able to make more observations concerning this phase of the beetle's life during 1908 than at previous times. The records for the first fifteen lots in the annexed table (Table III) comprise single larvae of the same age and parentage, that is, they are all from the same batch of eggs, hatching at the same average time but confined separately each individual ecdysis being recorded.

Lot No. 16, comprising 45 larvae, was from the same mass of 60 eggs as the larvae of lots No. 1-15, but upon hatching were confined together on their food. With them, the first ecdysis became general at 4 P. M., May 29; the second ecdysis began at 7 P. M., May 31, but was not general until 2:30 P. M., June 1, and was completed at 6 P. M., June 1, occupying a period of 23 hours. On June 3, the larvae were large, plump and healthy, eating voraciously, but only 30 in number, 15 having died. The third ecdysis began at 5 P. M., June 4,

TABLE III.

Duration of Larval Stadia for Different Generations, 1908.

Lot. No.	No. Larvae	Hatched	Source	1st Ecdysis Stadium I	Duration of Stadium: Days	Duration of Stadium: Hours	2d Ecdysis Stadium II	Duration of Stadium: Days	Duration of Stadium: Hours	3d Ecdysis Stadium III	Duration of Stadium: Days	Duration of Stadium: Hours	Entered soil Stadium IV	Duration of Stadium: Days	Duration of Stadium: Hours	Sums: Days	Sums: Hours	Total effective Temp. Degrees Fahr.	Average daily Effective temp. Degrees Fahr.
1	1	May 27, 11:00 a. m.	Hib. adults (nature)	May 29, 12:00 M.	2	1	May 31, 6:00 p. m.	2	6	June 4, 9:30 a. m.	3	15½	June 7, 4:30 a. m.	2	19	10	17½	285 8°	26 80°
2	1	"		" 29, 11:30 a. m.	2	½	" 31, 4:30 p. m.	2	5	Died			.. ..	..	..		.	..	....
3	1	"		" 29, 12:30 p. m.	2	1½	" 31, 11:00 p. m.	2	10½	Died 10 a.m. June 2			......	..	..	..	.	....	......
4	1	"		" 29, 7:00 a. m.	1	20	" 31, 2:00 p. m.	2	7	"			......	..	.	.	..	....	......
5	1	"		" 29, 7:00 a. m.	1	20	" 31, 1:30 p. m.	2	6½	June 4, 9:30 a. m.	3	19	Died	.					.. .
6	1	"		" 29, 11:00 a. m.	2		" 31, 7:00 p. m.	2	8	" 4, 12:00 M.	3	17	June 8, 7:00 p. m.	3	19	11	20	345.9°	28.05°
7	1	"		" 29, 8:00 a. m.	1	21	" 31, 1:30 p. m.	2	5½	" 4, 9:30 a. m.	3	19	" 7, 4:30 a. m.	2	19	10	17½	285.8°	26.80°
8	1	"		" 29, 1:00 p. m.	2	2	" 31, 6:00 p. m.	2	5	" 4, 11:00 a. m.	3	17	" 7, 4:30 a. m.	2	17½	10	17½	285 8°	26 80°
9	1	"		" 29, 11:00 a. m.	2	.	" 31, 11:00 p. m.	2	12	Died June 6	..		....	..	.	..	..	....	...
10	1	"		" 29, 8:00 a. m.	1	21	" 31, 11:30 a. m.	2	3½	June 4, 6:00 a. m.	3	16½	Died	..		.	.	....	...
11	1	"		" 29, 2:00 p. m.	2	3	June 1, 9:00 a. m.	2	19	" 4, 12:00 M.	3	3	June 8, 7:00 p. m.	3	19	11	20	345.9°	28.05°
12	1	"		" 29, 10:00 a. m.	1	23	May 31, 2:30 p. m.	2	4½	" 4, 7:00 a. m.	3	16½	" 7, 4:30 a. m.	2	21	10	17½	285.8°	26 80°
13	1	"		" 29, 1:00 p. m.	2	2	June 1, 2:00 p. m.	3	1	Died 6 p. m., June 3	..	..	....	..	..	..	..	....	.....
14	1	"		" 29, 3:00 p. m.	2	5	" 1, 1:00 p. m.	2	22	June 5, 11:00 a. m.	3	22	Died	..	..	..	..	....	......
15	1	"		" 29, 12:30 p. m.	2	1½	" 1, 7:00 a. m.	2	16½	" 4, 6:00 p. m.	3	11	Died	..		..	..	....	......
		1-15 Average.			2	½		2	14½		3	12½		3	6¼	11	9½		
16	45	May 27, 11:00 a. m.		May 29, 4:00 p. m.	2	5	June 1, 2:30 p. m.	2	22½	June 5, 8:00 a. m.	3	17½	June 7, Noon	2	4	11	1	298.2°	27.10°
17a	.	July 7, 6:30 a. m.		July 10, 2:00 p. m.	3	7½	July 13, 6:00 a. m.	2	16	July 15, 12:30 p. m.	2	6½	July 19, 7:00 a. m.	3	18½	12	½	425.5°	35.45°
18b	.	" 11, 7:00 p. m.	Gen. I—mixed	" 14, 6:00 a. m.	2	11	" 16, 1:00 p. m.	2	7	" 19, 7:00 p. m.	3	6	" 24, 8:00 a. m.	4	13	12	13	453.56°	35.82°
19c	58	" 13, 5:00 p. m.	Gen. I—Pair No 1	" 15, 6:00 p. m.	2	1	" 18, 11:00 a. m.	2	17	" 22, —:— p. m.	..	..	" 25, 9:00 p. m.	..		12	4	433.13°	35.12°
20d	43	" 13, 1:00 p. m.		" 16, 6:00 p. m.	3	5	" 18, 12:00 M.	2	6	" 20, 9:00 p. m.	2	9	" 24, 8:00 p. m.	4	1½	11	21½	409.26°	35.09°
21e	56	" 14, 9:00 p. m.		" 17, 12:00 M.	2	15	" 19, 1:00 p. m.	2	1	" 22, —:— p. m.	.	..	" 25, 11:00 p. m.	..	..	11	2	385.40°	35.03°
22f	32	" 16, 9:00 p. m.		" 18, 6:00 p. m.	2	21	" 21, 9:00 p. m.	3	3	" 23, —:— p. m.	..	.	" 27, 6.00 a. m.	..	..	10	9	362.00°	35 04°
		a to f Average			2	16¼		2	14		2	18¼		3	3¾	11	11		

and was general at 8 A. M., June 5, concluding at 2 P. M., June 5, occupying a period of 21 hours. But 18 larvae successfully survived the ecdysis. Entering the soil for pupation began on June 7, at 4:30 A. M. and all larvae had entered by June 8, 7 P. M. Table III summarizes.

2. *Number of Ecdyses.*

There can be no doubt but that the normal number of larval ecdyses, excluding pupation, is three and as additional evidence we have observed this number in two hundred and the fifty cases during the season without a single exception for whole number. The question may be considered as settled.

3. *Duration of the Larval Stage.*

There being no data concerning this point other than what are already included in Table III, it is unnecessary to repeat them here, but reference should be made to the column of sums of that table.

THE PUPA.

1. *Duration of Pupal Stage.*

Table IV summarizes sufficiently well all of our data for 1908 concerning this phase of the beetle's life cycle.

TABLE IV.

DURATION OF PUPAL STAGE, ACTUAL TIME IN SOIL, SEASON 1908.

Lot No.	No. Pupae	Entered Soil.	Adults Emerged	Length Time in Soil.		Sum of Effective Temp. Degrees Fahr.
				Days.	Hours.	
1	1*	June 7, 4:30 a. m.	June 21, 1:30 p. m.	14	9	418.4°
6	1	" 8, 7:00 p. m.	" 22, 6:00 a. m.	13	11	383.2°
7	1	" 7, 4:30 a. m.	" 19, 4:00 p. m.	12	11½	307.5°
8	1	" 7. 4:30 a. m.	" 21, 1:30 p. m.	14	9	418.4°
11	1	" 8, 7:00 p. m.	" 22, 1:00 p. m.	13	18	396.6°
12†	1	" 7, 4:30 a. m.	" 21, 1:30 p. m.	14	9	418.4°
16	45	" 7, noon	" 22, noon	15		444.2°
17a	..	July 19, 7:00 a. m.	July 30, 6:00 p. m.	11	9	425.9°
18b	..	" 24, 8:00 a. m.	Aug. 4, 7:00 p. m.	11	11	450.6°
19c	58	" 25, 9:00 p. m.	" 6, 7:00 a. m.	11	10	404.5°
20d	43	" 24, 11:00 p. m.	" 4, 8:30 a. m.	10	9½	396.4°
21e	56	" 25, 11:00 p. m.	" 5, 12:15 p. m.	10	13¼	397.4°
22f	32	" 27, 6:00 a. m.	" 6, 6:00 p. m.	10	12	410.6°

* These numbers correspond with the lots in Table III.

† Average of Lots No. 1 to 12, 13 days, 19½ hours.

THE ADULT.

1. *Length of Life in Confinement.*

a. In Pairs Normally Reproducing.

The data obtained on this point are scanty and much vitiated by the fact that the lots were neglected too soon to obtain normal results, but they supplement to some extent the data obtained in 1907 tending to support the theory that the average duration of life of normally reproducing adults is two months or more. The average here is 1.8+ months, the data however being insufficient.

TABLE V.

LENGTH OF ADULT LIFE IN CONFINEMENT, NORMALLY REPRODUCING.

Lot No.	No. Individuals.		Source.	Date Confined, 1908 (Emergence.)	Date of Death, 1908.		Length of Life, Months	
	Male	Female			Male	Female	Male	Female
I. Hibernated								
1	1	1	....	11 a. m., May 23	June 4*	July 7	0.4	1 5
2	1	1	Potato field, mating.	11 a. m., May 23	Aug. 16†	Aug. 16†	2.8+	2.8+
3	1	1		7:30 p.m., May 27	July 26	Aug. 16†	1.96	2.66+
II. Gen. I								
1	1	1	Hibernated adults (nature)	June 23	Aug. 16‡	Aug. 16‡	1.8+	1.8+
III. Gen. II	Many	Many	Pair No. 1, Gen I.	July 30—Aug. 8	August‡	August‡	0.5+	0.5+

* Escaped. † Liberated. ‡ Starved and entered hibernation.

2. *Length of the Period of Oviposition.*

As with the previous section, the results here are abnormally short in point of duration for the reasons given. They are merely tabulated therefore, without further comment.

TABLE VI.

LENGTH OF THE PERIOD OF OVIPOSITION. DIFFERENT GENERATIONS, 1908.

Generation No.	First Mated.	First Eggs Deposited.	Last Eggs Deposited.	Length of Period of Oviposition, Days.
Hibernated—				
Pair No. 1..........	11 a. m., May 23	7 p. m., May 23	2:50 p.m., July 4	42+
Pair No. 2..........	11 a. m., May 23	May 25*	August 16, p. m.	83
Pair No. 3	7:30 p.m., May 27	1:30 p. m., May 28	August 12, p. m.	76
I—Pair No. 1...........	9 a. m., June 23	July 8, a. m.	10 a. m., July 27	20+
II.—Pair No. 1c........	Aug. 11, 3 p. m.	Aug. 11, 10 a. m.	Aug. 12, p. m.	1+

* Average time of a period of 4 days.

3. *Mating.*

The observations on this habit are also limited, but those matings actually observed are summarized in Table VII. In a single case, the time actually involved from beginning to end of the act was obtained, being three and one-half hours (10:30 A. M. to 2 P. M., June 18, Pair No. 3, hibernated adults.)

TABLE VII.

FREQUENCY OF MATING IN REPRODUCING PAIRS. DIFFERENT GENERATIONS, 1908.

Generation No.	Pair No.	First Mating	Subsequent Matings	Last Matings	No. of Matings	Observed Period of Mating, Days	Period of Oviposition, Days	No. Eggs, Masses Deposited
Hibernated	1	11 a. m., May 23	May 28, 30, 31...... June 1..............	June 4*	6	12	42+	25
	2	11 a. m., May 23	May 27, 30.......... June 2, 4, 21....... July 1, 23, 26, 28.... Aug. 3, 4, 5, 5, 7, 7..............	August 11	17	80	83	48
	3	7:30 p. m., May 27	May 30............. June 3, 4, 10, 13, 18, 18, 20, 24, 24.... July 1, 9, 15, 17, 17 .	July 18	17‡	52	76	50
I	1	9 a. m., June 23	....	July 8	2	15	20+	22
II	1a 1c 1d 2d 3d	Aug. 3, 3 p. m. Aug. 9, 4 p. m. Aug. 9, 10 a. m.° Aug. 9, 10 a. m.° Aug. 9, 6:30 a. m.°	Aug. 4, 5, 6.......... Aug. 11, 12..........	Aug. 7, 9 a. m.‡ Aug. 13, 3 p. m.	5 4	3½ 4	.. 1+	.. 2
	1e 1f	Aug. 11° Aug. 11	Aug. 13............	Aug. 14	3	3	..	

* Male escaped. † Male died July 26. ‡ Male entered soil for hibernation.
° Only observed mating; hibernation followed within 10 days.

Mating was observed during the following hours of the day: Practically at any hour between 7 A. M. and 11 P. M., more commonly at 9, 10 and 11 A. M. and 1, 2, 3, 4 and 6 P. M. or at fractions of those hours. The function was observed most commonly at 9 and 10 A. M., over 31 per cent of the 58 times the act was observed being either at or between those two hours. Fifty per cent of the observed matings occurred in the morning and fifty per cent. in the afternoon or evening. Observations were continued throughout most of the night, up at least until midnight, commencing again at six o'clock in the morning.

4. *Potency of Fertilization.*

As concerns this point, it was noticed in the case of the hibernated pairs, and with these pairs only was opportunity presented to gather any data bearing on the question, that the female of Pair No. 1 continued to deposit fertile ova for one month after the absence of the male (June 4, 7 P. M., to July 4, 2:50 P. M.); and that the female of Pair No. 3 deposited fertile ova for seventeen days after the death of her mate. No other data were obtained.

5. *Number and History of Generations Reared in the Laboratory.*

Our data here are also meagre, but they certainly do tend to uphold the opinion that the adults of the second generation (or parents of the third generation) are at least able, if not willing, to reproduce and hence the observations of last year (Girault 1908) are upheld and Tower's (1906) dictum that "The second generation does not develop the germ-cells nor show any reproductive activity until after it has passed through a period of hibernation or aestivation" becomes in our minds less and less authoritative. These beetles of the second generation with us certainly showed reproductive activity, if repeated matings can be called such, and one pair, even under very adverse conditions—starvation—deposited fertile eggs, which surely must be conceded to be reproduction which cannot of course take place without development of the germ-cells. The beetles with us this year plainly showed symptoms of what we would call eagerness and ability to reproduce. These beetles were those of the second generation, as will be shown in the following brief historical sketch, and were normal in every way, that is to say, did not represent any special race of the species.

On May 23, 1908, or at the earliest possible date, 60 eggs of the species were collected from a potato plant in a small plot of potatoes at Urbana, Illinois and brought to the laboratory to comprise the first generation or descendants of the hibernated adults. The larvae came to maturity early in June and pupated and eleven adults emerged between June 21 and June 23. They were confined together with food. On the latter date a pair were found mating and were at once isolated as the parents of the second generation.* From this pair of adults of the first generation, there were taken for the special

* The others were accidentally poisoned with arsenate of lead.

purpose of rearing a sufficient quantity of the second generation, six lots or batches of eggs numbered from *a* to *f*. In all 49 adults were obtained from the six batches. For clearness, the batches are treated in detail: (1) Batch *a*, consisting of about 20 (number unknown) eggs hatched at 6:30 A. M., July 7, the resulting larvae entering the soil for pupation at the average time of 7 A. M., July 19 and on July 30 and 31, 4 adults were obtained. These were at once fed and at 3 P. M., August 3, a pair were observed mating and were isolated. This pair continued to mate until 9 A. M., August 7, the ♂ entering the soil shortly afterward; with them mating was observed five times, but no oviposition occurred. In the meantime, the two remaining beetles had hibernated (August 8), the mated female following a week later. Hibernation induced by starvation due to lack of time in which to feed the beetles. (2) Batch *b*, consisting of 60 eggs came to larval maturity at 8 A. M., July 24, and on August 4 and 5, two adults were obtained comprising the whole survival. These were males and hibernated on August 22. (3) Batch *c*, 58 eggs, came to larval maturity at 9 P. M., July 25, and gave from August 5 to 7, 4 adults which were placed on food as they emerged. A male died on August 8 and a pair were mating at 4 P. M., August 9; this pair was then isolated. On August 11 at 10 A. M., 3 eggs were deposited which proved to be fertile; mating was again observed at 3 P. M. the same day and at the same hour on August 12; later the same day (12) 9 eggs were deposited on a leaf, which also proved to be fertile; another mating was observed at 9 A. M., August 13, but thereafter no other matings were observed and further reproduction did not occur. The remaining adult died on August 22, but the mated pair remained alive without food until August 25, when the cage was broken up. Oviposition and mating in spite of insufficient food. (4) Batch *d*, 43 eggs, came to larval maturity at 10 P. M., July 24, and on August 4 from 7 to 10 A. M., 11 adults were obtained, the total survival. On August 9, 3 pairs observed mating were isolated but other matings did not occur with them nor oviposition, caused as we have reason to believe, by the neglect to supply food. Thus, on August 13 the third pair had entered the soil for hibernation and two days later the second pair had done likewise; the first pair remained on top of the soil until August 25, when they were killed and removed. Of the remaining five adults, two had died by August 11 and the three others hibernated on August 22. (5) Batch *e*, 56 eggs, came to larval maturity at the average time of 11 P. M., July 25, and gave 24 adults from August 4 to August 6, which were confined together with food. But a single pair was isolated, observed mating on August 11, though previously, mating had occurred promiscuously. This pair was neglected after isolation and no further reproductive activity occurred; on August 13 at 9 A. M., the male entered the soil for hibernation and on August 25 the pair were removed still alive. Of the remaining 22 beetles, 4 hibernated on August 11 at 9 A. M. and by August 22, all had disappeared beneath the soil, two having died there. No reproduction, but during the period of feeding, after several days, mating was frequent and promiscuous and there is good reason for believing that reproduction was prevented by actual starvation at a critical period. (6) Batch *f*, 32 eggs, arrived at larval maturity at the average time of 6 A. M., July 27, and gave 4 adults August 7 and 8; on August 11, a mating pair of this lot were isolated and the remaining two also paired. The first pair mated again on August 13 and August 14 but no oviposition followed and they were removed on August 25, after days of starvation. The second pair had hibernated by August 22, without depositing eggs and with no further observed matings.

In general it may be stated that the adults of the second generation just after emergence fed voraciously for several days and then began to mate as though eager to reproduce and one pair acutally deposited fertile eggs, insuring at least a portion of a third generation. It was at this time in their lives, just following the period of heavy feeding and the beginning of mating that stress of other work caused the food to be neglected and after August 8, the beetles were starving and were forced to hibernate. Incidentally, it was also true that their food-plant in nature was also very scarce at this time, so even if at large, it is not unreasonable to suppose that these beetles of the second generation would have been forced into hibernation before reproduction could begin, though willing and able to reproduce. What little evidence we have gathered this year forces us to conclude that the second generation of adults *exceptionally* are both willing and able to reproduce, merely supplementing what was previously indicated to be true in 1907. The evidence of course is gross in nature, for we did not actually examine the mated females in any case for spermatozoa, so that in the majority of cases, actual mating is open to question. It is needless to say that this should have been done. But in at least one case we are sure that both mating and reproduction occurred as fertile ova were deposited.

In regard to the seasonal history in 1908, the second generation was obtained nearly a month earlier than that obtained in 1907, so that there was ample time for a third generation. The following table summarizes the generations reared in confinement.

TABLE VIII.

GENERATIONS REARED IN THE LABORATORY, URBANA, ILLINOIS, 1908.

Generation No.	Eggs Deposited.	Adults Out.	Length of Cycle.		Effective Temp Sums, Degrees F.
			Days	Hours	
I.	May 21*	June 22	32	..	948.2°*
II. Lot a	July 2†	July 30, 11 p. m.	28	12	..
b.	July 6, 1:15 p. m.	August 4, 7 p. m.	29	5¾	1062.3°
c.	July 8, 3 p. m.	August 6, 7 a. m.	28	16	1056.6°
d.	July 8, 4:30 p. m.	August 4, 8:30 a. m.	26	16	979.6°
e.	July 10, 1 p. m.	August 5, noon.	25	23	976.9°
f.	July 11, 4 p. m.	August 7, 6 p. m.	27	2	1009.9°
III.	August 11 and 12.	Not reared to maturity	..	..	..

* Approximated; hatched 11 a. m., May 27. † Approximated; hatched 6:30 a. m., July 7.

LITERATURE REFERRED TO.

1905. **Stiles, Charles Wardell,** Bull. No. 24, Hygienic Laboratory, Public Health and Marine-Hospital Service of the United States, Treasury Department, Washington, D. C.

1906. **Tower, William Lawrence.** An investigation of evolution in chrysomelid beetles of the genus Leptinotarsa. Publication No. 48, Carnegie Institution of Washington, Washington, D. C.

1907. **Girault, Alexandre Arsene and Arthur H. Rosenfeld.** Biological notes on the colorado potato beetle, Leptinotarsa decemlineata (Say), with technical description of its stages. Psyche, Cambridge, Mass., XIV, pp. 45-57.

1908. **Girault, Alexandre Arsene.** Further biological notes on the colorado potato beetle, Leptinotarsa decemlineata (Say), including observations on the number of generations and length of the period of oviposition. Annals Ent. Society of America, Columbus, Ohio, I, pp. 155-178.

MINUTES OF THE MINNEAPOLIS MEETING.

The Fifth Annual Meeting of the Entomological Society of America was called to order at 10:45 A. M., December 27, 1910, in the School of Mines Building, University of Minnesota, Minneapolis, by the President, Dr. John B. Smith. In the absence of the Secretary, Professor J. G. Sanders was elected Secretary pro tem. Announcements.

Professor F. L. Washburn moved that the chair appoint a committee of three to confer with a similar committee from the Association of Economic Entomologists concerning the organization of an Entomological Employment Bureau or Clearing House. It was agreed that the organization of such a body would facilitate the securing of available men for entomological work. Several expressed favorable opinions concerning this proposition.

The following papers were presented:

Notes on the Tingid *Leptobyrsa explanata* Heid., by E. L. Dickerson; read by the Secretary.

Notes on *Sanninoidea exitiosa* by Dr. J. B. Smith. Discussion by Mr. R. L. Webster, asking if any tables of head widths of various larval instars of this species had been published. He reported that such measurements constituted a very good method of identification.

"The Structure of Spermatophores in Crickets," by Mr. J. P. Jensen. Read by the author. (Published in March ANNALS.)

Dr. Smith asked if studies had been made of the copulatory organs in various species. Mr. Jensen replied that comparative drawings of a large number of individuals of the same species had been made, likewise of different species. He also reported that *Nemobius fasciatus* var. *vittatus* had been found in large numbers digging in loose soils, securing and destroying eggs of *Melanoplus bilineatus*. He considered this insect as undoubtedly a considerable factor in the control of *Melanoplus*. Dr. Smith questioned: "Is not such the general habit of some *Orthoptera*?" Was answered by Professor Bruner, "Many *Orthoptera* are largely carnivorous."

Professor Oestlund invited members to visit and inspect his collection of *Aphididae*.

The Society then adjourned until 1:30 P. M.

The President appointed the following committees when the Society reconvened:

Committee on Employment Bureau to confer with similar Committee from the Association of Economic Entomologists: Messrs. F. L. Washburn, Herbert Osborn, and Henry Skinner.

Nominating Committee: Professors E. D. Sanderson, H. E. Summers and R. L. Webster.

Auditing Committee: Professors Lawrence Bruner and J. G. Sanders.

The following papers were read:

"The Biological Survey of the Insect Life of Kansas" by Professor S. J. Hunter.

"An Experimental Study of the Death-Feigning Habit of *Belostoma* (*Zaitha*) *flumineum* and *Nepa apiculata* Uhler," by H. C. and H. H. Severin. Discussed by E. C. Cotton with the remark that the weevil *Apion segnipes* which worked in border pea-pods in Tennsesee was unable to free itself from the pod but is released automatically by the sudden opening of the pod. The *Apion* when disturbed under such conditions does not feign death, but if handled later it feigns death.

"Announcement of Further Results Secured in the Study of *Tachinidae* and *Allies*," by C. H. T. Townsend, Piura, Peru. This paper was read in part by the Secretary. (To be published in June ANNALS.)

The "Report of the Committee on Nomenclature" was written by Professor T. D. A. Cockerell with H. T. Fernald and E. P. Felt and was read by the Secretary. After some discussion, Prof. H. E. Summers moved to receive the report, order it printed and consider it at a later date. Carried.

The Society then adjourned until Wednesday at 9:00 A. M.

At 9:00 A. M., December 28, the Society was again called to order by the President, Dr. Smith, and the following reports presented:

The Report of the Editor of the ANNALS, Professor Herbert Osborn, was presented and on motion of Professor Lawrence Bruner, was accepted.

The Report of the Auditing Committee on the accounts of the Editor was presented by Professor Lawrence Bruner and accepted. He also reported on the accounts of the Treasurer for the Committee and they were accepted subject to correction.

The Report of the Secretary of the Executive Committee was presented and accepted and is given in full later.

The following paper was read:

"Some Suggested Rules to Govern Entomological Publications," by T. D. A. Cockerell, read by the Secretary. Several suggestions were made by Dr. Wolcott concerning entomological publications, as follows:

That it is the privilege of contributors to demand proof of their papers, but it is also obligatory that corrected proof be returned as soon as possible. Likewise, it was remarked that contributors could not expect manuscripts to appear in print on extremely short notice, as is frequently the case, but should expect their papers to take their turn.

The Nominating Committee reported as follows for officers for 1911:

President—Professor Herbert Osborn.
First Vice President—Professor Lawrence Bruner.
Second Vice President—Professor A. D. MacGillivray.
Secretary-Treasurer—Professor A. D. MacGillivray.

Additional Members of the Executive Committee:

Professor J. H. Comstock	Dr. W. M. Wheeler
Dr. J. B. Smith,	Dr. H. Skinner,
Professor C. J. S. Bethune,	Dr. A. D. Hopkins.

It was moved by Professor M. H. Swenk that the Secretary be instructed to cast a unanimous ballot for the officers nominated.

Professor E. D. Sanderson moved that a vote of thanks from the Society be extended to Professor Herbert Osborn, Managing Editor, for his faithfulness and especial care in the publication of the Annals.

Professor T. B. Symons moved that a vote of thanks be extended to the authorities of the University of Minnesota for their kindness in offering the use of the School of Mines Building for the Meetings of the Society.

On motion of Professor T. B. Symons, the Society adjourned to meet in joint session with the Association of Economic Entomologists in the afternoon.

The Annual Public Address was given in the Handicraft Guild Hall at 8:00 p. m., by Professor F. L. Washburn: The Typhoid Fly in the Minnesota Iron Range.

Report of the Executive Committee.

December 27, 1910.

The Executive Committee met in the corridor of the Hotel Dyckman at 10:00, with the following members present: Professors Smith, Bruner, Osborn, and Sanders. The following business was transacted:

List of Members Deceased during the Year Ending November 30, 1910.

F. A. Herrick, New Brighton, Pa.
G. W. Peck, Roselle Park, N. J.
Henry Ulke, Washington, D. C.
G. A. West, Urbana, Ill.
Rev. J. L. Zabriskie, Brooklyn, N. Y.

The following were elected to membership in June, 1910:

E. M. Walker,
Edward E. Philips,
Alvin R. Cahn,
C. R. Alexander,
Miss A. C. Stryke.

The following were elected by the Executive Committee:

Henry E. Ewing,
M. D. Leonard,
R. D. Whitmarsh,
E. W. Stafford,
E. O. Essig,
H. R. Jennings,
George G. Becker,
Miss E. I. McDaniel,
F. H. Shoemaker,
W. R. McConnell,
W. R. Thompson,
D. Finkelstein,
C. R. Plunkett,
E. W. Scott.

The following resignations have been accepted and membership terminated:

C. C. Adams,
J. S. Faaborg,
A Mares.
F. W. Powers,
W. G. Wright.

The Secretary-Treasurer reported a list of eighty members, who, according to the rules of the Society, had been dropped for the nonpayment of dues. The Executive Committee referred this matter back to the Secretary and authorized him to write a personal letter to each.

The Treasurer presented the following report of receipts and disbursements for the year ending November 20, 1910.

RECEIPTS:

Balance forward		$ 38.32
Received from H. Osborn, subscriptions		109.05
Cash received for dues, 1910	316.70	
Cash received for dues past	80.00	396.70
Cash received for subscritpions, 1910	$243.00	
Cash received for subscriptions, past	58.90	
		$301.90
H. Osborn, Nov. 11, 1910		135.07
Total		$981.04

DISBURSEMENTS:

For ANNALS, Dec., 1909, 1000	$182.70	
March, 1910, 800	192.68	
June, 1910, 800	170.23	
		$545.62
Includes reprints, etc., clerical, typewriting		37.40
Postage, stamped envelopes, cards		22.21
Half-tones ANNALS		9.22
Dues, notices, statements		11.50
Express, telegrams, ledger paper, dating stamp		1.60
Excess remittance returned to Akerlind		1.00
Balance cash on hand		352.49
Total		$981.04

Of the $352.49 now on hand $100, the fees from life members, is deposited in the Rothschild Bank of Ithaca where it is drawing 4% interest.

There is charged against the Society to offset dues of members dropped, resigned and deceased, 91 members, $239.85; Charges against ANNALS to offset subscriptions for members dropped, resigned and deceased, $35.00; total, $274.85.

These charges reduce the apparent assets for the year considerably. Quite a number of these members dropped out last year, but the proper charge was not made on the books.

The Secretary was instructed at the Boston Meeting to take a mail vote of all members and fellows of the society as to whether the present arrangement for separate dues and subscriptions to the ANNALS should remain in force, or whether they should be combined into a single fee of two dollars with the provisions that all should receive without further expense the publications of the Society. The result of this vote was as follows: For the amendment 182; against the amendment 18; blanks returned but preference not expressed 2; total 202. While the vote was decidedly in the affirmative, only slightly over one-half of the members voted.

J. G. SANDERS, *Secretary.*

Report of the Committee on Nomenclature.

The Committee has received a letter from Dr. C. W. Stiles, of the International Commission on Zoological Nomenclature, stating that it is proposed to work out the correct names of all the animals most intimately connected with man. In the course of this work, it becomes necessary to deal with the insect parasites of man, and it is desired that the list, as finally presented, shall show the correct names as determined under the International Code, and enumerate all the synonyms. Dr. Stiles suggests that this work on the insects shall be undertaken in the first instance by the Nomenclature Committee of the Entomological Society of America, in correspondence with the like Committee of the Association of Economic Entomologists, and such other persons as it may seem desirable to consult. The report so prepared should, it is suggested, be referred to the Committee on Nomenclature of the International Entomological Congress and the International Commission on Zoological Nomenclature, whence it would pass to the Zoological Congress three years hence.

Your Committee is anxious to further these plans, recognizing that the proposed list would be of great service. There are, however, some difficulties. The Committee of the Association of Economic Entomologists was formed for the purpose of determining the common or vernacular names of insects, and has not hitherto concerned itself with scientific nomenclature beyond printing lists of scientific names to accompany and define the common names proposed. Your Committee itself was appointed to discuss nomenclatural questions, for which the data were supposed to be provided, and did not expect to have to report on matters outside of the range of nomenclature. It is obvious that the preparation of a complete and authentic list of the insect parasites of man involves many taxonomic questions to which nomenclature is only secondary. It is not understood whether the list should include only parasites in the restricted sense, but we suppose that in order to be of real value and importance, it should contain the names of various blood-sucking forms, Culicidae, *Glossina*, etc., etc., which are certainly intimately connected with man. Taking this for granted, we are at once brought into contact with various difficulties, e. g., those connected with the proper classification of the Culicidae, and under the circumstances, your committee is wholly unwilling to merely compile a catalogue from the literature, correcting any obvious violations of the rules of nomenclature which may be found.

Probably the only way in which your Committee could prepare a satisfactory work would be through inviting specialists in the different groups of insects to submit their lists, which might be published under the signatures of their authors, and discussed and amended as might seem necessary. For this purpose mere outlines, without details, would usually suffice. If the cooperation of the specialists was freely given, and their proposals were freely discussed for a period, the Committee might then be in a position to bring the results together in a single catalogue.

The Committee would call the attention of entomologists generally, to the importance of preparing lists giving the synonymy and indicating the generic types in their respective groups. Such work would go far toward permanence in generic designation, particularly if of such a scope as to include the genera of an entire faunal region, rather than accepting a continental or national limitation. Such contributions to knowledge should involve assistance from practically all workers in a group and your committee hopes that shortly this will be the general rule.

In dealing with various matters, it is occasionally found that the International Code, as at present constituted, is either capable of more than one interpretation, or fails to settle a matter in dispute. We have discussed some of these questions, but at the present time desire only to offer the following suggestions for the consideration of the Society. It is to be understood that so far as these provisions may be different from or additional to those of the International Code, it is intended that, if they are adopted, they shall be transmitted to the International Committee, for consideration as amendments to the code.

(1) Secondary homonyms, based on invalid combinations, shall not be recognized. This means that if a new species is published as A—b—, and is later wrongly transferred to another genus as B— b—, it is still permissible for an author to describe a new species as B— b—, although he may not

name one A— b— even if the species originally so named has been properly transferred to some other genus.

This point is not specifically covered by the International Code, although the spirit of the code seems rather against it. It is however covered by the American Ornithologists' Union Code (1908 edition, p. lvii), and correspondence shows that it is favored by many entomologists.

(2) When an author describes a new species, citing several localities, and not mentioning any one as typical, then any writer following may designate any one of the localities originally given as the type locality, provided always that nothing in the original name or description indicates otherwise. (If the name of the species has reference to any locality or to any collector who collected in only one of the localities cited, this will suffice to fix the type locality from the original publication alone.)

The following, formulated by a member of the committee, is now offered for discussion without endorsement, the majority of the committee feeling that it requires further consideration or perhaps amendment.

(3) Generic names shall not be considered as validly published unless the author, at the time of publication, either mentions an included species by its scientific (binominal) name, which name has been validated by a description; or cites a species in such a way that definite reference can be made, following the data given, to a previously published scientific name. It may be held, however, that when a genus is proposed with a description, and a single new species cited as type, the latter without description, then the generic description may cover both, just as if the author had given the whole combination at the beginning, followed by "n. g. and sp.", as is frequently done.

Differences of opinion exist as to whether the above rule, or the spirit of it, is in accordance with Article 25 of the International Code.

H. T. Fernald,
E. P. Felt,
T. D. A. Cockerell.

NOTICE TO MEMBERS AND CONTRIBUTORS.

The Annals of the Entomological Society of America will be published by the Society quarterly and will include the Proceedings of the Annual meetings and such papers as may be selected by the Editorial Board.

Papers may be submitted to any member of the Editorial Board and should be as nearly as possible in the form desired as final, preferably typewritten, and illustrations must be finished complete ready for reproduction. Plates must not exceed 5 x 7 inches unless intended to fold. In general, papers to be accepted must be original, complete and previously unpublished and, except in connection with the proceedings, it will not be the policy to publish preliminary announcements or notes. Authors will be allowed fifty reprints gratis and additional copies at cost to the Society.

Requests for information as to membership and the annual subscription and dues of members may be sent to the Secretary-Treasurer, A. D. MacGillivray, Cornell University, Ithaca, N. Y.

Communications relating to the Annals, and all orders for separate copies or reprints should be addressed to the Managing Editor or to ANNALS OF THE ENTOMOLOGICAL SOCIETY OF AMERICA, Biological Building, O. S. U., Columbus, Ohio.

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The Entomological Society of America.

FOUNDED 1906.

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Volume IV JUNE, 1911 Number 2

MAY-FLIES OF FALL CREEK.

By Anna H. Morgan.

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The following paper is a preliminary study of the ecology of the May-flies in the streams about Ithaca, N. Y., more especially in Fall Creek. In these, as in most fresh water streams, the nymphs of this order are abundant. In Fall Creek they are the dominant insects of the stream during the months of April, May and June, and by their fine adaptations to diverse environments they offer a satisfying field of study to any brook traveler. The nymphs may be easily secured, but only imagoes exist in most collections, and these usually as dried distorted specimens whose life-histories are little known. The winged or aerial life lasts but a few days at most; the nymphal or aquatic life may extend over two or three years. The imago exhibits great specialization of parts concerned with reproduction and more striking atrophy of other parts than may be seen any where else among insects. Imagoes of all the groups are remarkably alike in superficial appearance. The nymphs, on the other hand, display a series of adaptations as diverse as their environments. Only by rearing specimens from nymphal to adult life may these two stages be linked together. Many of the life-histories of those species found in Eastern North America have been made known. It has been with the hope of adding to the number of these life-histories, as well as with the purpose of gaining more knowledge of the habits of those already known, that this study has been begun. The earlier American workers, Say, Hagen and Walsh* scarcely took up

* Walsh, B. D. On the pupa of the Ephemerinous genus Baetisca Walsh. Proceed. of the Ent. Soc. of Philadelphia. 1864. pp. 200-206.

* Walsh, D. B. List of the Pseudoneuroptera of Illinois. Proceedings of the Natural Sciences of Philadelphia. 1862.

the rearing of nymphs but by their descriptive work they laid the foundation for the life-history studies which have followed. Berry† '03 reared and described the nymphs of Habrophlebia americana Banks, (which nymph is not a Habrophlebia but a typical Leptophlebia), Blasturus cupidus Say, and Callibaetis ferruginea Walsh. A note on the nymphs of the genus Tricorythus was published by Cockerell and Gill '06‡. The largest number of life-histories of Eastern North American forms has been written by Professor James G. Needham in Bulletins 47, 68, and 86 of the New York State Museum, and includes the following species:

Bull. 47.

Heptagenia pulchella Walsh.
Baetis pygmea Hagen.
Siphlurus alternatus Say.
Caenis diminuta Walker.
Hexagenia variabilis Eaton.
Ephemera varia Eaton.

Bull. 124.

Ephemerella dorothea Needham.
Potamanthus diaphanus Needham.

Bull. 86.

Chirotonetes albomanicatus Needham.
Ameletus ludens Needham.
Choroterpes basalis Banks.
Baetis pygmea Hagen.
Callibaetis skokiana Needham.
Ephemerella bispina Needham.
Caenis allecta Needham.
Leptophlebia praepedita Eaton.
Heptagenia interpunctata Say.
Ecdyurus maculipennis Walsh.

By Mr. W. E. Howard.

Polymitarcys albus Say.

With the exception of Callibaetis skokiana, Ephemerella bispina, Ephemerella dorothea, and Potamanthus diaphanus, all of these species have been taken in or near Fall Creek. For some of these further biological data have been secured. In addition to them eight species have been bred which it is believed have not been before recorded. These are all from Fall Creek with the exception of one, Ephemerella cornuta, reared for me by Miss Lucy W. Smith at Salisbury, Connecticut, and here included in the Ephemerella group. The life-histories which are given are those of Iron fragilis, sp. nov., Epeorus humeralis, sp. nov., Ephemerella rotunda, sp. nov., E. tuberculata, sp. nov., E. cornuta, sp. nov., E. deficiens, sp. nov., E. plumosa, sp. nov., and E. spinosa, sp. nov. The description of the female imago has been added to Prof. Needham's life-history of Ameletus ludens, and the Caenis allecta which he placed provisionally in that genus has on rearing been established in Tricorythus.

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† Berry, Edward. New or Hitherto Unknown Ephemerid Nymphs of the Eastern U. S. Am. Natural. Vol. XXXVII, pp. 25-31. 1903.

‡ Cockerell, T. D. A., and Marie Gill. Tricorythus, a Genus of May-flies. Univ. of Colo. Studies, Vol. III. No. 3, 1906.

PHYSICAL FEATURES OF FALL CREEK.

The vicinity of Ithaca consists of two highlands between which lies the basin of Cayuga Lake. The west highland known locally as West Hill is a long regular slope, while East Hill upon a terrace of which Cornell University stands, is furrowed with gorges made by streams flowing downward to the lake. On the gradual incline of the Eastern highland these streams flow along as quiet meadow brooks, or broadening out over stony beds are caught in a maze of ripply shallows, but on reaching the steep terraces of the highland they plunge downward through the narrow gorges by a succession of cascades till they come to the plain below. These streams coming far from their source and fed by many tributary waters are flooded and turbulent in the spring, but gradually dwindle to mere brooklets with trickling falls during the mid and late summer, when the tributaries fail of their supply. Few of the main streams become wholly dry. In March and April rich flora and fauna spring from their banks and waters, while through the dry season they supply enough water for the maintenance of life and the reproduction of another generation. Fall Creek, which bounds the Cornell Campus on the north, is a type of these streams.

About one mile east of the campus Fall Creek flows over a broad nearly level bed thickly strewn with flat stones and rocks which project from the water except at periods when the stream is swollen. On one side the creek is bordered by a soft sandy shore, on the other by a shelving ledge. Beyond this point, where the ledge gives place to soft drift, there is a series of permanent pools which mark the entrance of a small tributary spring. A cross section of this upper portion of the stream represents a variety of situations great enough to shelter widely different types of May-fly nymphs. Clinging to the surfaces of the stones in the mid current are the flat nymphs of Epeorus, Iron, Ecdyurus and Heptagenia; clambering in the trash which has collected between the stones are the nymphs of Ephemerella; on the sheltered surfaces or in the quiet border waters are Heptagenias about to transform in company with Leptophlebia, Siphlurus, and Ameletus; hidden in the sandy sweeps are Caenis and Tricorythus and burrowing in the soft muck banks are Hexagenia and Ephemera. Changing from this gradual descent

Fall Creek cuts downward through a narrow gorge, widens into the artificial pond known as Beebe Lake, hurries through a deep gorge and over a series of falls, cascades and riffles to the marsh below. This lower creek is inhabited by those true dwellers of the rapids, Chirotonetes albomanicatus and Baetis pygmea.

To the north of the lower portion of Fall Creek a small streamlet known as Pleasant Brook follows a parallel course to the lowlands. Its pools and cascades shelter a fauna similar to that of Fall Creek if somewhat less rich. This brook possesses the advantage of small size which makes its study easy. Devoid of tributaries to flood it in time of rain, and shut in by shrubbery, this stream furnished a safe place for the rearing cages of nymphs which were captured in Fall Creek.

METHODS OF REARING AND COLLECTING.

Rearing and collecting were begun on April 1, and continued to August, 1, after which only irregular collecting trips were made to the Creek. The only satisfactory method of rearing May-flies is one which keeps them in their own environment or in conditions closely imitating it. For this purpose Prof. Needham used a cylindrical cage made of wire cloth with a cheese-cloth cover. Such cages are the most convenient for carrying in a knapsack and many May-flies have been successfully reared in them. The space within them, however, is small and all surfaces are perpendicular to the water. If the imago becomes entangled, or if it is not strong enough to keep its footing on the upright surface it falls back into the water and drowns, or at least will never be able to transform. When two or three insects are in the same cage, particularly if the cage is in a strong light, there is danger of one or all falling into the water. For these reasons I have designed another cage, which though less conveniently carried about, has the merit of being more roomy and of supplying one slanting surface. This cage may be made of fine copper or galvanized wire cloth. A stiff cloth which will not bend easily will make the best cage. The cages which I used in Fall Creek were about five inches square on the bottom and five inches in height. Such a cage is easily cut and folded from a single piece of wire cloth. In the diagram shown in Fig. 2, the continuous heavy lines represent the cut edges, the lighter lines the folded edges of the laps, and the dotted lines the angles of the bottom, back, sides, front and cover. The laps on the sides should be folded over the cut edges of the bottom and the front and then securely fastened with solder. The cover may then be pushed down and secured by a wire catch or by a rubber band placed about the cage. When in use a stone should be placed in the bottom of the cage. This will serve the double purpose of keeping the cage upright and of providing a foot hold for the nymphs enclosed within it. In Fig. 1 the completed cage is shown inserted in the water. A represents the stone placed in the cage.

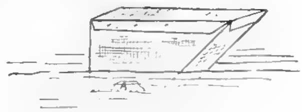


Fig 1

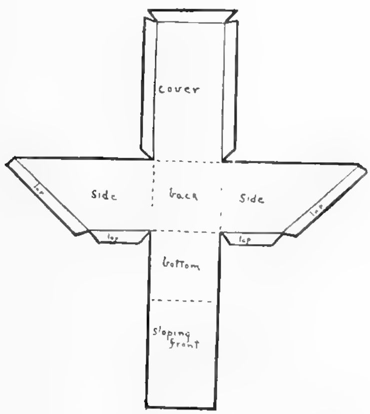


Fig 2

Fig. 1. Cage for rearing May flies, showing position in the water.

Fig. 2. Diagram to show construction of cage.

It is best not to insert the cage much more than two inches in the water except where a lowering in the stream is expected. Nymphs confined in this cage will naturally crawl up the sloping side for emergence and the sub-imagoes will find an easy grade on which to walk up to the light. The sub-imagoes will sit on the under side of the cover, but if it be lifted with some care the insects may be safely transferred from the cage to the collecting box.

Many times nymphs are collected for rearing in places not often visited. Such nymphs may be transported alive in jars of their native water with plants or stones to furnish forage and foot-hold. Fragile forms like Epeorus and Heptagenia may be better carried in a can of cotton or sphagnum thoroughly saturated with water. The nymphs should be carefully placed on the surface with a thin, very wet layer above them. If carried in this way they will arrive at their destination in much more perfect condition than if jostled about in a can of water. If a running water aquarium, or better, a convenient small stream is not available, the nymphs brought home for rearing may be placed in flower-pot saucers in which rapid evaporation will keep the water sweet. Small stones projecting from the water should be provided for emerging places. A cylinder of wire cloth with cheese-cloth top may be slipped over the dish so that the sub-imago may be easily caught.

In large aquaria where several kinds of insects are kept, care should be taken to exclude carnivorous beetles, and dragon-fly and damsel-fly nymphs for which May-flies are choice food. May-fly nymphs are mostly herbivorous and need only a supply of diatom-covered stones for forage and some aquatic plants like Chara or Nitella upon which they may depend for foot-hold and hiding. Needless to say the temperature of such an aquarium should be kept as nearly as possible to that of the streams. Of the nymphs which I have endeavored to keep in the aquarium of Cornell University, Blasturus cupidus, Callibaetis fluctuans, and Siphlurus alternatus proved most hardy. These lived from one to four weeks in rather adverse conditions, the water in the aquarium having been treated with aluminum sulphate for drinking purposes.

ECOLOGY AND DESCRIPTIONS.

The May-flies found during the past summer in or very near the Creek will be grouped under the three family heads given by Prof. Needham in Bull. 86. Notes and description of new species are given under their respective headings.

EPHEMERINAE.

Polymitarcys albus Say.

Two sub-imagoes were captured near night-fall on June 20.

Potamanthus sp.

Only two partly grown nymphs of this form were found. Both were taken on June 29 in sandy mud washed by a gentle current.

Hexagenia variabilis Eaton.

Full grown nymphs of Hexagenia variabilis Eaton the largest of our burrowing May-flies, were found abundantly on the sunny afternoon of May 16 in company with Ephemerella and the large dragon-fly Cordulegaster. At the place where they were Fall Creek is a leisurely brook meandering through sparse woodland and open meadow, and hemmed in by soft muck banks. In one such area the sloping banks were mined by Hexagenia nymphs, the open burrows showing only two or three inches apart. Most of the burrows were apparent by their round openings, but from some hairy caudal setae protruded at full length. When a nymph was pulled out it speedily began to burrow again, placing the forelegs together with the blade-like tarsi held vertically. It next pressed them forward and outward at the same time wedging the head between them in the cavity thus made. This movement was followed by a sudden lurch of the body forward accompanied by wriggling of the abdomen. During these motions the second pair of legs was folded close up to the body, while the third pair was held outstretched ready to brace against the mud. These motions rapidly repeated enabled the nymph to bury itself in a surprisingly short time. Some of the soft ooze taken from where the burrows were most numerous was later examined in the laboratory and found to be packed with diatoms. Stomachs of two of the nymphs were found full of silt and diatoms showing that the nymphs had found plentiful forage as they burrowed. Between two and five o'clock of this afternoon about twenty-five subimagoes emerged within a few yards distance. They flew up slowly and usually settled on low shrubs. Many were captured on near-by alders two to five feet from the ground where the yellow markings on their bodies and wings made them conspicuous.

Ephemera simulans Walker.

No representatives of this genus were collected previous to June 14 when a female specimen was captured at large near upper Fall Creek. From June 23 to 30 full grown nymphs were found about two inches below the surface in a muddy basin connected with the main stream. Near this place a swarm of Ephemera consisting of three to four hundred individuals was dancing about fourteen feet in air at half past seven o'clock in the evening of June 29th. Their steady rising and falling continued over the same area as long as the light kept them visible. One female captured from the swarm was placed on the surface of water in the laboratory. She was unable to fly and lay prone upon the surface. Immediately the last four segments of the abdomen began to move spasmodically and eggs poured forth from the oviducts. At the end of one minute the abdomen was empty, and the glass spread with a single layer of white, firmly adherent eggs, easily distinguished with the naked eye.

No Ephemera nymphs were found in the lower Creek up to this time, that cleaner portion being nearly devoid of mud. On the first of July, however, the water in Beebe Lake was allowed to run off, bringing into the Lower Creek large quantities of mud. Three days later the shores below the dam were again examined. Tracks similar to those made by earth-worms covered the bottom near the shore-line. Nymphs were crawling over the surface and setae could be seen projecting from many burrows. From an area of about ten square feet thirty nymphs were removed.

Heptageninae.

Represented entirely by dwellers in rapid water, this family is the dominant one in number, and the most homogeneous in nymphal form. It is represented here by four of its six North American genera Heptagenia, Epeorus, Ecdyurus, and Iron, given in order of their relative abundance. As a family the Heptageninae has taken possession of the rapid, thoroughly oxygenated water and the alga-covered stones of the middle stream, apparently coming into the calmer waters only at transformation time. In order to secure and keep this position against the mechanical force of the water acting upon them all alike, they have been forced into a series of similar adaptations. The principle feature of these adaptations are: a generally depressed body; dorsally placed eyes and flaring margins to the head; spreading legs with flattened femora and lateral pectinations on the claws; a series of over-lapping gill lamellae, and flat widely diverging caudal setae.

Heptagenia interpunctata Say.

Five species of the genus Heptagenia were collected and reared during the summer, but only the very common H. interpunctata will be listed until further work can be done upon them. H. interpunctata was common from April 30, when I found nearly grown nymphs beneath the flat stones in a tributary of the creek up to August 1, after which little collecting was done. During this time many emergings were observed, the greater number occurring between two and five o'clock in the afternoon.

Ecdyurus maculipennis Walsh.

Associated with Heptagenia and Epeorus, but with a preference for more gently flowing water, Ecdyurus maculipennis is a frequent dweller in the quieter border water of swift currents. My first collections are dated June 3. From this date till July 25 it was a common associate of Heptagenia and Epeorus,slightly smaller and a swifter runner than either of them. It also bears transportation and change of water with greater hardiness.

Iron fragilis.

The nymph of this species was described by Prof. Needham in 1905. In addition to this description there have been but two records of this genus in North America, Iron nitidus,* Oreg. Cal. and I. longimanus,† Colorado. The first nymphs of this species collected during the summer were found on May 9, in Coy Glen, the stream from which Prof. Needham's specimens were taken. Here thick growths of Cladophora and diatoms support an abundant May-fly population. The nymphs live in the swiftest water, on the under side of the stones, in the falls, or on the smooth rock floor. A census of the inhab-

* Iron nitidus Eaton. Rev. Monog. 246, 1885. Oreg. Cal. Banks, Cat. Neur. Insects. Am. Ent. Soc. '07.

† I. longimanus, Eaton, Ent. Mo. Mag. XVIII, 26, 1881. Rev. Monog. 245, 1885.

itants of twenty stones measuring about seven by eleven inches revealed the following inhabitants listed in the order of abundance, Simulium, Blepharocera, May-flies (Epeorus, Iron. Baetis), Stone-flies and Parnidae. In competition with such structures as the sucking disks of Blepharocera and the limpet like form of the water-penny (Parnidae), Iron has developed a successful hold fast of its own. The first pair of gill lamellae are very large and scoop shaped with their hinder edges overlapping the succeeding lamellae, and their front edges meeting beneath the posterior portion of the thorax. The lamellae diminish in width posteriorly and the last pair are incurved beneath the abdomen. The edges of the lamellae have a thickened border and when closely pressed to the supporting surface a successful holdfast is formed. This is one of three closely allied genera, Epeorus, Iron, and Rhithrogena, which represent remarkable modifications for life in rushing water. All three possess closely overlapping gill lamellae and but two caudal setae. The main differences are in the shape of the ventral abdominal disk which in Epeorus is incomplete, the first and last pairs of lamellae being distant; in Iron nearly complete, the first and last pairs of lamellae nearly meeting; in Rhithrogena the disk is completed by the perfect apposition of these lamellae.

The mouth-parts (Pl. X, fig. 1) are completely hidden from above by the flaring margin of the head with its bordering fringe of soft hairs. Viewed from beneath the small labrum (Pl. X, fig. lr) may be seen curving downward and backward over the tips of the mandibles and maxillae (md. a. and mx. a) to meet the median flaps of the broad labium (l. l. e.) The labium is flat and its outer surface (l) fits close down to the surface upon which the insect is foraging. Along the anterior margin of the outer surface of the labial palp is a series of incurving hairs (l. l. a.), behind these a set of overlapping plates, and still farther backward a single strongly chitinized scraper, (l. c.) On the inner surface of the palp is a semi-circular patch of inwardly directed hairs (l. b.) Closely apposed to the inner surface of the labium is the outer surface of the hypopharynx (fig. 1 hy), made up of two lateral, and one median portion, distinct, except at their bases. The separation of the two lateral portions from the median portion leaves a gutter-like trough between them on the inner side. The labial palpi are freely movable horizontally. They are moved outward, then pressed slightly downward and inward when feeding. Sometimes the labial palp is slipped between the median (fig. 1, l. e.) and the lateral flaps (fig. 1, l. d.), sometimes over the inner sides of both. In the first case the plates on the outer sides of the palp are brushed by the hairs on the inner side of the median flap while the semi-circular patch of hairs (l. b.) on the inner side of the palp is brushed by those on the outer side of the lateral palp. In the second and more frequent case the outer side of the palp is brushed by both flaps and the semi-circular patch of hairs fits into the chitinized gutter on the adjacent surface of the hypopharynx (hy. a.) Directly above the median portion of the hypopharynx are the grinding surfaces of the maxillae (mx. b.) with those of the mandibles (md. b.) directly above them. Food scraped inward by the labial palps is evidently deposited beneath the hypopharynx. From here it is probably sucked up into the mouth cavity through the slits between the median and lateral folds. The maxillary palps act in a manner similar to those of the labium, but because of their position above the hypopharynx, they must be able to place the food directly in the mouth cavity. The inwardly curving hairs on the lateral borders of the labrum help to keep the food in the mouth while it is being chewed up.

The foregoing observations were made by placing a nymph in a shallow dish of water, throwing a strong light upon it and studying it with a binocular microscope. The nymph was uneasy in this unnatural position and kept its mouth parts continually moving. Nymphs may be studied under more natural conditions if they are placed in a glass-bottomed box with a small amount of forage. The box may be placed upon some support which will elevate it above the table. The bottom may then be tilted at any easy angle and the nymphs studied with a hand lens from beneath.

Occurrence, habitat. The dates on which nymphs or imagoes were collected range from May 1 to June 15. These nymphs were all taken in cool, shaded waters and were most abundant during the early part of the season. The data for those reared in cages is as follows:

1 male emerged May 11, a. m., transformed May 13, a. m. Coy Glen.
1 male emerged May 12, a. m., transformed May 14, a. m., Pleasant Brook.
3 females emerged May 30, p. m., transformed June 1, p. m. Pleasant Brook.
1 female, 1 male emerged June 10, a. m., transformed June 12, M. Fall Creek.

Between the hours of two and four of June 15 about twenty emergings were witnessed from one view-point in a narrow swift portion of Coy Glen Brook. The nymphs popped from the surface of the water and flew unsteadily upward in the sunlight for about 20 or 30 feet when they veered into the tree tops or settled on the side of the gorge.

Iron fragilis sp. nov.

Measurements.

	Length of body	Length of setae	Length of Wing
Male imago	7 m. m.	21 m. m.	7 m. m.
Male subimago	6.5 m. m.	14 m. m.	
Female imago	7 m. m.	15 m. m.	
Female subimago	6.05 m. m.	14 m. m.	

Male imago. (Plate X, figs. 2, 3 and 4). (In alcohol). Body extremely delicate and fragile. General hue dull yellowish white, appearing hyaline in segments 2-7 of the abdomen. Eyes, conspicuous, grayish. Head, parchment color with the eyes gray, darker below; antennae, light brown except for white basal segment; ocelli, ringed with conspicuous, broad band of dark brown. Thorax, yellowish shading brownish above, pale below. Pronotum deeply notched behind. The lateral lobes of the pronotum and the median portion of the mesothorax shaded brown. A sub-triangular area of brown on either side of the median posterior elevations of mesothorax and metathorax. Legs, dull yellowish, the femora with a conspicuous dark brown spot at the middle. Tarsi with joinings and claws brown. Forelegs (Pl. X, fig. 3) longer than the body, its tarsal claws identical with those of the other two. Wings, (Pl. X, fig. 2) hyaline, sub-hyaline near the tip in costal and sub-costal regions. Abdomen. Tergites 1-9 with their posterior borders delicately shaded by transverse bands of brown growing more distinct posteriorly. Sternites, pale. Forceps pale, broad at the base and conspicuous (Pl. X, fig. 4). Setae 2, pale slightly brownish at the base.

Male sub-imago. The sub-imago differs most markedly from the imago in the following respects. The forelegs and setae are shorter, the forceps less conspicuous, and the wings are of the usual grayish sub-hyaline appearance. Head with occiput brownish. Bands of ocelli less prominent than in the imago. Thorax, brown, prominent ridges of mesothorax and metathorax shaded with brown, but without definite sub-trangular markings. Pleurae and sternum with ridges shaded brown. Coxae suffused with brown. Abdomen with tergites 1-10 suffused with brown, the transverse band of brown more distinct than in the imago. An irregularly shaped patch of white in the center of each segment near the pleura. The posterior lateral angles of the tergites whitish.

Female imago. Body heavier than that of the male, all over dull yellowish color; legs of nearly equal length; setae 2. Head with eyes distant and dark grayish, a whitish area of the head showing between them. Thorax, with the pronotum distinctly lined with brown. Subtriangular areas on mesothorax and metathorax present but less distinct than in the male. Abdomen with tergites shaded with brownish, a distinct transverse band of brown near the posterior border. Sternite 7 produced backward in a rounded lobe whose posterior edge touches that of sternite 8. Sternite 9 produced backward in a lobe with a shallow median indentation on its posterior margin.

Female sub-imago. General color much darker than the male imago. Thorax shaded all over with brown. Sternite 7 produced backward only half the length of sternite 8. The prolongation of sternite 9 much less pronounced and its posterior margin barely indented.

Epeorus humeralis.

(Pl. IX, fig. 1, 2, 7.) The genus Epeorus is represented in Fall Creek by this single species. It is closely allied to Iron but differs from it in the greater distance between the lamellae of the first and last pairs of gills. These nymphs are much larger than those of Iron fragilis, but are harder to transport because of the extreme brittleness of the bases of the lamellae.

Occurrence, habitat. Full grown nymphs and imagoes were taken at various dates from May 25 to July 15. This species is very common in the swift waters associated with Heptagenia and Baetis.

Epeorus humeralis sp. nov.

Measurements.

	Length of body	Length of setae	Antennae
Male imago	10 m. m.	20.5 m. m.	
Male subimago	9 "	12.5 "	
Female imago	9.5 "	13 "	
Female subimago	10 "	11.5 "	
Nymph	11 "	11 "	2.5 m. m.

Male imago. (Pl. IX, fig. 2, 7). (Live specimen). General color dull yellowish, becoming sub-hyaline on segments 2-5 of the abdomen. Conspicuous dark brown spots at middle of femora in all winged stages, larger than those in Iron fragilis; the body less fragile than that of the preceding species; the humeral cross vein blackish; the foreleg about three quarters the length of the body. Head, yellowish white; eyes conspicuous olive green, intersected in the lower portion by a brown band, ventral edge margined by a narrow black band border behind, this in turn by a white band of the same proportions; antennae brown, a brown ridge extending from their basal segments to the inner margins of the eyes; carina on middle of front brown; ocelli ringed with olive. Thorax, above yellowish white, translucent; pronotum partially hidden by the eyes, its lateral lobes shaded with dark brown; mesonotum buffy with edges brown and elevations lighter; scutellum fuscous.

Below, pale whitish yellow, mesonotum margined at the apex with a transverse band of brown. Pleurae and coxal areas pale with irregular shadings of dark brown. Legs whitish; coxae with dark brown spot; femora with conspicuous brown spot and a brownish band just before the apex; more distinct on the anterior legs; tarsi with flap and claw similar to that of Iron fragilis (Pl. X, fig. 3) and identical in all three legs. Wings hyaline with the humeral cross vein blackish brown (in all adult stages). Abdomen, pale whitish, translucent on segments 2-5. Tergites with distinct transverse brown pencilings on their posterior borders and a median broken line of brown more distinct on the posterior portions of the tergites. Sternites pale without markings. Forceps pale, (Pl. IX, fig. 2). Setae whitish.

Female sub-imago. General color of the body slightly darker than that of the imago. Abdomen darker, less translucent. Wings grayish, sub-hyaline. Thorax with markings less sharply defined and general color darker than that of the imago. Abdomen with the tergites suffused with brownish.

Female imago. (Live specimen). Forelegs shorter than those of the male. In specimens containing eggs the abdomen is a bright salmon pink, which does not fade readily in alcohol. Head, with eyes similar to those of the male, but smaller and distant being separated by a broad unmarked portion of the occiput. The dark bands of the ocelli are incomplete and a trifle narrower than those of the male. Thorax, with the pronotum exposed showing the prominent median indentation of its posterior margin; an area on either side the median line with a longitudinal blotch of brown. Abdomen with the tergites slightly darker brown than in the male. Sternite 7 prolonged two thirds the length of sternite 8. Sternite 9 slightly shorter and but shallowly notched on its posterior border.

Nymph. (Pl. IX, fig. 1). Body depressed, widest across the mesothorax gradually tapering to the last abdominal segment. Nymph larger and broader than Iron fragilis with its lamellae flaring; the lamellae of the first and last pairs of gills distant from one another and the tracheation of the lamellae conspicuous. Posterior lateral angles of the abdominal segments produced into backwardly directed spines which guard the bases of the lamellae (Pl. IX, fig. 1). Color, olive-greenish blotched and shaded with brown, pale below. Head with eyes and ocelli prominent, the latter with dark lunate bands on their inner margins. Antennae slender and bare. Lateral margins of the prothorax rounded anteriorly, and flaring. Legs flattened with a row of rather long soft hairs on the posterior margins of the femora and tibiae. General shape conical, rounded above, slightly flattened below. Gill lamellae obliquely reclinate with fasciculate filaments on the dorsal side of their bases. Setae 2, about as long as the body.

Baetinae.

This heterogenous group was represented in the summer's collecting by Blasturus cupidus, Leptophlebia praepedita, Leptophlebia mollis, Choroterpes basilis, Callibaetis fluctuans, Ephemerella excrucians, Caenis hilaris, Siphlurus alternatus, Chirotonetes albomanicatus, Ameletus ludens, Tricorythus allectus, Ephemerella rotunda, sp. nov., E. tuberculata, sp. nov., E. cornuta, sp. nov., E. deficiens, sp. nov., E. plumosa, sp. nov., and E. spinosa, sp. nov. All of these were taken in Fall Creek except the before mentioned E. cornuta. The descriptions of these species of Ephemerella is here given together with that of the female imago which has been added to Prof. Needham's life-history of Ameletus ludens. Tricorythus allectus, which was placed in that genus by Prof. Cockerell has been established there by several rearings.

Blasturus cupidus Say.

From April 20 to May 1 this species was the dominant May-fly of the quiet pools. On April 30 observations were made in a sheltered pool, tributary to Fall Creek. This pool was about fourteen feet long by five feet wide, carpeted with decaying leaves, and bordered on one side by a thick mat of spirogyra. Between 11:30 and 12:30 o'clock in the bright sunlight, about forty nymphs emerged and the sub-imagoes were captured. A few records of individual emergings were taken of which the following is typical. A nymph appeared from beneath some leaves, came close to the surface of the water and swam about there till a stick was found which projected out of it. It immediately clambered up the stick, thrust its head out into the air and rested there with its gills motionless, but apparently swallowed large gulps of air. Very soon a median split appeared in the mesothorax, widened toward the prothorax and then to the metathorax. The head and eyes of the sub-imago appeared, the mesothorax, then the metathorax, and finally by a sustained pull, terminating in a jerk, the wings were extricated from the wing pads and erected. Apparently exhausted by this effort the insect then paused with the posterior portion of the abdomen and the setae still lying loosely in the cast skin. By another jerk the body was wholly freed from the skin. The insect rested an instant upon the water's surface with its setae held widely divergent and upward, in their natural alert position. Immediately after this it fluttered upward and settled on a low shrub. The entire time from the appearance of the nymph to the completion of its emerging was ten minutes. Of this period, one minute was occupied in swimming, one in taking in air, and three minutes occurred between the appearance of the median slit in the nymphal skin and the complete freeing of the sub-imago. After its first short flight the insect remained on the shrub for about five minutes before disappearing higher up in the air. This custom of resting upon near-by objects is a habit varying with the species and apparently also with weather conditions. For example, sub-imagoes of Chirotonetes albomanicatus which usually fly upward immediately on emerging in clear weather walk about for a while on the shore, or take very short first flights on dark days. The period of greatest effort during emergence is that which precedes the splitting of the nymphal skin. The splitting is doubtless urged on by the distention of the alimentary canal which is caused by the air or water which has been swallowed.

Mating flights of Blasturus cupidus were observed over Fall Creek in the late afternoon of April 31, the height of their transformation season. About thirty individuals flying in close ranks rose and fell at varying altitudes of ten to thirty feet. When at their greatest height they were scarcely distinguishable against the sky, but when they were lowest the forelegs and the setae might be discerned. The forelegs were held stiffly, straight forward from the head, and the setae, projected at a wide angle behind, appearing to vibrate as the insects swung downward. After a few moments of ecstatic rising and falling, one of the individuals flying high in the swarm descended to one of the lowest, coupled with it and veered obliquely downward and across the stream. When about to alight on the opposite shore the two separated, one disappeared and the other turned back and flew close to the surface of the stream frequently brushing the water with the abdomen. Such matings were three times observed. Attempts to capture a fertilized female failed. The eggs brushed from the abdomen into the rapidly running water were, of course, impossible to find.

Leptophlebia.

Occurrence, habitat. Nymphs of this genus were found in a greater variety of situations than any other group. While it is for the most part a genus which belongs to the small rills it also takes advantage of the secluded places in the larger streams. Two species were common in this locality. These were Leptophlebia mollis, common after May 20, and L. praepedita, collected frequently after May 29.

Leptophlebia praepedita Etn.

This species has already been noted by Prof. Needham (Bull. 86, N. Y., State Mus.) This species is diurnal. Companies of them were seen dancing in bright sunlight on the afternoon of May 29, June 3, 20 and 21. A mating flight on May 29 occurred about five o'clock just above a dashing water-fall of Fall Creek. As the swarm rose and fell at alternate heights of ten to fifteen feet their silvery wings and bodies shone in the sunshine like falling snow-flakes. After half an hour of continuous flying and soaring the swarm gradually disappeared. Of the specimens captured all were males. Earlier in the afternoon a similar but smaller swarm was seen flying above a small tributary rill. This swarm did not at any time fly higher than six feet above the water. Practically the whole swarm was captured at one sweep of a large net. Of the captured insects forty were males and one was a female.

Choroterpes basalis Banks.

This species is plentifully represented in the Creek. The nymph is described in Bull. 86 of the N. Y. State Museum. Little attention was given to this species beyond the collection of nymphs which were constantly associated with Heptagenia.

Ephemerella.

This genus is nearly as diversified in habit as Leptophlebia. The nymphs have been found in pipe drains, in the gravel and trash of still pools, beneath leaves in springs, in the border waters of the creek and in its swiftest ripples. Like Leptophlebia they have been found in rather small numbers and widely scattered. My dates for rearings and captures range from the second week in May to the last of July. Better results would have been obtained if attention had been paid to this group earlier in the season for some species were very rarely found by May 10th.

Ephemerella serrata sp. nov.

Occurrence, habitat. The small nymph of this species was found occasionally in restricted areas of the upper Creek where it crawled about on stones, or in the trash, which was washed by running water. It was found in similar situations at Sheffield, Mass. My reared specimens of this species are dated

June 3rd. Collections of the nymphs were made June 12, 14, and July 1. By July the nymphs were becoming scarce. several cast skins were found on the dry stones of the shore, after the last date, but no nymphs were seen.

Measurements.

	Length of body	Length of setae
Male	5 m. m.	6 m. m.
Female imago	4.5 m. m.	
Nymph	5 m. m.	1.2 m. m.

Male imago. General color brown, paler on the legs and below. Head, above, eyes very prominent, upper division reddish brown, lower one darker. Front of head light, antennae light brownish; ocelli white, the lateral ones with an inner lunate band of brown, the median one with a complete ring of brown. Thorax, above yellowish shaded with brown; mesonotum with its posterior margin edged with brown. Ridges of the pleurae shaded with brown. Sternae pale with sub-quadrangular areas of brown before the middle legs and a median shield of brown behind them. Legs pale with a transverse band of brown at the distal end of the femora; first tarsus of the foreleg but slightly longer than the second; the third twice as long as the fourth. Wings hyaline, brownish at the base. Abdomen, brownish above, pale below. Setae 3, pale, the joinings of the basal segments ringed with brown.

Female imago. Eyes small and distant showing the light colored occiput between. Body more robust and abdomen slightly darker than that of the male. Foreleg twice as long as that of the male.

Nymph. Small with head and thorax rounded and the setae curving forward over the abdomen. General color a muddy yellow with darker markings on the dorsal side, pale below. This species is easily distinguished from Ephemerella deficiens by its double median row of spines on tergites 4-7 and by its generally lighter color. Head smooth, (Pl. VI, fig. 5); antennae light brownish, first and second basal segments edged with brown. Thorax, prothorax with a tubercle like elevation on either side the median line. Legs (Pl. VII, fig. 2) with the femora rather stout and their hinder margins bordered with a row of stout hairs sparsely distributed. Claws serrate (Pl. VII, fig. 2) with a chitinous ridged plate on the underside of the tarsus (Pl. VII, fig. 2). Abdomen, above, segments 5-6 pale marked with brown pencilings, other segments brown with darker edges. A double row of irregularly triply dentate spines extending over segments 4, 5, 6 and 7. The lateral margins of segments 4-9 spinose with their posterior lateral angles becoming more acuminate posteriorly. Gills present on segments 3-7; Elytroid lamella absent; the superior lamella simple; the inferior fimbriate lamelliform. Abdomen, beneath, pale with a median row of distinct linear brown spots on sternites 1-9. Setae, 3, sparsely beset with coarse hairs; color, pale with a transverse band of brown across the center.

Ephemerella deficiens, sp. nov.

Occurrence, habitat. Of similar habitat and closely associated with Ephemerella serrata in rapid waters, this species is the more common of the two and was collected frequently during the first half of May. It closely resembles E. serrata in shape and size, but the whole body is blackish while the gill lamellae, the legs, and the setae are nearly white.

Measurements.

	Length of body	Length of setae
Male imago	5 m. m.	Setae lost
Nymph	5.2 m. m.	2.5 m. m.

Male imago. General color blackish, thorax blackish brown. Head, eyes prominent, upper division reddish brown, lower division blackish brown (living specimen); ocelli white; antennae, carina and rings of ocelli brown. Thorax, above, pronotum brown; the mesothorax and metathorax blackish brown with blackish edges; pleurae brown with edges blackish; sternum brown with a broad transverse band of yellow behind the first pair of legs. Legs nearly white; coxae and an indefinite band at distal end of the femur brown. Wings hyaline shaded with brown at the base. Abdominal segments shaded with brown giving the effect of annular bands dark on the dorsum, paler beneath. Setae 3, pale at the base. (Only the bases of the setae remained when the specimen was taken from the cage). Forceps and penes are figured in Pl. IV, fig. 4.

Nymph (Pl. VI, fig. 4, Pl. VII, fig. 4, Pl. VIII, fig. 4). Color blackish brown, femora brown, gills, tibiae and tarsi whitish. Body broadest at the metathorax, the thorax arched, the abdomen slightly depressed and curving upward at the posterior end. Setae held upright or curved over the abdomen. Head, bluntly wedged shaped; ocelli inconspicuous whitish; antennae pale with a band of brown just above the basal segment. The maxillae with their palpi totally absent (Pl. VIII, fig. 4). Thorax, above blackish brown, the prothorax bordered laterally by a pale longitudinal band with a brown spot at its center; the prothorax and mesothorax with a longitudinal stripe of pale yellowish on either side the median line. Legs (Pl. VII, fig. 4) with the coxae and femora brown, the under side of the latter with a distinct hook shaped area of whitish. Tibia and tarsi pale whitish, the first two pairs of tibiae with a broad middle and a narrow proximal band of brown; the tarsi of all the legs with a middle band of brown and with the claws similar (Pl. VII, fig. 4). Abdomen above dark blackish brown. The posterior lateral angles of segments 9-10 pale whitish; the lateral margins of segments 1-9 spinose serrate with their posterior lateral angles produced into flat spines which become more acuminate posteriorly; segment 10 without spines and with its posterior margin truncated. Gills present on segments 3-7; Elytroid cover absent; gill lamellae whitish shaded with brown at the base, superior lamina entire, the inferior one bifed.

Abdomen, beneath, brown without markings. Setae 3, with a circlet of spines at their joinings. A broad band of brown across the two outer ones.

Ephemerella lata, sp. nov.

Occurrence, habitat. This species was first taken in Sandy River, Me., a stream similar to Fall Creek, where it was very common. Attempts to rear these nymphs were unsuccessful in both Sandy River and Fall Creek therefore a description of the nymph only can be here included. It occurs in the most rapid water of the stream crawling on the stones much like Heptagenia. My dates for its capture in Fall Creek are June 20 and 24. It is apparently a rare species in the stream.

Measurement.—Nymph. Length of body 7.2 m. m. Length of setae 3.5 m. m.

Nymph (Pl. VI, fig. 6; Pl. VII, fig. 1). General color brown with the prothorax and the eighth tergite conspicuously white. The fore femora very stout (Pl. VI, fig. 6) and edged with stout spines. Body arched above. The ventral side of the body and the legs flattened and modified for clinging to smooth surfaces. Head, sub-quadrangular with the broad truncate ledge projecting forward above the rounded heavily fringed frontal border (Pl. VI, fig. 6). Antennae with a conspicuous triangular ledge projecting above their bases. (Mouth-parts are figured on Pl. VIII, fig. 1). Thorax, prothorax two-thirds as long as the thorax, conspicuously whitish but with the posterior portion shaded brownish, the degree varying in different ages and individuals; mesothorax without markings; metathorax concealed from above. Sternum flattened, brown with pale suture lines. Legs (Pl. VII, fig. 1) with the femora pale marked by a pale transverse band; tibiae brown with two pale transverse bands. Abdomen, rounded above, flattened below. Gills on segments 3-8. Elytroid cover absent. Segments 4-9 with their posterior lateral angles produced backward into flat spines; segments 5-8 with their lateral margins spinose serrate; segments 4-7 with a double median row of small tubercles which arise near the posterior border. Sternite 9 produced backward into a median rounded lobe and two lateral flat spines. Setae 3, light brownish ringed at their basal joinings with darker brown.

Ephemerella tuberculata, sp. nov.

Occurrence, habitat. But a single specimen of this species has been taken. This was a nymph captured on June 22 in the gently flowing border water of the upper Creek.

Nymph, measurements. Length of body, 10.5 m. m.; length of setae, 4.5 m. m.

Body stout arched above, flattened below. Color above dark, below pale, with a median double row of distinct brown spots. Fore-femora very wide (Pl. VII, fig. 5). The head (Pl. VI, fig. 2) with two large erect tubercles on the occiput. Head, sub-quadrangular slightly flattened with the head projecting forward; a triangular ridge with the median ocellus at its apex projecting above the slightly indented fringed frontal margin. (Pl. VI, fig. 2). Left maxilla figured on Pl. VIII, fig. 3. Thorax, more than half the length of the trunk; color dark above, all except the prothorax pale below; prothorax, above slightly arched and flaring at its postero-lateral angles, a tubercle at the middle of the lateral margin and a smaller one on either side the middle of the posterior margin; mesothorax with one median tubercle. Legs, with femora unevenly brown above, pale below; tibiae brown with a pale transverse band through the middle; tarsi brown with a pale transverse band at the proximal end. Fore-femur (Pl. VII, fig. 5) shorter and thicker than the others and with its anterior margin unevenly toothed. Anterior edges of the other femora entire. Upper surfaces of all the femora with wart-like elevations; posterior edge of the first femur and anterior and posterior edge of the other femora with a row of sparse hairs. Abdomen with gills present on segments 3-8, without Elytroid cover, superior lamina entire; inferior lamina bifid fimbriate. Segments 2-7 with a median double row of spines; posterior margins of segments 1-7 and 9-10 edged with short hairs; posterior margin of segment 8 with numerous longer hairs. The posterior lateral angles of segments 3-10 produced backward into flat-pointed spines. Setae 3, with numerous hairs on their outer and inner margins.

Ephemerella rotunda, sp. nov.

(Pl. VI, fig. 1; Pl. VII, fig. 3; Pl. VIII, fig. 5; Pl. IX, fig. 6.)

Occurrence, habitat. This species was taken in portion of Pleasant Brook, where there was little water and that strongly tainted by pipe drains. But four nymphs were captured. The two which were successfully reared proved to be females. The dates for their rearing were June 8 and 10.

Measurements

	Length of body	Length of setae
Female imago	10.5 m. m.	14 m. m.
Female subimago	10 m. m.	10 m. m.
Nymph	10.2 m. m.	6 m. m.

Female imago. Thorax luteus; legs luteus or whitish; abdomen brown; setae luteus with very distinct brown joinings. Head parchment color. Thorax, above, luteus slightly darker on the mesothorax; pleurae luteus to whitish with brown edges. Axillary cords (Snodgrass, '09, The Thorax of Insects and the Articulations of the Wings, p. 553) of the fore-wing prolonged into slender acute spines which project backward on either side of the hinder lobe of the mesothorax. Axillary cords of the hind wings prolonged in similar but less prominent spines. Wings hyaline, costal region sub-hyaline (Pl. IV, fig. 6); abdomen brown, pale at joinings and beneath. Color evidently mostly due to contained ova. Sternite one longer than those following; sternite 7 with its posterior portion overlapping sternite 8 and with its posterior margin bilobed. Setae 3, nearly equal length, pilose; color pale luteus with distinct brown rings at the joinings.

Female subimago. Wings sub-hyaline and veins brown. Segment 7 not bilobed as in the imago.

Nymph (Pl. VI, fig. 1; Pl. VII, fig. 3; Pl. VIII, fig. 5). Head and body rounded and smooth, and without tubercles. Legs small in comparison with the size of the body. Head, rounded and without elevations (Pl. VI, fig. 1). The left maxilla is shown on Pl. III, fig. 5. Thorax, above smooth. Color, mottled brownish without definite markings. Prothorax wider than the head its lateral margins slightly flaring, and its width equal to that of the mesothorax; metathorax concealed from above. Legs weak, the femora poorly developed and with a row of hairs on its posterior margin (Pl. VII, fig. 3). Abdomen, above rounded, gills present on segments 3-7, the posterior margins of segments 4-9 with a double median row of small spinose elevations; segments 3-9 with their posterior lateral angles produced into flat spines whose margins are spinose serrate. Setae brownish indefinitely banded with whitish; basal joinings with circlets of hairs.

Ephemerella cornuta, sp. nov.

Occurrence, habitat. This, before mentioned species, was reared at Salisbury, Connecticut. The dates given by Miss Smith for its capture and rearing are July 20, 21. But two stages, those of the male sub-imago and the nymph are represented.

Measurements.

	Length of body	Length of setae.
Male subimago	10.5 m. n.	
Nymph	10 m. m.	6. m. m.

Male subimago, general color pale luteus with annular bands of brown on the abdomen. Eyes prominent. Head with ocelli white, encircled with broad bands of blackish brown; carina, frons and occiput pale; antennae light brown. Thorax, above pale luteus; the prothorax irregularly streaked with brown. Axillary cords of the fore-wing produced into a slender point extending backward on either side the median lobe of the metathorax, such prolongations not evident in the hinder wing. Legs, pale, the fore femora lightly shaded with brown. Wings, sub-hyaline, brownish at the base (Pl. IX, fig. 5). Abdomen pale whitish, with annular bands of brown shading. Setae 3, whitish.

Nymph. Body slender, and tapering from the mesothorax. Fore femora shorter and wider than the others and with its anterior margin unevenly toothed (Pl. VII, fig. 6). Head, with prominent incurving horns just below the antennae; general shape sub-quadrangular with the posterior angles rounded, and the frontal margin fringed with hairs and projected forward; origin of the antennae partly hidden by the curving ledges at the bases of the horns (Pl. VI, fig. 3). (Left maxilla shown on Pl. VIII, fig. 6.) Thorax, mottled brownish; prothorax quadrangular, its angles closely fitting to the mesothorax. Legs with the margins of the second and third femora entire; the first femur figured on Pl. VII, fig. 6. Abdomen, rounded above, flattened below; without dorsal spines or tubercles. Gills on segments 3-7; posterolateral angles of segments 3-9 produced into flattened spines becoming more acuminate posteriorly; posterior margins of segments 2-10 sparsely edged with hairs; lateral margins of segments 3-9 spinose serrate. Setae, pale, except for a single brown ring at the base of each.

Tricorythus allectus Needham.

This species was described by Prof. Needham in Bull. 86, N. Y. State Mus. as Caenis allecta, but afterward referred by him to the genus Tricorythus, in Bull. 124 N. Y. State Mus.

Occurrence, habitat. These nymphs are closely associated with Caenis, though they have not thus far been often found in the ill smelling mud generally preferred by that nymph. They clamber about in fine silt and sand, and the particles which adhere to their hairy bodies make them practically invisible. A handful of mud which appears to contain no sign of life, will after a few minutes draining, reveal slowly moving bits of mud which may prove to be either Caenis or Tricorythus according to the quality of the mud. Tricorythus allectus is one of the commonest species in Fall Creek. During June and July, the imagoes may be found strewn upon the surface of little protected inlets along its shores, or caught in the meshes of the spider-webs on walls and bridges near it.

Measurement. Length of body 6.5 m. m. Length of setae 4 m. m. Mouth—parts and gill lamella (Pl. XI.) The nymphs of Tricorythus may be at once distinguished from those of Caenis by the shape of the elytroid gill cover, rounded at the end in Caenis, distinctly triangular in Tricorythus (Pl. XI, fig. 1). Color yellowish, pale below; abdomen marked with transverse bands of brown broken by a median longitudinal pale stripe. Elytroid lamella prominent, purplish brown at the base. Body all over sparsely beset with hairs. Antennae pale with basal segments brown. Legs pale with a blackish spot at the proximal joint of each tibia. Gills not wholly hidden by elytroid lamellae. Lateral spines on segments 2-9. Setae 3.

Caenis.

This genus is plentifully represented by Caenis hilaris, Say, and by nymphs of some other species not yet reared here.

Chirotonetes albomanicatus Needham.

Occurrence, habitat. Nymphs of this abundant species were found full grown in the dashing waters of the falls and riffles from the latter part of May to August 12th. In May they were seen to emerge in greatest numbers during the late afternoon and twilight. They crawled up on the shore leaving their cast skins clinging to the stones or less often they flew up directly from the mid current. The dark wings and body and the white forelegs of the sub-imago made it very conspicuous as it rested upon the gray stones or flew upward. Robins made a regular custom of coming to the shores and collecting the insects as they emerged. From four to six nymphs might be often seen projecting from their beaks.

Siphlurus alternatus Say.

This elegant species has been found to be very desirable for the indoor aquarium. It lives in still pools and demands only a minimum supply of fresh water and plenty of plant food. It was common all through April, May, and a portion of June. Nymphs kept in the laboratory aquarium nearly all lived to emerge and doubtless could have been kept there several months had they been taken early enough.

Baetis pygmea Hagen.

This species has been found chiefly interesting for its habits of egg-laying. From early June to late August the stones in the waters of the creek were covered with small elongate egg-patches rounded at one end, narrower and sharply squared off at the other. Plate XII, fig. 1 shows a stone about seven by ten inches in size on which the egg masses were scattered with average abundance. The surface upon which the eggs rested was the down-stream side of the stone and that portion where they were thickest was nearest to the surface of the water. On the same plate (fig. 2) is shown a photograph in which the patches are enlarged sufficiently to show the individual eggs. The laying of the eggs may be seen if one closely watches some stone which is marked as a favorite site by the presence of many masses. The following observation was made through an ordinary reading glass, but the processes may be easily seen with the naked eye.

Flying close to the surface of the water, the insect alighted on a stone projecting slightly from the water and well protected from the force of the current on its downstream side. She immediately walked to the protected side and downward to the water. First, wrapping her wings about the abdomen, she made several attempts to immerse her head and thorax. This appears to be the critical stage of the performance, for many females are washed from the stone while attempting it. Once beneath the surface she started on a tour of inspection for the proper surface. This tour lasted for several minutes during which time she continually walked to and fro, pausing, feeling with the abdomen, and passing on unsatisfied. When a suitable place was finally found she braced her legs firmly, bent the abdomen downward, curved the setae upward and pressed the openings of the oviducts closely to the surface. The whole abdomen was then swung from side to side with a slow pendulum-like motion, each stroke leaving an irregular row of minute white eggs adhering to the surface. The strokes were at first somewhat circular and longer than those which followed. As the egg mass grew in length the insect moved forward a little to allow the eggs to lie in succeeding rows. When the egg supply was exhausted she stopped with a jerk of the abdomen and proceeded to clamber out of the water. When examined in the laboratory the abdomen of this female was found to contain only a few undeveloped eggs in the ovaries and none in the oviducts.

Ameletus ludens Needham.

Occurrence, habitat. In Pleasant Brook on April 25 nymphs of Ameletus ludens, were found in great abundance resting upon the bottom or darting about much like the nymphs of Callibaetis. They were the dominant insect of the stream at this time. One soft bottomed pool about four feet long, and two wide yielded about 300 nymphs in half an hour's collecting, and many more remained. Full grown nymphs were placed in cages for purposes of rearing. The female subimago was found to correspond with Prof. Needham's description given in Bull. 86 of the N. Y. State Mus. Attempts were then made to secure a male to add to the life-history since Prof. Needham was unable to procure one. The results of the rearing were as follows:

April 29,	1 nymph emerged,	transformed	April 30.	Female.
April 30,	1 nymph "	"	May 1.	"
May 7,	1 nymph "	"	May 8.	"
May 8,	3 emerged nymphs,	"	April 9.	"

Repeated rearings failed to secure a male specimen. An enclosure was then made in a neighboring rill by means of boards and fine meshed wire-cloth. Over this, a cheese-cloth tent was erected, and in it a large number of nymphs were placed. The records of the results obtained are as follows:

May 8, 12 nymphs emerged before 12 M., transformed before May 9, 12 M. All Females.
May 10, 40 " " before 12 M., " before 12 M., May 9. All Females.
May 12, 25 " " before 12 M., " May 13, before 12 M. All Females.

That these nymphs emerged so regularly before noon was doubtless due to the fact that the sunshine reached the tent only at this time and in the late afternoon. Rearings were made as long as the season lasted but neither among the reared specimens nor among the nymphs collected could a male be found. A few specimens of the same species were also collected in two other streams near Ithaca, but no males were found. The fact that no male specimens have been taken neither in collecting, or rearing, indicates a case of parthenogenesis in this species.

Female imago. Measurements. Length of body 10 m. m. Length of setae 10 m. m. Color bright reddish brown with whitish areas on the thoracic pleurae. Abdomen reddish brown slightly paler beneath with the ventral ganglia marked by darker areas. Antennae brown, paler at the base, the second segment very long. Thorax brown; legs brown, the third pair slightly paler than the others; wings hyaline with their bases shaded with brown and the veins very distinct. Setae brown with their joinings distinctly lined with brown.

SUMMARY.

1. The physical features of Fall Creek make possible the greatest variety of aquatic conditions. A study of the abundant May-fly fauna which lives under these conditions has revealed a series of striking adaptations to environment.

2. One may best observe the nymphs and secure adults of uncommon species by rearing the insects in their own surroundings. For this purpose a new type of breeding cage has been described and figured.

3. Observations upon representatives of 17 different genera have shown some interesting points in structure and ecology. Among these have been described the structural adaptations of various nymphs, the striking peculiarities of Ephemerella nymphs, the emerging of Blasturus cupidus, the swarming of Ephemera and Leptophlebia, and the egg-laying of Baetis.

4. No male specimen of Ameletus was secured either by collection or among 83 reared specimens. I have, therefore, suggested that this species may present a case of parthenogenesis.

EXPLANATION OF PLATES. (All figures much enlarged.)

PLATE VI.

Heads of **Ephemerella** nymphs.

Fig. 1.	Ephemerella	rotunda	sp. nov.
" 2.	"	tuberculata	"
" 3.	"	cornuta	"
" 4.	"	deficiens	"
" 5.	"	serrata	"
" 6.	"	lata	"

PLATE VII.

Legs of **Ephemerella** Nymphs.

Fig. 1.	Right legs		of	Ephemerella	lata	sp. nov.
" 2.	"	foreleg	"	"	serrata	"
" 3.	"	"	"	"	rotunda	"
" 4.	"	"	"	"	deficiens	"
" 5.	"	"	"	"	tuberculata	"
" 6.	"	"	"	"	cornuta	"

These drawings are all made from the upper or dorsal aspect. The enlarged sketches of the claw and tarsus of each show the ventral aspect of the tarsus with its chitinous comb which is used in clinging to the rocks.

PLATE VIII.

Mouth-parts of **Ephemerella** nymphs.

Fig. 1. Mouth-parts of Ephemerella lata. sp. nov.; r. md., right mandible; l. md., left mandible; lr., labrum; l., labium; mx., left maxilla; hy., hypopharynx, viewed from above.

Fig. 2.	Left maxilla	of	Ephemerella		serrata	sp. nov.
" 3.	"	"	"	"	tuberculata	"
" 4.	"	"	"	"	deficiens	"
" 5.	"	"	"	"	rotunda	"
" 6.	"	"	"	"	cornuta	"

PLATE IX.

Epeorus and Ephemerella.

Fig. 1. Epeorus humeralis sp. nov. Portions of the 3rd and 4th abdominal segments of the nymph with gills removed, to show lateral spines.

Fig. 2. Forceps and penes of Epeorus humeralis, sp. nov. (From below.)

" 3.	"	"	"	"	Ephemerella	serrata	sp. nov.	(From below)
" 4.	"	"	"	"	"	deficiens	"	(From below).
" 5.	Wings of				"	cornuta	"	
" 6	"				"	rotunda	"	
" 7.	"				Epeorus	humeralis	"	

PLATE X.

Iron fragilis sp. nov.

Fig. 1. Mouth-parts of the nymph; 1, outer aspect of the labium; ll., inner aspect of the labium; r. md., right mandible; l. md., left mandible; hy., hypopharynx.

Fig. 2. Wings.

Fig. 3. Foreleg of the male imago.

Fig. 4. Forceps and penes from below; dotted lines represent the portion of the penes hidden by the last sternite.

PLATE XI.

Tricorythus allectus Needham.

Fig. la. Elytroid lamella; hy., hypopharynx;

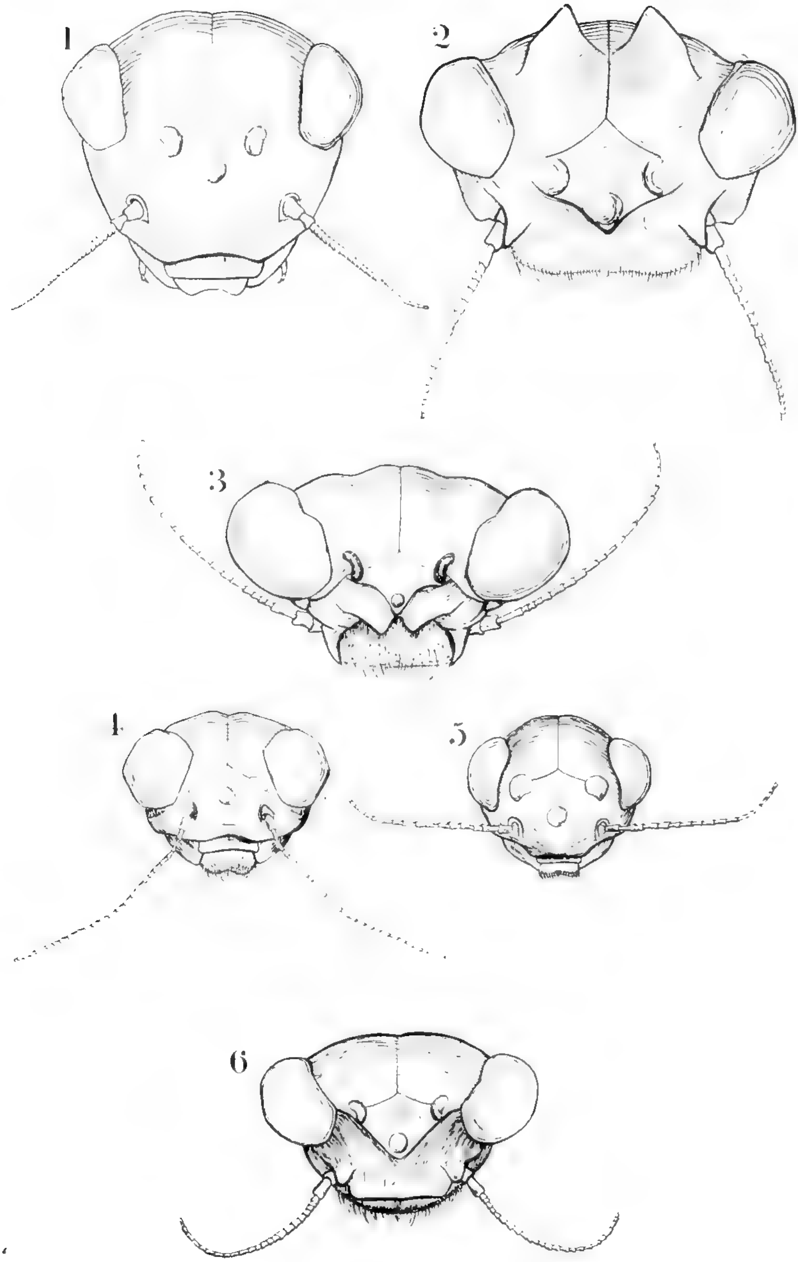
" lr. labrum; r. md., right mandible; l. md., left mandible.

" mx. left maxilla; l., labium.

PLATE XII.

Fig. 1. Surface of stone covered with masses of Baetis eggs.

" 2. A few of the masses enlarged.



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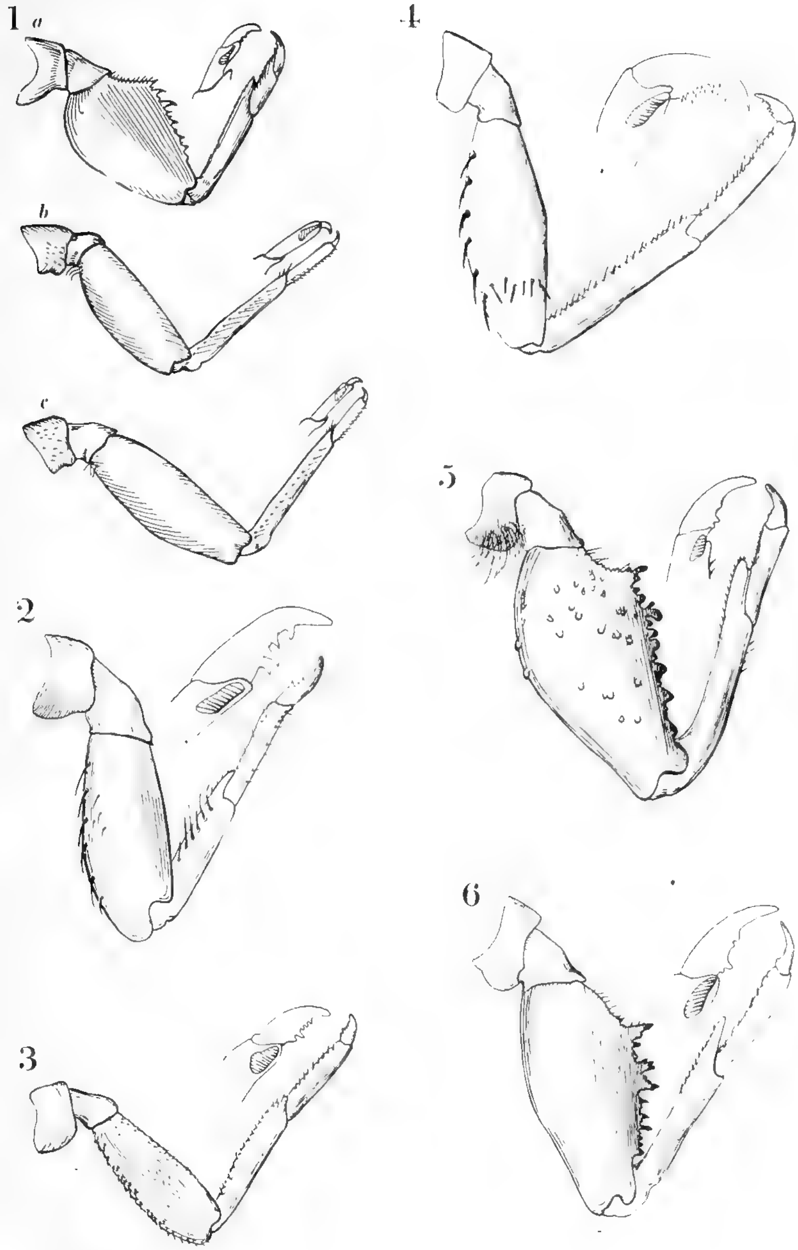

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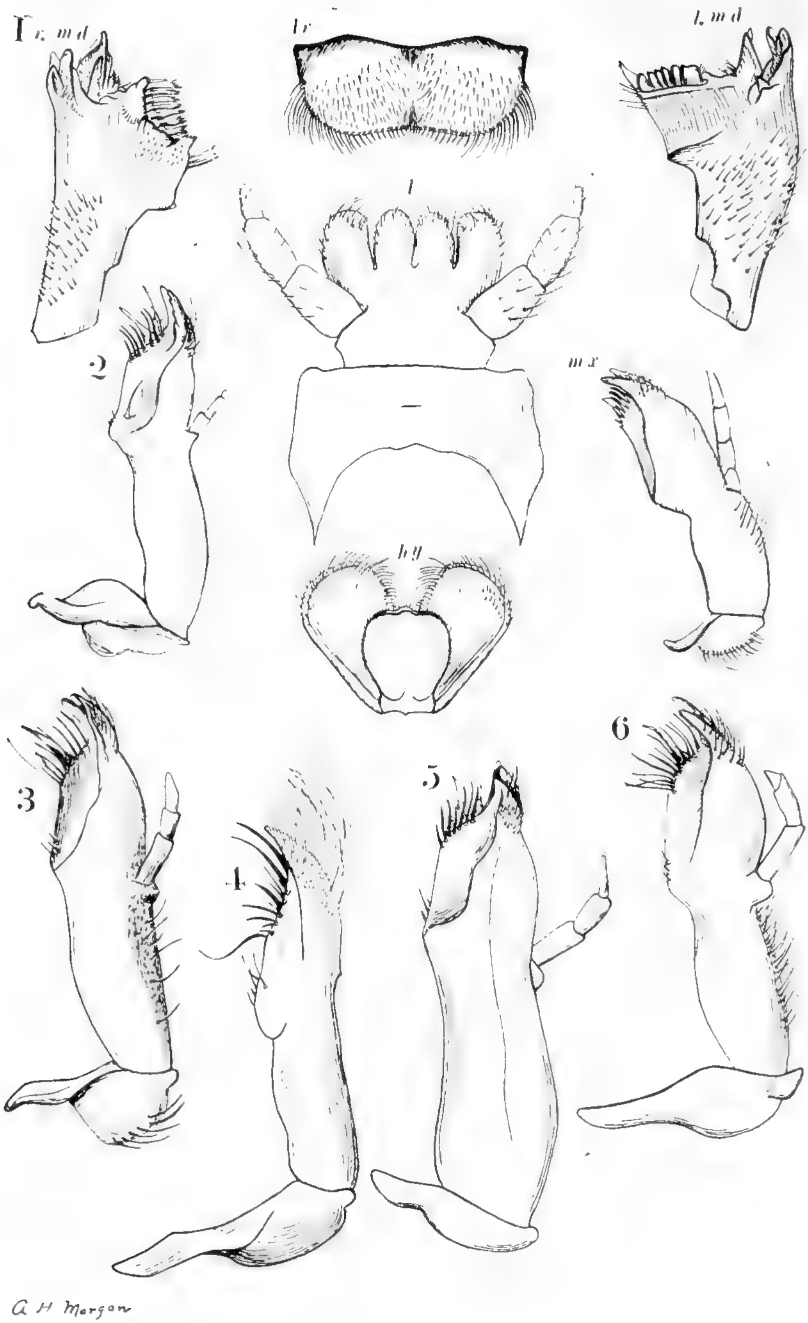
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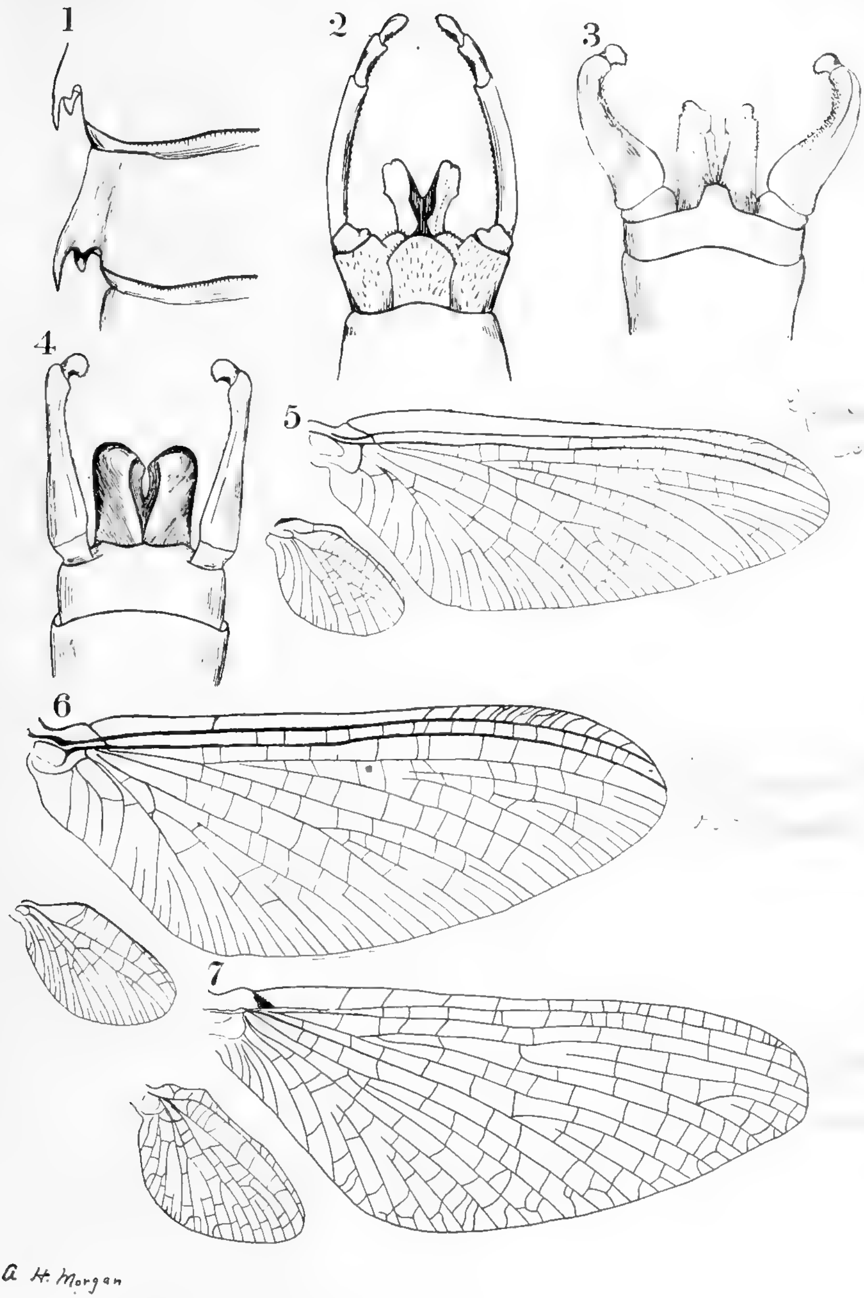
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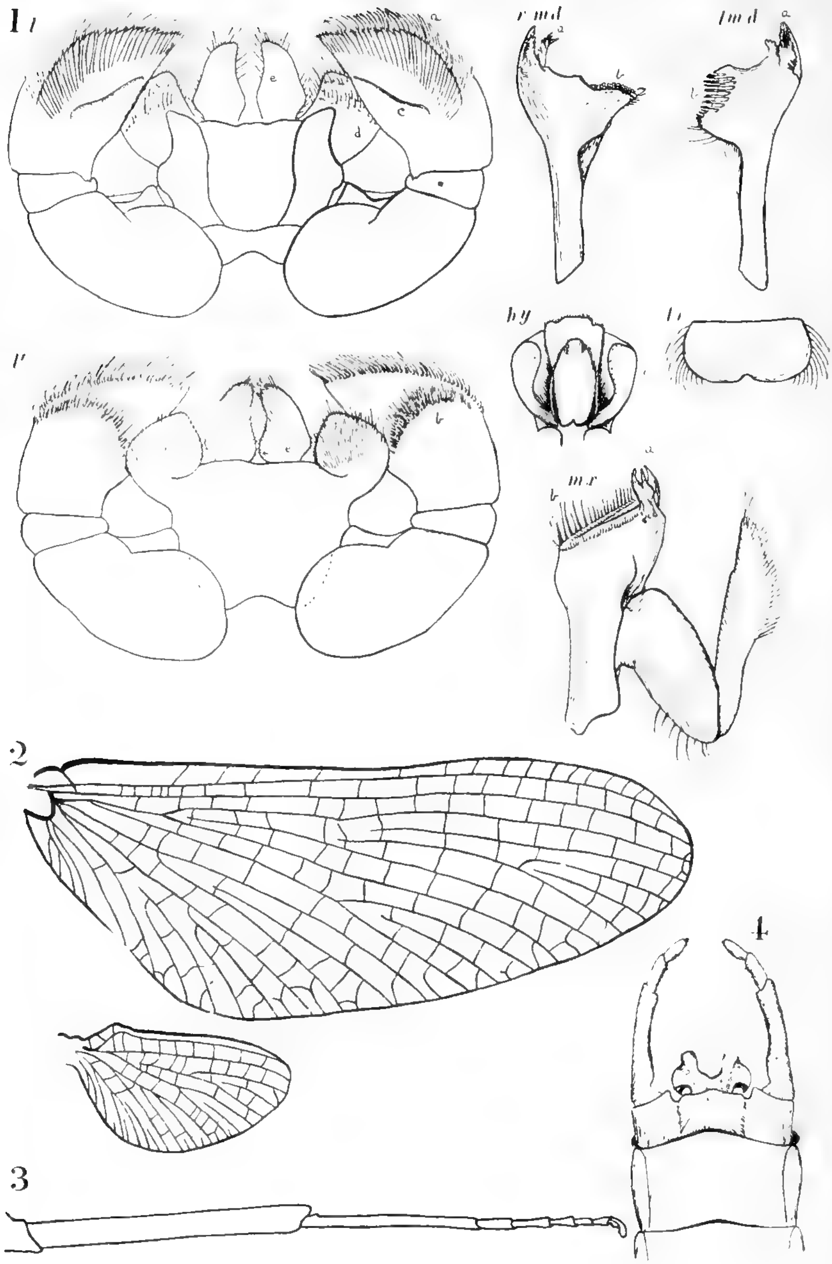
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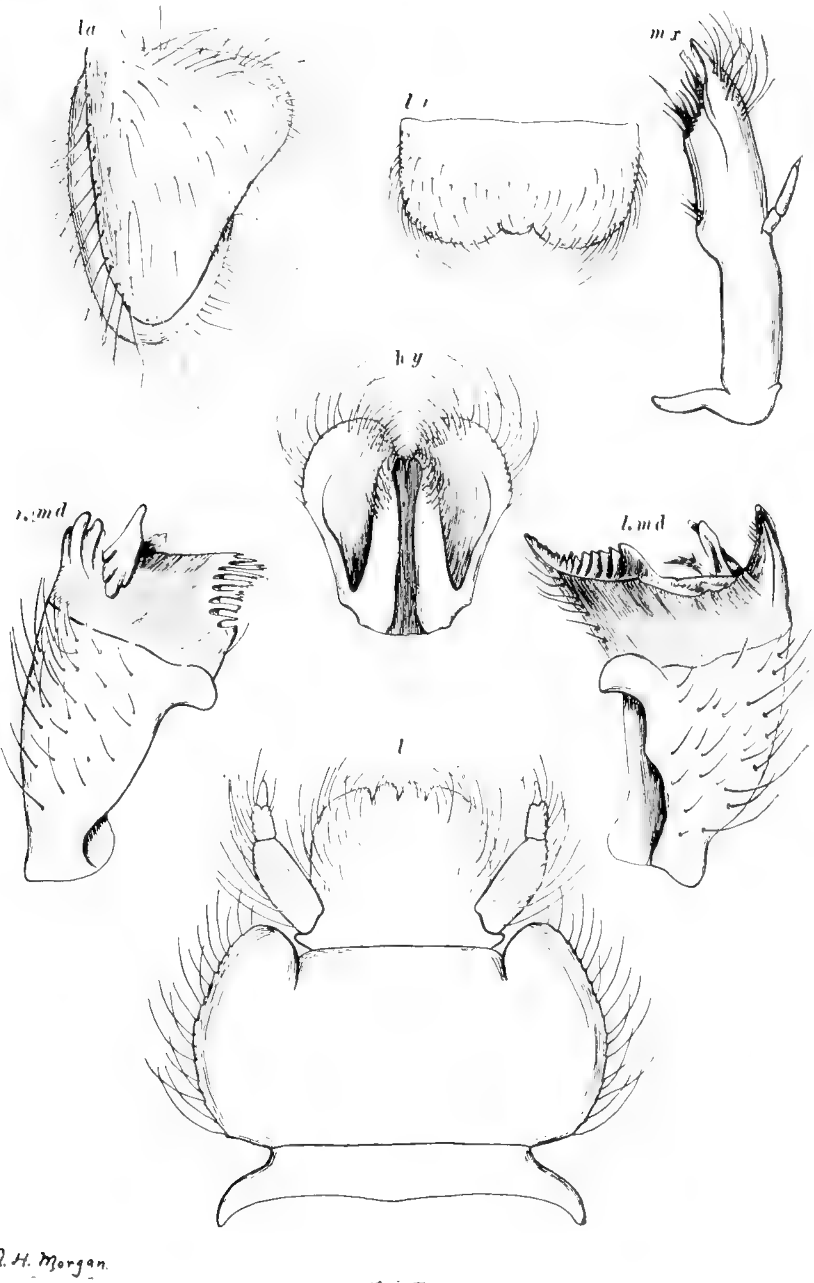
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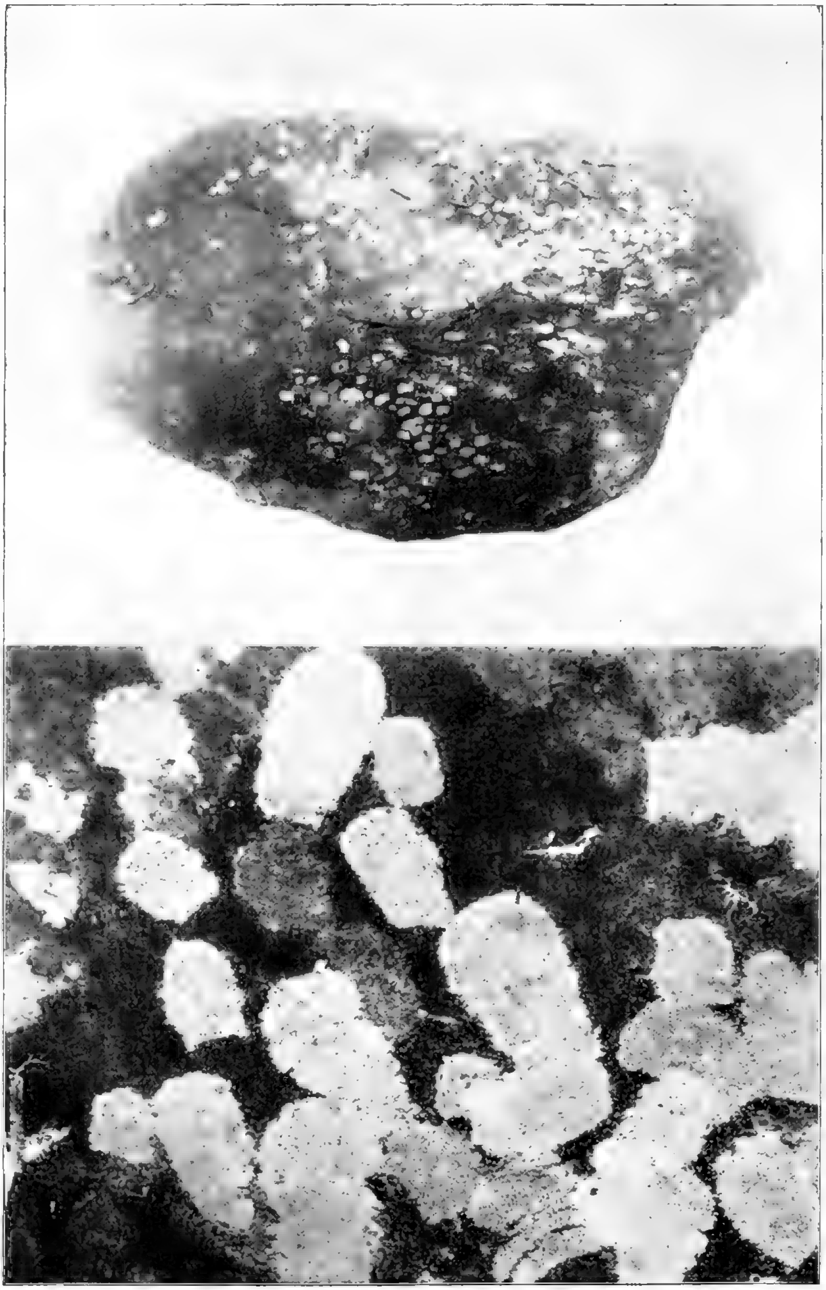

A. H. Morgan.

ANNOUNCEMENT OF FURTHER RESULTS SECURED IN THE STUDY OF MUSCOID FLIES.

By Charles H. T. Townsend,
Piura, Peru.

The work on the female reproductive system, eggs, and first-stage maggots of the Tachinid flies and their allies, begun in 1908 by the writer at the Gipsy Moth Parasite Laboratory in Massachusetts, under the direction of Dr. L. O. Howard, Chief of the Bureau of Entomology, has been prosecuted to date as time permitted. The results are now such that it becomes desirable to make an announcement of them in brief. This announcement is in advance of a series of much more complete papers, which will contain plates of the female reproductive and accessory organs, eggs, first-stage maggots, and cephalopharyngeal skeletons of the latter, some 200 drawings having already been completed for this purpose.

The female reproductive and accessory organs in the Muscoid flies consist of (1) ovaries, (2) oviducts and common oviduct, (3) spermathecae and their ducts—3 in number, (4) tubular (or colleterial or accessory) glands and their ducts—2 in number, (5) uterus when present, including what may be termed the preuterus which is present in some forms, (6) uterovagina, being a vagina proper which functions anteriorly as a true uterus when latter is absent, and (7) ovipositor or larvipositor and appendages.

The functions of most of the above organs are generally understood, but the following points need mention:

The tubular glands function as secretory organs for the production of the viscid fluid for coating the eggs, and are more or less rudimentary in those forms that deposit maggots; the preuterus is a small sac at the head of the uterus, in which the egg of some forms is fertilized before passing into the uterus proper, the spermathecal ducts opening into it; the uterovagina is a short tube homologous with the so-called insect vagina, its anterior portion filling the office of uterus in those forms without distinct uterus, the spermathecal and tubular gland ducts opening therein, its posterior end filling the office of vagina. The openings of the spermathecal ducts always mark the transition from common oviduct to functional uterus.

The results so far secured in the present work indicate at least 37 distinct series in the Muscoid flies (exclusive of Anthomyiidae and Acalyptratae), based mainly on the characters of the reproductive and accessory organs of the female fly, the egg, first-stage maggot, and in some cases the facial plate and other characters of the external anatomy of the adult. Undoubtedly further work will demonstrate the existence of further series demanding recognition. Briefly the series so far recognized may be tabulated as follows:

1. TRICHOPODINE series—Xanthomelanodes peruanus n. sp. (Peru) dissected and drawn, TD 3983. No uterus, uterovagina short and broad, tubular glands short and thick, spermathecal ducts very long and spermathecae attached in hood, oviducts of moderate length and thickness, ten eggtubes in each ovary in the above species, eggs flattened and pink-salmon to flesh-brown in color when mature. The chorion of egg is beautifully honey-comb reticulate. Xanthomelanodes and allies. Trichopoda and allies, many of which have been dissected, have same eggs and ovaries, and almost certainly the same type of reproductive system.

2. RUTILIINE series—Rutilia sp. and Amphibolia sp. (Australia) dissected, TD 1864, 1866. Uterus present, but its character not yet known. Maggots long and slender, hairy or furnished with hairs at anal end. Rutilia maggot has anal hairs, Amphibolia maggot is thinly hairy on body. Rutilia, Amphibolia and allies—Australian flies, most of rather large size. These will probably need division into several series.

3. PHASIINE series—Uterus present, form not known. Egg very elongate, slender, TD 480 (South Carolina), near Alophora, has what seems a piercing larvipositor or ovipositor, but curved in the opposite direction from that of Compsilura and not so sharp apically. Phasia, Alophora, Hyalomyia and allies, but these have yet to be studied.

4. GRAPHOGASTERINE series—Hyalomyodes sp. (South Carolina) dissected, TD 481. Uterus present, eggs and maggots slender. Hyalomyodes and allies, and probably Anurogyna.

5. GLOSSININE series—Functional uterus, whether uterus proper or uterovagina, greatly enlarged to hold the maggot until fully grown and ready to pupate, some special provision being evidently present for the feeding of the maggot during

its three stages. A most remarkable and distinct type, in any event, not only in its reproductive system and habit, but also in its venation and other characters. Glossina and allies—African blood-sucking flies, carriers of Trypanosomae of various forms of sleeping sickness in man and animals.

6. STOMOXYDINE series—Stomoxys calcitrans (Peru) dissected and drawn, TD 3985. No uterus, uterovagina short, spermathecal ducts long and doubled, tubular glands fairly well developed but not longer than oviduct plus common oviduct. Eggs elongate and deposited on dung. Adult with piercing mouthparts in both sexes. Ovipositor with a dorsal pair of bristly, slightly curved, subcylindrical chitinous processes. Stomoxys, and probably Lyperosia, Haematobia and allies—blood-sucking flies and probable carriers of microzoa of certain cattle diseases.

7. CALLIPHORINE series—Compsomyia macellaria (Peru) dissected and drawn, TD 3984. No uterus, uterovagina very short; spermathecal ducts very short, only as long as the spermathecae themselves; tubular glands only very moderately developed, about as long as common oviduct plus oviduct, the latter hardly half the length of the former. Ovipositor simple. Mouthparts fleshy. Eggs elongate, deposited in sores or on meat, the product of both ovaries being deposited at one time. Compsomyia and allies, and probably Calliphora, Lucilia and allies.

8. MESEMBRININE series—Probably a distinct series comes here, including Mesembrina and allies, and especially Dr. Adolf Lutz's strange Brazilian fly which Prof. Hermann determines to be Pseudogametes, and which seems to have Mesembrinine affinities.

9. MUSCINE series—Musca domestica (Peru) dissected and drawn, TD 3982. No uterus, uterovagina elongate; a pair of uterovaginal pouches springing from lateral anterior walls, one on each side below insertion of spermathecal and tubular gland ducts, being accessory copulatory vesicles of Hewitt; tubular glands long and slender; eggs elongate, deposited on dung, etc. Musca and allies.

10. SARCOPHAGINE series—Sarcophaga 2 spp. (Peru) dissected and drawn. Uterus, when distended, heart-shaped or cordate, maggots rather irregularly disposed therein. Uterovagina short, but with two dorsally-lying sacs or large pouches

developed from its anterior ventrolateral walls, one on each side, these two sacs and the uterovagina together forming the heart-shaped functional uterus, which contains the eggs until the embryo has developed to the fully formed maggot ready for deposition on host or food-substance. Sarcophaga and allies; and possibly Rhinophora, Melanophora, Brachycoma and allies, the last three genera being included by external anatomical analogy. Brachycoma is a Bombus inquiline or parasite; Rhinophora and Melanophora are terrestrial-isopod parasites.

11. METOPIINE series—Metopia sp., TD 3988; Selenomyia sp., TD 3998; Sarcomacronychia sp., TD 3996 (all Peru) dissected and the first drawn. Uterus thick short V-shape, the arms of the V being productions anteriorly of the ventral walls of the uterovagina on each side, on the same plan as that of Sarcophaga but in different form, not rounded but rectangular pouches, the form doubtless due largely to regular disposition of the contained eggs and maggots; spermathecal ducts very long, doubled on themselves; tubular glands thick and moderately long. Maggots and eggs regularly arranged on end in uterus in triple and quadruple file. The uterovagina forms the base of the V, thus functioning as part of the uterus; the empty arms appear as blind tubes. Metopia, Selenomyia, Sarcomacronychia and allies. It is to be noted that the facial plate in the adult of Metopia is widely different from that of the rest of the group, probably due to antennal development, thus indicating its inferior rank in this series. Largely muddauber-wasp inquilines or parasites, feeding on contents of nests. Related to the Sarcophagine series.

12. COMPSILURINE series—Compsilura concinnata (Europe), Dexodes nigripes (Europe), Vibrissina sp. (Florida), and Eucelatoria spp. (Florida and Peru) dissected; TD 290, 132, 775, 1229, 3906. Uterus slender, long, in several coils, maggots and eggs normally obliquely on end, the maggots usually in single file, deposited subcutaneously in host through the hollow curved piercer of female fly, the single file arrangement doubtless for the purpose of facilitating the passage of maggots through the piercer. This type is a modification of the Hemimasiceratine type, with the addition of a piercing larvipositor for subcutaneous deposition of the maggots. Compsilura, Vibrissina, Eucelatoria and allies, including so far as known all flies whose females are provided with a curved piercing sharp-pointed larvipositor.

13. TACHININE series—Tricholyga sp. (Peru) dissected and drawn, TD 3971. Tachina spp. (Europe, America and Japan) dissected. No uterus, uterovagina normal and capable of holding but few eggs at a time; eggs oval and flattened, provided with a terminal dorsal hinged lid or cap for exit of maggot, normally deposited in a comparatively undeveloped state of embryo on host. Tubular glands very long and highly functional. Chorion hard, opaque, not reticulate. Tachina, Tricholyga and allies. Everything here points to egg deposition, and it is thus difficult to understand Dr. I. C. Nielson's record of larviposition for his Tachina larvarum, female flies of which appear to be the same as the ordinary form from which we secured deposition of great numbers of eggs but never a maggot, at the Gipsy Moth Parasite Laboratory.

14. MEIGENIINE series—Eumyothyria sp. (Peru) dissected and drawn, TD 3981. Uterus in a single coil, tubular and thickened when full of eggs; egg oval and flattened like that of Tachina, maggot developing within egg in uterus certainly to some extent, but egg evidently deposited on host after a certain period of uterine incubation. The flat eggs exhibit a shingled arrangement in the uterus. The long well developed tubular glands show that the eggs are intended for deposition as such, before the escape of the maggot. Both tubular glands and eggs are practically same as in the Tachinine series. Eumyothyria and quite certainly Meigenia and allies. TD 651 (Florida) with small brown flat eggs, which were certainly uterine, and TD 738 (Ocean Beach, So. Florida), with Plagia-like venation and small flat uterine eggs may possibly come here.

15th series—Apparently what Coquillett determines as Sturmia distincta, which seems same as protoparcis Towns. and is probably referable to Zygobothria (Florida), TD 619; and other spp. (Europe and Florida) dissected. Short coiled strap-like uterus full of maggots and eggs on end, after style of Hystriciine series (which follows) but in only two or three coils and with white maggots which are evidently deposited on hosts, being without anal membraneous pad for leaf-attachment. Zygobothria and allies, provided Z. bimaculata Htg. of Europe, the type of the genus, agrees herein as it seems to in external characters. Type specimens of many genera will have to be dissected before we will know what name to give this series.

16. HYSTRICIINE series—Archytas sp. (Peru) dissected and drawn, TD 3989; and Melanophrys, Varichaeta, Copecrypta, Echinomyia, Jurinia, Paradejeania, Dejeania, Saundersia, and many others dissected and their maggots drawn. Very long coiled strap-like uterus, in many coils, band-like, wide and thick, full of eggs and maggots on end, the thickness of the uterus corresponding to the length of the maggots and eggs contained, but the uterus lying on edge in a spiral like a watch-spring; maggots developing therein and becoming dark colored when mature from the blackish dorsal and lateral minute scale-like plates, deposited on the foliage of plants in proximity to their hosts, being furnished with an anal membranous attachment pad for adhering to plant surfaces. Tubular glands short and small. The above named genera and their allies, forming a very large and predominant series especially in the mountainous regions of both Americas, and representing the most recent phase of Muscoid fly evolution. This series will need to be divided into several groups.

17. MASICERATINE series—Blepharipa politana n. sp. (Peru) dissected and drawn, TD 3977; others dissected and their maggots and eggs drawn. Very long coiled tubular slender uterus, in many coils, filled with thousands of microscopic eggs which are held till the contained maggots are fully formed when they have become black in color and are deposited on foliage to be swallowed by hosts in feeding, being placed in proximity to leaf-eating insects, probably always lepidopterous larvae. Tubular glands moderately thick and developed. The chorion of the egg in this series exhibits always a honeycomb-like or network system of reticulation, though often also showing minute light-colored points appearing as microscopic punctures. The chorion of egg is oval in outline viewed from above. TD 877 (So. Florida), the adult of which at first sight appears much like Cnephalia, has the egg-substance protruded beyond the chorion at both ends, giving the eggs a decidedly slender and pointed appearance especially when seen in situ through the walls of the uterus. The explanation of this peculiarity has yet to be learned. The series includes Masicera, Blepharipa, etc., forming with other leaf-ovipositing flies a large group more especially predominant in the lowlands of both Americas as well as other parts of the world, and representing an extreme phase of Muscoid fly evolution somewhat less recent than that of the Hystriciine series.

18th series—Species agreeing in external characters with Eumasicera but certainly not that genus (Peru), TD 3987; dissected; probably Exorista futilis O. S., determined in the adult by Mr. W. R. Thompson (Massachusetts), TD 344, 361. Uterus short, thick, tubular, in only two or three coils, filled with microscopic oval eggs of same character as those of Masiceratine series except that they show no honeycomb or network reticulation but a concentric-ring or concentric-arc pattern viewed from above, apparently due to a disposition of ridges or wrinkles in the chorion. Eggs deposited on foliage, probably for lepidopterous larvae only. The above mentioned forms must, I think, belong to the same genus as the reticulation of the chorion is of the same character; but until the type species of Exorista, Sturmia, and various other genera are dissected, it will be impossible to say what generic name must be given them; and still further genera must be dissected before we can know what name to give this series, which may include Phorocera, or even older genera. TD 437, which seems referable to Phorocera on external adult characters, probably comes in this series; it is European.

19th series—Ophirosturmia cincta gen. et sp. nov. (Peru) dissected and drawn, TD 4012. Uterus tubular and elongate in four to six coils, stouter near head, filled with microscopic oval brownish-yellow to yellow-brown eggs, whose choria exhibit a honeycomb reticulation, the eggs deposited on leaves in proximity to certain leaf-eating insects. There is no punctulation to the chorion. Distinguished from the Masiceratine series by difference in spermathecal ducts, and by the brown-yellow color of the mature eggs, as well as other points. Apical cell ending well before wing-tip.

There are other series yet to be defined among the leaf-ovipositing forms.

20. Gymnochaetine series—Gymnochaeta sp. (Peru) dissected, maggot drawn, TD 3973. Maggots and eggs on end in two or three rows in very long subtubular coiled uterus; maggots black by reason of the body segments bearing a large dorsal and two small lateral colored plates, these made up of minute colored scale-like plates of different form from those of the Hystriciine series; the maggot with ventral locomotory spine-pads and spine-rows composed of very microscopic spines and evidently specially fitted for locomotion in the open; no anal

membraneous attachment pad being present. This is a totally new type of maggot and indicates a widely diverse habit from others so far known. Gymnochaeta and allies.

21st series—Ophirion mirabile gen. et sp. nov. (Peru) dissected and drawn, TD 3980. Maggots and eggs rather loosely disposed in long slender tubular uterus, the eggs in two rows obliquely on end; an elbow-like preuterus, uterus arising from inside angle of elbow, common oviduct opening into one end of elbow and the spermathecal and tubular gland ducts into the other end; oviducts long and slender, tubular glands very short; maggots of a peculiar and new type, remarkable in that they appear emarginate laterally and are furnished with a dark-colored pattern.

22. Pseudodexiine series—Ophirodexia pulchra gen. et sp. nov. (Peru) dissected and drawn, TD 3999. Uterus thick, tubular, in two coils, with eggs and maggots obliquely on end; a true preuterus homologous with the forward half or more of the uterovagina, the uterus having evidently developed from the walls of the vagina proper; spermathecal and tubular gland ducts opening into the preuterus, which has capacity of just one egg; all these ducts very short; tubular glands only about three times as long as preuterus, or as long as common oviduct plus oviduct; oviducts very short and thick; common oviduct much longer and slender, being about twice length of preuterus. Maggots slender. Abdomen of fly elongate, subcylindrical; facial plate long, wide, not constricted by vibrissal angles, cut off abruptly below; antennae elongate, arista plumose. These characters apply to the above form, TD 3999. Ophirodexia and allies, including probably Pseudodexia, Leptoda, Cordyligaster, and a host of others. Atrophopoda may come here, or may be very distinct.

23. Ocypterine series—Probably a distinct series comes here for Ocyptera and allies. The genus has been dissected, but not with sufficient care. The eggs are elongate, stout, subcylindrical; maggot unknown to me.

24. Thryptoceratine series—Probably a series comes here for Thryptocera and allies. Eggs slender, elongate. Maggot not known to me.

25. Hemimasiceratine series—Uterus present, doubtless coiled, containing elongate white maggots which must be deposited on host. Hemimasicera, Sisyropa and allies. These

genera dissected and maggots drawn, but the form of uterus was not determined.

26. Siphosturmine series—Siphosturmia sp. (Peru) dissected. TD 4002. Single-coil uterus, sub-tubular, with two rows of eggs and maggots; very long ovipositor, sub-chitinous, in its unextended position in abdomen measuring nearly one-half the length of uterus; ovaries slender, elongate, with few eggtubes; oviducts long, common oviduct same length as oviduct; spermathecae elongate-oval, two joined in hood, the third free; spermathecal ducts elongate, about as long as common oviduct; tubular glands moderately elongate and slender, about as long as common oviduct plus oviduct. Siphosturmia and allies. Florida specimens of the genus have also been dissected.

27th series—Anisia, Erynnia, Gymnostylia spp., or forms allied to these genera so far as can be known by external adult characters, including Hypostena barbata of Coqt. in part (Peru and Maryland) dissected, TD 4001, 433. Plump white maggots with well-developed spine rows on ventral surface. Uterus slender, tubular, coiled three times within itself; maggots in single file, oblique to nearly longitudinal in position according to degree of crowding in uterus; spermathecal ducts long, tubular glands not long; ovaries elongate, with few egg-tubes. The maggots of the Peruvian form (TD 4001) show five highly developed ventral spine rows; those of the D. C. form (TD 433, collected by Knab on Plummers Island following a beetle of Calligrapha bigsbyana) are very similar, having five transverse rows of strong hooked spines on posterior half of median ventral surfaces. Maggots of TD 352 (Mass.) are short and plump, with strongly marked complete rows of spines encircling the body, and may not belong here; the fly has a different facies. The series embraces flies that are parasites of both the grubs and adults of certain beetles, especially Chrysomelidae. The European tachinid parasite of the imported elm-leaf beetle apparently belongs here. Many genera will likewise have to be dissected before this series can be named.

28. Parexoristine series—Parexorista cheloniae (Europe) and Parexorista sp. (Mass.) dissected, TD 432. Uterus in a single coil, containing elongate subcylindrical eggs which are furnished with a pedicel, the eggs incubated in uterus sometimes to an advanced stage of the embryo and then deposited on host attached to skin or hairs of latter by pedicel. Parexorista and allies.

29. Dexine series—Almugmyia arida gen. et sp. nov. (Peru) dissected and drawn, TD 3979. Dexia, Mochlosoma, Sirostoma, Sardiocera, and allied forms dissected and maggots drawn. Uterus thick, tubular, in one coil; eggs and maggots in a very oblique and somewhat spiral arrangement; ovaries very slender, elongate, consisting of few eggtubes; common oviduct rather long, oviducts short, spermathecal ducts long and doubled, tubular glands small. The maggots of Almugmyia and Sirostoma have anal spiracular tubes carried out in long slender anal processes which are tipped with bristles; the eggs of the first are sharply pointed anally, due to the presence inside the chorion of the anal bristles of the developing maggot. Probably the genera above mentioned all come in this series with many others, but the reproductive-system characters above given have not yet been verified for the genera other than Almugmyia. Parasites of white-grubs, woodboring-grubs, and probably others.

30. Myiophasiine series—Ennyomma globosa (South Carolina and Florida) dissected, TD 509. The maggot is so slender as to be almost filiform. Uterus present, but form not determined. Ennyomma, Myiophasia and allies. Parasites of weevil grubs in green fruits.

31. Phasiopterygine series—Phasiopteryx spp. (Colorado, Veracruz and Peru) dissected, TD 1791, 1791a, 4005. Uterus present, very long and slender, in many irregular knotlike coils and turns, the upper part more regularly coiled, receiving the eggs while latter are still microscopic, the eggs growing to full size in upper part of uterus. Ovaries and oviducts very small, the latter not over one-fourth the diameter of a full-grown uterine egg. Preuterus present. Spermathecal ducts very short, tubular glands short. Maggots with five longitudinal rows of strongly chitinized segmental plates, those of median row wide and covering dorsum of segments, those of inner lateral row narrowed, those of outer lateral row presenting a serrate outline below; underside white and soft. The chitinized plates of the maggot vary from brownish-yellow to black, overlap when the maggot in contracted, the segments telescoping and producing a strongly emarginate outline both from above and in profile. These plates are evidently ambulatory in function as well as protective against conditions of life in the open or subopen. Maggots elongate when not contracted, moderate-

ly wide, flat below; wide and short when contracted. The habit is larviposition, but one can not even guess at the larval habit and host relation. This is a most interesting and remarkably distinct type. Although the Colorado and Veracruz specimens of the fly look quite alike externally, the maggots from the Veracruz specimen all show two large black bunches of strong more or less swollen and hooked or cleft spines on cephalic segment which are wholly lacking in the maggots from the Colorado specimen, indicating two very distinct species. The maggots from the Peruvian specimen do not show these cephalic spine-bunches; they besides differ from both the Colorado and Veracruz maggots in the characters of the segmental plates.

The Veracruz specimen came from Orizaba (coll. by Herbert Osborn) and is probably P. bilimeki B. B., the type of which came from the same locality. A much fuller description with figures of the maggots and female reproductive system will be given in forthcoming papers.

32. Megaprosopine series—Microphthalma spp. (North and South America) dissected, TD 313, 3915. Uterus present, long, subtubular, in several coils, filled with thousands of slender pointed eggs and maggots. The maggot of Microphthalma is very hairy, being the extreme development in this respect so far as known. This series includes Microphthalma and allies, and almost certainly Megaprosopus. Trixodes is almost certainly the type of a separate series. The first and probably the second are white-grub parasites, while Trixodes is probably a woodboring-grub parasite.

33. Macronychniine series—No dissections of Macronychia have as yet been made. The uterus may well be Metopiine in form. At all events it must be quite distinct from the preceding series. The forms are perhaps muddauber-wasp inquilines.

34. Cuterebrine series—Cuterebra spp. (Florida and South Carolina) dissected, eggs drawn, TD 487, 486. Probably no uterus, as the eggs are certainly deposited; chorion of egg very thick and hard, furnished at what is probably cephalic end and with a hinged lid or cap opening on dorsal aspect of egg and provided for the exit of the maggot which could not otherwise escape from its heavy chorion-prison, thus demonstrating most conclusively that the egg is intended for deposition as such. Eggs probably deposited externally on skin or

hairs of host, and not swallowed, the maggots probably—almost certainly—penetrating skin at point of oviposition; Dermatobia hominis is practically known to have these habits. Cuterebra, Dermatobia, and probably Rogenhofera and Bogeria.

35. Gastrophiline series—Probably a uterus in which the eggs are incubated to a certain extent; eggs pediceled and perhaps ready to hatch soon after deposition, deposited on hairs of Equus and on Elephas, in the latter case probably on the hairs; maggots issuing from chorion in mouth or oesophagus of host and living in alimentary canal of same, passing out with the faeces when fully grown. Gastrophilus and probably Cobboldia, the latter parasitic in elephants in Africa and India.

36. Oestrine series—Uterus certainly present; maggots deposited in nostrils of ruminants, elephant and horse, living in nasal and pharyngeal cavities and issuing through nostrils when ready to enter ground for pupation. Oestrus, Rhinoestrus, Cephenomyia, Cephalomyia, Pharyngobolus—last known only as maggot in pharynx of elephant in Africa.

37. Hypodermatine series—Peristomalia or facilia of adult fly remote, enclosing between them what seems to be the excessively broadened clypeus or epistoma, perhaps both differing in this character of the facial plate most widely from all the other Muscoidea. The sclerites of these parts need careful study before they can be rightly interpreted. Perhaps a uterus in which the eggs are partially incubated; eggs deposited on hairs of ruminants, rodents and horse, taken into mouth of host, where they hatch or in oesophagus, the resulting maggots making their way slowly through the tissues to a position beneath the skin where they provide an air-hole and develop rapidly. Hypoderma, Oedemagena and Oestromyia. One of the most remarkable, widely divergent and at the same time well known groups of the superfamily Muscoidea.

It is to be noted that the statements "dissected and drawn" and "dissected" refer always to the female reproductive and accessory organs; also that the term maggot as used refers always to the first-stage maggot only, unless otherwise specified. The term series above is not used in a strictly taxonomic sense. The maggots of most of the genera mentioned above for maggot characters have been drawn and described.

Although much has been already accomplished in the investigations above outlined, the results as tabulated most graphically illustrate the astonishing amount of such work that yet remains to be done. The above 37 series, as defined or at least mentioned, and including others indicated therewith, will no doubt be more than doubled before the work is brought to a satisfactory conclusion. I have at present in tentative outline some 91 groups—taxonomic categories which are to be considered of subfamily or tribal rank, perhaps better the latter, and which may be termed GROUP UNITS. But before these can be satisfactorily defined, hundreds of type species of genera must be carefully dissected and figured, as well for their eggs and maggots as for the reproductive system. It is now most confidently believed—in fact, it is axiomatically apparent—that this method of work will finally clear up the taxonomy of these flies and put it on a sound basis.

ADDENDA.

In order to bring the outline of results up to date of reading proof of the foregoing (April 15, 1911), I wish to add the following very brief particulars:

CALLIPHORINE series—Synthesiomyia belongs here, as shown by dissection of Peruvian material. It was formerly thought to be more closely allied with Musca.

MESEMBRININE series—Dr. Lutz has sent me three specimens in fluid of Pseudogametes for dissection, but unfortunately all are males. The fly has a wonderfully strong Oestrid habitus, greatly resembling Cuterebra in general form and appearance. It will almost certainly need a separate group, the Pseudogametine.

SARCOPHAGINE series—Sarcophaga auribarbata n. sp., aurigena n. sp., argenta n. sp. (all Peru) have been dissected and drawn. Sarcophagula peruana n. sp. (Peru) and many other species of several genera (Florida and Peru) have been dissected and the maggots drawn.

TD 354, from Massachusetts, which is apparently closely related to this group, if not a member of it, is remarkable as showing most clearly in the first-stage maggot the seven main pairs of sclerites of the cephalopharyngeal skeleton enumerated at the end of these addenda, with the single exception of the dorsopharyngeal sclerite which is rudimentary or nearly absent.

Metopiine series—Prof. Osborn's important observations on the habits of Senotainia (Ohio Nat., VII, 1906, p. 38) indicate that these flies are guided to the nests of the host by observing the latter in the act of transporting spiders or caterpillars with which to provision same. I believe the maggots are deposited in choria, and stuck to the spiders or caterpillars. After the nest is closed the increased temperature probably arouses the maggots to activity, whereupon they first devour the egg or grub of host and then attack the stored provision. The entire contents of the uterus, which are not great, are deposited almost certainly at one time, extending over several hours, and probably may all be deposited in one nest if the conditions are favorable. Perhaps the fly attaches a maggot to the egg of host.

Compsilurine series—Eucelatoria australis n. sp. (Peru) has been dissected and drawn. The piercing larvipositor in this group is composed of two pieces, of which the upper is much shorter than the lower, the lower being concave dorsally and the upper concave ventrally. Both are sharply pointed but the lower piece curves broadly downward to the point and forms the main piercing organ. The two pieces are hinged at the posterior edge of their broad basal portion and the vagina opens between them. The maggot is expelled between these pieces within the skin of the host. Bouche, Heim and Kirschner were right as to the piercing function of this organ, while Giard was wrong. Nielson adopted the latter's view in his criticism of my original announcement of subcutaneous larviposition in these forms, to which I replied in Science (issue of Feby. 4, 1910, p. 195).

There are other forms with what appears to be a piercing larvipositor. Mention has already been made of TD 480, which seems to be near Alophora (see Phasiine series). Another case is furnished in a fly from Massachusetts with pseudodexiine aspect, TD 371, which has a broad blade-like larvipositor. These, if true piercers, are probably cases of independent specialization not indicating relationship with this group. Emphanopteryx (not Cryptomeigenia) has a piercer-like organ in the female, but it is doubtful if it is functional as piercing the skin of the host.

The genus Celatoria probably also possesses a piercing larvipositor similar to that of Compsilura. Judging wholly from the descriptions and figures, Coquillett evidently misinterpreted the sexes. The sex which he calls the male and which has the strong ventral keel is apparently the female, the keel being functional as a protection to the point of the larvipositor. The ventral groove described indicates this, and the fifth segment mentioned is probably the broad basal part of the larvipositor. If my surmise is correct, it appears that this form is unique in having the male front wider than that of female. At all events the genus must go in a group by itself, the CELATORIINE, on the remarkable spinose character of the last-stage maggot and puparium combined with the other striking characters.

GYMNOSOMATINE series—Gymnosoma sp. (California and Veracruz) dissected, TD 1815, 1815a. The uterus was not noted and is probably absent. The egg is large, white, very elongate-oval, flattened, chorion without reticulation. Gymnosoma and allies, perhaps including Oedemasoma, Parasites of adult pentatomids. Habit, host-oviposition.

TACHININE series—Neilsen is evidently wrong in his statement that his Tachina larvarum deposited maggots. The eggs which he referred to Carcelia were almost certainly those of his T. larvarum. This can be seen by reading his text. In his second paper (1910) he shows the egg of Carcelia to be pediceled.

MEIGENIINE series—This will need further division. The present forms are parasites of Chrysomelid larvae, sawfly larvae, and lepidopterous larvae. Tachinomyia appears to belong here. The following further groups can be indicated at present.

VIVIANIINE series—For Viviania, Cryptomeigenia and allies. All are parasites of adult beetles so far as yet known.

THRIXIONINE series—Thrixion and allies. Parasites of adult phasmids, etc.

PLAGIOPINE series.—Plagiops littoralis gen. et sp. nov. (Ocean Beach, So. Florida), TD 738, mentioned above under Meigeniine series, dissected. The uterus was not noted but is perhaps present. The egg is small, flattened, and ovate. Habit, host-oviposition.

PLAGIINE ser—Siphoplagia sp. (Florida) dissected, TD 489; Cyrtophloeba sp. (Mass.), TD 2731, and Plagia sp. (Mass.) TD 2711, dissected. The uterus is in several coils and strap-like in upper extent, the elongate subcylindrical eggs packed in rows and developing maggots therein. Habit, larviposition probably on host, as the uterine capacity is limited to a few hundreds.

Zygosturmiine series.—This is the 15th series above. Zygosturmia inca gen. et sp. nov. (Peru) dissected and drawn, TD 4031. Coquillett's Sturmia distincta and my protoparcis belong to this genus apparently. The oviducts are quite long and slender, common oviduct about two-thirds as long as oviduct, tubular glands about one and one-half times as long as common oviduct plus oviduct, spermathecal ducts about as long as common oviduct, tubular gland ducts only a little shorter than spermathecal ducts; ovaries with comparatively few ovarioles; no true preuterus; uterus strap-like, in but one or two coils, eggs and maggots packed in on the Echinomyiine plan.

Azygobothriine series—Azygobothria aurea gen. et sp. nov. (Peru) dissected and drawn. The ovaries are large, of many ovarioles. Common oviduct is about as long as one ovary. There is a nipple-like preuterus. The spermathecal ducts are very long, fully twice as long as common oviduct, sinuate, bent at or below middle. Tubular glands are short, only half as long as common oviduct, their ducts nearly twice as long as the glands. The uterus is wide and strap-like, in about two coils more or less.

Argyrophylax and Zygobothria seem to belong in the neighborhood of these two series, but may not come within either.

Hystriciine series—The leaf-larvipositing forms will need division into at least seven groups, the present including Hystricia, Bombyliomyia, Jurinia and allies. The others follow:

Melanophryonine series—Melanophrys and Artopharista which may or may not be the same.

Panzeriine series—Panzeria, Varichaeta and their allies. Nielson has described the first-stage maggot of Panzeria as having no minute colored plates, which I think is a mistake. The fragment which he thought to be first stage of this species seems either not to have been this species or else to have been a piece of a second-stage skin. His text and figures indicate this conclusion.

Micropalpine series—Micropalpus and allies. Copedrypta may or may not come here.

Echinomyiine series—Echinomyia, Fabricia and allies. Peletria and their allies may come here.

Saundersiine series—Saundersia, Epalpus and their allies.

Dejeaniine series—Dejeania, Paradejeania and Lasiopalpus.

Masiceratine series—This and the 18th and 19th series above represent only a part of the leaf-ovipositing minute-egg forms of Tachinidae, which exhibit a surprising variety of type, in female reproductive organs and eggs. They may be divided as follows, so far as now known, leaving the present group for Masicera, Blepharipa and allies, which have a long uterus containing black eggs with a honey-comb reticulation of the chorion.

Brachymasiceratine series—This is the 18th series above. Brachymasicera polita gen. et sp. nov. (Peru) dissected, TD 3987 Short uterus, black eggs, chorion with a wrinkle pattern and not honey-comb reticulate.

Belvosiine series—Belvosia, Latreillimyia and allies. Belvosia piurana sp. nov. (Peru) dissected, TD 4032. Uterus long, eggs black, chorion without reticulation but coarsely punctulate, the punctures largely double and triple.

Triachora has the chorion more finely and evenly punctulate, the punctures all single.

Blepharipezine series—Blepharipeza, Parachaeta and allies. Long uterus with black eggs, the chorion conspicuously honey-comb reticulate, the divisions with minute raised points.

Goniine series—Many specimens of various spp. of Gonia from both North and South America have been dissected, and drawings made of two of the dissections which appear widely different. One is a short thick uterus in only one to two coils, with very short oviducts and large ovaries, TD 4011; the other is a very long uterus in five or more coils, with elongate oviducts and somewhat smaller ovaries, TD 4037. Both are from Peru. Other specimens from Piura, Nana (near Lima), and Arequipa, Peru, show both long and short uteri, and I have found developed maggots in the short uterus as well as in the long one. The eggs are minute, flattened ventrally, ovate to subcircular; the chorion is without reticulation, but evenly, closely and very finely punctulate throughout. Preuterus present, common oviduct short, spermathecal ducts and tubular glands elongate. The maggot is elongate-pyriform; sometimes appearing nearly subcylindrical, and appears to lie curled in the sub-circular or oval egg. Pressure on the egg often causes it to assume an elongate narrow form pointed at ends, inside which the maggot probably lies straight. Slight pressure or teasing with a needle causes the cylindrical anterior portion of the maggot to protrude from the ventral edge of egg, at right angle to long axis. I can see no difference in the maggots from the short and long uteri, and am constrained to believe that here the uterus gradually increases in length as the eggs descend from the ovaries and fill it, although oviposition may begin while the uterus is still short. If this is so, it is an exceptional case in the great increase of length after maggots have become fully formed within the choria. There seem to be two forms of the flies in the Peruvian material, distinguishable externally, but the separation does not accord with the uterine difference. One or both of these forms are probably what has been called Gonia chilensis.

My dissections have shown Gonia frontosa (Mass.) to have a long coiled uterus; and what I identify as G. pallens and G. angusta (S. Florida) to have a very long uterus. The chorion of the egg is the same in these forms as above described.

The above observations indicate that much care and judgment must be used in describing the female reproductive organs in these flies. I have noted variations in lengths of uterus in other forms within certain limits; and variation in the number of rows of eggs in the strap-like forms of uterus as well as in certain others, without a corresponding variation in length. It is evident that we need careful investigations in various groups which shall determine how many days elapse between issuance of the fly or fertilization and complete development of the female reproductive organs. I have noted that in Varichaeta, under artificial conditions, this takes about fourteen days.

Phasiatactine series—Phasiatacta elongata gen. et sp. nov. (Peru) dissected and drawn, TD 4019. Uterus extremely long and slender, in very many coils and irregular turns, preuterus present. Ovaries large, oviducts long and slender, spermathecal ducts long and curved, tubular glands elongate. Eggs black, elongate, pointed at each end, chorion with areoles gathered around a dorsal opaque area, without reticulation.

Cnephalomyiine series—Cnephalomyia floridana gen. et sp. nov. (So. Fla.) dissected, TD 877. Uterus very long and slender, eggs blackish, elongate, obtusely pointed at each end, chorion, with an almost perfect hexagonal reticulation, interspersed with fine punctulations.

Cnephalodes pollinosus gen. et sp. nov. (Peru), TD 4038, which has been dissected and drawn, probably belongs here. The uterus is extremely long and slender, in numerous irregular coils and turns, the eggs elongate in single to quadruple file, chorion black with honeycomb reticulation and punctures. The characters of the maggot, including those of the cephalopharyngeal skeleton, show a close relationship with Gonia.

Ophirosturmiine series—This is the 19th series above. Uterus long and in many coils, eggs brownish-yellow, chorion honey-comb reticulate interspersed with closely-set microscopic raised points. Oviducts long, spermathecal ducts very long and slender, tubular glands moderately long, preuterus present. Phasmophaga evidentally does not belong here.

Ommasiceratine series. Ommasicera chaetosa gen, et sp. nov. (Peru) dissected and drawn, TD 4018. Uterus short and thick, in only one and a half or two coils; eggs brownish-yellow, chorion with an elongate-hexagon reticulation like a honeycomb pattern drawn out of shape longitudinally.

This concludes the leaf-ovipositing groups so far as I am able at present to indicate them. But there remains a multitude of these forms yet to be assigned, among which I can give notes on the following:

Paragermaria has a very long slender uterus, about 40 mm. in length, eggs black, chorion without reticulation, finely punctulate much like that of Triachora. It probably goes in the Germariine series, which will include Germaria and allies.

Cnephalia has a very long and slender uterus containing black eggs.

Attacta, as represented by a specimen from Guatemala which I doubtfully refer to this genus, has black eggs whose chorion is not honey-comb reticulate but shows minute punctures in a roughened surface. The uterus is probably elongate. The puncture pattern of the chorion appears in the peripheral area like a chitinous network, with an elongate or oval less-closely punctured central area. The surface of the chorion is closely and minutely roughened with projecting points.

Ceromasia has brownish-yellow eggs, the chorion is intensely honey-comb reticulate, each division closely set with microscopic raised points.

Phasmophaga has a brownish-yellow egg, the chorion appears not to possess any reticulation and is not punctulate; the surface appears to be quite smooth.

TD 390 (Mass.) is a small fly with a disproportionately long uterus; it has much the habitus of Eusisyropa, and has been determined by Mr. W. R. Thompson as Masicera sp. near pauciseta. The egg is deeply yellow with a slight brownish tinge, the chorion is reticulate with nearly perfect hexagons, and the surface is sparsely set with long chitinous spine-like points which look like short hairs growing therefrom. No punctulation.

TD 355 (Mass.) was at first determined by me as Eusisyropa blanda and so published in Tech. ser. Bull. 12 Bur. Ent., p. 116. I doubt if it is that genus. It contained some 700 whitish eggs in the uterus, which was thus probably of the short thick type. These eggs show the nearly mature maggots within. The chorion is thin, without reticulation or punctulation, and has much the appearance of the Phasmophaga chorion externally.

Finally, TD 747, a small yellow-legged fly with a pseudodexiine habitus and a very long slender uterus, from Ocean Beach, South Florida, shows black eggs whose chorion appears very similar to that of Phasmophaga in structure. There is no punctulation or reticulation, and practically no appearance of rugosity, the surface being quite smooth. Filaments of translucent substance appear to depend from the ventral surface of this egg, showing in every one of many mounted specimens as pendulous loops and coils. I have seen nothing of the kind in any other egg. They are perhaps intended for more secure attachment to leaf surfaces.

These examples might be multiplied, but I have given sufficient to show the wonderful diversity of type exhibited by these minute-egg forms, all of which are believed to oviposit upon the foliage of the plants.

Ophirionine series—This name should be applied to the 21st series above.

Eumyobiine series—Eumyobia flava gen. et sp. nov. (Peru) dissected and drawn, TD 4021. Ovaries large, oviducts short, common oviduct long, spermathecal ducts and tubular glands short, preuterus present; uterus very heavy and thick, in two stout coils or so, the elongate maggots developing therein. The eggs and maggots are packed in irregularly, in various positions. Pyrrhosia may belong here, and the present form may be that genus or one of its near allies, being apparently what Coquillett determines as Leskia. I have no alternative, however, but to name it to prevent doubt hereafter.

Pseudodexiine series—There are almost certainly many distinct groups here. The Orphirodexiine series must be erected for Ophirodexia and its allies.

Atrophopodine series—This is quite distinct from Ophirodexia, as shown by Diaphoropeza peruana sp. nov. (Peru) dissected and drawn, TD 4026. This species is not typical of the genus but comes nearer to it than to any other, and certainly belongs to the Atrophopoda group. Ovaries not large, oviducts very short, common oviduct very long, spermathecal ducts and tubular glands short, preuterus present; uterus thick and swollen, in one coil or so, eggs and maggots very oblique to longitudinal. It is as yet doubtful if Vanderwulpia can be here included. The group is proposed for Atrophopoda and its allies.

Beskiine series.—Beskia and allies. No proper material for dissection has yet been available but the group must be pointed out as probably furnishing a most marked deviation in larval habit from any hitherto known in the muscoid flies. In 1908, Mr. E. O. G. Kelley found, at Pawnee, Oklahoma, a maggot which he observed at the time to be, to quote from Mr. Webster's letter on the subject, "in the act of actually feeding on a grain aphid of wheat, probably Macrosiphum granaria." This maggot changed to a puparium which was attached to the base of a wheat leaf. From this puparium issued a fly of Ocypterosipho aelops, which is very close to Beskia if not the same. No confirmation of this larval habit has come to light since, but although the record is a most surprising one it is probable that the maggots of these flies are external feeders on aphids and perhaps some other soft-bodied insects. The anal stigmata of the puparium are borne at the ends of long processes which suggests an analogy with aphidophagous syrphids.

Steinielline series—From what Nielsen has shown of the characters of the first-stage maggot of Steiniella, the genus represents a separate group. This maggot possesses minute colored subchitinized plates interspersed with short spines, some of the plates bearing spines on their posterior edge. The maggots are almost certainly not deposited on leaves. The form is not allied with the Hystriciine group of series, the adult being very distinct in external characters. The minute colored plates of the first stage maggot are evidently an independent specialization, and are interesting as indicating the probable method of development of the more perfect colored scale-like plates of the leaf-larvipositing forms.

PSEUDOMYOTHYRIINE series—This is the 27th series above. Pseudomothryia perplexa sp. nov. (Peru) dissected and drawn, TD 4001, 4035. Ovaries small, of only about six ovarioles. Oviducts about one-third as long as ovary, common oviduct about twice as long as oviduct, spermathecal ducts very elongate, tubular glands about the length of latter, preuterus absent. Uterus slender, laterally compressed, in three to four coils, inside each other disposed in a more or less regular spiral, eggs and maggots in single file. The oral spine which terminates the mandibular sclerite of the cephalopharyngeal skeleton in the first stage maggot is very sharp and needle like. Methypostena and Tachinophyto perhaps come here. It is quite likely that Erynnia nitida, the European tachinid parasite of the imported elm-leaf beetle, occurs in North America and had been determined by Coquillett as Hypostena barbata.

EUZENILLIINE series—Euzenillia aurea gen. et sp. nov. (Mass.) dissected, TD 350. In this dissection the reproductive organs were not extracted intact, and I can judge only from the maggot which is a wholly new type. The latter is elongate, moderately slender, and thickly clothed all over with short fine minute spines except on posterior half of dorsum. The cephalopharyngeal skeleton is rather slender. The spermathecae are suboval or elongate-rounded, and the larvipositor is normal. A uterus is present, which is probably not long.

PAREXORISTINE series—Carcelia belongs here. Nielson, in his second paper (1910), has shown the egg to be elongate and pediceled, as in Parexorista.

DEXIINE series—This series needs splitting into several groups. Aside from the typical group, to include Dexia and allies, the following may be given as at present recognizable:

ALMUGMYIINE series—For Almugmyia and allies, whose reproductive characters are mentioned under the Dexiine series above. Microchaetina probably comes here, and may prove to be the same as the present form.

Sirostomine series—This will include Sirostoma and its allies, which are white-grub parasites. The females deposit their maggots at the surface of the soil, into which the latter penetrate in search of hosts. Phorostoma probably comes here.

Sardioceratine series—Sardiocera and allies. Theresia and Eutheresia gen. nov. for Coquillett's Theresia analis, probably come here. All are parasites of wood-boring grubs of Coleoptera. The host relations of Eutheresia are most interesting, and will be detailed elsewhere. The maggots of Sardiocera (which I determine as Coquillett's Theresia tandrec) and Eutheresia both have a pair of short anal processes carrying the tracheas with the anal stigmata at their ends.

Prosenine series—For Prosena, Myiocera and allies.

Echinodexiine series—For Echinodexia and allies. Probably Hystrichodexia, Eudexia, Hystrisiphona, and Bathydexia come here. These forms are distingiushed in the fly by having spine-like macrochaetae on scutellum and abdomen, and would thus seem to form a natural group by themselves. This character probably does not carry with it the leaf-larviposition habit, although the flies bear a strong superficial resemblance to the Hystriciine and allied forms. It will be noted that spine-like macrochaetae occur in the Blepharipezine series of the leaf-ovipositing minute-egg forms; also that this character does not extend to all the leaf-larvipositing forms.

Myiophasiine series—The females of Ennyomma globosa, parasitic in Chalcodermus aeneus in cowpea pods, probably deposit the living maggots at the weevil punctures of a certain age, and the very slender maggot bores in next the periphery of the hardened-sap pellicle which closes the puncture until it reaches the semiliquid frass, through which it can easily gain access to the host grub.

Phasiopterygine series—The peruvian species mentioned above, TD 4005, is Phasiopteryx australis sp. nov. It has been dissected and drawn. The uterus is about sixty millimeters in length, from one-sixth to one-half millimeter in width, and is perhaps the extreme development for relative length and slenderness in the superfamily, though Phasiotacta is a close second.

On page 78, T. A. E. S., XIII (March, 1895), I mentioned two specimens of a fly from Doctor Forbes, Ills., as doubtfully referable to Ormia, one of which was reared from Crambus sp. If these specimens belong to the Oestrophasiine series, as is quite probable, this will form the only rearing record yet known of any immediate relative of this group. Here seems to be a hint explanatory of the remarkable specialization of the first-stage maggot in Phasiopteryx, for it is probable that Oestrophasia has a similar maggot. The larvae of Crambus work underground, in silk-lined galleries, feeding on the stems of growing plants, especially corn. The Phasiopteryx type of maggot would be quite well adapted to search out such hosts. Its smooth segmental plates would enable it to penetrate the silken walls of the galleries, where an ordinary maggot would become enmeshed. Yet one cannot help thinking that the Phasiopteryx maggot is rather needlessly specialized for such prosaic purpose. Perhaps Oestrophasia has a still different type of maggot.

Characterizations to fit the new generic and specific names used in this article will be shortly published, probably in the more exhaustive paper from which the whole of the present data are taken in advance. I must explain that I consider it quite obligatory upon me, in all cases of doubt as to the determination, to give new names generic and specific to the forms dissected, described and figured. These names will fix the forms so as to prevent any further doubt arising as to their identity. If this plan increase the synonymy, as it doubtless will to an extent, there is no positive harm done; while the positive good is secured of certainty in determination.

In the forthcoming more complete paper will also be given fuller explanations of the functions of the various parts of the female reproductive system; the necessity for the use of the terms preuterus, uterovagina, etc., which may be thought by some to be superfluous, with numerous plates illustrating all the reproductive types that have been drawn.

I wish to announce that, after an extended comparative study of many maggot types, I find the first-stage cephalopharyngeal skeleton to consist of seven original main sclerites, all paired, as follows:

1. Pharyngeal—"lateral pharyngeal" of Hewitt in whole or part; "upper pharyngeal" of Nielsen plus "lower pharyngeal" of same author in whole or part.
2. Infrapharyngeal—lower wing of "lateral pharyngeal" of Hewitt in part; "lower pharyngeal" of Nielson in part.
3. Dorsopharyngeal—"dorsal pharyngeal" of Hewitt.
4. Hypostomal—after Hewitt.
5. Infrahypostomal—"the plate below the skeleton "of Nielsen.
6. Mandibular—after Hewitt.
7. Dentate—after Hewitt.

A considerable number of minor sclerites occur in various forms, but all seem to be derived from the above seven main ones, except those of the oral region which belong to the pseudocephalon and are probably developed from it. I have an extensive series of drawings of a very large number of types of first-stage skeleton, which will be published in due time in connection with a comparative study of all the sclerites that go to make up the skeleton in the various forms.

Under the Sarcophagine series in these addenda is mentioned TD 354 from Massachusetts, which most clearly shows all the above main sclerites except the dorsopharyngeal. The infrapharyngeal is so clearly exhibited in this form as to prove beyond doubt, I think, its distinctness as one of the main sclerites. In most forms the infrapharyngeal, while more or less present, is so intimately connected or welded with the pharyngeal as to appear a part of the latter. This has misled Nielsen and others.

It is worth while mentioning in a speculative way that the above seven main pairs of sclerites may represent the seven embryonic segments absent in the muscoid maggot, which have been inverted to form the skeleton proper of the maggot mouth and pharynx. The head in the most primitive insects is believed to be composed of seven segments and the abdomen of ten, the three thoracic segments bringing the total number to twenty. There are twelve segments in the muscoid maggot besides the pseudocephalon. Dr. C. Gordon Hewitt's admirable monograph of Musca may be studied with much profit in this conconnection.

What I have heretofore called the clypeus in the fly (Taxonomy, pp. 22-24) seems to be a part of the everted dorsal wall of the pharynx chitinized. The true clypeus is apparently the lower portion of what I have called the facial plate. The labrum seems to have projected itself forward, carrying with it the epipharnyx to form the dorsal part of the haustellum, and in this way becoming widely separated from the clypeus. Into the space thus left there appears to have been everted the chitinous portion of the pharynx to form the rostrum of the proboscis, which attaches basally in front to the epistoma or anterior edge of the clypeus, The morphological sequence of the parts is thus lost when the proboscis is extended, but when the latter is retracted the rostrum is inverted to a semblance of its original morphological position.

It should be stated that the ultimate categories of genera, or those which will eventually be found most serviceable for taxonomic recognition and which I shall call GROUP UNITS, may be considered as generally equivalent to tribes in other groups of insects. Most of the series given in these addenda are to be considered as such, and for that reason I have given them the names of the genera dissected and studied.

The article by me in a recent issue of "Science" entitled "On muscoid and especially tachinid synonymy, may be profitably read in connection with this preliminary outline of results to date in the Muscoidea.

ROBBERFLIES OF THE GENERA PROMACHUS AND PROCTACANTHUS.

James S. Hine.

The species of these two genera from America north of Mexico, have been considered by Williston in Volume XII, of the Transactions of the American Entomological Society, and the Mexican species of Promachus have been tabulated by Osten Sacken in Biologia, Diptera I, 192. The fact that it has been possible to get together an extensive collection of specimens of various species from different parts of North America has led me to make an attempt to identify many of the Nearctic forms, and as some success at least has been attained the following results are offered for the consideration of those, who for any reasons, have interest in the various species included.

One can not study these flies in the field without noting their highly predaceous habits. These habits have attracted the attention of observers in the past with the result that a few of the species have been mentioned as injurious from the standpoint of killing honey-bees and other useful insects, but in most cases the feeding habits are variable to the extent that each species accepts a large variety of insect life as food, so that after all it seldom happens that their attacks are concentrated in a particular direction sufficiently to establish a marked habit which shall be considered either injurious or beneficial. They are among the largest species of their subfamily, some specimens measuring nearly forty-five millimeters in length and the smallest over twenty millimeters, so if their predaceous habits could be controlled the results, very likely, would be of extraordinary importance.

The material used in the preparation of this paper has been procured from various sources and I am under many obligations for favors. The United States National Museum and the museums of Cornell University and the University of Kansas each have loaned specimens for study. Professor J. R. Watson, of Albuquerque, New Mexico, has sent me several specimens from that interesting region; Professor J. H. Schaffner has donated the material he collected during two summers in central Kansas; Professor C. F. Baker has sent me much material that D. L. Crawford collected in Mexico during the season of 1910; while Charles Dury of Cincinnati, and H. S. Harbeck, of Philadelphia, and others have forwarded various species from their respective localities. D. W. Coquillett, Chas. W. Johnson, J. M. Aldrich and other Dipterologists have aided in various ways. One finds it much pleasanter to work at a difficult task when he meets with such encouragement as I have had in this study.

The characters available for the separation of the species in both of these genera are rather meager and I doubt not that students will experience more or less difficulty in using the keys and descriptions. The differences which distinguish species are sufficiently evident, however, for the purpose when the proper comparisons can be made, but without the opportunity to make comparisons as is the case when a single species is considered one may not always feel satisfied with results.

I was not able to get all of the described species from Mexico and Central America but where I possessed specimens of species from these countries they are included in the consideration of their respective genera.

A list of the species and synonymy is given below but the reader is referred to Aldrich's Catalogue of North American Diptera and to other works for further references to literature.

List of the Species of Proctacanthus.

arno Townsend, Proc. Cal. Acad. Sci. IV, 599.
  brevipennis Wiedemann, Auss. zw., I, 431. Van der Wulp, Tijdsch. v. Ent., XXV, 108. Williston, Trans. Amer. Ent. Soc. XII, 73.
caudatus new species.
coquillettii new species.
duryi new species.
fulviventris Macquart, Dipt. Exot., Suppl. IV, 88. Osten Sacken, Catalogue 235, note.
heros Wiedemann, Auss. zw., I, 427. Schiner, Verh. Zool. Bot. Ges., 1866, 682; 1867, 396. Williston, Trans. Amer. Ent. Soc., XII, 74.
longus Wiedemann, Dipt. Exot., 183; Auss. zw., I, 426. Macquart, Hist. Natur. Dipt., I, 307; Dipt. Exot., I, 2, 123. Schiner, Verh. Zool. Bot. Ges., 1866, 682; 1867, 396.
  craverii Bellardi, Saggio, II, 50. Williston, Biologia, Dipt., I, 327.
micans Schiner, Verh. Zool. Bot. Ges., 1867, 397.
milbertii Macquart, Dipt. Exot., I, 2, 124.
  missouriensis Riley, 2d Mo. Report, 122, fig. 89.
  ?agrion Jaennicke, Neue Exot. Dipt., 57.
nigriventris Macquart, Dipt. Exot., I, 2, 124.
nigrofemoratus new species.
occidentalis new species.
philadelphicus Macquart, Dipt. Exot., I, 2, 123. Williston, Trans. Am. Ent. Soc., XII, 75.
rufiventris Macquart, Dipt. Exot., I, 2, 123, plate X, figure 2.
rufus Williston, Trans. Am. Ent. Soc., XII, 74.

Of the other North American species that have been placed in Proctacanthus, exquisitus Osten Sacken must belong to the genus Asilus if one may judge from the figure, for the posterior branch of the third vein meets the margin of the wing distinctly behind its apex; P. virginianus Van der Wulp has the appearance of a species of Erax. The specimen figured is a female and no spines are shown at the tip of the ovipositor; this fact, together with the presence of a stump of a vein at the base of the anterior branch of the third longitudinal suggests Erax, for I have never found a species of Proctacanthus with this character present; Proctacanthus zamon Townsend has been known as a synonym of Eccritosia amphinome Walker for some time.

List of the Species of Promachus.

albifacies Williston, Trans. Am. Ent. Soc., XII, 63. Osten Sacken, Biologia, Diptera, I, 195.

bastardii Macquart, Dipt. Exot., I, 2, 104.
laevinus Walker, List II, 108.
rubiginis Walker, Dipt. Saund., 123.
ultimus Walker, Dipt. Saund., 136.
philadelphicus Schiner, Verh. Zool. Bot. Ges., 1867, 389.

fitchii Osten Sacken, Catalogue, note 121, 234.
apivora Fitch, Country Gentleman, XXIV, 63; 3d N. Y. Report, 251, plate IV, figure 7.

forfex Osten Sacken, Biologia, Diptera, I, 194.
quadratus Bellardi, Saggio, II, 27, plate II, figure 3.

giganteus new species.

minusculus new species.

nigrans new species.

nigripes new species.

princeps Williston, Trans. Am. Ent. Soc., XII, 62.

quadratus Wiedemann, Dipt. Exot., 201; Auss. zw., I, 485. Osten Sacken, Biologia, Dipt., I, 192.

rufipes Fabricius, Syst. Ant., 794; Syst. Antl., 169. Wiedemann, Dipt. Exot., 203; Auss. zw. I, 487. Williston, Trans. Am. Ent. Soc., XII, 107.

sackeni new species.

truquii Bellardi, Saggio II, 80, plate II, figure 6. Williston, Biologia, Dipt., I, 322.

vertebratus Say, Journ. Acad. Sci. Phil., III, 47; Compl. Works, II, 62. Williston, Trans. Am. Ent. Soc. XII, 62.

Five species of Promachus from Mexico and Central America could not be procured so they are not considreed in this paper. They are anceps Osten Sacken, cinctus Bellardi, magnus Bellardi, nobilis Osten Sacken and pulchellus Bellardi.

Promachus fuscipennis, according to Osten Sacken, is not a North American species and Promachus trapezoidalis Bellardi is rightly included in the genus Mallophora as Williston has stated for it has the claws distinctly blunt at the tips. It may be of interest to state that this latter species has been taken at Brownsville, Texas. Heretofore it was known only from Mexico.

THE GENUS PROCTACANTHUS.

Proctacanthus was described by Macquart in 1838. The species falling here are all rather large and robust, the marginal cell is closed, palpi one segmented, antennal bristle bare, veins closing the discal and fourth posterior cells not parallel, the posterior branch of the third vein curves forward to meet the costa before the tip of the wing, anterior branch of the third vein not angulated at base nor does it bear a stump, ovipositor cylindrical and with a terminal circlet of spines which may be very small in some species, abdomen longer than the wings. These characters are all well marked and there is no difficulty in placing the various species in the genus. The venation is much like Erax but the circlet of spines at the tip of the ovipositor and the lack of silver white segments at the posterior part of the male abdomen are distinctive.

KEY TO THE SPECIES OF PROCTACANTHUS.

1. Segments of the abdomen thickly pilose on the sides, very large red species. **heros**
   Abdomen pollinose or sparsely hairy, smaller species......................2
2. Femora black, tibiae red, the colors strongly contrasting................3
   Femora and tibia of nearly the same color, so there is no strong contrast in colors..4
3. From above the hypopygium is wide, and longer than segments seven and eight combined. Male abdomen largely red, female abdomen not red. **caudatus**
   Hypopygium small, distinctly shorter than segments seven and eight combined. Abdomen of both sexes largely red above.........**fulviventris**
4. Abdomen red, except the first segment and anterior border of the second....5
   Abdomen in large part gray pollinose....................................6
5. Dorsum of the thorax uniformly brown, hypopygium from above wide, appendages longer than segments seven and eight combined............**rufus**
   Dorsum of the thorax usually striped with black, hypopygium small, the appendages from above shorter than segments seven and eight combined.. **rufiventris**
6. End lamella of the ovipositor densely pilose, spines at the tip small 7
   End lamella of the ovipositor sparsely hairy and with a circlet of enlarged spines at the tip..8
7. Wings nearly hyaline, many of the veins faintly margined with brownish.... **occidentalis**
   Rather small species, middle of the wing with a large dark colored patch **coquillettii**
8. Wings hyaline or with only the veins margined with brown................9
   Wings of a uniform brown all over......................................12

9. Scutellum with white bristles..**duryi**
Scutellum with black bristles..10
10. Wings clear hyaline, all the femora entirely black............**nigrofemoratus**
Wings with the veins margined with brown, at least the posterior sides of all, the femora red..11
11. Male genitalia elongate, the appendages curved inward at the tips and enclosing an open space beyond the other parts...........................**arno**
Male genitalia short, appendages but slightly longer than the other parts **micans**
12. Thorax with brown markings, wings clear brown........................13
Thorax with dark, nearly black, markings, wings pale brown............14
13. Wings long and wide, palpi with white hair, two or three bristles on the front side of the hind femora besides those near the apex..........**longus**
Wings rather short and narrow, palpi with black hair, four or five bristles on the front side of the hind tibia besides those near the apex **philadelphicus**
14. Abdomen very dark, nearly black pollinose.................**nigriventris**
Abdomen lighter, gray pollinose...15
15. Large stout species, middorsal stripe of the thorax gray pollinose and not plainly differentiated..**milbertii**
Small, rather slender species of southern distribution, middorsal thoracic stripe usually plainly differentiated and not distinctly pollinose........ **brevipennis**

Proctacanthus heros Wiedemann.

Total length, 32 to 45 millimeters. Body red all over, mystax and beard straw yellow, occipito-orbital bristles straw yellow; legs red with black bristles and yellow hair; bristles of the scutellum black; wings brown, some of the cells along the inner margin nearly hyaline at the middle. First four or five abdominal segments on each side with an area of dense yellow pile, hairs on the dorsum of these segments and on all parts of the posterior segments short and black.

The large size of this species together with the red color of the entire body and the pilose areas on the sides of the abdomen easily characterize it.

Specimens from Southern Pines, North Carolina, collected by A. H. Manee. Also others from Georgia and Mississippi.

Other writers have reported it from Florida, South Carolina and Kentucky.

Proctacanthus rufus Williston.

Total length 30 to 36 millimeters. Body red, with the exception of the first abdominal segment and the anterior margin of the second which are black. Mystax and beard yellow, the latter lighter than the former, palpi red with pale hair; thorax and legs mostly with dark hair and bristles, scutellum with numerous black bristles, wings nearly uniformly pale brownish, dorsum of the thorax plain red without distinct markings of any kind. Abdomen black at base above, otherwise red, the former color extends back to the anterior third of the second segment. Male genitalia enlarged, wider than the last abdominal segment, appendages from dorsal view wide at the base and narrowed towards the apex.

The red legs, uniform red thorax and enlarged hypopygium are characteristic.

Specimens are at hand from Ohio, Arkansas, Kentucky, New Mexico and Massachusetts. Others record it from North Carolina and New Jersey in addition.

The species appears to be partial to bare sandy areas such as are present along lakes, seas and rivers and in semi-arid regions. The larval and pupal stages are passed beneath the surface of the ground, and the pupa case is left partially protruding when the adult issues.

Proctacanthus rufiventris Macquart.

Total length 30 to 35 millimeters. This species is very much like rufus in coloration. In fact the only noticeable difference between the two is to be found in the markings of the thorax and the male genitalia. In most specimens of rufiventris the thorax is marked with dark, nearly black stripes and spots. The hypopygium is small, narrower than the last abdominal segment and the appendages from dorsal view are narrow for their entire length, short and rounded at the tips.

Specimens at hand from Louisiana, North Carolina, and Texas. Others record it from San Domingo, Honduras, and Porto Rico.

Proctacanthus fulviventris Macquart.

Total length 25 to 30 millimeters. Mystax and beard bright yellow, palpi black with yellow hair, proboscis and antennae black. Thorax black, scutellum with numerous yellow bristles and hairs; wings pale brown, femora clear black, tibiae red, except the apex of each which may be black, tarsi black or in some specimens the hind metatarsi are red. Abdomen black at the base, partly red posteriorly. Different individuals are colored differently. In two specimens before me the female abdomen is clear black except the dorsum of segments three to seven inclusive which is red, while in the male the segments beyond four are red, as is the dorsum of three and four, while the venter of the first four segments and the dorsum of the first two are practically all black. Male genitalia small, appendages much shorter than the last two abdominal segments, each widest at the base and gradually narrowed towards the apex which is rounded.

The small male genitalia together with the clear black femora and red tibia characterize the species.

The specimens before me are from Florida and records do not show that it has been collected in any other locality.

Proctacanthus caudatus n. sp.

Total length 28 to 30 millimeters. Mystax and beard pale yellow, palpi yellowish red with pale yellow hair, antennae and proboscis black; thorax dark with some light pollinose markings, bristles of thorax black, numerous but not very stout black bristles on the scutellum; femora black, tibia red, black at the apices, tarsi black; wings pale brownish. Male abdomen yellow, except first segment and the base of the second which are largely black, hypopygium from dorsal view wide, from side view widened near the apex which is obliquely truncate. Female abdomen entirely dark, except the posterior margin of each of the second to fifth segments which are red; first abdominal segment in both sexes with numerous yellow hairs on each side.

The male type and one female from Veracruz, Mexico, collected by D. L. Crawford, of Pomona College, Ontario, Cal.

The male hypopygium is very different from that of fulviventris or rufus.

In Volume I, page 206, Biol. Cent. Am. Osten Sacken mentions a female of a species of Proctacanthus which appears to be the same as this one. His specimen was taken at San Geronimo, Guatemala.

Proctacanthus occidentalis n. sp.

Total length 30 to 36 millimeters. A modest colored species having nearly clear wings with many of the veins narrowly margined with brown. Mystax very pale yellow, usually with a few black bristles, beard white, palpi black with some black and some white hair, occipito-orbital bristles partially white and partially black; thorax pale brownish or gray, mostly with black bristles, scutellum with numerous black bristles and scattering fine white hairs, humeral callus distinctly lighter gray than the other parts of the thorax and toward the median line from each of these is a small white spot which is of some use in determination for most other species do not have such a marking. Wings nearly hyaline, in most specimens the longitudinal veins are faintly margined with brown; femora red posteriorly and nearly black anteriorly, tibiae colored with reddish and blackish in various combinations; abdomen dark, gray pollinose, male genitalia shorter than the last two abdominal segments, appendages curved towards each other at the tips so that they nearly meet; female genitalia with the end piece densely yellowish pilose and with the spines at the tip so small that they are not plainly differentiated from the other hairs of the region.

Male type from Los Angeles County, California, and eleven other specimens from California and Idaho, mostly collected by Coquillett and Aldrich.

Proctacanthus coquillettii n. sp.

Total length 25 to 27 millimeters. Mystax and beard white or very pale yellowish, palpi black with white hair, antennae dark, nearly black, third segment short, oval, arista nearly three times as long as the segment which bears it. Thorax dark, brownish gray pollinose and with black and gray hair; legs with black and gray bristles and gray hair; femora uniformly dark, nearly black, tibiae and tarsi brownish red; wing hyaline with the middle third quite distinctly brown, abdomen uniformly dark, gray pollinose and with numerous gray hairs. Male genitalia rather short, appendages and other parts margined with dense rows of gray hair. Female genitalia with the end piece densely pilose but devoid of a terminal circlet of enlarged spines.

It is easily known by the brown patch on the middle of each wing, by the short third antennal segment and by the genitalia of the male. The female genitalia agree rather closely with occidentalis but differs from all other species by the spines at the tip being small and not plainly differentiated from others of the last segment of the ovipositor.

The female type and a male from Los Angeles, California, collected by coquillett, for whom I am pleased to name the species.

Proctacanthus micans Schiner.

Total length 26 to 36 millimeters. Mystax pale yellow, beard white, palpi black with most of the hairs with which they are clothed white, although there may be a few black ones. Occipito-orbital bristles mostly pale but in some specimens there are plenty of black ones. Thorax brown in ground color, grayish brown pollinose and with the usual dorsal markings, numerous black bristles on the posterior part with some gray hairs intermixed, anterior part with short black hairs; wings nearly hyaline with the veins quite distinctly margined with brown; legs rather dark from general view, femora dark before, brown behind, tibiae and tarsi in large part brown but somewhat variable. Abdomen dark, grayish brown pollinose; male genitalia rather small and compact, appendages scarcely protruding beyond the other parts, of nearly the same width throughout from side view and clothed with fine white hair. Female genitalia black or brown, end piece sparsely hairy and with a distinct circlet of strong spines at the tip.

The small compact male genitalia and hyaline wings with brown margined veins are characteristic.

Numerous specimens from Colorado, Arizona and New Mexico.

Proctacanthus duryi n. sp.

Total length 26 to 28 millimeters. Mystax pale yellow, beard and hair of the palpi nearly white, in fact all the bristles and hairs of the head are white or very pale yellowish. Whole body yellowish gray pollinose, dorsum of the mesothorax and scutellum with pale bristles; wing clear hyaline, veins pale brown; legs rather light colored, femora darker before than behind, all parts of the legs with black bristles and pale hair. Hair and bristles of all parts of the abdomen gray. Male genitalia about as long as the last two abdominal segments, female genitalia with a circlet of strong spines at the tip.

The rather small size of the species, with the white bristles of the whole body, especially the scutellum, and the general pale color are distinctive.

Male type and numerous other specimens taken along the Ohio River in Ohio and Kentucky by Charles Dury for whom the species is named.

Proctacanthus arno Townsend.

Total length 28 to 36 millimeters. Mystax white, usually with a few black bristles beneath, beard white, palpi black with black and white hairs, proboscis black, occipito-orbital bristles partly black and partly white, whole body grayish brown pollinose. Thorax with the usual markings above, mesothorax above with short black hairs anteriorly and rather stout black bristles posteriorly, scutellum with many black bristles and a few white hairs anteriorly. Legs in general color rather dark, femora nearly black before, brown behind, tibiae and tarsi somewhat variable but often quite dark so that they show no contrast with the femora; wings hyaline, usually with the veins faintly margined with brown, but in teneral specimens they are entirely glassy clear. Abdomen rather slender, male genitalia elongate, longer than the last two abdominal segments, appendages from side view, narrowest at the middle, slightly widened and curved inward at the tips so that from dorsal view a distinct open space is enclosed beyond the other genital parts. Female genitalia usually shining black with short white hairs, end piece rather sparsely hairy with a circlet of strong black spines at the tip.

The long male genitalia as described characterizes this species fully.

The type was collected at the southern end of Lower California. Specimens are at hand from southern Arizona, New Mexico, Utah, Palo Alto, California, and El Paso, Texas.

Proctacanthus nigrofemoratus n. sp.

Total length of the male type 30 millimeters, other specimens vary from 23 to 30 millimeters. Mystax beard and hair of the palpi white; palpi, antennae and proboscis black; occipito-orbital bristles partly black and partly white. Thorax gray pollinose, mesothoracic dorsum with black hairs and bristles, scutellum with black bristles; wings hyaline with pale veins. Femora uniformly black all over, tibiae pale on the basal parts, otherwise dark, nearly black, as are all the tarsi.

Basal part of the abdomen largely dark in ground color and gray pollinose, last three segments red in ground color and gray pollinose. Male genitalia slightly shorter than the last two abdominal segments combined, rather small and compact; appendages red, from lateral view of nearly the same width throughout and rounded at the apex.

The entirely hyaline wings, the uniformly black femora and the small size of the specimens make the species easy of determination. The female genitalia shining black with a distinct circlet of spines at the tip.

The male type and two other males and four females from San Jose, Mexico, collected by D. L. Crawford and McConnell.

Proctacanthus philadelphicus Macquart.

Total length 28 to 36 millimeters. Mystax dark yellow, usually with some black bristles intermixed, beard slightly paler than the mystax, palpi black and mostly with black hairs; occipito-orbital bristles part black and part yellow. Thorax rusty brown pollinose, mesothoracic dorsum with short black hairs anteriorly and with black bristles and hairs posteriorly, scutellum with numerous black bristles and hairs and often with a few white hairs intermixed. Legs in most part brown with black bristles and pale hairs, femora darkest anteriorly, wings uniformly brown all over. Abdomen rusty brown pollinose. Male genitalia slightly shorter than the last two abdominal segments combined, appendages brown, from side view nearly straight and near the same width throughout, the tips rounded but not curved towards each other. Female genitalia shining black, end piece rather bread, sparsely hairy and with a circlet of strong black spines.

The intense brown color of the body and wings and the dark yellow mystax are characteristic of the species.

Specimens from New Jersey, Maryland, Connecticut, Massachusetts, Virginia and Pennsylvania.

Proctacanthus longus Wiedemann.

Total length 32 to 36 millimeters. Mystax yellow, beard paler than the mystax, palpi black with paler hairs, occipito-orbital bristles part black and part pale. Thorax brown, gray pollinose, mesothoracic dorsum with the usual markings rather plainly shown, anterior part mostly with short black hairs, posterior part with black bristles, scutellum with black bristles and hairs; legs brown with black bristles and numerous pale hairs; tibiae slightly lighter than the femora; wings uniformly brown, wide and rather long. Abdomen brown, brownish gray pollinose, male genitalia shorter than the last two abdominal segments combined, from side view appendages nearly straight, of nearly uniform width with the tips rounded but not curved toward each other when viewed from above; female genitalia black with a terminal circlet of strong spines.

Related to philadelphicus but the pale hairs of the palpi, long, wide wings and more grayish pollinosity of the body serve to characterize it.

Proctacanthus craverii Bellardi reported from Mexico, from the description, I take to be a synonym.

Specimens at hand from Georgia, Florida and Texas.

Proctacanthus milbertii Macquart

Total length 28 to 40 millimeters. Mystax pale yellow, beard paler than the mystax, palpi black with black hair. Thorax gray pollinose, mesothoracic dorsum with the usual markings rather plainly shown, scutellum with black bristles and usually with a few pale hairs; wings uniformly light brown; legs brown, tibiae and tarsi lighter than the femora which are darker anteriorly than behind. Abdomen gray or in some cases brownish gray pollinose. Male genitalia shorter than the last two abdominal segments combined, appendages not curved toward each other at the tips; ovipositor usually black but occasionally red or partly red, with a circlet of strong spines at the tip.

Related to philadelphicus, but the mystax and wings are paler; the abdomen is gray and not brown pollinose and the thoracic markings are rather more distinct.

Specimens from western Ohio, Indiana, Wisconsin, Kansas, Missouri, Michigan, Colorado, California and British Columbia. It is one of our most common and widely distributed species.

Under the name Asilus missouriensis, Riley has written of this species as a distinct enemy of bees.

Proctacanthus nigriventris Macquart.

Total length 30 to 35 millimeters. Body very dark, nearly black; wings uniformly rather pale brown. Mystax very pale yellowish, often with black bristles intermixed, beard gray, occipito-orbital bristles black. Thorax dark, brown pollinose, mesothoracic dorsum with black hair and bristles, usual markings not plainly differentiated; scutellum with black hairs and bristles. Wings uniformly rather pale brown, legs dark nearly black; femora, except the apices, black, apexes of femora, tibiae and tarsi dark brown. Abdomen dark, nearly black, dark pollinose with a narrow band before each incisure light pollinose, venter and sides of the last two or three segments in the male gray pollinose; male genitalia dark red, rather short, appendages widest at the base, gradually narrowed toward apex where they are evenly rounded; ovipositor shining black with strong black spines at the tip.

The very dark color of the whole body is distinctive.

Specimens from New Jersey, collected by H. S. Harbeck, of Philadelphia.

Proctacanthus brevipennis Wiedemann.

Total length 20 to 28 millimeters. Mystax usually white but sometimes yellowish and occasionally largely black, in any case there is likely to be more or less black bristles mixed with the others, beard white, palpi with black hair, occipito-orbital bristles mostly black. Thorax brown, gray pollinose, mesothoracic dorsum with the usual markings very plainly differentiated, anterior part with short black hairs, posterior part with numerous black bristles; scutellum with black bristles and a few white hairs before. Wings uniformly pale brownish; legs brown, tibia and tarsi lighter than the femora, which are nearly black before and brown behind. Abdomen rather dark colored, more or less gray pollinose, male genitalia red, rather short, small, of nearly the same width throughout and evenly rounded at the tips. Ovipositor shining black, except occasionally when it is more or less red, with a distinct circlet of spines at the tip.

The small size and plainly differentiated thoracic markings are usually sufficient to place specimens of this species.

Specimens at hand from North Carolina, Kansas, New Jersey, Florida, and Georgia. The type of the species was taken in Kentucky.

THE GENUS PROMACHUS.

In 1838 Macquart described the genus Trupanea to receive the species which fall here. Ten years later Loew discovered that Macquart's name could not stand on account of previous usage and proposed Promachus to take its place. The species are large, although somewhat smaller than the species of Proctacanthus. The bristles of the antennae are naked, the veins closing the discal and fourth posterior cells are not parallel, the posterior branch of the third vein terminates beyond the tip of the wing, there are three submarginal cells and the abdomen is longer than the wings. These characters will place the species easily in most cases but certain species of Mallophora may cause trouble. In case they do the fact that the members of the latter genus have obtuse claws, while those falling under Promachus have pointed claws should obviate the difficulty. There are at least nineteen valid species of the genus described from North America, but since five of these from Mexico and Central America could not be procured only fourteen are treated in this paper. The genus appears to reach its greatest development to the southward and I have reasons for believing that there are yet in North America several undescribed species.

KEY TO THE SPECIES OF PROMACHUS.

1. First submarginal cell with a gray shadow which sometimes is very narrow..2
   First submarginal cell without any trace of a gray shadow................12
2. Male genitalia with dense silvery hair above, color of the tibiae very near like that of the femora.......6
   Male genitalia without silvery hair above, color of the tibiae usually in striking contrast to that of the femora.......3
3. Gray bands on the dorsum of the abdomen fully as wide as the black bands..4
   Gray bands on the dorsum of the abdomen confined to narrow posterior borders of the segments.......5
4. Thorax deep reddish brown, male genitalia clothed with black hair..**rufipes**
   Thorax yellowish gray, male genitalia clothed with gray hair ...**vertebratus**
5. Gray shadow in the first submarginal cell less than half as wide as the cell; male genitalia rounded at apex.........**sackeni**
   Gray shadow in the first submarginal cell darker in color than usual, distinctly more than half as wide as the cell; male genitalia truncate at apex **forfex**
6. Abdomen with black hair on some or all of the first five segments above..9
   Adbomen without black hair on any of the segments above..............7
7. Abdomen uniformly clothed with short gray hair, mystax very pale yellow or nearly white, beard white:..................................**truquii**
   Abdomen clothed with yellow hair, beard and mystax distinctly yellow....8
8. Gray shadow in the first submarginal cell wider than the marginal cell, male genitalia almost as long as abdominal segments five, six and seven combined.......................................**fitchii**
   Gray shadow in the first submarginal cell distinctly narrower than the marginal cell, male genitalia shorter than abdominal segments six and seven combined ....**quadratus**
9. Mystax white or with a very slight shade of yellowish, legs chiefly black..10
   Mystax plainly yellow, legs chiefly yellowish red.......................11
10. Abdomen densely brown pollinose on the sides...................**albifacies**
    Abdomen gray pollinose on the sides and extending across narrowly on the hind margins of the segments...............................**princeps**
11. Abdomen densely brown pollinose on the venter and sides, wings plainly brownish...**bastardii**
    Abdomen pale yellowish gray pollinose on the venter and sides, wings nearly hyaline..**quadratus**
12. Legs pure black..13
    Legs more or less reddish..14
13. Abdomen distinctly banded with black and gray, the gray bands slightly more than half as wide as the black..........................**nigripes**
    Abdomen not distinctly banded, although the narrow posterior margins of the segments are somewhat different from the other parts by appearing whiter...**aldrichii**
14. Very large species, 35 to 40 millimeters in length.................**giganteus**
    Small species, not over 25 millimeters in length................**minusculus**

Promachus vertebratus Say.

Total length 26 to 31 millimeters. Front and face clothed with yellow pollen, hairs and bristles of the whole head yellowish, beard paler than the mystax, often some of the bristles on various parts of the head are black but there does not appear to be any uniformity as to which ones are black and often there are none of this color. Proboscis shining black, palpi clothed with yellowish hair with an intermixture of black in some specimens, antennae black. Thorax yellowish pollinose, dorsum with a brown stripe at the middle divided by a narrow gray line, wings dilute brownish; legs somewhat variable in color, clothed with black bristles and recumbent pale hair, femora in large part black although they may be almost entirely reddish, or even only reddish in part; tibiae reddish with the extreme apices darker; all of the tarsi brown or black. Abdomen largely gray pollinose and clothed with pale hairs; dorsally the first six segments each have a rectangular black marking which occupies about the anterior half of its respective segment. Male genitalia black, clothed with pale hair, female genitalia shining black.

Specimens from Kansas, Wisconsin, Illinois and Ohio.

Promachus rufipes Fabricius.

Total length 28 to 35 millimeters. This is a larger species than vertebratus. The color of the thorax is much browner than in that species and the color of the wings is more pronounced. The palpi are black with black hair and the hypopygium is shining black with scattering black hairs. The legs are somewhat variable, or at least in the specimens before me they show two distinct types of coloration. The specimens that agree closer to the original description have pure black femora and reddish yellow tibiae with black apices. In another set of specimens the femora and tibiae, except the apices, are reddish brown throughout and do not show any contrast. In other respects the two series of specimens exactly agree and I prefer to consider them all rufipes.

Specimens at hand from District of Columbia, Tennessee, Mississippi, Iowa and Ohio.

Promachus sackeni n. sp.

I take this to be Promachus No. 2, Biolog. Cent. Am., Volume I, page 193.

Total length 22 to 27 millimeters. Mystax composed of black and yellow bristles intermixed, palpi black, mostly with black hairs but there may be light colored ones intermixed, especially on the basal parts, beard white, thorax gray pollinose above with the usual markings, wings uniformly pale brownish, the dark marking in the first submarginal cell very little more than one-fourth as wide as the cell at the widest part, femora, apex of the tibiae and the tarsi black with black bristles, remainder of the tibiae yellowish red with numerous pale hairs and a few black bristles, claws pointed and distinctly curved. Abdomen with much yellowish hair which on the sides is rather long; segments two to seven in the male and two to five in the female with gray pollinose triangles on the sides, the inner angles on each side meeting above on each of segments two to five in both sexes and forming a posterior gray band; the hypotenuse of each triangle is slightly concave, leaving on each segment a semicircular spot which is clear black; hypopygium black, slightly wider than the abdomen, evenly rounded posteriorly, with mostly black hairs dorsally and pale yellow hairs laterally; ovipositor black, somewhat longer than abdominal segments four and five.

Three males and three females from southern Arizona, in July and August, some of them collected by the late Dr. F. H. Snow.

Osten Sacken's specimens were procured in northern Sonora, Mexico, by Morrison. In a note after his description he mentioned Promachus trapezoidalis Bellardi as closely related, but Williston has shown, rightly I think, that the latter belongs to Mallophora. I have seen a male of this from Brownsville, Texas. Bellardi mentions the blunt claws and Williston calls attention to the same character.

Promachus forfex Osten Sacken.

This is a new name for Promachus quadratus Bellardi, since there is an older quadratus by Wiedemann.

Total length 23 to 30 millimeters. Mystax largely composed of yellow hair, but a few of the finer ones are black, antennae and proboscis black, palpi with black hair, occipito-orbital bristles black. Thorax sparsely gray pollinose with the usual darker markings dorsally, scutellum with two more or less irregular rows of black bristles and numerous shorter yellow hairs; wings uniformly yellowish brown, distinctly darker than in sackeni, cloud in the first submarginal cell two-thirds as wide as the cell, dark colored and with a distinct outline; femora, tips of the tibiae and tarsi, including the claws pure black, remainder of tibiae and pulvilli yellow, balancers pale yellow; abdomen largely clothed with light yellow hair, sides and narrow posterior margins of the first five segments in the female and seven in the male gray pollinose leaving a large quadrate dark marking above on each of the segments. Ovipositor composed of three segments, shining black; hypopygium black with black hair, from dorsal view gradually widened toward the apex where it is plainly truncate.

Male and female from Cordoba and a female from Vera-cruz in Mexico, collected by D. L. Crawford. Also a female from Puerto Barrios, Guatemala, collected by E. B. Williamson. The species appears to be southern in distribution and is not likely to be taken in the United States.

Promachus fitchii Osten Sacken.

Fitch described this species under the name apivora because he found it injurious to bees. His name could not stand, however, as it had been used before in the genus.

Total length 25 to 30 millimeters. Mystax, beard and hairs of the palpi distinctly yellow, occipito-orbital bristles pale yellow intermixed with black ones which are more numerous in some specimens than in others. Thorax yellowish brown pollinose above with short black hairs anteriorly and longer black hairs and bristles posteriorly, a tuft of yellowish hairs before the scutellum in well preserved specimens, scutellum with numerous yellow hairs and a few black bristles; legs mostly yellowish red although usually there is a black or blackish area on the front side of each femur; hairs of the legs yellow, bristles black; wings with a pale brownish tinge, shadow in the first submarginal cell plainly evident, a little more than a third of the width of the cell at the widest part, ground color of the abdomen black, uniformly clothed with rather short yellow hairs all over.

The long hypopygium is clearly distinctive in this species. It is nearly twice as long as in any other species I have seen.

Numerous specimens from Clay County, Kansas, collected by Prof. J. H. Schaffner. Aldrich catalogues it from Nebraska, Missouri, Kansas, Connecticut and Florida.

Promachus albifacies Williston.

Total length 22 to 28 millimeters. Mystax and beard white, at most only a few black hairs on the oral margin; palpi with many black hairs and usually with some scattering white ones among them; rear of the head with white hairs and a few black bristles above. Thorax brown pollinose with the usual stripes above, a tuft of white pile in front of the scutellum largely surrounded by black bristles, scutellum with numerous white hairs and black bristles; wings nearly hyaline, gray shadow in the first submarginal cell less than one-third as wide as the cell at the widest point; legs largely black but somewhat variable, often the femora are red posteriorly and the same may be said of each tibia at base. Abdomen pure black in ground color, distinctly brown pollinose on the venter and sides and on each side of each segment are numerous white hairs which tend to reach across the dorsum and form a very narrow hind border to the segment. Hypopygium small, short and clothed above with abundance of silver white pile.

The species is known from California, Colorado, Arizona, New Mexico and Mexico.

Promachus princeps Williston.

Total length 27 to 32 millimeters. Mystax white with a few black bristly hairs on the oral margin, beard white, palpi with numerous black hairs and a few white ones, rear of the head with white hair and some black bristles above; thorax gray pollinose, wings hyaline, gray shadow in the first submarginal cell very narrow and usually not sharply defined, legs approaching black, each femur posteriorly and each tibia at the base more or less dark reddish; abdomen black in ground color, gray pollinose on the sides and venter, with an area of white hairs on each side of each segment and these tend to approach each other and unite and thus form a band across the posterior margin of the segment. The abdomen is somewhat variable when different specimens are compared on account of the area covered with white hair.

This species may be separated from albifacies by the gray instead of brown pollinosity of the thorax, and sides and venter of the abdomen, by the wings being more nearly hyaline and by the gray shadow in the first submarginal cell being narrower and less sharply defined than in that species.

The species is known from California, Oregon and Washington.

Promachus bastardii Macquart.

Asilus laevinus, Trupinea rubiginis and Asilus ultimus of Walker, and Promachus philadelphicus Schiner are considered synonyms.

Total length 21 to 28 millimeters. Mystax and beard yellow, the latter paler than the former, palpi clothed with black hair, occipito-orbital bristles black; thorax brown, the usual markings present on the dorsum but not very plainly shown, legs in general color red with white hair and black bristles; in most specimens there is a black stripe of greater or less width on the anterior side of each femur, and the front legs especially may have more or less yellow pile on the tibiae and tarsi; wings quite distinctly uniformly brownish, shadow in the first submarginal cell about half as wide as the cell at the widest part, not very dark gray but with definite limits. Abdomen distinctly brown on the venter and sides and clear black above. From dorsal view the abdomen shows a very narrow band of white hair on the posterior margin of each segment and black hairs on a clear black background otherwise.

The hypopygium is clothed with silvery white hair above but is distinctly wider than in albifacies and princeps.

Specimens have been taken in New York, Massachusetts, Pennsylvania, Michigan, Kansas, Georgia and Ohio.

Promachus quadratus Wiedemann.

Total length 22 to 29 millimeters. Mystax and beard yellow, the latter distinctly lighter than the former, palpi black with yellow hair, but with a few black ones intermixed, rear of the head with yellowish hair, occipito-orbital bristles black. Thorax light brown pollinose with the usual middorsal stripe and lateral markings; wings very pale yellowish all over, shadow in the first submarginal cell narrow, hardly one-fourth as wide as the cell at the widest place; legs brown with light hair and black bristles, anterior part of each femur darker than the other parts of the leg; balancers brown. From above each abdominal segment has a rather wide posterior margin which is clothed with pale yellowish or white hair and which widens distinctly towards each side. The ground color of the abdomen is black and the color shows plainly on the anterior part of each segment but not so extensively as in bastardii. In the male the genitalia is of medium size and clothed above with silver white hair as in related species.

There has been some uncertainty in regard to quadratus but these specimens agree well with the original description. In comparison with bastardii the color as a whole is lighter, the palpi are clothed with mostly yellow hair instead of mostly black hair, the wings are much nearer hyaline, the gray shadow in the first submarginal cell is much narrower and the abdomen has much more light hair. Weidemann's type is recorded as from Georgia.

Specimens are at hand from Cameron Parish, Louisiana.

Promachus truquii Bellardi.

Total length 24 to 36 millimeters. Mystax pale yellowish, beard white, rear of the head with white hair, occipito-orbital bristles mostly black, palpi with many black hairs but beneath there are a number of pale yellow ones; thorax brown pollinose, sides with white hairs, dorsum with many short black hairs anteriorly and rather long white hair and black bristles posteriorly; legs in large part reddish brown with white hair and black bristles, anterior side of each femur largely black; wings nearly uniformly pale brownish, hardly as dark as in bastardii, gray shadow in the first submarginal cell plainly evident and with distinct limits, about a third as wide as the cell at the widest place. Abdomen brown pollinose on the venter and sides, black dorsally, uniformly clothed all over with short white hair, no black hair except a few black bristles on either side of the first segment. The hypopygium is furnished with silvery hair above very much as in albifacies.

The most apparent difference bewteen this and related species is the uniform distribution of rather short white hair over the abdomen and the absence of black hair except the black bristles on the sides of the first segment.

Several specimens from the Huachuca Mountains, Arizona. Besides the species has been reported from several places in Mexico.

Promachus nigripes n. sp.

Total length 28 to 32 millimeters. Mystax and beard white, rear of the eyes with white hair, occipito-orbital bristles largely black, palpi black with numerous black hairs and a few white ones on the lower side, antennae black. Thorax gray pollinose, mesothoracic dorsum with the usual markings not conspicuous, clothed largely with black hair and bristles, sides of the thorax with long gray hairs, scutellum with black hair and bristles; legs black, mainly with black hair and bristles, but there may be some white hairs especially on the femora; wings hyaline, no gray shadow in the first submarginal cell. Abdomen from above banded with black and white, a white pollinose band clothed with white hair on the posterior part of each segment and a wider black hand clothed with black hair before it, venter and sides white pollinose with white hairs. Hypopygium rather wide and clothed above with silvery hair, posterior ventral margin of the eighth segment with black and white hairs.

There is some variation among the different specimens. The hair on the posterior part of the mesothorax may be largely white, the legs may vary in the extent of the white or black hair present, although the bristles are always black, and in the male the margin of the eighth ventral segment may be furnished entirely with black hairs.

The distinct limitation of the black and white areas on the dorsum of the abdomen so as to form bands, together with the entirely black legs characterize the species.

The male type and seven other males and females taken at Albuquerque, New Mexico, by J. R. Watson.

Promachus aldrichii n. sp.

Total length 28 to 30 millimeters. Mystax and beard white, occipito-orbital bristles mostly black, palpi black with white hairs, only a few black ones above. Dorsum of the mesothorax mainly with black hairs, and bristles, but there is some rather long white hair on the scutellum and before it, prothorax gray pollinose, usual markings present but they are not very plainly shown; legs black, clothed with black and white hair and black bristles; wings clear hyaline, no shadow in the first submarginal cell; abdomen black in ground color, gray pollinose on the sides and venter and clothed everywhere with rather short hair which is almost all white, there being only a very few short black hairs on the anterior dorsal part of each segment. In the male the posterior ventral margin of the eighth adbominal segment is furnished with a fringe of white hairs and the hypopygium is silvery pilose above.

The most characteristic thing about the species is the uniform distribution of the white hairs on the abdomen so that this part does not appear evenly banded as in nigripes.

The male type and one female from Utah, and received from J. M. Aldrich of Moscow, Idaho.

Promachus minusculus n. sp

Total length 24 to 26 millimeters. Mystax and beard pure white, palpi black with some black and some white hairs, occipito-orbital bristles largely pale although there are always a few black ones intermixed. Thorax gray pollinose, thoracic dorsum with the markings not very distinct, clothed with black and white hair and black bristles, bristles of the scutellum partly white and partly black, wings pure hyaline, veins brown. Legs dark reddish in general coloration, femora darkest anteriorly, tibiae red, tarsi nearly black, all the parts clothed with reclining white hairs and black bristles. Abdomen rather dull black in general coloration, venter, sides and posterior part of the dorsum of each segment clothed with white hairs, anterior part of the dorsum for more than half the length of each segment clothed with black hairs. Hypopygium small and clothed both above and below with rather long silvery white hair, ovipositor black.

Easily known from other species of its group by its small size and general rather light color as well as by the very small hypopygium which is densely clothed with silvery hairs below as well as above.

Male type and five other males and females taken near Albuquerque, New Mexico, by J. R. Watson.

Promachus giganteus n. sp.

Total length, male 37, female 41, millimeters. Mystax and beard white, hair of the rear of the head white, occipito-orbital bristles mostly black, palpi black, largely with white hairs, but there are some black ones above, antennae black; general color of the thorax reddish brown, mesothoracic dorsum with a rather wide middorsal black stripe which is divided lengthwise by a narrow red interval, on either side is a second black area which is divided by a narrow red space which follows the transverse suture. As the surface of the dorsum of the mesothorax is somewhat denuded in the specimens studied it is likely that the markings described are plainer than would be the case otherwise, scutellum clothed with white hair and with two rows of black bristles near the margin; legs in large part dull reddish and clothed with black bristles and recumbent white hair, tarsi nearly black, femora darkened anteriorly; wings hyaline, no gray shadow in the first submarginal cell, veins brown and some of them towards the apex very narrowly margined with a nearly obsolete brownish shade. Abdomen as seen from above alternately banded with black and white, the former color usually wider than the latter. The black and white is segmentally arranged, the anterior part of each segment is black with black hair and the posterior part is white pollinose with white hair, sides and venter of the abdomen corresponds in color with the posterior parts of the segments. In the male the hypopygium is silvery pilose above and the posterior ventral margin of the eighth abdominal segment is furnished with a thickly placed row of white hairs.

The species cannot be mistaken among described North American species on account of its very large size.

The type female and one male taken at El Paso, Texas, by D. L. Crawford, and received from Carl F. Baker, of Pomona College, Claremont, California.

LOCOMOTION OF THE LARVA OF CALOSOMA SYCOPHANTA.*

By A. F. Burgess.
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Among the interesting data in the report on "The Gypsy Moth," by Forbush and Fernald, which was published by the Massachusetts State Board of Agriculture in 1896, will be found a record of a series of experiments to determine the distance which young gypsy moth caterpillars will travel. Seven caterpillars were used, and it was found that the distance they crawled before dying ranged from 36 to 144 feet. Another record of experiments conducted with another insect is given on page 23 of bulletin 72 of the New York State Museum, which is bulletin 19 on entomology, published in 1903. In it Dr. Felt writes concerning the grape root worm that he carried on "some experiments to determine the burrowing and traveling power of these little creatures. One small grub was placed on a piece of paper at 9.27 in the morning and its wanderings were carefully traced with a pencil till 4.43 in the afternoon. The little creature traveled almost continuously during the entire period and showed a decided tendency to turn to the left. It covered the relatively enormous distance of over 47 feet in seven hours, or an average of about 2 yards an hour. The grub was placed in a dry vial and under such unfavorable conditions lived about three days."

These experiments show that insect larvae are able to survive for a much longer time than would be expected, and to do so under adverse conditions. The ability to travel until food is secured being absolutely necessary to the existence of the individual this factor plays a very important part in determining the ability of larvae to survive, and especially is this true of predaceous forms. Our attention was strongly directed to this matter in connection with the work of importing and colonizing certain predaceous enemies of the gypsy and brown-tail moths in Massachusetts. The ability of the larvae of *Calosoma sycophanta*, a predatory species which has been received from Europe, to travel any great distance in search of food is of para-

* Read at the Minneapolis meeting, Dec. 28, 1910, in joint session with the Association of Economic Entomologists.

mount importance to the well-being of the species, and although the insects had been found to be very active in breeding jars it seemed worth while to secure more accurate data as to their powers of locomotion. Accordingly, a set of experiments was planned to determine the distance that a larva of this species would travel from the time of hatching until it died, provided no food or moisture was supplied. In order to carry out the test it was necessary to do so under conditions which never occur in nature, but the results indicate the practical impossibility of carrying on tests over so long a period unless absolute control is secured, so that a careful record can be made.

The following apparatus was used (Plate XIII): A small table 3 ft., 8 in. long, by 2 ft. wide was provided with spools at each end near the top, so that a roll of paper could be reeled across the top of the table, the result being accomplished by turning the spools. Beneath this paper was placed a piece of stiff wrapping paper which extended beyond the sides of the paper connected with the reels, and the edges were bent upward in such a manner as to prevent the escape of the larva from the sides of the table. The paper on the reels was ordinary wrap-

Fig. 1. Rolls of Records.

A. F. Burgess.

ping paper 18 inches wide. The larva was placed in the center of the table and a record of its travels was made with a lead pencil.

At 8:30 A. M., June 18, a newly hatched larva was placed in the center of the table by Mr. C. W. Collins, and the record was kept throughout the day with the assistance of Mr. R. G. Smith. The table had been placed in an attic room in the laboratory, having only one window, which was on the west side of the house. During the day the larva moved rapidly away from the light, and when it had reached the end of the roll the table was turned end for end and the insect began traveling in the opposite direction. Although there were forty yards of paper on this roll, it was necessary at 1 P. M. to remove the larva and substitute a fresh roll, as it had crossed the paper from end to end five or six times.

The complete record of the travel of this larva required 11 rolls of paper and one assistant and sometimes two, depending on the activity of the insect, had to be constantly at work. (Fig. 1.) The experiment was carried through continuously until the larva died, and the extraordinary vitality which it exhibited, promised, at one time, to exhaust the supply of assistants that could be spared for the work.

The following table gives the data secured from the record on each roll.

Time	Total	Distance	Rate per min.
8.30 a. m. to 1 p. m.	4½ hrs.	1323.63 ft.	4.9 ft.
1 p. m. to 4.40 p. m.	3 2-3 hrs.	719.40 ft.	3.27 ft.
4.40 p. m. to 9. 40 p. m.	5 hrs.	1213.14 ft.	4.04 ft.
9.40 p. m. to 1.45 a. m.	4½ hrs.	1164.51 ft.	4.75 ft.
2 a. m. to 8 a. m.	6 hrs.	733.17 ft.	2.03 ft.
8.40 a. m. to 11.40 a. m.	3 hrs.	926.03 ft.	4.03 ft.
11.54 a. .m to 4.40 p. m.	4 23-30 hrs.	933.15 ft.	3.26 ft.
5 p. m. to 10.15 p. m.	5¼ hrs.	712.15 ft.	2.26 ft.
10.35 p. m. to 2.05 a. m.	3½ hrs.	575.91 ft.	2.74 ft.
2.15 a. m. to 1.30 p. m.	11½ hrs.	766.5 ft.	1.13 ft.
1.30 p. m. to 8.45 a. m.	19¼ hrs.	190.44 ft.	.16 ft.

The larva remained alive from 8:30 Saturday morning until 8:45 Tuesday morning, 72 hours, and was active the greater part of the time. It was necessary to place the insect in a glass each time a new roll of paper was attached, so that the entire length of time that the larva was actually on the paper was about 70 hours. The table gives the distance traveled during different periods, the total amounting the 9,058 feet, or 1.71 miles.

The highest rate of travel per minute was during the first 4½ hours, and averaged 4.9 ft. For the first 24 hours the average was 3.69 ft. per minute; during the next 8 hours the average dropped slightly and for the remaining period the average was gradually reduced until the larva died.

The temperature in the room where the experiment was conducted ranged considerably higher than that outside the building, the following records being taken from the report of the U. S. Weather Bureau at Boston.

June 18—	Maximum,	79 degrees;	Average,	70 degrees.
" 19—	"	75 "	"	68 "
" 20—	"	86 "	"	74 "
" 21—	"	92 "	"	80 "

The larva was kept continually on a dry surface, so that evaporation was very rapid, and doubtless reduced the length of time that the insect would have survived under normal conditions.

For the first 36 hours the larva traveled almost continuously, stopping only occasionally for a minute or so to rest.

During this time it traveled away from the light, viz., from the window during the day time, and at night away from the single electric light which was in the room. On the second night, which was after 36 hours of continuous travel the larva began traveling toward the light, and continued to do so during the night.

Mr. R. G. Smith, who was on duty at the time, noted that from 8 A. M. on June 20, the larva traveled at a continuously decreasing speed. Marks were made showing direction of travel, and every fifteen minutes the time was noted on the lines of travel. Resting periods: 4.32 P. M., 8 minutes; 4.45 P. M., 5 minutes; 5.15 P. M., 10 minutes; 5.46 P. M., 12 minutes; 6.36 P. M., 4 minutes; 6.42 P. M., 7 minutes. The larva moved only several inches at a time. In the morning the larva rested often, but only for a few minutes at a time. Mr. J. J. Culver noted that about 11 P. M., June 20, the larva began to crawl backwards, at intervals bending the head down as if trying to bite itself. It would do this for two or three minutes, then either rest or crawl in the normal manner. At this time the larva had become either insensible to light, or too weak to continually travel from it, as it traveled toward the light as much, if not more, than from it. In backing the larva always moved from the light.

At 12.45 A. M., the larva was very weak, it had scarcely moved during the last hour, and remained in a humped-up position. If touched with a pencil point, it would jump, but would not move either forward or backward. Between 8.25 P. M., June 20, and 1.40 A. M., June 21, the larva rested 4 hours, 15 minutes.

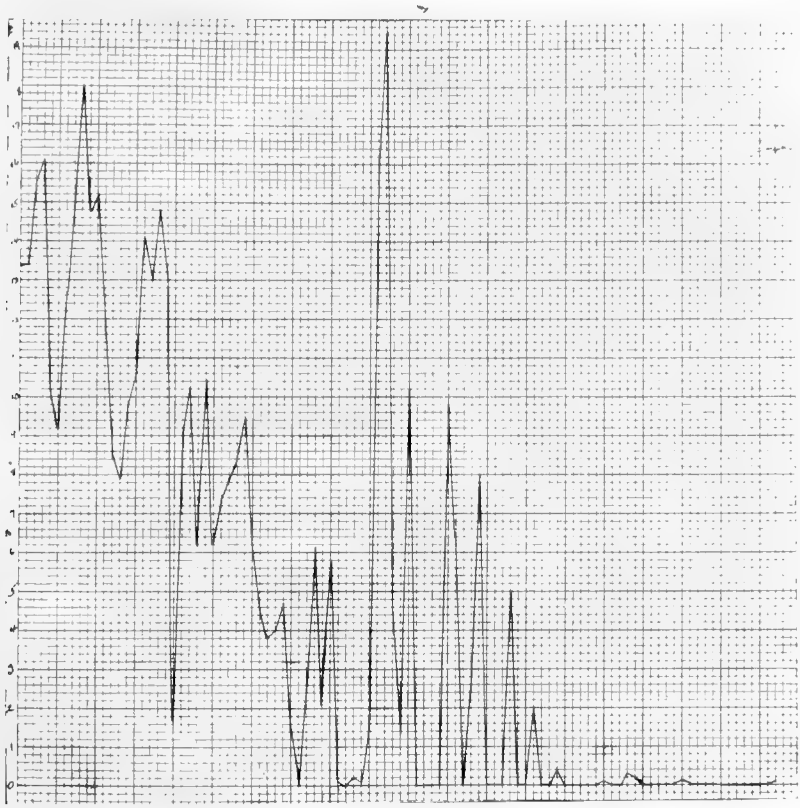

FIG. 2. Distance traveled by larva during the last twenty-four hours. Figures at left indicate number of feet each small horizontal space indicates a fifteen minute interval.

Mr. H. E. Smith, who was on duty at the time, noted that the larva did not move from 1.45 A. M. to 2.30 A. M., when it backed ¼ of an inch, remaining thus until 3.25 A. M., when it turned half way round in its tracks. The line from 1.45 A. M. to 4 A. M. was all backed over, except in a small circle which was traveled in the normal manner. At 3.55 A. M. the larva fell on its back and remained so until 4.05 A. M. when upon being touched in order to test life it grappled the lead pencil point and again regained its footing. It moved and backed in a small circle at 5.15 A. M. At 7.05 A. M. it fell on its back again, and remained there until it died at 8.40 A. M., June 21.

The rate of travel from 8.30 A. M., June 20, to 8.40 A. M., the following morning, which was the last twenty-four hours of the insect's life, is shown in the diagram (Fig. 2.) and illustrates how remarkable was the activity until almost the close of its life.

No delicate balances were available for weighing the larva after it hatched, but as soon as it died it was weighed by Mr. W. G. Fall, of the Massachusetts Department of Weights and Measures in Boston. The average weight of ten newly hatched larvae was .2973 grains; the weight of the dead larva was .18 grains, which indicates that it lost .1173 grains during the experiment.

Although the distance traveled is probably much greater than what would actually occur in nature, it is remarkable that so much latent energy can be stored up in an egg of one of these beetles. It is interesting to compare the ability to travel possessed by this larva with that of some of the higher animals. Through the courtesy of Dr. W. E. Castle and his assistant Mr. Detlefson, of the Bussey Institution, of Harvard University, we have been able to secure measurements and weights of young rats and guinea pigs and this information is used in making the comparison. The average length of all the legs of the larva of *Calosoma sycophanta*, ten specimens having been measured, was 3.37 mm., that of a young rat, one to three days old twelve specimens having been measured, was 19.08 mm., or 5 2-3 times greater, while similar measurements of a guinea pig showed that the average length of leg was 76.25 mm., or 22½ times greater than that of the beetle larva. If the ability to travel of the higher animals mentioned equalled that of *sycophanta*, the rat would be able to cover nine miles without food or water, while the guinea pig would have to cover over 38 miles under the same conditions. It might be said that the locomotive powers of a young guinea pig are superior to that of a rat of the same age but doubtless either would die before traveling a very short distance to obtain food.

If the traveling capacity is compared on the basis of weight the difference is much greater. The average weight of the beetle larva is 19.8 m. g., that of the rat 5250 m. g., and that of the guinea pig 7500 m. g. Thus if the rate of travel was in the same proportion the rat would cover 453 miles and the guinea pig 648 miles while the larva traveled 1.71 miles.

The length of life of the insect is also worthy of note when it is remembered that no food or water was supplied, as it indicates that the young larvae are able to survive several days in the field without food and still have sufficient vitality to make a thorough and active search for their prey.

DISCUSSION.

MR. J. B. SMITH: The thing that interested me most is the appropriateness of the German name, "laufkafer." Mr. Burgess' paper shows that the German name is absolutely correct when applied to the larva of this insect, because it certainly can run.

MR. HOWARD: It is estimated that there are now over a million of these insects in Massachusetts, that next year there will be ten millions, and the year after one hundred millions.

MR. J. B. SMITH: Dr. Howard's remark recalls to my mind the following experience: In south New Jersey there was one season an outbreak of a species of Geometrid caterpillar, which covered the scrub oaks in enormous numbers, and that season, in company with two or three entomologists, I was down in the region where the insects occurred. We found *Calosoma* of two species, *willcoxi and scrutator*, were present in enormous numbers on the young oak trees, feeding upon these larvae. The next year you could look through the whole territory and could not find a single specimen of either species.

MR. BURGESS: I think a possible explanation might be that, as far as we know the larvae of *Calosoma willcoxi* and *scrutator* do not climb trees, while the larva of *sycophanta* does so very readily.

MR. SUMMERS: This certainly is an interesting paper, but the point that is perhaps the most interesting is the comparison of the rat and the guinea pig. It seems to me that is a fallacy that ought to be pointed out. If a man could jump, in comparison to his size, as far as a flea, he could jump over a church tower. One might say too much on the relative endurance of animals, of the distance they can travel, unless the animals are of the same size, or unless the law of reduced power of locomotion with added weight and size is taken into account. The rat with the same endurance, I believe, could not travel the distance stated in the paper.

NOTES ON THE PEAR-SLUG.*

Eriocampoides limacina Retz.

By R. L. Webster.

Recent Injury. Nearly every year cherry and plum trees in Iowa suffer much injury by the common pear-slug. While the control of this insect has never been considered a difficult problem, yet it happens frequently that foliage is greatly damaged before one is aware that any slugs are present.

Serious damage is sometimes caused to cherry trees. Young cherry trees in the town of Ames have been killed as a result of defoliation following the injury by the slugs.

Appearance of the Injury. The slugs feed on the upper surface of the leaves, eating the parencyhma and leaving only the veins and the lower epidermis. Leaves thus eaten, dry, turn brown, curl up and fall from the tree. Frequently infested trees are left entirely bare of foliage in midsummer.

The Insect's Appearance. The insects in question are dark, olive colored slugs, with a slimy covering. The fore part of the body, just back of the head, is broad, but it tapers back of this. Where the slugs are common a peculiar sour odor may be noticed.

The slugs molt five times, and when mature they are about 2-5 of an inch long. After the last molt the slug has a clean and dry skin, quite free of slime, and orange in color. These orange slugs go to the ground and form small earthen cells in which to pupate. When the adult sawflies emerge they deposit eggs in the tissue of plants on which the young slugs are to feed.

PAST HISTORY AND DISTRIBUTION.

This insect has long been known in Europe. As far back as 1740 Reaumur gave an account of the pest and its injury. The first American account was written by Prof. Wm. D. Peck, of Harvard, and published in 1799.

Professor Peck wrote an essay on the insect, entitled the "Natural History of the Slug-Worm," which won for him a gold medal and a prize of fifty dollars, given by the Massachu-

* Read at the Minneapolis Meeting, Dec. 28, 1910, in joint session with the Association of Economic Entomologists.

setts Society for Promoting Agriculture. The essay was printed by the Society but it has now become very scarce. Harris, writing in 1841, said that the pamphlet was then "out of print and rarely to be met with." It was the good fortune of the writer to find this paper of fourteen pages in the Boston Public Library last winter. That so much concerning the habits of this insect had been determined at such an early date in the history of American economic entomology, is indeed surprising. In fact, almost all of the information concerning the insect in America dates back to the account of Peck.

The insect is widely distributed, having been recorded in Europe, North America, Australia, New Zealand and South Africa.

LIFE HISTORY.

GENERATIONS. There are in central Iowa two quite distinct generations of the insect. In the fall a very few slugs were found, lagging way behind the others, but these are probably only delayed individuals from the second generation, rather than a partial third generation.

About Ames the eggs and adults were found in late May and early June and larvae appeared in the fore part of June. By July 5 the first brood slugs were practically all gone. The adults from this brood of slugs appear about the middle of July and their eggs hatch late in the month. The slugs begin to mature a little before the middle of August and by September 1st they are practically all gone.

A part of the first brood larvae do not complete their transformations at once after entering the soil but remain as larvae until the next spring, making but one generation a year for a part of the slugs. This was noticed by Professor Peck and later by Marlatt. It seems to be a provision for the preservation of the species. Should the second generation be wiped out by natural enemies, the slugs that are held over would still be left to propagate the species the next season.

THE EGG. The eggs are deposited in the leaf tissue of the various food plants—placed just beneath the upper epidermis and thrust through the leaf from below.

In the insectary eggs hatched in 10 to 14 days in the spring; average, 12.1 days; in summer in 7 to 13 days, average, 10.5 days.

Parthenogensis probably occurs with this insect, but this has not been satisfactorily proved. Many sawflies were examined, but no males were found. Eggs deposited by virgin females hatched, but all the larvae were weak, and none even reached the second stage.

THE LARVA. The newly hatched slug is about 1.2 mm. long, at first free from slime, but this is secreted in a few hours. The young slugs begin to eat out tiny patches in the epidermis; later they eat through the parenchyma to the lower epidermis, leaving the veins. One slug ate a space of 825.9 square millimeters during its lifetime, 19 days, according to a record kept by Mr. T. M. McCall, insectary assistant at the time.

After each molt, except the last, the larvae eat their cast skin, all of it but the head.

Five molts are probably normal. In 14 cases 5 larvae molted 5 times; 5, 6 times; 3, 7 times, and 1 larva molted 8 times, all under insectary conditions. Sometimes in successive molts the width of the cast head was exactly the same; often there was very little difference.

The average head widths of the stages were: Stage I, .35 mm.; II, .51 mm.; III, .67 mm.; IV, .85 mm.; V, 1.04 mm.; VI, 1.13 mm. The geometrical ratio between the successive head widths was practically .35.

Larvae matured in 13 to 26 days; average 19.4 days. No essential differences were noticed in the two generations of the time required; the same total length was found in either case. The time required for the separate stages was: I, 5 days; II, 3.2 days; III, 3.4 days; IV, 3.2 days; V, 4.7 days (average from both generations). Stage VI usually entered the soil immediately after molting.

Both Peck and Marlatt remarked that heavy rains are said to destroy the slugs. Professor Peck, however, said that he had seen the slugs retreat to the under sides of the leaves in a shower; a fact that we observed several times in the Iowa work. It seems quite likely that the supposed efficiency of heavy rains is really only the disappearance of the slugs to the lower sides of the leaves.

How the larvae reached the ground was a puzzle to us at first, but we found that they dropped down of their own accord. Occasionally orange-colored larvae were found on tree trunks, but they were not crawling down, but appeared to be going upward.

Finally some black cloth screens were placed on the ground under infested cherry trees and the larvae dropped readily to the cloth. They were most active about 4 o'clock in the afternoon. Eighteen larvae dropped to cloth screens between 2.15 and 4 p. m., June 29, according to notes made by Mr. T. M. McCall.

THE COCOON AND PUPA STAGE. The small earthen cells of the larvae were found commonly in the summer within an inch of the surface of the soil. Probably they go deeper for the winter.

In the summer it was about 20 days after the slugs entered the soil that the adults emerged. In 19 cases the average time was 19.9 days, with a range of 15 to 23 days.

THE ADULT. The sawflies were most numerous early in the morning, although they were found in small numbers at other times in the day. In July the sawflies all appeared at about the same time, but in the spring the emergence was spread over a much longer time.

NATURAL ENEMIES.

EGG PARASITES. The most common egg parasite was *Pentarthron minutum* Riley, kindly determined for me by Mr. A. A. Girault. It is a very tiny, yellow-brown species, which has often been reared from the eggs of a number of common insects.

At Ames this species was reared abundantly in 1909, but not at all in 1910. A few individuals were reared from eggs collected at Reinbeck, Iowa, in August, 1910.

From the first brood eggs the parasites emerged from June 28 to July 20; from the second brood eggs, from August 11 to August 20th.

The eggs affected by this parasite turn black, and of course fail to hatch. Two or three individuals were reared from a single egg.

Professor Peck in his original account mentions what is doubtless this same species and gives figures of it. After looking over the account I came to the conclusion that Peck had reared the same parasite in Massachusetts in 1798 that I reared in Iowa a hundred years later. Mr. A. A. Girault, to whom I referred a copy of this account, corroborated my opinion that Peck's parasites were most probably *Pentarthron minutum.*

The second egg parasite, *Closterocerus cinctipennis* Ashmead, also determined by Girault, was reared equally abundant in 1909 and 1910, from eggs collected at Ames. This species also affected both broods of eggs, emerging from first brood eggs June 28 to July 22, and from second brood eggs August 4 to August 21.

This parasite was always reared singly from the eggs. The black form of the parasitic pupa could often be distinguished within the parasitized eggs. It is presumably a primary parasite.

PREDACEOUS ENEMIES. In 1910 nymphs and adults of *Podisus maculiventris* Say were found to be very active against the slugs. Most frequently the slugs themselves were attacked, but the Podisus also captured the adults, according to observations made by Mr. T. M. McCall.

One Podisus nymph was kept 47 days in an insectary cage, during which time it ate 66 slugs; 1.4 slugs a day. The greatest activity was immediately after the insect became an adult, when it ate 6 and 7 slugs a day.

A species of Chrysopa and an undetermined Reduviid were also observed to prey on the slugs.

EXPERIMENTS WITH INSECTICIDES.

Paris green, 1 pound to 150 gallons of water, was effective. A home-made arsenate of lead, single strength, was not effective. Used against the older slugs this spray was very inefficient. I could not see that any slugs at all were killed by it. When used against the very young slugs, about half of them were killed.

A 10% solution of kerosene emulsion appeared to be quite effective.

Several simple soap solutions were found effective, at concentrated strengths. Whale oil soap, 1 pound in 2 gallons of water; Ivory soap, 1 bar in 2 gallons and White Laundry soap, 1 bar in 2 gallons of water, were all satisfactory treatments. These soap solutions may be quite convenient for use on a few cherry trees when the fruit is present.

DISCUSSION.

A Member: I should like to ask if it is possible to use the spraying that is applied for curculio to kill the slug, or whether the slug works so late in the season that poison applied for the curculio would be washed from the leaves.

Mr. Webster: The spraying should be done about the middle of June in central Iowa. I am not familiar enough with the curculio to say whether this spraying would affect it or not.

A Member: It would be too late to arrest the curculio.

Dr. Howard: I regret that I did not hear all of the paper. I should like to ask about the affect of a strong stream of water on the slugs, without any insecticide at all.

Mr. Webster: I did not try that.

Dr. Howard: In city yards a strong stream of water from a hose can be used to wash off the slugs. This method has been tried and given good results.

THE MECHANISM IN THE HATCHING OF THE WALKING STICK, DIAPHEROMERA FEMORATA SAY.

By Henry P. Severin, Ph. D., Professor of Zoology and Entomology, College of Hawaii, and Harry C. Severin, M. A., Professor of Entomology, South Dakota State College of Agriculture and Mechanic Arts.

(WITH PLATE XIV.)

In the Phasmidae, Mantidae, Blattidae and Acridiidae, the cervical ampulla is said to play an inportant role in the process of molting, and in some Orthoptera, also in the process of hatching. This ampulla, consisting of a soft membrane joining the head dorsally to the prothorax, can be transformed by the afflux of blood into a greatly swollen pouch, which then projects out immediately behind the head.

The process of hatching of various Orthoptera has been studied by a number of entomologists. Riley (7) does not mention the cervical ampulla while describing the phenomenon of hatching in the Rocky Mountain Locust, for he writes as follows: "The hatching consists of a continued series of undulating contractions and expansions of the several joints of the body, and with this motion there is slight but constant friction of the tips of the jaws and of the sharp tips of the hind tibial spines, as also of the tarsal claws of all the legs against the shell, which eventually weakens and finally gives away. It then easily splits up to the eyes or beyond, by the swelling of the head."

Packard (5) objects to Riley's account of the supposed action of the jaws and spines and believes that "the egg-shell is without doubt burst open by the puffing out or expansion of the membrane connecting the head and prothorax, just as the common house-fly or flesh-fly bursts off the end of its pupa-case by the puffing out of the front of the head."

Kunckel d'Herculais (3 and 4) gives the following account of the physiological mechanism in the hatching of the Acridiidae: "Les Acridiens rompent la coque de l'oeuf, * * * par la pression exercee a l'aide de la membrane unissant dorsalement la tête au prothorax que se transforme par afflux de sang en une ampoule cervicale."

In Diapheromera femorata the mechanism, which ruptures the various membranes and springs off the operculum when the walking-stick is about to emerge from the egg, cannot be observed in action on account of the hard, thick, opaque chorion. If the operculum is carefully removed from an egg shortly before hatching, the embryo will be found with its head and prothorax situated directly beneath the portion of the egg removed (Fig. 1, *h* and *p*). The pressure exerted by the cervical ampulla is, therefore, directly against the operculum.

Hatching spines for the purpose of rupturing the embryonic envelopes and also for breaking or cutting open the egg-shell have been described from many insect eggs. Above the prothorax of Diapheromera, the thin amnion is covered by numerous long spines which point toward the operculum. These spines, like the egg-burster (or *ruptor ovi* as Riley (6) calls it) of Corydalus cornutus, are portions of the amnion itself. If the prothorax of a walking-stick is examined after its emergence from the egg, no spines are found, but simply short blunt protuberances. In all probability, the long spines of the amnion above the prothorax assist in rupturing the vitelline membrane which is especially thick beneath the operculum.

"When the young walking-stick is in the egg, ready to emerge, the meso- and metathorax are not remarkably elongate, but before the little creature is fairly out of its narrow prison, the thoracic segments assume their usual proportions. It is said to be a most curious sight by those who have observed this almost instantaneous development." (Caudell [2]).

An attempt was made by us to secure an explanation for this curious phenomenon observed by Caudell. After the chorion of the egg was removed, the embryo was found to be so curled up in the egg that the posterior end of the abdomen lay near the head region. A longitudinal section through the embryo showed that the thorax was folded transversely in a dorso-ventral direction (Fig. 2). In all probability it is simply the straightening out of these folds as the young walking-stick emerges, that causes the thoracic segments to assume their usual proportions. If the pressure exerted by the cervical ampulla at the time of hatching is not sufficient to rupture the amniotic and vitelline membranes and also to throw off the operculum, it may be possible that the straightening out of some of these thoracic folds assist in the process.

After pushing off the operculum, the young walking-stick, with the prothorax bent down at its union with the mesothorax, begins to emerge from the egg (Fig. 3). The cervical ampulla is now slightly swollen, and the prothorax possesses a deep green color, due to the blood which has accumulated within it.

The method employed during the process of emerging from the egg is almost identical with that which we (10) have described of a walking-stick withdrawing itself from its old skin during the process of ecdysis. A specimen examined under a binocular microscope during the process of emergence from the egg, will be seen to undergo a series of peristaltic-like movements of the segments of the body; these movements pass from the posterior end of the abdomen towards the head. With each series of these movements, the body is drawn out of the egg-shell a short distance, the legs also assisting somewhat in this process of extraction. At each pull of the legs in their attempted withdrawal from the egg-capsule, the strength of the pull is such, that the coxa of each leg presses against the body, causing in that region a temporary indentation. When the peristaltic-like movements reach the head, the walking-stick often raises the head vigorously upward in an attempt to withdraw the antennae.

The first part of the walking-stick to leave the egg is the dorsal surface of the prothorax (Fig. 3, *p*); then comes the head (Fig. 3, *h*), followed by the rest of the thorax. The antennae are freed next, and these may come forth either simultaneously or one soon followed by the other. The following order was often observed in the withdrawal of the legs: one middle leg was followed by the other; then the front legs were pulled out of the egg at the same time, and finally the hind legs. The abdomen does not leave the egg at any definite time in relation to the withdrawal of the other parts, but it may emerge after the antennae or, in other specimens, after the middle or front legs. The extrication of the antennae, legs and abdomen, however, does not always take place in the order just given, as is shown in the following table:

TABLE I.

Order of Withdrawal of the Antennae, Legs and Abdomen from the Eggs of Six Diapheromera femorata.

A	B	C	D	E	F
antenna	antenna	antenna	middle leg	abdomen	abdomen
antenna	antenna	antenna	antenna	antenna	antenna
front leg	middle leg	abdomen	middle leg	antenna	antenna
middle leg	abdomen	middle leg	antenna	middle leg	middle leg
middle leg	middle leg	middle leg	abdomen	front leg	middle leg
front leg	front leg	front leg	front leg	front leg	front leg
abdomen	front leg	front leg	front leg	middle leg	front leg
hind leg	hind leg	hind leg	hind leg	hind leg	hind leg
hind leg	hind leg	hind leg	hind leg	hind leg thrown off.	hind leg

Braces indicate that the two included appendages were extricated simultaneously.

Stockard (11) describes the hatching of Aplopus mayeri as follows: "When hatching the embryo's head and body come forth from the egg first, the antennae are then pulled out, the legs being the last parts liberated from the shell." The specimens noted under E and F in the above table agree with Stockard's observations on Aplopus, but both of these specimens had their appendages caught in the amniotic membrane (Fig. 4). In a previous paper we (9) have already called attention to the fact that dryness, at the time of hatching, has a marked effect upon the emergence of the walking-stick from the egg. With the addition of water which was added drop by drop to the egg-shell, within which the above-mentioned specimens were caught, these walking-sticks succeeded in freeing themselves.

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EXPLANATION OF PLATE XIV.

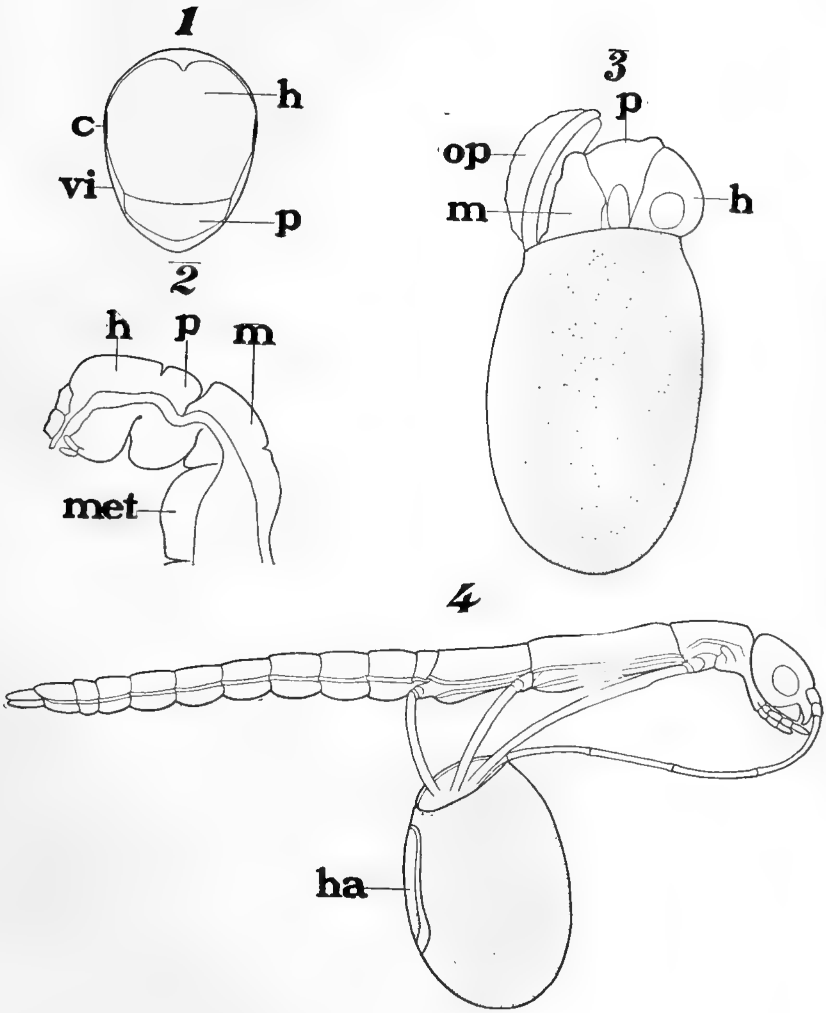
All figures were drawn with a camera lucida.

FIG. 1. View of embryo after the operculum has been removed showing the head and prothorax directly beneath. The pressure exerted by the cervical ampulla, which joins the head dorsally to the prothorax, would be directly against the operculum: *h*, head; *p*, prothorax; *vi*, vitelline membrane; *c*, compound eyes.

FIG. 2. Longitudinal section through the head and thorax of the embryo, showing the transverse folding of the thorax in a dorso-ventral direction; *h*, head; *p*, prothorax; *m*, mesothorax; *met*, metathorax.

FIG. 3. Walking-stick emerging from the egg, showing that the prothorax is bent down at its union with the mesothorax: *h*, head; *p*, prothorax; *m*, mesothorax; *op*, operculum still adhering to the egg by means of the so-called "shell membrane."

FIG. 4. Walking-stick with its appendages caught within the egg-shell: *ha*, "hilar area."



H. H. P. and H. C. Severin

SOME SUGGESTED RULES TO GOVERN ENTOMOLOGICAL PUBLICATIONS.

By T. D. A. Cockerell.

Many years ago in England, I captured a rather uncommon hemipterous insect, and sent a record of it to a well-known entomological journal. The editor, being a lepidopterist, had never heard of the bug, but did know of a very rare moth having the specific name (*bicolor*) employed. He accordingly changed the generic name to that of the moth, and I found myself the astonished recorder of an insect I had never seen alive, nor hoped to see. More recently I communicated to a publication in this country a short paper on a supposed new plant of the genus *Ribes*. The editor, not liking the title, substituted "A New Currant from Arizona," whereas the plant was a gooseberry, and was from New Mexico. These rather amusing instances are cited merely to illustrate the indisputable fact that it is risky for an editor to interfere with the contributions he publishes. On the other hand, I have been shown manuscripts sent in for publication which, if printed exactly as received, would be simply unintelligible. The editor is in a difficult position, and as a rule, I think the contributors have little reason to feel otherwise than grateful for the treatment they receive; it is at least not rarely better than they deserve.

Although I am against editorial alterations in manuscripts, I think it may be entirely proper to adopt some simple rules to be enforced in every case, the papers which fail to conform being returned to their authors for correction. As entomological editors appear to have no such rules, with the exception of a few relating to typography, it occurs to me that the Entomological Society might properly discuss and adopt a set, pressing them upon the attention of editors with such authority as it may be considered to possess. As the result of a little private correspondence, I believe it would be easier to get all the editors together to agree upon certain things, than to persuade them individually to take the desired step. I cannot do more than present a suggestive outline, which may be discussed and amended as necessary.

(1) When a new genus is described, the type species must be stated; it may be as well to add, that the binomial made by combining the generic name with the specific name of the type species must be printed.

(2) No new genus will be published, that is not based on a described species.

(3) Rules 1 and 2 also apply to subgenera.

(4) No new species may be described without comparing it with some other described species, or stating wherein it differs from other members of the genus.

(5) When a new species is based on specimens from several localities, it must be explicitly stated which is the type locality.

(6) When a new species is described the data concerning localities and collectors must be given in full so far as known. This is also strongly recommended in the case of all new records. If the locality, collector, etc., are not known, it may be well to say so, although this may be taken for granted if the writer is known to be careful in citing data.

(7) It is impossible to avoid all errors in spelling, grammar, etc., but so many of them have appeared in recent years, that American entomologists have some reason to feel ashamed. It would be easy to compile a list of scientific names which must be retained in our lists, although faulty to the extent of being offensive. This is true in spite of the freest recognition of the fact that scientific latin is a living and growing language, and must include many words unknown to the ancients. No rule can cover this difficulty, but it might be worth while to collect every year a list of these criticisable productions, and set them forth as a warning to authors and editors alike.

(8) It is not permitted to publish new varieties as binomials; the trinomial must in every case be written out.

THE COMPOSITION OF TAXONOMIC PAPERS.

By Richard A. Muttkowski.

TABLE OF CONTENTS.

Taxonomy is the most important incident of Science—things must be named before we can write of them. If we consider the proportion of zoological papers at the present time, we find that about two thirds are systematic. But this proportion increases to seven-eighths if entomological papers alone are considered.

In taxonomy we usually speak of only two types of contributions: (*a*) text books, prepared for a mixed public, and (*b*) original work, which is intended for the entire scientific world, but whose chief appeal is directed to a small group of contributors. These form a special class, distinct in conception and treatment from other scientific papers.

The style of composition proper in a morphological, ontogenetical or phylogenetical paper would be found impracticable in a taxonomic paper. Yet, while the greater number of entomological papers are taxonomic, it nevertheless remains a curious fact that as yet no compendium for taxonomic composition has been published.

For papers other than taxonomic we have Dr. T. Clifford Albutt's excellent book, "Notes on the Composition of Scientific Papers" (MacMillan Co., New York, 1904, 8vo). While many of the chapters of this work would be of interest to systematists, they do not pertain directly to taxonomy; the volume, on the whole covers a quite different ground, that of scientific theses.

To say that nothing at all has been published on the present issues would invite criticism. On the contrary, I have found copious and more than sufficient material in the more prominent journals of the past two decades. But these contributions are widely scattered; moreover, they are written as protests and usually deal with a single topic only. While I cannot lay claim to originality in the suggestions included in this paper, I have endeavored to treat all of the more vital topics bound up with taxonomy; aiming to suggest such standards in writing as would conform to the various needs of those interested.

Briefly stated, a standard is the result of an average or consensus of opinions upon a given subject, hence a criterion. Thus far the only criterion of any worker has been the approval of his fellow-workers along the special line of work he has adopted. This basis is hardly sufficient, as not a small coterie of workers but the world at large is intended to be benefited.

It must be remembered that this paper does not treat of criterions of species, but with the composition of descriptions and general methods of presentation. That these are perfect and above reproach probably none will maintain.

I have talked over these matters repeatedly with scientific workers. Curious to say, dissatisfaction with present methods and with the absence of definite standards was prevalent everywhere. The necessity of co-operation toward the achievement of practical standards was sometimes very strongly expressed. A digest of all these opinions, private or published, may be summed up in the following: Better methods of description are desirable; the nomenclature of species and genera, of colors and types to be regulated; titles of articles to be made more comprehensive; reprints to contain place, time and name of publication, etc.

I. Standards for Descriptions.

A. Specific Description.—J——— s———, an unencumbered species: Front pale, palpi scaled, thorax with black stripes, antennae yellowish, abdomen spotted, legs with pale, wings with black markings. Head with short pile, abdomen tufted, a small tuft between the antennae, which are fuscous at the base, white toward the tips. Wings white, with four or seven black lines crossing them, the lines curved or straight. Abdomen with tufts black, exceeding anal angle. Legs long, with spurs. Palpi reaching the vertex, legs slightly darker at the joints.

I dare say, that no living man could determine a specimen from this extravaganza. Yet the description is made from an actual species—*Conchylodes platinalis*, Lepidoptera–Pyralidae.

Furthermore, it is typical of many descriptions of the past, and, I regret to say, of too many in the present days.

It is curious how little logic is often applied in formulating a description. One specialist, who has written hundreds of descriptions, seems to have found particular pride in making these as intricate and involved as possible; there is no logical sequence in the treatment of the main divisions; on the contrary, the acrobatic description jumps from antennae to legs, from abdomen to head, wings to palpi, venation to tarsi, morphological characters to vestiture, color to structure, etc., etc. So much so, that after comparison is completed one must begin over again, as it is impossible to remember the way through the labyrinth.

Descriptions should not be written for personal aggrandizement, but to announce a new fact or discovery to the scientific world. Such being the case, the description, once published, belongs to the world at large and no longer to the writer. The author therefore owes it to science that the facts of which the world is to become owner be presented in a manner most accessible to, and best applicable by other men. If the author for any reason whatsoever is careless and inaccurate he sins against science. After all, there is an intellectual as well as a moral conscience.

"Head pale, eyes small, dark, vestitute smooth and yellowish, body moderate, legs short, tibiae stout," applies equally well to Mr. Jones as to *Pediculus capitis* strolling on his head. Brevity may be the point of wit, but science is no joke; taxonomy deals with facts, not idiosyncracies. Who has not felt the bane of two to eight lined descriptions, any one of which harmonizes easily with half a dozen or more distinct species? I do not believe that an entomologist lives who has not at one time or other execrated these brief, vacillating descriptions. But why do entomologists continually write others that are no whit better or longer? Let it be known, that one thorough description covering three pages may be of more use and more valuable to science than three descriptions on one page. One may suggest that the perusal of brief descriptions saves time; but when we come to analytic comparison of closely related species the brief description forms an obstacle which results in considerable loss of time. What of genera whose species are extremely variable? Can the extent of specific variation together with a description of the average be summarized in twenty lines? Hardly. The ideal description will be a careful analysis of all body parts with all their appendages, attributes and characteristics, to be followed by a summary of salient characters of the type and a comparison to related species. I maintain that this cannot be accomplished on less than a page.

It is terrifying and discouraging to be confronted by a page of solid description, where all characters, whether head, thorax, abdomen, or wings, flow together in a solid phalanx, so that it is impossible to pick out readily any special point desired. Descriptions should be paragraphed or captioned. This costs no extra labor, and, in fact, presents a much neater appearance when published than the solid, uniform mass of words. Besides it affords greater facility to the student who wishes to look up certain characters for comparison.

Again, a description should not be isolated. I mean, comparison to related species and indication of the position of the new species should follow the description. It is reprehensible negligence to describe a new species from a genus already containing a dozen or more species and to omit all mention of either relations or position; such proceeding is indeed worthy of reprimand. To say the least, the work of the author will be placed in an extremely doubtful light. The thought suggests itself, that the author himself was ignorant of the relations and that he described a species at hap-hazard.

After all this, why pay any attention to identity, number, and custody of types? Why state the locality from which the types came? Why select a holotype from a series of twenty specimens that show considerable variation? No one is ever expected to express any doubt of the scientific determination of the twenty. No one is ever expected to feel interested in looking up the types for comparison or study after having become familiar with the all-sufficient description of ten lines. This seems to be the opinion of some taxonomists. For they very carefully avoid all mention of the number of types, their identity (see nomenclature of types) and only grudgingly designate the locality from which the types came by the remarkably precise state name. The latter, it is supposed, will give the reader all the ethological information he desires; so that if he wishes to capture specimens of the same species, all he need do is to pack his trunks and hie himself to "Texas" or "Nevada" and pick the species from the mountain-sides and valleys, from water and land, from trees and grass, or just open his bottles to stop their fall from the heavens. It must be there, for the author said so; he said "Nevada" and this is Nevada.

The following is a scheme for an accessible description:

J——— s———. Not a new species:

1. (a) Sex, usually ♂, and dominant color; size.
   (b) Head: mouthparts, face, eyes, vertex, antennae, occiput, etc.; vestiture, colors, structure, etc.
   (c) Thorax: prothorax, mesothorax, metathorax, structure, vestiture, colors. Legs, their color, structure, vestiture and appendages; etc.
   (d) Abdomen: structure, markings, color, vestiture, appendages, etc.
   (e) Wings: color, markings, vestitute, venation, etc.
2. (a) ♀ and dominant color; size.
   (b, c, d, e) as above. Difference from ♂.
3. Summary of salient characters. Unique characters. Variation.
4. Comparison to related species, position of species.
5. Material: Types, identity (see nomenclature) of types, exact date and locality of capture. How (ethology) and by whom captured.

Of course, this scheme cannot be strictly adhered to in the different orders; it is, however, sufficiently elastic to permit the changes required. What is important in one order, is negligible in another. But the fundamental idea of setting forth by paragraphs or captions the principal parts of a description in successive order, will no doubt be understood.

B. Redescription.—How a redescription should be formed depends on the original description. If the original was carefully drawn, the other may be a summary of the first with possible new points of variation, etc., discovered. Or if, as very often is the case, the original was insufficient, the redescription should be carefully formed; in fact, the author should aim to replace the first with the second description. Even though his name stand not as the sponsor of the species, the task of redescribing is not a thankless one, as need hardly be explained.

Redescriptions are also written for convenience, either as summarizing the knowledge of the species, or, as indeed commendable, to place an otherwise inaccessible description within the reach of the student. Much of what has been said under the preceding caption applies here also and needs no repetition.

C. Generic description.—What is a genus? A classificatory group of plants or animals, embracing one or more species; the primary condition of binary nomenclature; a uninominal used for the lowest phase of the grouping of living forms accepted by naturalists.

What constitutes a genus? A single species or several that, aside of specific differences, have certain morphological features in common, which distinguish them from all other groups of species.

When is a genus valid? When so stated by the sponsor, the nomenclator having noted certain morphological characters, the value of which is recognized by fellow-workers, and who accept this diagnosis upon the given characters; when placed with a monomial (specific) to signify that the species possesses certain distinguishing group characters.

As genera constitute the lowest, but at the same time the most important, phase of grouping, at least some attention should be given to the formation of generic descriptions; especially so in larger contributions, such as monographs and generic summaries and synopses. Generic description is allied to specific description; hence methods ought to be similar.

Some of the essentials of a generic description are the following:

1. That the type species be cited. It should be noted that the type species must be a species then or previously described; else we have merely a nude name.

2. That the characters on which the species is based be given. Although the generic name alone, when coupled with a described species, is recognized as valid by the codes, the systematist will insist that the absence of a generic description is an unfair apprisal on the part of the nomenclator.

3. That these characters be stated concisely; that is, write to the point. Brevity is not conciseness. One may be brief and vague at the same time.

4. That these characters be stated in orderly manner. Especially in larger papers unity of methods is advantageous. If one description begins with the legs, another with head, a third with the venation, etc., study is made difficult. Uniformity of methods facilitates study and progress.

5. That other species belonging to the new genus be listed. While this necessitates thorough study on the part of the nomenclator, it really is his duty. To split up large genera upon characters drawn from a single species is a simple matter. But the nomenclator should verify the stability of his characters by extensive comparison with related species.

6. That other genera be compared, or, at least, the position of the new genus indicated. To describe a new genus of a family already containing twenty or thirty genera and not indicate the position or relations of the newcomer, is not scientific; it denotes carelessness or ignorance.

Not exactly essential, but still of value in extended papers are the following:

7. The etymology of a new name should be explained. This often gives a clue to a character or to the relation of a genus.

8. The distribution of a genus should be cited; namely, whether it is Oriental, Palearctic, Nearctic, etc.

9. The order and family of the genus should be indicated in title or text. This pertains especially to brief papers. As nobody can be familiar with the specialties of all authors or with all generic and family names, this offers an aid in the study and classification of papers.

10. The validity of the generic name should be considered by the author. It is the author's province to do so in the first place. If taxonomists cared to put a little time or expense to the verification of a name, there would be fewer homonymns coined each year.

II. Standards for Colors.

Of all standards these are most needed, since they are most sinned against. That no color standard should exist in a division of zoology, which is of prime importance economically as well as numerically, and where frequently colors are our only tangible guides—unfortunately so—for generic and specific determination, is hardly conceivable. Yet such is the case. After one and a half centuries of entomology, in which the number of described species has been advanced from a few hundred to several hundred thousands, we are utterly lacking of any color standard and are guided in our nomenclature of colors solely by the individual impressions of the taxonomist. That such a basis is absolutely at fault, needs no special asseveration.

The perceptions of most men in regard to colors are extremely crude. (To anyone who may doubt this statement I advise a visit to some artist. One may state to him his impressions of ten different shades of color; and observe then, how often the shade will be misnamed by the amateur as against the professional testimony of the artist. I do not claim a better perception than other men and am found at fault equally as much as others.) In their school days men were taught the tale of three to seven primary colors, and a small trifle of the shades resulting from combinations of the primaries. A little of this they remember through the rest of their lives. And, strange to say, when a man would not use a term or expression to designate an anatomical detail unless he is absolutely certain that it is correct, this same man will unhesitatingly designate colors, when, to say the least, there is good reason to doubt his exact knowledge of the particular color. I do not say that this is intentional; it results from overconfidence of his particular knowledge. This carelessness arises from the lack of proper standards. Accordingly men are forced to formulate their own standards, which are necessarily at fault It is only through an average or consensus of opinions that standards are reached.

In a desire to be conscientious men often circumscribe a condition when they find their exact knowledge of colors inadequate. This is usually done by the addition of such terms as "pale, light, medium, shining, glabrous, bright, vivid, dark, dull," etc., to the primary color. While this effort is commendable, it offers no more certainly than the mere citation of the primary shade; and the interpretation of the circumscriptive adjective is frequently very liberal.

Probably the most liberty has been taken with the term "fuscous" in our descriptions. This term has been made to designate any darker shading on a light back-ground, beginning with a tinge of the palest yellow against a white or translucent base to a seal or clove brown against any lighter background. "Orange," "yellow," and "green" are others of these liberally interpreted colors. The heart-rending or laughable (as one views it) puzzling of students, who are familiar with exact anatomy but not with the vagaries of taxonomy, when attempting to determine a species from description and to seek conformity between the colors as given by the author and the specimen in hand, affords too well known illustration.

Viewing the matter from the stand-point of my own desultory experiences, the question occurs to me: If at the present time, when the approximate number of described insects amounts to about 300,000 species, identification is difficult, the determination often exhausting the patience of the taxonomist in the vain endeavor to divine the protologist's perceptions of colors; further, this difficulty having encumbered taxonomy with labyrinthine synonymy;—what, then, will be the condition of taxonomy fifty years hence, if we continue with present methods, when species will have increased to approximately 1,000,000?

Happily there is a tendency among our eminent specialists in the last decade to standardize their descriptions as far as colors are concerned. (This is beautifully instanced by Packard in his later works, such as his monograph of the Lepidopterous family *Notodontidae*). Yet these are so few that their number may be regarded as negligible. That the necessity of color standardization is imperative and that this is well recognized is shown by Dr. J. B. Smith's addition of a plate of colors to his recent "Dictionary of Entomological Terms."

Structural (iridescent) colors are sometimes difficult to define because of the varying hue, according to the angle of refraction and reflection. Yet with reliable color charts these difficulties would be obviated.

Frequently the belief asserts itself that specimens were described in lamp-light. How unsatisfactory and misleading artificial light is taxonomists ought to know only too well. The simple experiment of exposing green, yellow and brown insects, notably shining specimens, successively to gas, electric, acetylene, candle, kerosene and the natural sun-light yields some surprising results.

A color standard need not be an assortment of infinitesimal shadings, gradings, and combinations of the primaries. A representative selection of from thirty to fifty colors is sufficient for all practical purposes.

The fact that detailed comparison of the colors of a specimen to color charts entails some extra labor should not deter taxonomists from making these comparisons. The appreciation and gratitude of their fellow-workers as well as of their followers will be their reward. The dominant color should be stated in all cases. True, the colors of dead insects are rarely quite the same as in life, or those of younger insects the same as those of mature specimens. Yet the fact that colors have faded in death, or that they change with age, is of secondary importance. A description is not based on possibilities, but on tangible concrete actualities. These alone should rule. If there are good reasons for assuming that the colors of the specimen are not representative, this can, and, in fact, should be stated. Having a dominant color as a basis, it is comparatively simple to fix the position, extent, and shade of the other colors an insect may exhibit from further comparison to charts.

The terminology of colors may be somewhat cumbersome. But science is not "belle lettres"; the taxonomist does not consider whether the sentences he reads are syntactically correct or rhetorically rounded, but judges from their contents as to their value. At that, why a composite terminology? Why not a restricted nomenclature based on a few names with divisions indicated by subnumerals, as red 1, red 2, red 3, etc.. blue 1, blue 2, etc., etc.?

Good works on colors exist, notably Ridgeway's Nomenclature of Colors, as adopted by Ornithologists. (Unfortunately this excellent work is long out of print, and because of its limited edition it is now practically impossible to purchase a copy in the book-market). But for practical purposes a simple chart, as that hand-painted by Frederick Oughton (London), if selected by a representative commission of entomologists, could be manufactured at low expense, which would be easily justified by the demand. This would offer a standard for all times, not to mention the other obvious advantages resulting thereby.

III. Standards of Nomenclature.

A. Generic and Specific Nomenclature.—This is the only sphere where standards already exist. These standards are the codes of zoological nomenclature, such as the International Code of Zoological Nomenclature, the A. O. U. Code of Nomenclature, etc., which are commonly followed by zoologists. If I say "followed by zoologists," the phrase must be given the most general and generous interpretation. Speaking of a class I can say "commonly"; but when speaking of groups of specialists—to say it mildly, many groups use the nomenclature of 1810 instead of 1910. This sounds anomalous, but it is not. For the regulation of nomenclature by codes of universal sanction is comparatively recent, and the commissions are only gradually bringing order into the nomenclatural chaos that existed before their day.

One cannot expect, I suppose, that a specialist on the biological phase of insects should be interested in the "arbitrary, dry" codes of nomenclature. Yet it must be remembered, that taxonomists alone have caused the chaos. Taxonomy is "arbitrary" also. What one man considers a variety, another calls a distinct species; and still another refuses to recognize either opinion. Or are "splitters" and "lumpers" only births of fancy, or memories of the distant past?

The aims of the codes of nomenclature are to make the nomenclature as free and unencumbered as possible. Hence the rules set down for guidance. If taxonomists disdain, or even refuse, to follow these rules, who else should follow them?

B. Anatomical (Morphological) Nomenclature.—Standards for generic and specific nomenclature have been noted. The present issue is of equal significance.

The chief objection that may be stated on this question is indefiniteness. A lesser offense is the scope of the terms; *e. g.*, while by "front" the author may intend to include nasus, epistoma, rhinarium, labium, etc., we, however, know that front means *frons* in the scientific interpretation and nothing else. What the author thinks, we cannot telepathically or by any other means divine.

Each business has its technical nomenclature. No hardware man will hand you a shingling-hammer when you ask for a claw-hammer. To the business man the two terms signify two different things and he will never be so careless as to use the one for the other. Yet among taxonomists we find a continual interchange of terms, such as joint for segment, tarsi for tarsal claws; mouth for labrum or mandibles, abdomen for venter, etc.

When a taxonomist writes "face yellow, abdomen spotted," it is supposed, that he knows what he means. But unfortunately I do not. A specialist, who knows the peculiarities of the score or twenty-five other men working on the same branch of science, will possibly understand what is meant. Not so the individual who attempts to determine a species, less because of special interest, but because of some observation he made on it and which he desires to record in his book of field-notes.

Another idiosyncracy is to use comparative terms for the length or size of any portion of the body, as, for example, "front as wide as the eyes, elytra twice the width of the pronotum, tarsi about two thirds the length of the tibiae, etc." This mode of measurement is miserably uncertain; miserably, because of the misery of the student who attempts to make the same comparisons and cannot see them as the author saw them.

How many men are able to mark the exact middle of a line at a glance? Aside of usual differences in refraction in two eyes, some aberration will be caused by the strain of focusing to the same point. A "mathematical" eye is a virtue that very few people possess. Still more difficult is to find the exact third of a line. What then of paralleling lines, or approaching lines? What of curved lines, irregular lines, etc.? Or is the chapter on "Optical Illusions" as taught in Physics only an illusion?

Bad as color illusions are, mathematical illusions are worse. The chapter on "Optics" ought to form the favorite reading of many taxonomists. A difference of one millimeter on an insect of 20 mm. length is slight; but it makes a considerable difference on an insect of 8 mm. It is a peculair experience to read in a description of a beetle or any other insect "elytra twice the width of the pronotum" and then find by actual measurement that the pronotum is 4 mm. at its widest point while the elytra are 10 mm. or more in length. Similarly with most other comparative measurements. When tested by the micrometer or millimeter scale they will be found considerably aberrant. Hence the urgent advisability to introduce exact measurements instead of the unreliable optical method of comparison.

One standard does exist in anatomical nomenclature, namely the Comstock-Needham nomenclature of wing venation. The merits of this system are undisputed and recognized by all modern systematists. But instead of unreservedly adopting a system the value of which they confirm, taxonomists intermingle the antiquated miscellaneous wing nomenclature with the logical modern terminology. As a result we are continually thrown from one style of naming the veins to the other. This may not be troublesome for the specialist. But if a student is generally interested in entomology, he finds himself in a constant quandary as to the special terminology of each particular order, as they are easily confused; whereas the Comstock-Needham nomenclature was especially designed to obviate this difficulty. It is true, certain orders have certain appendages which it is desirable to retain, *e. g.*, for Neuroptera the thyridium cell and end-forks, bees the subcostal cells, etc. These should be retained, as they are special attributes of the respective order, family or genus. But the fundamental principles of venation, as outlined by the Comstock-Needham nomenclature, are possessed by all orders, viz., costa, subcosta, radius, media, cubitus and anal vein. Why not use them instead of vein 1, 2, 3, 6, 8, 10, etc.? The terminology is simpler, it is less aggravating, it is more logical, and it is an aid to the student and worker.

C. Nomenclature of Types.—Quite as important as specific and anatomical nomenclature is the nomenclature of types. Considerable attention has been given to the latter study in recent years. As the various departments of natural history are dependent mainly upon descriptions for the taxonomic knowledge of specimens, the types of these descriptions grow in importance as the sum of our knowledge of species increases. The best description is not perfect, but, more often than not, deficient in some important taxonomic character. Hence the need of later systematists to refer to the type as the absolute standard of comparison. A nomenclature of types has accordingly been developed in recent years which is given the same importance as that which taxonomists attach to species nomenclature. While less diversified than the latter, it should become of equal interest to the taxonomist, as it remains for him to apply it.

With the close of the year 1906 we have a series of five primary types and four supplementary types designed to meet the needs of both systematist and type custodian. Some of these designations will possibly be disregarded or even found insufficient; this depends upon the individual, whether he be "splitter" or "lumper."

The first step toward a logical nomenclature of types was made when taxonomists began to set aside one of a series of specimens as the type proper, and to name the remaining specimens cotypes. Too often it had been found that a series which the protologist defined as one species actually represented two or more species. Hence the advisability of naming only one specimen the type and the others differently. The name "cotype", although used so universally, is in such case a misnomer and was finally set aside for the more pertinent and exact "paratype"—to signify specimens of the original series other than the type specimen. As the word "type" is subject to many interpretations according to the combination in which it is used, Schuchert in 1897 devised the word "holotype"—meaning "sole type"—for the single specimen on which a description should be based. The name "cotype", however, was not discarded; its applicability only was limited. "Cotype", in its present interpretation, is properly applicable only in paleontology; for instance, when we have a fossil and its reverse. Another instance, from zoology, would be the following: two flies caught in coitu and not separated in death. If mounted together neither male not female can be called holotype; there is no necessity of singling out one of the specimens, as there can be no doubt of the two belonging together.

The following is a summary of type nomenclature:

A. Primary Types.

1. Holotype (**H. T.**)—A single specimen, or one selected of a series.
2. Allotype (**A. T.**)—A single specimen of the sex not designated by the holotype.
3. Cotype (**S. T.**)—Specimens of the original series when there is no holotype (=syntype).
4. Paratype (**P. T.**)—Specimens of original series when there is a holotype.
5. Morphotype (**M. T.**)—A single specimen of the second form described of a dimorphic sex.
6. Lectotype (**L. T.**)—A cotype chosen after publication as holotype.
7. Chirotype (**X. T.**)—Specimen on which a manuscript name is based.

B. Supplementary Types.

1. Plesiotype (**P. t.**)—Material on which subsequent descriptions or figures are based (=apotype and hypotype).
2. Neotype (**N. t.**)—A specimen from the same locality as the original type described or figured when the original type is lost.
3. Heautotype (**H. t.**)—Specimen identified by the nomenclator or used by him for illustration, but not belonging to original series (=autotype).
4. Plastotype (p. t.)—Plastic reproductions from type specimens. These must be casts. Models not included.

The five prior names (1, 3, 4, 6, 7) for primary types are sufficiently simple and certainly not cumbersome for the systematist. Yet it appears to me that one condition quite as important as the holotype has been overlooked; also a second one, which, if not general, still applies to certain orders of insects.

The first of these is easily apparent, Very many descriptions are based on one sex alone; often several decades pass before the unknown sex is discovered and described. Since this description is of primary interest to taxonomists, the specimen on which this description is based in my estimation also merits a type name; and, what is more, should be classed among the primary types with the holotype. The second case is sex-dimorphism, common in a few orders of insects, rare in others, but still of such frequent occurrence that a type name for the dimorphic individual appears advisable. To designate these cases properly I have elsewhere (Bull. Milwaukee Museum, Vol. I, page 10, 1910) suggested the terms "allotype"—the other—for the unknown sex, and "morphotype"—form—for the dimorphic form of a sex.

Allotype designates the sex not represented by the holotype. The allotype need not be described by the protologist (first describer); it can be contained in the original as well as in any subsequent description by other authors. Thus, if the protolog describes only a holotype male, the first female subsequently described is to be called the allotype; and vice versa. Morphotype applies only to the second form of a dimorphic sex. Here also the date when and the author by whom described are immaterial. (As the first form of a dimorphic sex will be represented in the holotype or allotype, there may be some doubt as to the advisability of classing morphotypes among primary types. However, as both forms of a dimorphic sex are of equal importance to taxonomists I have placed morphotype in a position similar to the holotype and allotype.)

Thus far few others than cataloguers have made use of the type-terminology here outlined. In fact, most of the terms were originated by them, since the thorough acquaintance with their subject gained by the compilation of catalogues has made them more susceptible to the various needs of taxonomy. As all of these terms are broad and permit of great latitude in interpretation and application, the systematist ought not hesitate to apply them. Past laxity in the treatment of types, and also in their preservation, has resulted in infinite confusion and has helped to increase synonymy beyond all reasonable bounds, so that in some orders the synonyms average 1.5 to each valid species.

IV. Standards for Keys (Tables) of Genera and Species.

1. ♂ with appendage to hind tibia..2
   ♂ without appendage..4
2. ♀ with abdomen tufted..3
   ♀ with abdomen untufted..Kilimanjaro
3. Vein 6 usually curved in ♂, ♀ variable........................ Popocatepetl
   Vein 6 usually straight .... Aconcagua
4. ♀ with abdomen untufted..5
   ♀ with abdomen tufted ....Matterhorn
5. Vein 6 curved .... Elias
   Vein 6 curved at end in ♂.. Everest

I defy anybody to reduce a specimen to its proper genus with a key of the foregoing type. Unfortunately, only too many of that sort exist and new ones are continually fashioned.

A genus is the primary condition of taxonomy, and the use of secondary sexual characters for generic definition is an outrage; an offense, which should not be condoned. Some of the best taxonomists have placed their work in a questionable light by means of unsatisfactory tables like that given above. The only recourse in such cases is the original description, which is by no means such a simple proceeding as would appear on the face of it, as it often means a long, tedious search through many volumes.

One may call the aid of the extended generic description, but the purpose of the key is to summarize what differences exist between genera. Tables are meant to be short-cuts through taxonomy; but I might as well try to run an engine on a railway which has one track alternately on each side of the ties, as determine a specimen from many generic tables. The use of geographical names in the key above is pertinent. It is just as difficult to climb those mountains as to determine specimens from some keys. Tables of the style outlined cause loss of time, besides loss of temper. We are all human; and a scientist is not always the "dry, imperturbable fossil" the joke-antiquarians would have us believe.

Among species tables we see many of similar nature. Yet here vagueness is excusable, while for an unsatisfactory genus table no valid excuses can be made. If the relations between two genera become too intimate, if distinctions fail—then the genera merge.

Sexual characters are often the only ones that can be reliably applied in specific keys, and their use will be questioned by no one familiar with the difficulties of specific determination. Errors are possible everywhere, but they are offset by good work in other parts of the paper. Most often they result from a misconception of the specific value of certain characters. The aim, however, to compile a table of practical value will be easily apparent.

Many of the difficulties of specific keys could be obviated by more care in the explanation of the essential characters used, their individuality, their variation, and their relation to others. But is there an excuse for the use of such terms as "larger species," "smaller species," "more slender," "more robust," and the like, in tables without in any way defining the limits of the terms? It is with feelings diametrically opposed to pleasure that I plod through a table of, say, 25 species, along lines indicated by "larger species," and "smaller species." What does the author mean thereby, I wonder? At which size does he draw the line? My specimen is of moderate size and might be referred to either group. Therefore, is bulk the author's criterion? Or is length? Or width? Or odor?

There are plenty of good, workable tables that will serve as models. An ideal table that would permit of "hard and fast" lines of division for species is, of course, impossible. But much could be done toward improvement by the elimination of indefinite terms from specific tables and sexual characters from generic tables.

V. Standards for Indices.

Indices are the bane of scientific works. While their purpose is to facilitate reference to, and study of the contents of a volume, it is rarely, indeed, that they achieve their purpose, because of their general insufficiency. Beginning with ordinary check-lists, bibliographies, travels, monographs, etc, taxonomic works are most often poorly equipped as regards indices.

It is impossible for any man to know all the species and genera of the average order. It is a fact, however, that just those publications which are greatest in volume and importance (taxonomical, ethological and otherwise) are the most poorly indexed. Some authors cite only genera in the index. Others feel that such method is insufficient and append the names of the species under the genera. While that is an improvement, it offers little aid to the student not familiar with the particular order.

In this age of books, when it is possible to distinguish genera, species, synonyms, etc., each by various styles, sizes and impressions of types, the antiquated system of indices, as above referred to, seems inconceivable. The trouble lies—so it seems to me—in the fact that authors seem to confound the index with a table of contents.

To quote, "an index is a pilot through strange seas of thought. A book without an index is like a ship without a rudder." Continuing the simile—a book of entomology with generic index only is like an ocean-steamer with a canoe-rudder; and an index with the species names under the genera is like a ship with the rudder at its side.

I need hardly assert that it is those books which are freely and carefully indexed that are most referred to. I feel much as the gentleman who said to me: "A scientific writer who does not care to make a complete and usable index to his works, should be prevented from writing at all! At the bottom of every insufficient index is not carelessness, but downright laziness!"

To set the standard for indices is not very difficult; but the standard varies with the contents of books and papers. Here is the criterion: Since the aim of an index is to make the contents of a volume accessible to the reader, it should be so constructed that it will permit access to the greatest possible number of references in the least possible time. In other words an index is a medium of saving time. Hence an index should not be merely a carelessly jumbled summary of the contents, but a carefully arranged alphabetic list of all names, facts and captions in the volume. This includes technical as well as popular names, generic as well as specific names.

There is such a thing as over-indexing. The author must use his judgment as to the amount of detail he desires to index. Also, unnecessary repetition should be avoided. One fact, however, is patent; that if the author wishes to see his work considered at all as a work of reference, he must supply it with a good index. I, for one, do not care to use poorly indexed books, and consult such as rarely as possible. To say the truth, I consider it a personal affront, when upon purchasing a book, I find myself maltreated to several hundred pages of facts and names, and a two-page index. The author has no cause to treat his readers as if their brains were ware-houses; that they need but read his book and file away the contents together with the exact page number, etc., for future reference. By purchasing and reading a book I am doing the author a twofold service. And if I remember some of the statements and quote the book as an authority, the acme of the author's expectations is then reached. More he has no right to demand. But a starved index is inimical to progress, since few men will care to quote when they are unable to find the passages from an insufficient index.

When is an index desirable? One friend has stated this succinctly: "Any taxonomic paper citing more than fifty names should have an index of its own." This seems reasonable to me. An index of fifty names, run in two columns, eight point on a ten point base, would occupy less than the ordinary four by seven page of our journals. Because of the practice of societies and institutions to send reprints to an author for private distribution, this special index seems more than justified; unless the author expects his associates to supply the index privately. But this is expecting too much. Take, for instance, some of our well-known entomologists, who receive hundreds of reprints in a year, among them contributions exceeding 100 pages. It is astonishing, how few of these larger papers are supplied with an index at all; at that, the indices are mostly of the Spartan type. Should these men undertake the necessary clerical work and compile the missing indices? True, many of these men keep card-indices of their specialties. But what of workers on more than one branch of entomology, or zoology? To keep card-catalogues—hence general indices— of their widely distributed interests would necessitate the employment of a clerk throughout the year.

I close with the classic from Pope, "He who knows how to prepare a good index, holds the eel of science by the tail."

VI. Standards for Titles.

In logical order the title should have been treated first. But since the title is usually the last thing written by an author for his contribution, so let its place be among the last in the order of standards.

Take any entomological journal in hand and glance over the titles of papers. Many of these will sound much like the following examples: "A Revision of the Genus Popocatepetl; Some New Species of Orizaba; A New Aconcagua; A New Variation and the Life History of Kilimanjaro alta; etc." Occasionally one meets a title like the following: "A New Genus and Species of the Family Sierra"; and indeed a rarity is "New Species of the Order Andes."

In North America alone there are about 70,000 described species of insects, distributed in approximately 8,000 genera (probably more). Nevertheless, everyone is, as a matter of course, expected to know immediately from the lucid "Genus Popocatepetl" just where the genus belongs, to what family, to which order. Everyone is expected to be familiar with all of the 8,000 genera and to have no difficulty at all in placing the genus revised or enlarged, as indicated by the title. And even considering that there are about 500,000 specific and 80,000 generic names in zoology, "Popocatepetl" is too important not to be as well known as "pater" and "mater."

Especially in taxonomic entomology the saying holds good: "Familiarity breeds contempt"—for others. Some taxonomists appear to become so obsessed with their particular specialty that other orders or families of insects do not exist for them. There are 18 other orders after Comstock, 30 others after Handlirsch (restricted to *Pterygogenea*—winged insects); yet these are of little importance beyond the fact that they exist and that some foolish people bother about them. So taxonomists of a certain type would have us believe. We are lucky, indeed, if with indignant compassion they will cite the family in which the order occurs; indignant, because "those barbarians" do not happen to take any special interest in their particular branch.

Let us go a step farther. There are eighty-two families in the order *Coleoptera*, sixty-one in *Diptera*, about seventy-five in *Lepidoptera*, about seventy in *Hymenoptera*, not to speak of *Hemiptera*, *Neuroptera*, *Pseudoneuroptera*, and other orders. A conservative estimate would show over four hundred families of insects in North America alone, distributed in nineteen (Comstock) or thirty-one (Handlirsch) orders. Most of these families average three to four subfamilies to each family, and two tribes to each subfamily. Figuring on this basis there are 1200 subfamilies and 2400 tribes of insects. And this for North American insects only! What of the orders, the families, the subfamilies, the tribes, the genera, of fishes, of mollusks, of birds, of mammals, of crustaceans, etc. in North America? What of their number in the entire world? Not all our articles are confined to a single fauna. The Central and South American faunas are beginning to be explored more thoroughly, as shown by the ever increasing number of articles upon the regions named.

And yet, on an average but six out of twenty titles cite the family, and but one of twenty the order. Of course, the fact that the journal is specially devoted to entomology, gives me a clue to the position of the genus; accordingly I know that the paper is an entomological paper, but that is all. But what of journals dealing with natural history in general? How can I know from the title whether the genus belongs to botany or to zoology or paleonotology, whether it is a paper on insects or canaries, on mollusks or angle-worms?

An hour spent in a scientific library in the classification of articles would be an educative influence for all those who neglect the mention of family and order in their articles, The difficulties they would meet—such as antiquated catalogues, under-indexed catalogues, or, as in some cases, the entire lack of catalogues—would forever cure them of this apparently trifling but nevertheless momentous negligence. Even when there are good catalogues at hand, it is a complex proposition to place a genus. For the terminology of some orders, such as *Diptera*, and *Hymenoptera*, *Coleoptera and Hemiptera*, etc., is, in part, alike; the necessary consultation of both text and catalogue in such cases causes an irksome and avoidable loss of time.

The solution of all troubles is so simple, so obvious—in fact, it is inherent in the subject—that it seems strange why taxonomists have not adopted the simple means. But one entomologist is known to me who in all of his papers inserts the order name in his titles. That is the solution: Insert the order of the insect, bird, mammal, or whatever-it-be behind the genus and family name in the title. This holds good also for morphological, ethological and other papers as well as for those dealing solely with taxonomy.

VII. Standards for Reprints.

This chapter does not properly belong in this consideration. But since reprints form an important part of the specialists' literature, a few words on the topic may be of interest.

Sometimes I receive reprints of articles published by "Enigma" University; that is a tangible fact. The paging of the reprint is the same as originally published; that is another tangible fact. But I look in vain from page to page in the endeavor to discover the number or year of the volume, the month of publication, etc. That editor who arranged the reprint of an article sent me, published in nineteen-something on pages 260–290 of a certain periodical, yet paged the separate 1–30; and carefully effaced all reference to the name of the publication, the year or number of the volume, the year and month of publication;—that editor, I say, deserves no honorary mention. After guessing at the probable publications in which the article might have appeared, I looked over the recent volumes of many and ultimately succeeded in finding the exact place, page and time of publication. I owe that editor thanks, since through him I was led to other articles of high interest; but I spent an entire evening in trying to find out "What's which" in the reprint. To be fully consistent, the editor should have effaced the title of the article itself.

To be sure, this was an extreme case. Yet that in these "enlightened" days, after years of discussions, protests and recommendations, there should be men who retain the benighted idea that it is preferable to change the paging of reprints from the original—this seems hardly conceivable. Why the change at all? No advantage is gained thereby. On the contrary, it is a disadvantage for workers who are not constantly in touch with all the leading centers of scientific work and who have no large scientific library at their elbows. For these it results in tedious correspondence, and this most often when there is little time to be spared for these irksome labors.

One lucid individual went to another extreme. The travels of a certain explorer, together with the scientific results of his collections, as monographed by various specialists, were published in a large scientific journal. As all of these contributions were finally to be collected in a separate volume, and as the paging of this volume would be just as important for reference as that of the journal, the editor thought of a "happy" solution of all difficulties. Namely, the original paging of the contribution as it appeared in the journal was retained for the reprint; the future paging of the volume was also put in; and to meet all contingencies the reprint was given a special paging of 1—50 or other. Unfortunately, this genius forgot to note which was which, so that, as the printer's folio number and the publisher's file number are at the bottom of each page besides the three numbers above, I now have my choice between five numbers for page reference.

As a rule reprints do not suffer from surplus information as in the preceding case; they usually lack part of the necessary information. This lack in most cases is the absence of the volume number (or the year of the volume) from the reprint, or the year of publication, or both. Sometimes the two are given, but the name of the publication is nowhere indicated. The benign opinion that every scientific worker is familiar with the size of the volumes, the style of composition and the issues of "the four-hundred" leading scientific publications,—this opinion is, of course, founded on long experience and hence must be considered sound. If I receive a reprint that contains the year and number of the volume, but not the title of the publication itself, it is, therefore, a simple proposition to locate the correct journal from the size of the page and the style of composition, as there are only about three hundred others among the "four hundred" that resemble it.

Often the title of the journal is present and the number of the volume given, but not the year of the volume. The latter is omitted because it is a matter of common knowledge that the institution or society began its journal way back in the forties and that a new series is begun with each score of years; so that the tale, "Reprinted from the Enigmatical Journal, Series 4, Volume 17" will tell me all that is necessary to be told. From the number of the volume I ought to infer the year of the volume and if I am too much of an "ignoramus" as not to know such a monumental fact as the year a certain society or institution was founded,—well, then "look it up!"

Similarly, if I read 1906 on a reprint just received, I am to know intuitively that that means the year of the volume, not the year of publication; that the contribution had been in the hands of the editor since 1905, but owing to the press of legislative matters on the state printer could not be published until 1910.

It appears ridiculous that a matter intrinsically so simple, and extrinsically of such vital importance as the correct marking of reprints should be so carelessly treated. Or is there really a living editor who would consider the puny additional (?) expense of the line on the reprint giving all the needed information? Penny wise, pound foolish. Can a simpler solution be found than "Reprinted from the Ecstatic Journal, Series 6, Volume 14, pages 28–67, 1910 (Publ. May, 1910)"?

Conclusion.

The scope of matters that are left to our imagination, divinition and intuition by scientific papers is monumental. A catalogue of merchandise that does not describe the ware and state its prices would be flung aside instantly. Yet for science anything, no matter how poorly constructed, how poorly presented, should be acceptable. Science should lead the world. But if science in general cannot apply more logic to its methods than taxonomists apply to taxonomy, its leadership will be short-lived. This may be a harsh and pessimistic view; but I believe that I do not stand alone in this attitude.

Again referring to the merchandise simile—imagine to yourself a catalogue of merchandise, say furniture, that would not bear the proper legend on the cover; further, that the pages contained nothing else but names of furniture—no illustrations of the same, no measurements, no prices quoted;—imagine the action of the man receiving it! Certainly no other place than the paper-basket would be accorded it. And certainly many of the articles of our journals are little better as far as usable information is concerned than the furniture catalogue just referred to. Is it with reverence that we remember such names as Smith and Walker of British Museum fame? And yet some systematists appear to have chosen them as patrons and models for imitation. They succeed only too well in imitating them, and occasionally outdistance them.

One may say, these are all minor matters. That is true. But their aggregate forms an imposing array. One drop in a cup will not make it acrid; but a number of drops will change it into a cup of bitterness. So with entomology. One little carelessness does not amount to much; but many will fill even the most ardent student with feeling akin to disgust.

Science is no longer in its infancy and we have a right to demand advanced methods of work. The desire for improvement is innate to all men. I have never heard of a writer (at least in science) who was well satisfied with what he had written. Literary critics say, "An author is his favorite reader"; but self-satisfaction is short-lived, more so in science than elsewhere. Hence the attitude of scientific workers toward their work may be defined as "a minimum of self-conceit with a maximum of scruples." Writers do not confess these qualms of the intellectual conscience to the public, but reserve them for some private interchange of confidences. Unfortunately, the ratio of these qualms decreases, not inversely, but in the same ratio that the system and methodical effort of the worker decreases; so that the most conscientious workers are usually most diffident as regards their own work (all the more, as those contributions requiring the greatest amount of labor and time generally show the least for it), while the careless workers have few misgivings of their efforts. I have an inkling that some day to come a contribution will have to be passed upon by a commission of scientists (like so many examination papers) before they are declared acceptable to science.

Cooperation and centralization (to a certain extent) are desirable. There ought, in fact, to be a scientific clearing house somewhere in this beautiful world, and I hope that it will be achieved some day.

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THE STRUCTURE OF THE CENTRAL NERVOUS SYSTEM OF CORYDALIS LARVA.

By William A. Hilton.

Concerning the insects, many extensive works have been published upon the nervous system from early times down to quite recently. The work of Dujardin, '50, may be said to be a starting point. Numerous papers by Villanes from '87 to '93 give general accounts of the structure, but nothing very definite as to the distribution of individual nerve termination and origin within the ganglia. The extensive work by Saint-Remy, '90, is also a somewhat fragmentary account of numerous forms of tracheate head ganglia. Other earlier papers dealing with cephalic ganglia in particular are those of Newton, '79, and Packard, '80, and in more recent times we have the valuable works of Kenyon, '96, and Haller, '04. In connection with the structure and relationships of abdominal ganglia, the investigations of Binet, '94, and Benedicenti, '95, should be mentioned; and for a summary of the form and structure of the insect nervous system, the general work of Berlese, '97, is invaluable.

Although there are numerous and extensive papers dealing with the structure of insects, very few give a very complete account of the whole nervous system of a single species and practically no single work treats of the larval centers in much detail, although numerous papers take up the development and some as Bauer, '04, consider the transformations of larval into the adult conditions.

The external anatomy and general distribution of ganglia and nerves of Corydalis have been studied by Krauss, '84, and by Hammar, '08. The relations of the trachea to the nervous system and their distribution within it by Hilton, '09. The present paper is a continuation of the study of the nervous system in the larval form and, although not as complete as might be wished, it is at least a start in the direction of a clearer comprehension of the insect central nervous system, undertaken for the purpose of preparing for a study of the finer structure of the nerve cells, and for experiments upon their metabolism and function.

The methods employed were various. For obtaining the best idea of the general distribution of nerve cells and fibers, and the tracts of which they are parts, intra vitam methylene blue injections were used. Beautiful results were obtained at times, but it was only after hundreds of specimens were gone over that much was learned as to the organization of the ganglia. Sectioning methods with the usual fixers and stains gave fair results and the methods of Golgi and Cajal were tried, also those of Villanes and Kenyon. All of these gave good preparations except the Golgi method which I hope to try again at another time. There were difficulties in the way of fixing and staining because the ganglia are inclosed in chitin and because of the numerous tracheal vessels, and in the larger ones it was not possible to get perfect whole mounts. Sketches were made from the methylene blue preparations both before and after fixation and in the first stages of the work peripheral nerves were traced by means of gross dissections.

ABDOMINAL GANGLIA.

The abdominal ganglia, eight in number are quite uniform in appearance and general structure with the exception of the eighth or most caudal. The first abdominal is separated by only short connectives from the third thoracic, and the seventh is even closer to the eighth. The seven first abdominal ganglia have quite uniformly on each side, two large nerve trunks connected with them, a cephalic lateral and a ventral more caudal branch. The eighth ganglion has four pairs of branches leading into it from the caudal end of the animal.

Specimens were injected with methylene blue and nerves traced to the periphery and from here followed into the ganglia as nerve tracts as far as possible. In an earlier study on the nervous system of larval insects I found that in some cases some of the more cephalic branches connected with the ganglia were in large part if not totally sensory, that is arising from bipolar nerve cells and nerve plexuses, from tactile hairs and from the surface of the hypodermis. In Corydalis at various times during several years I have tried to determine the motor and sensory parts of each peripheral trunk for the purpose of following them into the central nervous system. To some degree methylene blue stain is of a differential value in determining the nature of nerve trunks, for very often the first neurons to take the stain are sensory, while motor fibers and cells are often slower to turn blue. But this method is not absolutely sure, for there is great variability in the staining reactions of different individuals. The only sure way of telling whether a given branch is motor or sensory is by tracing the nerves to their endings in muscle fibers or from their origin in bipolar sense cells at the periphery. The tracing of a motor or a sensory nerve or tract is not possible in a large number of cases because the stain is incomplete or too dense, but occasional selectively stained preparations enable one to make positive if not complete statements in regard to nerve trunks; that is to say, one can determine surely from a specimen that a large number of branches of a certain nerve are all motor or all sensory, but it would be impossible to say with *perfect* assurance that the nerve was pure motor or pure sensory because some fine terminations might remain uncolored, especially in the case of a stain which was good for sensory terminations, for there would be a strong probability that some at least of the fine motor ends would not show.

The work of Hammar, '08, on the nervous system of Corydalis has been very helpful, and the general description of the nervous system given by him is so complete that I shall not need to spend time on the gross anatomy of the various ganglia, and in speaking of the several branches of the ganglia I shall follow his terminology.

There are three chief branches breaking from the *Lateral* trunk of each of the first seven abdominal ganglia, their method of branching from this trunk and from each other is somewhat variable, but these three main parts are easily recognized. Branch 2 is large and comes off quite near the base of the lateral trunk, runs caudally a short distance and then disappears between muscle fibers in a ventral direction. I could not determine it to be anything but a motor branch although some of the fibers from it are among the first to stain and some of them pass not into the ganglion connected with the nerve trunk, but run directly up to the next ganglion by the way of the connectives, in a tract which from its other connections in other species and in this form, and from its staining reactions, I took to be sensory. Branch 3 is long, it runs up to the dorsal side of the animal and is without doubt mixed motor and sensory, containing fibers which supply dorsal muscles and fibers which come from the hypodermis. Branch 4 runs into the lateral appendage and seems to be sensory, for the most part at least. Besides these, there are two minute branches, 1 and 5, running out to the trachea, according to Hammar, '08.

The ventral trunk runs caudally and ventrally, branches 1, 2 and 3 run to more and more caudal portions of the ventral side of the animal and seem to be entirely sensory, branch 3 runs to some extent also into the lateral appendage, while branch 4 runs into the tracheal gill and was the only one traced into it. So this whole ventral trunk seems to be for the most part sensory.

The eighth abdominal ganglion seems to be made up of at least two centers fused, there are four main trunks entering it on each side below and all of these so far as could be determined are both motor and sensory. Trunk (a) is most lateral, (b) a ventral trunk corresponding to the ventral one of other abdominal ganglia, (d) a more median one supplying lower dorsal and ventral portions of the body and (c) median, with a large branch which runs back up the intestine.

NERVE CELLS.

(Fig. 5.)

The nerve cells of the periphery have already been figured in an earlier article, Hilton '02. The functional cells of the ganglia both thoracic and abdominal appear to be much of the same type in methylene blue preparations, uni- or bipolar nerve cells, one of the processes or branches of which may run out quite a long distance before they break up into a number of terminations, the other portion usually breaks up into branches near the cell body. Indications of multipolar cells were seen in some specimens but with these usually all of the processes but one were very small and hard to trace very far. In addition to the functional neurones of both large and small size, there were in all of the ganglia, numerous neuroblasts, or smaller cells with slight protoplasm about the nucleus, and neuroglia networks.

NERVE TRACTS IN ABDOMINAL GANGLIA.

(Figs. 1 and 2.)

By means of methylene blue preparations it was possible in some more deeply stained specimens to trace the main tracts of fibers within the ganglia and within the connectives and in lighter stained specimens the distribution of special tracts and even individual fibers. At times the cells stained as well as the fibers at other times only fibers were colored.

Fig. 1.

Fig. 2.

Fig. 1. Figure of the 7th and 8th abdominal ganglia from methylene blue preparation. Dorsal side. A few nerve cells are shown in black. The chief nerve trunks show with their fibers. The central "Punktsubstanz" of the ganglia dotted. Some of the larger tracheal tubes shown as thick solid black lines.

The caudal end is down in this and the following figures. x30.

Fig. 2. Sixth abdominal ganglion from ventral side. Methylene blue. x30.

Stained or unstained, the central region of each ganglion is more opaque or darker, due to the nerve fibers crossing and terminating in this region. This forms on each side a central body made up of two oval masses more or less fused into one at the middle line, the "Punktsubstanz" of some authors. The nerve fibers of the connectives when stained in a mass form deep lines apparently running straight through the center of the ganglia, these longitudinal bundles of nerve fibers seem to be a little broader before entering and after leaving the central mass. The nerve trunks in deeply stained specimens send masses of fibers into the ganglia and in the case of most of the fibers, the region where they seem to terminate is in the central part of each ganglion. This is true of all the ventral fibers and of most of those from the lateral trunk, but a few of the latter, and some fibers from the second branch of the lateral, run up into the edge of the ganglion only, and then straight up the connective to the next ganglion above. In the case of the eighth adbominal the four nerve trunks enter the fibrous central mass from below, those most medially placed seem to be continued up through to the connectives and to be largely continuous with them in deeply stained specimens, while the more lateral trunks are lost sight of as they enter the central portion of the ganglion, although *some* of the fibers from the more laterally placed nerve trunks pass through the edge of the ganglion without communication with its cells and pass up the outer side of the connectives on either side to the next ganglion above. There are then two masses of fibers entering each center but the last, those of the connectives and those of the nerve trunks. I will first take up those of the connectives.

Beginning with the seventh abdominal ganglion great masses of fibers enter, and it is possible to distinguish; (a) Fibers which run straight through without terminating. There seem to be great numbers of these, but this is due *in part* to the fact that when fibers *do* terminate in a ganglion they end at various levels. These fibers can however individually in a number of cases be traced through a ganglion without endings of any sort within it, just how far some of these may run without termination is a question, but there was no difficulty in tracing them through three ganglia and there is no reason to doubt that they may be longer than this. Those most easily followed were usually of larger size than the rest. (b) Fibers from below, terminating within the ganglion. Of these there are several sorts: (1) Those ending in the lower part of the "punktsubstanz" on the same side. (2) Those ending on the same side above. (3) Those crossing over towards the opposite side from below. (4) Those crossing over to the opposite side above.

In those entering from below some run straight in and end in the caudal region of the central fibrous mass, while in many specimens fibers from the outer side of the connectives sweep sharply in towards the center of the lower part of the ganglion to end near the middle line, either on the same side or just over it. (c) Fibers from above. In general there are similar bundles of fibers to those traced from below: (1) Those ending in the lower part of the ganglion on the same side. (2) Those ending on the same side but in the cephalic portion of the ganglion. (3) Those crossing to end in the lower part. (4) Those crossing to end in the upper part.

In the case of fibers ending in the ganglion from the cephalic direction, none were seen forming such a dense sweep into each center from the sides of the connectives, although there were a few fine ones of this sort. Most of the fibers leave the "punktsubstanz" to run in the connectives without great deviation from a straight course. (d) Fibers passing into the connectives from cells within the ganglion. There may be distinguished in many of the preparations cells with their fibers well stained, the more central of these may be more clearly seen in some cases. Some of the larger more central cells seem to be merely for association within the ganglion, with all of their processes ending within it. Others send one main process up one connective and another down into one of the other great masses of fibers. Other cells of medium or small size, located chiefly at the sides of the ganglion send one long process into one of the nerve trunks while the other shorter process may run for a short distance in the connective trunk or be lost in the central mass of the ganglion.

THE FIBERS OF NERVE TRUNKS.

These have already been spoken of to some degree. Most fibers of both cephalic and ventral nerves seem to enter the central part of the ganglion and are lost track of in the "Punktsubstanz," but both the lateral and ventral trunk-fibers are continued into the connectives in the cephalic direction at least, and possibly to some extent in the caudal, although this was not determined. In the case of the lateral trunks of all the abdominal ganglia, there is a possible sensory tract entering the cephalic edge of the nerve center without coming to the central "punktsubstanz" or having any communication with nerve fibers, running along the outer side of the connective and for the most part ending in the basal portion of the ganglion next above, near or across the middle line. A similar tract to this has been described coming from the two most lateral trunks in the last ganglion.

These fibers which enter from cephalic lateral trunks seem to stain among the first and in the case of some other insects were found to come from bipolar sensory cells at the periphery, and I still think that they are to some extent sensory, but these tracts which have no communication with the cells of the ganglia with which they are connected are not *all* of the sensory fibers of each nerve center, for the ventral branches have many sensory fibers and these do not follow exactly the same path, and in the case of the first seven abdominal ganglia many of the fibers could be traced from the branch 2, which so far as could be determined was a decidedly motor trunk.

Fibers other than those coming from cells on the opposite side to run into the branches as motor axones, are directly supplied by cells on the same side, long branches from certain cells run into the various motor trunks while the other terminations are in the "punktsubstanz."

Fibers from the periphery or from sensory cells enter the ganglion from both main trunks and are of the following groups: (a) Those ending within the ganglion to which the trunks are connected, the exact termination of these I could not make out, but some at least ended near the central part of the ganglion, although very often arborizations of the terminations could be traced both on the same side and on the opposite side. Fibers entering straight from below in the last abdominal broke up into branches near the middle line with arborizations in the central margin of the ganglion.

(b) Those passing from one ganglion to the next without sending branches to the center to which the nerve trunks are connected, some of these fibers may run past one or more ganglion, but the most of them form a definite tract from the periphery by way of lateral trunks, running on the outside of the connectives, and turning sharply in towards the middle line in the caudal portion of the central mass of fibers, to end here or a little higher up, or to cross over and end in the "punktsubstanz" of the opposite side not far from the middle line.

(c) Those passing from the periphery into the nerve trunks and having extensive arborizations in the ganglia to which they are connected and then passing on to another ganglion with arborizations in it. Only a few of such fibers were distinguished one in connection with the 8th ganglion was the clearest case. A nerve fiber from the periphery was easily traced into the 1st. lateral trunk, a branch from this fiber was given off in the cephalic and lateral region of the ganglion, this fiber could be traced into the "punktsubstanz" of the nerve center, some of its arborizations ending on the same side and one branch was traced to the cephalic region of the other side, while the main fibers passed up the connective and ended by arborizations in the "punktsubstanz" of the ganglion next above chiefly on the same side in the caudal region.

ABDOMINAL GANGLIA STUDIED IN SECTION.

Individual cells and fibers were not so easily traced by this method, but general masses of fibers and the location of cell groups were determined.

All of the ganglia, connectives and nerve trunks are inclosed in a chitinous envelope which in many cases is very close to the nervous tissue but usually separated by neuroglia cells. This envelope is especially thick about the connectives just before and just after they enter a ganglion, it appears as a uniform mass in section with large and smaller openings where trachea penetrate it.

In places under the chitin of the ganglia, especially on the dorsal side, there are large spaces with little or nothing in them but delicate neuroglia networks. The trachea radiating in the chitin covering the connectives and ganglia have already been referred to; as stated in a previous paper large branches and fine tracheoles run to the nervous system and are distributed to all centers and their branches. These are superficial or run in the chitinous sheath, and the deep, supplied in part by the superficial twigs but chiefly by larger special branches and enter the ganglion and connectives. In these connectives it is easy to see numerous openings, large and minute between the masses of nerve fibers, and in cross section the air tubes are shown to be fully as numerous as one would expect from a study of surface views where all the trachea were made to show. Tracheal tubes within the ganglia are particularly noticeable in the centers of bundles of fibers and most easily seen in these traced from the connectives. The exact place and method of termination was not determined. Injections of fluids into the ganglia by way of trachea failed to penetrate any of the finer branches.

All of the abdominal ganglia seem to be of practically the same type, but individual variations occur.

In all of the nerve centers the cells are grouped for the most part on ventral and lateral portions of the ganglion and towards the caudal end, a few cells occur on the dorsal side especially near the middle line and these are often quite large.

Description of 4th abdominal ganglion traced by sections beginning at the caudal end:

The connectives entering from the ventral side are easily followed as distinct longitudinal masses of fibers well up into the ganglion, these connectives as well as others in other parts of the nervous system are composed of numerous closely packed longitudinal fibers, scattered between these are the openings of trachea, when the ganglion is reached the chitin for each of the connectives becomes fused into one mass and farther in the central portion of chitin between them disappears and the two bundles of fibers are more or less crowded against each other. Farther up into the ganglion the fiber bundles do not occupy all of the area under the chitin because large spaces on all sides occur and then soon cells in a single layer are found close to the wall of the ventral side, and then on the dorsal side a very large cell is found wedged in between the two bundles of fibers. Some of the cells of the ventral side may be seen at this level sending fibers into the two longitudinal bundles. The single layer of cells on the ventral side becomes a double row of medium and small, and the large cell of the dorsal side gives way to a group of small ones and there comes to be on the ventral side two groups of fibers running more transversely, probably made up in part from fibers connected with the cells appearing on the ventral side.

Farther up these ventral nerve cells extend out laterally so that numbers of them might be seen from the dorsal side. No cells are left for a distance on the mid-ventral line, and they disappear from the mid-dorsal line also to some extent, but before they are gone fibers can be traced about the connective bundles and to the cell region of the ventral side. At this level there are nerve fibers seen between the cells on the ventro-lateral margins of the ganglion and fibers connected with these regions of the nerve center join the bundle from the cells on the dorsal side, on the ventral median side of the ganglion, while a third runs in from these cells into the central part of the longitudinal fibers. We have then at this level three transverse bundles of fibers crossing from the lateral cell groups, a dorsal, a ventral and median and a little farther along we have also a bundle of fibers running across the section but from the dorsal to the ventral side and uniting to some degree with the three right and left commissures. Other little branches from these main ones and other tracts from the lateral cell groups also invade the longitudinal bands from the connectives.

A little above this level again on the ventral side a single layer of cells appears in the middle line and no cells are seen on the dorsal side except laterally.

A little above this, the large ventral trachea enter passing through the cell layer and breaking up into numerous branches. The central fibrous mass of the ganglion is largely made up of longitudinal strands in all levels so far and besides the commissures mentioned there are usually a number of fibers crossing irregularly both dorso-ventrally, laterally and obliquely especially at about this last level. None of them are large and the great mass of fibers remains longitudinal. It is at about this level that the ventral nerve trunks come off from the lateral and ventral sides of the ganglion from the central part of the latero-ventral cell mass, just before the tracheal trunks are reached. Fibers from this trunk may mingle with the cells of this region and are also continued into the central mass of fibers of the ganglion.

Beyond this point the cells become thin again especially ventrally and also laterally, the central thickest part of the ganglion is now reached and the fibers form a rather large dense mass. Longitudinal ones may still be seen mixed in with numerous lateral and transverse strands all bound up together into a dense fibrous mass with no very marked special tracts or strands except for quite a well marked short broad median commissure of fibers connecting more intimately the two already well fused masses of each lateral half of "punktsubstanz."

Slightly beyond this, the cells have about disappeared, only a few remaining at the dorso-lateral edges of the ganglion.

Beyond this something of the central commissure remains, many of the other crossed fibers in the central part of the ganglion have disappeared. A bundle of fibers partly transverse and partly fused with the central longitudinal bands begins to be seen on either side of the ganglion ventrally, these are partly mixed with the main longitudinal tracts. They are endings of the bundles of the lateral nerves to be followed later and might be called lateral nerve tracts. At this level a few scattering cells on the ventral side and two small dorso-lateral groups, one on each side of the ganglion indicate about all of the cell masses seen lower down, while in the mid-dorsal line a new group of dorsal cells makes its appearance and sends fibers *through* the central part of the ganglion as a central tract which breaks up laterally and can be traced to various parts of the central fiber mass of the ganglion. For several sections these fibers become quite prominent and the central commissure seems to be lacking, then as this central tract disappears higher up, another and a better marked commissure comes to view running transversely through the center of the ganglion from side to side. At this level cells again come into view laterally. The ventral tracts of the lateral nerves become more prominent and there is a dorsal band of fibers close to the edge of the "punktsubstanz" on the dorsal side. This last is parallel with the median.

Slightly beyond this a few cells are seen on the ventral side laterally, two of the same commissures, a dorsal and a median may be seen, but the lateral cells have disappeared to give place to the entrance of the fibers of the large lateral nerves. These fibers for the most part run directly into the lateral nerve tract noted above when it was seen more caudally. Beyond this and beyond the entrance of the lateral nerve, a few cells are seen laterally, one or so in the mid-dorsal line, and the dorsal and median connectives disappear and only a few tangled fibers replace them, although for a few sections the great sweep of transverse fibers is continued from side to side, from the lateral nerve tract.

Above this no commissure or cross fiber of any sort connects the lateral halves of the ganglion and a small group of nerve cells comes to lie on the middle line and dorsal and ventral to it. At the line of separation of the lateral halves, the tracts of the lateral nerves can be distinguished as a dense mass on either side of the longitudinal fibers which are continued out into the connectives.

Above this as the cells disappear and we come clearly into the region where there are only longitudinal tracts, these may be followed and they are indistinguishable from other fibers of the connectives. The reason why the lateral tracts could be told from the longitudinal for such a distance was because they seemed denser and stained more deeply. The fibers in the cephalic connectives have about the same arrangement as the caudal ones.

In other abdominal ganglia, ventral and lateral groups of nerve cells were more clearly seen contributing to the commissures and the central tracts. Some of the fibers of the lateral trunks end in the central portion of the ganglion, probably in cells.

The tract of the lateral trunk needs a word of additional comment. In preparations made by a method that removes the cells and all but the denser fibers so that little more than a skeleton of the fibrous framework is left, it is found that a transverse portion connecting the two sides of the ganglion is *much* denser than other parts of the fibrous mass and under the highest powers of the microscope, this seems to be very finely granular as well as fibrous and is continuous from side to side between the nerve trunks. This same fine granular substance with fibrils in it was traced up into the connectives a short distance, and as many fibers are seen to end in this region it may be due to a dense grouping of their endings that there is a deeper color at such a place. Similar substances to this only in more isolated portions is found in other parts of the ganglion and in other nerve centers. In specimens stained with ordinary hematoxylin there is no differentiation between this substance and the general fibrillar mass.

The eighth abdominal ganglion is similar to the others except that the connective fibers begin *within* the ganglion and there are more commissures developed. The first lateral branch can be easily traced out into the connective on the outside, fibers also deeper in go on up the connective, while still others enter the ganglion and are distributed to all parts of one side and probably also across to some extent, as there are numerous cross connections, by means of at least three of four well marked commissures, besides irregular fibers. Other branches also send fibers to the central mass, some of these run straight through, while others seem to cross in commissures or end.

In general then, there are in each abdominal ganglion, cells on the ventral caudal region, on the lateral sides, and a few on the median dorsal side. These cells surround a central fibrous mass made up of strands running longitudinally through the ganglion from the connectives and best marked in the cephalic and caudal parts; fibers running across from side to side, these run in about three commissures, a dorsal, a ventral and a median and at various cephalic and caudal levels these commissures are interrupted. The lateral nerve trunks may be seen to contribute largely to the formation of the large ventral commissure. The other cross connections seem to be more exclusively from cells on the sides of the ganglia and from these cells also other cross or diagonal fibers may be followed.

The dorsal group of cells which seems to be to a large degree for association, sends fibers through the ganglion to the cells of the lateral and ventral groups, so that these fiber tracts may be found above or below the commissures penetrating to the opposite side, or part way through when the median commissure is present.

THORACIC GANGLIA.

Methylene blue method. (Fig. 3).

The three thoracic ganglia are quite a little larger than the abdominal and the branches come off differently.

There are on each side three main trunks the most cephalic of these has its most cephalic branches pure sensory, but No. 2 was not determined, also No. 1 of trunk B or the middle trunk seems sensory while other branches of the middle trunk are more or less mixed and the last which goes into the leg is also mixed. So then the more cephalic nerves are sensory while the rest seem to be mixed. The exact nature of the two parts of the last or leg branch was not determined, but there was no reason from the staining reactions to indicate that they were of greatly different composition.

In the thoracic region as in the abdominal, the main trunks easily took up the stain, but here greater difficulty was encountered in surface studies because of the larger opaque mass of the ganglion. Cells and fibers were however made out and found to be in a general way similar to the conditions found more caudally. The main tracts of the connectives and of the nerve trunks enter the central portion of each center as in the abdominal region, but their distribution within was harder to make out. There were tracts entering the last thoracic ganglion from below, leaving it again as in the abdominal centers.

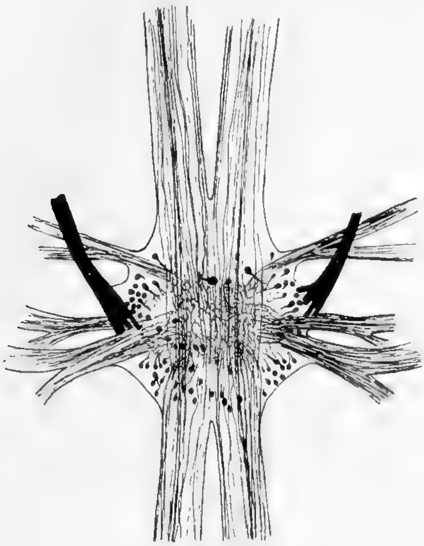

Fig. 3.

Fig. 4.

FIG. 3. Third thoracic ganglion from below. Methylene blue. x30.

FIG. 4. Connective branch leading off between the 2d and 3d thoracic ganglia, nerve fibers from above and below enter the nerve trunk from the connective. Also large and small nerve fibers shown. Methylene blue. x45.

Tracts from the first abdominal pass up the outside of the connective and cross over into the middle line, but from the third thoracic to the second, and from the connectives of the second to the first no such tract was clearly recognized. Fibers entering laterally both from motor and sensory nerves all pass in towards the central part of the ganglion. In other words there was no indication of a tract passing from cephalic branches into the edge of the ganglion to run without termination up the outside of the connective to the next center. But there was an indication of fibers passing through or into one ganglion from the one below it.

In the cephalic part of the thoracic ganglia fibers coming from above may some of them be traced as a fine tract ending in the cephalic portion of the ganglion. Other than these differences, there were no essential ones between these nerve centers and those of the abdominal region.

In regard to the arrangement of cells as shown by methylene blue, it was found that the lower ventral and lateral regions had the greatest number, great masses of them, with many more cells than in the smaller ganglia. For the most part similar arrangements of individual fibers were seen. Nerve cells sending fibers directly into motor trunks, cells of medium or rather small size, were observed, but these were few in number. Most of the cells seen had their processes running into the "punktsubstanz" of the ganglion. Large and smaller association cells were found as in the lower regions and of various sorts such as already described for them, some at the surface of the ganglion other at the edges of the "punktsubstanz."

Between the third and second and the second and first thoracic ganglion, there are branches off from the connectives, a pair between each of these, and between the subesophageal and the first thoracic there are two pairs. The upper of these last were not so well stained in any of the preparations but all of the others were quite well colored and found to be motor. These branches when studied as to their composition did not differ much from each other and in each one, fibers could be seen descending to run out the nerve trunk from the ganglion next above and also from the ganglion below. These two tracts of fibers entering the lateral trunks were clear and distinct from each other for quite a distance into the nerve trunk. (Fig. 4).

THORACIC GANGLION IN SECTION.

(Plate XV, Figs. 1–4.)

The internal structure of the thoracic ganglia is much more complicated than the abdominal, due to the fact that the larger branches from the more numerous nerve cells are more intimately woven together, and it was practically impossible to follow commissures or tracts very far except in a very general way. However, a general description as detailed as seems necessary will be given of one of the thoracic ganglia, the first.

From above the connectives which enter as in the abdominal ganglia are in every way similar. Not many cells are seen scattered in the upper part of the ganglion, then two large groups appear one on each side laterally and a small ventral group. (Fig. 1-3, Plate I). These masses at the sides of both large and small cells are at least three deep. The three groups a little farther along become united by a single row of cells which farther up becomes double layered and all the cell groups are not distinguishable in the single mass. There are also at about this level as a part of this mass a few cells in the mid-ventral line between the bundles of fibres of the connectives.

Farther up, the connective tracts are less clearly *all* longitudinal fibers and the lateral part of the nerve cell mass gives way for the entrance of the first or most cephalic of the three nerve trunks, the fibers of which pass into and mingle as transverse and dorso-ventral fibers in the connective tracts. The fibers of this nerve are very extensive and may be followed into the center of the ganglion, both dorsally and ventrally. Fibers from the ventral cells on either side of the ganglion enter the center of each lateral half from below and are there lost and partly pass into the nerve trunk. Fibers from the cells in the mid-ventral line, which cells form a wedge shaped mass at higher levels between the connective masses, run to the dorsal side of each of these masses of longitudinal fibers, and from here circle about to become associated with the fibers of the nerve trunks and with other more median strands on each side of the ganglion and with the strands described above which come from the ventral mass. Slightly beyond this part and nearer the center of the ganglion the two central masses of fibers or connective masses become fused together, the cells disappear and commissures, a dorsal, a ventral and a median, connect to some degree the sweeps of fibers already described. (Fig. 4, Plate XV, just above this level.)

Farther down, two commissures, a median and a dorsal are seen but numerous fibers cross the middle line at many levels and angles. Farther on but one commissure can be noted, a ventral, but many other fibers cross at different angles and the whole lateral portion of the ganglion is a dense system of complicated interlacing fibers having a dense meshwork. On the lateral part of each ventral half the fibers stain darker, probably due to more numerous fine branches in this region and on the dorsal median line a little wedge shaped group of cells makes its appearance, the only cells of this region. These send their fibers through the center of the ganglion to the ventral side, while a central commissure crosses these to end in the tangled mass of fibers on either side of the ganglion. Farther along, these dorso-ventral bands a little one side of the middle line do not cross the now larger central commissure, but run in to it as do the other fibers from the ventral side, running from the more deeply stained ventral mass already spoken of.

Farther along and at the level of the next nerve, three commissures, a ventral, a dorsal and a median may be again recognized while the fibers of the middle nerve both end in the lateral portions of the fibrous mass and contribute to the three commissures. In this level only a few scattering nerve cells were seen. Beyond this a ventral, almost a lateral group appears again on each side and fibers from these form a little arch about the now smaller mass of darker staining fibers. On the mid-dorsal line fibers from this arch and others from these cells also ramify into all parts of the ventral portion of the ganglion. Along from this the dorsal part comes to be separated into two separate masses of longitudinal fibers of the connectives again. Farther along the arch becomes in its dorsal portion fused into a median commissure which soon disappears as the cleft between the connectives becomes deeper and reaches way down to the now small area of deeply staining substance which now forms a ventral commissure. The ventral cell group has become more lateral at this level and another large group has come in just dorsal to it, but still only on the side. In the mid-ventral line also, there has come in a small new group of cells.

The last nerve trunk comes to be associated with this commissure of deeply staining fibers on the ventral side and farther along fibers also pass freely into it from the lateral group of cells which has been spoken of as coming in more dorsally, this for a time remains distinct from the other more ventral groups.

Along farther these cell groups unite to form a large thick single lateral mass and from them more fibers run into the commissure of deeply staining fibers and "Punktsubstanz."

Soon after this the commissure breaks through as the two connective bundles separate, each with a little of the darkened mass which soon disappears as do the cells of the ganglion.

Although the above description is only a very general one, it will be seen that the ganglion is more complicated than the abdominal, but the general plan of arrangement and structure is as in the abdominal region. The nerve cells as in the abdominal ganglia are chiefly grouped in the caudal, cephalic and ventral regions and may be seen to take direct part in the formation of commissures as well as diagonal strands. While dorsal cells on the median line and ventral median cells, send fibers through the ganglion dorso-ventrally, as well as association fibers to different tracts and lateral groups. In both thoracic and abdominal ganglia dark staining masses made up of very minute fibers fused together are chiefly found on the ventral side and associated with a ventral commissure.

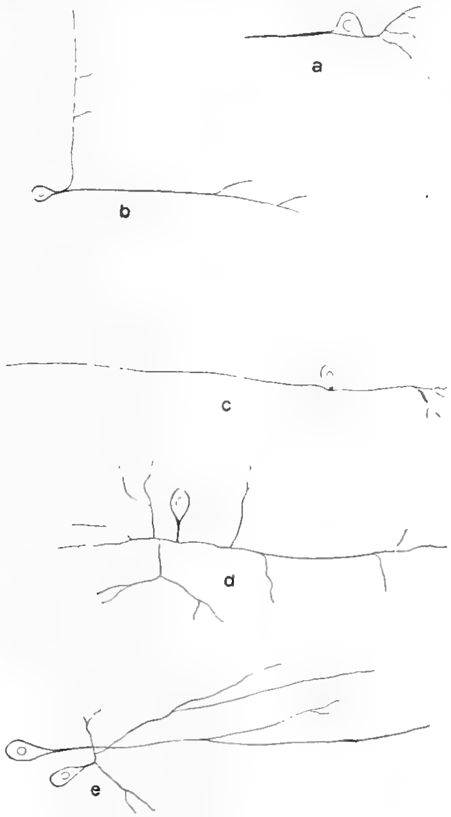

Fig. 5.

FIG. 5. Nerve cells from the central nervous system. (a) Motor nerve cell from the 3d thoracic ganglion. (b, c and d) Association cells from the same. (e) Cells from the brain. x100.

THE SUBESOPHAGEAL GANGLION.

(Figs. 6 and 7, Plate XVI, Fig. 5.)

This ganglion is larger than the others described, and is less flattened and less easy to study from the surface. The branches have already been traced quite well to the periphery and I will only mention them briefly.

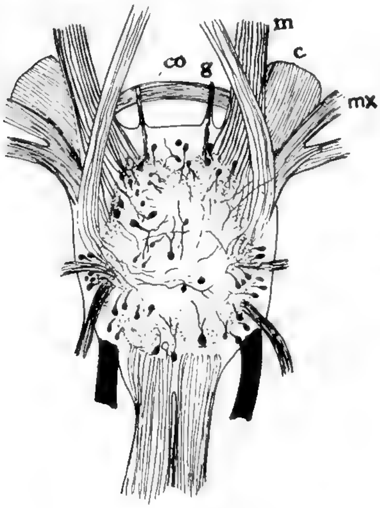

Fig. 6.

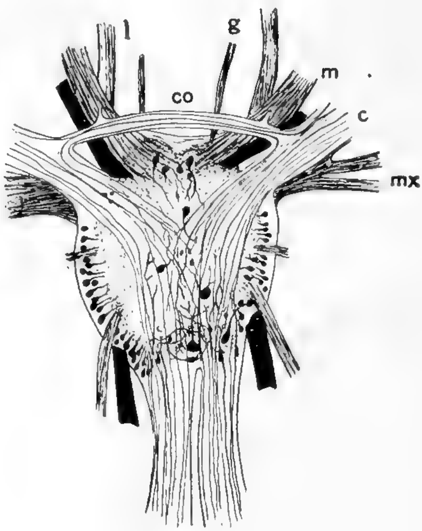

Fig. 7.

FIG. 6. Subesophageal ganglion from the ventral side. Methylene blue. x30.
c........connective with brain.
co.......commissure
mx......maxillary
m........mandibular
l. . ....labial
g ....gustatory

FIG. 7. Subesophageal from the dorsal side. x30.

The caudal portion of the ganglion becomes thick soon after the connectives have entered. The cephalic lateral portion of the ganglion is connected with the supraesophageal above by two large connectives, but smaller than those from the 1st thoracic ganglion. These cephalic connectives or crura cerebri are connected together a short distance away from the ganglion by a cross branch or commissure.

From the cephalic end there are three pairs of large nerve trunks, the *mandibular*, the *maxillary* and the *labial*. The mandibular is the largest the labial the smallest and most ventral. All appear to be mixed nerves, both sensory and motor.

Either side of the middle line on the cephalic border are two small nerves, the *gustatory*, which are motor in part at least. On either side of the ganglion not far from its central portion is a small *ventral* nerve and not far from the connectives near the entrance of the caudal tracheal tubes are the small *salivary* nerves. I know nothing of the composition of these two last pairs.

The dense central mass of the ganglion prevents one from tracing nerve fibers very deeply in surface preparations, but a few more fortunate specimens gave now and then a fiber or a tract which could be easily followed. In general with the nerve trunks and connectives of other ganglia, these bundles of fibers entered the central portions and like them, too, the nerve cells were chiefly grouped on the sides with scattering cells on the dorsal and a denser mass on the ventral and caudal portions, but in this the dorsal side has more cells than was usual with the other ganglia. The same arrangement of cells and fibers was noticed as in others, that is, most of the peripheral cells could be seen to send their processes into the central portion. Fibers from the connectives above and below could be traced through the ganglion, but there were such masses of them that it was difficult to tell whether they were branched or not.

Fibers from the lower connectives were seen to end in the caudal portion of the "punktsubstanz": (a) On the same side, (b) Crossing over the middle line. These were both superficial fibers and resembled those in the bases of the abdominal ganglia. Probably deeper fibers end higher up.

Fibers running *down* the upper connectives run: (a) Down the connective to end in the central portion of the ganglion; (b) Down the connective to end in the caudal region of the ganglion.

Probably among both of these groups of fibers there are some which cross over into the opposite side of the ganglion.

Fibers running down the connectives and crossing over to the opposite side through the commissure connecting the crura cerebri: (a) Cross over in the commissure to the opposite side and run down to end in the upper or lower portions of the ganglion.

Two other sorts may be given although no *complete* fibers were traced through such a course;

(b) It seems probable from the specimens that fibers cross to the opposite side in the commissure and run over to the opposite side of the ganglion:

(c) Probably some fibers cross in the commissure and run back to the brain.

Fibers running straight through the ganglion from above and from below were not traced but it is very possible that such are present as in other ganglia.

THE NERVE TRUNKS.

The mandibular branch sends its fibers into the cephalic dorsal border of the "punktsubstanz." Some of its fibers seem to end here, others pass in deeper.

The maxillary sends its fibers into the very center of the upper half of the ganglion and here some of them seem to end or cannot be traced farther in surface views. This is true of the more cephalic branch of the maxillary in part at least, while the rest of the fibers of this and those of the caudal branch are traced in laterally a little farther down.

The fibers of the labial nerve; some of them run in deeply about where the branch enters the ganglion, others go down farther and may be traced as far as the place where those of the ventral nerve trunk enter the mid-lateral portion of the central fibrous mass.

The salivary nerve fibers run in and can be traced to near the point where the ventral nerves were.

The small gustatory nerves run some distance down into the ganglion from the point where they take their exit and a motor nerve cell was found sending out its axon directly into this tract.

SUBESOPHAGEAL GANGLION STUDIED IN SECTION, BEGINNING AT THE CAUDAL END.

The connectives which run up to the subesophageal ganglion are much like the others described. As the caudal portion of the ganglion is reached these two longitudinal tracts of fibers become fused although they may be distinguished from each other. A group of nerve cells appears on the lateral sides, and a group of large ones on the median side dorsally, some of these penetrate in between the tracts and a few cells appear ventrally on the median line, while the cells become more numerous laterally. The salivary nerves enter latero-ventrally and unite with the mass of longitudinal fibers. The cells disappear dorsally, but some are between the mass of fibers of each connective and the lateral cell group has become more ventral. There is at this level a transverse commissure on the dorsal side and fibers running down ventrally in the ventral line. Farther along the fibers do not so many of them run from dorsal to the ventral side and a median commissure comes to be formed. More cells come in laterally and ventrally and these sending their fibers into the central mass contribute to its complexity. These cells also run into the large but ill-defined median commissure.

Two little spots of darker more dense fibers come in on the ventral side and fibers from the ventral cells form an arch about them.

Farther cephalad the median commissure becomes less well defined. The dorsal is lost and a median group of cells comes in dorsally again. Fibers from the ventral and dorsal cells, especially the former go in curved sweeps to the dorsal and ventral sides of the fiber mass, fibers also run in laterally from the lateral cell groups. Farther along no clear commissure can be seen, but sweeps of fibers cross from both sides, those of opposite sides interdigitating to some degree. The ventral darker mass of fibers mentioned a short time ago has now become a transverse mass and is larger, being joined by fibers from the labial and ventral nerves. At the level of this entrance only a few scattering groups of cells are seen.

The dark fiber mass becomes expanded to the center of the "Punktsubstanz."

The broad cerebral cruri are reached. From the central to the dorsal side laterally four small groups of nerve cells mostly small, with now and then a large one are seen. Fibers from the cerebral crus can be traced to the center of the fiber mass and into one or more of the several irregular masses of dark fibers. Dorsally and ventrally fibers cross from side to side and run diagonally from the dorsal to the ventral side. Farther along a ventral commissure of dark fibers is present, some of its strands reaching up into the dark fibers in the direction of the commissure and farther along breaking through it. A short distance cephalad of this point the ventral mass disappears and the lateral halves of the general mass of fibers becomes distinguishable once more as the upper region of the ganglion is reached. At this upper region, lateral cells are no longer seen, there is however, a small group ventrally placed, either side of the middle line and a small dorso-median mass. Fibers sent in from these curve up to run into the crus which may also at this level be seen to receive fibers from the middle and opposite parts of the ganglion by the way of a group of fibers just one side of the middle line and a group running from the center of the lateral central mass.

Just beyond this last level at the place where the maxillary branch enters, a little group of nerve cells comes in between it and the crus. Fibers from this large maxillary nerve run into the crus, into the central and ventral portion of the ganglion and apparently across to the other side, while many of its fibers are lost in the deeper staining central masses.

Farther along the ventral cells become much more abundant, a wedge shaped group 6–7 layers thick with a few large cells. A few cells come in on the mid-dorsal line and some come in latero-ventrally just above where the maxillary nerve joins the ganglion, and some of these cells seem to contribute directly to the nerve.

The large mandibular nerve joins the ganglion on its upper border, fibers come to it from ventral and dorsal sides of the ganglion and connections with the darker fiber masses in the center can be traced. Cells are now in masses both dorsally and ventrally as the cephalic end of the ganglion is approached and some of these at least seem to contribute directly to the nerve.

The above description is a very general one, only the main features of structure and arrangement were spoken of. The complexity of the ganglion is such that a general summary of it follows:

(a) *Cells*

The cells at various levels differ greatly. Beginning at the caudal end and passing forward there might be recognized about three main dorsal cell groups one after another which fuse and separate from each other at various levels. The median ventral cells are at first also separated from the other groups but farther up they grow out laterally to become continuous with the lateral and dorsal cells at various levels while they become absent from the mid-ventral line, then become united again on the cephalic region where all the cell groups are joined together. In intervals where these groups are not in distinct masses a few scattered cells are often found.

(b) *Connectives*

Ventral connectives. Fibers from these run straight into the ganglion for a short distance until the central, tangled mass is reached. Only a few of the fibers in the central part of the ganglion can be seen to take a straight course through it. Many others run straight or nearly so for a short distance and then turn off sharply to one side. Fibers from the connectives seem to end at all levels and in practically all parts of the central fibrous mass and to be contributed to by cell masses especially on the ventral side, but also clearly on the dorsal. These fibers coming in from both sides of the ganglion at different levels and as single fibers or groups add considerably to the complexity of the ganglion as does the fact that many of the fibers from the connectives which run through to the crura cerebri and nerves do not always take a straight course or run to the same parts of the nerve trunks. Sweeps of fibers for instance, can be traced quite straight up on the ventral side of the ganglion and then may be seen to turn over to the dorsal side.

Crura cerebri. These have fibers from the caudal connectives but not nearly all from them can be traced into the crura, for they are smaller and have their own special fibers which come from almost every part of the ganglion. The cells in various parts seem to furnish many of these, some of which come from the same side, but single strands were followed running in the direction of the crura which were from the opposite side. Fibers may also be seen to sweep back into it, probably from the mandibular trunk.

(c) *Nerve trunks.*

Mandibular. Many of the fibers of this end in the first part of the fiber mass. A few apparently run into the crura. Some fibers could be traced from near the median central part of the ganglion in a line with the lower connectives. Some came to it from cephalic median cells.

Maxillary. Fibers were followed into this from the lower connectives and from the upper parts of the ganglion. From this nerve trunk some fibers seem to end near the junction of the nerve with the central "punkstubstanz."

Labial. This is made up from fibers which enter the ventral central portions of the ganglion, just above the entrance of the small ventral nerves. They may be traced from the connectives up and from the upper portion of the ganglion down into these trunks and ventral caudal cells evidently contribute fibers to the mingled mass which is connected with these branches.

(d) *Commissures.*

The commissures connecting the crura cerebri have fibers which cross from one side to the other in the case of descending or ascending strands. No other kinds were recognized although I think there is a strong probability that some fibers merely cross and do not descend at all.

Within the ganglion there are a number of commissures connecting the lateral halves. Some of these are of straight fibers, others are closely woven deep staining masses. Dorsal, ventral or median commissures are found at almost every level, especially ventral ones, although not always clearly marked. A longitudinal section through the whole ganglion shows from three to four main commissures, a cephalic, a caudal and two median ones.

THE SUPRAESOPHAGEAL GANGLION.

(Figs. 8, 9, and Pl. XVI, Figs. 1–4.)

The brain is made up of two large ovoid masses distinctly marked from each other on the the middle line. It is connected on the ventral side to the subesophageal ganglion by means of the short, broad crura cerebri. All of the larger nerves come out laterally and of these there are three main trunks, the only ones to be considered at this time.

Three portions of the brain may be made out each connected with these trunks. The most dorsal is the *protocerebrum,* and it is also the largest and best marked and connected with the optic nerves which divide on each side into seven branches one for each ocellus.

The middle lobe of the brain or the *deutocerebrum* is the least marked of any and its nerve trunk the antennal, is the smallest of the three. It enervates muscles at the base of the antena as well as sense organs in it and so is mixed. This lobe is best seen on the cephalic and dorsal side and not at all on the cephalic ventral.

Fig. 8.

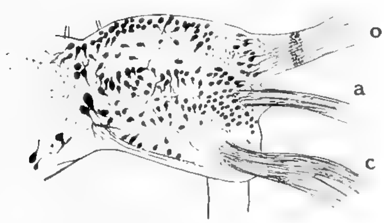

Fig. 9.

FIG. 8. Supra- and sub-esophageal ganglia with their attached nerves and ganglia. The brain is turned over cephalad. The sub-esophageal ganglion is dorsal. x30.

a........antennal	fn ......frontal nerve
c........clypeolabral	v........vagus ganglion
f ....frontal ganglion	o........optic

FIG. 9. Cephalic view of one half of the brain. Methylene blue. x30.

Finally the *tritocerebrum* is well marked as a little lobe just dorsal of the crus giving off the rather large clypeo-labial trunk which with the arched nerve comes off as one. From the distribution of this it seems probable that it is mixed.

This arched nerve runs ventrally and cephalad to unite at the middle line with the one of the opposite side in the *frontal* nerve ganglion. A branch from this small nerve center runs forward as the *frontal* nerve, another runs back on the dorsal surface of the esophagus to the small *vagus ganglion*, which sends two branches farther down the alimentary canal.

General form of the Brain from Methylene blue.

In successfully stained preparations almost all parts of the brain, especially the parts in from the nerve trunks are seen to be covered with nerve cells, both large and small. Those just under the chitin seem to quite completely incase the central dark staining portions of the ganglion. This central dark mass in each well separated lateral half of the ganglion is roughly of the same general shape as the surface. In the main part out from the median portion there is a lobe deep in and opposite the ocular nerve, this is in the central portion of the ganglion and connected with it, but extending down into the tritocerebrum is another lobe almost as large near the crus.

Partly separated from the central lobe of "punktsubstanz" is a spherical mass of dark staining substance and out from this a little distance in the ocular lobe and beyond its constriction from the main part of the protocerebrum is another little mass of deeply colored material. About each of these last little masses of "punktsubstanz" a special arrangement of cells is seen, while over the surface of the main portion of dark substance on every side the cells form a thick covering.

Fibers running up the crura may be traced into the ganglion in its dorso-caudal region. Some apparently run only to the lower portion of the "punktsubstanz," others may be followed farther up and are lost in the central area. Fibers can also be traced to the central portion of the ganglion, to the medial portions and probably freely ramify all through the central mass.

Near the middle line of the ganglion some large cells on the surface were found with long processes extending down long distances in the direction of the crura and probably were continued into it.

The great bulk of fibers connected with the crura seem to take origin or terminate in the central portion of the "punktsubstanz."

The ocular nerves enter the protocerebrum through large nerve trunks which form a decided lobe on the surface of the brain. At the junction of this *ocular* lobe with the ganglion there is a little area of deeply staining substance mentioned, before and back of this are nerve cells, and also a few cells on the eye side of the mass. These may be seen to send their processes into a dark mass and in towards the main part of the brain. Fibers run out the nerve from the ocular lobes' deep staining mass and into the spherical body before mentioned and into parts of the "punktsubstanz" near it, the former are processes from cells located near the ocular "punktsubstanz." About the spherical mass may be seen many nerve cells whose fibers are connected with it.

Nerve cells on all surfaces of the protocerebrum are very numerous and may be seen sending their processes into the central fibrous mass of the ganglion.

The deutocerebrum is less marked than the other two neuromeres and the fibers of its nerve, the *antennal*, come in closer to the clypeolabial segment of the brain than the ocular portion. The fibers of the antennal nerve can be traced as a distinct band for nearly one-half of the distance from its entrance to the middle line, where they seem to end in a mass of deep staining fibers of the clypeolabral trunk where it joins the main central portion and here at least some fibers can be seen to end well towards the caudo-ventral portion of the ganglion.

The tritocerebrum is best marked in the dorso-cephalic side of the ganglion where it lies over the crus. The fibers of its nerve seem to be of two sorts. The labral part is often stained while the arched nerve portion is clear. Both branches enter the ganglion and plunge at once into the mass of deeply staining fibers. Not quite so many cells were stained overlying this region in the specimens prepared. Some of these sent fibers more or less directly into the central mass while others as in other surfaces of the brain seemed to be association cells in a small area.

SMALL GANGLIA OF THE HEAD.

Connected with the arched nerves somewhat cephalad of the brain is the frontal ganglion. This in well stained preparations may be seen to have a central deep staining mass surrounded by nerve cells, the processes of some of which run into the central mass, while those of others run out from the cell, and down into the nerve which runs under the brain and connects this with the smaller so-called *vagus* ganglion. This last is like the former only smaller and fewer cells surround the central mass, some of the fibers run from this and probably also rather directly from the cells of the ganglion, down and out the two caudal branches. Occasionally the two lateral ganglia of the esophagus take the stain but their connections or structure was not especially studied. They seemed to differ from the other two ganglia, as they showed from the surface no nerve cells, the whole body taking on a uniform deep blue color. Sections showed them composed of very many cells closely massed together.

Sections of the frontal ganglion show a small mass of cells quite well filling the caudal end, a few larger, but mostly smaller cells of the same general sort found in other places. Of these there were about two large and eight smaller ones at a level where the ventral nerves come off on each side of the "Punktsubstanz," although farther cephalad than the place where these nerves are seen from the surface. Farther cephalad where there are only three or four large cells, fibers cross in various directions in the central portion of the ganglion. A large cell for instance was seen to send a process into the center of the ganglion where it broke up into a number of branches. Fibers cross in the various directions but most run longitudinally. At a level where a branch to the frontal ganglion arises, there are no nerve cells, the central part of the ganglion is divided into three masses of longitudinal fibers by trachea and cross fibers. This division is continued only for a short distance.

Farther along a dorsal and a few small ventral cells come in. The central mass of fibers is rather uniform, but made up of both cross and longitudinal strands. A little farther cephalad three cells come in dorsally at about the level where the arched nerves come off. Fibers running from side to side connect these nerves through the center of the ganglion.

The so-called vagus ganglion has a central mass of fibers and at its central part a nearly double row of cells closely packed about this central fibrous mass, these cells are continued down from the center a short distance, especially on the dorsal side.

THE BRAIN STUDIED IN SECTION.

(Plate XVI, Figs. 1–4.)

Only the main features of the structure of this complicated organ will be given at this time. Many of the elements of the brain of the adult may be present in the larva but for the proper interpretation of these it will be necessary to follow up this work with studies on the ganglia of pupae and adults.

As in the other centers, a central fibrous mass forms the bulk of the organ and about this central "Punktsubstanz" nerve cells are grouped in great numbers on practically all sides but the ventral. As in the other ganglia, large and small nerve cells and small neuroblasts are found, the latter are especially abundant and occur in great masses. Besides these, filling in between and in places where there are no nerve cells is the neuroglia network, which is often continued to the layer of surface supporting cells just under the chitinous sheath of the ganglion.

In sections we may recognize the dense staining parts seen in surface views to be masses of fibers more or less complexly arranged in the central and ventral portion, more or less paralleled by straight bands of the entering nerve trunks. Some of the special denser masses of fibers have already been described from surface views as that in the ocular lobe just as it joins the brain and in from the little spherical area just within and beyond this point. These two masses although quite separate from each other dorsally, ventrally and laterally are centrally connected by fibers and are also connected to each other to a less degree in the same way. The central fibers described in connection with the crura cerebri, are continued down into the labral lobe, but the deepest mass is in the central portion dorsally where it is somewhat lobed because of groups of cells on the surface and due to the processes of some of these cells passing down into the center. In this central "Punktsubstanz" either side of the middle line, is a well marked denser group of fibers, a rod of substance projecting from those on the dorsal side of the brain. This runs down to the mid-ventral line and there branches into two parts, one ventral, the other dorso-lateral. Farther along each of these parts run caudally as a single piece, one ventrally, the other dorso-laterally and the middle portion of the rod and afterwards the dorsal part disappears in section because of the curve in it. Later the lateral part disappears and the mid-ventral portion extends in towards the middle line to meet, but not unite with its fellow of the opposite side, running caudally in this way some distance, just above a ventral fibrous commissure and below a broad central one. In other words this body is a long slightly curved rod standing up in the ganglion with its base divided into two portions of which the lateral is shorter, the median longer and extends in towards the middle line. These represent the *stalks* and *roots* of the "mushroom bodies," the cup, such as described by Kenyon and others is not present and the special cells if developed were not recognized. This stalk and root of fibrous substance seemed to have a lighter core, that is in sections it gave to some extent the appearance of a tube. The fibers which compose it are very densely massed together. Preparations in which the tissues were allowed to macerate showed them to be little affected.

On the cephalic margin of the brain as on the dorsal side, the central fibrous mass as a whole is lobed as already spoken of and masses of cells fill in over these. The cell groups are difficult to describe in detail. The whole dorsal and lateral portions of the ganglia are covered with them, both large and small and in places many cells deep. There are almost no cells on the ventral side of the brain.

Beginning laterally and dorsally we have about the spherical mass of fibers back from the ocular lobes, masses of cells, on the dorsal, ventral and mesal sides. A peculiar condition of some of the dorsal and ventral sides of this mass is the appraent epithelial character of some of the cells. Most of these are very small and are probably neuroblasts. The epithelial character is especially marked in two places on each side because there are little cavities one dorsal and one ventral in the outer portion of the circular mass of fibers. (Plate XV, Figs. 1, 2, 3.) There are some fibers from the two lateral groups of cells just described which run both to the mesal group and out the ocular nerve. This is also continued dorsally and forms all along the dorsal part of the ganglion a thick layer, in the middle region of the brain.

A group of large cells occurs dorsally either side of the middle line, most of these point ventrally or centrally and send fibers to the crura cerebri, to the commissures and to the central portions of the fibrous mass; theirs are the longest fibers recognized from any cells in the brain.

Out laterally and ventral to the ocular lobes in the region of the antennal lobe and just above the crura is a small group of nerve cells, sending fibers into the crura and into the fibrous substance near that region of the brain.

In the cephalic region the cells surrounding the spherical mass may be seen divided into a dorsal, a ventral and a median group of small cells, already mentioned, while larger ones fill in on the dorsal side and are part of the general dorsal mass. These and the median masses run together and separate again at various levels, groups of smaller and larger cells often alternating, and these are continued on the cephalic and caudal sides of the ganglion. One of the most marked is a small group of cells surrounding a curved lobe of the central mass of the ganglion and continuous with cells on the cephalic side of the brain.

Fiber Tracts in the Brain.

(1) *The labial.* Fibers seem to end chiefly in the dense fibrous mass located in the labial lobe. A few fibers could be traced doubtfully into a dorso-lateral group of cells.

(2) *Antennal nerve.* Fibers from this end in cell groups either side of it. Fibers pass down ventrally into the lateral central part of the "punksubstanz" in large masses where some of them end, others cross to the ventral side and run in strands back in the main tract of the crura towards the other side. Others run towards the crus of the same side and apparently into it.

(3) *Ocular.* Fibers seem to end in the lateral mass of the ocular lobe, numbers of them connect this with the more median spherical "punktsubstanz." Fibers connect these two masses and fibers from the surrounding cell groups run into one or both of them.

Fibers connect the ventral epithelial-like cell region with the lateral dark mass, and also with an adjoining group of small cells more medially situated.

The more median ventral mass of epithelial-like cells lying ventral to and slightly out from the spherical fibrous area probably has connections with the larger more dorsal cells.

The more dorsal of epithelial-like cells which are one side of a small cavity, send fibers into the lateral optic "punktsubstanz" and are connected by fibers with the more central dorsal cells which adjoin it.

(4) The *Crura cerebri.* The main mass of fibers goes up to the central portion of the "punktsubstanz" on each side and receives branches from all parts of it and also especially from the median and lateral dorsal cell groups and probably also from lateral masses. A large part of the band runs ventrally and forms or is joined into a commissure with fibers from the other side. Fibers come into this last from all ventral parts of the ganglion from *both* directions, from ventral parts of the mushroom bodies, and from various lobes of the deep staining mass of the ganglion.

(5) *Commissures.* Two commissures have been mentioned, a ventral which was described above. The other more medial is found toward the caudal region. It is short and broad.

SUMMARY.

1. In the abdominal ganglia practically all the nerve trunks and branches are mixed motor and sensory.

In the thoracic ganglia, the three main trunks are mixed. Pure sensory divisions were found in connection with cephalic branches. The branches given off between the thoracic ganglia and between the 1st thoracic and the subespohageal seem to be motor. At least the more caudal ones were determined to be, with fibers ascending and descending from the ganglia below and above.

The three large nerve trunks connected with the subesophageal ganglion seem to be mixed motor and sensory. The other smaller ones were not determined, but the small gustatory nerves were motor at least.

The three main trunks connected with the supraesophageal ganglion were all mixed but the ocular.

2. Sensory tracts were recognized entering thoracic and abdominal ganglia and distributed to various parts of the ganglion to which they were connected. That is distributed to one or both sides either as individual fibers or as branches from

one. Some tracts were found distributed to the next center above as well as the nerve center to which their nerve trunks were connected. Others were found passing in to the ganglion to which the trunk was attached but giving no branches and passing on up to end in the next above or higher up.

A number of fibers apparently sensory were found passing through a number of ganglia without branches. These were often larger strands and although not traced as far as the head there was no reason to doubt that some of them were that long.

Sensory fibers and tracts were however traced into the large head ganglia and were found distributed to all portions of the fibrous mass. Sensory tracts were easily traced in connection with the ocular trunk, connecting it with the special lateral masses of fibrous substance.

3. Motor tracts could be traced as having their origin from cells in the ganglion to which the motor trunks were connected. Motor fibers could be traced out of the ganglia some distance but were not followed in as much detail as the sensory.

4. Association and descending tracts were recognized in all centers and at all levels of variable extent. Probably some of these were motor tracts.

5. Cells of many sizes were found in all centers. The largest and the smallest functional nerve cells seemed to be for association, those of the former sort having extensive aborizations, the second kind being much less extensively branched. Many of the medium sized cells were found to be motor. The general type was uni- or bipolar with one long branch which might run out for a considerable distance. Some association cells seemed to be bipolar with long processes running out in both directions. Some association cells seemed to be uni- or bipolar with all the branches coming off and branching again not far from the cell. A few multipolar forms were seen.

Neuroblasts were found to some extent in all ganglia, but great masses of them were especially noticeable in the brain.

Neuroglia networks filled in places under the chitin where there were no nerve cells and also formed more or less of a network in the regions where they were present.

6. Cells were grouped about the central fibrous mass in all of the ganglia. In the abdominal they were found to be especially abundant in the caudal and ventral regions, although the cell masses extended out laterally in all, and there were

often well marked mid-dorsal masses of large and smaller cells, as well as scattered cells in all parts. In the more cephalic ganglia, the cells are not quite the same in distribution. Cell groups and masses are found abundantly ventrally, but also on the dorsal and lateral sides and also great masses of them at the cephalic as well as the caudal end.

In the supra esophageal ganglion, cells are especially abundant dorsally and on the cephalic and caudal borders, less abundant laterally and ventrally. The cells are very numerous. Each side of the middle line a group was located with very long processes, the cells being mostly large.

Other groups were densely massed lateral to these, both cephalad and caudally, some of them were large, others small, and two groups of small cells on each side out near the optic nerves were found with a cavity near them.

Nerve cells were found partly surrounding two masses of fibers on each side near the optic nerves.

From the distribution of the cells and fibers there was no evidence of the dorsal cells being especially *motor* and of a ventral, particularly *sensory* region as Binet was led to think from experiments. I would rather incline to Kenyon's idea of ventral motor and dorsal sensory if I choose either of the two views, as undoubtedly most of the ventral cells in the thoracic and abdominal ganglia are motor cells, while many if not most of the fewer dorsal cells of these ganglia seem to be association cells, sending their fibers superficially over the surface or deeply into and *through* the fibrous mass to be associated with the cells and fibers of the ventral side.

7. In all of the ganglia the central mass into which many of the nerve cells send their processes has a very complex arrangement of fibers and nerve terminations. Certain portions of this mass in all are much denser than the rest.

In the brain this central "punktsubstanz" is somewhat more intricate in its texture on the dorsal side than on the ventral and is more or less lobed while off from the central mass there are two smaller groups of "punktsubstanz" in connection with the optic nerves on each side. In the central part of the brain is a *stalk* and *root* of a mushroom body on either side, but the *cup* is not present. The ventral portion of the ganglion is mostly made up of *straight fibers*.

In all of the lower ganglia there are at almost any level, from one to three commissures recognizable, a dorsal, a median and a ventral. These are broken up at various levels so that there may be several, three or more, cephalic or caudal parts of these commissures. There are more in the 8th abdominal and in the subesophageal than in the others.

From dorsal to ventral sides also, fibers chiefly from dorsal cells connect the upper and lower surfaces.

In the brain there are two commissures a broad short median and a longer ventral. Many other cross and longitudinal fibers connect all levels.

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PLATE XV.

A series of four photographs of cross sections through the 1st thoracic ganglion of Corydalis through a caudal level. The last figure is through the more central portion of the ganglion. Nerve cells show at the sides. The central fibrous mass is shown in all, and longitudinal fibers can be traced. In the last three figures cross commissures may be seen. The dark mass at the left or ventral side is part of the surrounding tissues and not a part of the ganglion. x60.

PLATE XVI.

FIG. 1. Photograph of a cross section parallel with the long axis of the brain through its central region. One half only shown. The dorsal side is up. The optic nerve is the swelling off at the right above, while leading off below is the broad crus. The dorsal masses of cells show, also central fibers and the stalk and root of the mushroom body. x75.

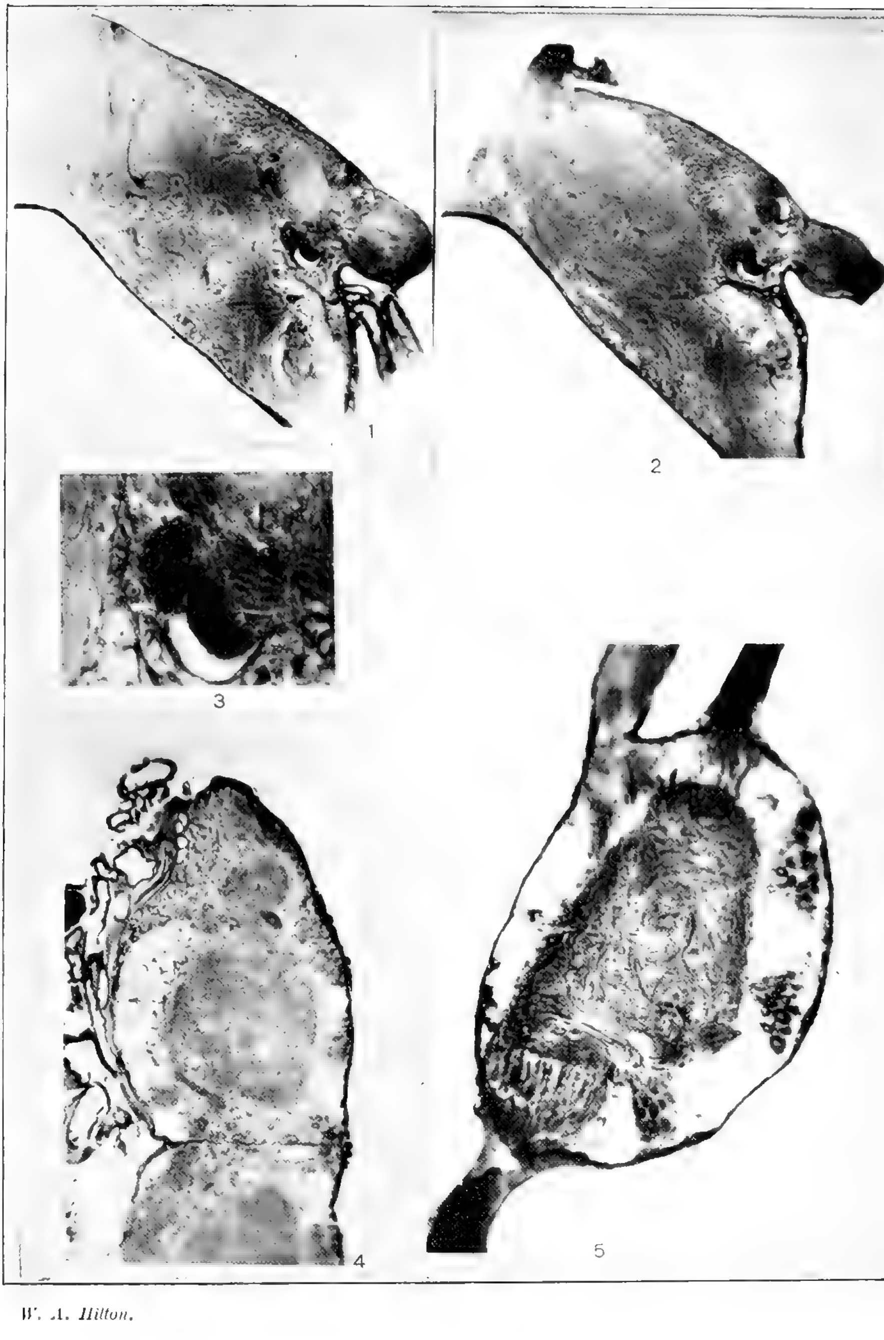
FIG. 2. A similar photograph from the same series cut farther one side, cephalad. x75.

FIG. 3. Photographs of the larger cavity shown in Figs. 1 and 2. x250.

FIG. 4. Section of the brain cut in a similar way as Figs. 1 and 2, but farther cephalad. The ventral side is at the left. The dorsal to the right. x75.

FIG. 5. Longitudinal section of the sub-esophageal ganglion. Above the first branch to the left is one of the crura cerebri, the next it is the mandibular. Below the branch cut only through its edge is one of the ventral connectives. x75.

W. A. Hilton.



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A STRUCTURAL STUDY OF THE CATERPILLARS.—II. THE SPHINGIDAE.

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This paper may be considered a continuation of that published in the Annals of the Entomological Society of America, III, 94–132, with plates 10 to 20. The references to figures with the prefixed numeral I, refer to plates 13 and 14 of that article.

In the caterpillar stage the Sphingidae may be defined as follows: With secondary hair on the body, epicrania, front, clypeus, maxillae and labium, but never on the antennae or distal parts of the maxillae and labium. There is almost always secondary hair on the adfrontals. It is present on the mandibles in *Cressonia* only, and the labrum bears a single additional hair in *Pachysphinx*. Front not more than half the height of the head (measuring here and elsewhere in this paper from the base of the front to the vertex. The frontal punctures are close together, and when distinct the primary setae are somewhat further from them than they are from each other, but they are distant from the outer edge of the front. The lobes at the two lower outer angles of the front tend to be large. Adfrontals not very wide, often narrow, not extending between the clypeus and mandible when distinct in the lower part; puncture a little below the upper seta. Clypeus narrow in the middle, often grading into the membrane below. Labrum well marked, often with very deep notch; vi distant from the margin, and usually directly below ii. Mandible with a large scrobe, bearing the two usual setae, one at the tip, and the other about half way out, toward the posterior side. Antennae with second joint most often twice as long as the first; the remaining joints exceptionally minute. Maxillary palpi stout, the second joint somewhat shorter than the first; submenta ill-defined, and mentum broad at the base. Spinneret broad, flat and short, with the usual three sclerites; labial palpi similar in form, and set obliquely to it, forming with it a sort of scoop (which would seem more useful in feeding than in spinning).

Claws not distinctly notched, broadening abruptly at their base. Prolegs with a double row of hooks, about 20 to 60 in number; not very regularly arranged in *Hemaris*, etc. The hair on the prolegs is never as rudimentary as higher on the body.

Secondary hair always minute, rudimentary, mostly visible only under a lens; but the body is often roughened by the tubercles; primary hair (iii and v alone are easy to identify but in *Proserpinus flavofasciata* i and ii are marked by larger black spots) often considerably better developed; but their tubercles are never raised, even when the others are. Segments with 8 or 9 annulets, usually ill-defined in front. Usually with a wart, horn or peculiar marking on the dorsum of the eighth abdominal segment—if a horn, bearing tubercles and secondary hair. With other armature only in *Ceratomia amyntor*, *Lintneria eremitus* and some exotic *Smerinthinae.*

Tree-feeders with a few exceptions (*L. eremitus*, *Deilephila*, *Protoparce*, *Choerocampa*) or feeders on vines.

In synoptic form the Sphingidae are distinguished as follows:

1. Maxillary palpi three-jointed; the four upper ocelli in a rectangle; the upper setae of thoracic segments on a level........................**JUGATAE**
1. Maxillary palpi with but two free joints; the four upper ocelli in a curve; the upper setæ of the thorax, when single, one above the other..(**FRENATAE**)
2. With outer hooks on the prolegs..................**Microlepidoptera**, etc., etc.
2. With a single inner band of hooks on the prolegs............................3
3. Hooks of prolegs alternately of three lengths................**Butterflies**
3. Hooks of prolegs all of the same length................................ **Noctuidæ, Notodontidæ, Arctiidæ, Eucleidæ, etc.**
3. Hooks of prolegs alternately and regularly of two lengths.................4
4. Secondary hair present on antennæ and palpi................**Lasiocampidæ**
4. No secondary hair on antennæ or palpi.................................5
5. Secondary hair if present, confined to leg-bases..**Geometridæ, Thyatiridæ**
5. With dense secondary hair on body and head, including labrum........ **Apatelodes** (**Eupterotidæ ?**)
5. With considerable secondary hair on body and head, but little or none on labrum..6
6. Primary tubercles represented by branching spines, or warts bearing several hairs ....**Saturnoidea**
6. Primary tubercles bearing minute simple hairs, hardly distinguishable from the secondaries; and all hair minute..........................**SPHINGIDAE**

Semanophoræ and Asemanophoræ are separated rather by different tendencies than by sharp differentiating characters, and the same is true to an even greater extent of the subfamilies of each. Marking in a general way the *Asemanophoræ* there may be mentioned the strong tendency for the head to taper toward the vertex (which none of the *Semanophoræ* show); the densely granulated skin of the middle stages (except *Lapara*, and shared by one or two *Semanophoræ*); the generally higher front, with more tendency to develop lobes at the lower outer angles. The first abdominal segment is never swollen, and the horn is never replaced by an eyespot; the clypeus tends to be wider, at least at the ends.

In the majority of the *Semanophoræ* the last thoracic or first abdominal segment is much swollen, and the horn is frequently replaced by an eyespot. The front often makes a perfect equilateral triangle. The skin is very sparsely if at all granulated in the last stage, and is rarely granulated in the earlier stages. On the labrum, seta iii is quite generally on a level with ii, in the Semanophoræ more often nearer the level of vi, at least in normally formed labra. Normal oblique stripes are rather rare.

If we except *Pachysphinx occidentalis* we might define the SMERINTHINAE as caterpillars with heavily granulated body in the last stage, and more or less granulated head, with the setæ rising from the apex of the granulations. All except Pachysphinx have an acute triangular head, and even in this the head tapers strongly toward the vertex. The labrum is always normal in arrangement of its setae, with the distance between the setæ ii full half the width of the labrum, and with moderate, flaring notch. Except in its smooth skin, and normal horn *Pachysphinx occidentalis* agrees exactly with *P. modesta*, and in horn it agrees with *Smerinthus*.

The SPHINGINAE, which comprise the rest of the *Asemanophoræ*, are less homogeneous. *Ceratomia* has a densely granulated skin, but is distinguished from all the *Smerinthinæ* by possessing a row of middorsal granulations. In the more specialized forms the labral setæ are closer together around the notch, and this reaches its extreme in *Cocytius*, which has a head of normal Smerinthid form. *Lapara*, also with a triangular head, is easily separated from the Smerinthinæ and placed in this series, as its labrum (as well as markings and habits) agrees closely with *Hyloicus*.

I cannot distinguish the three subfamilies of *Semanophoræ*, even by tendencies, and am inclined to treat them as a single subfamily. The eyespot in place of a horn occurs only in the *Philampelinæ*, but they are not all of the same type. Humped caterpillars occur in all three (Choerocampa, Darapsa, etc., Erynnyis) and cylindrical ones also (Deilephila, Sphecodina, Pseudosphinx); reduced horns (Pergesa, Pholus vitis, and Erynnyis) and normal ones (Xylophanes, Darapsa, Hemaris); rounded heads (Deilephila, Macroglossa, Pseudosphinx) and squarish ones (Choerocampa, Darapsa, Erynnyis). The labrum of Pseudosphinx and Erynnyis is a little peculiar, but that of

Deilephila comes as near as that of Hemaris, to it. *Hemaris croatica* is an almost perfect connecting link between *Hemaris* and *Macroglossa.* Altogether a tabulation of the genera which shall be workable must be mainly artificial in its arrangement.

THE GENERA (AND SUBGENERA) OF SPHINGIDAE.

1. Head high and triangular, no horn.............................**Lapara**
1. Head rounded, or horn more or less developed..........................2
2. Head half higher than wide, horn well defined, enlarged tubercles on anal plate...3
2. Otherwise...4
3. Four tubercles on anal plate, face smooth ....(**Dilina**)*
3. Two tubercles on anal plate, face rough........................**Cressonia**
4. Head much higher than wide and triangular; horn rather small and soft, not well distinguished from the body...............................5
4. Head about as wide as high, or trapezoidal.............................6
5. Face smooth, sides tuberculate...............................(**Amorpha**)
5. Face as rough as sides of head, all heavily tuberculate.................. **Smerinthus and Paonias**
6. Seven setæ on labrum, transverse ridges,—one each on meso- and metathorax ....**Pachysphinx**
6. Six setæ on labrum, transverse ridges more numerous or wanting..........7
7. Body heavily granular, with granular obliques, middorsal line, and subdorsal on thorax, the latter raised into two pair of short horns......**Ceratomia**
7. Body smooth or nearly so in last stage, no middorsal granules............8
8. Labrum with ii decidedly higher than i................**Hyloicus (cupressi?)**
8. Labrum with ii on a level with i or lower..............................9
9. Head triangular, smooth, as well as cervical shield; anal plates exceptionally rough; labrum with a deep narrow notch, with the setæ i, ii and vi crowded around it ....**Cocytius**
9. Head rounded on the vertex, but in Chlænogramma with two enlarged granulations; anal plate rarely rough; setæ ii of labrum almost half as far apart as width of labrum, or more....................................10
10. Head much higher than wide, and tapering to about half its width at the vertex...11
10. Head as wide as high; tapering decidedly toward the vertex.............12
10. Head nearly as wide as high, rounded or squarish, or if tapering a little then strongly granulated...17
11. Horn nearly twice as long as height of head...............**Chlænogramma**
11. Horn slender, and but little longer than height of head..**Daremma** (undulosa)
12. Horn recurved at tip.....................................(**Acherontia**)
12. Horn regularly pointed..13
13. Notch very shallow, in depth only 1-7 height of labrum....**Phlegethontius**
13. Notch of labrum at least twice as deep................................14
14. Horn very slender, head well rounded at the sides........**Daremma** (catalpæ)
14. Horn normal or short..15
15. Mesothorax acutely humped, sometimes surmounted with a tubercle.... **Lintneria**
15. Body normal in form...16
16. Head normally with two pair of back side-stripes...................**Herse**
16. Head normally with one pair of dark side-stripes..................**Sphinx**
17. Head heavily granulated, body cylindrical, with normal obliques on sides..18
17. Head not granulated, or body swollen, or without oblique stripes but with a continuous subdorsal picked out in enlarged granulations............19
18. Body somewhat granulated in last stage, especially on the obliques, etc. **Atreides**
18. Body unusually smooth...**Dolba**

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* Exotic genera in parenthesis.

19. Setae i, ii and iii of the labrum on a level; labral notch very shallow, abdomen cylindrical and rather slender.................................20
19. Setae i higher than ii and iii, ii usually decidedly higher than iii...........21
20. Metathorax swollen, supraanal not noticeably armed..........**Erynnyis**
20. Cylindrical, supraanal with two large tubercles..............**Pseudosphinx**
21. Horn reduced to a granule or replaced by an eyespot; metathorax strongly swollen; head full as wide as high and squarish...................**Pholus**
21. Horn present in all forms with swollen body, swelling rather belonging to the first segment of the abdomen than to the thorax; head rounded, or if squarish, full as high as wide..................................22
22. Horn wanting ....(**Deilephila** vespertilio)
22. Horn replaced by an eyespot..23
22. Horn conical well developed...24
23. Head very rough in last stage, horn very slender in middle stages, replaced by a high tubercle in the next to last ....**Sphecodina**
23. Head nearly smooth in the last stage; horn stout in penultimate...... **Proserpinus** (in part)
24. Horn blunt and cylindrical; body marked with a large subdorsal eyespot on the thorax, and with well defined distant annulations, beginning with the second abdominal segment...............................(**Daphnis**)
24. Horn acute; no eyespot on side of thorax..............................25
26. Body more or less swollen on first segment of abdomen, thence tapering to the head 30
25. Body not swollen..26
26. Head and general surface of body distinctly but sparsely tuberculate, the setæ rising from the apex of the tubercles; cervical and anal shields rougher than the rest of the body...................................27
26. Body smooth, head rarely with very slight tubercles, from the slope of which the setæ rise...28
27. Tubercles only visible under a lens ....(**Macroglossa**)
27. Head and cervical shield appearing rough to the naked eye..........**Hemaris**
28. Notch of labrum hardly 1-3 its height; setæ i and ii spaced about in the ratio 2:3; vi only 1-3 way up from the apex of the lobe toward ii and much nearer the middle line..**Deilephila**
28. Notch of labrum deeper, setæ i and ii only about half as far apart as the setæ ii are from each other; vi nearer to ii than to the apex of the lobes....29
29. Front about half as high as height of epicrania; without normal oblique stripes (with reversed oblique spots).................**Proserpinus** (in part)
29. Front smaller; with seven normal obliques..............................14
30. Horn not so long as height of head......................................31
30. Horn very slender.......................................(**Hippotion**)
30. Horn normal 32
31. Head very finely granular, appearing under low power smooth and dull (**Pergesa**)
31. Head distinctly vermiculate.......................................**Amphion**
32. Head sparsely tuberculate...33
32. Head smooth and dull under low power, granular under high power, with smooth areas about the setae.......................................34
33. Body slightly swollen, spiracles pale with two black bars..........**Deidamia**
33. Body much swollen, spiracles dark with a white dot at each end........ **Darapsa, Ampeloeca,** (**Clarina**)
34. Front higher than wide.......................................(**Theretra**)
34. Front wider than high ....**Xylophanes**

Sphinx. (*Hyloicus* in part). Head slightly tapering toward the top, or with sides rounded out (*S. drupiferarum*), with irregular vermiculate grooving; the setae rising as often from the grooves as from the elevated portions. Front about $\frac{1}{3}$ height of head, with lobes at the lower outer angles well marked and about $\frac{1}{4}$ to $\frac{1}{3}$ its height. Ends of clypeus as wide as $\frac{1}{5}$ height of front. Labrum high, with a notch $\frac{1}{5}$ to $\frac{1}{3}$ its width, the setae i and ii spaced about in the ratio 1:2, vi a little nearer in *S. drupiferarum*, a little farther off in *S. gordius, luscitiosa and eremitus;* iii, a little higher than vi but much below ii; notch deep and slit-like in S. *gordius* and *luscitiosa*, shallower and more flaring in the others. Mandible with a few (perhaps four, but ill defined) large teeth. Second joint of antenna decidedly longer than the first, and nearly twice as long as wide. First segment of body much larger in diameter than head and more or less enclosing the back of it. Skin entirely smooth, granulated until the last stage; supraanal more or less granulated. Horn normal, much longer than head, and curved downward. The seven stripes similar.

There is also some variation in the horn. In the majority of species it is cylindrical in the basal part, and strongly down-curved in its entire length; but in chersis the basal part is more often nearly straight, and in gordius it is regularly conical and the whole horn is almost straight. The European species *ligustri*, which comes next to *drupiferarum* in the adult, in the caterpillar resembles it closely in markings, but has the normal Sphinx head. (Fig. 1). That of *drupiferarum* would not differ in face view from Fig. 10. See also I, Figs. 39–41 of S. gordius.

Lintneria has a conical hump on the mesothorax, which in the next to last stage, and sometimes in the last, is surmounted with a hard tubercle. Otherwise it resembles Sphinx in structure. It is considered a subgenus of Sphinx. (L. eremitus, Fig. 8.)

Hyloicus. Head rounded and decidledy larger in diameter than the body. Horn straight and slender. Labrum with very shallow widely flaring notch; with setæ i and ii nearly evenly spaced; ii much lower than i and the setæ i, ii and vi of each side forming an equilateral triangle. Second joint of antennæ only half longer than wide, and first joint very short. Supraanal long and triangular. Fig. 10.

H. pinastri is longitudinally striped with green and white, with a broad red dorsal, or else suffused with red. Horn black. *H. cupressi* of the southern states is reported as similar, with the white lateral stripes broken into patches; and is probably similar in structure.

Herse. I cannot distinguish Herse from Sphinx by any satisfactory characters. The head in both convolvuli and cingulata is intermediate between those of *drupiferarum* and the other Sphinxes. Setae i and ii of the labrum are about $\frac{2}{3}$ as far apart as the distance between the two setae i, and i is but little higher than ii. The two main joints of the antennæ are practically equal. In the only specimen of *H. cingulata* I have seen the horn is very short, but this may be an abnormality; it is normal in *H. convolvuli.*

Dolba. The head does not taper decidedly toward the top, and is decidedly granular, the setæ rising from the apex of the widely separated granules, as in *Smerinthus.* Otherwise it agrees with those species of Sphinx in which the labrum is not deeply notched. The head comes surprisingly close to that of Darapsa, but may be distinguished by the decidedly higher front, and the fact that iii of the labrum, as in most Asemanophorae, is nearer to the level of vi than ii. I, Figs. 39–41 represent not this species but *Sphinx gordius.*

Atreides has a very similar head. The supraanal plate is an equilateral triangle; the markings are picked out with raised granules, and there are several transverse rows on the thorax, and scattered granules on the abdomen as in Smerinthus, but very widely scattered and small.

Acherontia. Has a slight transverse hump on the mesothorax (suggested in some Sphinx); the tip of the horn is recurved sharply; the fine annulations are wanting from the thorax. Otherwise entirely like Sphinx (e. g. S. kalmiae). *A. atropos* examined, European.

Ceratomia. (sens. str.) Head about as wide as high, decidedly tapering, somewhat granulated in back, but with the setæ not springing from the granulations, structurally as in the lower species of *Sphinx.* Body densely granulated, with the subdorsal and obliques picked out in raised granulations, and also with a *mid-dorsal row.* The subdorsal row is produced on the meso-, and metathorax into two pairs of short soft horns. (I, Figs. 45 and 49.) Aside from subfamily characters, I have seen no trace of kinship between this species and *Daremma.* The latter seems to come closer to *Chlaenogramma.*

Daremma. Skin smooth; horn normal, rather slender and short; or longer but very slender (*catalpæ*). Head slightly granular, but the setae do not rise from the apex of the granulations. Otherwise the characters common to *undulosa* and *catalpæ* are shared by Sphinx.

In *D. undulosa*, the type, the head is $\frac{1}{4}$ higher than wide, very strongly tapering toward the vertex, the horn is only a little slenderer than normal, and the labrum is moderately notched, with seta iii in the normal place. In *D. catalpæ* (Fig. 11), the head is broad and rounded, shaped as in *Deilephila;* the labrum is quite deeply notched, with iii nearly on a level with ii, as in the Semanophoræ; the body is unusually cylindrical and the horn is very slender. I have seen a specimen from the U. S. National Museum, with no data but the name *Daremma hageni*. It is a typical Smerinthus in structure, and could be the fourth stage of one of the larger species (cerisyi), but is rather sparsely granulated. I should suspect it was misidentified.

Chlænogramma. Head like that of *Daremma undulosa*, but with inconspicuous enlarged granules on the vertices. Body like *Atreides plebius*. Horn normal in length.

Cocytius (*antæus*). Head not at all tuberculate, but decidedly higher than wide, and terminating in two enlarged granules, like a fourth-stage Smerinthus, but higher and closer together at the vertex. Front full as high as wide, the lobes at the outer lower angles are not only well marked in outline, but project very conspicuously; front less than $\frac{1}{3}$ height of epicrania, iii and ii of the labrum are on a level, but the notch runs even higher, and is very narrow. The distance between the two setæ ii is less than $\frac{1}{3}$ the width of the labrum, and i, ii and vi are all located practically in the notch. Cervical shield as smooth as head, the anal is very rough, like the horn, and is a narrow triangle. Skin not at all granulated. Altogether an unusually distinct genus for this series. The structure so far as it is not unique suggests *Sphinx* rather than any other genus, but I understand the moth comes nearer to *Phlegethontius*.

Phlegethontius (*Protoparce*) Notch of labrum only one-seventh its height, not reaching the level of seta vi; iii and iv not so high as usual. Caterpillar distinctive in appearance, but not otherwise separated in structure from normal *Sphinx*. *S. rusticus* is said to be sparsely granulated on the lines. I, Fig. 51.

Lapara (*Ellema*). Skin quite smooth, not only in the last, but in earlier stages. Horn wanting entirely. Anal plate fully as long as wide and acute. Head somewhat higher than wide, (Fig. 4), in the earlier stages extremely high, triangular, with small and distant tubercles, like Fig. 12; front $\frac{1}{3}$ its height, higher than wide. Labrum (Fig. 5) with a very shallow notch, broadly flaring, with the apex of the lobes far to one side and the outer edges nearly straight; i lower than ii, but not so much so as in *Hyloidus*, i and ii about equally spaced; both crowded down toward the margin; vi decidedly nearer the middle line than ii. Scrobe of mandibles smaller than usual. Second joint of antenna hardly longer than wide, and first joint very short. First ocellus directly behind the second, and nearer to the posterior one than the second is to the fourth. With longitudinal stripes, or checkered, never with obliques.

Except for the labrum and markings, which are essentially as in *Hyloicus pinastri*, there is nothing to connect this genus with the *Sphinginae* in the caterpillar; there are a couple of parallelisms to the *Smerinthinæ;* the shape of the head, and low first ocellus as in Cressonia.

I cannot distinguish the species in the caterpillar.

Smerinthus (*Sphinx*) and *Paonias* (*Calasymbolus*) (I, Figs. 42-44). Head decidedly higher than wide, triangular; with nearly acute apex and sides somewhat rounded out; with numerous widely spaced raised tubercles, each bearing a seta; front about as in Sphinx, with several tubercles somewhat smaller than those on the epicrania; labrum with a notch about ¼ its width, in depth, with the setae arranged as in Sphinx, but the distance between the two setae vi is full half the width of the labrum (in the Sphinginæ it is mostly distinctly less than half); iii, iv and v about equally spaced on the outer edge. Clypeus and mandible and antennæ as in Sphinx, but the adfrontals are somewhat wider. Body finely granulated, strongly tapering toward the head; first prolegs less used than the others and slightly reduced. Subdorsals on thorax, and obliques on abdomen marked by rows of raised granules. No granules on the middorsal line, but they show a tendency to arrange themselves in a row on each side of it. Horn soft, not well distinguished from the body and about as long as the height of the head, not down-curved. Supraanal an equilateral triangle in shape, not specially armed, acute; The transverse rows of granulations on the thorax are all about equal. Ocelli in normal arrangement, as in Sphinx.

The species show very little distinctive in the way of structure (or for that matter in color and markings) *P.* (*Calasymbolus*) *astylus* may be a little rougher, with better developed setæ than the others, both on head and body, and the horn seems a little better defined in *S. ocellatus* than the others.

Pachysphinx (*Triptogon, Marumba*). Head wider than high, with sparse granulation on the sides, nearly smooth, but a little vermiculate on the face; the apex bluntly rounded. No subdorsal row of granulations on the thorax but the meso- and meta-thorax each have one high transverse crest. Horn soft, variable in size. The three lower ocelli form a right triangle, the posterior being unusually high. The labrum has an additional seta, on the margin; the four marginal setæ that result are about equally spaced.

1. *P. modesta.* Body normally granulated, about as in Smerinthus; horn minute, about $\frac{1}{16}$ in. long; thoracic crests high and granular. (Fig. 7.)

2. *P. occidentalis.* Body smooth, with a few raised granules on the last oblique line, only; horn about as long as height of head. Thoracic crests rounded over and hardly distinguishable. (In the penultimate stage it is granular like *P. modesta.*) This, as may be seen, is very different from the eastern form *modesta.* (Bred from the egg by Mr. Brehme; Western.)

Amorpha (*A. populi* of Europe) Labrum very deeply notched (like Cressonia). Head decidedly higher than wide, triangular, smooth on the face. Anal plate unarmed, and horn, etc., as in *Smerinthus.* The last four oblique rows of granules very distinctly extend over three segments. The characters are nicely intermediate between *Smerinthus* and *Dilina*, showing no special closeness to *Pachysphinx.*

Dilina (*Mimas*). Horn sharply separated from the body and down curved as in *Sphinx;* half longer than width of head, mostly cylindrical. With a longitudinal subdorsal row of granules on the thorax. Head half higher than wide, and acute-triangular. Face smooth, the sides of the head sparsely tuberculate. Supranaal with four raised tubercles in a rectangle. Otherwise about as in *Smerinthus. D. tiliae* of Europe.

Cressonia. With only one large pair of enlarged tubercles on the supraanal plate. Front as wide as high and only one-fourth as high as the epicrania. Entire head tuberculate; first ocellus moved down and posterior one up so that they are not so far apart and as the second and fourth are from each other. *Mandibles with a tuft of secondary hair* on the outer part of the scrobe. Otherwise as in Dilina. *C. juglandis.* (Figs. 12 and 13.)

Deilephila (*Celerio*) (Fig. 9, and I, Figs. 46 and 52). Head distinctly wider than high, rounded on top, roughened with irregular grooves, but not as strikingly as is usual in the *Sphinginæ.* Front triangular, the outer edge but little sinuous; clypeus narrower at the two ends than in the *Sphinginæ.* Labrum with a broadly flaring notch only one-third as deep as the height of the labrum or less, setae i and ii about two-thirds as far apart as the setae i are from each other, nearly on a level; vi less than half way up to ii. Antenna with the first and second joints nearly equal in length and diameter. Ocelli with the first four of nearly equal size, in a regular curve, but the second decidedly nearer to the third than to the first. Posterior ocellus about half way between the upper and the lower; the three lower ocelli forming approximately a right triangle. Skin smooth, the tubercles marked by tiny chitinous rings, those of the primaries two or three times as large as the others. Horn normal, moderate, entirely wanting in *D. vespertilio.* Supraanal broad. Caterpillar as a whole cylindrical, tapering toward the head, almost always with a conspicuous row of subdorsal spots or eyespots, which are all about equal in size except the last. The front is smallest in *D. euphorbiæ.*

D. lineata, *gallii*, *euphorbiae*, *lathyri* and *vespertilio* were examined. Aside from those mentioned above the differences come down to a slight variation in the depth of the notch of the labrum; and the markings.

Chærocampa (in the broader sense). (Fig. 6.) Head squarish, full as high as wide, very finely granular, so as to appear smooth and dull with low power; the region about the setæ may be glossy but not raised. Front triangular, wider than high (except in alecto) at least $\frac{3}{5}$ height of head; posterior ocellus lower making the triangle formed by the three lower ocelli acute-angled; second joint of antenna about twice as long as first; notch of labrum at least $\frac{1}{3}$ its height, usually more; i and ii only half as far apart as the two setæ i are from each other; vi nearer to ii than to the tip of the lobes. Body with the first abdominal segment much swollen and bearing an eyespot, with or without less prominent ones on the following segments; thorax lacking the mottling characteristic of the abdomen in the darker forms; horn regularly conical; skin smooth.

Subgenus *Theretra*. Horn well developed; large eyespot normal, followed by a series of simpler ones in a subdorsal stripe; pattern of abdomen wanting from the first segment, as in some *Philampelinæ;* body with dark obliques slanting up and back. *T. alecto.*

Subgenus *Xylophanes*. Horn and eyespots as in *Theretra*. Front distinctly wider than high; labral setae i and ii a trace farther apart and nearly on a level; notch broad and only $\frac{1}{3}$ height of labrum; second joint of antenna only half longer than the first. Perhaps a little near to *Deilephila* than the others are. *X. tersa.*

Subgenus *Pergesa*. Horn very short and sharply downcurved; the first eyespot only is present, and it has a black shade below. Setæ i of labrum much higher than ii, and they are spaced as in Theretra, that is, in the ratio 1:2. Notch nearly half height of labrum; antennæ with second segment twice as long as first.

Subgenus *Hippotion*. Similar to *Pergesa*, but with the horn long and slender (fig. 15).

Pholus (*Philampelus*). Horn reduced to the merest rudiment in *vitis*, replaced by an eyespot which bears a pale crescent in its posterior part, in *pandorus*, *achemon* and *labruscæ;* said to be completely wanting in a Texan species. Metathorax much swollen, first segment of abdomen distinctly smaller. The front of the body is completely retractile in *P. achemon* and *pandorus*, apparently less so in *vitis* and *labruscae*. Supra-anal broad, not specially armed. Head fully as wide as high, squarish; front higher than wide, and nearly half its height. Setæ i, ii and vi of labrum especially close together.

Ampeloeca. (*Darapsa*, *Everyx*, *Ampelophaga*). Head rounded, with widely separated small tubercles, similar to fig. 16, but higher; front more than $\frac{2}{5}$ its height, decidedly higher than wide, also tuberculate. Labrum with a fairly deep notch; setæ as in *Chærocampa*. Body decidedly swollen at first segment of abdomen, but not enough to withdraw the head.

Horn decidedly longer than head. With a subdorsal line, and the normal obliques. Spiracles red with white ends (agreeing with the *Macroglossa* group, *Clarina*, and some specimens of *Protoparce*). Otherwise like Choerocampa.

In *A. versicolor* the horn is nearly twice as long as the head, thick and strongly down-curved; in *myron* it is shorter, straight and conical, but apparently it is exceptionally variable in all three species.

Clarina. Horn only about as long as head; tubercles of head very small and inconspicuous; otherwise wholly like Ampeloeca,—with continuous subdorsal. *C. syriaca*, of Syria.

Deidamia. Horn rather longer than head. Supraanal an acute equilateral triangle. Spiracles pale with a black bar on each side. Front full as wide as high. Body but little swollen. Otherwise like Ampleœca.

C. syriaca and *D. inscriptum* are marked almost exactly like A. myron, but with evanescent obliques.

Amphion. Head irregularly roughened, without raised isolated tubercles, squarish, as in related genera. Supraanal as long as wide and acute; spiracles dark. Horn shorter than height of head. Front full as high as wide, third ocellus much enlarged (as in Clarina and Deidamia also). Body but little swollen. Otherwise like the related genera (I, figs. 48 and 53.)

Sphecodina. Body not at all swollen on the first abdominal segments. Head large, very rough in the last stage, but without raised tubercles; in the next to last as in *Ampelœca.* Front higher than wide, $\frac{3}{7}$ height of head. Clypeus broader than in *Deilephila*, etc. Labrum like *Pergesa.* Horn replaced by a wart; in the last stage similar to that of *Pholus*, in the next to last high, and cylindrical; before that surmounted by a slender horn, which rises, not as in Pholus from its posterior side, but from the middle. Supraanal wide.

Proserpinus (Fig. 3). Horn normal but rather short (*gauræ*) or replaced in the last stage by an eyespot, which may be nearly flat (*proserpina*), or with an obliquely conical center (*flavofasciata, juanita*). Head and skin smooth. Spiracles single-colored, yellow in *flavofasciata* and *proserpina*, black in *gauræ.* Head squarish, higher than wide in *proserpina*, full as wide as high in *flavofasciata.* Adfrontals only about $\frac{1}{8}$ as wide as front is high, with their setae i below the top of the front. Front nearly half as high as head, broadly triangular. Ocelli normal.

Labrum with a moderate or rather shallow notch, with the setæ i and ii only half as far apart as the setae i are from each other (thus agreeing with the preceding genera rather than with *Hemaris*). Supraanal an equilateral triangle; joints of antennæ nearly equal in diameter. In the next to last stage *flavofasciata* at least, has a horn similar to that in adult *gauræ*.

Macroglossa. Head and body nearly smooth, but marked by slight raised white tubercles. Head very small and round, the body sharply tapering toward it. Horn normal, longer than height of head. Adfrontals $\frac{1}{5}$ height of front in width, and with seta i higher than the top of the front. Third, fourth and lower ocelli evenly spaced, and very close together, nearer to each other than to the posterior. Front $\frac{2}{5}$ height of head; distance between setæ i and ii of labrum $\frac{2}{3}$ that between the two setae i. True legs single-colored; spiracles red with white spots at the two ends. The genus shows likenesses to *Hemaris* on the one hand especially to *H. croatica*, which is very similar; and to the *Darapsa* group on the other, rather than to *Proserpinus*.

Hemaris (*Haemorrhagia*). Head rough and tuberculate; cervical shield, etc., also rough, and skin generally with more or less distinct raised tubercles. Horn moderate, or long and slender. Front $\frac{1}{3}$ height of head. Otherwise as in *Macroglossa*, even as to the coloring of the spiracles. The species I have seen make a very good graded series, from *Macroglossa* to *H. thysbe*.

H. croatica. Cervical shield no rougher than head, without any distinct anterior ridge; lower ocellus close to the next one as in *M. stellatarum*. Legs without any black. Head regularly rounded, not distinctly higher than wide.

H. rubens. Head and cervical shield with fine granulations separated from each other by about twice the diameter of a granulation, except toward the anterior edge of the cervical shield, where they are nearly in contact, and in a single even row. Front, and head as a whole higher than croatica, agreeing with the following species. Feet with a little black on the front of the coxæ only. Horn rather short.

H. diffinis (typical). Cervical shield with the granules no larger than in *H. rubens*, but with the surface of the shield raised into ridges, so as to appear much rougher, considerably rougher than the head. The granules on the anterior edge make a ridge, but they are not confluent and the ridge is not well defined. The true legs have the femora marked with deep black brown.

H. diffinis axillaris. Head conspicuously rough. Anterior band of cervical shield of crowded granulations, not all in a single row; the shield decidedly rougher than in the normal form; horn longer than head.

H. thysbe. Even rougher than the preceding, the cervical shield with the granulations almost in contact, and on the anterior edge more or less confluent. Horn long and the outer part slender. Femora jet-black and very conspicuous.

In the next to last stage, *H. diffinis*, at least can hardly be separated from *Macroglossa*. The horn is minute.

Erinnyis (*Dilophonota*). Seta ii of labrum fully as high as i, and the setae i, ii and iii almost evenly spaced; iii, iv and v about evenly spaced along the outer edge. Supraanal sometimes with the rudiments of a pair of tubercles. Notch of labrum hardly $\frac{1}{3}$ its height, in depth. Head squarish, and full as high as wide; metathorax sharply humped; the abdomen abruptly smaller, and cylindrical. Horn short. In *E. edwardsii* the horn is somewhat shorter than the head, in *E. ello*, only a third as long, and only twice as long as thick. The tubercles on the anal plate are distincter in *edwardsii*, and the supraanal is narrower.

Pseudosphinx (I, Figs. 47 and 50). Cylindrical with slender horn. Fourth ocellus as far from the lower as from the first; front wider than high and nearly half as high as head. Labrum very shallowly notched, with the setæ i and ii nearly on a level, and almost evenly spaced; iv directly below iii and much nearer to it than to v. vi not far from margin. Two conical spines on anal plate.

The following species were examined. I am especially indebted to Prof. J. B. Smith; Dr. Geo. Dimmock, Mr. William Beutenmuller, and Dr. H. G. Dyar, for the privilege of examining specimens in their own collections and in those of the institutions they represent. Exotic species are in italics; those from the far west, or from Florida only, are also indicated.

SPHINGINÆ

- *Acherontia atropos*
- *Herse convolvuli*
  - cingulata
- Cocytius antæus Fla.
- Phlegethontius quinquemaculatus
  - carolina (sexta), I, Fig. 51.
- Atreides plebeius
- Dolba hylæus

Sphinx ligustri II, Fig. 1.
drupiferarum
chersis
kalmiæ
gordius, I, Figs. 39-41
luscitiosa
Lintneria eremitus, II, Fig. 8.
Hyloicus pinastri, II, Fig. 10.
Lapara bombycoides, II, Figs. 4-5.
coniferarum
Chlænogramma jasminearum
Daremma undulosa
catalpæ, II, Fig. 11.
hageni ? (W)
Ceratomia amyntor, I, Figs. 45 and 49.

SMERINTHINÆ
Pachysphinx modesta, II, Fig. 7
occidentalis (W)
Smerinthus *ocellatus*
jamaicensis
cerisyi
Paonias excæcatus
myops, I, Figs. 42-44.
astylus
Amorpha populi
Dilina tiliæ
Cressonia juglandis, II, Figs. 12 and 13.

CHOEROCAMPINÆ
Deilephila lineata, II, Fig. 9.
gallii, I, Figs. 46 and 52
euphorbiæ
lathyri
vespertilio
Chœrocampa (Pergesa) elpenor
porcellus
Chœrocampa (Hippotion) celerio, II, Fig. 15.
Chœrocampa (Theretra) alecto
Choerocampa (Xylophanes) tersa

PHILAMPELINÆ
Pholus achemon
pandorus
vitis (fasciatus)
labruscæ (Figure only) Fla.
Daphnis nerii
Clarina kotschyi syriaca
Ampelophaga (Ampeloeca) myron versicolor
Ampelophaga (Darapsa) choerilis
Deidamia inscriptum
Sphecodina abbotii
Amphion nessus I, Figs. 48 and 53; II, Fig. 14.
Proserpinus proserpina, II, Fig. 3
flavofasciata
juanita
gauræ
Macroglossa stellatarum

SESSINÆ
Hemaris croatica II, Fig. 16
rubens (W)
diffinis and form axillaris
thysbe
Erynnyis alope edwardsii Fla.
ello Fla.
Pseudosphinx tetrio Fla., I, Figs. 47 and 50.

FIELD KEY TO THE SPHINGID CATERPILLARS.* OF THE EASTERN UNITED STATES.

A. Horn completely wanting, head half higher than wide and triangular...... **Lapara coniferarum** and **bombycoides**
A. Eighth abdominal segment bears a little hard nodule (caterpillar brilliantly marked with black, white and red).......... **Pholus fasciatus (vitis)**
A. Eighth abdominal segment with an eyespot, otherwise unarmed..........B
A. Eighth abdominal segment with a horn, otherwise unarmed ....F
A. Eighth abdominal segment with a horn, mesothorax sharply humped or tuberculate.... .... **Lintneria eremitus**
A. Eighth abdominal segment with a long horn, and thorax with four much shorter ones..................................... **Ceratomia quadricornis**
B. Slanting white patches on the sides...................................C
B. Pale on the sides, obliquely mottled, eyespot white. .**Pholus labruscae** (Fla.)
B. Otherwise marked; eyespot dark-ringed...............................D
C. White patches are full three times as long as broad........ **Pholus achemon**
C. White patches are 2½ times as long as broad.............. **Pholus pandorus**
D. Checkered contrastingly with red and green........ **Proserpinus juanita**
D. No red .... .E
E. Eyespot ringed with jet-black.................... **Proserpinus flavofasciata**
E. Eyespot ringed with brown............................ **Sphecodina abbotii**
F. Slanting lines on the sides, sloping upward toward the rear................G
F. Slanting lines, if present, running in the opposite direction................Y
G. Slanting lines dark and more than seven, with a double set on the dorsum **Amphion nessus**
G. A single slanting line running up to the horn.............. **Cocytius antæus**
G. Numerous slanting lines, on the dorsum only .... **Cocytius cluentius**
G. Slanting lines indefinite in number or evanescent; spiracle marked with two vertical bars, caterpillar a little humped........ **Deidamia inscriptum**
G. Slanting lines six or seven, and distant...............................H
H. Head rounded, with two pair of vertical dark stripes; on Convolvulaceae **Herse cingulata**
H. Head mostly with one or no vertical dark stripes; on other plants..........I
I. Horn rudimentary................................. **Pachysphinx modesta**
I. Horn as long as head, or longer.......................................J
J. Skin rough and granular, head triangular...............................K
J. Skin nearly smooth, but with the stripes marked with raised granulations. .O
J. Skin smooth... P
K. Horn well defined and much longer than height of head. .**Cressonia juglandis**
K. Horn about as long as height of head, and not very distinct from body, straight............ L
L. The oblique stripes irregularly shaded with red patches.... **Paonias astylus**
L. One of two pairs of red spots alone, or with one or two much larger than the others .... **Paonias myops**
L. With a number of equal red spots or with none...........................M
M. With none, horn normally blunt, or blueberry................ **P. astylus**
M. Horn always acute.......... ....N
N. Horn pink, violet or blue.............. **Smerinthus cerisyi** and **jamaicensis**
N. Horn normally blue-green............................ **Paonias excæcatus**
N. Horn normally yellow-green, yellow on the sides............ **Paonias myops**
O. Head broad and rounded, granulated.................... **Atreides plebeius**
O. Head high and tapering, nearly smooth.......... **Chlænogramma jasminearum**
O. Head broad and tapering, nearly smooth............................ **Phlegethontius rusticus,** and occasional specimens of **Sphinx chersis,** etc.
P. First segment of abdomen much swollen, subdorsal stripe well developed. .Q
P. Caterpillar nearly cylindrical, subdorsal stripe present on thorax only....S
Q. Subdorsal stripe complete............................ **Ampelophaga myron**

* See "Field Tables of Lepidoptera (1906) p. 69.

Q. Subdorsal stripe broken in the middle....................................R

R. Horn near twice as long as head, and down-curved............**A. versicolor**

R. Horn little longer than head and nearly straight..............**A. chœrilis**

S. With pale substigmatal bands on the segments which have obliques, meeting the obliques to form chevrons................**Phlegethontius 5-maculatus**

S. No stigmatal band...T

T. With the obliques showing no trace of red and edged above with a row of black spots, horn reddish....................**Phlegethontius carolina**

T. Obliques not edged above with a row of black dots; usually with red or violet. U

U. Horn little longer than the height of the head, which is decidedly higher than wide.. **Daremma undulosa**

U. Horn about half longer than the head, which is as wide as high............V

V. Ground color very pale green (or the alternative pink or fawn)......... **Sphinx chersis**

V. Ground color bright grass green (or crimson or brown)....................W

W. Only six stripes are fully developed (pink); head broad and rough to the naked eye... **Dolba hylæus**

W. With seven equally well-developed stripes...............................X

X. Horn green, black at the sides, straight; stripes with pink.............. **Sphinx gordius** and **luscitiosa**

X. Horn deep red (as also the stripes on the head); stripes violet .... **Sphinx drupiferarum**

X. Stripes heavily marked with black, and often shaded with blue........ **Sphinx kalmiæ**

Y. With oblique stripes running up toward the front ....Z

Y. With pale transverse stripes; black............**Pseudosphinx tetrio** (**Fla.**)

Y. Catocala-like with small horn and a tubercle on middle of abdomen **Madoryx** (**M. pseudothyreus** occurs in Fla.)

Y. With subdorsal eyespots ....A

Y. Checkered or with patches of yellow dots C

Y. Metathorax sharply humped with a dorsal eyespot.........................E

Y. More or less striped longitudinally..F

Z. Oblique stripes and subdorsal red....................**Proserpinus gaurae**

Z. Oblique stripes and subdorsal yellow..................**Pachylia ficus** (Fla.)

A. A single eyespot on segment A1................**Xylophanes porcus** ? (Fla.)

A An eyespot on A1 dark-pupilled, the rest light-pupilled....**Xylophanes tersa**

A All the eyespots alike ....B

B Ground color bright green; last eyespot quite like the others, lower part of head light...**Deilephila lineata**

B Ground color olive green; last eyespot often stretching out toward the horn; head with a black band below..........................**Deilphila gallii**

C Horn very slender.................................. **Daremma catalpæ**

C Horn normal ....D

D Subdorsal yellow powdering if present continuous with that lower on the sides; lower part of face black.......................**Deilephila gallii**

D Patches of subdorsal yellow powdering on each segment; or checkered with black and green; lower part of face concolorous......**Deilephila lineata**

E Eyespot black with a pale ring...........................**Erynnyis alope**

E Eyespot black, with some red behind...................**Erynnyis ello**

E Eyespot red, with a black center........................ **Erynnyis crameri**

F Horn slender; with red dorsal stripe and two white stripes or rows of white spots on the sides...............................**Hyloicus cupressi**

F Horn various; otherwise marked, not feeding on pine......................G

G Front edge of cervical shield raised and rough............................H

G Cervical shield lightly and evenly granulated..........................
Younger stages of **Proserpinus flavofasciata, Hemaris,** and very young stages of many **Sphingidæ.**

H Dorsal dark stripe edged on both sides with pale; horn much longer than head ....**Hemaris thysbe**

H Dorsal dark stripe vague; horn about as long as head........ **Hemaris diffinis**

EXPLANATION OF THE FIGURES.

PLATE XVII.

FIG. 1. Front view of head of *Sphinx ligustri.* It is fairly typical of the species in which the head tapers moderately, but more rounded out on the sides than the average. The front is also wider and less lobed at the bottom.

FIG. 2. Labrum of *Hemaris thysbe.* Compare Annals E. S. A. III; Pl. xiv. Fig. 50.

FIG. 3. *Proserpinus proserpina.* Typical of the Semanophoræ; compare also Figs. 6 and 14.

FIG. 4. Front view of head of last stage of *Ellema harrisii.* The triangular head, which is more typical of the Smerinthinæ.

FIG. 5. Labrum of the same. *Hyloicus* is similar.

FIG. 6. Labrum of *Hippotion celerio.*

FIG. 7. Labrum of *Pachysphinx modesta. P. occidentalis* is the same, and the normal Smerinthinæ differ only in having one less marginal seta.

FIG. 8. Labrum of Sphinx (Lintneria) eremitus. typical of the lower species of Sphinx. For one of the higher type see Annals E. S. A. III, Pl. xiii, Fig. 40, which is *S. gordius*, labelled "Dolba hylaeus" in error. The species labelled *gordius* is certainly *S. drupiferarum.*

FIG. 9. *Deilephila lineata.* The other species are about the same.

PLATE XVIII.

FIG. 10. Front view of head of *Hyloicus pinastri. Sphinx drupiferarum* is similar in outline, and so are all the species described as having a broadly rounded head.

FIG. 11. Labrum of *Daremma catalpae*, showing seta iii high, as in the Semanophoræ.

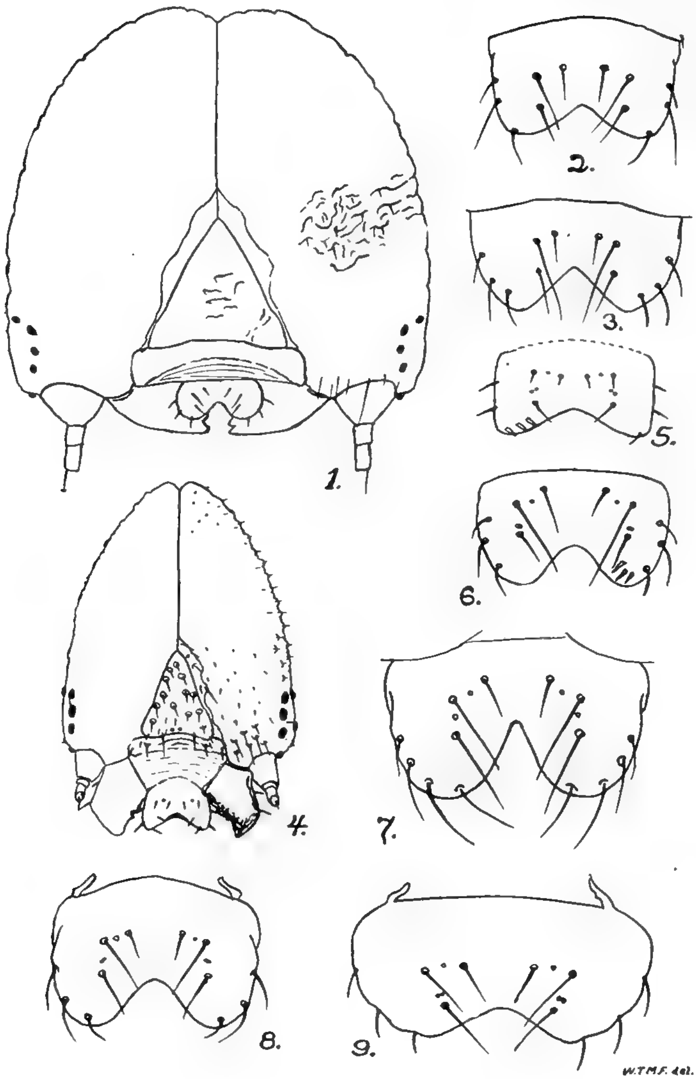
FIG. 12. Next to last stage of *Cressonia juglandis.* In the same stage Lapara has the same peculiar shape.

FIG. 13. Labrum of *Cressonia juglandis*, last stage.

FIG. 14. Labrum of *Amphion nessus.* Typical.

FIG. 15. Head of *Hippotion celerio*, showing the slightly squarish form which is most frequent in the Semanophoræ.

FIG. 16. Head of *Hemaris croatica.* It is broader than our species of Hemaris, and resembles Macroglossa except in the small front.



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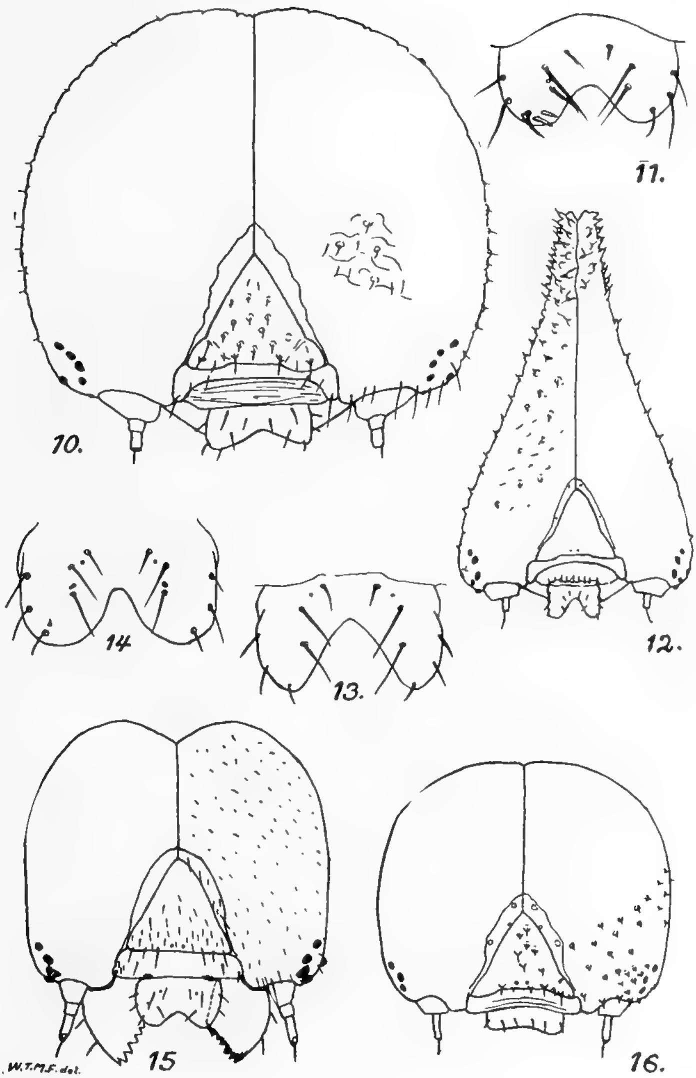

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SOME NOTES ON HEREDITY IN THE COCCINELLID GENUS ADALIA MULSANT.*

By Miriam A. Palmer.

It is the purpose of this paper to give a report of some experimental investigations in heredity which were made with four different forms belonging to the genus *Adalia* Mulsant. These forms shall herein be designated as *melanopleura* Leconte, *annectans* Crotch, *coloradensis* Casey, and *humeralis* Say.†

Melanopleura (Fig. A, Pl. XIX), as met with in this paper, is described as follows: Head black, with fine apical line of white, and with a whitish triangle next each eye with the apex pointing mesad and nearly reaching the median line. Sometimes a median strip of whitish connects these spots and extending forward to the apical line, which may also widen, leaves only a pair of black spots or brownish dots, one on either side of the median line on the anterior part of the head. (See head markings in Figures A, B, C, and F, Pl. XIX). Pronotum pale, with black M-shaped design and a lateral black spot, except in an unusually albinic form where the spot is absent or represented by a mere dusky area. The black spot when present may vary from a moderate sized area well enclosed by the surrounding white, to a large area which may break more or less widely through the surrounding white so as to connect with the M design. See pronotum markings in Figures A, B, and C, Pl. XIX). The basal marking is usually large in this form but may be rather small in some cases. Elytra brownish red and immaculate, or with faint dot on lateral margin of each elytron. Legs yellowish brown, darker on outer margin. Length 4–6 mm., width 3–4 mm.

Annectans, Figures B, C, and F, Plate XIX, includes quite a range of variation. The group as met with in this study is described as follows: Head as in *melanopleura*, pronotum as

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*This paper is an outgrowth of breeding cage work with the *Coccinellids*, assigned me by Professor Gillette as a part of his Adams Fund project on Life Histories of the Plant Lice and Their Enemies.

† These determinations are according to Major Thos. L. Casey, who very kindly criticized my determinations of the forms referred to in this paper, excepting that *annectans* includes also an unusual and rather rare form (Fig. F, Pl. XIX), the status of which seems to me a little uncertain, but which Mr. C. W. Leng determines as *annectans*. Lacking any biological proof to the contrary I have included it under *annectans*.

given for *melanopleura* except that the basal marking is on the average somewhat smaller and is, in rare cases, even absent. The lateral black spot also is absent in an unusually albinic form, Figure F, Plate XIX. Elytra reddish yellow, usually lighter than *melanopleura*, quite yellowish for several weeks after emergence, becoming redder with age, though some never develop much of the red color. In the individuals reared of the more albinic form, Figure F, Plate XIX, the red color began to appear immediately after emergence but was paler in the region of the spots, giving a sort of blotchy appearance. This paler area may persist even in old beetles which have hibernated. Each elytron typically with a longitudinal posteriorly pointed black dash from the base at each side of the suture, and two sub-basal spots, the outer more basal, also with a transverse series of three black spots just before the middle, and two more at apical fourth, the outer very close to the margin. These black spots may vary from mere dots with some absent, to large blotches which may have more or less tendency to confluence; so that in color pattern many resembled *ovipennis* Casey, and a very few came very close to *transversalis* Casey as figured by Johnson.* Mr. Casey, however, to whom I submitted specimens of these beetles, says that they are not his species as they do not show the proper punctuation. Some specimens show a rather definite pattern of red spots, two on each elytron, one a large oblong spot at the humerus and the other a smaller round spot close to the suture and between the middle and apical series of black spots. Legs and size as in *melanopleura*.

In the more albinic form, Figure F, Plate XIX, the anterior spots were always lacking and the middle and apical series were irregularly represented. Altogether this form differs from the rest of the group in three respects; namely, in lacking the anterior or basal elytral black spots, the absence of the lateral black spots on the pronotum, and in the presence of the redder coloration of the elytra. Three individuals of this form appeared in one batch of *annectans*, and one in another batch of *annectans*, also two from a batch of larvae, from *melanopleura* parents, which produced both *melanopleura* and *annectans*. In these broods there were also some individuals which might be

* Johnson, Roswell H., 1910—Determinate Evolution in the Color Pattern of the Lady-beetles, Carnegie Institution of Washington. Pub. No. 122. Papers of the Station for Experimental Evolution, No. 15.

considered as intergrading forms to some extent. This form presents a rather strikingly different appearance from the rest of the group, since all of these characters seem as a rule to go together, making a rather pronounced gap in the series of variation. It seems indeed to be closer to *coloradensis* than to *annectans.* Furthermore, among the 109 *annectans* which were reared from eggs of two *annectans* females and two *melanopleura-annectans* hybrid females, mated with one *annectans* male and one *melanopleura* male, not one of these forms appeared, which fact seems to show that it is not a common fluctuating variation at least. It seems that the heredity might be segregate and experiments are now in progress to determine this point. It is on this account that I have thought best to call attention to it separately though for the rest of this paper it will be included under *annectans.*

Coloradensis Casey, Fig. E, Pl. XIX, is described as follows: Head black with fine apical margin of whitish, and triangular pale spot next each eye as found in *annectans.* Pronotum black with very fine apical pale margin sometimes obliterated, the posteriorly pointed median pale dash from the apical margin very small when present, sides with same pale pattern as *melanopleura* but lacking the black lateral spot, basal marking absent. Elytra brownish red, about the same color as *melanopleura*, with a duplex black spot at the middle, sometimes in the form of a band, sometimes appearing as two separate spots, also a similar series of spots, two in number at apical fourth, the inner one the larger. Legs and size as in *melanopleura*, but the shape perhaps a little more narrowly oval.

Humeralis, Say, Figure D, Plate XIX; Head same as in *melanopleura*, except that sometimes a different pattern appears as shown in Figure D, Plate XIX. Pronotum black with fine apical line and narrow side margins pale, apical line sometimes obliterated, basal marking always absent. Elytra black with a large oblong yellowish red to bright red spot at humerus and another small round one at three-fifths and close to the suture. The red marking on the elytra seems identical with the red pattern above mentioned as appearing in some specimens of *annectans.* Legs and size same as given for *melanopleura*, shape usually a little more rounded posteriorly.

The work with these forms was at first undertaken merely for the purpose of obtaining specimens for life history drawings of *melanopleura* and *annectans.* In rearing these forms the fact of their interbreeding with each other and with *humeralis* was discovered, and then the work was directed along the line of heredity investigation. About four hundred beetles were reared to maturity from about three thousand eggs hatched. These beetles proved much more difficult to rear than the larger species such as *Hippodamia convergens* and *Coccinella quinque-notata* because of their more limited range of food and more delicate constitutions. All large aphids brought disaster in the breeding cage and sometimes even the small cottonwood louse, *Chaitophorus populicola* Thos. was rejected. In the latter case it was perhaps due to an odor left by a certain species of attendant ants, since these lice did not always prove objectionable. One feed of unfavorable lice would sometimes cause the death of from one-half to nine-tenths of a cage of larvae.

Work was begun with these beetles with the capture, May 13, 1910, in the foothills near Fort Collins, Colorado, of a pair of *annectans*. Eggs of this female were laid in the laboratory and the larvae reared. When the beetles eight in number emerged, four proved to be like the parents and four were *humeralis*. Three subsequent batches of larvae giving nine adults, were reared from eggs laid by this female and her spotted daughters with the result that three of the beetles were *annectans* and six were *humeralis*.

For the purpose of obtaining more material and also of ascertaining how frequently such mixing occurred, two or three dozen pupae of this species were collected outdoors, and as soon as the beetles emerged and the colors developed the different forms were isolated in separate cages. About fifteen percent were *humeralis* and the rest were about evenly divided between *melanopleura* and *annectans*. The humeralis beetles escaped by accident, but from the eggs of the other forms a considerable number of larvae were reared to maturity. From the eggs laid in the *melanopleura* cage thirty beetles were reared, and in each batch a large proportion were *annectans*, sometimes over half the batch and once the entire batch. Practically the same proportions were obtained from eggs of one or two females captured at other times. Besides the forms already mentioned three individuals of *coloradensis* appeared among the progeny of the above mentioned cage. Unfortunately these were not used for breeding purposes but were pinned up and put in the collection. Breeding experiments are now, however, in progress with this form.

From the cage of *annectans* only *annectans* were obtained. Twenty-five adults were reared from eggs laid in this cage, and fifty-seven from eggs laid by a female tested in a way to be explained later, making eighty two beetles in all, and every one proved to be *annectans*. The eggs of one *annectans* female captured out of doors produced several *melanopleura* but this female had probably been fertilized by a hybrid male or even by both *melanopleura* and *annectans* males before it was captured.

The *humeralis* beetles reared from the first pair mentioned were used for breeding purposes and all the individuals reared came true to type, about thirty beetles maturing.

It was now indirectly evident that mixing was quite common between *melanopleura* and *annectans* and that it sometimes occurred between *annectans* and *humeralis*, but there was no evidence that it occurred between *melanopleura* and *humeralis*. To ascertain whether this latter were possible and also to make the actual crosses in the other cases in order to further investigate the law of heredity, efforts were made to cross *humeralis* as often as possible with *annectans* and *melanopleura*. *Humeralis* was found to hybridize just as freely with one form as with the other. No more difficulty was encountered than would be expected even among members of the same form under the same circumstances. On one occasion an *annectans* male chose a *humeralis* female even though a female of its own kind was present in the cage.

Unfortunately only one female of *humeralis* was available for this purpose sufficiently early in the season, but there were several males which proved capable and these were crossed with females of both *melanopleura* and *annectans*. The female of *humeralis* that was used was probably the one that produced all of the above mentioned 30 *humeralis*, all true to type, she, at any rate produced a large proportion of them. This beetle was crossed with an *annectans* male but she died so soon that only two beetles were reared from this union. They were *annectans* but were too feeble for further breeding. An *annectans-humeralis* hybrid female was mated with a *melanopleura* male and later with an *annectans* male. This female had previously been kept in a cage with its brothers and the eggs laid had produced seven *humeralis* and four *annectans*, but after these crossings no more *humeralis* appeared though forty-seven beetles were reared. Three crosses were made by means of the *humeralis* males and *melanopleura* and *annectans* females and from these 169 beetles were reared in the first generation. All but one were either *melanopleura* or *annectans* according to the composition of the female. This one exception was a *humeralis* beetle. A noticeable character of the progeny of these crosses was the greater vigor of the individuals so that a larger percent matured as compared with the purer strains. From one of the above three pairs, an *annectans* female and a *humeralis* male, the first generation of which consisted of fifty-seven *annectans*, four second generation beetles were reared and they proved to be two *annectans* and two *humeralis*. The beetles then refused to lay any more eggs and seemed to be preparing for hibernation. They had been unavoidably subjected for a few days to a temperature low enough to stiffen them up considerably and cause them to nearly cease eating and the subsequent removal of them to an almost summer temperature, though it caused the eggs to hatch in half the time they had under the low temperature and increased the appetites and rate of growth of the larvae quite remarkably, failed to cause the beetles to lay any more eggs. Work had, therefore, to close for the season at this interesting point, and the beetles were put into hibernation.*

From these crosses there is another lesson to be learned besides the relation of *annectans* and *melanopleura* to *humeralis*, namely; something about the heredity between *melanopleura* and *annectans* themselves. The process of mating these forms with *humeralis* which is recessive to both, served as a test of the germinal composition of the member of the pair carrying the dominant characters. In the case where two *melanopleura* females, which had been isolated from *annectans* from time of emerging were crossed with *humeralis males* there were produced 29 *melanopleura* to 25 *annectans*, and 31 *melanopleura* to 26 *annectans* respectively. *Melanopleura* was in each case a little in excess of 50 percent. In the case of the *annectans-humeralis* hybrid female mated with the *melanopleura-annectans* male the progeny was 19 *melanopleura* and 28 *annectans*. The higher percent of *annectans* was doubtless due to the fact that an *annectans* male was put into the cage during the latter

* Just as this article was ready to send to the publisher a lot of second generation beetles, from the *melanopleura* females crossed with the *humeralis* males, emerged. From the eggs of the first generation *melanopleura-humeralis* hybrids there were reared 19 *melanopleura* and 7 *humeralis*. From the eggs of the first generation *annectans-humeralis* hybrids there matured 12 *annectans* and 5 *humeralis*. These figures come very near to the Mendelian ratio for progeny of hybrids.

part of the period, because just before the last three batches the proportion was 16 *melanopleura* and 18 *annectans*, and the last three batches gave 3 *melanopleura* and 10 *annectans*, thus making a sudden change in the proportion. This male was in all probability pure *annectans* as there has not been found, in my experience, any proven case of *annectans* carrying *melanopleura* characters. The characters carried by the female could have had no influence whatever in the results, since neither of the characters carried by the female was dominant to the characters carried by the male. Either the *melanopleura* or the *annectans* characters of the male would realize themselves whether they met an *annectans* or a *humeralis* character of the female. These results approximately show that the *melanopleura-annectans* hybrids carry the characters in the proportion of half and half. The somewhat high percentage of *melanopleura* obtained in these cases was more than balanced by the extremely low percentage obtained in the case of the progeny of the cage of *melanopleura-annectans* hybrids, in which case *melanopleura* constituted less than half of the progeny when it should have constituted three-fourths. The mortality in this latter case, however, was so great that the data are hardly sufficient.

Another *melanopleura* female from *melanopleura-annectans* hybrid parents after being fertilized by some of its *melanopleura* brothers was isolated for a few days, during which time it laid three batches of eggs. From these eggs were reared 9 *melanopleura*, 3 *humeralis*, and 1 *annectans*. Excepting the one *annectans*, this was just the right proportion for the progeny of two hybrids according to the Mendelian law. This *annectans* individual, (if it did not get in by mistake which was very unlikely, great care having been exercised) must have been due to fertilization by a *melanopleura-annectans* male probably before the *melanopleura-humeralis* male. The female was then mated with a *humeralis* male and after that 14 adults were obtained, 6 *melanopleura* and 8 *annectans*. The results in this case seem to indicate that there had been a cross between the *melanopleura* ancestors of this female and *humeralis*, while still in nature and that in the first generation reared in captivity the dominant *melanopleura* had kept it concealed, so that it was not until the second generation that the crossing between two hybrids happened to take place, thus allowing the *humeralis* character to appear.

From the cross between an *annectans* female (reared from *melanopleura* parents) and a *humeralis* male 57 beetles matured all *annectans*. This showed the female to be pure strain though descended from *melanopleura* parents.

The foregoing results are given below in tabulated form:

	mel.	col.	ann.	hum.	total
Crosses					
1 Male—*annectans* / Female—*humeralis* } 1st gen.			2		2
2 Male—*humeralis* } 1st gen.			57		57
Female—*annectans* } 2nd gen.			2	2	4
3 Male—*humeralis* } 1st gen.. } 2d gen.	29		25		54
Female—*melanopleura**	19			7	26
4 Male—*humeralis* } 1st gen..			12	5	17
Female—*melanopleura**	31		26	1	58
5 Male—*melanopleura** and later *annectans* } 1st gen.	16		18		
Female—*annectans-humeralis* hybrid	3		10		47
Humeralis Hybrid					
Female—*annectans-humeralis*. / Male—*annectans-humeralis* } offspring ...			7	10	17
Female—*melanopleura-humeralis* / Male—*melanopleura-humeralis* (probably). / Also *melanopleura-annectans* (prob.)	9		1	3	13
Female—*melanopleura-humeralis* / Male—*humeralis* } offspring.	6			8	14
Melanopleura-annectans Hybrids					
Cage of males and females—offspring	11	3	16		30
Female captured, male *annectans?* —offspring	7		6		13
Two females and one male mated with recessive } offspring (See crosses 3, 4 and 5)	76		69	1	
	94	3	91	1	
Annectans					
Cage of males and females—offspring			19		19
One female, captured, male unknown, offspring			6		6
One female with *humeralis* male (See cross 2)—offspring			57		
			82		
Humeralis					
One female with 3 males—offspring (Female used later in cross 1)				30	30
Total					407

* melanopleura-annectans hybrid.

From the foregoing results the following conclusions seem to be quite evident:

I. *Melanopleura* is dominant over *annectans*, *coloradensis*, and *humeralis*, and the heredity is segregate.

1. Over *annectans* since

   a. The hybrid form between *melanopleura* and *annectans* is *melanopleura*. Of the progeny, 30 in number, of a cage of *melanopleura*, *annectans* constituted over half. In the progeny of two females and one male tested by mating with *humeralis* there appeared 76 *annectans* and 69 *melanopleura*, altogether, which is very close to the Mendelian ratio for the segregation of characters in hybrids.

   b. *Annectans* has in no case given evidence of carrying *melanopleura* characters. The 25 progeny from a cage of *annectans* showed no *melanopleura* characters nor did any of the 57 progeny of the *annectans* female mated with *humeralis*.

2. Over *coloradensis* since the hybrid form between *melanopleura* and *coloradensis* is *melanopleura* as is shown by the fact that 3 *coloradensis* appeared among the offspring of *melanopleura* parents.

3. Over *humeralis* since

   a. The hybrid form between *melanopleura* and *humeralis* is *melanopleura*. In the first generation from three crosses of *melanopleura* with *humeralis* or with *annectans-humeralis* hybrids, *humeralis* appeared but once among 159 individuals. A *melanopleura-humeralis* female mated with its brothers gave 9 *melanopleura*, 1 *annectans*, and 3 *humeralis*. The same female mated with a *humeralis* male gave 6 *melanopleura* and 8 *humeralis*, approximately showing the segregation of characters to be according to the Mendelian law. The second generation from crossings of *melanopleura* with *humeralis* consisted of 19 *melanopleura* and 7 *humeralis*.

   b. *Humeralis* has given no evidence of carrying *melanopleura* characters. The 30 offspring from *humeralis* parents all came true to type.

II. *Annectans* is dominant over *humeralis* since

   a. The hybrid form between *annectans* and *humeralis* is *annectans*. In the cross between *annectans* and *humeralis* *humeralis* did not appear at all in the first generation of 57 progeny, but did appear in half of the second generation which consisted of 4 beetles. *Annectans-humeralis* hybrids mated with each other produced 7 *annectans* and 10 *humeralis* in one case, and in another 12 *annectans* and 5 *humeralis*.

   b. *Humeralis* has given no evidence of carrying *annectans* characters, as shown by the 30 offspring of *humeralis* parents all true to type.

This subject is still unfinished and experiments are now in progress to determine the relation of *coloradensis* and the rather albinic form of *annectans* to the other forms.

It would be interesting to interbreed these forms with other species of *Adalia*, especially with the European *frigida* Schneider and with *bipunctata* Linneaus.

Observations were also made on the beetles used in the foregoing experiments for the purpose of ascertaining the heritability of the characters of the spots on the elytra in *annectans* and of the markings of the pronotum in this same form and in *melanopleura*. The progeny resulting from the mating of *annectans* and *melanopleura* beetles with the recessive *humeralis* were examined when the number was large enough to afford sufficient data. The beetles in these cases were particularly advantageous for this purpose because the dominant characters would be the only ones to show in the first generation, thus reducing the number of strains which would appear to one or two. In the case of the *melanopleura-annectans* hybrids there would be one strain of *annectans* and one of *melanopleura*, which would afford a very simple series and show very plainly whether these characters behave at all as unit characters or whether they seem to be fluctuating variations. The results are shown in the drawings Figures 2 to 7, Plates XX to XXII.

In the markings of the pronotum, special attention was paid to the character of the lateral black spot and the extent to which was it enclosed by the surrounding white. The median posteriorly pointed dash of white from the apical margin and also the basal marking of whitish are sometimes very small or even absent; but in this study only secondary attention was paid to these and the drawings, except curve (e), Fig. 7, Plate XXII, are arranged in series according to the aforesaid black spot. The pronota of *melanopleura* and *annectans* are arranged separately in each case.

In the case of the elytra primary attention was paid to the confluence of the spots, and the series is arranged according to the number of confluences in each case. The parents of each series are drawn in full or designated above and the first generation progeny in a row below. The numerals below each drawing indicate the number of individuals in that class. As the *humeralis* parent seems to have no influence on the characters of the first generation it was not thought necessary to draw this parent.

Figure 2, Plate XX represents the *annectans-humeralis* hybrid female and her progeny resulting from union with a *melanopleura-annectans* hybrid male, and also for the last few days of the experiment, with a pure *annectans* male. The numbering of the spots is after Weise taken from Johnson 1910. In this case the progeny would contain four strains of *annectans*, one from the mother, one from the *melanopleura-annectans* father, and two strains from the *annectans* father, which, however, could hardly have affected more than the last three batches of eggs. This would be just the number of strains to be represented if two members of *annectans* were mated. The males in this case were both lost and so can not be shown in the figure. Of the batches after the *annectans* male was introduced, in the elytra series, one beetle was in class (d), six in class (e), three in class (f), and one in class (i). In the pronota series four were in class (k) and seven in class (l). There was considerably less variation among these than in the foregoing batches, but whether it was due to the *annectans* male or to environmental influences can not be ascertained with certainty; but as these were reared later in the season than the foregoing batches, during the latter part of August and the early part of September, during which time an unusually cold wave occurred, the only environmental influence would probably have been a lower temperature. This factor, however, would, from the experience of Tower* and Johnson, be expected to produce a melanic effect, but here the difference was albinic rather than melanic, so the case does not seem to be explained by the environmental factor, and unless it was produced by some unknown cause, seems most probably to have been due to heredity factors introduced by the *annectans* male.

It will be noted in this case, Figure 6, curve (a), Plate XXI, and Figure 7, curves (a), and (b) Plate XXII, that all of the beetles, of both *melanopleura* and *annectans*, which were reared from this female were rather at the albinic end of the scale as to both elytral and pronotal characters. In the elytra none have more than two full confluences and the mother ranks at

* Tower, William Lawrence, 1906. An Investigation of Evolution in Chrysomelid Beetles of the Genus Leptinotarsa. Carnegie Institution of Washington, Pub. No. 48.

about the middle of the series and at one of the highest points of the curve. In the case of the pronotum the mother was decidedly more melanic than the apex of the curve for either *annectans* or *melanopleura*. The curves for these two forms were not alike, annectans having the greatest number, 45 per cent at the albinic end of the scale with the black spot well enclosed by the surrounding white. In the *melanopleura* series only 11 per cent were at this point, the largest number, 83 per cent, having the black spot rather weakly enclosed. None of the *annectans* here showed the red pattern on the elytra, as shown in Figure B, Plate XIX, though the mother shows it faintly.

Figure 3, Plate XX, represents the *annectans* female crossed with *humeralis* male. In this case we would expect to find only two strains of *annectans*. Here, however, the variation was considerably broader than in the former case where four strains were represented, the curve beginning at the same point of albinism as the former case and extending to four and a half confluences (that is to four and a pronounced tendency to a fifth confluence), Figure 6, curve (b). The mother was several degrees more albinic than the highest point of the curve. Note here that in the mother there is an absence of spot 4 and also that there is a small spot between spots 1 and 2, which, though very unusual, probably denotes tendency to confluence between spots 1 and 2. Neither the presence of this extra spot nor the absence of spot 4 show in any of the progeny examined, though both confluence and tendency to confluence appear between spots 1 and 2. The mother of these seems to have shown nothing of the red pattern mentioned above and shown in Figure B, Plate XIX, but in the 37 offspring, 9 showed it very plainly, 16 moderately plain, 4 faintly, and in 6 it was absent.

Figure 4, Plate XXI shows a *melanopleura-annectans* hybrid female, crossed with a *humeralis* male, and her first generation progeny. Here there can be but one strain of *annectans* to appear in the progeny. The curve of variation, Figure 6, curve (c), Plate XXI, covers a somewhat wider range of variation than in the case of the first instance, curve (a) where four strains are represented, the largest number of confluences being three. Here 23 out of 27 or 85 percent lack spot 6. In the pronota of *annectans* a peculiarity was observed in that sometimes either the basal marking or the apical median dash were lacking.

For these pronota two curves were given, Figure 7, curves (d) and (e), curve (d) to show the variation of the lateral spot only and (e) to represent the general melanism when the other markings are considered, each degree representing about the equivalent of the melanism of the state of the lateral spot as given in the legend for the respective columns. The curve for *annectans* in this series was much broader than that for *melanopleura*. The mother was rather toward the albinic end of the series for *annectans* and at the melanic end for *melanopleura*. All of the *annectans*, 27 in number, had the red spots on the elytra, as shown in Fig. B, Plate XIX.

Figure 5, Plate III, shows another *melanopleura-annectans* hybrid, female mated with a *humeralis* male, and her first generation progeny. Here again would be but one strain of *annectans*. The range of variation in the elytra of *annectans* was not very broad, showing none of the more albinic forms, the curve, Figure 6, curve (d), Plate XXI, beginning at one confluence and extending to three and a half confluences. In the pronota of the *annectans* series, Figure 7, curve (g), Plate XXII, uniformity almost obtains, 93 per cent having the lateral spot well enclosed and 7 per cent being one-fifth enclosed. In the *melanopleura* series, however, the curve, Figure 7, curve (h), Plate XXII, is very broad extending to a degree of melanism that is quite rare. The mother ranks at the albinic end of the scale though the highest part of the curve for her *melanopleura* offspring is four degrees further to the melanic end of the scale.

GENERAL OBSERVATIONS.

In comparing the curves for the elytra it must be born in mind that the chief points of comparison are the melanic positions of the range and highest points of the curves. Since the number of individuals represented by each of the curves was not uniform, the exact number on any one line shown by the different curves is not truly comparable; only the melanic position of high and low points and range in each curve can be compared with the same in another curve.

It will be noted that each curve has one or two points that are much higher than any other points in the curve, and that these high points in the different curves vary greatly in melanic position, also that the curves vary considerably in their range. It seems as though these high points in the curves might represent centers of variation. The curves would then signify that different strains of these beetles have different centers of variation and different scopes of variation. Curve (c), Figure 6, Plate XXI, which represents but one strain of *annectans* covers a wider range than curve (a) which represents four strains. Curve (d), which also represents one strain is quite narrow, seeming to signify that this strain had a greater degree of constancy than the others. The mother in each of these cases occurred within the range of variation for her progeny but not always at the highest point of the curve though in both of the instances where this observation was possible she occurred at one of the high points, see curves (a) and (b), Fig. 6, Plate XXI. Two of the mothers being *melanopleura* had no place in the elytra series, and since in the cases where the mother was *annectans* two or more strains were represented, the fact of the highest part of the curve not being at the same position as the mother might in this case be explained as due to one of the other strains involved.

There seemed in some cases to be a certain measure of heritability of different characters in the color pattern of the elytra. The absence of spot 6 in Figure 4, Plate XXI, seemed to be inherited to a large degree since it was lacking in 21 out of 27 beetles. The mother being *melanopleura* could not be observed on this point. This spot seems from my observations to be the one most frequently lacking in this form, indeed almost the only one except in a small minority of beetles. Spot 4 was absent in only three beetles in this study, in Figure 3 (a), Plate XX, and in two others not drawn but ranked with (f) and (g) respectively in Figure 2, Plate XX, spot 5 was faint in one, Figure 3 (c). The absence of spot 4 seemed not to be inherited in these cases, as no case of absence occurred in the 37 progeny of the mother, Figure 3 (a), which lacked it, and it appeared only twice in the 30 offspring in Figure 2, Plate XX.

Some observations were made on the order in which confluences take place. Spots 6 and 7 seemed to be the first as a rule to connect, as in this study there was only one instance where a beetle showed confluences and had these spots separate, see Figure 3 (e). There were three such cases where spot 6 was absent, but even in the case of absence there was often a projection toward its position from spot 7 as though in these instances the confluence was even more persistent than the spot itself. After this confluence no further order was observed except that between spots 4 and 5 it seemed to be the most unusual and perhaps the last in order.

In the case of the pattern of reddish spots on the elytra of *annectans* Figure B, Plate XIX, it seemed as though there might be segregation in some cases at least, and that the absence of the character was dominant to its presence. In the series in Figure 2, Plate XX, it shows faintly in the mother (the dimness may be due to fading after death as this character was not recorded during life) and it was plainly evident in the mother and a brother of this beetle, in fact in all of the individuals of this strain that have been preserved. It shows in none of the 30 progeny of this beetle, but this absence may be explained as due to the males, which being lost, can not be examined as to their possession of the character.

In the series in Figure 3 where the mother does not show the marking but carries two strains of *annectans*, it appeared in five-sixths of the beetles to a greater or less degree. As the male in this case was *humeralis* both of these strains must have come from the mother and its absence in her development would seem to signify the dominance of the absence of the character over its presence. The proportion, however, found in the progeny seems rather puzzling unless the *humeralis* character from the male could have had any influence in the proportion, which seems unlikely.

In the series in Figure 4, Plate XXI, it appeared in all of the 27 *annectans* progeny. The mother, being *melanopleura* of course does not show it. In the series in Figure 5, Plate XXI, some show it and some do not. The exact number in each case can not be determined as some of the beetles have developed so much of the red color in their elytra during hibernation that it is impossible to tell with certainty whether they possess the character or not. The mother being *melanopleura* of course does not show the character. The fact that some clearly show its presence and others just as clearly show its absence when they are all from one strain of *annectans* seems to be evidence against segregation in this case.

In the pronota curves in Figure 7, Plate XXII, the matter is a little more complex as there are both *annectans* and *melanopleura* to be represented for each female except one, Figure 2, Plate XX. As the curves for these two forms even when from the same parents were different in every case not only in the position of the apex but also in range and sometimes very different, it would seem that each strain keeps distinct; that is, the pronotal characters of *annectans* do not mix with those of *melanopleura*.

When, however, the characters of the mother are compared with those of her offspring which are of the same form as herself little uniformity was found. In no case did she rank at the highest point of the curve, neither did she ever occur at the lowest point, nor ever outside of the range of variation for the offspring. There seemed to be some degree of heredity but it was not constant. The results appear a good deal the same as in the elytra, that there are centers of variation and a certain limit of range that were inherited to a greater or less degree, but with no evidence of segregation of unit characters such as occurs between *melanopleura*, *annectans*, and *humeralis*.

ADDENDA.

Since sending the foregoing article to the publisher results have been obtained in the experiments concerning the relation of *coloradensis*, the so-called albinic form of *annectans*, and a similar form of *melanopleura* to the other forms treated. The albinic form of *annectans*, so-called for want of a better name is above described separately under *annectans* and figured at F, Plate I. The albinic form of *melanopleura* is identical with that of *annectans* in pronotal characters, namely, it lacks the lateral dot, the lateral margin of the pronotum being broadly pale as in *coloradensis;* in all other characters it agrees with *melanopleura*. The results obtained are tabulated as follows:

Parents				Ist gen. Offspring						total
Male		Female								
Appearance	Characters carried†	Appearance	Characters carried†	M	al. M	al. A	A	C	H	
C	C and H	H	H					4	3	7
unknown	M and A	al. A	C and A	4	2	1	1			8
H	H						3	2		5
H	H	al. M	C and M	3				1		4
C	C and H	M	M and H	6	7			4	6	23
al. A.	C and A	M	M and H	3	3		3	2		11
al. A.	C and A	al. A.	C and A			13	5	5		23
‡A	A and H	H	H				7		10	17
		A	A and H				11		2	13
al. M.......	C and M	al. M.	C and M		4					4
			Total....	16	16	14	30	18	21	115

*A means *annectans;* C, *coloradensis;* H, *humeralis;* al. A. albinic *annectans;* al. M, albinic *melanopleura*.

†These are given as shown by the offspring when not known from pedigree breeding.

‡This male was, judging from appearance, an intergrade between *annectans* and albinic *annectans*. It lacked the basal spots on the elytra but possessed the lateral dot on the pronotum, which latter seems to be the ultimate distinguishing character.

These results seem to furnish conclusive evidence

1. That *coloradensis* is a good variety or type equal with *melanopleura*, *annectans*, and *humeralis*, acting as a unit character in heredity.
2. That when crossed with *annectans*, *coloradensis* produces a blended hybrid, in both elytral and pronotal characters, namely the form above referred to as an albinic form of *annectans*.
3. That when crossed with *melanopleura* a blend is produced in the pronotal characters, identical with the *annectans* blend; but in the elytra *melanopleura* dominates entirely.* This form was mentioned in the description of *melanopleura* as a "more albinic form."
4. That when crossed with *humeralis coloradensis* dominates perfectly so that the hybrid form is indistinguishable from the pure strain of *coloradensis*.

It seems that in every instance the more albinic character dominated over the more melanic one; for example: immaculate elytra, in *melanopleura*, dominate over the spotted ones of each of the other forms. The absence of the black lateral dot in the pronotum, in *coloradensis*, dominates over its presence in each of the other forms. The presence of the whitish basal marking on the pronotum, of *annectans* and *melanopleura*, dominates over its absence in *coloradensis* and *humeralis*. The absence of the basal elytral spots, in *coloradensis*, dominates over its presence in *annectans*. The usual absence of confluence in the median and apical series of spots in *annectans* dominates over the confluence in these spots in *coloradensis*. *Humeralis* which presents the most melanic characters in every particular in both elytra and pronotum is perfectly recessive to each of the other forms.

The inheritance of the faint lateral dot on the elytra in *melanopleura* was observed in the specimens at hand but no law was ascertained. It seems to be a mere fluctuating variation.

The single *humeralis* beetle mentioned in the article as appearing among the first generation offspring in the 4th cross in the table, between *humeralis* and *melanopleura* parents, was tested in breeding. It proved to be a male and was put into a cage with two *humeralis* females, from the eggs of which seven progeny were reared to maturity. All of these were *humeralis*

* This statement is to be reconciled with the statement in the foregoing article that *melanopleura* is dominant over *coloradensis* by the fact that at that time the hybrid was considered as only a variant of *melanopleura*.

which seems to prove that the beetle in question was pure strain. This beetle may possibly have gotten into the cage by mistake in spite of the great care exercised as several dozen cages containing larvae of all the forms were being tended and cleaned daily.

Five other offspring were reared from *humeralis* beetles obtained in these experiments, and these all came true, making 42 progeny in all reared from *humeralis* parents, breeding true in every instance.

Two *humeralis* beetles without dorsal spots were obtained as the progeny resulting from a cross between a *melanopleura* male, (evidently a *humeralis* hybrid) from out of doors, with an *annectans-humeralis* female representing the third generation of *humeralis* reared in the laboratory. All of the ancestors and progeny, two in number, of this female, by a former mating showed the dorsal spots normally developed. These two beetles were the only progeny obtained from this union and efforts to rear offspring from them, though they proved to be male and female, have thus far been fruitless, seemingly due to a weak constitution as the eggs hatch poorly. The male seemed weak and both beetles died soon. It would seem from this case that the absence of these spots dominated over its presence, which is contrary to the behavior of heredity with regard to the other characters of this group. If this is not the case the strain in the laboratory must have carried this character of absence through three generations without it having a chance to meet its equal so as to be able to realize itself.

Another cross which was made between an *annectans* male and a *humeralis* female last August but which laid no eggs until this, the following spring, produced in the first geneartion 26 beetles, all *annectans*. The *humeralis* female was later used in the first cross represented in the first table in addenda.

EXPLANATION OF PLATES.

PLATE XIX.

FIG. A. *Adalia melanopleura* Leconte.
FIG. B. *Adalia annectans* Crotch.
FIG. C. *Adalia annectans* Crotch.
FIG. D. *Adalia humeralis* Say.
FIG. E. *Adalia coloradensis* Casey.
FIG. F. *Adalia annectans* Crotch.
FIG. G. *Adalia melanopleura* (more albinic form).
FIG. H. Pupa of *A. annectans, melanopleura, coloradensis,* and *humeralis.*
FIG. I. Larva of *A. annectans, melanopleura, coloradensis and humeralis.*
FIG. J. Eggs of *A. annectans, melanopleura, coloradensis and humeralis.*
All drawings are magnified 5 diameters.

PLATE XX.

FIG. 1 shows in diagram the results of the foregoing experiments in inheritance between *annectans, melanopleura, coloradensis, and humeralis.* The numerals beneath the circles in each case indicate the number of individuals in that class. The lines connecting with higher circles indicate parentage in each case.

FIG. 2. *a* and b—characters of *annectans-humeralis* female, mated with males indicated.
c to *j*—elytral characters of *annectans* offspring.
k to *n*—pronotal characters of *melanopleura* and *annectans* offspring. Numerals indicate number of individuals in the class in each case.

FIG. 3. *a*—elytral characters of *annectans* mother, mated with male indicated.
b to *o*—elytral characters of *annectans* offspring.
p to *v*—pronotal characters of *annectans* offspring.
Numerals indicate number of individuals in each class.

PLATE XXI.

FIG. 4. *a* and *b*—characters of *melanopleura annectans* mother mated with male indicated.
c to l—elytral characters of *annectans* offspring.
m to *t*—protonal characters of *annectans* offspring.
u to *v*—pronotal characters of *melanopleura* offspring.
Numerals indicate number of individuals in each class.

FIG. 5. *a* and *b*—characters of *melanopleura-annectans* mother, mated with male indicated.
c to *d*—pronotal characters of *annectans* offspring.
e to *k*—elytral characters of *annectans* offspring.
l to *r*—pronotal characters of *melanopleura* offspring.
Numerals indicate number of individuals in each class.

FIG. 6. Shows the curves representing the variation in the elytral characters of the *annectans* offspring, drawn in the foregoing figures. The numerals on the left show the number of individuals. The degrees of melanism are designated by the legend below in each case, the most albinic being at the extreme left and the most melanic at the right. "Confluence ½"means one case of tendency to confluence, "confluence $\frac{2}{2}$" means two cases of tendency to confluence. The latter is here given a rank of its own as it does not seem equal in melanism to one full confluence. The curve above the legend "spot 6 absent" does not represent all the individuals lacking that spot, but only those with no case of confluence.

Curve (a) represents the series in Fig. 2, Plate II. The full line triangle shows the position of the mother in this series.

Curve (b) represents the series in Fig. 3, Plate II. The broken line triangle represents the position of the mother.

Curve (c) represents the series shown in Fig. 4, Plate III.

Curve (d) represents the series shown in Fig. 5, Plate III.

The mother of the series for curves (c) and (d) were *melanopleura* and so have no place in this diagram.

PLATE XXII.

Fig. 7 shows the curves for the pronotal series.

Curve (a) represents pronotal characters of *annectans* offspring shown in Fig. 2, Plate II.

Curve (b) represents pronotal characters of *melanopleura* offspring in Fig. 2, Plate II.

The open triangle represents the mother of the series represented by curves (a) and (b), Fig. 2, *a* and *b*, Plate II.

Curve c) represents the *annectans* series in Fig. 3, Plate II.

Curve (d) represents the *annectans series* in Fig. 4, Plate III.

Curve (e) represents the *annectans* series in Fig. 4, Plate III, according to general melanism.

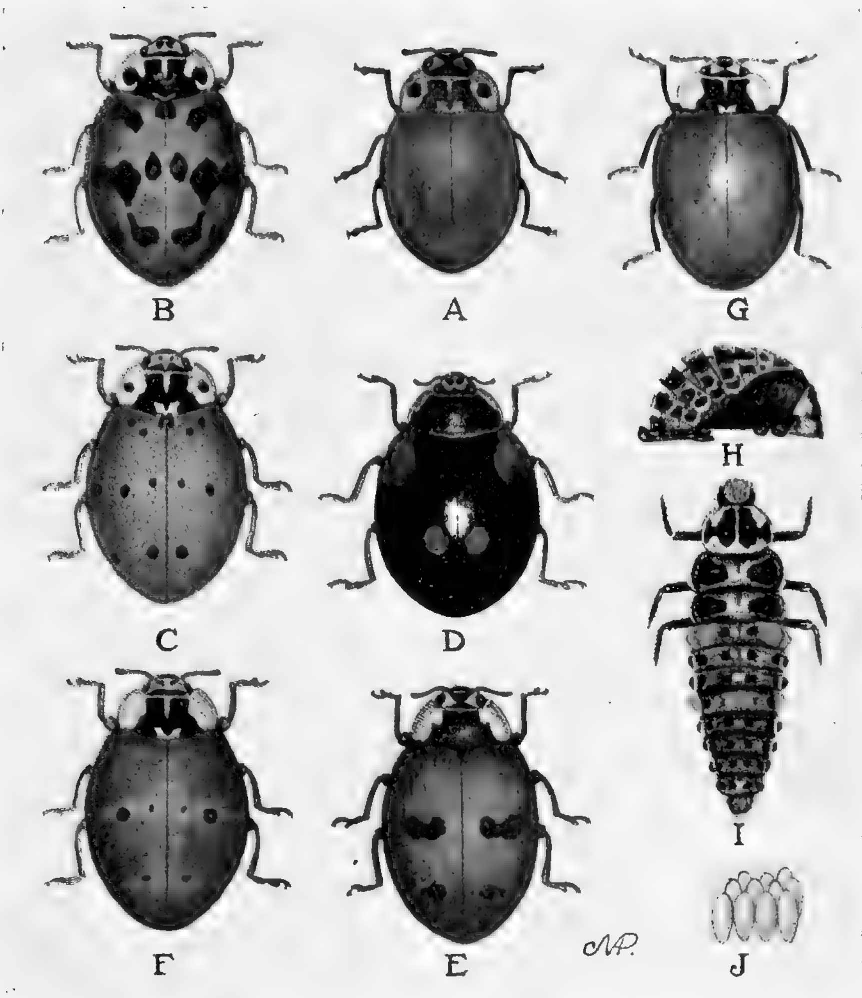
Curve (f) represents the *melanopleura* series in Fig. 4, Plate III.

The open triangle represents the mother, Fig. 4, *a* and *b*, Plate III.

Curve (g) represents the *annectans* series, Fig. 5, Plate III.

Curve (h) represents the *melanopleura* series, Fig. 5, Plate III.

The solid triangle represents the mother Fig. 5 (a) and (b), Plate III.



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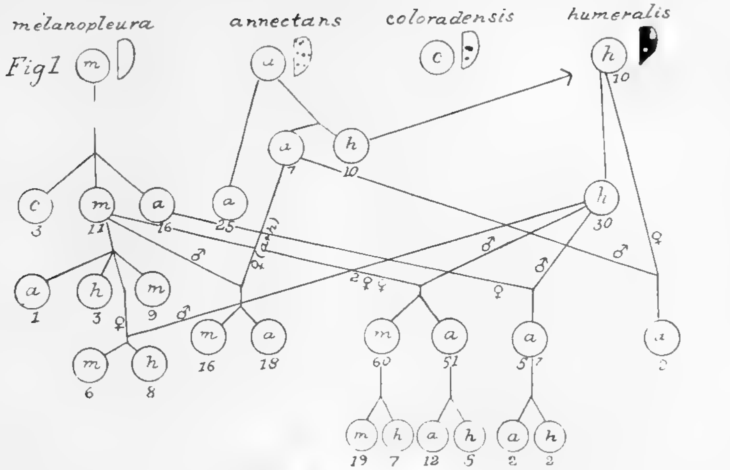

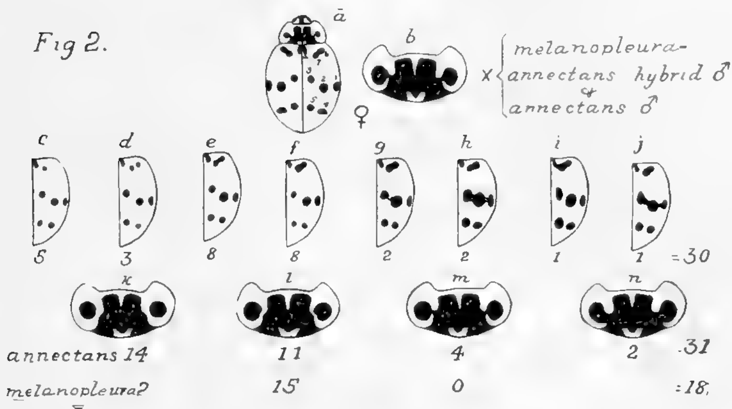

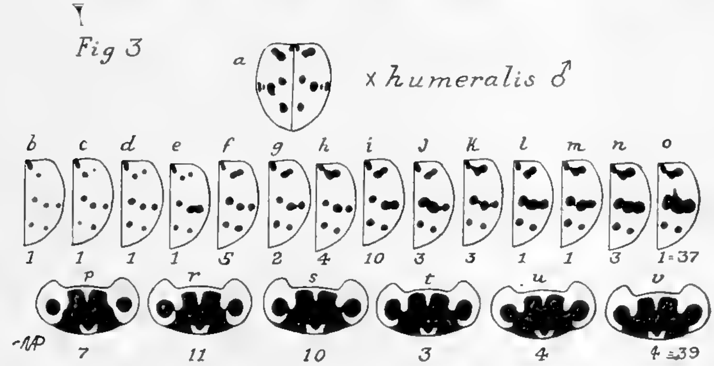

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Fig 4

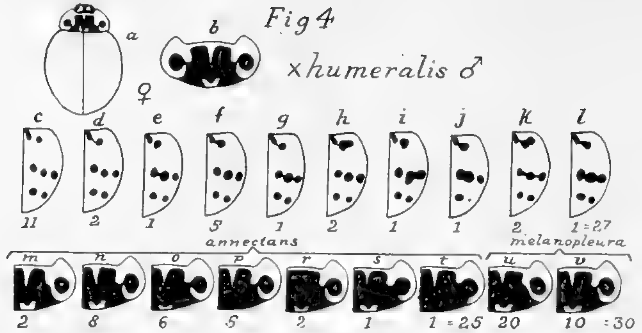

Fig 5

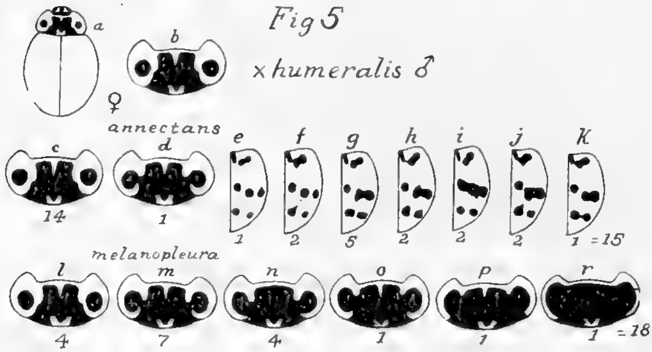

Fig 6

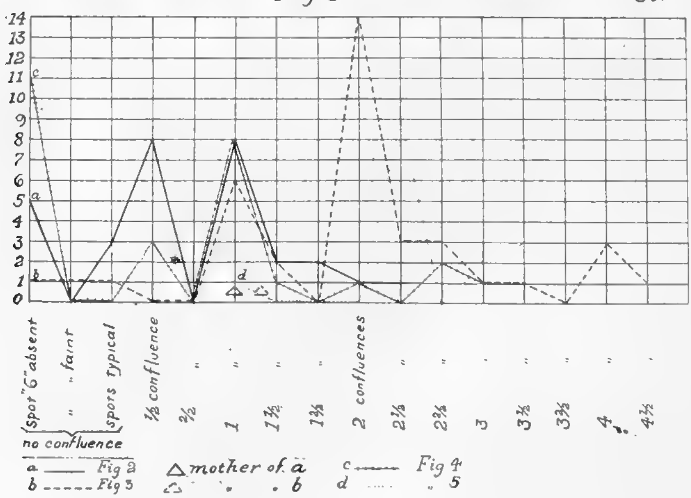

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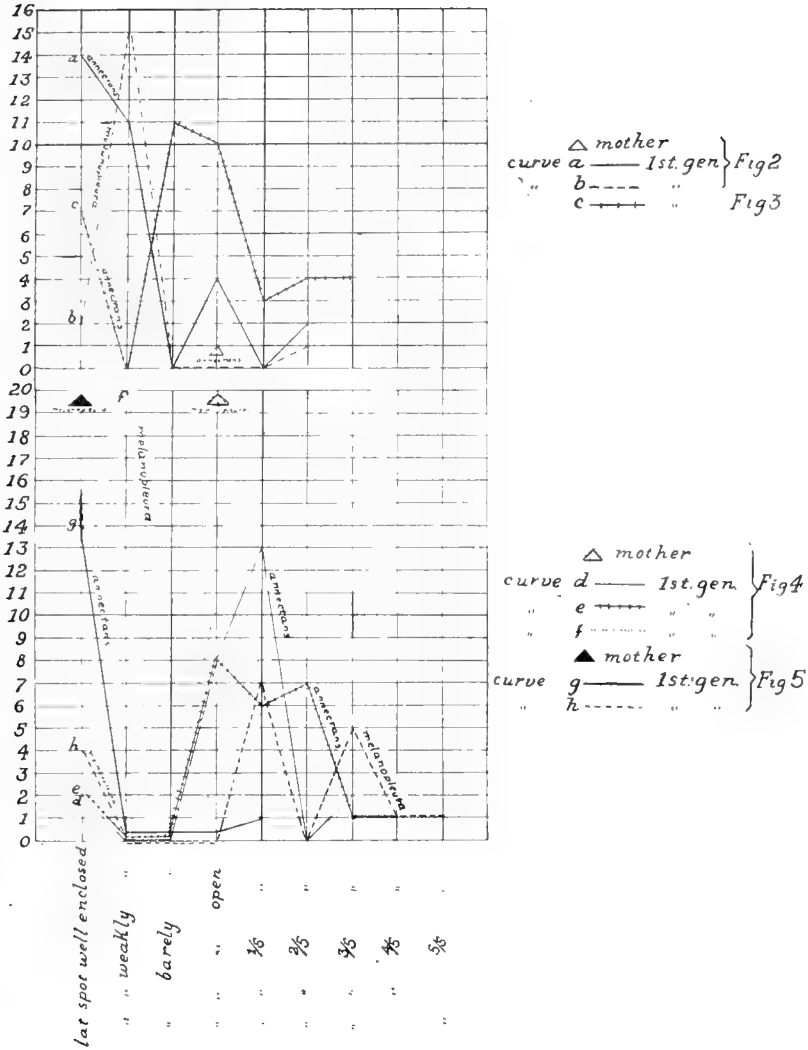
Fig 7.



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SPECIFIC CHARACTERS USED IN THE GENUS PSEUDOCOCCUS.

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INTRODUCTION.

The purpose of this investigation was to determine the value of the specific characters used in the descriptions of species of Pseudococcus. While all characters used have probably not been noted and while some of those omitted may be of considerable value still the more common and important characters have received attention.

The investigation has been limited to five species,* namely: *agrifoliae* Essig, *citri* Risso, *crawii* Coq., *longispinus* Targ., and *obscurus* Essig. A large number of individuals in each species has been used giving a comparative study for specific variation.

The writer wishes to thank Professor Alex. D. MacGillivray for the many invaluable suggestions given.

TABULATION AND STUDY OF CHARACTERS.

An examination of the descriptions of species in this genus shows a great similarity in the characters used. Provided that these characters do not vary beyond certain limits, this would make the identification of the species easier. However, if these characters vary to any great extent and overlap and merge into each other, the adherence by systematists to these characters instead of the introduction of new ones is unfortunate, and would make the identification of species very difficult, if not impossible. In that case the most valuable data in the descriptions would be the locality and host-plant data.

Body. 1. Size.–In the great majority of descriptions, the length and width of the body is given. In the measurements given, a great variation in the length of each species is noted.† Lengths such as 3–4 mm., 2–5 mm., 1.5–4 mm., are very frequent, showing the wide variation noted by those describing species. The tables‡ showing the lengths of the body, (Tables 1, 2, 3, 4, 5) in the five species studied do not show a variation any greater than this. A variation of from one and one-half

* The writer does not express an opinion upon the validity of these species.

† R. Mathewson. Can. Entom. XXXIX, p. 286.

‡ In these and the following tables an ocular micrometer with a 2-5 and 1-8 inch objective were used. All measurements are given in microns.

to twice the length of the smaller specimens is shown. A greater variation would probably be found if a larger number of specimens were measured.

TABLE 1. PSEUDOCOCCUS OBSCURUS ESSIG.

Specimen	Length of Body	Length of Setal-loop	Length of Setae of Anal-lobes		Length of Setae of Anal-ring
I	2736	544	152	136	176
II			152	152	168
III	2784		160	160	184
IV	2526	736	152	144	192
VI	2304	720	152	148	190
IX	3120	560	156	146	185
XI	2040	320	136	135	176
XII	2688	848	137	145	168
XIII	3000	696		152	167
IVX	3072		150	142	168

TABLE 2. PSEUDOCOCCUS AGRIFOLIAE ESSIG.

Specimen	Length of Body	Length of Setal-loop	Length of Setae of Anal-lobes		Length of Setae of Anal-ring
I	2928	1160	221	216	240
II	3312	1129	224	223	200
III	4200	1165		208	184
V	3336		182	184	176
VII	4205	120	208	225	292
X	2928	400	200		200
XIII	3120	405		215	248
XVII	4080		208	203	208

TABLE 3. PSEUDOCOCCUS CITRI RISSO.

Specimen	Length of Body	Length of Setal-loop	Length of Setae of Anal-lobes		Length of Setae of Anal-ring
I	3120	416	162	178	108
II	2304	256	180	163	108
III	2526		245	223	120
IV	2808		216	209	129
V	2664	448		228	118
VI	2448	240	221	216	117
VII	3144		181	182	120
VIII	2328		192		115
IX	2662	144	235	216	125
X	2712		225	233	130

TABLE 4. PSEUDOCOCCUS CRAWII COQ.

Specimen	Length of Body	Length of Setal-loop	Length of Setae of Anal-lobes		Length of Setae of Anal-ring
I	3048	98	228	245	144
IV	2184	101	241	239	168
V	2160	120		200	154
A	2256		216	215	176
B	2160			256	192
VI	2165			248	201
VII	2208	108	208	201	169
VIII	2376		200	176	160
IX	2373		224	222	184
X	2448		223	220	160

TABLE 5. PSEUDOCOCCUS LONGISPINUS TARG.

Specimen	Length of Body	Length of Setal-loop	Length of Setae of Anal-lobes		Length of Setae of Anal-ring
I	2088		132	120	139
II	2160		130	124	132
III	1944		96	108	120
IV	2328		95	113	121
VI	2664		113	121	132
VII	2592		127	128	137
VIII	2952		125	123	144
X	3312		228	126	131
A	2950		120	119	133
B	2526		115	122	131

Also only the larger individuals were studied because of the danger of including those in the nymphal stage. Each species was collected from the same or neighboring host plants and were apparently under similar conditions, so that size cannot be taken as a specific character of any great importance. These measurements were taken from mounts. If unmounted specimens were used, the variation would probably be still greater, as then a second factor, namely, the amount of secretion present, would enter. Because of the great variation in size of the different individuals in a species the size of a specimen can be of but little if any value in specific determination.

2. Shape.—In descriptions the shape of the body is variously given as elongate-ovate, rounded-oval, convex, tapering at ends, elongate, etc., words which are nearly synonymous. A few species are stated to be considerably out of the ordinary

in shape, but in general synonyms are used in the descriptions of body shape. In the species studied, this could not be an important specific character as all the species studied were of practically the same shape. However, in some species, this might be a distinguishing character.

3. Color.—In descriptions the color of specimens is usually given, being stated as, whitish, greyish, pinkish, with a red tinge, etc. The dermis of specimens in this genus is red. The color of the insect depends on the extent that this dermis is hidden by the waxy secretion. The amount of waxy secretion depends largely on the position in which the individual develops. Those in exposed position requiring more of the waxy covering as a protection than those developing in well protected situations. This variation in color is well shown in *agrifoliae* Essig. The color in this species is usually of a reddish, pinkish, or pinkish brown. The writer has found specimens, however, ovipositing in exposed positions which were completely covered with the waxy secretion and through which the red dermis was not visible. Thus all variations from a white to a red specimen were found. In the other species studied the color was normally white. In the five species studied color as a character for separating the species could not be relied upon.

4. Segmentation.—In many descriptions the segmentation is referred to as distinct or not distinct. This is a character that is not used to any great extent. This is fortunate as the value of the prominence of the segmentation as a specific character is extremely doubtful. In mounted specimens it would depend to a large extent upon the method used in preparation. The segmentation in chloroform mounts is well preserved. In caustic potash mounts it would be largely obliterated. In unmounted as well as mounted specimens the age and size of the specimens is of great importance. In nymphs of Pseudococcus the segmentation is very distinct. As it passes through its last moult and becomes an adult, this distinctness of the segmentation is lost to a degree. Then as the insect becomes more and more distended with eggs this tendency to lose its prominent segmentation is increased. Also the distinctness of the segmentation in unmounted specimens would depend somewhat upon the amount of secretion covering the insect. With these factors it does not seem that the distinctness of the segmentation can be a very satisfactory specific character.

ANTENNAE.—The number of segments of the antennae is a generic and not a specific character, and so is of no importance in separating species. Several species have been described with seven segmented antennae. The number of segments, eight, of the type of the genus, *longispinus* Targ, has been adopted in this paper. However, a dimorphism has been described in two instances, viz.: by Folsom for *trifolii* Forbes, and by Essig for *agrifoliae* Essig. In these descriptions there is said to be a winter form which has seven segmented antennae; this form giving rise to the summer form with the normal eight segmented antennae. If further investigation shows these observations to be correct, it will be of both specific and generic importance.

The comparative length of the different segments of the antennae is a character that is the most used of any of the characters of the insect's body. The relative length of the segments and the formulae deduced from the measurements is almost invariably contained in descriptions. Sometimes a considerable variation is noted, several formulae being given.

In this study ten specimens of each species were used. Aside from the question of variation which will be taken up later, the relative length of the antennal segments is not a desirable character to use. The greatest difficulty in its use is the difficulty of making correct measurements and the determination of the exact limits of the various segments. The chitin is not continuous from one segment to the next and consequently the portion between the chitinous parts of the segments, the conjunctiva, is not visible or only slightly so in well cleared specimens. Consequently, in making measurements, the determination of the end of a segment will be only approximately at the center of the conjunctiva. This difficulty will be much increased if there are some bends in the antennae. A second difficulty is to determine some point at the end of the segment from which the measurement will always be taken. This difficulty is most apparent with the first segment. This segment is an irregular truncated cone with the sides of different lengths, and but little longer than the width across the base. It will be seen that the determination of the same points for the measurement of this segment would be nearly impossible. In the tables given the writer does not feel that the measurements of the first segment are dependable. Another difficulty in getting dependable formulae is the very slight difference in the length of some of the segments compared to each other. A difference of only two or three microns is all that is found in some of the segments. It would be exceedingly difficult to eliminate inaccuracies to the extent that the formulae would not be changed by them. Or in other words, the limit of error is so small that error, even with the greatest care, is bound to occur. Unconsciously the measurements would be made to conform to a given formula or to other measurements. The writer continually met this difficulty. The measurements given in Tables 6–10 were taken with an ocular micrometer at a magnification of 660 diameters. Much more accurate work was possible than would have been with a camera lucida.

TABLE 6. Pseudococcus crawii Coq.

Specimen	1st	2nd	3rd	4th	5th	6th	7th	8th	Formulae
I	60 65	67 67	74 77	55 53	38 48	46 41	48 48	103 106	83214765 83214(75)6
II	67 62	72 79	87 84	48 46	50 48	48 46	48 53	110 115	83215(647) 832175(64)
III	60 62	72 67	74 79	53 53	58 48	46 48	50 50	108 108	83215476 832147(65)
IV	70 70	72 77	94 96	55 46	58 53	53 48	48 48	108 118	83215467 83215(67)4
V	60 67	72 74	96 94	50 43	60 58	53 48	48 50	115 117	83215647 83215764
VI	62 65	77 79	91 86	46 48	55 70	50 46	50 48	118 110	83215(67)4 83251(47)6
VIII	62 62	70 67	82 82	53 50	53 53	53 50	46 50	115 115	8321(456)7 83215(467)
IX	60 60	67 70	74 74	48 48	55 65	48 48	53 53	108 113	832157(64) 832157(64)
X	60 58	67 67	79 77	48 48	50 52	46 43	50 48	108 108	8321(57)46 83215(47)6
XI	65 60	67 69	72 77	48 43	48 48	53 41	50 48	106 106	832167(45) 8321(57)46

An examination of the tables mentioned will show the great variation met with. Following herewith is a discussion of the tables of each species:—

Crawii Coq. Formula (2, 3, 8) 5, 4, 7, 6, 1, Coq. West Am. Scientist '89.

There is no question about the determination of this species. They were all taken from one plant of white sage (*Ramona polystachia*) at Santa Paula, California. In the tables a formula is found which agrees with the one given by Coquillett. In but one specimen was the formula the same for the right and left antennae of the same individual. All the other formulae differed as much as the specifically diagnostic formulae published for all the species of Pseudococcus.

LONGISPINUS TARG. Formula, (2, 3, 8) (1, 4, 5, 6) 7. Newstead, "British Coccidae." Vol. II. The specimens examined were taken from palms in the Horticultural Forcing-house of Cornell University. Of the ten specimens measured, the formulae of the right and left antennae of but one specimen were identical. No formula was found which agreed with the one given by Newstead. The formulae varied as much as the specifically diagnostic formulae published for all the species of Pseudococcus.

TABLE 7. PSEUDOCOCCUS LONGISPINUS TARG.

Specimen	1st	2nd	3rd	4th	5th	6th	7th	8th	Formulae
I	79 84	79 79	84 84	41 43	53 50	43 43	50 48	101 96	83(12)5746 8(31)257(64)
II	65 67	72 67	79 74	36 38	41 46	38 36	46 43	103 101	83217564 83(12)5746
III	58 60	65 62	63 60	36 36	41 43	38 34	43 41	96 91	82317564 82(13)5746
IV	62 58	62 58	70 70	31 34	48 48	41 38	48 43	108 96	83(21)(75)64 83(21)5764
V	55 58	72 72	67 65	29 36	50 48	29 43	43 46	106 106	823157(46) 82315764
VI	62 60	72 77	74 74	43 46	60 58	46 48	48 48	106 106	83215764 82315(76)4
VII	74 72	72 82	74 91	48 50	62 62	43 46	43 48	101 103	8(13)254(67) 83215476
VIII	65 70	67 72	70 70	43 41	50 46	41 43	43 46	98 96	83215(47)6 82(31)(75)64
IX	55 60	65 65	65 65	36 34	48 50	38 41	46 43	101 101	8(32)15764 8(23)15764
X	62 62	72 70	65 65	43 41	58 48	41 43	48 43	101 103	82315746 82315(76)4

TABLE 8. PSEUDOCOCCUS AGRIFOLIAE ESSIG.

Specimen	1st	2nd	3rd	4th	5th	6th	7th	8th	Formulae
I	94 89	77 82	74 74	50 53	55 55	50 53	48 48	108 115	81235(46)7 81235(46)7
II	72	72 74	74 72	48 48	58 48	48 53	41 53	106 108	83(21)5(46)7
V	72 72	79 79	72 72	48 48	48 53	48 53	50 43	113 110	82(13)7(456) 82(13)(56)47
VII	72 72	82 82	72 70	53 53	60 60	50 50	48 53	115 118	82(13)5467 82135(47)6
VIII	74 72	72 70	74 79	89 89	48 48	53 98	108 98		74(13)265 (76)43125
XIII	74 77	91 84	82 82	65 65	70 72	55 60	48 53	113 115	82315467 82315467
XIV	82 79	82 79	74 77	53 50	60 65	53 50	55 50	110 120	8(12)357(46) 8(12)35(467)
XVI	77 74	84 79	74 74	55 50	60 62	50 58	53 50	115 110	82135476 82(13)56(47)
XVII	72 72	77 82	72 74	53 55	60 55	53 53	50 46	115 110	82(13)5(46)7 8231(45)67

AGRIFOLIAE ESSIG. No formula is given in the description. The description refers however to the figures of the antennae for the relative length of the segments. Measuring the figure, the following formula is constructed, 7, 1, 3, 2, 4, 6, 5. The figure is evidently taken from a nymph, as this species has normally eight segmented antennae. These specimens were all taken from a single oak tree (*Quercus agrifoliae*) at Santa Paula, California, and are from the lot of specimens that the type of the species was taken. In two specimens the formulae of the right and left antennae were found to be the same although the formula of each specimen is different. The formulae of the twenty antennae varied as much as the specifically diagnostic formulae published for the species of Pseudococcus.

TABLE 9. PSEUDOCOCCUS CITRI RISSO.

Specimen	1st	2nd	3rd	4th	5th	6th	7th	8th	Formulae
I	67	60	58	41	41	41	43	101	81237(456)
	62	60	60	43	43	48	48	103	81(23)(67)(45)
II	55	60	55	38	36	46	46	103	82(13)(67)45
	60	58	50	36	41	38	43	101	81237564
III	60	67	72	41	48	46	55	106	83217564
	60	65	72	41	48	46	53	108	83217564
IV	60	65	60	36	41	36	50	110	82(13)75(64)
	65	60	62	36	36	38	48	108	813276(54)
V	60	62	67	36	48	43	53	113	83217564
	58	62	65	36	43	43	50	113	83217(65)4
VI	65	72	67	46	48	48	50	103	82317(56)4
	62	72	65	48	46	50	53	110	82317645
VII	67	60	67	36	38	41	48	106	8(13)27654
	67	58	60	38	41	43	43	98	8132(67)54
VIII	67	72	67	38	43	43	46	108	82(13)7(65)4
	72	62	67	41	48	43	48	103	8132(75)64
IX	60	67	60	43	43	38	41	96	82(13)(45)76
	60	65	60	43	41	46	43	96	82(13)6(74)5
X	67	67	72	41	41	41	50	108	83(12)7(456)
	67	65	67	43	48	46	48	108	8(31)2(75)64

CITRI RISSO. Formula 6, 3, 2, 1, 5, (4, 6, 7) Newstead, "British Coccidae" Vol. II. The specimens of this species were taken from coleus in the Horticultural Forcing-houses of Cornell University. No formula was found that agreed with the one given by Newstead. In one specimen the formulae for the right and left antennae were identical. The formulae of the twenty antennae varied as much as the specifically diagnostic formulae published for all the species of Pseudococcus.

OBSCURUS ESSIG. Formula 8, 1, 3, 2, 4, 7, 5, 6. Essig, "Pomona Jour. Ent." '09. The specimens of this species were taken from an elder tree (*Sambucus glauca*) at Santa Paula, California, and are from the lot of specimens that the type for the species was taken. In one specimen the formulae of the right and left antennae were identical.

TABLE 10. PSEUDOCOCCUS OBSCURUS ESSIG.

Specimen	1st	2nd	3rd	4th	5th	6th	7th	8th	Formulae
I	84 65	72 67	77 65	41 53	58 58	41 96	53	103	813257(64) 62(31)54
II	84 72	72 75	79 84	48 43	55 53	46 43	48 48	84 98	(81)325(47)6 832157(64)
III	82 72	79 79	84 79	29 38	60 53	50 46	53 50	101 103	83125764 8(32)15764
IV	82 77	89 79	84 86	48 48	65 65	50 48	50 48	108 108	82315(67)4 83215(764)
V	89 74	86 84	91 96	53 50	58 65	48 55	50 48	113 113	83125476 83215647
VI	79 74	74 72	82 82	38 36	65 60	41 41	50 48	106 98	83125764 83125764
VII	77 89	82 74	84 74	38 41	53 53	41 41	50 46	108 106	83215764 81(23)57(64)
VIII	84 84	89 84	89 96	53 48	67 70	48 41	53 50	108 110	8(32)15(74)6 83(21)5746
IX	72 65	79 65	74 60	41 46	60 53	48 146	53	106	82315764 6(12)354
X	84 86	72 74	84 84	48 46	58 60	46 34	55 60	55;43 108	(13)25(78)469 8132(75)46

No formula was found agreeing with the one quoted. In specimen X the right antenna has nine segments and in specimen IX the left antenna has six segments. An examination of Table 1 shows that this specimen is the largest specimen studied, and as it was found in an egg mass it was undoubtedly an adult. Specimen I, which will be seen to be of normal size (Table 1), also had the left antenna with six segments. This variation in the number of segments was also noted in other specimens. The formulae of the twenty antennae measured varied as much as the specifically diagnostic formulae for all the species of Pseudocóccus, as well as one formula placing the specimen in the genus Phenacoccus and two formulae placing the specimens in the genus Ripersia.

From the above review it will be readily seen that the relative length of the segments of the antennae are valueless as specific characters. Other workers as well have found this character very variable. Kellogg & Smith, '04, found that in twenty-five specimens of *Cereputo yuccae*, a closely allied genus, no two formulae agreed, "and that there was practically as much variety in these formulae as there is among the eleven formulae published as specifically diagnostic for eleven North American species of the genera *Cereputo* and *Phenacoccus*." Again Tinsley, J. D., '08, in discussing the variation in the antennae of *P. virgatus* Ckll. gives eleven different formulae. Again the same author, 1900, in his description of a new species, *P. texensis* Tins., gives three different formulae. Ehrhorn, Edw. M., 1900, in his description of a new species, *P. maritimus* Ehr., gives four formulae. The universal use of antennal formulae in descriptions is unfortunate, as this has given an excuse for the creation of new species and is valueless in analytical tables for the determination of specimens. The sooner that the valuelessness of this character is realized by systematists describing new species of this genus, the sooner will a search for valuable characters be begun and a serious mistake in taxonomy be corrected.

Legs. Tables 11–15. The length of the legs is used to quite an extent in descriptions. Their length compared to the length of the antennae is often stated, also the length of the different segments compared with each other. They are often spoken of as long and strong. The presence of hairs is often noted, also that of knobbed digitules.

For the study of the legs five specimens of each species were used. They were the same specimens that were used in the study of the antennae. The measurements of the different segments are the greatest length of these segments, so that the sum of the lengths of the different segments will be greater than the length of the leg. Like the basal segment of the antennae, the coxa is very difficult to measure and the results are not entirely reliable.

At the right hand side of the tables, formulae are appended. These formulae are constructed in the same manner as the antennal formulae. The segments are numbered in order beginning with the coxa.

The formulae show but little if any more satisfactory results for specific determination than do the formulae of the antennae. The formulae of each pair of legs for each of the species will be discussed together.

Prothoracic Legs. In *crawii* Coq. and *citri* Risso the third segment is always the longest, the fourth segment coming next in order. In the remaining three species the third segment is usually the longest but may be equal to or less than the fourth segment. The first segment is always third in order in the formulae. In no species does the second segment bear any fixed relation to the fifth. The sixth segment is always much the shortest and comes last in order in the formulae.

Mesothoracic Legs. In *crawii* Coq. the third segment is always the longest. In the other species the position of the third and fourth segments vary in relation to each other. The first segment always comes third in the formulae. The second and fifth segments vary in relation to each other in each of the species. The sixth segment always comes last in the formulae.

Metathoracic Legs. In *obscurus* Essig and *citri* Risso the fourth segment is usually longer than the third. In *obscurus* Essig an exception is seen to this in the right leg of Specimen XI. In *obscurus* Risso an exception is seen to this in specimen VII. In the other species the fourth segment is always longer than the third. The first segment always comes third in the formulae. In no species do the second and third segments bear any fixed relation to each other. The sixth segment is always much the shortest and comes last in the formulae.

It will be seen from the above discussion that the variation in the formulae is too great for them to be of service in specific determination. Exceptions are found to any generalization that might be made. The limits within which there can be variation are so small that the variations are almost sure to go beyond these limits. Other parts of the legs as setae, digitules, etc., apparently offer no characters of a specific nature.

TABLE 11. PSEUDOCOCCUS CRAWII COQ.

Segment	Specimen	Side	Coxa	Tr.	Femur	Tibia	Tarsus	Claws	Formulae
Prothoracic	I	Rt.	192	120	288	252	114	39	341256
		Lft.	198	120	288	252	108	36	341256
	IV	Rt.	240	126	312	248	120	42	341256
		Lft.	228	120	318	276	120	42	341(25)6
	V	Rt.	228	120	276	240	108	42	341256
		Lft.	222	120	270	240	108	42	341256
	VIII	Rt.	210	120	276	216	108	30	341256
		Lft.	210	120	282	216	108	30	341256
	IX	Rt.							
		Lft.	204	114	288	252	114	36	341(25)6
Mesothoracic	I	Rt.	204	120	312	264	114	39	341256
		Lft.	210	126	312	270	114	42	341256
	IV	Rt.	246	120	324	306	120	42	341(25)6
		Lft.	234	126	336	312	120	42	341256
	V	Rt.	240	120	300	276	114	42	341256
		Lft.	228	120	300	282	114	42	341256
	VIII	Rt.	216	120	294	270	114	33	341256
		Lft.	222	120	300	270	114	33	341256
	IX	Rt.	210	120	294	276	120	36	341(25)6
		Lft.	216	120	300	288	120	36	341(25)6
Metathoracic	I	Rt.	222	126	330	342	114	42	431256
		Lft.	222	126	330	336	114	45	431256
	IV	Rt.	252	132	360	390	132	48	431(25)6
		Lft.	258	138	348	390	132	48	431256
	V	Rt.	240	126	330	360	120	42	431256
		Lft.	240	126	330	360	120	42	431256
	VIII	Rt.	216	126	306	336	126	36	431(25)6
		Lft.	216	126	306	354	126	36	431(25)6
	IX	Rt.	240	132	336	366	132	39	431(25)6
		Lft.	240	132	342	360	132	39	431(25)6

TABLE 12. PSEUDOCOCCUS CITRI RISSO.

Segment	Specimen	Side	Coxa	Tr.	Femur	Tibia	Tarsus	Claws	Formulae
Prothoracic	I	Rt.	174	90	210	186	90	24	341(25)6
		Lft.	174	90	104	180	90	24	413(25)6
	III	Rt.	198	90	234	210	96	24	341526
		Lft.	192	90	240	210	96	21	341526
	IV	Rt.	180	90	216	192	84	24	341256
		Lft.	180	96	222	192	96	24	341(25)6
	VI	Rt.	138	84	186	174	84	24	341(25)6
		Lft.	138	84	186	174	84	24	341(25)6
	VII	Rt.	174	90	210	192	90	24	341(25)6
		Lft.	174	90	210	192	96	24	341526
Mesothoracic	I	Rt.	180	90			102	27	
		Lft.	186	96	234	228	102	27	341526
	III	Rt.	210	102	264	240	102	30	341(25)6
		Lft.	210	102	264	246	102	30	341(25)6
	IV	Rt.	186	102	240	234	96	24	341256
		Lft.	174	102	240	228	96	24	341256
	VI	Rt.	144	90	210	210	96	30	(34)1526
		Lft.	156	90	210	210	96	30	(34)1526
	VII	Rt.	180	96	240	228	96	27	341(25)6
		Lft.	180	90	234	216	99	27	341526
Metathoracic	I	Rt.	196	96	234	234	108	30	(34)1526
		Lft.	196	96	240	248	108	30	431526
	III	Rt.	222	114	276	282	108	30	431256
		Lft.	216	108	276	282	108	33	431(25)6
	IV	Rt.	192	108	258	270	108	30	431(25)6
		Lft.	192	108	258	270	108	30	431(25)6
	VI	Rt.	168	96	216	228	108	30	431526
		Lft.	168	96	228	240	108	30	431526
	VII	Rt.	186	102	252	252	102	30	(34)1(25)6
		Lft.	194	92	252	246	102	30	341526

TABLE 13. PSEUDOCOCCUS LONGISPINUS TARG.

Segment	Specimen	Side	Coxa	Tr.	Femur	Tibia	Tarsus	Claws	Formulae
Prothoracic	VI	Rt.	162	96	240	240	102	24	(34)1526
		Lft.	180	96	240	240	102	24	(34)1526
	VII	Rt.	216	114	270	240	108	24	341256
		Lft.	216	114	270	240	108	24	341256
	VIII	Rt.	168	96	234	216	108	30	341526
		Lft.	180	96	234	216	108	27	341526
	IX	Rt.	156	102	216	204	90	24	341256
		Lft.	156	96	216	204	96	24	341(25)6
	X	Rt.	180	96	240	240	108	24	(43)1526
		Lft.	180	96	240	240	108	24	(43)1526
Mesothoracic	VI	Rt.	180	108	264	252	114	30	341526
		Lft.	180	102	264	270	114	30	431526
	VII	Rt.	222	120	300	294	120	30	341(25)6
		Lft.	224	120	300	294	120	30	341(25)6
	VIII	Rt.	192	108	258	240	108	30	341(25)6
		Lft.	192	108	252	240	108	30	341(25)6
	IX	Rt.	162	102	228	240	108	30	431526
		Lft.	162	102	228	234	108	30	431526
	X	Rt.	192	108	264	264	108	30	(34)1(25)6
		Lft.	186	108	270	264	108	30	341(25)6
Metathoracic	VI	Rt.	204	114	306	348	120	30	431526
		Lft.	204	120	300	360	120	30	431(52)6
	VII	Rt.	240	132	312	348	120	30	431256
		Lft.	240	132	318	354	120	30	431256
	VIII	Rt.	210	114	288	306	114	30	431(52)6
		Lft.	204	114	282	300	120	30	431526
	IX	Rt.	180	108	252	294	120	30	431526
		Lft.	180	108	258	300	120	30	431526
	X	Rt.	204	120	300	318	114	30	431256
		Lft.	198	114	300	324	114	30	431(25)6

TABLE 14. PSEUDOCOCCUS OBSCURUS ESSIG.

Segment	Specimen	Side	Coxa	Tr.	Femur	Tibia	Tarsus	Claws	Formulae
Prothoracic	IV	Rt.	186	102	264	258	102	24	341(25)6
		Lft.	180	102	270	264	102	27	341(25)6
	V	Rt.	198	96	258	258	108	30	(34)1526
		Lft.	204	96	264	258	108	27	341526
	VII	Rt.	156	90	240	240	114	30	(34)1526
		Lft.	150	90	246	234	102	30	341526
	VIII	Rt.	180	102	264	258	108	30	341526
		Lft.	180	102	264	258	108	30	341526
	XI	Rt.	180	102	258	246	102	24	341(25)6
		Lft.	180	102	270	258	102	24	341(25)6
Mesothoracic	IV	Rt.	198	108	300	312	114	30	431526
		Lft.	192	108	300	312	114	30	431526
	V	Rt.	210	120	300	312	114	30	431256
		Lft.	210	120	300	312	114	30	431256
	VII	Rt.	150	96			108	30	
		Lft.	150	102	288	282	108	30	341526
	VIII	Rt.	204	108	300	312	108	33	431(25)6
		Lft.	210	108	300	306	114	30	431526
	XI	Rt.	180	120	300	294	108	30	341256
		Lft.	180	108	300	288	108	30	341(25)6
Metathoracic	IV	Rt.	228	120	330	360	120	30	431(25)6
		Lft.	210	120	330	360	120	30	431(25)6
	V	Rt.	222	120	330	366	120	30	431(25)6
		Lft.	228	120	330	360	120	30	431(25)6
	VII	Rt.	210	120	300	330	114	30	431256
		Lft.	204	108	300	330	114	30	431526
	VIII	Rt.	216	114	224	360	120	30	431526
		Lft.	216	120	230	360	120	30	431(25)6
	XI	Rt.	210	120	324	318	120	30	341(25)6
		Lft.	210	120	318	330	120	33	431(25)6

TABLE 15. PSEUDOCOCCUS AGRIFOLIAE ESSIG.

Segment	Specimen	Side	Coxa	Tr.	Femur	Tibia	Tarsus	Claws	Formulae
Prothoracic	VIII	Rt.	208	112	256	216	96	32	341256
		Lft.	200	104	248	216	88	32	341256
	X	Rt.	224	120	280	272	96	32	341256
		Lft.	232	120	288	286	88	32	341256
	XIII	Rt.	248	120	288	304	96	32	431256
		Lft.	240	120	288	304	96	32	431256
	XIV	Rt.							
		Lft.	216	112	280	272	104	32	341256
	XVI	Rt.	224	112	260	264	96	32	341256
		Lft.	232	112	280	264	104	32	341256
Mesothoracic	VIII	Rt.	208	120	288	288	112	32	(34)1256
		Lft.	200	112	280	272	112	32	341(25)6
	X	Rt.	232				104	36	
		Lft.	240	128	312	312	112	36	(34)1256
	XIII	Rt.	240	120	328	336	104	36	431256
		Lft.	240	124	328	336	104	36	431256
	XIV	Rt.	232	120	296	296	112	32	(34)1256
		Lft.	224	120	296	304	112	32	431256
	XVI	Rt.	216	112	304	304	112	32	(34)1(25)6
		Lft.	224	120	312	296	112	32	341256
Metathoracic	VIII	Rt.	224	128	312	344	120	36	431256
		Lft.	216	128	304	320	120	36	431256
	X	Rt.	248	128	352	432	120	36	431256
		Lft.	248	128	346	424	120	36	431256
	XII	Rt.	256	128					
		Lft.	264	136	360	432	112	40	431256
	XIV	Rt.	248	128	336	366	120	36	431256
		Lft.	232	120	312	366	120	36	431(25)6
	XVI	Rt.	232	128	328	360	120	32	431256
		Lft.	240	128	320	354	120	32	431256

MARGINAL WAX FILAMENTS. The number, length and stoutness of the marginal wax filaments is a character often used. The length of the filaments compared to the length of the body and to each other is the form most used. The favorite character for separating *longispinus* Targ. and *citri* Risso is the extreme length of the caudal filaments in the former.

This character refers to specimens before treatment with caustic potash. Only a slight study has been made of this character because living specimens of three of the five species studied were not available. A difference however has been noted between *citri* Risso and *longispinus* Targ., in the former the appendages are robust and covered with granules of wax, in the latter the appendages are slender and do not have granules upon them, being more linear and wire like. The objection to the use of this character in the determination of species is the ease with which the filaments are removed and the danger that the specimens consequently would not be in a natural condition. Also in recently moulted specimens the normal waxy covering would not be formed. The length of the caudal filaments in *longispinus* Targ. is evidently a good character if the specimens can be examined in a normal condition.

Anal Lobes.—The anal lobes are frequently mentioned as being faintly indicated, normal or prominent. Also the presence of one or more setae is occasionally used.

The observations made upon the segmentation of specimens would apply very largely to a discussion of the anal lobes. As a specimen becomes older and more distended with eggs the anal lobes become less prominent. Consequently in the use of this character the age of the individual would have to be carefully considered. In the setae of the anal lobes there is evidently a good character. (Tables 1–5). Upon each anal lobe there are generally several setae. One of these, however, is much longer and more robust than the others and is usually situated at the caudal extremity of the lobe. This is the seta referred to in the tables and discussion. The variation in the length of this seta is considerable, but the limits of variation are so great that this does not lessen the value of the character. The comparison of the length of this seta to the length of the setae of the anal ring is probably the most useful way of expressing the character.

Setae of the Anal Ring.—The number of setae on the anal ring is a generic character and although often given in descriptions is of no importance as a specific character. Their length compared to some other part of the insect is seldom mentioned.

However, the length of these setae is a very promising specific character. The variation is considerable but not so great as to nullify the usefulness of the character. To determine the distal termination of the setae is sometimes difficult, but it can be done with considerable accuracy. Another difficulty is that the distal end of the setae have a tendency to curl, but in spite of this and the above mentioned factor the length of a seta can usually be quite accurately measured. As stated above the comparison of the length of the setae of the anal ring with the setae of the anal lobes is probably the most available way to use this character.

In *agrifoliae* Essig considerable variation is found and the character is hardly satisfactory, The setae of this species are especially difficult to measure because they are not robust.

DERMIS.—The presence of setae and groups of spinnerets upon the dermis is a character commonly noted. This is usually not given enough in detail to be of assistance in the separation of species.

EGG-SAC.—Considerable use is made of the egg laying habits of the species. Whether the egg-sac is of a fibrous nature or is a mealy secretion is often stated. Also its presence or absence is noted, depending whether the species is ovoviviparous or oviparous.

If a study of specimens of Pseudococcus can be made with the insects in a natural condition, the manner of oviposition is a good specific character. Whether a species is ovoviviparous or oviparous is not always a sharply separated condition, for an individual may give birth to living young and also deposit eggs. However, the formation of an egg sac is an indication that a species is oviparous and the formation of this egg-sac is constant for the species. In a normally ovoviviparous form a mealy secretion which is distinctly of a fibrous nature is made upon the plant. *Crawii* Coq. and *longispinus* Targ. do not form a distinct egg-sac but form a mealy secretion upon the plant. *Citri* Risso and *obscurus* Essig form an egg-sac of considerable size. *Agrifoliae* Essig forms an egg-sac but not so extensive a one as the last two named species.

The writer is working on a monograph of the North American species of this genus. He would be glad to exchange specimens of Coccidae for species of Pseudococcus not now in his collection. Correspondence to this end is invited.

CORRECTIONS TO MY PAPER IN THE JUNE (1911) ISSUE OF THE ANNALS E. S. A.

By Charles H. T. Townsend,
Piura, Peru.

In a paper about to be published reviewing the results set forth in Pantel's 1910 publication in La Cellule, I stated that the said results were entirely unknown to me at the time of sending in the last proofs and corrections, including the addenda, to my paper in the June (1911) issue of the Annals of the Entomological Society of America. Largely due to this fact but also in part to a regretable haste to present as complete a statement of results to date as possible, I have committed several errors that must be corrected. Aside from certain typographical errors which will be apparent, the following brief statements will serve to cover the points in question:

I should have stated that the spermathecae are "usually" three in number. Pantel has shown that Chaetotachina rustica has only one spermatheca, and Siphona (Pantel et al.) has only two. (Page 127.)

The uterovagina is a vaginal tube which functions anteriorly as a fertilizing but non-incubating uterus when the incubating uterus is absent. It may be pointed out that fertilization is a true function of the muscoid uterus, quite as much so as incubation. The eggs must be held for a certain time to insure fertilization. (Page 127.)

Phasia has no uterus and deposits flattened macrotype eggs on host (Pantel). Alophora has likewise no uterus, but evidently deposits its elongate eggs subcutaneously in host (Pantel). Each is the type of a distinct tribe or group unit. (Page 128).

Compsilura, Eucelatoria and allies have a separate piercer and larvipositor in the female. Pantel has first properly described these organs in Compsilura, and I have verified his results in Eucelatoria. The larvipositor is a short subconical membranous tube approximated to the upper base of the elongate curved piercer. The maggots are ejected through the larvipositor within the puncture in the skin of the host made by the piercer. This is more fully explained in the paper above mentioned reviewing Pantel's results, where are also given the functions of the ventral carina of the female. (Pages 130, 140.)

The Peruvian species which I referred to Tricholyga proves to be a typical Euphorocera, truly congeneric with E. tachinomoides T. of the Southwest. (E. claripennis of Coqt. is not a Euphorocera.) (Page 131.)

It is probably a mistake to suppose the existence of a special membranous anal pad for attachment of the maggots of the Hystriciinae to plant surfaces. This is evidently effected by the chorion in whole or part, probably including the vitelline membrane. (Pages 131, 132, 133, 134.)

The Myiophasiine flies are parasites of weevil grubs in buds as well as fruits, as for example cotton buds (squares) and doubtless buds of other plants. (Page 136.)

It seems probable that the Cuterebrine flies have a uterus in which the eggs are partially incubated. The hinged lid of egg is at the cephalic end. (Page 137.)

The piercer-like organ of the female of Emphanopteryx is probably functional in piercing the skin of the host, but this has yet to be demonstrated. (Page 140.)

Celatoria probably has the piercer and larvipositor as separate organs. (Pages 140, 141.)

Phasiatacta has the chorion with alveolae (not areoles) gathered around a dorsal opaque area. (Page 144.)

Pyrrhosia evidently can not go in the tribe Eumyobiini, since Pantel has shown that it has the eggs and maggots regularly arranged in the uterus. (Page 147.)

Certain of the above points are brought out fully in the paper referred to as reviewing Pantel's results, besides many other important points in connection with the subject.

A certain number of the series given represents subfamilies, but the great majority corresponds to tribes. Each series name given in the paper should have the final "E" changed to "I" and serve as the name of a tribe, each tribe taking as its type the type species of the genus from which its name is derived. At least seven families and twenty subfamilies should be recognized in the Muscoidea on the basis of our present knowledge, but it is premature to attempt to define these at present, for further knowledge of the many forms yet to be investigated will quite certainly modify our present conceptions.

The article in "Science" on "Muscoid and especially Tachinid Synonymy" appeared in the issue for June 2, 1911. This and the forthconmig review of Pantel's 1910 paper, which review also includes correlation of results secured by Portchinski a quarter-century ago, taken with the present corrections and the paper to which they refer, will present a fairly complete general statement of the progress of this work up to the early part of the present year, so far as known to me. Further and more extended papers are in preparation.

July 31, 1911.

ENTOMOLOGICAL MEETINGS, DECEMBER, 1911.

The next annual meeting of the Entomological Society of America will be held during Convocation Week at Washington, D. C., on Tuesday, December 26th, and the forenoon of Wednesday, December 27th. The annual public lecture of the Society will be held on Wednesday evening. This lecture will be delivered by Professor J. H. Comstock, of Cornell University. His subject will be "On Some Biological Features of Spiders." Plans are already underway for the meeting and the attention of members is called to the matter at this time so that they may know that every effort possible is being made to make it an instructive and interesting meeting. Every member should plan to be present at the opening meeting.

The annual meeting of the American Association of Economic Entomologists and of the Association of Official Horticultural Inspectors will be held at the same place during this week. The address of the President of the American Association of Economic Entomologists will be held Wednesday afternoon, the sessions for the reading of papers on Thursday, and Friday forenoon. The Horticultural Inspectors will hold their opening session on Thursday evening and other meetings on Friday afternoon.

The Secretary will be glad to furnish members desiring to recommend candidates for membership with the necessary blanks.

Alex. D. MacGillivray, Secretary-Treasurer,
604 East John St., Champaign, Illinois.

NOTICE TO MEMBERS AND CONTRIBUTORS.

The Annals of the Entomological Society of America will be published by the Society quarterly and will include the Proceedings of the Annual meetings and such papers as may be selected by the Editorial Board.

Papers may be submitted to any member of the Editorial Board and should be as nearly as possible in the form desired as final, preferably typewritten, and illustrations must be finished complete ready for reproduction. Plates must not exceed 5 x 7 inches unless intended to fold. In general, papers to be accepted must be original, complete and previously unpublished and, except in connection with the proceedings, it will not be the policy to publish preliminary announcements or notes. Authors will be allowed fifty reprints gratis and additional copies at cost to the Society.

Requests for information as to membership and the annual subscription and dues of members may be sent to the Secretary-Treasurer, A. D. MacGillivray, Cornell University, Ithaca, N. Y.

Communications relating to the Annals, and all orders for separate copies or reprints should be addressed to the Managing Editor or to ANNALS OF THE ENTOMOLOGICAL SOCIETY OF AMERICA, Biological Building, O. S. U., Columbus, Ohio.

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ANNALS

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Volume IV DECEMBER, 1911 Number 4

MONOGRAPH OF THE GALL-MAKING CYNIPIDÆ (CYNIPINÆ) OF CALIFORNIA.

By David T. Fullaway.

INTRODUCTION.

All the gall-making species of the hymenopterous family Cynipidæ are included in the natural group or division Cynipinæ. Other members of the family, which is well represented in California, are parasitic on dipterous, coleopterous, and wood-boring hymenopterous larvae.* The gall-making species have been collected and studied by a number of American students, including Osten-Sacken, Bassett, Ashmead, Gillette and others, but previously no thorough systematic collecting of the galls or flies has ever been attempted to the writer's knowledge, and the descriptions of the California species are scattered through the various entomological periodicals of the past thirty-five or forty years.

In 1906, Miss Rose W. Patterson, (now Mrs. C. B. Blakeman), a student of entomology in Stanford University, under the direction of Professor Kellogg, began a systematic collection of the galls occurring in the vicinity of Stanford University and of San Jose, California, which extended through several years, the range of her collecting being widened on several occasions by excursions into the northern part of the state. To these collections there were added the contributions of students and other interested persons from different sections. Specimens bred from this material were carefully labelled and preserved by Miss Patterson with voluminous notes, but her removal from the university prevented the completion of the work of identification and description, and the whole collection, was recently turned over to the writer to be worked up. The

* They are also recorded from Hemerobius and Aphidæ.

Stanford collection, which includes eighteen undescribed species, forms the basis of the present work, in which it is attempted to bring together in monographic form all the Californian species. The table for genera and generic definitions have been adapted from Dalla Torre and Kieffer's monographs, from which much of the nomenclatorial data has also been derived. The author is greatly indebted to Professor Kellogg, under whose direction the work was performed, and to Mr. William A. Beutenmüller and Professor C. P. Gillette, who have compared specimens of doubtful identity with types in their possession, for helpful suggestions and advice during the progress of the work.

Fam. CYNIPIDÆ.

Subfam. CYNIPINÆ.

Cynipides, Psenides, Inquilinæ. T. Hartig, Zeits. f. Ent., vol. 2 (1840), p. 187, 197.
Cyniphoideæ. A. Forster, Verh. Zool. Ges. Wien, vol. 19 (1869), p. 329, no. 2.
Cynipina. C. G. Thomson, Opusc. Ent., vol. 8 (1877), p. 778.
Cynipinæ, Inquilinæ. Ashmead, Tr. Am. Ent. Soc., vol. 13 (1886), p. 60.
Cynipinæ. Dalla Torre, Cat. Hymen., vol. 2 (1893), p. 37.

Body rugose, shagreened or punctate, rarely entirely smooth. Scutellum without cups, sometimes with deep impression on disc but not cup-shaped. Wings usually with three more or less complete cubital cells, cubitus arising in the middle of the basal vein (in one species wanting altogether). Areolet closer to base of radial cell than middle. Second segment of posterior tarsi without spine. Four first abdominal tergites of unequal size, second nearly always at least half as long as abdomen. Sternites ordinarily more or less visible. Hypopygium usually teminating in a point, ventral valve at least as long as broad, sometimes plowshare-shaped. Phytophagous species, living in galls.

KEY TO GENERA.

1 Wings more or less foreshortened, not reaching beyond the middle of the abdomen.... 2
Wings normally developed.... 3
2 Thorax covered with a dense pubescence, flat, closely punctate; mesonotum glabrous in the middle; antennae 12-segmented. Galls on *Quercus*.... 5 **Trichoteras** Ashm.
Thorax only sparsely pubescent, evenly rugose or wrinkled; antennae 13-14 segmented. Galls on *Quercus*.... 1 **Biorhiza** Westw.
3 1st abdominal segment longitudinally striate, 2d and 3rd segments connate; face radiately striate; ventral valve short. Inquilines in galls on *Quercus*.... 9 **Synergus** Hartig
1st abdominal segment smooth.... 4
4 Face with two parallel ridges from insertion of antennae to clypeus; antennae ♀ 12-14 segmented, ♂ 14-15 segmented; scutellum with basal foveæ; radial cell closed. Inquilines in galls on *Quercus*..10 **Ceroptres** Hartig
Face without such ridges.... 5

5 Hypopygium plowshare-shaped, tarsal claws simple........................ 6
Hypopygium not usually produced, truncate and ending usually in a short spine (ventral valve).. 8
6 Scutellum without foveæ; radial cell open on costal margin; abdomen microscopically reticulate. Galls on *Rosa*............15 **Lytorhodites** Kieff.
Scutellum usually with basal foveæ; abdomen without microscopic reticulation.. 7
7 Radial cell closed. Galls on *Rosa*......................14 **Rhodites** Hartig
Radial cell open. Galls on *Quercus*..........13 **Compsodryoxenus** Ashm.
8 Suture separating mesonotum and scutellum wanting, the latter without foveæ, anterior margin not elevated in a ridge, an arcuate transverse groove delimiting mesonotum posteriorly, parapsidal grooves wanting or not distinctly percurrent. Galls on *Quercus*..........2 **Neuroterus** Hartig
Suture separating mesonotum and scutellum, anterior margin of latter elevated to form a ridge.. 9
9 Body covered with silky pile, abdomen dorsally sometimes glabrous; radial cell open. Galls on *Quercus*..........................6 **Cynips** L.
Abdomen glabrous, 2nd segment alone sometimes sparsely pubescent laterally at base.. 10
10 Radial cell closed; pronotum not medially contracted..................... 11
Radial cell open or partly open on costal margin; pronotum sometimes medially contracted.. 12
11 Mesonotum wholly smooth. Galls on *Rubus*.......12 **Diastrophus** Hartig
Mesonotum not wholly smooth; antennae 12-segmented. Inquilines in galls on *Rosa* and *Quercus*...............................11 **Periclistus** Forst.
12 2nd abdominal segment produced linguiform on dorsum; parapsidal grooves percurrent; base of scutellum with an arcuate transverse groove; ridges on metanotum arcuate; claws bidentate. Galls on *Quercus*..........
3 **Diplolepis** L. Geoffr.
2nd abdominal segment not produced linguiform......................... 13
13 Claws simple, sometimes obscurely dentate, but then antennae slenderer at apical third than at middle, and metanotal ridges angularly curved. Galls on *Quercus*..................................8 **Callirhytis** Forst.
Claws bidentate; antennae not slenderer at apical third than at middle; metanotal ridges straight and parallel, or arcuate...................... 14
14 Scutellum basally with arcuate transverse groove; parapsidal grooves incomplete; head and thorax densely pubescent; Galls on *Quercus*.....
4 **Disholcaspis** D. T. & Kieff.
Scutellum with basal foveæ; parapsidal grooves percurrent. Galls on *Quercus*..7 **Andricus** Hartig

1 **BIORHIZA** Westw.

Biorhiza, Westwood, Intr. Classif. Ins., vol. 2 Syn. (1840), p. 56.
Philonix, A, Fitch, 5th Rep. Ins. N. York (1859), p. 3.

Wings in agamic generation wanting or very rudimentary, in sexual female very rudimentary, in male always present. Antennæ of female 13-14 segmented, of male 15-segmented, 3rd segment longer than the 4th, in male often strongly excised, succeeding segments progressively shorter but all longer than broad. Pronotum narrow in the middle, mesonotum in wingless generation only partly smooth and shining, in generation with developed and rudimentary wings usually entirely so, parapsidal grooves complete or little marked, scutellum in wingless generation with a transverse groove at base, in female with rudimentary wings, with weak foveæ separated by a carina, in generation with developed wings, with two sharply separated foveæ. Abdomen large, laterally compressed or globose, smooth or pubescent, ventral spine short. Tarsal claws bidentate.

Biorhiza californica (Beutenm.)

Philonix californica, Beutenmüller, Ent. News, vol. 22 (1911), p. 69.

"Female. Head pitchy brown black, minutely rugose with scattered, short hairs. Antennæ 13-jointed; first joint stout, cylindrical; second joint shorter, stout and rounded at the tip; third joint very long and slender; fourth, fifth and sixth joints slender and shorter than the third; remaining joints gradually becoming shorter and thicker toward the thirteenth, all pitchy brown and pubescent. Thorax pitchy brown or dull rufous, evenly rugose, somewhat wrinkled and with a few scattered hairs. Parapsidal grooves very fine and somewhat lost in the rough surface anteriorly, convergent at the scutellum. Scutellum evenly rugose like the thorax, and of the same color. Abdomen compressed, convex at the sides and rather sharply keeled on the dorsum and venter, dark pitchy brown, smooth and shining. Legs pitchy brown, somewhat paler than the abdomen and pubescent. Wings aborted, not extending to the middle of the abdomen. Length 1 mm.

"Gall. On the upper surface of the leaves of a species of white oak. Monothalamous. Rounded, flattened disc-like, becoming slightly elevated toward the middle. The sides are flat and very thin, and the gall rests closely on the leaf. The larva lives in the center of the elevated part. The color is pinkish or purplish, with the apex sometimes yellowish. Width, 3 to 4 mm. Height, 1 mm.

"Habitat. Kern Co., California, January."

(Wm. Beutenmüller.)

I have not seen specimens; the type is in the National Museum.

2 NEUROTERUS Hartig.

Cynips (part.), Linne, Syst. Nat. ed. 10 (1758), p. 343, 553.
Neuroterus, Spathegaster, Hartig, Zeits. f. Ent., vol. 2 (1840), p. 185, 192, 186, 194.
Ameristus, A. Forster, Verh. Zool. Ges. Wien, vol. 19 Abh. (1869), p. 330, 333.
Dolichostrophus, Ashmead, Tr. Am. Ent. Soc., vol. 14 (1887), p. 129 nota.

Head, thorax and scutellum smooth or microscopically reticulate and shining. Parapsidal grooves wanting or very indistinct. Mesonotum not separated from scutellum by a suture, posterior margin with an arcuate recess or indention, a broad transverse groove at base of scutellum. Antennæ of female 13-14 segmented, of male 14-15 segmented. Abdomen large and subpetiolate in female, small and with a long petiole in male. Wings of male very long, usually shorter in female. Radial cell nearly always open and very long. In galls on *Quercus*.

Neuroterus quercus-batatus (Fitch).

Cynips quercus-batatus, A. Fitch, 5th Rep. Ins. N. York (1859), p. 30.
Neuroterus batatus, G. Mayr, Gen. Gallenb. Cynip. (1881), p. 37.
Neuroterus quercus-batatus, Dalla Torre & Kieffer, Das Tierreich, lief. 24 Cynipidæ (1910), p. 334.

Female. Black, shining, mouth-parts, base of antennæ, legs beyond tibiæ and at joints above, tegulæ, pedicle and ovipositor brownish. Head faintly rugose, face pubescent, antennæ 13-segmented, fuscous to black, except three first segments, which are brown, only slightly pubescent, 1st and 2nd segments stout, 2nd the same width throughout, 3rd segment longest, not as 1 and 2 together, 3rd and 4th very slender, becoming thicker and shorter outwardly to 7th, 8-12 subequal, last only a little longer than penultimate. Thorax microscopically reticulate, mesonotum without parapsidal grooves but with two rather large basal depressions separated by a median ridge, scutellum without basal foveæ, smooth, sparsely pubescent, sculpturing on mesonotum and scutellum excessively fine, on pleura and prothorax somewhat coarse. Abdomen smooth, shining, much compressed, about as broad as long, ovipositor exserted. Wings hyaline, pubescent, subcostal, radial, basal and cross-veins distinct, black, radial cell long. open, vein at base angulate, areolet distinct but small, cubitus indistinctly reaching basal. Length 1.75 mm.

Male. Microscopically reticulate or rugose, rather shiny. Head black, ocelli, mouth and antennæ at base brown, the latter 14-segmented, fuscous to black from 4th segment outwardly, 3rd a little longer than 1 and 2 together and excised at distal end, 4th about two-thirds of 3rd and subequal with 5th, following segments a little smaller and subequal except 13th, all somewhat pubescent. Prosternum blackish, pronotum narrow in the middle, at sides yellowish brown, reticulate and shining, the color extending up on to the scapulæ, mesothorax and scutellum smooth, shining, microscopically sculptured, the latter fuscous yellowish brown, mesopleura fuscous brown, coarsely sculptured, shining, metathorax sordid white, slightly rugose. Abdomen long petiolate, smooth, shining, at base sordid white to yellowish white, otherwise black, much compressed apically and pubescent at tip. Legs very pale yellowish, tips of tarsi black. Wings extending beyond abdomen more than its length, hyaline, pubescent, radial cell long and open, vein at base arcuate, cubital vein reaching basal, areolet distinct and large. Length 2 mm.

Gall. Early summer galls on under side of leaf of *Quercus douglasi*, a flat, irregular swelling, distorting the leaf, polythalamous, 8 mm. by 5 mm., and a sordid brown color. Late summer galls, from which adult flies emerge the following spring, small hard woody swelling in terminal twigs of *Q. lobata*, containing numerous long, oval larval cells imbedded in soft spongy interior of gall.

Habitat. Stevens Creek, beyond Cupertino, Cal. (R. W. Patterson.) San Jose, Cal. (Rose Patterson.)

Neuroterus saltatorius (Riley).

Cynips saltatorius (Hy. Edwards in MS), C. V. Riley, Tr. Ac. St. Louis, vol. 3 (1876), p. 213.

Neuroterus saltatorius, Ashmead, Tr. Am. Ent. Soc., vol. 14 (1887), p. 128.

Female. Black, smooth and polished, legs at joints sordid white. Head microscopically reticulate, antennæ 13-segmented, filiform, slightly incrassate towards tip, 1st and 2nd segments stout, 3rd longest, about twice as long as 2 or 4 but not as long as 1 and 2 together, succeeding segments subequal, the three last a trifle longer than preceding ones. Thorax smooth and flat, faintly sculptured, with two large depressions posteriorly on either side of median line, which is ridged, scutellum rugose. Abdomen as broad as long, much compressed, ovipositor exserted. Wings hyaline, pubescent, veins blackish, radial cell long, open, vein at base slightly angulate, areolet present but two of the enclosing veins indistinct, cubitus not reaching basal vein. Length 1.5 mm.

Gall. Small, subglobular, 1.25-1.50 mm., pale reddish brown, with a small nipple at either pole; slightly sculptured.

Habitat. Stockton, Cal. (Hughes Ranch.)

3 **DIPLOLEPIS** L. Geoffr.

Cynips (part.), Linne, Syst. Nat. ed. 10 (1758), p. 343, 553.
Diplolepis (part.), L. Geoffroy, Hist. Ins., vol. 2 (1762), p. 309.
Dryophanta, A. Forster, Verh. Zool. Ges. Wien, vol. 19 Abh. (1869), p. 331, 334, 335.

Cheeks not more than half the length of the eye. Parapsidal grooves percurrent. Scutellum without foveæ, an arcuate transverse groove at base, rarely interrupted in the middle. Metanotal ridges curved. Radial cell open at the margin. Tarsal claws usually bidentate. Abdomen longer than vertically broad, 2nd tergite produced caudally linguiform. Head and thorax in agamous generation densely pubescent, antennæ 13-segmented and clothed with long, erect hairs. Body in sexual generation for the most part glabrous, antennæ of female 14-segmented, without long erect hairs, of male 15-segmented. Mesonotum smooth and shining. Abdomen in male petiolate. In galls on *Quercus*.

Diplolepis discus (Bass.)

Dryophanta discus, H. F. Bassett, Tr. Am. Ent. Soc., vol. 26 (1900), p. 326.
Diplolepis discus, Dalla Torre and Kieffer, Das Tierreich, lief. 24 Cynipidæ (1910), p. 362.

"Head black. Antennæ thirteen jointed, joints one and two rather large, subequal, third long, fourth two-thirds as long as the third, remainder gradually shorter, all yellowish red. Thorax smooth, shining, with a few scattered hairs and deep parapsidal grooves. Scutellum slightly rugose. Foveæ not distinct. Abdomen dark, shining brown. Legs dark brown. Wings rather large; veins very pale, almost colorless. Areolet wanting. Cubitus nearly obsolete. Radial area open. Body .06, antennæ .05, wings .07.

"Galls. Among the galls sent me several years ago by Mrs. E. H. King, from Napa City, California, were a few specimens from which no insects appeared, but from which I removed three dead but perfectly developed individuals. The galls were circular, flat, sessile discs growing in clusters on the under sides of the leaves of some species of oak, closely resembling *Q. alba;* but I am not sure this oak grows in that section. The galls are hardly one-eighth of an inch in diameter, and except in size and color might be taken for what is, I think, called the 'blue spangle gall,' not uncommon on the white oak in the Atlantic States. It is smaller and lacks the blue color." (H. F. Bassett).

I have not seen examples of this species.

Diplolepis clavula (Beutenm.)

Dryoplanta clavula, Beutenmüller, Ent. News, vol. 22 (1911), p. 67.

Female. Reddish brown, eyes, ocelli, mandibles, oral margin, occiput, a broad median stripe from occipital margin to the mouth (broken beneath ocelli), antennæ, prosternum, pronotum above and below, dorsal and subdorsal vittæ on mesonotum concurrent with median longitudinal lines and smooth lines over base of wings, mesopleura, base of scutellum and a median spot, metanotum and abdomen wholly black. Head reticulately rugose, face pubescent, antennæ 14-segmented, 1st segment stout, clavate, 2nd oval, 3rd long but not as long as 1 and 2 together, 4th as long as 3, succeeding segments to 9th progressively shorter, 9th and following segments subequal except the last, which is longer than penultimate by one-half, all rather pubescent. Pronotum narrow in the middle, rugoso-punctate, pubescent, mesonotum faintly rugose and deeply punctate, each puncture with a pale brown hair, parapsidal grooves distinct, reaching anterior margin, median longitudinal lines extending half-way to posterior margin, smooth lines over base of wings rather short, mesopleura smooth, shining black, densely pubescent, a triangular area beneath wings aciculate, scutellum rugose, pubsecent, foveæ indistinct, a transverse arcuate groove at base with median carina, metanotum somewhat punctate, pubescent. Abdomen smooth, shining, somewhat compressed, the second tergite produced caudally acutely to a point, the posterior margin oblique, pubescent at base, 3rd tergite fairly wide, others concealed beneath, ovipositor sheath expanded at tip, with an apical tuft of hairs, ovipositor exserted. Legs fuscous brown and pubescent. Wings hyaline, quite pubescent, veins distinct, radial cell long, open at the margin, vein at base angulate and clouded with brown, areolet moderate, cubitus nearly reaching basal vein, radius incrassate at the tip, cubital cell with a large brown cloud at base and numerous spots at apex, a brownish cloud beneath 2nd cross vein, one at break in anal cell, and another at base of cubitus. Length 2 mm.

Gall. Small gourd or trumpet-shaped galls on the leaves of *Quercus lobata*, oval or subglobular outwardly, with long neck which is somewhat expanded at point of attachment. The gall is 7 mm. long, 2 mm. wide, the neck narrowing to less than 1 mm.; the walls quite thin, the large oval larval chamber lying directly beneath. It has a reddish appearance and is faintly rugose from minute crystalline bodies lying on the surface. It is also often covered with a grayish brown tomentum.

Habitat. Palo Alto, Cal. (Miss Bertha Wiltz.) Napa and Sonoma Counties, California (Beutenmüller).

Diplolepis echina (O.-S.)

Cynips echinus, Osten-Sacken, Tr. Am. Ent. Soc., vol. 3 (1870), p. 56.
Dryophanta echina, Beutenmüller, in litt.
Dryophanta speciosa, Beutenmüller, in litt.

Female. Reddish brown, eyes, ocelli, tips of mandibles, oral margin, antennæ distally from 2nd segment, dorsal and lateral vittæ on mesonotum concurrent with median pair of lines and lines over base of wings, and abdomen dorsally black or blackish. Head faintly rugose, antennæ 14-segmented, filiform, outer third slightly thicker, 1st segment stout, obconic, 2nd subglobular, 3rd longest, nearly as long as 1 and 2 together, 4th and succeeding segments to 9th progressively shorter, 9-14 subequal, less than one-half as long as 3rd, all sparsely covered with appressed grayish hairs. Thorax faintly rugose and sparsely, in some parts rather thickly covered with appressed yellowish gray pubescence, pronotum narrow in the middle, parapsidal grooves on mesonotum distinctly percurrent, median longitudinal lines reaching half-way to posterior margin, smooth lines over base of wings distinct and long, scutellum without distinct foveæ, a rather narrow, arcuate transverse groove with smooth shining bottom at base. Abdomen smooth, shining, second tergite produced caudally linguiform almost to apex, pubescent at base, dorsal valve and sheath of ovipositor prominent, the latter with apical tuft of yellowish brown hair. Legs rather stout and clothed with a grayish pubescence. Wings hyaline, pubescent, veins brownish, distinct, radial cell open at the margin, vein at base only slightly bent, radius incrassate at tip just before costal margin, areolet distinct, cubitus nearly or quite reaching basal vein, a small brownish cloud near base of cubital cell, another beneath areolet, and still another at the break in anal vein. Length 2.5-3 mm.

Gall. Moderately large, reddish, echinus-shaped galls attached to the leaves of *Quercus douglasi*. Numerous pointed processes project from the more or less globular body of the gall, giving it the characteristic echinus appearance. The gall is composed of a crystalline substance said to be hardened gallic acid. Monothalamous. About 12 mm. in diameter.

Habitat. St. Helena, Cal. (Miss Julia Begley). Placer County, California (Osten-Sacken).

Diplolepis douglasi (Ashm.)

Holcaspis douglasii, Ashmead, Proc. U. S. Nat. Mus., vol. 19 (1896), p. 127.
Holcaspis douglasi, Dalla Torre & Kieffer, Gen. Ins. Hymen. Fam. Cynip. (1902), p. 53.
Dryophanta douglasi, G. Mayr, Verh. Zool. Ges. Wien, vol. 52 (1902), p. 290.
Diplolepis douglasi, Dalla Torre and Kieffer, Das Tierreich, lief. 24 Cynipidæ (1910), p. 369.

Female. Very similar to *D. echina*, from which it can scarcely be separated except on the character of the gall. In specimens before me I notice the following minor differences: antennæ black distally from 6th segment instead of from 2nd; abdomen black on dorsum only posteriorly; areolet rather indistinct and only the cloud near base of cubital cell present.

Gall. Pink, star-shaped galls occurring on leaves of *Quercus lobata*, composed of a crystalline substance similar to the material forming the gall of *D. echina*, and covered with a pale bloom which imparts a lilac shade to the whole body. The gall is 8 mm. high and 10 mm. in diameter, the pedestal widening rapidly to the dorsal rim, which bears about eight irregular pointed projections forming the star. Mononthalamus. Hollow within, the oval larval chamber partly attached.

Habitat. San Jose, Cal. (R. W. Patterson.) Marin County, California (Beutenmüller).

Diplolepis dubiosa n. sp.

Female. Black, the antennæ, legs, tips of mandibles, tegulæ, postscutellum and sheath of ovipositor luteous. Head faintly rugose and covered with closely appressed whitish hairs, antennæ 14-segmented, filiform, outer third slightly incrassate, 1st segment stout, obconic, 2nd suboval, 3rd longest, 4th and succeeding segments to 9th progressively shorter, 9th and following segments subequal, except the last, which is somewhat longer then penultimate. Pronotum narrow medially, mesonotum faintly reticulate, shining, parapsidal grooves distinct, reaching anterior margin, scutellum deeply rugose, foveæ distinct, large and broad, contiguous, separated only by a carina. Abdomen about as large as head and thorax together, smooth, shining, 2nd tergite produced caudally almost to apex, slightly pubescent laterally near the middle, spine of ventral valve moderate, pubescent. Wings hyaline, pubescent, veins pale brown to black, radial cell long, narrow, open at the margin, vein at base only slightly bent, areolet distinct but the enclosing nervures (except distal one) very delicate. Claws unidentate. Length 2 mm.

Male. Black, the antennæ, legs (except coxæ), tips of mandibles, palpi, tegulæ and petiole luteous. Head faintly rugose, face and cheeks covered with long, whitish hairs. Pronotum, mesonotum and pleura faintly reticulate, shining, metanotum faintly aciculate, pubescent, scutellum deeply rugose. Abdomen long, slender, compressed, pubescent laterally on 2nd segment. Antennæ 15-segmented, 1st segment obconic, 2nd subglobose, 3rd longest, succeeding segments to 13th progressively shorter, 13th and 14th subequal, 15th short and pointed. Length 1.75 mm.

Gall (Pl. XXIII, fig. 1). A small, brown, thin-shelled gall arising, several together, in the staminate ament of *Quercus agrifolia*. The gall is about 3 or 4 mms. long, rather angulate and more or less clavate. Polythalamous.

Habitat. Palo Alto, Cal. (R. W. Patterson.)

4 DISHOLCASPIS D. T. & Kieff.

Holcaspis, G. Mayr, Gen. d. Cynip. (1881), p. 9, 35.
Disholcaspis (n. n. for Holcaspis, preoccupied), Dalla Torre and Kieffer, Das Tierreich, lief. 24 Cynipidæ (1910), p. 371.

Agamic generation. Head and thorax covered with a rather dense pubescence, abdomen bare, the sides basally slightly pubescent. Cheeks less than half the length of the eyes. Antennæ 13-15 segmented, pubescent. Pronotum narrow in the middle. Parapsidal grooves incomplete, not reaching anterior margin. Base of scutellum with a transverse groove. Ridges of the metanotum arcuate. Radial cell long and open at the margin. Tarsal claws bidentate. Second tergite of abdomen not produced linguiform caudally. Sexual generation unknown. Galls on *Quercus*.

Disholcaspis truckeensis (Ashm.)

Holcaspis truckeensis, Ashmead, Proc. U. S. Nat. Mus., vol. 19 (1896), p. 127.
Disholcaspis truckeensis, Dalla Torre and Kieffer, Das Tierreich, lief. 24 Cynipidæ (1910), p. 380.

"Gall. An irregular, inflated, hard, woody gall, over an inch long and about half an inch in diameter, issuing from a slit in a terminal twig of *Quercus chrysolepis* var. *vaccinifolia;* polythalamous.

"Gall-fly. Female. Length, 3.4 mm. This species, in color and size, closely resembles *H. ficigera*, Ashmead, but differs as follows: The 14-jointed antennæ, except the first two joints, pleura, and metathorax blackish, shining; the rest of the insect—except the dorsum of the second abdominal segment, which is obfuscated—brownish yellow; the head and thorax punctate, and covered with a glittering white pubescence. Abdomen highly polished, bare, except the sides of second segment basally; spine of ventral valve short, stout, hairy. Wings hyaline, veins brown, areolet distinct, cubital cell open at base, while the basal vein of radial cell is only obtusely angular.

"Type No. 3080, U. S. N. M.

"Two specimens, reared December 6th, 1880, from galls collected by Prof. J. H. Comstock, in California, October 16, 1880." (W. H. Ashmead.)

I have not seen examples of this species.

Disholcaspis eldoradensis (Beutenm.)

Holcaspis eldoradensis, Beutenmüller, Bul. Am. Mus. Nat. Hist., vol. 26 (1909), p. 38.

Female. Testaceous, eyes, ocelli, occiput, anterior margin of face, antennæ distally from 8th segment, pecten, dorsal and subdorsal vittæ on mesonotum concurrent with median longitudinal lines and lines over base of wings, median vitta on metanotum and dorsal valve black, vertex and front of head, tibiæ and tarsi of legs, and abdomen dorsally fuscous. Head faintly rugose and covered with dense grayish pubescence, antennæ 14-segmented, 1st and 2nd segments stout, 2nd a trifle longer than broad, 3rd segment longest, longer than 1 and 2 together, 4th segment as long as 3rd, succeeding segments to 10th progressively shorter, 10th and following segments subequal except the last, which is somewhat longer than penultimate; all the segments sparsely pubescent. Thorax coarsely punctate and covered with pubescence, parapsidal grooves on mesonotum indistinct, median longitudinal lines reaching half-way to posterior margin, smooth lines over base of wings distinct, scutellum rugose, foveæ inconspicuous, long, narrow and oblique. Abdomen smooth and shining, much compressed, 2nd segment reaching half-way to apex, pubescent at base, 3rd, 4th and 5th segments fairly broad, dorsal and ventral valves thickly pubescent. Wings hyaline, pubescent, veins heavy, black ,radial cell long, open at the margin, vein at base of cell decidedly angulate, radius itself almost straight, areolet rather large, cubitus not quite reaching basal nervure. Claws simple Length 2.5-3 mm.

Gall. Small, brown, cushion-shaped galls, sessile on twigs of *Quercus kelloggi* and *Quercus lobata*, hard and woody with the base broadly inserted in a slit in the bark. The top is flat and much pitted. Length about 4 mm., breadth about 3 mm., height about 3mm.

Habitat. Stanford University, Cal. (R. W. Patterson). Sonoma County, California. (Beutenmüller).

Disholcaspis chrysolepidis (Beutenm.)

Holcaspis chrysolepidis, Beutenmüller, Ent. News, vol. 22 (1911), p. 68.

Female. Very similar to *D. eldoradensis*, from which it can scarcely be separated, except on the character of the gall. Specimens before me show the following differences: parapsidal grooves deep and distinct, reaching half-way to anterior margin, pubescence on the thorax less abundant.

Gall. Galls sessile on the twigs of *Quercus chrysolepis* and *Quercus dumosa* and massed together around the stem, 15 to 30 in a mass; very irregular but more or less cushion-shaped outwardly and rugose, 3-4mm. in diameter, this portion of the gall surmounting smooth, lobular enlargements, sometimes arranged in a rosette. Sometimes the galls are elevated or arranged palisade-like, the outer face rough, the sides smooth, and with a median constriction. They are described as reddish or beef colored when fresh. Monothalamous, with a large internal pupal cell.

Habitat. Alma Soda Springs, Cal. (W. R. Dudley). Placer County, California. (Beutenmüller.)

5 TRICHOTERAS Ashm.

Trichoteras, Ashmead, Psyche, vol. 8 (1897), p. 67.
Trichoteras, Ashmead, Psyche, vol. 10 (1903), p. 150.

Head and thorax closely punctate, opaque, and densely pubescent. Antennæ of female 12-segmented, 3rd segment a little shorter and thicker than 4th equal to 5th, succeeding segments to 9th becoming gradually shorter, 9th to 11th only a little longer than thick, 12th as long as 10 and 11 together, Disc of the mesopleura bare, smooth and shining. Scutellum cushion-shaped, a little longer than wide, with two smooth, lunate foveæ at base. Tarsus of hind legs not longer than tibia, claws with a tooth at base beneath.

Trichoteras coquilletti Ashm.

Trichoteras coquilletti, Ashmead, Psyche, vol. 8 (1897), p. 67.

"Galls. Small, brown, sub-opaque, globular galls, averaging from 6 to 8 mm. in diameter, and internally with a central kernel or larval cell held in place by radiating filaments.

"These galls were collected by Mr. D. W. Coquillett, at Los Angeles, California, from the upper surface of the leaves of an unknown oak, who forwarded them to the Department of Agriculture, where three specimens of the gall-wasp were reared. Structurally and in general appearance the galls very closely resemble *Dryophanta polita* Bass., but the sub-apterous wasp is quite different from that species.

"Agamous female. Length 2.5 mm. Head and thorax ferruginous, closely punctate, and very hairy; prosternum and pleura blackish; legs fusco-piceous, the articulations paler.

"Antennæ 12-jointed, shorter than the body, the scape fully as long as the first joint of flagellum, obconical, and much stouter, pedicel one and one-half times as long as thick, 2nd joint of flagellum distinctly longer than either the 1st or 3rd joint; 4th joint of flagellum a little shorter than the 3rd, the 5th and following joints gradually shortening, the penultimate joint being scarcely longer than thick, the last joint fully as long as the first joint of flagellum, or twice as long as the penultimate. Wings abbreviated, narrowed and not extending beyond tip of abdomen, the veins dark brown, the marginal cell open, the areolet indicated by the union of the surrounding nervures. Abdomen black, polished, pubescent along the sides towards base, and as long as the head and thorax together, compressed and viewed from the side it is as broad as long, the hypopygium armed at tip with a long spine.

"Hab. Los Angeles, California.

"Type No. 3498, U. S. N. M.

"Described from 3 female specimens bred Nov. 26 and 29 and Dec. 6, 1892." (W. H. Ashmead).

I have not seen examples of this species.

6 CYNIPS L.

Cynips (part.), Linne, Syst. Nat. ed. 10 (1758), p. 343, 553.
Cynips (part.), T. Hartig, Zeits, f. Ent., vol. 2 (1840), p. 185, 187.
Cynips, Forster, Verh. Zool. Ges. Wien, vol. 19 Abh. (1869), p 331, 335.
Cynips, G. Mayr, Gen. d. Cynip. (1881), p. 28.
Diplolepis (part.), L. Geoffroy, Hist. Ins., vol. 2 (1762), p. 308.

Agamic generation. Body densely pubescent throughout, abdomen dorsally sometimes more or less bare. Antennæ filiform, 12-15 segmented, without long, erect hairs. Pronotum narrow in the middle. Parapsidal grooves percurrent. Scutellum with two basal foveæ, separated by a median carina. Metanotal ridges parallel. Radial cell open at the margin. Tarsal claws bidentate.

Cynips canescens (Bass.)

Holcaspis canescens, H. F. Bassett, Tr. Am. Ent. Soc., vol. 17 (1890), p. 66.
Disholcaspis canescens, Dalla Torre and Kieffer, Das Tierreich, lief. 24 Cynipidæ (1910), p. 378.

Female. Reddish brown, eyes, ocelli, tips of mandibles, antennæ distally from 8th segment and a spot on 1st, prosternum, 1st abdominal segment, tarsi and ventral valve fuscous to black, clothed with pale grayish pubescence throughout except abdomen dorsally, which is bare. Head faintly rugose, antennæ 14-segmented, filiform, 1st and 2nd segments stout, 3rd segment longest, longer than 1 and 2 together, and a little longer than 4th, succeeding segments progressively shorter, the last in some specimens indistinctly divided and longer than penultimate. Pronotum narrow in the middle, mesonotum punctate, each puncture bearing a hair, parapsidal grooves reaching about halfway to anterior margin, median longitudinal lines extending about half-way to posterior margin, smooth lines over base of wings distinct and broad, mesopleura and scutellum punctate, basal foveæ on latter obsolete. Abdomen compressed, dorsally bare, smooth and shining, ridged apically, pubescent at sides and beneath, 2nd segment occupying about one-half its length, 3rd tergite distinct, only sternites of following segments visible, dorsal and ventral valves prominent and pubescent. Wings hyaline, pubescent, veins prominent, radial cell open at margin, vein at base angulate, areolet large, cubitus not reaching basal vein. Length, 4 mm.

Gall. Brownish, globular galls, about 10 mm. in diameter, occurring singly or in clusters on the twigs of *Quercus douglasi.* Sometimes a little irregular in shape, not much roughened, and covered with a yellowish brown fuzz. Monothalamous, with a large, globular larval chamber, quite distinct from the cortical layer and held in place by loose, spongy tissue.

Habitat. Hornitos, Cal. (Miss Hazel Engebretsen).

Cynips corallina (Bass.)

Holcaspis corallinus, H. F. Bassett, Tr. Am. Ent. Soc. ,vol. 17 (1890), p. 66.
Holcaspis corallina, Dalla Torre, Cat. Hymen, vol. 2 (1893), p. 55.
Disholcaspis corallina, Dalla Torre and Kieffer, Das Tierreich, lief. 24 Cynipidæ (1910), p. 377.

Female. Very similar to *C. canescens*, but the pubescence is regularly more extensive on abdomen, only a small rhomboidal area dorsally on second segment remaining bare. The antennæ are brownish throughout, the basal segments darker, but light at the joints. The abdomen is not compressed apically but rotund, and all the tergites are visible.

Gall. Pale yellowish, globular galls, about 12 mm. in diameter, found on the twigs of *Quercus douglasi.* The galls are pointed at the poles and the surface is roughened by irregular ridges, or bears short, blunt tubercles giving it the appearance of coral.

Habitat. Mt. Diabalo, California. (Harold Morrison.)

Cynips multipunctata (Beutenm.)

Dryophanta multipunctata, Beutenmüller, Ent. News, vol. 22 (1911), p. 67.

Female. Reddish brown, eyes, ocelli, tips of mandibles, face medially, pecten, dorsal and subdorsal vittæ on mesonotum concurrent with median longitudinal lines and lines over base of wings, abdomen dorsally, sometimes entirely black or blackish. Head broad, bulged beyond the narrow eyes, faintly rugose and punctate, with a thick covering of pale yellowish pubescence, antennæ 14-segmented, 1st and 2nd segments brown, following segments brownish black, 1st to 4th segments light brown distally, 1st and 2nd segments as usual stout, 3rd segment longest, longer than 1 and 2 together and a trifle longer than 4th, the following segments progressively shorter except the last, which is one-third longer than penultimate. Thorax faintly rugose and punctate, pubescent, except on median longitudinal lines which are bare, parapsidal grooves complete, median longitudinal lines reaching more than half-way to posterior margin, smooth lines over base of wings distinct and rather long, pleura pubescent, mesopleura spotted with black, scutellum rugose and punctate, each puncture bearing a hair as on head and mesothorax, black at base, foveæ indistinct. Abdomen smooth, shining, faintly punctate, all the segments clothed with long, straight, pale yellowish pile, but dorsally and laterally bare in spots, rotund but ridged dorsally, 2nd segment occupying half its length, 3rd and 4th segments also wide, ventral valve large, triangular, with broad apex, bearing a large tuft of hairs, dorsal valve also hairy at tip. Legs pale brown and clothed with hairs. Wings large, hyaline, pubescent, veins brownish black, subcostal, radial, anal and cross veins thickened, the radial vein incrassate at tip, radial cell open and rather short, vein at base angulate and clouded, areolet large and distinct, cubital vein reaching almost to basal, clouded area at base of cubital and discoidal cells and at break in anal vein, the cubital cell with 12–15 black spots. Length 4.5 mm.

Gall. Small, dark brown, globular galls in clusters of ten to twelve on terminal twigs of *Quercus lobata*, 8 mm. in diameter, more or less irregular in shape due to compression, the exposed surface rugose. Monothalamous, the small, round larval cell, 2 mm. in diameter, imbedded centrally in spongy tissue.

Habitat. Palo Alto, Cal. (Miss Bertha Wiltz). Kern County, California. (Beutenmüller.)

Beutenmüller describes the gall of this species as "covered with a dense, short and compact woolly substance and hairs." He states also that it occurs on leaves. His specimens are obviously different from mine, although specimens of the fly from my collection which he has compared with those in his possession, he states are similar.

Cynips maculipennis (Gillette).

Holcaspis maculipennis, Gillette, Can .Ent., vol. 26 (1894), p. 236.

Disholcaspis maculipennis, Dalla Torre and Kieffer, Das Tierreich, lief. 24 Cynipidæ (1910), p. 375.

Female. Rufous, antennæ and abdomen mixed with black, densely clothed with sordid white silky pubescence except on abdomen dorsally. Head broad, bulging beyond the eyes, faintly punctate, antennæ 14-segmented, filiform, 1st and 2nd segments stout, 3rd longest, succeeding segments to 10th progressively shorter, 10th and following segments subequal except the last, which is a trifle longer than penultimate. Pronotum narrow in the middle, mesonotum finely rugose, parapsidal grooves deep and reaching to anterior margin, median longitudinal lines extending half-way to posterior margin, smooth lines over base of wings distinct and rather broad, scutellum finely rugose, cushion-shaped, foveæ indistinct. Abdomen well developed, broader than long, slightly compressed, valves black. Wings large and rather broad, hyaline, veins brown with brownish cloud at base of cubital cell, another beneath areolet, and numerous small brown spots in cubital cell. Length 4.5 mm.

Gall. Large, globular galls on the leaves of *Quercus garryana* and of other species of oak, yellowish brown and covered with rather large, dark brown spots, about 30 mm. in diameter. The outer shell is very thin and the single larval chamber is held in place by radiating fibers.

Habitat. McConaughy (Siskiyou Co.), Cal. (R. W. Patterson).

Cynips heldae n. sp.

Female. Very similar to *C. multipunctata*, from which it can scarcely be separated, except on the character of the gall.

Gall (Pl. XXIII, fig. 2). A small gall, with very irregular shape, occurring on *Quercus lobata;* more or less cubical, with many ridged and pointed projections, about 8 mm. long and 5 mm. square. My specimens, which are old and dry, are brownish, but in its natural state the gall was probably reddish, and is composed of a crystalline substance similar to the material forming the gall of *Diplolepis echina*.

Habitat. Ukiah, Cal. (Miss Held).

Cynips kelloggi n. sp.

Female. Reddish brown, the eyes, ocelli, a spot on front of head, tips of mandibles, oral margin, prosternum, antennæ distally from 7th segment, metathoracic carinæ, abdomen dorsally at apex and dorsal valve, tibia of hind legs and tarsi black or blackish. Head rugoso-punctate, antennæ 15-segmented, 1st segment obconic, 2nd oval, 3rd long, as long as 1 and 2 together, following segments to 10th progressively shorter, 11th to 15th subequal. Thorax rugose, pubescent, parapsidal and median grooves complete, median longitudinal lines reaching half-way to posterior margin, smooth lines over base of wings distinct, pleura smooth, shining, punctate in the middle, pubescent above and below, scutellum coarsely rugoso-punctate, pubescent, foveæ rather large, oval, oblique, shallow, with smooth bottom, not approximate, metanotum rugose. Abdomen smooth and shining, 2nd segment occupying about one-half its length, 3rd segment wide but 4th and 5th narrow, all the segments laterally pubescent, sheaths of ovipositor projecting and with dorsal valve pubescent. Legs slightly pubescent, claws unidentate. Wings hyaline, pubescent, veins black or blackish, radial cell open at the margin, its basal vein arcuate, almost angulate, areolet distinct, cubital vein reaching basal. Length 2-3 mm.

Gall. An elongated swelling of the twig of *Quercus douglasi*, about 20 mm. long and 10 mm. in diameter, its outer covering the same as the bark of the twig. Polythalamous.

Habitat. Stevens Creek, beyond Cupertino, Cal. (R. W. Patterson).

7 ANDRICUS Hartig.

Cynips (part.), Linne, Syst. Nat., ed. 10 (1758), p. 553.
Andricus (part.), T. Hartig, Zeits. f. Ent., vol. 2 (1840), p. 185, 190.
Andricus, Aphilothrix, A. Forster, Verh. Zool. Ges. Wien, vol. 19 Abh. (1869), p. 331, 335, 336.
Andricus, G. Mayr., Gen. d. Cynip. (1881), p. 12.

Cheeks at most only half the length of the eyes. Antennæ of female 12-16 segmented, of male 14-17 segmented. Pronotum narrow in the middle. Mesonotum shagreened or nearly smooth, sometimes transversely folded. Parapsidal grooves usually percurrent. Scutellum with two basal foveæ, without median line on disc. Metanotal ridges parallel or arcuate. Radial cell elongate, open at the margin. Tarsal claws bidentate. Abdomen almost glabrous. Agamic and sexual generations.

Andricus quercus-californicus (Bass.)

Cynips quercus californica, H. F. Bassett, Can. Ent., vol. 13 (1881), p. 51.
Andricus californicus, G. Mayr, Gen. d. Cynip. (1881), p. 28.
Andricus (Callirhytis) californicus, Ashmead, Tr. Am. Ent. Soc., vol. 12 (1885), p. 294.

Female. Reddish brown, eyes, ocelli, tips of mandibles, 3rd to 6th and 1st antennal segments proximally and ventral valve black or blackish. Head, thorax and legs covered with yellowish white pubescence. Head faintly rugose, broad and bulging laterally beyond the eyes, antennæ 14-segmented, filiform, 1st and 2nd segments stout, 3rd long, longer than 1 and 2 together, succeeding segments to 9th progressively shorter, 9th and following segments subequal except the last, which is twice as long as penultimate. Pronotum narrow in the middle, faintly rugose, mesonotum shallowly punctate, parapsidal grooves incomplete, reaching slightly beyond the middle, median longitudinal lines extending half-way to posterior margin, smooth lines over base of wings long and thin, a median bare spot on pleura smooth and shining, scutellum cushion-shaped, rugose, with rather indistinct basal foveæ. Abdomen broad, smooth and shining, dorsally ridged at apex, 2nd segment occupying about half its length, pubescent at sides basally, ventral valve and sheath of ovipositor also pubescent. Wings hyaline, pubescent, veins brownish, radial cell rather short and open at the margin, vein at base angulate, areolet large, cubitus almost reaching basal vein. Length 5 mm.

Gall. The familiar "oak-apple;" large, smooth, yellowish white, globular galls found on the branches of *Quercus lobata*, 50 to 60 mms. or more in diamater, sessile, polythalamous, the numerous larval cells imbedded internally in a rather dense cellular tissue.

Habitat. Santa Rosa, Cal. (Miss Josephine Van Wormer).

Andricus chrysolepidis Ashm.

Andricus chrysolepidis, Ashmead, Proc. U. S. Nat. Mus., vol. 19 (1896), p. 119.

"Gall. A very hard, ovate, or globular gall, with a nipple at apex and a centrally imbedded larval cell; externally it is covered with a dense, fine, short pubescence like the pubescence on a peach, although sometimes this is rubbed off. Diameter, 5-8 mm.

"Gallfly. Female. Length, 3 to 5 mm. Reddish brown, antennæ and legs brownish yellow, eyes and abdomen dark, reddish brown. Head and thorax closely punctate, sparsely pubescent. Antennæ 14-jointed, very slightly thickened at tips. The thorax, besides the two parapsidal grooves, which are obsolete anteriorly, has a median groove extending anteriorly for more than half length of the mesonotum, two short median grooves anteriorly on each side of this, and the usual groove on the shoulders. Scutellum cushion-shaped, rugose, the foveæ distinct, pleura finely, minutely rugose, slightly striated at base. Abdomen polished, the short apical segments under a high power show a fine, delicate punctuation; while the ventral valve projects but slightly. Wings glossy, hyaline, veins yellowish, areolet small; neither the apex of the submarginal nor the radial vein reach the margin.

"Types No. 3066, U. S. N. M.

"One female, reared from a gall found on *Quercus chrysolepis*, at Colfax, Placer County, California, October 8, 1885, by Mr. Albert Koebele; and two specimens reared January 18 and 29, 1886, from same galls. Other of the galls are numbered 3816 U. S. N. M." (W. H. Ashmead.)

I have not seen examples of this species.

Andricus congregatus Ashm.

Andricus congregatus, Ashmead, Proc. U. S. Nat. Mus., vol. 19 (1896), p. 120.

"Gall. An irregular, rugose, yellowish brown woody swelling, containing numerous cells, growing apparently from the extreme tips of very slender twigs of *Quercus chrysolepis*, the gall appearing to have a long peduncle, or it may be at the apex of the petal of a leaf, the leaf in consequence being aborted. The gall is more or less contracted in the middle and varies in length from 2–4 cm. and in diameter from 1–2 cm.

"Gallfly. Female. Length, 2 mm. Pale brown or brownish yellow, the eight terminal antennal joints, the middle and posterior tibiæ, metathorax, abdomen dorsally, and wing veins brown. Head and thorax closely, uniformly punctate. Antennæ 14 or 15-jointed, depending upon whether the terminal joint, which presents a rather distinct suture, is counted as one or two joints. The terminal joints all appear delicately fluted. Mesonotum has three distinct grooves, extending its whole length, and the groove on the shoulder is long. Scutellum minutely rugose, the foveæ oblique, distinct, but rather widely separated. Wings hyaline, with short pubescence.

"Type. No. 3068 U. S. N. M.

"Seven female specimens, received from Prof. E. W. Hilgard, Oakland, California, and reared November 10, 1876. The gall also occurs on *Quercus agrifolia*, and Prof. Riley says "a woody deformation of the stamniate aments and quite abundant on some trees." (W. H. Ashmead).

I have not seen examples of this species.

Andricus crystallinus Bass.

Andricus crystallinus, H. F. Bassett, Tr. Am. Ent. Soc., vol. 26 (1900), p. 319.

Female. Cherry red to reddish brown, eyes, oral margin, spot on front above the insertion of antennæ, antennæ distally from 7th segment and a band on segments 1, 3, 4 and 5, dorsal and subdorsal vittæ on mesonotum concurrent with median longitudinal lines and lines over base of wings, scutellum at base, metathorax largely, pedicel, abdomen dorsally at base and on 3rd, 4th and 5th segments, pecten, hind coxæ, tips of tarsi and dorsal valve black or blackish. Head minutely rugoso-punctate, face pubescent, antennæ 14-segmented, 1st segment obconic, 2nd oval, 3rd as long as 1 and 2 together, a trifle longer than 4th or 5th, succeeding segments to 10th progressively shorter, following segments subequal. Pronotum narrow in the middle, punctate, mesonotum also punctate, parapsidal grooves complete, median longitudinal lines reaching half-way to posterior margin, smooth lines over base of wings long and rather broad, pleura smooth and shining, pubescent on upper and lower margins, scutellum rugose, foveæ large, oval, deep, bottom smooth and shining, approximate, covered throughout with dense pubescence. Abdomen smooth and shining, 2nd segment occupying about four-fifths of its length, basally pubescent at sides, 3rd segment rather wide, 4th, 5th and 6th quite narrow, these segments minutely punctate, ovipositor sheaths exserted and pubescent, legs light brown, claws bidentate. Wings hyaline, pubescent, subcostal, radial, basal and anal veins heavy and brown, others rather faint, radial cell open at margin and rather long, its basal vein arcuate, areolet indistinct, cubitus not reaching basal vein. Length about 2.25 mm.

Gall. Irregularly shaped palisadal galls, in clusters of 5 or 6, on under side of leaves of *Quercus dumosa*, *Quercus douglasi* and *Quercus agrifolia*? and binding leaves together. Outwardly fuzzy. The individual gall is about 7 mm. long and 2 to 3 mm. across.

Habitat. Jasper Ridge, in the vicinity of Stanford University, Cal. (R. W. Patterson). St. Helena, Cal. (Miss Julia Begley). Napa, Cal. (Bassett.)

Andricus pacificus Ashm.

Andricus pacificus, Ashmead, Proc. U. S. Nat. Mus., vol. 19 (1896), p. 118.

Female. Reddish brown, eyes, ocelli, tips of mandibles, and tip of dorsal valve blackish, 1st abdominal segment more or less fuscous, legs and antennæ basally a yellowish brown. Head faintly rugose, pubescent, antennæ 14-segmented, 1st and 2nd segments stout, 3rd long, longer thna 4th, succeeding segments to 10th progressively shorter, 10th and following segments subequal except last, which is a trifle longer than penultimate. Thorax faintly rugose, parapsidal and median grooves on mesonotum reaching half-way to anterior margin, median longitudinal lines extending half-way to posterior margin, smooth lines over base of wings distinct and long, pleura aciculate, scutellum deeply rugose, especially at apex, and pubescent, foveæ large, subcircular, shallow, with shining, punctate bottom, and contiguous. Abdomen about equal in length to head and thorax together, 2nd segment extensive and succeeding segments, which are microscopically punctate, telescoped, occupying only a fourth its length, valves conspicuous. Wings glassy hyaline, pubescent, radial cell open at the margin, areolet large, cubitus not reaching basal vein, vein at base of radial cell arcuate. Length 2.5–3.5 mm.

Gall. Dark greenish or yellowish brown, drupe-like galls, 2 cm. in length and 1 cm. in width, arising from the leaf-buds of *Quercus chrysolepis*, pointed at apex and with more or less obvious nipple, surface rugose. Apparently monothalamous. The exit hole of the mature insect is at the base. Internally the gall is of a hard, pithy structure, and an elongated, cylindrical canal leads to the large centrally imbedded larval cell. These galls are described by Ashmead as smooth and sometimes polished.

Habitat. Stevens Creek, above Cupertino, Cal. (R. W. Patterson.) Placer County, California. (Ashmead.)

Andricus dasydactyli Ashm.

Andricus dasydactyli, Ashmead, Proc. U. S. Nat. Mus., vol. 19 (1896), p. 117.

"Gall. This gall, in structure, is very peculiar, and consists of an oblong or elongated, woody tube, in shape not unlike a date seed; it is two centimeters long by from one-half to three-fourths of a centimeter in diameter, one end being attached sessilly to the branch and covered with long, brownish yellow wool. Internally there is a cylindrical hollow, which, however, does not extend its entire length, being interrupted or stopped up by the small larval cell which is situated near its center.

"Sometimes three or more of these galls occur close together on the branch, and with their woolly covering present a curious appearance. One of the specimens in the collection is almost globular, but all the others are as described above.

"Gall-fly. Female. Length 3.8 mm. Clear reddish brown; vertex of head and the extreme tip of abdomen dusky; antennæ and legs brownish yellow. Head and thorax minutely, finely punctate, the pleura with fine striæ. Antennæ 14-jointed, rather long, the 3rd joint one-third longer than 4th, the following to 8th gradually shortening, beyond this about equal, the terminal joint being slightly lengthened. The parapsidal grooves are only distinct on the posterior half of the mesonotum, entirely wanting anteriorly; anteriorly extending to about the middle of the mesonotum are two median, glabrous lines; posteriorly there is a long median grooved line, while the line on the shoulders is distinct; the scutellum is more coarsely rugose at the apex, the basal foveæ large, ovate, oblique, approximate, glabrous at bottom. The abdomen is slightly longer than the head and thorax together and of the usual shape. Wings glassy hyaline, only slightly pubescent, the veins pale yellowish, except the basal nervure and the vein at base of marginal cell, which are brown; this last vein is arcuate but not angulate. The areolet is large and the cubital cell is not quite closed.

"Type. No. 3063, U. S. N. M.

"Described from many female specimens, which issued at various dates between January 18, 1885 and February 11, 1886. The gall occurs in California on *Quercus chrysolepis*, and was sent to the Department of Agriculture by Mr. Albert Koebele." (W. H. Ashmead).

I have only seen specimens of the gall, which were collected from *Quercus chrysolepis*, in the Stevens Creek Canyon, above Cupertino, Cal. It is very characteristic and unmistakable.

Andricus kingi Bass.

Andricus kingi, H. F. Bassett, Tr. Am. Ent. Soc., vol. 26 (1900), p. 316, 317.

Female. Brown, eyes, ocelli, tips of mandibles, tips of tarsi and dorsal valve black. Head finely reticulate, face a pale brown, without pubescence, antennæ 14-segmented, 1st and 2nd segments stout, 3rd segment long, nearly as long as 1 and 2 together, one-third longer than 4th, 4th and 5th subequal, succeeding segments to 9th progressively shorter, 9th and following segments subequal, all the segments more or less fuscous. Thorax finely reticulate and punctate, covered with a sparse pubescence, parapisdal grooves complete and deep, median longitudinal lines and smooth lines over base of wings rather indistinct, median longitudinal groove from posterior margin very indistinct, mesopleura smooth, shining, microscopically reticulate, pubescent below, scutellum rugose, basally with large, circular foveæ, shallow, with smooth bottom, and contiguous, separated only by a carina. Abdomen smooth, shining, compressed, 2nd segment occupying about one-half its length, following segments wholly visible, dorsal valve and ovipositor sheaths prominent, last segment reticulate, 3rd, 4th, 5th, 6th and margin of 2nd punctate. Wings hyaline, pubescent, with faint iridescence, radial cell open and rather long, areolet small, cubitus not reaching basal vein. Length 2mm.

Gall. Small, pink, cone-shaped galls on the under side of leaves of *Quercus lobata*, about 5mm. high and 4 mm. across the base, which is broad and rather saucer-shaped. The outer portion of the gall is conical, the sides curved inwards slightly. The larval chamber is near the apex, where the exit hole is found. Some of the galls, from which flies were bred in every way identical with those from typical specimens, are said to be whitish striped with red and on leaves of *Quercus douglasi*, but specimens are not at hand.

Andricus parmula Bass.

Andricus parmula, H. F. Bassett, Tr. Am. Ent. Soc., vol. 26 (1900), p. 312.

Female. Ferruginous, the legs and antennæ yellowish brown, eyes, ocelli, tips of mandibles, tips of tarsi, abdomen dorsally at apex and ventral valve black. Head faintly rugose, face pubescent, antennæ 13-segmented, 1st and 2nd segments stout, 3rd segment long, only a little longer than 4th, 4th and 5th segments subequal, succeeding segments to 10th progressively shorter, 10th and following segments subequal, except last, which is twice as long as penultimate. Pronotum narrow in the middle, mesonotum coarsely reticulate, parapsidal grooves incomplete, reaching but half-way to anterior margin, median longitudinal lines extending half-way to posterior margin, smooth lines over base of wings distinct, pleura finely striated, with a triangular smooth area posteriorly, scutellum rugose, sparsely pubescent, basal foveæ large, elliptic, oblique, with smooth bottom, not approximate, metanotal ridges only slightly curved, faced with black. Abdomen about as long as head and thorax together, smooth and shining, more or less lenticular in shape, second segment occupying half its length, 3rd segment rather broad, following segments narrow, ovipositor sheath exserted, concolorous. Wings rather opaque whitish, faintly iridescent, veins faint, yellowish, radial cell narrow, open at the margin, vein at base arcuate, almost angulate, areolet indistinct, cubitus not reaching basal vein. Length 2 mm.

Gall. Very small, flat, reddish, disc-shaped galls on the under side of leaves of *Quercus lobata*, about 3 mm. in diameter, slightly elevated in the center. Much smaller than gall of *Andricus pattersonæ* and quite distinct from it.

Andricus wisliceni Ashm.

Andricus wisliceni, Ashmead, Proc. U. S. Nat. Mus., vol. 19 (1896), p. 119.

"Gall. A small, globular gall, with a slight projection at base where it is attached to the twig; it varies in color from a yellow brown to dark brown, and some are mottled with purple and brown. It is hard, and contains in the center a small larval cell; diameter, 3-4 mm.

"Gall-fly. Female. Length, 3 to 3.4 mm. Pale brownish yellow, almost devoid of pubescence, the abdomen polished and discolored with brown, eyes dark brown, the mandibles black. Head and thorax finely punctate, shining; in front of the anterior ocellus is a deep transverse foveæ, and there are some coarse scattered punctures on the mesonotum. Antennæ 14-jointed, the 3rd joint about one-eighth longer than the 4th, the joints from 7th to apex short, about twice as long as wide, dusky, and delicately fluted. Parapsidal grooves distinct, the groove on the shoulders very long, distinct, and a little bent anteriorly. Scutellum cushion-shaped, rugose, the foveæ at base large and distinct, separated only by a slight carina; pleura smooth, but under a high power showing faint delicate striæ. Wings hyaline, the pubescence short, veins, except the sub-marginal vein from the portion extending from the basal vein to apex, and the angulated cross vein at base of marginal cell, which are brownish or piceous, yellowish.

"Type. No. 3065, U. S. N. M.

"Nine female specimens, reared October 14, 1886, from the galls sent to the National Museum by Mr. Albert Koebele, collected in Sacramento County, California, on *Quercus wisliceni*." (W.H.Ashmead).

I have not seen examples of this species.

Andricus quercus-flocci (Walsh).

? Cynips quercus lana, A. Fitch, 5th Rep. Ins. N. York (1859), p. 34.
? Cynips quercus lanæ, Osten Sacken, Proc. Ent. Soc. Philad., vol. 1 (1861), p. 62.
Cynips quercus flocci, B. D. Walsh, Proc. Ent. Soc. Philad., vol. 2 (1864), p. 482.
Cynips (Andricus) flocci Osten Sacken, Proc. Ent. Soc. Philad., vol. 4 (1865), p. 352.
Andricus flocci, G. Mayr, Gen. d. Cynip. (1881), p. 28.
? Andricus lana, Ashmead, Tr. Am. Ent. Soc., vol. 12 (1885), p. 295.

Female. Black, ocelli, antennæ, legs distally from the coxæ, tegulæ and ovipositor sheath brownish. Head reticulately rugose, shining, face with whitish pubescence, antennæ 13-segmented, 3rd segment longest, not as long as 1 and 2 together and only a little longer than 4th, following segments progressively shorter except last, which is one and one-half times the length of penultimate, distal segments fuscous. Pronotum narrow in the middle, rugose and pubescent, mesonotum smooth and shining, or more or less shagreened, parapsidal grooves deeply impressed, complete, the median longitudinal lines reaching more than half-way to posterior margin, smooth lines over base of wings distinct and reaching anterior margin, pleura aciculate, scutellum rugose, slightly pubescent, basal foveæ large, shallow, with smooth bottom, approximate. Abdomen smooth, shining, greatly compressed apically, 2nd segment occupying more than half its length, pubescent at base, 3rd and following segments narrow, ventral valve perpendicular, reaching tergal line, ovipositor exserted and curving upward, ovipositor sheath pale, pubescent. Wings hyaline, pubescent, veins brown, radial cell long, open at the margin, vein at base arcuate, areolet small, cubitus not reaching basal vein. Length 2.25 mm.

Gall. A mass of twenty or more smooth, brown, elliptical or loaf-shaped galls, 2mm. high and 1 mm. in diameter, on under side of leaves of *Quercus lobata*, covered with reddish or yellowish wool. Monothalamous.

Habitat. Palo Alto, Cal. (Miss Bertha Wiltz.)

Andricus pattersonæ n. sp.

Female. Very similar to *A. kingi*, from which it can scarcely be separated, except on the character of the gall. Some of the specimens have the abdomen dorsally and the antennæ distally from 9th segment more or less blackish, and dorsal and subdorsal vittæ on mesonotum concurrent with the median longitudinal lines and smooth lines over base of wings.

Gall (Pl. XXIII, fig. 3). Thin, flat, disc-shaped galls from leaves (presumably) of *Quercus douglasi*, about 6 mm. in diameter, greenish gray with lilac center, the margin irregular; upper surface a trifle wrinkled but otherwise smooth.

Habitat. Stanford University, Cal. (R. W. Patterson.)

Andricus wiltzæ n. sp.

Female. Head and thorax black, abdomen walnut brown, darker (almost black) on the dorsum, antennæ brown, 1st, 3rd and 4th segments spotted with black, distally from 6th segnemt fuscous to black, tegulæ, sheath of ovipositor, anterior legs and joints of middle and hind legs brown. Head broad and thin, with close, reticular sculpturing, eyes narrow, antennæ 13-segmented, 1st and 2nd segments stout, 1st obconic, 2nd subglobular, 3rd longest, as long as 1 and 2 together, following segments progressively shorter to last, which is twice penultimate. Prothorax narrow in the middle and transversely folded, sparsely punctate, each puncture bearing a hair, mesonotum openly reticulate, transversely folded, parapsidal grooves complete and distinct, median longitudinal lines reaching almost half-way to posterior margin, smooth lines over base of wings distinct, pleura smooth and polished, aciculate in the middle, pubescent below, scutellum deeply rugose, basal foveæ large, oval, with smooth, shining bottom, approximate, separated only by a carina, metanotum smooth, polished, pubescent. Abdomen stout, subglobose, smooth and shining, 2nd segment occupying less than one-half its length, 3rd segment rather broad, slightly punctate, 4th, 5th and 6th segments narrow, all with oblique margins, ventral valve concealed, black, ovipositor sheath slightly projecting, pubescent. Wings hyaline, pubescent, subcostal, basal and radial veins heavy, brown, others faint, radial cell long, narrow, open at the margin, vein at base arcuate, areolet distinct but veins on two sides faint, cubitus faint, not reaching basal vein. Length 2.5 mm.

Gall. Polythalamous galls formed in the buds of *Quercus lobata*, distinguished by the thickly compacted cluster of aborted leaves.

Habitat. Stanford University, Cal. (Miss Bertha Wiltz.)

Andricus brunneus n. sp.

Female. Brown to reddish brown, the eyes, ocelli, tips of mandibles, antennæ distally, metanotum in the middle, tips of tarsi, abdomen dorsally at apex and dorsal valve black or blackish. Head faintly reticulate, face pubescent antennæ 14-segmented, 1st segment obconic, 2nd oval, 3rd longest, as long as 1 and 2 together and a little longer than 4th, succeeding segments to 9th progressively shorter; 9th and following segments subequal, except the last, which is a little longer than penultimate. Pronotum and mesonotum finely reticulate, sparsely punctate, each puncture bearing a hair, parapsidal grooves indistinct, reaching but half-way to anterior margin and rather widely separated, median longitudinal lines extending half-way to posterior margin, smooth lines over base of wings distinct and long, pleura smooth, microscopically reticulate, pubescent above and below, scutellum rugose, basally with large, transverse foveæ, smooth at bottom, contiguous, separated only by a carina, metanotum almost smooth. Abdomen smooth, shining, compressed and dorsally ridged, 2nd segment occupying not more than one-third its length, pubescent at the base, 3rd, 4th, 5th and 6th segments punctate, 7th segment reticulate, dorsal valve and sheaths of ovipositor exserted. Wings hyaline, pubescent, subcostal, basal and vein at base of radial cell heavy, brown, others faint, radial cell long, open at margin, vein at base arcuate, with fuscous suffusion, areolet small but distinct, cubitus not reaching basal vein. Length 3 mm.

Gall. Thin-shelled, subglobular galls on leaves of *Quercus douglasi*, about the size of a pea, pointed at opposite poles.

Habitat. Stanford University, Cal. (R. W. Patterson.)

8 CALLIRHYTIS Forst.

Callirhytis, A. Forster, Verh. Zool. Ges. Wien, vol. 19 Abh. (1869), p. 331, 335.

Andricus (Callirhytis), G. Mayr, Gen. d. Cynip. (1861), p. 27.

Differs from Andricus only in the following particulars: parapsidal grooves not always complete, tarsal claws simple.

Callirhytis chrysolepidicola (Ashm.)

Cynips chrysolepidicola, Ashmead, Proc. U. S. Nat. Mus., vol. 19 (1896), p. 124.

Female. Brown, eyes, tips of mandibles, face above base of antennæ and on anterior margin, and metathoracic carinæ black, antennæ, abdomen dorsally, and tibiæ and tarsi of middle and hind legs fuscous. Head rugose, slightly pubescent, antennæ 15-segmented, 1st and 2nd segments stout, 1st obconic, 2nd smaller, 3rd segment longest, longer than 1 and 2 together, 4th-6th segments progressively shorter, following segments subequal except the last, which is smaller than penultimate. Mesothorax punctate and pubescent, parapsidal grooves indistinct, scutellum small, cushion-shaped, rugose and pubescent, foveæ distinct, oval, shallow and approximate. Abdomen darker than head or thorax, smooth and shining, 2nd segment pubescent at base, ventral and dorsal valves of medium length and pubescent, ovipositor long, extending much beyond the abdomen. Wings hyaline, pubescent, subcostal, radial basal and 2nd transverse veins heavy, black, other veins rather feeble, radial cell open at margin, areolet distinct. Length 2 mm.

Gall. Stem or twig galls; brown, with a bluish tint, and rugose, over 25 mm. long and about 15-20 mms. in diameter, the long axis lying in the direction of the twig, hard and woody, polythalamous.

Habitat. Pacific Grove, Cal. (C. P. Smith.) Pine Canyon, Cal. (Ashmead.)

Callirhytis apicalis (Ashm.)

Andricus apicalis, Ashmead, Proc. U. S. Nat. Mus., vol. 19 (1896), p. 120.
Callirhytis apicalis, G. Mayr, Verh. Zool. Ges. Wien, vol. 52 (1902), p. 289.

"Galls. Irregular, brownish black, globular galls of a dense pithy substance, growing on the roots of *Quercus wisliceni*, sometimes three or four together, pressing each other into irregular shapes. Diameter usually about half an inch.

"Gall-fly. Female. Length 5.8 to 7 mm. Bright brick red, the mandibles black at tips. Head and thorax finely punctate with some larger, coarser punctures scattered over the surface, and almost free from pubescence. Cheeks full, bulging. Antennæ 14-jointed, filiform, the 3rd joint slightly larger than 4th and narrowed toward base, the apical joint twice as long as the preceding, fusiform. Parapsidal grooves distinct, a more or less distinct medial groove and distinct grooved lines on the shoulders. Scutellum rugose, with two large foveæ at base, separated by a carina; pleura anteriorly slightly rugose, posteriorly nearly smooth, with some very delicate striæ. Abdomen smooth, with a few hairs on the side of second segment; the terminal segments show a fine, delicate punctuation; the spine of the ventral valve is long. Wings hyaline, except the entire apical third, which is smoky or dark brown, the veins stout, black, the angular projection in marginal cell at base being very distinct.

"Type. No. 3067, U. S. N. M.

"Three specimens, reared by Mr. Albert Koebele, form galls collected in Sacramento County, California, but the year of collecting and the date of rearing are not given. A single specimen (No. 3714) was reared February 17, 1886. The bright red color and smoky bases of wings will readily distinguish the species." (W. H. Ashmead).

I have not seen examples of this species.

Callirhytis quercus-pomiformis (Bass.)

Cynips quercus pomiformis, H. F. Bassett, Can. Ent., vol. 13 (1881) p. 74.
Andricus pomiformis, Ashmead, Tr. Am. Ent. Soc., vol. 12 (1885), p. 295.
Callirhytis pomiformis, G. Mayr, Verh. Zool. Ges. Wien, vol. 52 (1902), p. 289.
Callirhytis quercus-pomiformis, Dalla Torre and Kieffer, Das Tierreich, lief. 24 Cynipidæ (1910), p. 568.

Female. Black, antennæ, legs, mandibles and abdomen ventrally dark brown. Head coarsely rugose, antennæ 14-15 segmented, 1st and 2nd segments stout, 3rd segment longest, a little longer than 4th, succeeding segments to 9th progressively shorter, 9th and following segments subequal, 15th a mere tip on preceding segment. Thorax coarsely rugose, parapsidal grooves distinct, complete, median longitudinal lines reaching half-way to posterior margin, scutellum rugose, with subcircular basal foveæ shallow, smooth and shining at bottom, not exactly approximate. Abdomen more or less smooth and shining, 2nd segment occupying about two-thirds its length, ventral valve and sheath of ovipositor pubescent. Legs clothed with pubescence. Wings hyaline, radial cell open at the margin, a black cloud at base, subcostal vein scarcely reaching margin, vein at base of radial cell angulate, areolet distinct, cubitus not always reaching basal vein. Length 3 mm.

Gall. Yellowish, subspherical galls, about 35 mm. in diameter, the surface more or less roughened by slight elevations in the form of longitudinal ridges, containing within numerous oval larval cells imbedded in the pithy substance of the gall.

Habitat. Stanford University, Cal. (R. W. Patterson.)

Callirhytis quercus-agrifoliæ (Bass.)

Cynips quercus agrifoliæ, H. F. Bassett, Can. Ent. vol. 13 (1881), p. 53.
Andricus (Callirhytis) agrifoliæ, G. Mayr, Gen. d. Cynip. (1881), p. 28.
Callirhytis quercus-agrifoliæ, Dalla Torre and Kieffer, Das Tierreich, lief. 24 Cynipidæ (1910), p. 567.

Female. Pale yellowish brown, the antennæ distally from 10th segment and abdomen dorsally fuscous to black, eyes, ocelli, tips of mandibles, prosternum, metathorax, tips of tarsi and ventral valve black. Head faintly rugose, almost granulose, face pubescent, antennæ 14-segmented, filiform, 1st and 2nd segments stout, 1st obconic, 2nd oval, 3rd segment longest, as long as 1 and 2 together and a little longer than 4th, succeeding segments to 9th progressively shorter, 9th-13th subequal, last segment longer than penultimate by a half. Thorax elevated, subspherical, pronotum narrow in the middle, granulose, slightly pubescent, mesonotum reticulate, almost shagreened, parapsidal grooves deeply impressed, not quite complete but approaching anterior margin, median longitudinal lines reaching half-way to posterior margin, smooth lines over base of wings long and very distinct, pleura largely granulose, slightly pubescent above and beneath, aciculate in the middle, scutellum granulose, pubescent, basal foveæ large, oval, transverse, and shallow, with smooth, shining bottom, approximate, metathorax shallowly punctate, pubescent. Abdomen long oval, smooth and shining, 2nd segment occupying about half its length, 3rd and 4th segments rather wide, succeeding segments narrow, posterior margins in all oblique, ovipositor sheath exserted, pubescent. Wings hyaline, pubescent, veins pale brown, radial cell long, narrow, open at the margin, vein at base angulate, areolet distinct, cubitus not reaching basal vein. Length 3.5 mm.

Gall. Moderately large, brownish, hard, globular galls, about 10 mms. in diameter, on twigs of *Quercus agrifolia*, surface microscopically pubescent. Internally composed of a dense, cork-like substance, in which the single larval cell is imbedded.

Habitat. Palo Alto, Cal. (R. W. Patterson.)

Callirhytis lasia Ashm.

Callirhytis lasius, Ashmead, Proc. U. S. Nat. Mus., vol. 19 (1896), p. 132.

Female. Pale brownish yellow, legs lighter than body, abdomen dorsally darker, head and thorax pubescent. Head faintly rugose. antennæ 14-segmented, 1st segments obconic, 2nd long oval, 3rd segment longest, as long as 1 and 2 together and incised proximally for two-thirds its length, succeeding segments to 9th progressively shorter, 9th and following segments, which are fuscous, subequal, except last, which is longer than penultimate. Thorax closely punctate, punctation rather coarse, parapsidal and median grooves from posterior margin distinct, the former almost complete, median longitudinal lines reaching nearly half-way to posterior margin, smooth lines over base of wings rather long, scutellum flat, closely punctate, basal foveæ transverse and not separated by a carina. Abdomen smooth and shining, 2nd segment occupying less than half its length, pubescent at base, 3rd, 4th and 5th tergites visible, dorsal and ventral valves with a brush of hairs. Wings hyaline, pubscent, veins farily distinct, radial cell open at margin, short, vein at base arcuate, radius only slightly bent, almost a straight line, areolet present and distinct, cubitus not reaching basal vein. Length 2 mm.

Gall. Brownish, subglobular, depressed galls on under side of leaves of *Quercus chrysolepis*, 6-7 mm. in diameter, punctate, and covered with pubescence, which is pale brownish tinged with red. Polythalamous.

Habitat. Stevens Creek Canyon, above Cupertino, Cal. (R. W. Patterson.)

Callirhytis quercus-suttoni (Bass.)

Cynips quercus suttoni, H. F. Bassett, Can. Ent., vol. 13 (1881), p. 54.
Andricus (Callirhytis) suttoni, G. Mayr, Gen. d. Cynip. (1881), p. 28.
Callirhytis quercus-suttoni, Dalla Torre and Kieffer, Das Tierreich, lief. 24 Cynipidæ (1910), p. 564.
Callirhytis polythyra, Beutenmüller in litt.

Female. Reddish brown, tips of mandibles, oral margin, antennæ distally from 4th segment at joints, prosternum, base of scutellum, metathorax, abdomen dorsally at base, ventral valve and hind tibiæ and tarsi black or blackish. Head faintly rugose, face pubescent, eyes narrow, antennæ 15-segmented, filiform, 1st and 2nd segments stout, 3rd segment longest, longer than 1 and 2 together and one-half longer than 4th, succeeding segments to 9th progressively shorter, 9th-15th subequal. Pronotum narrow in the middle, mesonotum coriaceous and sparsely punctate, pubescent, parapsidal and median grooves reaching less than half-way to anterior margin, median longitudinal lines and smooth lines over base of wings distinct, pleura pubescent, medially smooth and bare, scutellum rugose and pubescent, a rather broad, arcuate groove at base in place of the usual foveæ. Abdomen smooth and shining, second segment occupying less than half its length, pubescent at base, 3rd and 4th segments rather broad, succeeding segments narrow or concealed, ventral valve prominent, ovipositor sheath exserted, pubescent. Legs thickly covered with short hairs. Wings hyaline, pubescent, veins brownish, rather faint, radial cell long, narrow, open at the margin, vein at base angulate, areolet distinct, cubitus not reaching basal vein. Length 3.5 mm.

Gall. Spherical or elongate twig swelling on *Quercus agrifolia*, and *Quercus chrysolepis*, about 20-30 mms. in length and 15-25 mms. in diameter, covered with normal bark and ligneous within. Polythalamous, the numerous oval cells lying near the surface.

Habitat. Claremont, Cal. (Baker.)

Callirhytis vacciniifoliæ Ashm.

Callirhytis vacciniifoliæ, Ashmead, Proc. U. S. Nat. Mus., vol. 19 (1896), p. 130.

"Gall. A thin shelled, globular gall, with a central kernel held in place by radiating filaments and closely resembling the gall produced by *A. inanis* Osten-Sacken, but the average size is smaller and the color of the gall darker. It measures from half an inch to a little over an inch in diameter and is found on *Quercus vacciniifolia* in California.

"Gall-fly. Female. Length, 2 to 3.2 mm. Red or brownish red (one specimen has the thorax almost black), antennæ and legs brownish yellow, sometimes obfuscated; several terminal joints of the antennæ are dark brown. Head closely punctate; thorax almost smooth, the parapsidal grooves sharply defined, complete, a short median groove posteriorly and the groove on the shoulder indistinct; scutellum rugose, the foveæ large, broad, distinct, and separated only by a carina; mesopleura smooth, polished, the triangular piece beneath tegulæ alone being punctate. The abdomen is longer than the head and thorax together, the segments oblique, the second segment occupies about two-thirds of the whole surface and is a little pubescent at sides near the base, impunctate, some of the short terminal segments a little dusky; spine of ventral valve rather long, hairy. Wings hyaline, pubescent, the veins pale brown; the vein at base of marginal cell is slightly bent, but not angulate, the marginal cell being very long and narrow, areolet distinct, but the surrounding veins delicate, cubital cell almost closed.

"One of the specimens is but 2 mm. long and of a uniform brownish yellow color, but structurally it does not seem to differ from the others.

"Type No. 3087, U. S. N. M.

"Four specimens, reared October 16, and December 4, 1884, from galls collected by Prof. J. H. Comstock, at Truckee, California, on *Quercus vacciniifolia*." (W. H. Ashmead).

I have not seen examples of this species.

Callirhytis maculipennis Kieff.

Callirhytis maculipennis, Kieffer, Bull. Soc. Metz, ser. 2, vol. 11 (1904), p. 131.

Callirhytis maculipennis, Kieffer, Invert. Pacif., vol. 1 (1904), p. 42.

"Black, opaque and pubescent. Head rugose, enlarged behind the eyes; front coriaceous, temples longitudinally striated and finely punctured, nearly smooth and shining close behind the eyes. Antennæ brownish-red, the last joints more or less fuscous, 14-jointed, nearly glabrous; second joint hardly longer than thick; the third at least thrice as long as thick, the following joints gradually decreasing in size; joints 9-13 nearly equal, one third longer than thick; the last a little longer than the penultimate. Thorax coarsely rugose; mesonotum irregularly rugose posteriorly between the parapsidal furrows, anteriorly and laterally more or less transversely rugulose; parapsidal furrows complete; the four glabrous lines of the mesonotum are rigid; mesopleura shagreened and smooth; scutellum hardly longer than wide, rugose, with two triangular foveæ at the base and a longitudinal middle furrow in the anterior two-thirds. Metanotum glabrous, shagreened, with three longitudinal carinæ, the lateral ones curved outwards. Wings hyaline, fringed, with a fuscous spot at the base of the radial cell; first abscissa of the radius angulate. Legs brownish red, hind femora and middle part of the hind tibiæ fuscous; claws simple. Abdomen smooth, shining, laterally pubescent only at the base of the second segment, longer than the head and the thorax united; second segment one-fourth shorter than the whole abdomen, finely punctulate apically, laterally very sloping; the two following segments also punctulate. Length of female 3.5-4 mm.

"Gall. A bud gall on *Quercus agrifolia*, globular, the diameter 22 mm. or more, whitish, smooth and glabrous, apically with a very small wart; the inner substance is also whitish, somewhat spongiose, and contains below the middle several brownish cells which are 4 mm. high and 2 mm. wide.

"This species is allied to the genus *Amphibolips*, from which it is excluded by the tarsal claws being simple." (J. J. Kieffer).

I have examined an example of both gall and gallfly of C. maculipennis. kindly furnished by Mr. Baker.

Callirhytis eriophora Kieff.

Callirhytis eriophora, Kieffer, Bull. Soc. Metz, ser. 2, vol. 11 (1904), p. 132.
Callirhytis eriophora, Kieffer, Invert. Pacif., vol. 1 (1904), p. 43.

"Brownish red, opaque, scarcely pubescent, and finely shagreened. Head enlarged behind the eyes. Antennæ 14-jointed, the second joint longer than thick; the third fully thrice as long as thick, scarcely longer than the fourth; the following joints gradually shorter and thicker; the penultimate, one-third longer than thick, shorter than last. Mesonotum nearly glabrous, with four dusky longitudinal stripes, the lateral of which are abbreviated anteriorly, the two others shortened posteriorly; parapsidal furrows not complete, anteriorly obliterated. Scutellum rugose, nearly glabrous, basally with two divergent foveæ. Metanotum black-brown, with two parallel carinæ. Wings hyaline, fringed, the veins brown, the first abscissa of radius angulated. Legs faint yellow; claws simple. Abdomen dark red-brown, above nearly black; the second segment occupying nearly the whole abdomen, very shining, glabrous, posteriorly microscopically punctulate; ventral-spine eight times as long as wide. Length of the female 3-3.2 mm.

"Gall. A bud gall on *Quercus wislizenii;* the gall is rounded, 10 mm. in diameter, the outer portion a yellowish wool-like substance, the inner a globular, ligneous, thin-shelled and monothalamous cell, 4 mm. or more in diameter." (J. J. Kieffer).

I have seen examples of this species, kindly furnished by Mr. Baker.

Callirhytis clarimontis Kieff.

Callirhytis clarimontis, Kieffer, Bull. Soc. Metz, ser. 2, vol. 11 (1904), p. 132.
Callirhytis clarimontis, Kieffer, Invert. Pacif., vol. 1 (1904), p. 43.

"Brownish yellow, finely shagreened and scarcely shining. Head enlarged behind the eyes. Antennæ black-brown apically, 14-jointed; the third joint nearly five times as long as thick, one half longer than the fourth; the following joints gradually decreasing in length, the penultimate one-third longer than thick, the last more than twice as long as thick. Mesonotum nearly glabrous, with four dusky longitudinal stripes, the two lateral ones abbreviated anteriorly; the parapsidal furrows complete. Scutellum rugose, nearly glabrous, with two divergent foveæ at the base. Metanotum black-brown, with two parallel carinæ. Wings hyaline, fringed, the veins dusky, the first abscissa of the radius angulated. Legs and coxæ faint yellow, claws simple. Abdomen glabrous, highly polished, not punctulate, dorsally more or less black-brown, the second segment surpassing somewhat the middle, laterally very sloping; ventral-spine four to five times as long as wide. Length of the female 3.5-4 mm.

"Gall. The gall of this species was found on *Quercus agrifolia;* it is a bud gall 8 mm. in diameter and more, globular, opaque, yellowish, with some sparse brown spots, glabrous, apically with short and sparse hairs and a small wart; the inner substance is brown, spongiose, and encloses a globular, faint yellow, thick-shelled, monothalamous shell 5 mm. in diameter and more; wall of the cell 1.6 mm. thick." (J.J.Kieffer)

I have seen examples of this species, kindly furnished by Mr. Baker.

Callirhytis bakeri Kieff.

Callirhytis bakeri, Kieffer, Bull. Soc. Metz, ser. 2, vol. 11 (1904), p. 132.
Callirhytis bakeri, Kieffer, Invert. Pacif., vol. 1 (1904), p. 44.

"Brown-red, shagreened and pubescent. Head enlarged behind the eyes. Antennæ sometimes black-brown apically, 14-jointed; the second joint longer than thick; the third joint four times as long as thick, one-third longer than the fourth; joints 4-6 subequal, the fourth scarcely longer than the fifth, the eight apical joints gradually decreasing in length, the penultimate one-half longer than thick, a little shorter than the last, or sometimes only half the length of the last. Thorax scarcely shining; parapsidal furrows obliterated anteriorly; scutellum rugose, the two basal foveæ black, deep, separated by a small carina and oblique and divergent; postscutellum and metanotum rugose, the two carinæ parallel. Wings hyaline, fringed, veins brown, first abscissa of the radius angulated. Legs and coxæ faint yellow, claws simple. Abdomen black-brown, highly polished and shining, glabrous, longer than the head and the thorax united, the second segment with a pubescent spot on either side at base; these spots occupy the basal three-fourths, the segments are microscopically punctured apically; ventral-spine four times as long as wide. Length of the female 3.8-4 mm.

"Gall. A bud gall on *Quercus crassipocula* [*chrysolepis*]; gall oval, about 13 mm. high and 11 mm. thick, smooth, glabrous, ligneous, apically with a thin, longitudinally striated, thick and more or less bent point which is about 8 mm. high and 1.5 mm. thick; proximally with some bud-scales lying close to the base of the gall; the inner substance subspongiose." (J. J. Kieffer).

I have seen examples of this species, kindly furnished by Mr. Baker.

Callirhytis rossi Kieff.

Callirhytis rossi, Kieffer, Marcellia, vol. 2 (1903), p. 84.

"Forme Agame. Noir; mandibules, les sept premiers articles antennaires, pattes antérieures, tibias et tarses des pattes intermédiaires, et écaillettes ferrugineux; scape plus ou moins noirâtre; toutes les hanches noires; fémurs intermédiaires et postérieurs, tibias et tarses des pattes postérieures d'un brun noir. Abdomen d'un brun marron, dessus noir en partie. Vertex avec des rides irrégulières et grossières; face avec des stries rayonnant de la bouche jusqu' au bord des yeux; joues égalant la moitié de la longeur de ces derniers. Mandibules bidentées, aussi larges que longues. Palpes maxillaires composés de quatre articles, dont le premier dépasse de moitié la longeur du second; celui-ci à peine plus long que le troisième, trois fois aussi long que gros; le dernier un peu plus long que le premier et distinctement plus gros. Palpes labiaux composès de trois articles dont le second n' est pas plus long que gros; le premier cylindrique, presque trois fois aussi long que gros; le troisième plus gros que les autres, un peu aminci aux deux bouts, avec une petite nodosité à l'extrémité, deux foix aussi long que gros, à peu près aussi long que le premier. Antennes à peine plus épaisses vers l'extrémité, composées de 14 articles, dont le second est deux fois aussi long que gros; le troisième quatre fois aussi long que gros, un peu plus long que le quatrième; les suivants diminuant graduellement; le douzième et le treizième à peine plus longs que gros, le quatorzième double du treizième. Thorax mat, à peine pubescent; mésopleures avec une tache brillants et lisse; partie inférieure des propleures ridée régulièrement et longitudinalement; pronotum, mesonotum, scutellum et segment médiaire ridés grossièrement et irrégulièrement; sillons parapsidaux percurrents, entre eux se voient deux arêtes parallèles situées dans le tiers antérieur du mesonotum; côtés du mesonotum avec un sillon longitudinal bien apparent. Fossettes du scutellum profondes, très rapprochées à leur base. Segment médiaire avec deux arêtes faiblement convergentes et circonscrivant une aire traversée par une arête en forme de T; côtés du segment médiaire avec une dent distincte. Crochets des tarses simples, à piene aussi longs que la palette. Ailes antérieures faiblement enfumées dans leur tiers apical, avec une tache d'un brun marron à l'angle basal interne de la meme cellule; nervure sous-scotale marquée de brun noir à l'endroit de l'insertion de la basale; bord cilié; cellule radiale peu longue, ouverte à la merge, largement aussi à la base et faiblement au sommet; premiére partie du radius arquée, au moins aussi longue que la partie apicale de la sous-costale; aréole distincte; nervures d'un brun clair, base du cubitus peu marquée. Ailes inférieures hyalines, avec une nervure sous-costale, une basale s'étendant des crochets frénaux au bord postérieur et une médiane s'arrêtant à la basale. Abdomen avec une large tache de pubescence de chaque côté de sa base, avec sept segments distincts, aussi long que la tête et le thorax réunis; second segment occupant la moitié de la longeur de l'abdomen; bord postérieur des six premiers segments finement et densément pointillé; apres la mort, à moins que les insectes n'aient été tués dans l'alcool, le second segment atteint presque l'extrémité abdominal, et ne laisse à découvert qu'un mince bord des deux segments suivants. Spinule ventrale trois fois aussi longue que large. Taille ♀ 4 à 5 mm.

"Oeuf presque globuleux, un peu plus long que gros, atteignant la cinquième de la longueur de son pédicelle.

"Galle. On trouve la galle de cet insecte sur un Chène à feuilles caduques et légèrement pubescent sur le dessous, à jeunes rameaux tomenteux de blanc. [*Quercus chrysolepis?*] Elle est formée aux dépens d'un bourgeon axillaire; comme celle de *Cynips tozæ* Bosc., elle chevauche sur le rameau qui, pour l'unique exemplaire que j'ai recu, était gros de 3 mm. Sa forme est sphérique, sa couleur d'un jaune brunâtre, son diamètre de 40 mm., sa surfcae couverte d'aspérités surtout dans la moitié supérieure; ces aspérites atteignent au maximum 1 mm. en hauteur et sont souvent confluentes de facon à former des carènes ou des rides irrégulières, longitudinales ou transversales. Au pôle supérieur, la galle se prolonge en une pointe conique, haute de 5 mm., large d'autant à sa base, ligneuse, et striée longitudinalement. L'intérieur est spongieux comme chez celle de *Cynips tozæ*, avec le centre lignieux; cette partie ligneuse et très dure, dont le diamètre mesure 18 mm., renferme de nombreuses cellules larvaires séparées l'une de l'autre par une paroi épaisse de 0.60 à 1 mm., longues de 3.5 à 4 mm. et larges de 2 mm. Chacune de ces cellules renferme une galle interne de même forme, étroitement appliquée au tissu environment, mais d'un gris jaunâtre un peu plus clair, se détachant assez facilement et à paroi extrêment mince et fragile. Eclosion en mai de la seconde année. J'ai obtenu 19 Cynipides d'une seule galle.

"Patrie. Californie. L'unique exemplaire m'a été envoyé par M. le docteur Ross, à qui l'insecte est dédié." (J. J. Kieffer.)

I have not seen examples of this species.

Callirhytis nigra n. sp.

Female. Black, ocelli, antennæ, tegulæ, legs and ovipositor sheath brown. Head broad and thin, microscopically reticulate, face and cheeks pubescent, antennæ 13-segmented, incrassate at tip, 1st and 2nd segments stout, 2nd oval, about one-half of 1st, 3rd and 1st segments subequal, 4th–6th a little shorter, 7th and following segments shorter and subequal, except the last, which is twice as long as penultimate and a little longer than 3rd; all the segments more or less pubescent. Pronotum narrow in the middle, sides deeply punctate, each puncture bearing a hair, mesonotum coriaceo-reticulate, almost smooth and shining, parapsidal grooves distinct and complete, median longitudinal lines not reaching half-way to posterior margin, smooth lines over base of wings distinct, mesopleura smooth and shining, aciculate above, pubescent beneath, scutellum deeply rugose, basal foveæ oval, deep, with smooth, shining bottom, approximate. Abdomen smooth and shining, much compressed apically, 2nd segment occupying about half its length, its posterior margin oblique, 3rd and 4th segments narrow, ventral valve oblique and extending upwards to dorsal line, ovipositor sheath protruding slightly and pubescent. Legs covered with pubescence. Wings hyaline, pubescent, veins faint, brownish, radial cell long, open at the margin, vein at base arcuate, areolet and cubitus indistinct. Length 1.75 mm.

Gall. An irregular swelling or enlargement of the terminal twigs of *Quercus lobata*, subglobular, 15 mm. x 12 mm., apparently monothalamous.

Habitat. San Jose, Cal. (R. W. Patterson.)

Callirhytis guadaloupensis n. sp.

Female. Yellowish brown to reddish brown, one specimen with the head, pronotum, median stripe on mesonotum, scutellum, metanotum and abdomen darker; tips of mandibles, ocelli, basal region of antennæ, pecten, tibiæ, tarsi and caudal aspect of femora black or blackish. Head closely punctate, pubescent, antennæ 14-segmented, 1st and 2nd segments stout, 3rd segment long, longer than 1 and 2 together, 4th to 8th segments progressively shorter, following segments subequal, except last, which is twice penultimate. Thorax rugose and partially pubescent, parapsidal grooves on mesonotum reaching half-way to anterior margin, median longitudinal lines and smooth lines over base of wings distinct, the former extending less than half-way to posterior margin, scutellum pointed, deeply rugose and pubescent, basal foveæ inconspicuous, pleura rugose and pubescent. Abdomen smooth, six tergites visible, the second occupying less than one-third the entire length, pubescent at base, dorsal and ventral valves pubescent, tips with tufts of hair. Wings small and narrow, veins heavy, outer third of cubitus not reaching margin, the basal portion of which is hairy, areolet distinct, basal third of cubitus not reaching basal vein. Length 2.5 mm.

Gall (Pl. XXIII, fig. 4). Hard, smooth, flat, disc-shaped galls on under side of leaves of *Quercus chrysolepis*, 5–6 mm. in diameter apparently monothalamous.

Habitat. Guadaloupe, Cal. (R. W. Patterson.)

Callirhytis sanctæ-claræ n. sp.

Female. Reddish brown, eyes, tips of mandibles and ocelli black, legs yellowish brown. Head faintly rugoso-punctate, pubescent, antennæ 14-segmented, 1st and 2nd segments stout, 3rd segment long, a little longer than 1 and 2 together, succeeding segments to 9th progressively shorter, 9th and following segments subequal, except the last, which is a little longer than penultimate. Thorax rugoso-punctate, parapsidal grooves on mesonotum distinct, extending half-way to anterior margin, median longitudinal lines reaching half-way to posterior margin, smooth lines over base of wings distinct, mesopleura almost bare, upper portion closely and finely punctate, lower portion aciculate, scutellum rugoso-punctate, basal foveæ large, shallow, with smooth, shining bottom, approximate, separated only by a carina, metanotum pubescent. Abdomen smooth, shining, very much compressed, 2nd segment occupying more than two-thirds its length, posterior margin finely punctate, ventral valve conspicuous, paler than the rest of the abdomen, dorsal valve darker and pubescent, ovipositor sheath conspicuously exserted. Wings hyaline, pubescent, veins distinct, yellowish, radial cell open at the margin, vein at base arcuate, almost angulate, areolet distinct, cubitus not reaching basal vein. Length 3–3.5 mm.

Gall (Pl. XXIII, fig. 5). Acorn galls at the tip of leafy twigs of *Quercus chrysolepis.* 15 mms. long, and double, the basal portion smaller, and telescoped in the upper portion; rugose and covered with a whitish bloom. Monothalamous.

Habitat. Stevens Creek Canyon, above Cupertino, Cal. (R. W. Patterson.)

9 **SYNERGUS** Hartig.

Synergus (part.), T. Hartig, Zeits. f. Ent., vol. 2 (1840), p. 186, 197.

Face radiately striated, clypeus imperceptible or nearly so, subdorsal frontal grooves always present, usually long. Antennæ 13-15 segmented in female, 14-15 segmented in male, distally from 3rd segment in female filiform, in male often thickened, 3rd segment often strongly emarginate basally and distally more or less thick. Mesonotum shagreened, very often transversely wrinkled, parapsidal grooves complete, scutellum with basal foveæ. Abdomen compressed, 1st segment or petiole longitudinally striate, tergite of the 2nd segment greatly enlarged and covering the greater part of the abdomen, or in the male obscuring it, 2nd and 3rd tergites joined without suture and enclosing following segments. Radial cell closed, short. Claws bidentate. Ventral valve short. Inquilines in galls on *Quercus.*

Synergus agrifoliæ Ashm.

Synergus agrifoliæ, Ashmead, Tr. Am. Ent. Soc., vol. 23 (1896), p. 189.

"Female. Length 2-2.4 mm. Brownish yellow, the legs and coxæ paler, the metathorax dusky; ocelli, eyes and mandibles black, or brown-black. The face and pleura are finely striated, head and thorax finely minutely rugose, pubescent, the parapsidal furrows wanting, the foveæ of scutellum small, shallow, hardly apparent; antennæ 13-jointed, flagellar joints 2 and 3 equal, little shorter than the first. The abdomen is not quite as long as the head and thorax combined, slightly conpressed, and vertically it is almost as wide as long with the tips sometimes dusky. Wings hyaline, pubescent, the veins pale or hyaline, the areolet distinct, but the closing vein very delicate; in two specimens it is absent.

"The male is but 1.5 mm. long, and, excepting the black eyes and ocelli, entirely brownish yellow.

"Habitat. Los Angeles, California.

"Described from thirteen specimens, bred by Mr. Albert Koebele, from a gall not unlike *Neuroterus saltatorius* Edw., occurring on *Quercus agrifolia.*" (W. H. Ashmead).

I have not seen examples of this species.

Synergus brevicornis Ashm.

Synergus brevicornis, Ashmead, Tr. Am. Ent. Soc., vol. 23 (1896), p. 189.

"Female. Length 2.8-3 mm. Stature similar to *S. læviventris*, but the sculpture of the thorax is more rugose, the abdomen proportionately shorter, the ventral valve projects slightly, and the antennæ reach back only two-thirds the length of thorax. Vertex of head, thorax and abdomen black; orbits, cheeks, face, antennæ and legs, brownish yellow, the depth of color often varying; middle and posterior coxæ black, the front pair often dusky basally, posterior femora often more or less clouded; antennæ 13-jointed, filiform, the 3rd joint one-third longer than 4th; face and mesopleura rather coarsely striated; scutellum rounded, depressed at base with two distinct foveæ; the grooves of the mesonotum rounded, almost obsolete by the coarse sculpture. Abdomen highly polished, the second segment entirely hiding all the others and gaping open at apex, in consequence the ventral valve projects, is brownish and armed with a slight spine. Wings hyaline, pubescent, the veins pale, the submarginal and marginal veins brownish apically; areolet large, closed, the cubital cell only partially closed.

"The male is but 1.8 mm. long, with the head wholly, except stemmaticum, and the legs, including coxæ, brownish yellow. The antennæ are short, 15-jointed, the 3rd joint long, strongly excised, the apical joint brown.

"Habitat. Eldorado County, California." (W. H. Ashmead).

I have not seen examples of this species.

Synergus flavus Kieff.

Synergus flavus, Kieffer, Bull. Soc. Metz, ser. 2, vol. 11 (1904), p. 133.
Synergus flavus, Kieffer, Invert. Pacif., vol. 1 (1904), p. 45.

"Pale yellow or reddish yellow; head distinctly broader than the thorax, without carinæ; front and vertex smooth, face and cheeks paler yellow. Antennæ of the male 15-jointed, the two to three last joints more dusky; second joint longer than thick; the third scarcely longer than the fourth, faintly emargined outwardly; the fourth twice as long as thick; the following ones gradually becoming shorter; the penultimate joint is a little longer than thick, shorter than the last and all are very slender; antennæ of the female 14-jointed, filiform and slender; the third joint fully thrice as long as thick, the following gradually decreasing in size, the penultimate only one-third longer than thick, shorter than the last. Mesonotum finely coriaceous; mesopleura very finely longitudinally striated; scutellum brownish red, rugose, the usual foveæ small, not very distinct, separated by a small carina. Metanotum brown or black-brown, the carinæ parallel. Wings hyaline, veins brownish. Tarsal claws simple. Petiole of abdomen black, coarsely longitudinally striated; the second segment reaching to the apex of the abdomen, smooth and not punctured.

"Bred from galls of *Callirhytis maculipennis;* the guests live in the spongiose substance of the gall, outside of the cells, and do not hinder the development of the gall makers." (J. J. Kieffer).

I have seen examples of this species, kindly furnished by Mr. Baker.

Synergus dimorphus O.-S.

Synergus dimorphus, Osten-Sacken, Proc. Ent. Soc. Philad., vol. 4 (1865), p. 376.

Synergus dimorphus, Gillette, Tr. Am. Ent. Soc., vol. 23 (1896), p. 86, 87.

Female. Black, antennæ, ocelli, face on anterior margin, mandibles basally, genæ and orbital margins, tegulæ, legs (except coxæ) and ovipositor sheath yellowish brown, tips of antennæ and tarsi fuscous. Head faintly reticulate, face radiately striate, antennæ 14-segmented, 1st segment stout, 2nd slender and oval, 3rd longest, slightly longer than either 4 and 5, following segments progressively shorter, except the last, which is somewhat longer than penultimate. Pronotum wide in the middle, rugose, mesonotum transversely wrinkled (some specimens without transverse folds, rugose), parapsidal grooves incomplete, extending less than half-way to anterior margin, median longitudinal lines not reaching the middle, smooth lines over base of wings distinct, mesopleura transversely aciculate, with a triangular smooth patch beneath wing, scutellum deeply rugose, foveæ indistinct, small, oval and approximate, separated by a median carina; pronotum, mesonotum and scutellum sparsely covered with silvery pubescence. Abdomen smooth and shining, vertical and horizontal dimensions almost equal, tergal line from the side almost straight, sternal line semicircular, 2nd tergite wholly obscuring the following segments, posterior margin faintly punctate. Wings hyaline, pubescent, radial, subcostal, basal and 2nd transverse veins black, heavy, others faint, radial cell short, closed, vein at base slightly arcuate, areolet indistinct, cubitus not reaching basal vein. Length 2.25-2.5 mms.

Male. Black, tips of mandibles, palpi, antennæ (except distally infuscated basal segments), legs (except trochanters and coxæ), ventral margin of abdomen and a transverse basal band brown. Head rugose and finely reticulate, antennæ 15-segmented, reaching middle of abdomen, 3rd and 4th segments subequal, 3rd longer than 1 and 2 together, incised at base, following segments progressively shorter to last. Thorax coarsely rugose, mesonotum transversely wrinkled, parapsidal grooves complete and deeply impressed, median longitudinal lines distinct, posterior margin of abdomen punctate. Wings hyaline, pubescent, areolet distinct, cubitus nearly reaching basal vein. Length 3.5 mm.

Bred from galls of *Cynips multipunctata* on *Quercus lobata*.

Habitat. Stevens Creek Canyon, above Cupertino, Cal. (R. W. Patterson.)

Synergus oneratus oneratus (W. Harr.)

Cynips oneratus, T. W. Harris, Treat. Ins. N. Eng. (1842), p. 398.

Synergus oneratus, B. D. Walsh, Proc. Ent. Soc. Philad., vol. 2 (1864), p. 488, 498.

Synergus oneratus oneratus, Dalla Torre and Kieffer, Das Tierreich, lief. 24 Cynipidæ (1910), p. 632.

Female. Yellowish brown, legs and face light yellowish brown, eyes, ocelli, tips of mandibles, prosternum, pecten, mesopleura beneath, metathorax apically and hind tarsi black; pubescent. Head faintly rugose and sparsely punctate, punctation in the form of irregularly scattered shallow pits, face pubescent, radiately striate, antennæ 14-segmented, 1st segment large, 2nd subglobular, 3rd and 4th segments subequal, as long as 1 and 2 together, 5th and succeeding segments to 11th progressively shorter, 11th to 14th subequal. Pronotum wide in the middle, rugose, mesonotum transversely wrinkled, parapsidal grooves distinct, extending half-way to anterior margin, median longitudinal lines not reaching the middle, mesopleura coarsely aciculate, with a triangular smooth patch beneath wings, scutellum coarsely rugose, almost coarsely reticulate, basal foveæ transversely elongate, shallow, smooth and shining at bottom, approximate, metanotum rugose. Abdomen smooth and shining, 2nd tergite completely obscuring the following segments, posterior margin microscopically punctate, apex dorsally black, dorsal valve prominent, pubescent, ovipositor protruding. Wings hyaline, pubescent, a few of the veins heavy and black, the others faint, radial cell closed, very short, vein at base not much curved, areolet small and indistinct, veins enclosing it almost obliterated, cubitus not reaching basal vein and very faint. Length 2-3 mm.

Male. Black, antennæ, face beneath antennæ and around eyes, ocelli, tegulæ, coxæ, trochanters, femora, tibiæ largely, and abdomen on posterior margin brownish or pale brown; sparsely pubescent. Head reticulate, faintly punctate, face radiately striate, antennæ 15-segmented, all the segments conspicuously grooved or channeled, 3rd and 4th segments subequal, longer than 1 and 2 together, succeeding segments to 11th progressively shorter, 11th and following segments subequal. Thorax coarsely rugose, mesonotum tranversely ridged, parapsidal grooves indistinct, almost wholly obliterated by the coarseness of sculpture, pleura coarsely aciculate, small median patch smooth, scutellum coarsely rugose, almost coarsely reticulate, smooth and shining beneath rugæ, foveæ large, oval and shallow, with smooth bottoms, separated only by a carina, metanotum rugose. Abdomen smooth and shining, 2nd tergite completely obscuring following segments, posterior margin microscopically punctate. Wings hyaline, pubescent, costal, subcostal, radial and basal veins heavy, black, others faint, radial cell closed, areolet small, indistinct, cubital vein faint and not reaching basal, vein at base of radial cell almost straight. Length 1.5-2 mm.

Bred from galls of *Holocaspis eldoradensis* on *Quercus lobata*.

Habitat. Jasper Ridge, near Stanford University, Cal. (R. W. Patterson.)

Synergus punctatus Gillette.

Synergus punctatus, Gillette, Tr. Am. Ent. Soc., vol. 23 (1896), p. 90, 94.

Female. Black, the ocelli, face anteriorly, antennæ, tegulæ, pedicel, abdomen anteriorly and posteriorly and legs brown; sparsely pubescent. Head faintly reticulate, shining, face radiately striate, antennæ 14-segmented, 1st and 2nd segments stout, 3rd long, about as long as 1 and 2 together and longer than 4th, succeeding segments to 10th progressively shorter, 10th and following segments subequal, except last, which is longer than the penultimate, all longitudinally grooved or channeled and pubescent. Pronotum broad in the middle, rugose, mesonotum transversely wrinkled, folds rather shallow, parapsidal grooves reeaching less than half-way to anterior margin, median longitudinal lines and smooth lines over base of wings distinct, mesopleura aciculate, triangular patch beneath wings smooth and shining, scutellum deeply rugose, foveæ large, circular shallow, metathorax almost smooth. Abdomen smooth and shining, 2nd tergite completely obscuring following segments, pubescent at base, posterior margin punctate, sheath of ovipositor conspicuous, pubescent. Wings hyaline, pubescent, veins basally heavy, black, radial cell closed, short, vein at base only slightly bent, areolet subobsolete, only one of its enclosing veins distinct, cubitus not reaching basal vein. Length 1.25 mm.

Bred from galls of *Holcaspis eldoradensis* on *Quercus lobata.*

Habitat. Jasper Ridge, near Stanford University, Cal. (R. W. Patterson.)

Synergus ochreus n. sp.

Female. Brown, the legs and face light brown, eyes, ocelli, tips of mandibles, pecten, dorsal vitta on abdomen, ventral valve and tips of tarsi black. Head rugose, face radiately striate, subdorsal striæ from base of antennæ to ocelli and continued around eyes, antennæ 15-segmented, 1st segment stout, obconic, 2nd narrowly ovate, half the length of the 1st, 3rd-6th subequal, one-third longer than 1st, 7th-9th progressively shorter, 10th and following segments subequal. Pronotum wide in the middle, transversely rugose, pubescent, mesonotum transversely wrinkled or folded, parapsidal grooves complete, widely separated, obscured by transverse folds, a median longitudinal groove posteriorly reaches half-way to anterior margin, median longitudinal lines short, smooth lines over base of wings distinct, mesopleura transversely aciculate and shining, pubescent above and below, scutellum cushion-shaped, rounded posteriorly, faintly rugose and punctate, each puncture bearing a hair, basal foveæ large, circular or transversely oval and shallow, bottom punctate, shining, pubescent. Abdomen compressed, smooth and shining, 2nd tergite reaching apex and almost wholly obscuring following segments, faintly but broadly punctate on posterior margin, ventral valve reaching line of the tergum, black. Wings hyaline, pubescent, veins, excepting anal and cubital, heavy, brown, radial cell short, closed, vein at base slightly arcuate, areolet absent, veins on two sides and basal abscissa of cubitus scarcely visible. Length 3.5 mm.

Bred from galls of *Cynips multipunctata* on *Quercus lobata.*

Habitat. Stevens Creek Canyon, above Cupertino, Cal. (R. W. Patterson.)

Synergus niger n. sp.

Female. Black, antennæ, ocelli, tips of mandibles, tegulæ, legs (except hind coxæ basally), abdomen on ventral and posterior margin, and ovipositor brown, last segment of antennæ fuscous. Head broad, smooth and shining, microscopically reticulate, face radiately striate except in a circular smooth patch above mouth, antennæ 14-segmented, rather stout, 1st and 2nd segments stouter than those following, 3rd segment longest, longer than 4th but not as long as 1 and 2 together, following segments progressively shorter, except last, which is much longer than penultimate. Thorax smooth and shining, pronotum broad in the middle, microscopically coriaceo-reticulate, pubescent, mesonotum finely sculptured and punctate, each puncture bearing a hair, parapsidal grooves incomplete, reaching about the middle, median longitudinal groove coextensive, median longitudinal lines extending less than half-way to posterior margin, smooth lines over base of wings distinct, mesopleura smooth and shining, transversely aciculate in middle, pubescent beneath, scutellum deeply rugose, foveæ large, subcircular and shallow, with smooth, shining bottom, contiguous, separated by a carina, metanotum smooth, punctate and pubescent. Abdomen smooth and shining, 2nd tergite extending to apical margin and almost wholly obscuring the following segments, nearly as long as head and thorax together, but not wide, line of the tergum only slightly arcuate, ovipositor sheath exserted. Wings hyaline, pubescent, veins brown, only subcostal, radial and basal nervures distinct, radial cell closed, vein at base slightly arcuate, areolet indistinct or absent, cubitus indistinct. Length 1.75-2 mms.

Male. Differs in having 15-segmented antennæ and the head brown below base of antennæ, on cheeks and on orbital margin.

Bred from a bud gall on *Quercus lobata*.

Habitat. Stanford University, Cal. (R. W. Patterson.)

Synergus splendidus n. sp.

Female. Reddish brown, the eyes, tips of mandibles, occiput dorsally and front almost to base of antennæ except a narrow orbital margin, antennæ basally, pronotum in the middle, pecten, mesopleura basally, mesonotum, scutellum, metathorax, 1st abdominal segment and dorsal ridge of 2nd tergite basally black. Head broad and thick, eyes bulging, microscopically reticulate, face radiately striate, pubescent, antennæ 15-segmented, 1st and 2nd segments stout, obconic, touched with black, 3rd segment longest, a little longer than 4th but not as long as 1 and 2 together; following segments progressively shorter, the last, which is fuscous, not much longer than penultimate. Pronotum wide in the middle, rugose and microscopically coriaceo-reticulate, covered with short appressed hairs, mesonotum rugose and distinctly transversely wrinkled, parapsidal grooves complete, median longitudinal lines widely separated and not reaching the middle, smooth lines over base of wings distinct, mesopleura transversely aciculate, pubescent beneath, scutellum rugose, basal foveæ small, oval, smooth at bottom, approximate, separated only by a carina, metathorax smooth and covered with short appressed hairs. Abdomen longer than head and thorax together, greatly compressed, smooth and shining, 2nd and 3rd tergites connate, reaching apical margin, incised dorsally at apex for one-third the length, exposing the following segments, posterior margin of all the segments minutely punctate, ovipositor sheath projecting obliquely from venter and reaching line of the tergum, ovipositor exserted. Wings hyaline and clothed with rather long, erect hairs, veins distinct and fuscous, radial cell short, closed, vein at base slightly arcuate, areolet small, cubital vein reaching basal. Length 5 mm.

Found in jar with galls from *Quercus lobata*.

Habitat. California.

Synergus multiplicatus n. sp.

Female. Black, the ocelli, face anteriorly, genæ, orbital margin and margin of occiput, antennæ, pronotum (except medially), mesopleura and legs (except hind tibiæ and tarsi) yellowish to reddish brown. Head broad, width twice length, coarsely rugoso-punctate, transversely rugose on vertex, antennæ 14-segmented, 1st and 2nd segments obconic, 3rd segment longest, as long as 1 and 2 together and longer than 4th by a half, 5th and following segments progressively shorter, except the last, which is nearly twice as long as penultimate, with fuscous tip. Thorax rugose, mesonotum transversely wrinkled, parapsidal grooves complete, median longitudinal lines and smooth lines over base of wings distinct, mesopleura coarsely aciculate, with small triangular patch beneath wing smooth, fuscous beneath and pubescent, scutellum coarsely rugose, almost coarsely reticulate, foveæ longitudinal, oblique and shallow, bottom rough, not exactly approximate. Abdomen smooth, 2nd and 3rd tergites connate, covering the greater part of the abdomen, 4th tergite narrow posteriorly, all traced with microscopic reticulation, dorsal valve and sheath of ovipositor projecting slightly and pubescent. Wings hyaline, pubescent, veins brownish to black, radial cell closed, vein at base arcuate, areolet small, cubitus not reaching basal vein. Length 1.75-3 mm.

Male. Similar to female except legs infuscate, metanotum black, connate 2nd and 3rd tergites obscuring following segments, brownish on posterior margin and punctate, face yellowish brown instead of reddish brown, length about 2 mm.

Bred from galls of *Cynips kelloggi* on *Quercus douglasi*.

Habitat. Jasper Ridge, near Stanford University, Cal. (R. W. Patterson.) Frohm, Cal. (R. W. Patterson.) Paso Robles, Cal. (John Morehouse.) San Jose, Cal. (R. W. Patterson.)

Synergus varicolor n. sp.

Female. Black, thorax mixed with brown, antennæ (except tip), face below antennæ, genæ, orbital margin broadly, tegulæ, abdomen on ventral and posterior margins and legs wholly brown. Head reticulate, face radiately striate, slightly pubescent, antennæ 14-segmented, 3rd segment longest, longer than 4th, 4th-6th subequal, following segments progressively shorter, except the last, which is a little longer than penultimate. Pronotum wide in the middle, mesonotum rugoso-punctate, pubescent, parapsidal grooves incomplete, reaching half-way to anterior margin, median longitudinal lines and smooth lines over base of wings distinct, mesopleura aciculate anteriorly, posteriorly smooth and shining, scutellum deeply rugose, basal foveæ large, oval, and shallow, bottom rough, contiguous, separated by a carina. Abdomen highly polished, 2nd and 3rd tergites connate, wholly obscuring following segments, line of the tergum only slightly curved, sternal line semicircular, only tip of ovipositor, which is brown, protruding. Wings hyaline, pubescent, radial cell closed, areolet and basal part of cubitus rather indistinct. Length 2.5 mm.

Male. Differs in having 15-segmented antennæ and the head almost entirely, prothorax, mesonotum, mesopleura and ventral and posterior margin of abdomen brown.

Bred from galls of *Callirhytis pomiformis* on *Quercus agrifolia*.
Habitat. Stanford University, Cal. (R. W. Patterson.)

Synergus maculatus n. sp.

Female. Yellowish brown, the eyes, ocelli, tips of mandibles, prosternum, metathorax and abdomen dorsally at apex black. Head finely punctate, face radiately striate, antennæ 14-segmented, 1st and 2nd segments stout, 3rd segment longest, slightly longer than 4th, succeeding segments to 10th progressively shorter, 11th-13th subequal, last somewhat longer than penultimate. Thorax faintly punctate and pubescent, parapsidal grooves incomplete, reaching half-way to anterior margin, scutellum rugose, foveæ indistinct. Abdomen as long as head and thorax together, elliptical when viewed from above, oval as seen from the side, smooth and shining, 2nd and 3rd tergites connate, reaching apex, and almost completely obscuring following segments, dorsal valve and ovipositor sheath conspicuous, slightly protruding. Wings hyaline, veins faint, areolet distinct, faint on two sides, radial cell closed. Length 1.75 mm.

The male differs in having stout 15-segmented antennæ and more black on abdomen dorsally.

Bred from a small, yellowish-brown, depressed globular gall, about 2 mms. in diameter, on upper surface of leaves of *Quercus agrifolia*.

Habitat. Stanford University, Cal. (R. W. Patterson.)

Synergus dubiosus n. sp.

Female. Yellowish brown, eyes, tips of mandibles, occiput dorsally continued on to vertex and front almost to the base of the antennæ, with the exception of a narrow strip on eye, pronotum in the middle, pecten, pleura beneath, mesonotum, scutellum and metathorax entirely, pedicel and abdomen dorsally almost to apex black, Head faintly rugose, sparsely and shallowly punctate on vertex, face radiately striate, pubescent, antennæ 14-segmented, thick but filiform, 1st and 2nd segments stout, 3rd segment long, as long as 1 and 2 together, 3rd-5th subequal, 6th and following segments progressively shorter to last. Pronotum faintly rugose, closely punctate, clothed with short, appressed, whitish pubescence, parapsidal grooves incomplete, reaching more than half-way to anterior margin, median longitudinal lines and smooth lines over base of wings distinct, mesopleura transversely aciculate, scutellum deeply rugose, basal foveæ large, oval and shallow, bottom rough, contiguous, separated by a median carina. Abdomen short, not quite as long as the thorax, smooth and shining, 2nd and 3rd tergites connate, completely concealing following segments, elliptical from above, triangular from side, posterior margin truncate and narrowly punctate. Wings hyaline, pubescent, veins black, radial cell closed, areolet distinct, cubitus not reaching basal vein. Length 4 mm.

The male has 15-segmented antennæ.

Bred from galls of *Callirhytis pomiformis* on *Quercus agrifolia.* Habitat. Stanford University, Cal. (R. W. Patterson.)

10 **CEROPTRES** Hartig.

Ceroptres, T. Hartig, Zeits. f. Ent., vol. 2 (1840), p. 186, 197.

Face with two parallel ridges from insertion of antennæ to clypeus, beyond these striate, antennæ in female 12-14 segmented, distally thickened, in male 15-segmented, sometimes 14-segmented. Parapsidal grooves usually not reaching anterior margin of mesonotum, scutellum with two basal foveæ. 2nd and 3rd tergites more or less connate, covering nearly the entire abdomen. Radial cell closed, ventral valve short, claws bidentate. Inquilines in galls on *Quercus.*

Ceroptres pomiformis Ashm.

Ceroptres pomiformis, Ashmead, Tr. Am. Ent. Soc., vol. 12 (1885), p. 300.

"Male. Length .05 inch. Slender, head yellowish brown, with a dark brown blotch enclosing ocelli; eyes brown; antennæ 15-jointed, yellowish, with the apical third brown; thorax black, finely pubescent; abdomen bright yellowish brown, infuscated towards tip; wings hyaline, veins yellow, radial area closed, narrow.

"This pretty little species is described from two specimens bred from gall of *Andricus pomiformis* Bass., sent to me from California." (W. H. Ashmead).

I have not seen examples of this species.

Ceroptres dorsalis Prov.

Ceroptres dorsalis, Provancher, Addit. Hym. Quebec (1888), p. 398.

"♀ Long. .18 pce. D'un beau jaune-miel, avec les yeux, une tache sur le vertex, le lobe médian du mésonotum, le métanotum et une ligne sur le dos des premiers segments de l' abdomen, noir. Les mandibules noires à l' extrémité. Les antennes avec les pattes, jaune sans aucune tache. La face fortement striée et d'un jaune plus pâle. Ailes hyalines, à nervures brunes, légèrement velues, la radiale fermée en avant. Abdomen comprimé, à tarière redressée, depassant la ligne du dos. Los Angeles (Coquillett).

"Superbe espèce, bien remarquable par sa taille.

"♂ Même coloration que dans la ♀, mais très remarquable par son duexième segment abdominal qui se développe en une double écaille dépassant l'extrémité de l' abdomen et se prolongeant en dessous d' au moins le double de l' épaisseur des autres segments." (L.Provancher.)

I have not seen examples of this species.

Ceroptres niger n. sp.

Female. Black, femora distally, tarsi, oral margin and sheath of ovipositor brown; somewhat pubescent. Head faintly reticulate and shining, face striate, pubescent, antennæ 13-segmented, 3rd segment as long as 1 and 2 together, longer than 4th, succeeding segments to 10th progressively shorter, 10th and following segments subequal, except the last, which is twice as long as penultimate. Pronotum wide in the middle, rugose, mesonotum faintly reticulate and shining, parapsidal grooves not reaching anterior margin, mesopleura aciculate, a median patch smooth and shining, scutellum coarsely rugose, almost coarsely reticulate, foveæ transverse, large, oval and shallow, with smooth bottom, widely separated. Abdomen smooth and shining, 2nd tergite reaching more than half-way to apex and pubescent at base, 3rd tergite rather wide, 4th and 5th narrow, faintly punctate on posterior margin, ovipositor sheath exserted, dorsal valve conspicuous and pubescent. Legs clothed with pubescence. Wings hyaline, pubescent, radial cell closed, short, basal vein not much curved, areolet present but enclosing veins indistinct, cubitus not reaching basal vein. Length 1.5 mm.

Bred from galls of *Holcaspis eldoradensis* on *Quercus lobata*.

Habitat. Jasper Ridge, near Stanford University, Cal. (R. W. Patterson.)

11 PERICLISTUS Forst.

Aylax (part.), T. Hartig, Zeits. f. Ent., vol. 2 (1840), p. 186, 195.
Periclistus, A. Forster, Verh. Zool. Ges. Wien, vol. 19 Abh. (1869), p. 332, 337.

Face radiately striate, antennæ filiform, in female usually 12-segmented, in male 14-segmented, mesonotum faintly rugoso-punctate and pubescent, parapsidal grooves complete or sometimes not reaching anterior margin, scutellum with two transverse basal foveæ, 1st abdominal segment or petiole deeply striate, 2nd and 3rd tergites connate, covering a large part of the abdomen. Radial cell short, closed. Inquilines in different galls.

Periclistus californicus Ashm.

Periclistus californicus, Ashmead, Tr. Am. Ent. Soc., vol. 23 (1896), p. 188.

"Male and female. Length 2-2.4 mm. Similar to *P. smilacis*, the punctuation finer, the pubescence denser, antennæ dark brown. Legs reddish yellow, sometimes obfuscated, the middle and posterior coxæ black, shining. The parapsidal grooves are only distinct on the posterior half of the mesonotum, entirely wanting anteriorly, and there is no distinct grooved line on the shoulders, while the short anterior median grooves are wanting; scutellum rugose, foveæ large, distinct, oblique; mesopleura smooth, highly polished. Wings hyaline, pubescent, iridescent, veins brown, the areolet large, cubital and marginal cells closed. Abdomen densely black, highly polished.

"Described from nine specimens, labelled No. 125, reared during July, 1886, by Mr. Albert Koebele, from *Rhodites polita* Ashm. and numerous other specimens labelled No. 3839, reared at the Department during January and February, 1886, from the same gall collected in Wyoming and Colorado," (W. H. Ashmead).

I have not seen examples of this species. Doubtfully Californian.

Periclistus obliquus Prov.

Periclistus obliquus, Provancher, Addit. Hym. Quebec (1888), p. 397.

"♀ Long. .10 pce. D'un jaune sale avec une tache au métathorax, les jambes postérieures, surtout a l' extrémité, et l' abdomen en plus ou moins grande partie, noir. La face non striée. Les sillons parapsidaux obliques, se rapprochant en arrière. La radiale ouverte en avant, le radius atteignant le bord costal, l' areole incomplete. Abdomen presque entièrement noir; la tarière saillante, l' écaille ventrale terminée en pointe fine. Los Angeles (Coquillett)." (L. Provancher).

I have not seen examples of this species.

Periclistus piceus n. sp.

Female. Piceous black, mandibles, tegulæ, femora, tibiæ, tarsi (except at tips), ovipositor and ovipositor sheath brown or brownish. Head microscopically coriaceo-reticulate and pubescent, densely pubescent on face below antennæ and cheeks, antennæ 12-segmented, filiform, 1st segment obconic, 2nd subglobose, stout, 3rd segment as long as 1 and 2 together, 3rd-6th subequal, following segments progressively shorter, except the last, which is more than twice as long as penultimate. Pronotum and mesonotum faintly rugose, thickly clothed with appressed, whitish hairs, pronotum wide in the middle, parapsidal grooves on mesonotum incomplete, reaching less than half-way to anterior margin, median longitudinal lines and lines over base of wings inconspicuous, mesopleura smooth and shining, pubescent above and beneath, scutellum deeply rugose, pubescent, basal foveæ small, circular, shallow, with smooth bottom, contiguous, separated by a carina, metanotum pubescent. Abdomen smooth and shining, 2nd tergite covering the greater part of the abdomen, following tergites very narrow, posterior margin pubescent, ventral valve conspicuous, tuberculate, sheath of ovipositor projecting upward obliquely to line of tergum. Legs pubescent. Wings hyaline, pubsecent, veins fuscous, distinct, radial cell short, closed, vein at base slightly arcuate, areolet distinct, cubitus not reaching basal vein. Length 2.5 mm.

Male. Similar to female, but antennæ 14-segmented, 3rd segment basally emargined, parapsidal grooves in many specimens apparently complete, pubescence more or less sparse.

Bred from galls of *Rhodites politus* on wild rose (*Rosa californica*).

Habitat. Pt. Arena, Cal. (Miss Mabel Patterson.)

Very similar to *P. californicus*, but apparently distinct.

12 **DIASTROPHUS** Hartig.

Diastrophus, T. Hartig, Zeits. f. Ent., vol. 2 (1840), p. 186, 194.

Face radiately striate, antennæ in female 13-15 segmented, in male 14-15 segmented, pronotum narrow in the middle, mesonotum smooth and shining, bare, parapsidal grooves complete, distinct, scutellum with basal foveæ. Radial cell open at the margin, claws bidentate, ventral valve scarcely as long as wide. Sexual. Galls on *Rubus*, *Potentilla* and *Smilax*.

Diastrophus kincaidi Gillette.

Diastrophus kincaidii, Gillette, Can. Ent., vol. 25 (1893), p. 110.
Diastrophus kincaidi, Kieffer, Bull. Soc. Metz, 2nd ser., vol. 10 (1902), p. 92.

Female. Black, the antennæ, legs (except tips of tarsi), tegulæ and sheath of ovipositor brown or brownish. Head smooth and shining on occiput, vertex and front to insertion of antennæ, face radiately striate and pubescent, pubescence extending on to genæ, antennæ 13-segmented, 1st and 2nd segments stout, 1st obconic, 2nd globose, 3rd segment long, as long as 1 and 2 together, following segments progressively shorter to last, which is considerably longer than penultimate; all the segments more or less pubescent, distally from the middle infuscate. Pronotum wide in the middle, aciculate at the sides, pubescent, mesonotum smooth and shining, parapsidal grooves complete, rather widely separated at scutellum, median longitudinal lines and smooth lines over base of wings distinct, mesopleura transversely aciculate and shining, scutellum evenly rugose, basal foveæ oblique, oval, with smooth shining bottom, contiguous, separated by a median carina, metanotum rugose and bare. Abdomen smooth and shining, dorsally depressed, 2nd tergite reaching more than half-way to apex, 3rd tergite rather broad, ovipositor slightly protruding. Legs pubescent. Wings hyaline, pubescent, faintly iridescent, veins brownish, radial cell open at the margin, vein at base almost straight, areolet distinct, cubitus reaching basal vein. Length 3 mm.

The male has 14-segmented antennæ, of which the 3rd segment is basally emargined.

Gall. Large galls surrounding the stem of the thimbleberry (*Rubus nutkanus*), 25-60 mm. long and 12-25 mm. in diameter. Polythalamous.

Habitat. Pt. Arena, Cal. (Miss Mabel Patterson.) Alameda County, California. (Beutenmüller.)

13 **COMPSODRYOXENUS** Ashm.

Compsodryoxenus, Ashmead, Proc. U. S. Nat. Mus., vol. 19 (1896), p. 128.

Head confluently punctate or faintly rugose, antennæ filiform, 13-14 segmented, thorax closely and confluently punctate or faintly rugose, parapsidal grooves shallow but distinct, pleura punctate, scutellum rugose, abdomen compressed, ventral valve prominent, sharply pointed, plowshare-shaped. Radial cell open, vein at base arcuate and surrounded by a brown cloud, margin of basal vein clouded and a brown spot before the break in the anal vein. Claws simple. Galls on *Quercus*.

Compsodryoxenus brunneus Ashm.

Compsodryoxenus brunneus, Ashmead, Proc. U. S. Nat. Mus., vol. 19 (1896), p. 129.

"Galls. The gall of this species was likewise confused in the collection with a similar gall (*Andricus chrysolepidis*) occurring on *Q. chryslepis* in California, but I can distinguish two kinds of galls, although both bear the same number (2972). Both are very much alike externally, but one is polythalamous, the other monothalamous, and I believe the latter is the one producing the present gall-fly.

"Gall-fly. Female. Length, 2 to 2.6 mm. Head, antennæ, thorax, and legs pale or light brown, the antennæ towards tips dusky, pleura blackish, the abdomen black, polished, the posterior legs dusky or darker than the other. Wings hyaline, marked as in previous species.

"The species is closely allied to the preceding, but it is smaller, paler colored, and has 13 joints in the antennæ.

"Type No. 3085, U. S. N. M.

"Specimens reared June 9, 1883, (?1893). Under this number the record book contains the following: January 13, 1893, Received today from Mr. H. W. Turner, of Martinez, California, a lot of elongate, oval twig galls, found on scrub oak; some of them were collected January 3rd in Pine Canyon, Mt. Diabalo Contra Costa County, and some from apparently the same species of oak at Martinez; placed galls from different localities into different bottles to breed." (W. H. Ashmead).

I have not seen examples of this species.

14 **RHODITES** Hartig.

Cynips (part.), Linne, Syst. Nat., ed. 10 (1758), p. 343, 553.
Rhodites, Aylax (part.), T. Hartig, Zeits, f. Ent., vol. 2 (1840), p. 186, 194.

Head large, broader than the thorax, antennæ 14-15 segmented, pronotum narrow in the middle, parapsidal grooves complete or not reaching anterior margin, deep longitudinal groove beneath on mesopleura, scutellum with basal foveæ or a wide transverse groove, abdomen smooth in female, strongly compressed apically, sternite of last segment plowshare-shaped, broad at the base and gradually narrowing to a point, abdomen in male small, compressed and rounded apically. Radial cell closed, short. Claws simple. Galls on *Rosa*.

Rhodites bicolor (W. Harr.)

Cynips bicolor, T. W. Harris, Treat. Ins. N. Engl. (1842), p. 399.
Rhodites bicolor, Osten-Sacken, Proc. Ent. Soc. Philad., vol. 2 (1862), p. 43, 48.
Rhodites spinosellus, Cockerell, Entomol., vol. 23 (1890), p. 75.

Female. Black, tips of mandibles, palpi, ocelli, legs (except coxæ, trochanters and tips of tarsi), tegulæ and abdomen reddish brown. Head faintly punctate on occiput, vertex and front to insertion of antennæ, face and genæ coarsely punctate and clothed with silvery pubescence, antennæ 14-segmented, 1st and 2nd segments stout, 2nd globose, 3rd segment longest, much longer than 4th and nearly twice as long as 1 and 2 together, succeeding segments to 9th progressively shorter, 9th and following segments subequal, except the last, which is much longer than penultimate; all the segments rather thick. Pronotum narrow in the middle, punctate and pubescent, mesonotum elevated, rugoso-punctate, faintly pubescent, parapsidal grooves reaching more than half-way to anterior margin, median groove from posterior margin shorter, not extending beyond the middle, median longitudinal lines and smooth lines over base of wings distinct, mesopleura rugose and faintly pubescent, smooth, bare patches in the middle and beneath, scutellum deeply rugose, basal foveæ wanting, sharp declivity on either side at base smooth and shining, metanotum rugose and pubescent. Abdomen compressed, smooth and shining, 2nd tergite reaching half-way to apex, 3rd and following tergites fairly wide, valves touched with black. Wings subhyaline, pubescent, iridescent, veins brownish, radial cell short, closed, vein at base angulate, areolet distinct, cubitus reaching basal vein. Length 5 mm.

Male. Similar to female but antennæ and abdomen piceous black, legs more or less fuscous, wings hyaline, nervures black.

Gall. Spiny galls occurring in clusters on the wild rose (*Rosa californica*); yellowish brown, body spherical, the spines as long as or longer, sometimes shorter than the diameter of the body. Monothalamous.

Habitat. Stevens Creek, above Cupertino, Cal. (R. W. Patterson.)

Rhodites politus Ashm.

Rhodites polita, Ashmead, Bull. 1, Colo. Biol. Assoc. (1890), p. 14, 38.
Rhodites politus, Beutenmüller, Bull. Am. Mus. Nat. Hist., vol. 23 (1907), p. 644.

Female. Black, the legs reddish brown outwardly from base of femora. Head faintly punctate, face pubescent, antennæ 14-segmented, filiform, 3rd segment longest, nearly twice as long as 4th or 1 and 2 together, following segments progressively shorter, except the last, which is nearly twice penultimate. Pronotum narrow in the middle, closely punctate and pubescent, mesonotum sparsely and shallowly punctate, each puncture bearing a short hair, parapsidal grooves complete, median longitudinal lines rather short, mesopleura finely rugoso-punctate, the disc bare and highly polished, scutellum rugoso-punctate much longer than wide. Abdomen smooth and shining, compressed beneath, ventral valve projecting and acutely pointed. Wings hyaline, pubescent, veins brownish black, radial cell short, closed, with a brownish cloud, vein at base angulate, areolet distinct, cubitus reaching basal vein. Length 3 mm.

Gall. Small globular galls with weak spines, on leaves of wild rose (*Rosa californica*), often in tangled clusters.

Habitat. Pt. Arena, Cal. (Miss Mabel Patterson.) Los Angeles. (Beutenmüller.)

15 **LYTORHODITES** Kieff.

Lytorhodites, Kieffer, Bull. Soc. Metz, ser. 2, vol. 10 (1902), p. 96.

Differs from *Rhodites* only in the following particulars: scutellum without foveæ, radial cell more or less open at the margin, abdomen usually faintly reticulate. Galls on *Rosa*.

Lytorhodites arefactus (Gillette).

Rhodites arefactus, Gillette, Can. Ent., vol. 26 (1894), p. 157.
Lytorhodites arefactus, Kieffer, Bull. Soc. Metz., ser. 2, vol. 10 (1902), p. 97.
Rhodites similis, Beutenmüller, Bull. Am. Mus. Nat. Hist., vol. 23 (1907) p. 640.

"The galls are dense, corky enlargements of small shoots, usually close to the stem from which the shoot arises, and the shoot is usually dead beyond the gall when the latter is mature. The galls are irregular in shape, vary from one-half to seven-eighths of an inch in diameter, and are polythalamous. The surface is of a rusty color, is finely wrinkled, and reminds me of dried fruit. The surface appears dry and hard, but it is easily dented with the finger-nail and is always free from spines.

"Described from eighteen galls collected in March in the vicinity of Fort Collins, Colorado. Galls brought into the laboratory March 7th began giving flies March 23rd.

"Gall-flies. Females. General color cinnamon-rufous; head entirely rufous, except a blackish area between either compound eye and the mouth; under a power of 60 diameters the lower face appears rather coarsely wrinkled, the wrinkles converging towards the mouth, the upper face, vertex and occiput very finely rugose; the face sparsely set with a short gray pubescence; antennæ short, the first three joints, and sometimes the base of the third, rufous, the remaining joints black; number of joints, 14. Thorax rufous above, with a black suture separating the mesothorax and scutellum, parapsidal grooves entire, broad, moderately deep, well separated at the scutellum, and with numerous elevated lines crossing them; median grooves distinct and extending well forward. The surface of the thorax is finely rugose, and, in a proper light, shows numerous punctures, each puncture bearing a short yellowish hair. Scutellum coarsely wrinkled near the margin and less coarsely wrinkled on the central portion, which is considerably elevated, transverse groove at base, color rufous. Mesopleura, except spot just beneath the wings, rufous, sutures, metathorax and sternum black or blackish;

entire pleura rugose. Abdomen rufous, with venter and posterior half of dorsum blackish, all abdominal segments covered with a microscopic network of impressed lines, most prominent on the terminal segments. Wings but little smoky, radial area not at all closed along the costal margin, areolet distinct and rather small. Feet, including the coxæ, entirely rufous, the claws only being black. Length from 3½ to 4½ mm.

"Described from twenty-one specimens bred from the galls.

"Males. Three to three and one-half mm. in length, black, feet more reddish in color than in the females, bases of the coxæ black, antennæ black throughout; otherwise like the females.

"Described from forty-two bred specimens.

"There is one male among those reared that has the rufous marking of the female on head, antennæ and thorax.

"This species resembles very closely *Rhodites multispinosa* Gill., but the galls are very different." (C. P. Gillette).

I have not seen examples of this species.

INDEX OF GENERA AND SPECIES.

Fullaway.

THE GENERA HYPERA AND PHYTONOMUS
(Coleoptera, Family Curculionidæ)
IN AMERICA, NORTH OF MEXICO.*

By E. G. Titus, Sc. D.

TABLE OF CONTENTS.

INTRODUCTION.

The genera *Hypera* and *Phytonomus* belong to the tribe *Hyperini*, a member of the subfamily *Curculioninae* of the Coleopterous suborder Rhyncophora.

Both genera are well distributed over the northern hemisphere, being especially abundant in Europe, the last catalog of Heyden, Reitter and Weise listing in Phytonomus from "*Europae caucasi et Armeniae Rossicae*" 64 species, 3 varieties and 21 aberrations.

In America Leconte in 1876 listed 9 species, three of which are European. Since that time, we know of the introduction of two more European species. The present paper includes 13 species. One Phytonomus has been described from Mexico and in South and Central America are a number of species of *Phelypera*, a very closely related genus.

In the present paper will be treated only those species known to occur in America, north of Mexico, of the genera

* Revised from a thesis submitted as a partial requirement for the degree of Doctor of Science at Harvard University, May 1, 1911.

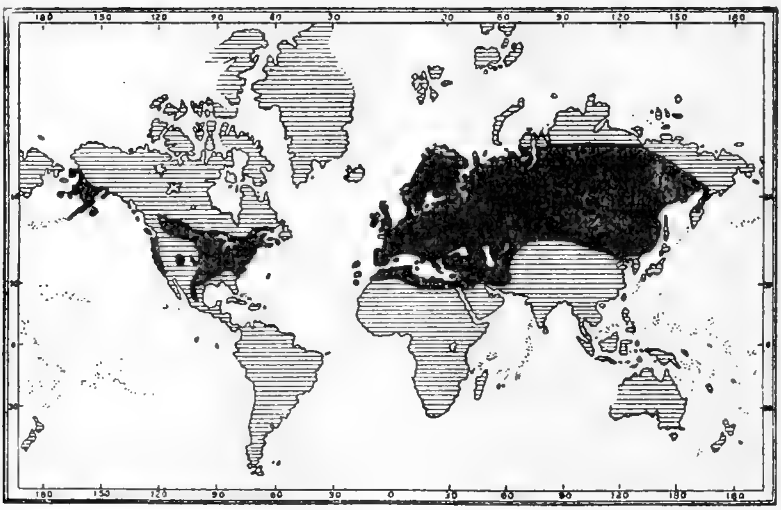
Contributions of the Entomological Laboratory, Bussey Institution, Harvard University, No. 39.

Hypera and *Phytonomus*. Specimens have been seen of all the species reported from this region, and the types of six species have been examined.

In connection with the study of the American species the author has studied 45 of the European species, in some cases including a large number of specimens. Over 500 American specimens have been examined, exclusive of several thousand specimens of *P. posticus*.

ACKNOWLEDGMENTS.

It is with pleasure that I here acknowledge the generous loans and gifts of material and the receipt of many records from the various sources here given.



MAP 1. Distribution of Hypera and Phytonomus.

From the personal collections of C. A. Frost, Framingham, Mass.; F. A. Sherriff, Melrose Highlands, Mass.; Frederick Blanchard, Tyngsboro, Mass.; C. T. Brues, Bussey Institution, Harvard University; Charles Schaeffer, Brooklyn, N. Y.; R. P. Dow, New York, N. Y.; E. A. Bischoff, Irvington, N. J.; Henry Wenzel, Philadelphia, Pa.; W. S. Blatchley, Indianapolis, Ind.; J. D. Evans, Trenton, Ont.; A. B. Wolcott, Chicago, Ill.; Prof. H. F. Wickham, Iowa City, Ia.; R. L. Webster, Ames, Iowa; Warren Knaus, McPherson, Kan.; Franklin Sherman, Jr., Raleigh, N. C.; Norman Criddle, Aweme, Man.; Trevor

Kincaid, Seattle, Wash.; G. I. Reeves, Pullman, Wash.; E. C. Van Dyke, San Francisco, Cal.; F. E. Blaisdell, San Francisco, Cal.; Henry C. Fall, Pasadena, Cal.; and C. N. Ainslie, Salt Lake City, Utah.

Determined European material of *Phytonomus murinus, P. variabilis* and *P. viciae*, has been received from Dr. Edmund Reitter of Paskau; and Prof. Victor Ferrant of Luxemburg, and numerous specimens representing a number of European species from Baron von Rothkirch, Lubben, Germany.

From the following institutions I have had material and records: U. S. N. Museum through Dr. L. O. Howard and Mr. E. A. Schwarz; Am. Mus. Nat. History, Mr. Frank Lutz; Department of Agriculture, Dominion of Canada, through Dr. Gordon Hewitt; Brooklyn Academy Arts and Sciences, Charles Schaeffer; American Entom. Society and Philadelphia Academy of Sciences, Dr. Henry Skinner; State Entomologist's office of New York, Dr. E. P. Felt; Cornell University, Dr. Alex. MacGillivray; Illinois University (Bolter collection) and Ill. St. Lab. Nat. History, Dr. S. A. Forbes; Field Columbian Museum, W. J. Gerhard; Colo. Agric. College, Prof. C. P. Gillette; Conn. Agr. Exp. Station, Prof. W. E. Britton; N. J. Agric. College, Dr. J. B. Smith; Boston Soc. Nat. Hist., Mr. C. W. Johnson, and last but by no means the least I have had the advantage of studying the collections in the Museum of Comp. Zoology at Cambridge, Mass., and the kind and ever-ready aid of Mr. Samuel Henshaw, Curator, in searching the literature and examining specimens.

To Dr. L. O. Howard I am indebted for the translation of a paper by Dr. Martelli that was published in March of this year.

To Mr. C. T. Brues and Mr. F. W. Chapman, for aid in securing the photographs of many of the species here illustrated.

To Prof. F. M. Webster, of the Bureau of Entomology, Washington, D. C., and his assistants, who have aided in the alfalfa weevil work in Utah.

To my associates in Utah, and especially to Dr. E. D. Ball, Director of the Experiment Station, for having made possible the opportunity to study the life history, and to my assistant, Mr. V. A. Sadler, for his efficient aid in the field work on *Phytonomus posticus*.

Finally, I am greatly indebted to Dr. W. M. Wheeler, of Bussey Institution, Harvard University, under whom much of the systematic work has been developed, for his sincere kindness, his encouragement and advice.

HISTORY.

In 1817 Germar in Germar & Zincker's magazine published a short article calling attention to the fact that he had for a long time been studying the genus Curculio, and that he had found good characters in the large complex of species upon which to erect new genera. At that time he published the names of these proposed genera, each with one or more included species, promising later to give the descriptions.

In 1821, in the same magazine, he published descriptions of several of the genera noted in 1817. Among these was the genus *Hypera*, which he divided into two groups, containing altogether 14 species. In the former paper he gives no characters whatsoever to distinguish the different groups, merely mentioning some of the work he had done and giving the list. The genus dates from this latter paper (1821). 1817

In 1826 Curtis in his illustration of British Insects figured on plate 116, dated May 1, 1826, *Hypera fasciculata*, and stated in the appended description that the type of the genus Hypera was *Curculio punctatus*. He included in his list a number of other species which he had examined. *H. punctatus* was one of the species included by Germar in the original description of the genus and hence will stand as the type.

In the same year (1826) Schönherr published his work "*Curculionidum dispositio methodica*," in which in pt. iv, p. 175, he erects the genus *Phytonomus*, dividing it into two groups, nearly identical with those of Hypera given by Germar. He makes the type of the genus and of his first group *Hypera polygoni* L. *Hyp. punctata* was included in his second group. He gave with each group a number of species which he considered as belonging to that complex. He undoubtedly intended to make Hypera a complete synonym, but since the type of Hypera had already been fixed, both genera should stand. At later dates both Gyllenhal and Germar accepted the genus Phytonomus as including *all* the species under the two groups, upon what grounds it is impossible to state. Giebel cites the species in the collection at "Univ. Halle-Wittenberg" under the name of Hypera. It is apparent that these include Germar's material and would indicate that he had not changed the name in his own collection.

Why later writers (Jekel, Lacordaire and especially Fowler) should attempt to fix other types for the genus Hypera I do not know, unless I have overlooked papers to which they had access. There is no clue to such literature in their articles.

Capiomont in 1867–8 in his "Revision des Hyperides," accepts this group as outlined by Lacordaire in the Genera des Coleopteres, tome vi, p. 395. Capiomont creates several new genera in the group and separates Phytonomus from Hypera, but not on the lines given by Curtis. The paper is, however, very valuable, as being the first thorough treatment of the group after Schönherr.

Kirsch and Kraatz, each publishing in 1871, contribute nothing new to the separation of the groups included, neither does Seidlitz in his Fauna Transylvanica in 1891.

Petri in 1901 in his admirable monograph of the tribe *Hyperini* closely followed Capiomont's work. He also gives a very good list of the synonomy of the species.

The larger European catalogues before 1901 usually treated the genus Hypera with Phytonomus as a synonym or a subgenus. Weise in the Heyden, Reitter and Weise Catalog of 1906 has followed Petri except in the synonomy of the species, where he recognizes "aberrations" for most of those forms previously called varieties. This is certainly a step in the right direction, since in the species I have studied these so-called aberrations appear to be nothing more than forms due to one of several causes and likely to appear in any generation of the species. The term evidently should cover all such cases as immature specimens, color changes due to temperature or food conditions, size forms, and specimens which have lost all or part of their pubescence, especially the scales. Most of these should never have been described, as is evident from the efforts of both Capiomont and Petri to separate such forms from the typical species as *they* conceived it.

The literature of the group is of considerable size as may be judged from the bibliography of the species here treated. Without doubt references have been omitted that should have been given, but I trust that no serious omissions occur. The effect of this large number of references has been to make the synonomy of the species very difficult. It is apparent that the name of *Phytonomus meles* is in doubt, but I do not care to change it without knowing more regarding the species *trivialis* Herbst and *roeseli* Gmelin, both of which were described previous to Fabricius' description of *meles*. The species *major* Herbst which had been assigned here as a synonym is according to Schönherr a Cleonus. Schönherr in his monumental work on the Curculionids in 1834 and 1842 gives no further aid on this synonomy.

Regarding the Stephens species the papers of Walton have been followed even where they differ from later authors since it is believed that they more nearly represent the true synonomy. Walton was in correspondence with Germar and Gyllenhal and with other continental European entomologists, and exchanged specimens with them. Where there was a further question, the papers of Capiomont and Petri have been followed if possible.

I have not attempted to place the American forms in the subgenera given by Capiomont believing that these need so much revision as to names and species included that it is well to let them alone. A more thorough study of the life-history of the various Eurasian species will without doubt introduce more synonomy if the other species of that region are as variable as those introduced into America.

The most constant characters are the scale structure, form and shape of thorax, shape and size of beak, and the genitalia. Petri has well pointed out the extreme differences in the stem of the male genitalia, the "forceps" of Petri.

All the species described from America north of Mexico have been identified, and I feel compelled to make one of the Leconte species, *Phy. setigerus*, a synonym of *trivittatus* of Say, this latter not having been previously recognized since Say's description. One new species, *Phy. maritimus* is described. *Hypera ocellata*, 1902: (Biol. Cent. Am. Coleop. v. 4, pt. 4, p. 3) was described from "Omilteme, Guerrero, 8,000 feet, Mexico (H. H. Smith)." From the description and figure, it apparently belongs near *Phytonomus eximius*.

The term *Phytonomini* of Leconte must give way to *Hyperini*, the genus *Hypera* being erected prior to *Phytonomus*.

CHARACTERS OF THE TRIBE HYPERINI.

1863: Lacordaire; Gen. des Coleopteres, tome vi, p. 395 (Hyperides).
1867: Capiomont: Revision de la Hyperides (Ann. Soc. Ent. Fr. pp. 417-560, pl. 11-12).
1868: Capiomont: Rev. de la Hyperides (con.) (Ann. Soc. Ent. Fr. pp. 74–284, pl. 1–4).
1871: Kirsch: Zur Kenntnis der deutschen Hyperiden (Berl. Entom. Zeits., pp. 173–191).
1901: Petri: Monogr. des Coleop.—Tribus Hyperini, pp. 210, figs. 58, pl. 3, also as: Bestim.—Tab. Coleop. Hft. 44, pp. 1–42.

In this group the *body* is more or less oval, the *thorax* never exceptionally long, the beak never extremely long and slender; thorax and elytra more or less covered with scales and with hairs that may be simple, emarginate or thickened.

The *head* is small and round, with the beak or rostrum well developed, often with a carina or keel on the upper surface; *antennae* set in a groove on the side of the beak, the groove usually slopes downward toward the lower side of the eyes; *antennae* (Pl. XXIV, fig. 17), composed of twelve joints, a long *scape*, seven *funicle* joints, the first two of which are longer than any of the others, and a four-jointed *club*, the antennae rarely reach to the middle of the prothorax; *eyes* oval, round or elongate-oval, often narrowed below, rather large and close together in front; *mouthparts* at the apex of the beak as usual, *labrum* wanting, *mandibles*, (Pl. XXIV, fig. 3, 4, 15), often with fine punctures, broad, stout, more or less pincer-shaped, with teeth, *maxilla* (Pl. XXIV, fig. 1, 16) broad, with short, conical four-jointed palpi which are rigid and taper more or less to a point; *lacinia* provided with stout teeth and rather long hairs, apparently always with short spines on the inner surface; *submentum* nearly rectangular, emarginate; *mentum* short and broad, *labial palpi* (Pl. XXIV, fig. 2) three-jointed, rigid, conical.

Prothorax more or less rounded above as seen from the side, sides usually somewhat swollen, anterior and posterior margins rarely as wide as the middle; oval, transverse-oval or elongate; always with a short process below between the front coxae.

Scutellum always minute.

Elytra differing greatly in form, sometimes at least three times as long as the thorax, in other species less than twice as long, elongate; oval, broad or obovate; from the side usually rather flat at the base, often rising for a short distance, and then may be abruptly declivous or rounded to the apex; 10 striae and 11 interspaces including the sutural and side spaces.

Venter as in other Curculionidae, front coxae almost contiguous, middle coxae separated by the more or less elevated process of the mesosternum and the shorter process of the metasternum; hind coxae usually rather widely separated, the intercoxal process of the third abdominal (first visible) segment being broad, but in all species examined ends in a point which is sometimes concealed beneath the metasternum; side pieces of the mesosternum diagonally divided; side pieces of the metasternum dilated in front usually rather narrowly, the outer angle causing a sinuousity in the edge of the elytron; ventral abdominal segments unequal, first and second concealed as usual, the fifth and sixth shortest, usually the seventh or fourth next, the third longest, or in some the seventh the longest; sutures straight or nearly so.

Last dorsal abdominal segment in the male with an extra piece, which appears as another segment and is (in the species examined) covered with peculiar many branched hairs or scales, pygidium not exposed.

Legs clothed with hairs or scales, usually the femora and coxae with scales only, sometimes these only in front; the apex of each of the tibia possesses a ring or crown of spines of varying length; articular surface of the hind tibiae distinctly terminal, sometimes with a projection on the inner side; tarsi dilated, third joint strongly bilobed, elongate, with a setose pad beneath; claws long, simple, free.

The description of the stages relate only to the following species: *Hypera punctata*, *Phytonomus posticus*, *P. nigrirostris*, *P. meles*, and *P. comptus*. The characters seem however, to be common to the species named, where the stages are known.

Egg: (not known in *comptus*): more or less oval, white, yellow or some shade of yellow, reticulated with hexagonal depressions.

Larva: In the younger stages (not known in *comptus*) slender, widest in the middle, head dark, dorsal surface set with dark or black tubercles upon which are inserted hairs, which are usually clavate at the tips, except on the anal segments where they are longer and simple; beneath the thorax the surface is projected into lobes, sometimes each lobe of each of the three pairs is bilobed and set with bristles; abdominal segments beneath with smaller lobes; sides with two swollen areas on each segment, the one on which the spiracles are placed has one or more tubercles set with hairs, anal segment of three lobes, two side and one dorsal; a dorsal abdominal median paler line is present, this may extend onto the thorax.

Later stages: Head dark, glabrous with very fine transverse lines, antennae minute, two-jointed, situated near the anterior border; labrum emarginate, with a row of hairs near the edge; mandibles stout, toothed, usually dark; two small ocelli on each side of the head with a long hair between them; palpi two-jointed, a long hair or spine below the first joint. Segments of the body dorsally of two distinct parts, (Pl. XXIV, figs. 23–32), the smaller anterior part always with one pair of tubercles, a tubercle each side of the dorsal line; the posterior part larger, broader and extending almost to the spiracles, containing on the dorsum, at least, one row of tubercles, some of the thoracic and last abdominal segments may have more rows; spiracles black, nine in number situated a little above the middle and well forward on the side of the segments which possess them, below them one or two tubercles, the spiracles and these tubercles are on the first set of swellings or enlargements; the enlargement below the first is usually small, the third is on the venter and contains the leg-like tubercles.

Cocoon: All the species noted above spin reticulate cocoons, usually oval or globular, varying considerably in the size and shape of the openings.

Pupa: Rather short and wide, all the appendages very evident, wing-pads rather long, thorax broad, the abdominal segments with transverse rows of setae; the thorax with hairs, those on the prothorax regularly twenty in number, a row of five pairs curving around the anterior margin on each side, the fifth of which is sometimes set far back; and a curved row of five pairs beginning near the center and passing backward to the posterior outer angle. The arrangement of these hairs appears to be constant in each species examined (pupa of *meles* not seen).

Life-history: *Eggs* laid, except with *Hyp. punctata*, in the spring on the food plants or inserted into some part of the plant, such as leaf, leaf-sheath, petiole, stem, flower-heads or buds. The habit of *comptus* is not known, but from the time the larvae appear it is probable the eggs are laid in the spring, the same holds for *P. eximius*.

Larvae upon hatching, generally remain concealed for some time feeding in a protected place, usually not feeding in the open except at night or when very numerous, when they pass out onto the leaves even in broad daylight. Some feed in flower-heads (*meles* and *nigrirostris*, prob. also *eximius* and *comptus*); others in the leaf-buds (*posticus*), but all when numerous will defoliate their food plant.

The larva when full grown spins a cocoon that may be placed among the flowerets (*nigrirostris*), on the upper surface of the leaves (*comptus*); on or near the ground, in leaves or other debris (*posticus*) or in the ground (*H. punctata*). Even in the same species there is some diversity of habit.

In those species where the cocoon spinning has been watched the process is as follows (Folsom, Titus for *Hyp. punctata*, Titus, Ainslie, Sadler for *P. posticus*, Titus for *P. nigrirostris*).

In *Hypera punctata* the larva buries itself in a small oval cell in the ground, slightly under the surface; this cell it smooths with its head and by turning around and around with its body in the characteristic curved position; the other species do not form cocoons in the ground. The spinning in the species observed is done with the mouth. The first hairs are placed as a round network on the surface where the larva is lying, then lying on its back it reaches with the head to one side slowly spinning the thread upward. The thread hardens and is thus sometimes carried over to the other side making a framework upon which to attach other threads. More often the threads are laid down along the first network and gradually built up on each side, the larva often puts its mouth or parts of its mouth through the coarser network and fastens a thread outside. The meshes are gradually reduced in size by placing other threads in both directions inside the first rows, this is especially true with *comptus* and *punctata*.

Every few seconds, or at least every half minute the larva reaches back to the anus and apparently from some gland secures a fresh supply of silk, the operation of securing this silk can be better described as sucking than "nibbling" though it partakes of the character of both. It may be that this is a secretion from the malphigian glands as found by Silvestri to occur in *Lebia*. Pupation occurs from one to three days after the cocoon is completed.

When the adult beetle appears it rests in the cocoon until the wing-covers are somewhat hardened and then eats its way out. From the descriptions given apparently some species devour the entire cocoon, this has been noticed but rarely with *posticus* and has not been reported for *punctata.*

The beetles usually feed by night and rest concealed in the daytime beneath rubbish or leaves or even in cracks in the ground. The smaller specimens often lie in the leaves or opening leaf-buds. The beetles cause considerable injury by their feeding habits at this time, gnawing the parenchyma from the stems and feeding upon the leaves.

The introduced European species, and probably all the species, hibernate as adults.

The group has in common with some other Curculionidae the habit of distributing themselves by flying at some stated period, in Phytonomus it appears at least in three species (*nigrirostris*, *posticus*, *meles*) to be in the spring. *P. posticus* has two flights, the second occurring in the summer, *Hypera punctata* has at least late summer or fall flight.

Food-plants: Kleine has published (1910) the food plants of the European species of Phytonomus so far as known. They include plants in many different groups, but especially among the legumes (Fabaceae) and buckwheat (Polygonaceae) families.

The native American species whose food-plants are known are *comptus* on *Polygonum; eximus* and *quadricollis* on *Rumex; trivittatus* (setigerus Lec.) on *Lathyrus*, and *maritimus* on "Vicia."

The introduced species are primarily leguminous feeders, attacking especially clovers and alfalfa; probably they will feed upon any species of *Trifolium*, *Medicago* or *Melilotus*. They will also attack the Astragalus group and the vetches. *Hyp. punctata* will live upon beans in both larval and adult stages. Other food-plants reported for them, such as golden-rod, potatoes, timothy, wheat and cabbage, are doubtless more or less accidental.

Along the Atlantic Coast the introduced species are but occasionally noticed as injurious to the crops, but as they move westward across the Alleghany Mountains, their injuries increase. It is probable that when *Hypera punctata* from the East and *Phytonomus posticus* from the West meet on the western plains, we will hear much more regarding their injurious feeding habits. It is certain that the alfalfa weevil (*P. posticus*) is a most serious pest in the parts of Utah where it is at present common and doubtless will be so in any of the western alfalfa regions. Railroads lead in all directions and it is only a matter of time until this species has reached the other alfalfa growing localities. (Map 11.)

In the dry regions. where there is little rainfall during the hot summers and very little humidity in the atmosphere, it is very doubtful if the fungus diseases will work. In the coast regions the fungus is undoubtedly the one enemy that keeps the species there present in check.

Cultural methods, the introduction of better methods of farming, rotation of crops, use of gathering machines, careful stamping out of incipient colonies and the hope of parasites from Europe are all factors leading toward the control of the species of this group in the more arid climates.

Plates XXXIII and XXXIV illustrate something of the problem from the standpoint of the western farmer and show what is being done to aid in cultural lines. Plate XXXIII is adapted from Bul. 110 of the Utah Agr. Exp. Sta., which gives an account of the work accomplished against *P. posticus* up to July 1, 1910.

GENERA HYPERA AND PHYTONOMUS.

While these two genera are closely related, there are unmistakable characters that readily separate them. *Hypera* has the beak short, blunt and thick; scarcely one-half longer than the remainder of the head; mandibles never emarginate; elytra much wider than the thorax; usually wider or as wide as the distance from base to point where the elytra curve downward; humeri very prominent, convex; alternate interspaces beginning with the sutural one strongly elevated and wider than the others; intercoxal process broad, stem of male genitalia (Pl. XXIV, fig. 14), fully as wide as long.

Type: *Hypera punctata* Fab.

In *Phytonomus* the body is never stout, broad and thick, beak never short and blunt; intercoxal process somewhat narrowed at tip; mandibles always more or less emarginate; elytra as wide or a little wider than the thorax; stem of male genitalia (Pl. XXIV, figs. 5–13), much longer than wide, generally two or three times longer.

Type: *Phytonomus arator* L. (polygoni L.)

Hypera lays eggs in the fall, some larvae hatch then, others the next spring. Cocoon may be formed in the ground, and the meshes are very much closer than in any Phytonomus cocoon known.

Phytonomus lays eggs in the spring (so far as known); the cocoon apparently never formed beneath the surface of the earth.

TABLE OF SPECIES.

Beak stout, never longer than prothorax.
Large robust species, beak shorter than prothorax; hairs of prothorax and elytra long and slender; scales striate, narrowed toward tip, emarginate without processes, concave, rounded at base....... **Hypera punctata**
Elongate, rather stout, sides of elytra almost parallel, thorax longer than broad, beak scarcely as long as prothorax; setae on prothorax thick, numerous, scales sparse, parallel-sided, deeply emarginate.
Phytonomus diversipunctatus
Beak more slender, always longer than prothorax.
Front between the eyes narrower than eye at widest part.................. **1**
Front between the eyes always distinctly wider than eye at widest part, usually slightly concave.. **8**
1. Scales not at all cleft or emarginate.................................. **2**
Scales more or less emarginate.. **4**
Scales cleft.. **5**
2. Body not elongate, flattened, sides of elytra never parallel; scales truncate, concave, widest at middle, striate........ **Phytonomus eximius**
Body elongate, flattened, sides of elytra parallel...................... **3**
3. Thorax deeply punctured, polished; scales concave, truncate, widened at tip, finely striate; setae thickened at tip, more numerous on posterior part of elytra.............................. **Phytonomus quadricollis**
Thorax not polished, punctures shallow, indistinct, glabrous, more or less confluent; scales parallel-sided or narrowed at tip, thick, indistinctly striate, no hairs on dorsum..................... **Phytonomus comptus**
4. Scales finely striate, deeply emarginate, sides curved; hairs thick at base and near tip abruptly narrowed to a point; prothorax as wide as long; punctures of elytral striae with minute setae. **Phytonomus trivittatus**
Scales deeply emarginate; hairs on prothorax thick, sides parallel, tip notched; prothorax longer than wide, setae in elytral striae short, thick and white.............................. **Phytonomus maritimus**
Scales deeply emarginate, processes and elytral scales as long as body of scale; beak scarcely longer than prothorax, species small, stout.
Phytonomus pubicollis
5. Scales cleft nearly or quite to base.................................. **6**
Scales not nearly cleft to base.. **7**
6. Prothorax much wider than long, sides prominently rounded.
Phytonomus meles
Prothorax not wider than long, species rather narrow, elongate; hairs on dorsum long, fine, pointed.................... **Phytonomus nigrirostris**
7. Prothorax almost as wide as long; hairs on dorsum, especially on posterior part of elytra, semi-decumbent, long and pointed. . **Phytonomus posticus**
8. Scales of elytra cleft to or almost to base; prothorax with numerous emarginate hairs mixed with sparse cleft scales, front distinctly concave, beak much longer than prothorax........ **Phytonomus seriatus**
Scales of thorax and elytra all deeply cleft, some scales on head are cleft; prothorax with sparse, thickened, blunt hairs, beak scarcely longer than prothorax.................................. **Phytonomus castor**

Hypera ocellata—described 1902: Biol. Cent. Amer. Coleoptera, v. 4, pt. 4, p. 3, would appear from the figure and description to be related to *Phy. eximius*, except that the beak is described as short and widened at the tip. The species has eleven black elytral spots and ochreous and gray scales. The two specimens were collected at "Omilterre, Guerrero, 8,000 feet (H. H. Smith) Mex."

The following names are undoubtedly *nomina nuda* but if opportunity offers someone should examine the specimens provided they are still in existence and correctly determine them.

1837: Dejean: Cat. Coleop. Coll. Dejean. p. 286. *Phytonomus confusus*—Amer. boreal.

1869: Giebel: Col. Univ. Halle Wittenberg, p. 44, No. 28, "*Hypera nudirostris* Germar in litt., Nord Amer." No. 31 an unknown species from "Nord Amer."

Hypera punctata Fabricius.

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- 1762: Geoffroy: Ins. 1: 279. "Curculio no. 5."
- 1779: Schaeffer: Icones Insectorum, tab. 25, fig. 6.

Curculio punctatus:
- 1775: Fabricius: Systema Entom., p. 150, no. 119.
- 1781: Fabricius: Species Insectorum, 1: 190, no. 166.
- 1781: Laichart: Verz. u. Besch. d. Tyrol Ins. Kafer, 1 (pt 1): 16, no. 221
- 1787: Fabricius: Mantissa Ins., 1: 117, no. 221.
- 1787: Schneider: Neus Mag. Entom. 3(pt 2): 116, no. 190.
- 1788: Zschachii: Pars Entom. p. 21, no. 458.
- 1789: Villers: Entom. Fauna Suec., 1:213, no. 169; 4: 279, no. 169.
- 1790: Gmelin: Linn. Syst. Nat., ed. xiii, p. 1786, no. 378.
- 1790: Olivier: Hist. Nat. Ins., 5: 541, no. 315.
- 1790: Rossi: Fauna Etrusca, 1: 131, no. 335.
- 1792: Fabricius: Entom. Syst. emend. 1(pt 2): 472, no. 329.
- 1792: Paykull: Monog. Curc. Suec., p. 111, no. cvii.
- 1795: Fabricius: Nomen. Entom., p. U.
- 1795: Herbst: Nat. Ins. Kafer, 6:505, no. 540.
- 1795: Panzer: Entom. Germanica, p. 329, no. 174.
- 1795: Rossi: Fauna Etrusca, (Hellwig ed.) 1: 139, no. 335.
- 1795: Weber: Nomen. Entom. sec. E. S. Fab. p. 57.
- 1796: Fabricius: Index Alphabeticus, E. S. emend., p. 54.
- 1797: Bergstrasser: Epit. Entom. Fab. Nomen. p. 68, 71.
- 1800: Paykull: Fauna Suecica, 3: 306, no. cxxix.
- 1801: Fabricius: Sys. Eleutherat., 1:529, no. 133.
- 1805: Illiger: Magaz. f. Insektenkunde, 4: 133.
- 1828: Boitard: Man. d'Entom., 1: 409.
- 1853: Moretti: in Gene, ed. 2.

Rhynchænus punctatus:
- 1802: Fabricius: Ind. Gen. et sp. Sys. Eleuth., p. 69, no. 54.
- 1813: Gyllenhal: Ins. Suec., 1 (pt 3): 108, no. 38.
- 1820: Billberg, Enum. Ins., p. 42.
- 1827: Gyllenhal: Ins. Suec., 1(pt 4, app. 3): 572, no. 38.

Brachyrhinus punctatus:
- 1804: Latreille: Hist. Nat. Gen. et parc. 11: 171, no. 59.

Hypera punctata:
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1821: Germar: Germ. & Zincker Mag., 4: 344, no. 22.
1821: Dejean: Cat. coll. Coleop., p. 89.
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1826: Sturm: Cat. Ins. Sammlung, 1: 157.
1829: Curtis: Guide Arr. Brit. Ins., p. 50, no. 3.
1829: Stephens: Sys. Cat. Brit. Ins., p. 167, no. 1707.
1831: Stephens: Entom., 4: 93.
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1849: Walton: Stett. Ent. Zeit., 10: 259.
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1869: Giebel: Verz. z. Mus. Univ. Halle-Wittenberg p. 43, no. 1.
1869: Targione-Tozzetti: Bul. Ent. Soc. Ital., 1: 80-81.
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1871: Kirsch: Berl. Ent. Zeit. 15: 184.
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1877: Stein & Weise: Cat. Col. Europe, ed. 2, p. 143.
1880: Koppen: Die Schadlichen Ins. Russlands, p. 209.
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1883: Weise in H. R. & W. Cat. Col. Eur. et. Cau., ed. 4, p. 159.
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1890: ———: Bul. Ent. Soc. Ital., 22: 275.
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1830: Gebler: Bemerk uber d. Ins. Sib. vorz. Altai, p. 168.
1833: Carmagnola: in Villa: Cat. Coleop. dupl. p. 24.
1833: Dejean: Cat. Coleop. coll. Dejean, ed. 2, p. 264.
1834: Schonherr: Gen. et sp. Curc. 2 (pt 2): 401.
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1864: Jekel: Ann. Ent. Soc. Fr. (4) 4: 562, 563.
1865: Disconzi: Entom. Vicentia, p.79, 81, no. 36.
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1868: Villa: La Lombardia, 13 giugno.
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1877: Heyden: Jahrb. Nassau. Vereins, 29: 311.
1878: Schneider & Leder: Beit. kennt. Kauk. Kaferfauna, p. 287.
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1882: Lintner: Rural New Yorker, 41: 616, 9 Sep.
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1883: Riley: in Rep. U. S. Dept. Agr. f. 1881-2, pp. 171–9, pl. 10, f. 1.
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1883: Lintner: Rural New Yorker, 42:310, 19 May.
1883: Mann: Psyche, 4: (Bibliog. rec. 3309, 3325, 3326). p. 96.
1884: Lintner: Country Gentleman, 49: 457, 29 May.
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1889: Smith: 10th Rep. N. J. Agr. Exp. Sta., p. 241, 313.
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1890: Riley & Howard: Ins. Life, 3: 70–71.
1890: Smith: Cat. Ins. New Jersey, p. 250.
1890: Lintner: 6th Rep. St., Entom. N. Y., p. 182.
1891: Smith: Ins. Life, 3: 231–2.
1891: Lintner: 7th Rep. St. Entom. N. Y. p. 315, fig. 33.
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1891: Hamilton: Ins. Life, 4: 270.

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1892: Webster, F. M.; Ohio Farmer, 4 June, p. 422.
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1893: Butler: Indiana Farmer, 14 Jan., figures.
1893: Riley & Howard: Ins. Life, 5: 279.
1893: Lintner: Country Gentleman, 58: 386, 18 May.
1893: Webster, F. M.: Ins. Life, 6: 186.
1893: Lintner: 8th Rep. St. Entom. N. Y., p. 300.
1893: Lintner: 9th Rep. St. Entom., N. Y., p. 440.
1893: Riley & Howard: Ins. Life, 6:328.
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1893: Meinert: Fort. z. Mus. Bille Larver Coleop., p. 279, no. 508.
1894: Riley & Howard: Ins. Life, 6: 328.
1894: Webster, F. M.: Ohio Farmer, 10 May, p. 377, figs., 17 May, p. 39.
1894: Wheeler: Bul. 116, Mich. Agr. Exp. Sta., p. 47-52, fig. 1-3.
1894: Hopkins: Ins. Life, 7: 145.
1894: —— —— ——: Michigan Farmer, 8 Sep.
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1897: Webster: Journ. N. Y. Ent. Soc., 5:202.
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1898: Felt: Country Gentleman, 26 May, 63: 406.
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1902: Sanderson: Ins. Inj. Staple Crops, pp. 177–79, fig. 98.
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1906: Folsom: Entomology, ed. 1, pp. 58, 381.
1906: Weise in H. R. & W.: Cat. Coleop. Eur., ed. 2, p. 655.
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1910: Smith: Cat. Ins. N. Jersey, p. 381, fig. 157.
1911: Webster, F. M., in Westgate and Hillman, Farmer's Bull. 455, p. 39, fig. 22.

Curculio austriacus:
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1784: Herbst: Fues. Archiv., 5: 82, no. 70.
1789: Villers: Entom. Succ. Fauna., 1: 214, no. 177; 4: 281, no. 177.
1790: Gmelin: Linn. Syst. Nat. ed. xiii, p. 1778, no. 324.
1790: Olivier: Hist. Nat. Ins. 5: 571, no. 56.
1795: Herbst: Nat. Ins. Kafer, 6: 243, no. 207, T. 77, fig. 11.
1795: Panzer: Fauna Ins., civ. no. 8.
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1802: Marsham: Entom. Brit., 1: 302, no. 184.

Brachyrhinus austriacus:
1804: Latreille: Hist. Nat. Gen. et parc., 11: 179, no. 89.

Rhynchænus austriacus:
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1819: Samouelle: Entom. Useful Comp., p. 369.
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Hypera punctata var. *austriaca:*
1871: Gemminger & Harold: Cat. Coleop., 8: 2386.

Phytonomus punctatus var. *austriacus:*
1901: Petri: Monogr. Coleop. Trib. Hyperini, p. 202.
1901: Petri. Bestim.-Tab. Coleop. Hft. 44, Hyperini, p. 39.

Curculio pictus:
1785: Fourcroy: Entom. Paris., 1: 117, no. 5.
1789: Villers: Entom., Fauna Suec., 1: 216, no. 187; 4: 282, no. 187.

Hypera punctata var. *picta.*
1871: Gemminger & Harold: Cat. Coleop., 8: 2386.

Curculio linzensis:
1790: Gmelin: Linn. Syst. Nat. ed. xiii, p. 1799, no. 477.

Hypera punctata var. *linzensis:*
1871: Gemminger & Harold: Cat. Coleop., 8: 2386.

Phytonomus punctata var. *linzensis:*
1901: Petri: Monogr. Coleop. Trib. Hyperini, p. 202.
1901: Petri: Bestim.—Tab. Coleop., Hft. 44, Hyperini, p. 39.

Curculio medius:
1802: Marsham: Entom. Brit., 1: 302, no. 185.

Phytonomus proximus:
1833: Carmagnola: in Villa Cat. Col. Eur. dupl., p. 24.
1843: Sturm: Cat. Coleop. Sammlung, p. 201.

Hypera punctata var. *proxima:*
1871: Gemminger & Harold: Cat. Coleop., 8: 2386.

Phytonomus rufus:
1834: Boheman in Schönherr: Gen. et sp. Curc., 2 (pt 2): 402.
1842: Boheman in Schönherr: Gen. et sp. Curc. 6 (pt 2):
1844: (Dohrn): Cat. Col. Eur., p. 52.
1849: (Dohrn): Cat. Coleop. Eur., p. 61.
1858: Dohrn: Cat. Coleop. Europ., p. 79.

Hypera punctata var. *rufa:*
1871: Gemminger & Harold: Cat. Coleop., 8: 2386.
1877: Stein & Weise: Cat. Col. Eur., ed. 2, p. 143.
1883: Weise in H. R. & W. Cat. Coleop. Eur., ed. 4, p. 159.
1891: Weise in H. R. & W.: Cat. Coleop. Eur., p. 303.

Phytonomus punctatus var. *rufus:*
1901: Petri: Monogr. Coleop. Trib. Hyperini, p. 202.
1901: Petri: Bestim.—Tab. Coleop. Hft. 44, Hyperini, p. 39.

Phytonomus punctatus var. *hostilis:*
1837: Dejean: Cat. Coleop. Coll. Dejean, ed. 3, p. 287 (credited–Ziegler).
1901: Petri: Monogr. Coleop. Trib. Hyperini, p. 202.
1901: Petri: Bestim.—Tab. Coleop. Hft. 44, Hyperini, p. 39 (hortilis).

Hypera punctata var. *hostilis:*
1871: Gemminger & Harold: Cat. Coleop., 8: 2386.

Phytonomus opimus:
1876: Leconte: Rhyncophora of North America, p. 124, 415.
1884: Reinecke: Buffalo Freie Press, 12 Aug.
1884: Reinecke: Bul. Br'klyn. Ent. Soc., 7: 76.
1882: Leconte: Trans. Am. Ent. Soc. 9: proc. p. xxxvi.

Hypera opimus:
1880: Austin: Supp. Check List Coleop. N. Am., p. 45, no. 8881.

Phytonomus fallaciosus:
1896: Desbrochers: Frelon, 5: 67.

Original Description: Fabricius, 1775, p. 150, as *Curculio punctatus.*

"*punctatus.* 119. *C. brevirostris, fuscus, elytris punctis, holosericeis elevatis; marginecue flavo.*

"Habitat in Suecia.

"*Major, ovata, Rostrum brevissimum. Thorax gibbus, glaber. Elytra striato punctata, et praeterea punctis elevatis, holosericeis atris adspersa.*"

Adult: (Plate XXV). Length 5 to 10 mm. Width 3 to 5.7 mm.

Stout, black or brownish black. Clothed with blackish brown pale brown, yellow-brown or gray scales which are short broad and emarginate at the tips, and with short erect bristles, edge of elytra yellow brown or at least paler than remainder of scales.

Head clothed with short metallic yellowish scales; *front* not as wide as breadth of eye, densely clothed with dark yellow hairs or scales which extend over two-thirds of the beak. *eyes* elongate oval, narrowed beneath, rather prominent; *beak* scarcely two-thirds the length of the prothorax, and one-half thicker at tip than width of front, beneath on the sides and near the tip polished and densely punctate; an elongate impression on dorsal surface above the antennal groove; *antennal groove* black, deep, punctured; *antennæ* reddish-black, scape reaching to middle of eyes, not as long as funicle, not greatly enlarged at tip; first joint of funicle distinctly longer than second, enlarged at the apex so that it is about one-half as thick as long, second joint equal to three and four united, joints three to seven regularly shorter and broader, seven as wide as long, club elongate-oval, pointed at tip, antennæ with many fine hairs, those on club very fine and dense. Mandibles polished, dull red, not emarginate at tip, maxillæ and all the palpi pale brownish-red.

Prothorax broader than long, broader in female than in male, in the female broadly widened in front of the middle, in the male converging more behind than in female; sides broadly impressed, only slightly swollen; dorsum densely rather coarsely punctured, densely clothed with scales and with many slender pointed hairs; usually with a narrow pale median dorsal line bordered by wide dark, almost black in some, bands of scales which reach to the sides; sides and beneath with dark yellow scales, generally with a dark spot on sides behind and an indistinct dark line running from this spot toward the front.

Scutellum extremely small, narrowly triangular, clothed with pale scales.

Elytra very broad, at tip broadly rounded, sides especially in the male nearly parallel, humeri prominent and clothed with darker scales. Suture and alternate interspaces more strongly elevated than others, deeply striately punctured, striae without setae; each interspace with a single row of black setae pointing backward and partially decumbent, more erect behind; tip of elytra and often the sides with some short white hairs. The coloration of the scales varies from solid gray to black, through various shades of brown yellows. Some specimens are tesselated with brownish-yellow and black, the tesselation usually on the more elevated interspaces.

In the male the outer interspaces have paler scales even in the darkest specimens, in the female this pale coloration is sometimes, but rarely, entirely absent.

Venter with lighter colored scales and many light hairs; front coxæ slightly separated, mesosternal process between middle coxæ broad perpendicular, triangular at tip; intercoxal process of first abdominal segment very broad, coxæ separated by more than their width. First segment in male impressed, emarginate posteriorly. Stem of male genitalia (Pl. XXIV, fig. 14), nearly or quite as broad as long.

Legs short, stout, especially the femora; black, tarsi often ferruginous, claws long curved, red and darker at tips; front tibiæ and hind femora distinctly curved, front tibiæ more so in male; legs usually clothed with lighter scales and hairs than the body, femora scaled, tibiæ and tarsi sparsely haired; middle tibiæ with a distinct apical hook.

Egg: elongate oval, 1.1 mm. to 1.2 mm. long, 0.5 to 0.6 mm. broad, very regularly hexagonally sculptured. The sculpture at one end often merging into striæ. As the larva develops the egg changes from an orange or chrome yellow to a dull black.

Larvæ: (Pl. XXVI, fig. 1). (Descriptions from Riley, Folsom and observations by the author). *First stage:* 1.5 to 2 mm. long, narrow, thickest at middle, tapering toward both ends; head brown, blackish-brown or black, with many fine transverse lines on the face; eyes very small, circular, projecting; mandibles terminating in two large sharp teeth, more or less separated, the lower one again divided into two or three parts; palpi pale yellow, mandibles brown or dark brown; dorsum of first thoracic segment with a rectangular dark band interrupted by a paler dorsal line which is the continuation of the stem of an inverted Y on the face, this dorsal band becomes wider on the abdominal segments and extends to the tip of anal segment. Hairs on the tubercles clavate as in several other species. Color varies with place of feeding, if concealed in bud or stalk is very pale, if exposed is more or less green.

Second stage: Color greener, head dark brown, front and sides of rectangular plate on first thoracic segment dark, the remainder greenish; dorsal median line with a fine dark border, darker than the remainder of the larva. Side line below spiracles indistinct. Length 4–4.5 mm., width 2 mm.

Third stage: Black lines on each side of dorsal line very distinct; head as in second stage, eyes densely black, antennæ darker; color of larvæ (Folsom) may be blue green. Usual color pale green. Length 5 to 7 mm., width 2.5 to 3 mm. in the middle.

Fourth stage: Dorsal line very white indistinctly bordered by rose color, usually rather pale but sometimes rosy-black, the outer borders of this coloration are black and form distinct lines, interrupted on the margin of each segment; head very dark brown; larva much darker green; lines below the spiracles dark both showing a tendency to be brown or blackish, anal segments brown; the surface of the body much rougher in this stage than in others, the triangular points of the cuticle standing out prominently; tubercles on the thoracic segments below very strong and the hairs more prominent than in earlier stages. Length 8 to 14 mm.

Cocoon: (Plate XXVI, fig. 2). A fine network of rather coarse brown threads, not so dark as in *comptus*, but the reticulations closer than in any species studied. Oval, 9–10 mm. long and 6.5 to 7 mm. wide.

Pupa: (Plate XXVI, fig. 4, 5). When first formed with yellow-green head, small brownish-black eyes, yellow antennæ, legs and wing-pads paler. Abdomen dark green with a distinct pale dorsal line that extends onto prothorax but in those I have seen not onto the head. Frontal row of hairs rather distant from margin; central pairs close together, three following pairs form a curved line ending near the posterior outer edge; a few hairs on remainder of thorax; transverse rows of blunt setæ on each dorsal abdominal segment; hairs on beak rather short and thin; those on anal segment moderately long, stout and dark. Length 5.5–7 mm. Width 3.5–4.5 mm. Probably some are larger than these measurements show.

Map 2. Distribution of *Hypera punctata* Fab. in America.

Distribution: The species was described by Fabricius in 1775 from Sweden, and both Schaeffer and Geoffroy list it without a name. Nearly all of the earlier writers mention it and in 1826 Curtis made it the type of Germar's genus Hypera.

It is common over all Europe and northern Asia, occurs and probably also common in central Asia and in China. Asia Minor and the north coast of Africa appear to be more rarely inhabited by this species, *isabellinus* taking its place in Egypt.

It is becoming well distributed over the United States and southern Canada, occurring now on both coasts and at least as far south as Texas, Tennessee and North Carolina.

The following records are based on literature, specimens seen, and records sent me by various collectors.

The type of *opimus* is from the Melsheimer collection and is an almost perfect specimen of the pure gray form. The Canadian specimen mentioned in 1876 by Leconte was received by him from Mr. D'Urban of the Geol. Survey of Canada about 1850–55. It was not until 1881 that the species was again reported, when it occurred at Barrington, N. Y.; in 1882 Lintner took a specimen in Vermont. In 1884 *punctatus* reached Canada in numbers, flying across the lake from Buffalo to Ridgeway, 1889 it occurred in several places in Ohio, probably having reached there the previous year. Hamilton reports it from Western Pennsylvania in 1891 and Schwarz identified a beetle taken from the stomach of a crow killed in Michigan in 1892 as this species. Southward by 1890 it had spread over New Jersey and reached Philadelphia where it was very common (Liebeck). The year 1894 gave records from Maryland, Michigan, W. Virginia (Hopkins), and Indiana. C. T. Brues took it in 1897-98 along the shore of Lake Michigan at Chicago, it being one of the very common species at that time. Folsom records its first appearance at Urbana as 1903 and it was common there in 1904. In Pennsylvania, Stewart and Rathvon report it in 1891 and it apparently soon afterward reached Maryland and the District of Columbia, since in 1894 it was seriously damaging clover in western Maryland. Lintner in 1893 received specimens from a correspondent at Hillsboro, Va., where it was then troublesome. Franklin Sherman, Jr., writes me that he collected specimens in North Carolina in 1901; there are specimens in the Brues collection from Austin, Texas, 1901–2. I have specimens collected at Memphis, Tennessee, in 1906, and took one female at N. Topeka, Kansas, 17, September, 1910. R. L. Webster reported it from Iowa in 1910. On the west coast Hanham reported it from Vancouver in 1902 (Fletcher) and in 1906 E. S. Wilmot states it that was up the Fraser River as far as Harrisons, about twenty miles from the south line of British Columbia. It was not until 1905 that it was reported from Ottawa, Ontario (Harrington). There are specimens in the Blaisdell and Van Dyke collections from San Francisco, 1908, and in the Van Dyke collection from near Seattle, Washington, 1907, G. I. and Miriam Reeves collected it at Vancouver, Wash., in 1911.

Felt (*in litt* 1911) gives a large number of New York records and says distributed commonly over the entire state. Blatchley (*in litt.* 1911) states that it is in all parts of Indiana.

Maine: Old Orchard Beach (Fall coll.); York Beach (Frost coll).

New Hampshire: Base Mt. Washington ix–19–09 (Frost).

Vermont: Hartland (U. S. N. M.).

Massachusetts: Framingham viii–4–06, vii–5–06, ix–7–07 (Frost); Bedford (Frost); Forest Hills winter and fall 1910–11 common; Salisbury, Lynn, Wakefield, Marion (Fall coll); Stoneham iv–2 (Sherriff); Brookline viii–13, Boston viii–20–02, iv–6–04 Parshley (B. S. Nat. Hist.); Nantucket Id (Bolter coll.).

Rhode Island: Providence 18–Sep–02 Armstrong (U. S. N. M.); Kingston.

Connecticut: Stratford 1891 (Ins. Life); common from records by Britton, (*in litt*, 1911), which include the following: New Haven, 9 Nov., 1903, pair in coitu, H. L. Viereck; 16 Oct., 1903, 18 Aug., 1903, B. H. W.; 16 Aug., 1904, B. H. W.; 9 July, 1909, B. H. W., 12 Sep., 1907, W. E. Britton; Poquonock, 7 July, 1903, B. H. W.; Cromwell, 14 Aug., 1903, B. H. W.; E. Hartford, 21 Aug., 1903, B. H. W.; Colebrook, 21 July, 1905—June, 1911 (Titus); Branford, 20 Aug., 7 Sep., 1905, H. W. W.; Westville, 3 Sep., 1905, 9 Sep., 1907, W. E. B.; Stonington 7 July, 1906, G. A. Hyslop.

New York: Oscana Lake, Aug., 1891, (Van Dyke coll.); Ithaca, 1895 (Ohio U.) 1885, 18 July, 1 Sep., and 1890, 10 May, and many other dates (Cornell Univ.) Thousand Isles 9–21, Danley Corners 16–Aug.–85, Motts Corners, 23 Aug.,–85 (Cornell U.); Berington, Yates Co., July, 1882, J. B. S. (U. S.

N. M.); Dundee 13–3, Rockaway Bch (U. S. N. M.); Babylon Je 18, G. D. Bradford, Staten Id (A. M. N. H.); Buffalo in many collections; from Dr. Felt (*in litt.*) Albany, Buffalo, Canandaigua, Coeymans, Ithaca, Karner, Mosholu, Marlborough, Newport, Oswego, Phoenicia, Pike, Sheepshead Bay.

New Jersey: Distributed over entire state, (J. B. Smith). N. Brunswick, June, vi–15, Monmouth, Chester ix–1; Sea Isle City 5–29, Jamesburg, June; Woodbury 6–19; Anglesea 6–26, Avalon 7–25, Westville 8–13; Atlantic City 6–24 (coll. J. B. Smith); Anglesea 1–28; Phila. Neck 1-31, Malaga ix–18 (coll. Wenzel); Highlands N. J. (U. S. N. M., Mich. Agr. Coll.); Cape May, Ft. Lee (A. M. N. H.); Highlands 8–7–90, (Soltau) Anglesea 22–7 (U. S. N. M.); Hopatcong (A. M. N. H.).

Pennsylvania: Bucks Co (J. B. S.); Crooked Ck, Allegheny (Felt coll.); W. Park (Wenzel); "Pa" (Horn coll.); Pa (Bolter coll.).

Maryland: See records above under general distribution.

Delaware: Close 1907, records from state.

District of Columbia: Washington 11–8, 11–7 (U. S. N. M.) common (Schwarz).

Virginia: Falls Ch. (Felt list). Common (Schwarz).

West Virginia: Berkeley and other counties (Hopkins); Morgantown (Felt list).

North Carolina: Raleigh 22 Oct., 1901, Newton, Aug., 1902 (Sherman).

Tennessee: Memphis (Titus coll.) 1906.

Texas: Austin, 1901–2 (Brues coll.).

Michigan: Detroit, Sep. 2, Hubbard and Schwarz (U. S. N. M.). Common.

Ohio: N. E. Ohio, 1890 (Webster); Wooster, 1893:(Webster); Lucas Co., 1893 (Hine); Cincinnati 1892 (Dury); Wauseon, April, 1894 (Hine); Sandusky, July 12, 1899; Big Chicken Id. L. Erie, 25 July, 1903, Columbus (Ohio State University); Cleveland, June 23 (Webster); Cuyahoga Falls, 14–viii–04 (Warner, U. S. N. M.).

Indiana: Indianapolis (Fall coll.); Stilesville ix–18 (Wickham coll.); common throughout state (Blatchley).

Illinois: Chicago, 1897–1898, common (Brues); Urbana, ix–26–10 Titus; Cobden ix–25–10, (Titus); in coll. Field Col. Mus: Willow Spr. viii–17–07, viii–31–07; Roby ix–7–06; Cook Co. (Chope); Chicago ix–2, (Brand); Glencoe v–31–09, (Gerhard); Carbondale ix–22–09 (Gerhard).

Wisconsin: Bolter coll; Lugger coll.; Beaver Dam ix–4–10 (Van Dyke).

Iowa: Burlington, April, 1910 (Webster, R. L.).

Kansas: North Topeka, 17 Sep., 1910 (Titus).

Washington: Washington Lake near Seattle v-9-07, ix–9–07 (Van Dyke); Vancouver (G. I. & M. Reeves).

California: Mt. Lake near Presidio Mil. Res. San Francisco, May, '08, (Blaisdell and VanDyke).

Oregon: "*Ore.*" (U. S. N. M.).

British Columbia: Victoria 1902 (Hanham), Harrison, 1903 (Wilmot).

Food Plants and Life History: In Europe this species has several times been reported as injurious locally, but only for short periods. The earliest record I have found is Villa's statement at the time of the outbreak in the region of Lombardy in 1868, when he says that Moretti in a revised edition of Gene's publication in 1853 reports this species as injuring clover, and believes that this referred to a previous serious injury about 1834–35. I have not seen the work mentioned. In 1868 the species caused serious damage in northern Italy so that a commission was appointed to investigate the matter and published several papers giving recommendations.

Targione-Tozzetti in 1879 notes a severe outbreak in the region around Florence; Koppen in 1880 mentions its injuries to agriculture in Italy. Bargagli in his work on the Rhyncophora writes of the species as injurious and in 1884 reports that the previous year it had been excessively abundant. He believed that this was due to the very dry year killing off the predaceous and parasitic insects that ordinarily keep it in check. Bertolini reports it from clover at Trento in 1893. It was again injurious in the region of Florence in 1902–1903.

In America its first notice as an injurious species was in 1881 in New York when there was a severe outbreak and from this place it rapidly spread in all directions year by year. Five years later Arthur of the Geneva station studied the fungus that was then attacking it. This disease keeps the species well in check throughout the eastern states. However, when the species reaches the dry western climates it is probable that it will cause much more serious damage.

The life history of the species was published by Riley in 1882 and a more recent paper by Folsom (1909) gives much additional information regarding its habits and distribution.

The following account is condensed from Folsom's most excellent paper on this subject, supplemented by observations I have made the past fall, winter and spring on the species in captivity and on the grounds of the Bussey Institution and other places around Boston. I have succeeded in forcing the larvæ through to pupation by the middle of March. The beetles of the year lay eggs throughout the fall from September until winter forces them into hibernation.

Folsom states that he rarely found the weevils in early spring, those found being "either dead or in the last stages of decrepitude and evidently incapable of doing anything toward the propagation of their kind."

Eggs are laid in old clover stems, on the outside of green stems, leaf petioles and among young leaves, or on the ground amongst the debris at the base of the plant. In captivity the beetles freely deposited their eggs in the stems of growing alfalfa and clover. As related by R. L. Webster the adults stand head downward boring the hole in which to deposit the eggs with their beak.

Apparently the majority of the eggs hatch in the fall, the young larvæ wintering over in various sizes ranging from those newly hatched of 1.5 mm. length to specimens 5 to 7 mm. long and certainly three-quarters grown. During the winter they may be found inside hollow stems, among the young leaves, or among the dried leaves about the base of the plants. On warm winter days they come out to feed on the young leaves, I have found them feeding in the bright sunshine on warm days in January and February; Glascow also reported finding larvæ feeding at this time of year (Folsom).

In early spring the overwintering eggs begin to hatch and the larvæ that have been hibernating come out on the plants and feed. The very young larvæ eat small holes in the leaves while the older ones cut pieces out of the edge or even cut off young leaves. The damage to clover is sometimes quite severe and alfalfa plants show the riddling still plainer.

The beetles feed on the leaves and stems, both eating off the parenchyma and making feeding punctures in the stems.

Folsom gives the length of the egg-period in as 23 to 45 days. One lot of 54 eggs laid by one beetle in the insectary at Forest Hills were divided, 27 kept inside hatched in 18 days, while those placed outside hatched with an average of 31 days.

According to Folsom the average for the first larval stage is about 9 days; and the others very variable. Larvæ reared by me in 1910–11 passed the first stage in 8–9 days, the second in 10–12, third in 15–16 and spun their cocoons 12–16 days later. The cocoon spinning occupies one or two days,

Pupæ are apparently formed about two days after the cocoon is finished. The pupal period (Folsom) is from 10 to 20 days. Beetles appear in Illinois as early as May 9 and as late as July 15. The period of greatest emergence being "the last week in June."

Copulation does not occur for several weeks or even more than a month after their appearance. Meanwhile they spend their time hidden during the day and coming out at night to feed. Both beetles and larvæ usually feed during the night.

The largest number of eggs reported by Folsom was 40. Taking advantage of their propensity for continued mating I have supplied a female with fresh males and fresh food-plant after each egg-laying period; this combined with a warm room seemed to act as a stimulant and I received 68 eggs. Dissection later showed many undeveloped eggs in the ovaries.

Folsom gives as foodplants "all kinds of clovers and alfalfa as well." In central Illinois red clover is most heavily infested, alfalfa second and white clover third. Webster found that one year in Ohio the white clover was most seriously injured. Lintner reports the larvæ and adults feeding on beans, the latter especially on the pods.

Kleine gives as the food-plants in Europe: *Medicago sativa, Trifolium pratense* and *T. incarnatum* and *Helianthus tuberosus*.

Enemies: Riley reported *Collops quadrimaculatus* in the larval stage feeding on the eggs, and *Cicindela repanda* probably preying upon the larvæ. Webster notes that larvæ are eaten by birds and that turkeys (especially), and chickens are very fond of them. In Europe Torka in 1907 reported, evidently quoting from Eckstein, finding the species in the stomach of *Botaurus stellaria*.

The worst enemy of the insect is undoubtedly a fungus disease which attacks the larvae under favorable conditions sweeping them off in great numbers. This disease was first noted by Arthur in New York in 1885 and has since appeared wherever the Phytonomus has been distributed throughout the eastern and central states. Folsom states that it requires damp and not too cold weather to develop and affects the larvæ in October and November and again in April and May.

This fungus is known as *Entomophthora sphaerosperma* Fres., and is a common disease upon many insects, the only other representative of the Coleoptera reported as attacked is a Lampyrid larva. The list of its hosts includes (Thaxter, 1888); in the Lepidoptera, imago of *Colias philodice* and larvæ of *Pieris;* in Hymenoptera several Ichneumons, and a Halictus; in Diptera, imago of the common house fly (*Musca domestica*) and representatives of several families of small diptera; in Coleoptera as noted above; Hemiptera, *Aphis*, *Typhlocyba*, larvæ, pupæ, imagines; in Neuroptera; imago of *Limnephilus*(?); Thrips in various stages of a species on Solidago. This species of fungus occurs in Europe as well as in America, here being known from Maine to North Carolina and westward into the Mississippi Valley.

The fungus develops in the body of the host, as a network of branching mycelia, some of the branches push through the ventral wall and become attached as rhizoids to some surface; over the body is formed a gray velvety coating of fine threads which have penetrated the skin; on the tips of some of these are formed conidia from these come temporary spores which are shot away for some distance and may thus alight upon another host and begin to grow. Resting spores develop inside the host and probably may thus live over until the next season.

The sick larvæ crawl up the plants during the night, ascending as high as possible, if on a slender stem or a grass blade they coil themselves about it in a horizontal position.

Arthur (1885) states that they die by noon, remaining in this position and during the late afternoon have changed to a velvety gray. By the next morning the larva is only a blackened shriveled mass.

This disease is so destructive to the larvæ of *Phytonomus nigrirostris* and *Hypera punctata* that there is rarely any cause for worry on account of their injurious habits in the Eastern States. When they appear in numbers any season they are nearly all killed before reaching maturity.

Phytonomus eximius Leconte.

Phytonomus eximius:
1876: Leconte: Rhyncophora of N. America, p. 414, no. 4–5, p. 415.
1877: Popenoe: Tr. Kans. Acad. Sc., 5:38–9.
1881: Riley: American Naturalist, 15: 912.
1882: Riley: Report of the Entomologist, p. 111.
1883: Riley: in Rpt. U. S. Dept. Agr., p. 171.
1883: Lintner: 1st Rpt. St. Ent. N. Y., p. 248.
1885: Henshaw: Cat. Coleop. Am. N. of Mex., p. 137, no. 8231.
1898: Beutenmuller: Journ. N. Y. Ent. Soc., 1:40.
1909: Webster, R. L.: Entom. News, 20: 81.

Hypera eximius:
1880: Austin: Supp. Check list Coleop. N. Amer., p. 45, no. 8885.

Adult: (Plate XXVII, fig. 6–8). Length 4.8–5.5 mm. Width 1.5–2 mm. Black, densely clothed with golden-yellow, rust-red, brownish-black or black scales or some combination of the colors, hairs sparse, usually pale.

Head densely, finely punctured, scales dense on head, especially between the eyes, sparse on beak; *front* narrow, scarcely as wide as beak at tip, about as wide as one eye; *eyes* oval, scarcely elongate, narrowed beneath very slightly; *beak* not as long as prothorax, generally covered with fine punctures which often merge into striæ that extend almost to the tip which is a little widened, apical two-thirds of beak sparsely clothed with long pale or black hairs; *antennæ* black, not densely haired, very long in proportion to size of the insect; scape reaching at least to the eyes, first funicular joint as long as three following, enlarged at tip, second joint as long as third and fourth united, club long pointed, densely pubescent with very fine short hairs.

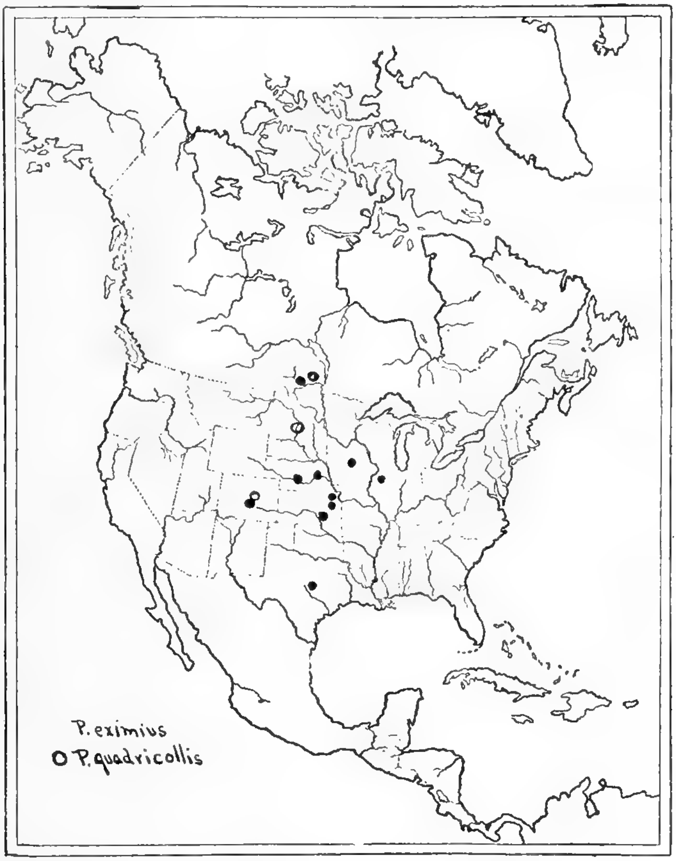
Prothorax as long as wide, narrowed in front, sides obliquely sloping back for two-thirds of length, then slightly contracted to posterior edge, sides somewhat swollen, impressed behind; dorsum and sides clothed with ribbed scales that are almost quadrate in form, and with a few short pale or white hairs.

Scutellum narrowly triangular, scales yellow.

Elytra at base one-third wider than widest part of prothorax, gradually widening for two-thirds of length where they become almost one-half wider than prothorax, then gradually sloping to the rounded tip; scales as on prothorax, hairs on interspaces very sparse, interspaces flat; punctures of the striæ without hairs. In some specimens the scales are dark yellow with tesselated brown or black spots on alternate interspaces beginning with the sutural area; others are rust-red either uniformly scaled or with spots of brown, yellow or gray scales intermixed, or they may be covered entirely with gray scales.

Venter with entire surface clothed with paler scales and fine pale hairs; these hairs are especially evident in a small area on the mesosternum; abdominal surface often rubbed so that it appears spotted with black; *mesosternal process* between middle coxæ elevated, narrowly linear, ending in a rounded point; *intercoxal process* of first abdominal segment broad; male genitalia (Plate XXIV, fig. 7) with *stem* broad, sides obliquely sloping to a broadly rounded tip.

Legs black, last tarsal joint, especially of hind legs usually pale, femora all clothed with scales, tibiæ and tarsi with pale hairs, front tibiæ in male curved, with a distinct thin process apically on the inside, crown of spines on tibiæ pale yellow.



Map 3. Distribution of *Phytonomus eximius* Lec. and *P. quadricollis* Lec.

Distribution: Type locality, Topeka, Kansas, 2 specimens from E. A. Popenoe, one of which is in the Mus. Comp. Zool., in the Leconte collection.

Dom. of Canada: Manitoba: Aweme, 2–vii–07, 11–June–03, 7–vii–08, 15–viii–08 (all in coll. Norman Criddle).

United States: Illinois: 5 in Bolter coll. Univ. of Ill.

Iowa: Iowa City (coll. Wickham) (R. L. Webster *in litt.*)

Nebraska: "Neb." (collections U. S. N. M., Schaeffer, Fall, Wenzel); Lincoln, H. Soltau, 5–5 (U. S. N. M.); Lincoln, Bruner, May 3 (Mich. Agr. Coll.) Malcolm, vi–20–09, C. R. Oertels, vi–22–09 (coll. Frost); Lincoln, Salt basin, vi–26–09, H. Shoemaker (coll. Wickham); Kearney (coll. Wenzel).

Kansas: "Kan." (Horn coll. Am. Ent. Soc., Mich. Agr. Coll., U. S. N. M., Fall coll.); Douglas Co. May, Bridwell (U. S. N. M.); Wilson Co. 4–17–97 (coll. Cornell Univ.); Benedict Ks, 4–23–96, W. Knaus; Onaga Ks (coll. VanDyke).

Texas: Dallas (Mich. Agr. Coll.); Bolter coll. 1.

Colorado: Florissant June, '07, Cockerell, (2 in Fall coll.): Horn coll. Am. Ent. Soc. 1.

Food plants: Rumex brittanicus and probably other species.

Life History: Popenoe (1877) bred the type specimens from pupae in cocoons found on the leaves of *Rumex brittanicus*. He states that the cocoon is yellow brown, loosely interwoven, broad in outline, and the pupæ very "nervous" when disturbed. Warren Knaus, McPherson, Kansas (*in litt* 1911) states that he collected specimens in copula 23 Apr., 1896 in Wilson Co., Kansas on a species of Rumex and that young larvæ were then present feeding on the leaves and flowers, the season was late and the beetles were disappearing.

Phytonomus quadricollis Leconte.

Phytonomus quadricollis:
- 1876: Leconte: Rhyncophora of North America, p. 126, no. 8, p. 415.
- 1885: Henshaw: Cat. Coleop. Am. N. of Mex., p. 137, no. 8235.
- 1909: Webster, R. L.: Entom. News, 20: 81 (in error).

Hypera quadricollos:
- 1880: Austin: Supp. Check list Coleop. N. Am., p. 45, no. 8888.

Adult: (Plate XXVII, figs. 3–5). Length 4 mm. Width 1.5 mm.

Elongate, black or "blackish brown", with dense closely set gray or dull yellow small rounded scales; legs pale red.

Head clothed with coarse hairs; front much wider than width of eye, flat; *eyes* elongate-oval; *beak* as long as prothorax, rather slender, at least three times as long as wide; tip slightly enlarged, a few sparse punctures on the glabrous portion, feebly carinate; *antennæ* brownish red, scape reaching to the eyes, smooth, first joint of funicle as long as two following or nearly so, club elongate, second and third funicle joints subequal.

Prothorax square, slightly narrowed in front, sides variable but never more than scarcely rounded; polished with closely set shallow punctures in which the scales and hairs rest.

Elytra much wider than posterior margin of prothorax, oblong-oval, humeri rounded, sides almost parallel, rounded at tips; striæ impressed, punctured, each puncture with a short white thick hair or seta; a single row of white setæ, short and stout in front and longer behind on each interspace; interspaces not elevated. Setæ on all parts of insect more or less decumbent; scales very evenly, regularly set, so that they appear almost as if in rows on the interspaces; color very uniform dull yellow or dirty white or gray. In one specimen there is almost a complete tesselation, with pale brown quadrate maculæ on the yellow ground.

Venter with scales usually paler and on abdomen intermixed with transverse rows of short white hairs; mesosternal process between middle coxæ long, narrow, enlarged at tip, elevated; intercoxal process of first abdominal segment broad at base and rapidly curving to a blunt point. Stem of male genitalia (Plate XXIV, fig. 8) gradually and evenly rounded to the blunt tip, sides parallel for two-thirds of length, edges not strongly curved inward.

Legs pale red, claws dark red; femora only little curved; femora clothed in front with scales; tibiæ and tarsi and usually the femora clothed behind with long stout hairs; tibiæ and tarsi clothed in front with hairs or scales or both, crown of spines on posterior tibiæ short and yellow; sometimes all the legs are entirely covered with short hairs or setæ and with scales.

Distribution: (See Map 3). Type locality, "Dacota," 1 specimen in Leconte collection, Mus. Comp. Zoolog.

I have seen a number of specimens of this species collected by Norman and Evelyn Criddle on *Rumex venosus* along streams at Aweme, Manitoba (23–vi–08, Criddle coll.) (v–26–04, Wenzel coll.), vi–11–03, (Wickham coll.) and also one specimen in the Horn collection (Am. Ent. Soc.) from Colorado.

R. L. Webster (1909) records the species from "Ykn," Las Vegas, N. Mex., and Wyoming (Bolter coll.), but an examination of these specimens shows that they do not belong in the tribe Hyperini.

Phytonomus comptus Say.

Phytonomus comptu
- 1831: Say: Desc. of N. American Curculionidae, p. 12–13.
- 1834: Gyllenhal in Schönherr: Gen. et sp. Curc. 2(pt. 2): 384.
- 1842: Gyllenhal in Schönherr: Gen. et sp. Curc. 6(pt. 2): 380, no. 70.
- 1853: Melsheimer: Cat. Desc. Coleop. United States; p. 95.
- 1859: Leconte: Comp. Writing of Thomas Say, 1: 274.
- 1873: Crotch: Cat. Coleop. of N. Amer., p. 118, no. 6992.
- 1878: Hubbard & Schwarz: Proc. Am. Phil. Soc., 17: 663.
- 1879: Dury: Journ. Cin. Soc. Nat. Hist., p. 14.
- 1880: Zeisch & Reinecke: List Coleop. vic. Buffalo, p. 14.
- 1881: Zeisch & Reinecke: Bul. Buf. Soc. Nat. Hist., 4: 14.
- 1881: Riley: American Naturalist, 15: 912.
- 1882: Riley: Report of the Entomologist, p. 111.
- 1883: Riley: in Rpt. U. S. Dept. Agr. f. 1881–2, p. 171.
- 1883: Lintner: First Rpt. St. Entom. N. Y., p. 248.

1883: Brodie & White: Check List Ins. Dom. Canada, p. 47.
1885: Henshaw: Cat. Coleop. Amer. N. of Mex., p. 137, no. 8230.
1890: Smith: Cat. Ins. N. Jersey, p. 250.
1898: Beutenmuller: Journ. N. Y. Ent. Soc., 1: 40.
1899: Smith: Cat. Ins. New Jersey, p. 343.
1902: Dury: Journ. Cin. Soc. Nat. Hist., 20: 182 (sep. p. 76).
1902: Ulke: Proc. U. S. N. Museum, 25: 355. (Dist. Columbia list).
1902: Wickham: Bul. Lab. Nat. Hist. St. Univ. p: .
1907: Pierce: Ann. Rpt. Neb. St. Board Agr. p. 258.
1909: Webster, R. L.: Entom. News, 20: 81.
1910: Smith: Cat. Ins. New Jersey, p. 381.

Hypera compta:
1871: Gemminger & Harold: Cat. Coleoptera, 8: 2381.
1880: Austin: Supp. Check List Col. N. America, p. 45, no. 8884.

Phytonomus diversus:
1833: Dejean: Cat. Coleop. coll. Dejean, ed. 2, p. 263.
1834: Gyllenhal in Schönherr: Gen. et sp. Curc. 2 (pt 2): 371.
1837: Dejean: Cat. Coleop. coll. Dejean, ed. 3, p. 286.
1842: Gyllenhal in Schönherr: Gen. et sp. Curc., 6 (pt 2): 372.
1873: Crotch: Cat. Coleop. N. America, p. 118, no. 6992a.

Phytonomus rumicis var. *diversus.*

Phytonomus rumicis var. *comptus:*
1901: Petri: Monog. d. Coleop.-Tribus Hyperini, p. 129, 202.
1901: Petri: Bestimm.-Tabel. Hft. 44, Hyperini, p. 40.

Original description: Say, 1831, p. 12–13:

"2. P. comptus.—Elytra with subquadrate, brown spots. Inhabits United States.

"Body cinereous-olivaceous covered with small scales; rostrum shorter than head and thorax, rather narrower at base; antennæ and feet rufous; thorax somewhat rounded, with a much dilated brown, somewhat metallic vitta (p. 13) scutel small triangular; elytra with slightly impressed, but punctured striæ, interstitial lines flat, with more or less brown quadrate spots, particularly near the suture, where they are alternate.

"Length much over three-twentieths of an inch."

Adult: (Plate XXIV, figs. 1, 3, 5, 6, 17; Plate XXVIII, figs. 1–4).
Length 3.3–5 mm. Width 1.2–1.7 mm.

Rich brown to reddish black and more rarely black, thorax usually darker than the elytra; elongate; closely covered with small scarcely striate rounded scales. Antennæ and legs ferruginous.

Head small, very finely punctured, beneath with fine transverse lines; covered above and below with very narrow blunt scales, on the sides wider and more numerous; these scales are almost hairlike in character; *eyes* oval, slightly elongate without a fovea behind; *front* never as wide as an eye; *beak* about as long as the prothorax in the females, shorter in the males; slightly widened at the tip which is almost always entirely red, never with a carina, rarely curved strongly, usually with many short, scale like hairs on the black portion and a few long slender hairs near the tip on the polished portion, these are set in minute punctures; *antennal groove* not deeply curved downward, roughened, above it on the beak an elongate depression; *antennæ* only slightly hairy, scape not nearly reaching to the margin of the eyes, polished, equal in length to the funicle, first funicle joint nearly twice as long as second, second longer than third, seventh joint broader and shorter than the others, last joint of club more elongate, longer than others, all covered with fine pubescence; antennæ inserted about one-third back from tip of beak.

Prothorax slightly longer than wide, widest in the middle, anterior and posterior margins of almost the same width, sides rounded and impressed posteriorly, a deep impressed groove near the anterior sternal margin which extends upwards on the sides gradually becoming indistinct; anterior margin below with a fringe of hair projecting forward over the suture; punctures rather coarse and dense in each puncture lies a small narrow truncate or rounded scale.

Scutellum small triangular, elongate and usually covered with finer paler scales.

Elytra elongate-oval; narrow in front, sloping gradually outward for three-quarters of length and then quickly narrowed, from the side only slightly declivous behind; striæ distinct, punctured, interspaces scarcely elevated, scales arranged irregularly on interspaces as compared with *quadricollis*, but much more regular than in other species, often overlapping, but never lying across the striæ; *no setæ in the strial punctures.*

Venter covered with fine generally paler scales, abdomen flatter in male than in female and with a faint indication of an impression on the first segment; mesosternal process between the middle coxæ elevated for half its length and broadly triangular, then curved backward contracted and again enlarged near the truncate point; the process of the metasternum appears to fit into a socket on the under side of the mesosternal process; intercoxal process of third segment of abdomen not as wide as coxa, projected further forward than usual. Male genitalia (Plate I, figs. 5–6) with *stem* having elongate parallel sides for two-thirds of the length then curved smoothly in to the rounded point.

Legs with all the coxæ, and femora in front clothed with narrow scales, tibiæ and tarsi with hairs which are sparsely set almost in rows and sometimes short and stout; crown of spines on hind tibia short and stout, spur of hind tibia very short, stout and red; tarsi above and claws usually darker than remainder of legs; pad on the third joints long and pale.

The color of the adult beetle varies extremely; from a large number of specimens bred by Dr. J. B. Smith, at Trenton, N. J., I have found almost all the varieties sent from various localities over the United States. The prevailing color seems to be rust-red, which is evidently the color of the specimens described by Gyllenhal as *diversus*. Other specimens are brown, gray, grayish-green, metallic-red, gray or gray-green; others tesselated over the entire elytral surface with brown and black maculæ on a background of red or brownish yellow scales; a few are metallic greenish-black. The specimens sent Schoenherr by Say are evidently small males of the obsoletely tesselated reddish forms. The relation with *P. rumicis* is only superficial and extends neither to the thoracic form, elytral markings, scale shape or genital structure. The metallic vitta mentioned by Say as occurring on the prothorax appears usually in the spotted forms and is rather rare; the common elytral basal spot so characteristic of the genus is indistinct or absent

Egg: unknown.

Larvæ: (Plate XXVIII, fig. 7). First stage not seen.

Second or third stage: 4.5 mm. long, .6 mm. wide in the middle, dark brown above, pale below, Hairs very long and pointed, head jet black, first thoracic segment pale.

Fourth stage: 5–6 mm. long, 0.7–0.8 mm. wide in middle, very dark brown above except first thoracic segment and interrupted pale lines; paler on sides and below. A central dorsal row of pale spots occurs between the tubercles from the first abdominal to the anal segment; only faintly indicated on the thoracic segments. Tubercles of the abdominal dorsal segments in two rows, the first containing one tubercle on each side of the dorsal median line, the second having four pairs of tubercles, these are jet black and between them there are always pale spots; first lateral enlargements on each segment with a pair of black tubercles, second enlargements each with a single tubercle; anal segment on each side with a pair of tubercles in front of the second and third tubercles of the second row; last segment with the four tubercles of the second row on each side arranged in a diamond, more elongate laterally. Each tubercles is set with a long slender dark hair, none of the hairs appearing blunt or truncate. On the thorax the tubercles are more numerous on the first segment but on the others arranged as on the abdominal segment but without evident pale spots between. (Described from alcoholic specimens loaned by Dr. J. B. Smith, collected in June on Polygonum at Trenton, N. J.) The colors of the living larvæ may be somewhat different from those of alcoholic specimens and the arrangement of the thoracic tubercles, especially those on the first segment could be better understood from non-shrunken specimens.

Cocoon: (Plate XXVIII, fig. 5). 4–5 mm. diameter, coarsely reticulate, of brown coarse threads, usually almost globular. (Specimens from Trenton, N. J., Indian Territory, Columbus, Ohio and Pegrim, Ill.)

Pupa: (Plate XXVIII, fig .6) 4 mm. long by 1.8 mm. wide across the base of the wing-pads. Anterior line of prothoracic hairs close to margin, first three pairs in front, fourth and fifth on side; the two central pairs are on a line, almost with the fourth and fifth anterior and form a square; three posterior pairs on a curved line near the hind margin about equidistant from each other and the inner one the same distance from the posterior hair of the central pairs; all of these hairs very long and slender; hairs on the head and beak not so long; transverse rows of setæ on the dorsal abdominal segments and rows of hairs on the terminal segment. Pupa dark on head, base of wing pads, parts of legs, metathorax above, and on parts of abdomen. (Described from one specimen from Dr. J. B. Smith, same lot as larvæ.) The coloration of the specimen appears to have been affected by the alcohol in which it is preserved. Some of the segments are somewhat shrunken, especially on the abdomen.

Map 4. Distribution of *Phytonomus comptus* Say.

Distribution: Type locality, "United States," Say 1831.

Generally distributed over the United States, Ontario and perhaps other parts of Canada. Ranging from Michigan to Texas, and from the Atlantic seaboard to the Rocky Mountains, also occurring in Oregon and Washington.

Dominion of Canada: "Can." (Horn coll. Am. Ent. Soc.; Mus. Comp. Zool.; Coll. Mich. Agr. Coll.); Grimsby, Ont., (Pettit) (coll. Mich. Agr. Coll.; Amer. Entom. Soc.)

United States: Massachusetts: "Mass." (coll. Blanchard; coll. Horn, Am. Ent. Soc.); Tyngsboro 6–12–89 (Blanchard); Lowell (Blanchard); Chicopee 3, (Cornell Univ.); Framingham vi–24–08 (Frost); Sherborn vi–16–09 (Frost); Andover vi–9–07 (Frost).

New York: "N. Y." (Bolter coll.; U. S. N. M.; Am. Ent. Soc.; Dietz coll. Mus. Comp. Zool.); Staten Id, 7–6–91 (Fall); Long Island, Staten Island (Linell, U. S. N. M.); Buffalo (Am. Ent. Soc.).

New Jersey: "N. J." (U. S. N. M.); Berkeley Hts. (Bischoff coll.); Ft. Lee (A. M. N. H.); Phila. Neck, Westville 4–26–, 6–23, Gloucester 8–17 (Wenzel coll.); in list Insects N. J. 1910 are recorded: Hopatcong (Palm); Ft. Lee (Schaeffer); Hudson Co. (Linell); Newark Dist. (Bischoff), Westville, Gloucester; and "on Polygonum;" I have also seen specimens of adults, larvæ and pupæ from Trenton (J. B. Smith).

Pennsylvania: "Penn." (Horn Coll. Am. Ent. Soc.; Melsheimer, Mus. Comp. Zool.).

District of Columbia: Washington 7–11, 14–4, 8–4 (U. S. N. M.).

Michigan: South Haven 6–1–91 (Mich. Agr. Coll.) Grand Ledge 6–6 (Hubbard and Schwarz, U. S. N. M.); Detroit, June (Hubbard & Schwarz); "Mich. 144046" (Leconte coll. Mus. Comp. Zool.); also recorded in Wickham's Lake Superior list.

Ohio: Columbus (Ohio State Univ. coll.); recorded by Dury from vicinity of Cinicnnati.

Indiana: "Ind." (coll. F. M. Webster; coll. Blanchard); Vigo Co., 5–29–92, 5–21–93, 6–25–92, 6–7–93, 6–10–98, 4–23–03, 7–8–02 (Blatchley).

Illinois: "Ill." (Bolter coll.); "N. Ill." (Lugger coll.; Peabody coll. Ill. St. Lab. Nat. Hist.; Dietz coll. Mus. Comp. Zool.; Bolter coll.); "S. Ill. Soltau" (U. S. N. M.); Algonquin 17–July–09 Nason 222; Pegrim 4–Oct.–02 (Titus, coll. Ill. St. Lab. Nat. Hist.); the Nason specimen is in the Fall collection.

Missouri: "Mo." (Dietz coll. Mus. Comp. Zool.; Bolter coll. Ill. St. Lab.).

Iowa: Wickham coll. and Dietz coll. (Mus. Comp. Zool.).

Arkansas: Blanchard coll.

Indian Territory: "I. T." (U. S. N. M.) one specimen with cocoon and another specimen of the same form and color.

Texas: Columbus 8–11 (U. S. N. M.).

Nebraska: Horn coll. (Am. Ent. Soc.); Mus. Comp. Zool.

Colorado: Colo. Springs (R. L. Webster *in litt*); Dixon Can. on willow, 30–June–92 (Gillette) and Spring Canon (Wickham's list). These two latter localities are west of Ft. Collins in the edge of the foothills.

Oregon: Am. Mus. Nat. Hist. 1.

Washington: "W. T." two in Horn coll. (Am. Ent. Soc.).

The specimens reported by Dejean and Schönherr were given as from "America boreal." Probably the Say specimen of *comptus* was from the Mississippi valley region, though his statement "United States" would lead one to believe that he had specimens from a number of places.

Food Plants and Life History: Riley (1881) reports breeding this species from "*Polygonum nodosum.*" Dr. Smith bred it from a species of *Polygonum* in New Jersey. I have seen specimens from Columbus, Ohio, (Osborn), with the cocoon still attached to a leaf that appeared to be Polygonum. Through the kindness of Dr. S. A. Forbes I have permission to use some notes made by me while connected with the State Entomologist's office several years ago.

In October, 1902, I found several species of larvæ feeding on leaves and flowers of a Polygonum (identified for me by Dr. Gleason as probably *P. hartwrightii*) on the Hartwell ranch near Pegrim, Ill. At that time the country was flooded with water, only the top of the plants being above the water. The larvæ were almost full grown and some were already in the cocoons, others had changed to pupæ. The cocoons were made on the upper side of the leaves, the edge being bent over to aid in concealment. I bred a number of adults and some parasitic Hymenoptera. Dr. Forbes very kindly loaned me this material and from it Mr. J. C. Crawford of the U. S. Nat. Museum has described ——— ———. The parasitic pupæ of this species were naked, jet black and formed in the cocoon of the host.

In Biol. Cent. Am. Coleop. v. 4, pt. 4, p. 2, this species is incorrectly referred to as probably a synonym of *P. rumicis.*

Phytonomus diversipunctatus Schrank.

Curculio elongatus:
- 1792: Paykull: Monog. Curc. no. xlv. (nec. Fab. 1775).
- 1800: Paykull: Fauna Suecica; Insecta, 3:236, no. liii.
- 1834: Sahlberg: Ins. Fennica, 2: 49, no. 28.

Rhynchaenus elongatus:
- 1813: Gyllenhall: Insecta Suec. 3:99, no. 31.
- 1820: Billberg: Enum. Insect. p. 42.
- 1840: Zetterstedt: Ins. Lapponica, p. 180, no. 11.

Hypera elongata:
- 1821: Dejean: Cat. coll. Coleop., ed. 1, p. 89.
- 1826: Sturm.: Cat. Ins. Sammlung, p. 157.
- 1848: Walton: Ann. Mag. Nat. Hist., (2) 1:300.
- 1849: Walton: Stett. Entom. Zeit., p. 258.

1869: Kraatz: Verz. Kafer Deutsch., p.
1871: Gemminger & Harold: Cat. Coleop., 8: 2382.
1871: Kirsch: Berl. Ent. Zeit., 15: 190.
1877: Stein & Weise: Cat. Col. Eur. ed. 2, p. 143.
1880: Austin: Supp. Check List Coleop. N. Amer., p. 45, no. 8882.
1884: Bargagli: Rass. Biol. Rinc. Europei, p. 93.
1884: Bedel: Col. Bassin de la Seine, p. 258, no. 13 and p. 78.
1881: Heyden: Cat. Coleop. Sibiria, p. 166.
1883: Weise in H. R. & W. Cat. Col. Eur., p. 159.
1889: Fauvel: Rev. Entom, 8: 157.
1891: Fowler: Brit:: Coleop., 5: 230, no. 234.
1891: Weise in H. R. & W.: Cat. Coleop. Eur. p. 304.
1896: Heyden: Cat. Coleop. Sibiria, ed. 2, p. 152.

Phytonomus elongatus:
1826: Schoenherr: Curc. dispos. meth. pt. 4, p. 175.
1829: Gebler: Ledebour Reise d. Altai, p. 168.
1830: Gebler: Bemerk. d. Ins. Sibiriens vorz. d. Altai, 3: 168.
1833: Dejean: Cat. Coleop. coll. Dejean, ed. 2, p. 263.
1834: Gyllenhal in Schönherr: Gen. et sp. Curc. 2 (pt) 2: 374, no. 9.
1837: Dejean: Cat. Coleop. coll. Dejean, ed. 3, p. 286.
1842: Bohoman in Schönherr: Gen et sp. Curc. 6 (pt 2): 369, no. 44.
1843: Sturm: Cat. Coleop. Kafer Sammlung, p. 201.
1844: (Dohrn): Cat. Col. Europe, p. 52.
1848: Gebler: Bul. Imp. Soc. Mosc. 21: 354.
1849: (Dohrn): Cat. Col. Eur. p. 61.
1849: Gaubil: Cat. Syn. Coleop. d'Eur. et d'Alg., p. 156.
1849: Redtenbacher: Fauna Austriaca, Die Kafer, p. 805.
1853: Zebe: Syn. d. bisher in Deutsch. aufgef. Coleop. p. 75.
1855: Jac. du Val: Gen. Coleop. d'Europe, p. 109.
1857: Lentz: Neue Verz. d. Preuss. Kafer, p. 124.
1858: Matheiu: Ann. Ent. Scc. Belg., 2:197, no. 192.
1858: Dohrn: Cat. Coleop. Eur. p. 79.
1858: Redtenbacher: Fauna Austriaca, Die Kafer, ed. 2, p. 726.
1859: Schiodte: Berliner Entom. Zeit., p. 141.
1862: Schaum: Cat. Col. Eur., p.
1865: Thomson: Skand. Coleop., 7: 164, no. 6.
1866: de Marseul: Cat. Coleop. Eur. et. conf., p. 100, no. 40.
1868: Capiomont: Rev. d. Hyperides, p. 193, 283.
1876: Leconte: Rhyncophora of N. America, p. 125.
1877: Heyden: Jahrb. Nassau, Vereins, 29: 312.
1878: Schneider & Leder: Beit. kennt. Kauk. Kaferfauna, p. 287.
1881: Everts: Tijd. v. Entom., 24: 40.
1884: Bargagli: Bul. Ent. Soc. Ital., 16: 166.
1885: Henshaw: List Col. Am. N. of Mex., p. 137, no. 8228.
1889: Hamilton: Tr. Am. Ent. Soc., 16: 155, no. 455.
1891: Seidlitz: Fauna Transsylv. p. 676.
1893: Everts: Tijd. v. Entom., 36: 81.
1901: Petri: Monog. Coleop.-Tribus Hyperini, p. 175, 201.
1901: Petri: Bestim. Tab. Coleop. Hft. 44, Hyperini, p. 29, 37.
1903: Everts: Coleop. Neerlandica, p. 602.
1906: Weise in H. R. & W. Cat. Col. Europ., p. 656.
1910: Kleine: Entom. Blatter, 6: 200.

Curculio diversipunctatus:
1798: Schrank: Fauna Boica, 1 (pt 2): 494, no. 546.

Hypera mutabilis:
1821: Germar: Germ. & Zincker Mag. 4: 341, no. 13.
1869: Giebel: Verz. z. Mus. Halle Wittenberg, p. 44, no. 25.

Phytonomus mutabilis:
1834: Gyllenhal in Schönherr: Gen. et sp. Curc., 2 (pt 2): 374, no. 10.
1844: (Dohrn): Cat. Col. Eur. p. 52.

Hypera punctulata:
1821: Dejean: Cat. coll. Coleop., p. 89. (Credited to Ziegler).
Hypera elongata var. *variabilis:*
1821: Dejean: Cat. Coleop. coll. ed. 1, p. 89 (Credited to Ziegler).
Phytonomus elongatus var. *variabilis:*
1833: Dejean: Cat. Coleop. coll. Dejean ed., 2, p. 264.
1837: Dejean: Cat. Coleop. coll. Dejean, ed. 3, p. 286.

Original desrciption: Schrank: 1798, p. 494–5:
"Curculio diversipunctatus.
Wohnort:—Um Gern.

AUSMESSUNG.

Lang vom Grunde des Ruckenschildes bis zum After .... 2½′
Breit uber die Flugeldecken .... 1½′

Anm. Die Fohlhorner, Schienbeine, und Fussblatter muschelbraun; Russel und Kopf braunschwarz, erhaben punctirt, mit rostgelben einzelnen sehr kurzen Harchen in den Vertiesungen. Die Flugeldecke (denn es ist nur eine einzige, ohne alle Nahe, die zugleich die Seiten des Hinterleibes ziemlich an der Bauch hinab bedeckt) schwarzlicht braun mit Punctreisen; die Puncte entfernt, vertieft. Die Flugeldecke ist mit niederliegenden grauen sehr kleinen Haaren dicht bedeckt, die ihr das Ansehen geben, als wenn sie mit rothlichen Puncten dicht besaet ware.

Vielleicht ist dieser Kafer Hrn. Herbsts *Curculio suspiciosus* und wenn das ware, so musten unsere beiderseitigen Benennungen in die viel bessere; Curc. Millefolii abgeandeart werden, indem die Larve des Herbstichen Kafers dei Blatter der Schaafgarbe abweidet."

Adult: (Plate XXVII, figs. 1–2). Length 5–11 mm. (according to Capiomont, although Petri saw no specimens as large as 11 mm.) Width 6 mm. (measured from three specimens Lignitz, Hildesheim, and the Greenland specimen in the Mus. Comp. Zoology).

Body elongate, black, rather stout, scales cleft to the base, in the specimens seen the pubescence always gray or brown, very uniformly distributed and generally of an uniform color.

Head with front as broad as width of eye or broader, flat, densely pubescent; *eyes* nearly circular in outline; *beak* scarcely narrower than front at base, about, two-thirds as long as prothorax, densely punctured, punctures often in irregular striæ, keel at base very indistinct, a long groove above the antennal insertion; *antennæ* inserted near the tip of the beak, pale reddish brown or reddish yellow, club darker, scape reaching over the edge of the eyes but not to their middle, not as long as the funicle, first and second funicular joints very long, the first the longer, the second as long as third and fourth united, club elongate oval, pointed, densely pubescent, The fifth funicle joint is much the smallest.

Prothorax broader than long, widest in front of the middle, strongly rounded, sides densely punctate, the punctures forming irregular striæ, dorsum densely punctured, clothed with brown hairs, no scales present, and sometimes show a median and two side lines that are paler than the rest of the prothorax.

Elytra narrow at base, only slightly wider than the thorax before the middle; humeri not very prominent, sides of elytra obliquely widened until the elytra become one-third wider than at base; deeply strongly punctate in the striæ; interspaces strongly elevated (less strongly so in female according to Petri, but I can see no difference); scales gray or brown, hairs brown and never occurring in single rows on the interspaces, rather short and depressed. Scales cleft to the base, processes not elongate.

Venter sparsely clothed with scales and hairs, the former often metallic and not so deeply cleft as on dorsum, gray or gray-green; mesosternal process between the middle coxæ elevated, narrowly triangular at the point; intercoxal process of first abdominal segment broad and subtruncate at tip, last abdominal segment longer than two previous ones united, a distinct depression on the first segment in the median line that extends onto the metasternum (at least in the male, the Greenland specimen has this portion hidden).

Legs rather short, stout, femora in male nearly clavate, anterior tibiæ of male slightly curved, hind tibiæ with a curved spine (said by Petri to be long) inside at the tip, crown of tibial spines short, stout, yellow. All the legs sparsely clothed with gray or silvery gray hairs. The mucronate process on hind tibiæ appears to be widened at the tip and slightly emarginate.

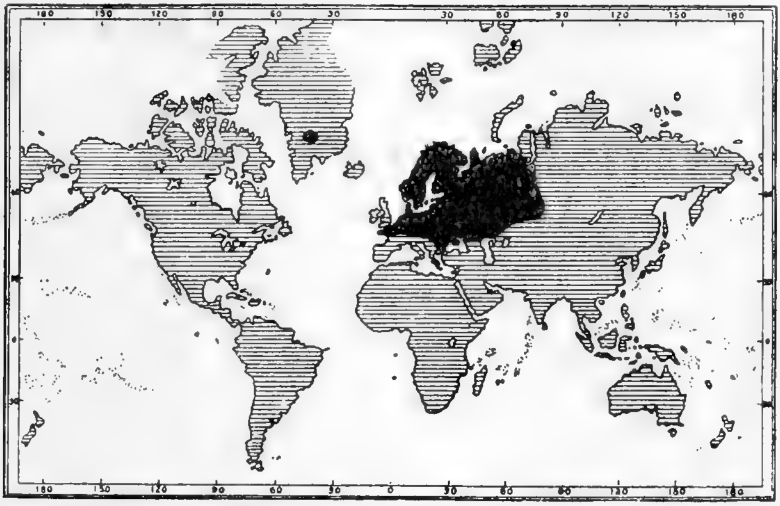
One of the specimens seen shows a tendency to be tesselated on the alternate interspaces beginning with the sutural one, the maculæ being brown on a gray background, but they are very indistinct.

Larvæ: Lucas von Heyden (1877) in his Kafer Nassau states that his father, C. H. von Heyden, took the larvæ of this species when sweeping for insects in a meadow back of Offenbach (Germany) in May, near the end of the month; they were green with a white dorsal median line and in June changed to pupæ without spinning a cocoon! "*Ohne*" is quoted either to emphasize the fact or to note that it was so in the notes of his father. He quotes then the description of the larvæ of *Phy. plantaginis* given by DeGeer, stating that the larvæ of *Phy. elongatus* is much like this description. However *plantaginis* spins a cocoon as both DeGeer and Heyden note and DeGeer's description would fit almost any green Phytonomus larva.

Distribution: The species was described by Paykull from Sweden as *Curc. elongatus.* Schrank's specimens of *diversipunctatus* were from "Gern." Capiomont reports the species from North and Middle Europe, N. France, Belgium and England. Petri from E. Prussia and various points in Germany, Austria and Hungary.

The species is here included because of a single specimen received by Leconte from Chr. Drewsen from Greenland and now in the collection of Mus. Comp. Zool. at Cambridge, Mass. This one specimen is identical with European specimens I have in my collection.

The name *elongatus* is preoccupied by a Fabrician species (1775), and must give way to *diversipunctatus* of Schrank or *mutabilis* Germar (1821). Germar states under his description of *mutabilis* that it is scarcely different from *diversipunctatus* Schrank. A comparison of the two descriptions leads me to believe that they are the same species. So far as I can ascertain no one has since Schönherr's Monograph mentioned Schrank's species, while *mutabilis* is generally considered a synonym of *elongatus*.



MAP 5. Distribution of *Phytonomus diversipunctatus* Schr. over world (page 61).

The species appears to be more common in the northern parts of Europe and is recorded by Zetterstedt and others from Greenland, Finland, Norway and Sweden. Gebler records it from Barnaul, Siberia, as rare. Walton states the Stephens, Curtis, and other early English references to this species are incorrect, that they did not possess "*elongatus*" and that it is doubtful whether it occurs in the British Isles. Fowler says very rare, but I believe he is referring to the earlier writers' notice of the species and not to any records that were certain. I have been unable to find further references to the names *palustris*, *variabilis* and *punctulata* than those given in the Dejean catalogues. It does not appear to me that the Dejean species were really described. Gyllenhal's *palustris* is certainly not this species.

Kleine gives as food plants *Plantago major* and *P. media*.

Phytonomus seriatus Mannerheim.

Phytonomus seriatus:
1853: Mannerheim: Bul. Soc. Imp. Mosc., 26 (pt 3): 107, 243, no. 228.
1873: Crotch: Cat. Coleop. of N. Am., p. 118, no. 6993.
1889: Hamilton: Trans. Am. Ent. Soc., 16: 155.
1909: Webster, R. L.: Entom. News, 20: 81.

Hypera seriata:
1871: Gemminger & Harold: Cat. Coleop., 8: 2387.
1889: Fauvel: Revue Entom., 8: 157, no. 458.

Phytonomus pubicollis:
1909: R. L. Webster: Entom. News, 20: 80.

Original description: Mannerheim, 1853, p. 243:

"228. *Phytonomus seriatus: oblongus, niger, dense brunneo-aureo-pubescens et squamulosus; antennis pedibusque rufescentibus; rostro breviore, parum arcuato; thorace crebre punctulato, convexo, utrinque antrorsum rotundato, lineis tribus e pilis pallidoribus flavescentibus notato, elytris subtiliter tenue e pilis palpunctulatis, sutura infuscata, interstitiis alternis 3, 5 et 7 nonnihil elevatioribus pilis flavogriscis densius obductis, 1, 3, 5 et 7 maculis nigris seriatis. Longit. sine rostro 3 lin. Latit. 1 1-3 lin.*

"*Habitat in insula Kadjak, ubi mense August exemplare singulum in baccic Rubi cepit D. Holmberg.*

"*Ph. suspiciosus* Herbst, Schonh. (*militi* Gyllenh.) *affinis, sed thorace angustiore, densius squamoso, subtilius punctato, ante medium et non in ipso medio-rotundato-dilatato, elytrisque longioribus, levius striato-punctatis, maculis nigris in series quatuor regulares dispositis ab illo dignoscendus.*"

Adult: (Plate XXIX, figs. 6–7). Length 5.5–5.7 mm. Width 1.8 mm. Body black and legs dark, antennæ rufous, club darker; oval, closely finely covered with broadly emarginate hairs and scales that are split almost to the base.

Head clothed with thick hairs which are usually notched at the tip; distance between the eyes as great as the width of the eye in the female and almost as wide as the length of the eye in the male; *eyes* scarcely oval, medium in size; *beak* stout, not as long as the prothorax, at the tip wider than at base; hairs dense and long, simple at the tip, dorsal carina scarcely evident but the elongate depression above the antennal insertion is very plain, tip smooth somewhat elevated and with two small punctured side grooves; mouth parts reddish; many small punctures scattered over the beak, especially near the tip; *antennal grooves* not smooth polished; *antennæ* with scape smooth, polished, enlarged at tip, not reaching to the eyes and shorter than the funicle; first funicle joint slightly longer than second and is twice as long as third; club very dark, almost black, elongate oval, pointed and densely pubescent with pale hairs.

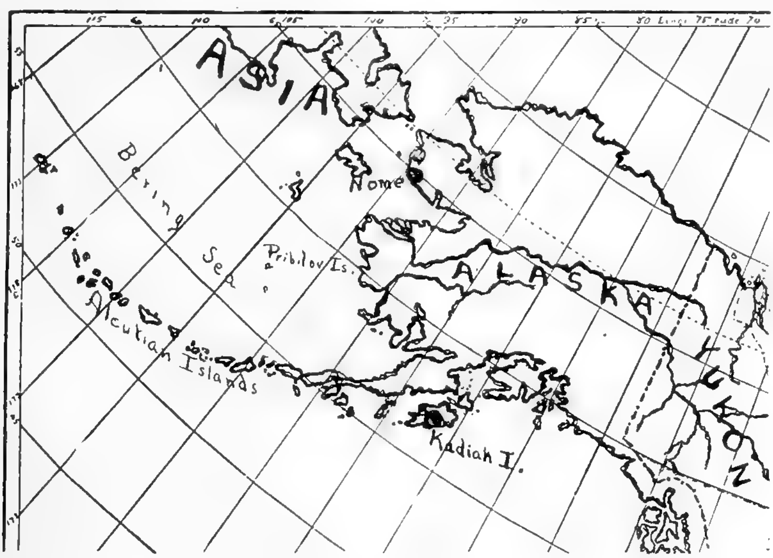
Prothorax polished, closely deeply regularly punctured, narrower anteriorly, widest about one-third of distance from front where it is almost as wide as the elytra at the base, sides abruptly drawn in to the venter, closely densely covered with long thick hairs which are deeply broadly notched at the tip.

Elytra broadly elongate-oval, almost as wide at tip as at base, humeri not prominent, elytra gradually widened for two-thirds of their length and then abruptly obliquely narrowed to the truncate tip; striæ deeply punctured, interspaces elevated, the alternate ones beginning with the sutural space more so, all with fine sparse punctures. Scales of the elytra cleft to the base, fine and very elongate, making a dense covering; long white hairs present on posterior portion of interspaces, remainder of the elytra with interspaces having scattered black and white hairs, more or less decumbent.

Venter clothed with deeply cleft scales, very dense on the sternal portion, rather sparse on the abdomen, last segment distinctly longer than the two previous and in male with a shallow impression near the center; third segment deeply impressed back of the intercoxal process which is broad and gradually curves until near the middle when it abruptly terminates in a sharp triangular point. Male genitalia with the stem broadly rounded at the point. Mesosternal process between the middle coxæ elevated, narrow linear. In the single female I have seen there is at the apex of the seventh abdominal segment a deep impression.

Legs with femora black and densely clothed in front with deeply cleft scales, tibiæ and tarsi very dark red, clothed with fine long silvery hairs, hind tibiæ slightly curved, front tibiæ more strongly so, hind tibiæ with a prominent mucronate process which at the apex is bifurcate in the male; the process scarcely evident in the female.

The tesselation in these specimens is remarkably different and consists of a mixture of gray and brown scales with very small maculæ of black scattered over the interspaces; on the thorax there is an indistinct trilineation, the outside paler lines being very narrow; some of the scales are metallic.



Map 6. Distribution of *Phytonomus seriatus* Mann.

Distribution: Type locality: Kadiak Island, Alaska, one specimen collected by H. J. Holmberg in August, 1851. Mannerheim relates that Holmberg was picking raspberries and found this, the only beetle taken on the island, on a berry.

Through the kindness of E. C. Van Dyke and of Prof. Trevor Kincaid I have had the opportunity of examining three specimens of this species. One very perfect male (coll. Van Dyke) collected by Trevor Kincaid on Pribilov Islands viii–15–97; and a fine female collected by Mr. Kincaid on St. Paul Island, viii–15–97, and loaned from his collection; the third a specimen collected by Mr. F. E. Blaisdell at Nome, Alaska, it is also a male and a very dark form with the scales much sparser and grayer. The specimen belongs to Mr. Van Dyke. Both males have the tip of the penis projecting and have the mucronate process at the tip of the hind tibiae. Mr. Kincaid (*in litt.*) states that he has another specimen remaining from those collected by him.

Prof. Washburn sent me from the Lugger collection, one specimen of this species collected in "Alaska." This is probably the specimen mentioned as *P. pubicollis* by R. L. Webster (1909).

In the collection of the U. S. Nat. Museum are several specimens of this species collected, according to Mr. Schwarz, by the International Seal Expedition.

This is an interesting species on account of its scale and hair formation bringing it between *pubicollis* and *trivittatus*. Further collections from this region will doubtless give us evidence of a greater distribution and it may be that the species occurs on both continents. Some of the Siberian forms described are impossible for me to separate from several European forms, especially from *P. suspiciosus*, on account of the meager descriptions, but this latter species can be readily separated from *P. seriatus* by the scale and hair characters, the hind tibiæ and the last abdominal segment.

Phytonomus trivittatus Say.

Phytonomus trivittatus:

1831: Say: Desc. N. American Curculionides, p. 12–13.
1859: Leconte: Comp. Writings of Thomas Say, 1: 273–4.
1873: Crotch: Cat. Coleop. N. America, p. 118, no. 6998.
1876: Leconte: Rhyncophora of N. America, p. 430, app. sp. 7 (unrecog.)
1885: Henshaw: Cat. Coleop. Am. N. of Mex., p. 137.
1909: Webster, R. L.: Entom. News, 20 : 81.

Hypera trivittata:
1880: Austin: Supp. Check List Coleop. N. Am., p. 45, no. 8889.
Phytonomus setigerus:
1876: Leconte: Rhyncophora of N. America, p. 125, no. 3, p. 415.
1885: Henshaw: Cat. Coleop. Am. N. of Mex., p. 137, no. 8229.
1889: Kilman: Canad. Entomologist, 21: 136.
1890: Wickham: Canad. Entom., 22: 171.
1903: Evans: Canad. Entom., 35: 319.
1909: Webster, R. L.: Entom. News, 20:81.
Hypera setigera:
1880: Austin: Supp. Check List Coleop. of N. Amer., p. 45, no. 8883.
Phytonomus castor:
1909: Kwiat: Entom. News, 20: 335 (nec *castor* Lec.)
1909: Titus: Journ. Ec. Entom., 2: 149.
1910: Titus: Bul. 110, Utah Agr. Exp. Sta., p. 72.

Original description: Say, 1831, p. 12:

"*P. trivittatus.* Blackish-brown with numerous scale-like hairs.

Inhabits North-west Territory.

Body blackish-brown, with numerous robust hairs almost resembling scales, which are longer in three yellowish metallic thoracic vittæ of which the lateral ones are broader and terminate in a spot on the humerus; the vittæ and spot are pale brownish cinereous; antennæ rufous; elytra with large costal spots, interstitial lines obsoletely alternating with blackish and pale brown-cinereous; suture behind the middle also pale brown-cinereous; thighs beneath near the tip emarginate; anterior tibiæ a little incurved at tip.

Length one-fifth of an inch."

Adult: (Plate XXIX, figs. 1–5). Length 3.75–6.5 mm. Width 1.5–3.5 mm.

Black or dark brownish red, elongate oval, usually densely pubescent with scales and hairs. Legs black or reddish-black.

Head densely closely pubescent with long slender hairs the pubescence extending some distance down the beak, especially dense on the front which between the eyes is narrower than the width of a single eye; beak with a smooth flat carina or keel, possessing above the antennal groove a long shallow narrow impression, sides and tip of beak more or less sparsely finely punctured, with a few long slender hairs. Some of the hairs on the head above and behind the eyes are broader. *Eyes* elongate oval, without a fovea behind; *antennal groove* deep, strongly sloping towards the base of the eyes; *antennæ* rufous or reddish testaceous, scape reaching the margin of the eye, at least as long as the first six joints of the funicle, first funicular joint stout, one-half longer than the second which is distinctly longer than the third, club elongate-oval, darker and finely densely pubescent, more or less pointed at tip.

Prothorax narrowest anteriorly, strongly widely rounded near the middle, but nowhere as wide as the elytra at their base; the dorsum with a narrow light median longitudinal line bordered on each side by a much wider dark line or band, and beyond these on the edge the scales are again light, the lower part of the sides and part of the venter with dark scales; the side band of light scales extends back onto the elytra near the humeri and in one specimen partially covers it, in the others examined the humeri are very dark. Thoracic hairs all pale, striate or ribbed thick at the base and near the tip pointed, there are narrow elongate scales and wider scales emarginate at the tip and in the wider forms the processes are more prolonged; no fringe of forward directed hairs on the anterior border beneath; prothorax polished, punctures circular, rather deep, and distinctly separated.

MAP 7. Distribution of *Phytonomus trivittatus* Say, *maritimus* Titus, *pubicollis* Lec., and *castor* Lec.

Elytra about four times as long as prothorax along the dorsum, or in some specimens longer; striæ very distinct, their punctures especially so on the dorsum, in each black circular puncture there is a short stout hair; the interspaces have elongate hairs which are thickened and ribbed for two-thirds of their length and then abruptly narrowed on one side and slender to the point; scales of the elytra striate only slightly emarginate, points produced as long slender processes. All the elytral and most of the thoracic hairs are more or less decumbent, curved backward, especially on the prothorax and near the base of the elytra. Alternate interspaces often tesselated with dark brown, especially on the sides. Hairs on interspaces white, except for an occasional black one, humeral spot very large and distinct, brownish-gray or even black or parti-colored, this spot extending back on the interspaces for a considerable distance; a dark common central basal elytral spot is present

Venter with scales of under side of thorax shorter and wider, on the abdomen some are arranged in transverse rows at the posterior margins of the segments; mesosternal process between the middle coxæ elevated, curved backward, narrowly elongate and ending in a sharp point; a short triangularly produced process from the prosternum is also evident between the front coxæ; intercoxal process of first abdominal segment rounded broadly to a point.

Legs vary from black to reddish-brown, all the femora darker than tibiæ and covered with long narrow emarginate scales, the points of which are very long and slender; crown of spines on anterior tibiæ yellow and blunt;tibiæ and tarsi hairy, first three joints extremely setose beneath with silvery hairs; front femora of the male not strongly curved.

The declivity of the elytra in this species is very evident as will be seen from the illustration, but not as great as in *P. maritinius*, where it extends quite to the tip.

Distribution: Type locality for *trivittatus;* "North-west Territory," and for *setigerus*: "Kansas." The type specimens of *setigerus* are in the Leconte coll. in Mus. Comp. Zoology, type no. 398; there are two specimens marked type.

Dominion of Canada: Manitoba: Aweme, iv–23–10 (E. Criddle).

Alberta: "Edmonton, Ont." (James White) Kilman records this specimen in 1897, I have not seen it.

British Columbia: "Ft. McLeod, N. W. Ter." (U. S. N. M.) Vancouver Id. (Wickham), recorded in 1890, specimen not seen.

United States: Illinois: Palos Park (Kwiat) vi–28–07 (coll. Wolcott, Fall, Titus, Liebeck).

Nebraska: West Point, 4–88 (U. S. N. M.).

New Mexico: Gallinas Can. (Snow) R. L. Webster *in litt.*

The Ft. McLeod record is possibly from one of the specimens reported by Evans (1903) as collected by John MacCoun in "Northwest Territory of Canada." Through Dr. Hewitt, Mr. J. D. Evans has loaned one specimen which is labeled "N. W. T. Can. J. M. 1879."

Food Plants and Life History: The Palos Park, Illinois, specimens were bred by A. Kwiat from larvæ collected on a ground pea *Lathyrus venosus* 30 May, 1907; they spun reticulate white cocoons, one of which I have seen, and transformed to adults June 28, 1907. Mr. A. B. Wolcott tells me that he also has bred it from the same locality and that the larva is deep green in color. The cocoon is pure white and rather loosely woven.

Phytonomus maritimus new species.

Phytonomus rumicis:
1909: Webster, R. L.: Entom News, 20: 81.

Adult: (Plate XXIX, figs. 8–9). Length, 5 to 6.5 mm. Width 2 to 2.5 mm. Stouter and thicker than *trivittatus*, elytra much more declivous; reddish black, clothed with pale yellow scales and white and black hairs.

Head densely pubescent with rather stout hairs, a few notched at tip; *beak* with a smooth median *carina, front* between eyes narrow, an elongate, narrow, polished groove above the antennal groove; *eyes* elongate oval rather large; antennal groove deep, black, smooth; *antennæ* reddish, scope reaching margin of eyes, longer than first six funicle joints, club elongate oval, second and third joints shortest, fourth rather long pointed at tip, entire club finely pubescent with gray hairs.

Prothorax not polished, narrower in front than behind, widest in middle, shaped much as in *trivittatus* but sides are fuller and more rounded; punctures large, often confluent; dorsum of prothorax with two wide dark bands separated by a very narrow, light line, sides darker than center line; in some specimens the dorsum is entirely light. Scales broad, deeply emarginate, striate; hairs stout, white and usually notched at tip, sides parallel; scutellum very minute, covered with fine gray or white pubescence.

Elytra at base but slightly wider than prothorax, one of the Nantucket Id., specimens tessellated almost all over, the darker spots alternating along the central line; elevations between striæ, each with a single row of white hairs, each hair stout, parallel-sided and notched at tip; striæ with a fine short pointed white hair in each puncture. All the hairs semi-decumbent; scales on the elytra more elongate than on thorax, processes more slender and pointed; the dark spots are velvety black scales, rarely with a black hair on the part of the interspaces where they occur; there is a tendency on all the specimens for a black band to occur on the third interspace beginning at the base of each elytron and gradually fading out.

Venter; scales more of the shape of those on the elytra than of the thoracic scales, prosternal process short, triangularly pointed; mesosternal process between middle coxæ long, curved, pointed; intercoxal process of third abdominal (first visible) segment broad, rounded almost to the center and terminating in a short, sharp point. In the male this segment is emarginate posteriorly.

Legs; dark red, clothed in front with elongate emarginate scales, tibial crown of spines pale red or yellowish red, a distinct emarginate process on each tibia at the tip, not as prominent as in *seriatus*.

The declivity of the elytra is extremely prominent and extends quite to the tip. The scales beneath the elytra on the abdomen are sparse except for a dense fringe on each segment posteriorly.

Distribution: (See Map 7). Type: U. S. N. M., Nantucket Id.

Massachusetts: Nantucket Island (U. S. N. M., Field Col. Mus., Bolter Coll. Univ. of Ill.); Edgartown Martha's Vineyard Id. vi–27–10 Johnson (Coll. Bost. Soc. Nat. Hist.); Chatham, vii–14–07 (Coll. Frost).

The Nantucket Island specimens are, I believe, all from the same lot and were probably collected by H. Soltau. They have stood in the various collections under the name of *Phytonomus rumicis* L. They, however, do not belong to this group of the genus. One of the specimens is marked collected on vetch, and another specimen "on Vicia sativa."

Superficially the species resembles *P. murinis* Fab. more than *P. trivittatus* Say but it belongs in the group with the latter species.

Phytonomus castor Leconte.

Phytonomus castor:
1876: Leconte: Rhyncophora of N. America, p. 126, 415.
1885: Henshaw: Cat. Coleop. Am. N. of Mex., p. 137,. no. 8233.
1909: Webster, R. L.: Entom. News, 20: 81.
1910: Titus: Journ. Ec. Entom., 3: 470.

Hypera castor:
1880: Austin: Supp, Check List N. Am. Coleop., p. 45, no.

Adult: (Plate XXX, figs. 7–9). Length 5–5.5 mm. Width 1.8–1.9 mm.

Black, elongate oval, small, densely pubescent with fine gray and black scales and hairs. Legs black or reddish black.

Head covered with very fine hairs and with scales which are cleft to the base or nearly so; *front* as wide as eye, in one specimen wider, with a distinct fovea; *eyes* elongate oval, narrower below; *beak* shorter than prothorax, widened at the polished tip which is jet black, sparsely punctured, along groove above the point of antennal insertion on the dorsal carina which is very indistinct; *antennæ* inserted very near the tip, the groove deep and wide, scape polished reddish yellow, reaching almost to the eyes (in one specimen almost black), longer than the seven funicular joints, first funicle joint about one-third longer than second, which is longer than third; club pointed, finely, densely pubescent, darker than remainder of antennæ.

Prothorax longer than wide, narrowed in front, sides rounded, widest in front of middle, densely punctured, clothed with numerous brown and white hairs and with gray or grayish-black scales cleft to the base; distinctly trivittate with white in some, in others there is scarcely a trace of the lighter lines; scales on sides and venter of prothorax sometiems shorter and broader, metallic in color, but always deeply cleft.

Scutellum minute, triangular, clothed with pale scales.

Elytra one-third wider than prothorax at their widest point, back of the middle, at base scarcely one-quarter wider; humeri distinctly clothed with jet black scales; interspaces elevated, each with a more or less complete row of white or brownish-white setæ, processes of the scales more slender and elongate, causing the pubescence to lap over the striæ; where the strial punctures can be seen they contain very short pale setæ; the type specimen has beautiful pearl-gray scales intermixed with brown and black scales to form an almost completely tesselated surface; other specimens seen possess the tesselation on parts of elytra, costal edge of elytra of all specimens seen covered with paler scales.

Venter with gray or brownish gray scales and short white setæ, on the abdomen the scales are arranged in transverse rows; mesosternal process between the middle coxæ somewhat elevated, linear, apparently with a triangular point (very densely covered with scale); intercoxal process of third abdominal segment broadly truncate.

Legs with femora and coxæ black, tibiæ and tarsi dark brown or reddish brown, femora clothed in front with scales, eslewhere the legs are covered with hairs; tibial crown of spines pale.

Distribution: Type locality "Canada" 1 specimen, Mus. Comp. Zool.; also Aweme, Manitoba, 24–vi–09 (N. Criddle). All the specimens seen are males. Life history is not known. The species is very closely related to *P. trivittatus* Say and to the European *P. viciae.*

Phytonomus pubicollis Leconte.

Phytonomus pubicollis:
1876: Leconte: Rhyncophora of N. America, p. 125, no. 5, p. 415.
1885: Henshaw, Cat. Coleop. Am. N. of Mex., p. 137, no. 8232.
Hypera pubicollis:
1880: Austin: Supp. Check List Coleop. N. Am., p. 45, no. 8886.

Adult: (Plate XXIX, figs.10–12). Length 3.2–4.5 mm. Width 1.5 mm. Black or reddish black, rather stout, clothed with fine gray or brownish gray pubescence of scales and hairs; legs black.

Head clothed with gray or yellow-brown hairs; *front* narrow, not as wide as one of the eyes; a distinct fovea between eyes on front; *eyes* oval, not prominent; *beak* two-thirds as long as prothorax, polished near the tip, sparsely punctured, a groove above the insertion of the antennæ, not carinate, projections above tip of antennal groove more evident than in any species but *seriatus; antennal* groove black, polished; *antennæ* rufous or piceous, scape reaching to the margin of the eyes, but not longer than the funicle, first funicluar joint much longer than second, or as long as second and third united, second nearly twice as long as third, the funicle joints are darker from the third on and the club is dark, densely pubescent with fine hairs, oval, pointed.

Prothorax almost quadrate, a little wider in the middle and narrowed anteriorly, never nearly as wide as elytra at base, clothed with brown, gray and white hairs and intermixed scales; the scales are deeply, roundly emarginate, the processes long and slender, scales never cleft; thorax polished, closely densely punctured. There is an obsolete trivittation on the thorax caused by a few pale scales in the center and on the side in longitudinal lines, the intermediate bands are of brown scales.

Elytra at base at least one-third wider than prothorax, humeri rounded with dark scales (sometimes almost black), striæ, especially the first and second, deeply punctured, interspaces elevated, a quadrate common spot at base reaching the second interspace, darker brown in color (more evident in type specimen); interspaces clothed with gray and brown scales alternating with brown and black tesselations, especially evident on the last third of the sutural space; hairs or bristles decumbent, sparse on the dorsum at the base, more numerous behind and lying closer to the scales. From the side the elytra show a distinct elevation about two-thirds of the distance towards the tip, then are rapidly obliquely slanted to the blunt tip.

Venter clothed with fine deeply emarginate scales, a depression on the first and last segments; mesosternal process between middle coxæ very narrow, linear, elevated, clothed with paler scales; intercoxal process of first segment not broad, pointed.

Legs with femora black or brownish black, tibiæ and tarsi testaceous, claws and last tarsal joint sometimes darker; posterior tibiæ with a very short crown of spines, anterior tibiæ strongly curved inward, anterior femora deeply contracted near the apex.

Distribution: (See Map 7). Type locality "Vanc. Id.", one specimen, a male, in the Leconte collection, Mus. Comp. Zoology.

I have examined one other specimen, also a male, from Vancouver Island, loaned me by Mr. H. C. Fall, Pasadena, Cal.

R. L. Webster (1909) determined a specimen from Alaska in the Lugger collection as this species. I have seen but one specimen from this collection marked Alaska and it is *P. seriatus* Mann.

Phytonomus meles Fabricius.

Curculio griseus:
- 1776: Muller: Zool. Dan. Prodr. Anim., p. 88 (nec. Fabricius 1775).
- 1790: Gmelin: Linn. Syst. Nat. ed. xiii, p. 1757, no. 204.
- 1827: Gyllenhal: Ins. Suecica, 4 (pt. 4 app.): 372, no. 40.

Curculio meles:
- 1792: Fabricius: Syst. Ent. emend., 1 (pt. 2): 466, no. 300.
- 1795: Fabricus: Nomen. Entomologicus, p. U.
- 1795: Herbst: Nat. Ins. Kafer, 6: 495.
- 1795: Panzer: Entom. Germanica, p. 325, no. 148.
- 1795: Weber: Nomen. Entom. sec. E. S. Fab., p. 56.
- 1796: Fabricius: Ind. Alphabeticus, E. S. Emend., p. 57.
- 1801: Fabricius: Syst. Eleutherat., 2: 523, no. 97.
- 1828: Boitard: Man.d' Entom., 1: 407.

Brachyrhinus meles:
- 1804: Latreille: Hist. nat. Gen. et parc., 11: 165, no. 31.

Rhynchaenus meles:
1813: Gyllenhal: Ins. Suec., 3 (pt 3): 97, no. 29 *pedestris*).
1820: Billberg: Enumerat. Ins., p. 42.
1828: Zetterstedt: Fauna Ins. Lapponica, 1: 319, no. 35.
1840: Zetterstedt: Ins. Lapponica, p. 179.

Hypera meles:
1821: Germar: Germ. & Zinck. Mag., 4: 340, no. 9.
1833: Villa: Cat. Coleop. Eur. dupl. coll. Villa, p.
1844: Villa: Cat. dei Coleop. della Lombardia, p.
1848: Walton: Ann. Mag. Nat. Hist. (2) 1: 299, no. 12.
1849: Walton: Stett. Entom. Zeit., 10: 261.
1861: Waterhouse: Cat. British Coleop., p. 71, no. 12.
1863: Lacordaire: Hist. nat. Ins. Coleop., 6: 401.
1869: Kraatz: Verz. Kafer Deutschland, p. 52.
1871: Kirsh: Berl. Ent. Zeit. 15. 189.
1871: Gemminger et Harold: Cat. Coleop., 8: 2383.
1877: Stein & Weise: Cat. Col. Eur. ed. 2, p. 143.
1874: Redtenbacher: Fauna Austriaca, Kafer, 2. 254.
1879: Tacshenberg: Die Kafer und Haubflugler, 2: 123.
1880: Koppen: Die Schaflichen Ins. Russlands, p. 209.
1880: Rupertsberger: Biol. d. Kafer Europa, p. 201.
1882: Fuast: Deut. Entom. Zeits., p. 259.
1882: Heyden: Cat. Coleop. Sibiria, p. 165 (subg. Dapalinus).
1883: Weise in H. R. & W. Cat. Col. Eur., ed. 4, p. 159.
1884: Bargagli: Bul. Ent. Soc. Ital., 16: 167.
1884: Bargagli: Rass. Biol. Kinc. Eur., p. 94.
1884: Bedel: Coleop. Bassin d. l. Seine, p. 79, 259, no. 16.
1891: Fowler: British Coleop., 5: 230, no. 235.
1891: Schneider: Coleop. & Lepidop. Bergen, p. 113, no. 37.
1891: Weise in H. R. & W.: Cat. Coleop. Europ., p. 302.
1893: Bertolini: Bul. Ent. Soc. Ital., 25: 245.
1894: Rupertsberger: Biol. d. Kafer, p. 209, 294.
1896: Heyden: Cat. Coleop. Sibiria, p. 152, (subg. Dapalinus).
1896: Martirelli: Ann. d. Hist. nat., 26: 295 (sep. p. 15).
1903: Everts: Coleop. Neerlandica, p. 603.

Phytonomus meles:
1833: Dejean: Cat. Coleop. coll. Dejean, ed. 2, p. 264.
1834: Gyllenhal in Schönherr: Gen. et sp. Curc., 2 (pt 2): 390, no. 32.
1837: Dejean: Cat. Coleop. coll. Dejean, ed. 3, p. 287.
1842: Boheman in Schönherr: Gen. et sp. Curc., 6 (pt 2): 382.
1842: Germar: Stett. Entom. Zeit., 3: 101.
1843: Schmidt: Stett. Ent. Zeit., 4: 24.
1843: Sturm. Cat. Kafer Sammlung, p. 201.
1844: (Dohrn): Cat. Coleop. Europe, p. 52.
1847: Hochhuth: Bul. Imp. Soc. Mosc. (2) 1: 493, no. 103.
1849: (Dohrn): Cat. Coleop. Europe, p. 61.
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1851: Perris: Mem. Acad. Sc. Lyon, n. s., 1: .
1853: Zebe: Syn. d. bisher in Deutsch. aufgef. Coleop. p. 75.
1855: Jac. du Val: Gen. Coleop. d' Europe, p. 110.
1857: Lentz: Neus Verz. Preussichen Kafer, p. 125.
1858: Dohrn: Cat: Coleop. Eur., p. 79.
1859: Motschoulsky: Col. d. Gov. Jak. (Melang. biol. Ac. Petrop.) p.
1860: Motschoulsky: Cat. Ins. Amour, p. 9.
1862: Laboulbene: Ann. Ent. Soc. Fr., (4) 2: 569–573, pl. 13, fig. 29–33.
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1868: Capiomont: Revis. de Hyperides, p. 173–175, pl. 2, fig. 20.
1869: Giebel: Coll. Univ. Halle-Wittenberg, pp. 44, 47.
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1872: Bertolini: Cat. Syn. e Top. Coleop. Ital., p.
1874: Kaltenbach; Pflanzen Feinde, p. 121.

1874: Siebke: Enum. Ins. Norvegicum, 1: 266, no. 9 (miles).
1878: Schneider & Leder: Beit. kennt. Kauk. Kaferfauna, p. 287.
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1883: Lintner: First Rpt. St. Ent. N. Y., p. 248.
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1901: Petri: Monog. Coleop.—Tribus Hyperini, p. 158–9, 202.
1901: Petri: Bestim. Tab. Coleop., Hft. 44, Hyperini, p. 38.
1906: Weise in H. R. & W.: Cat. Coleop. Eur., p. 65.
1909: Ferrant: Die Schlad. Ins. Land-u. Forst. pt. 2, p. 137.
1910: Kleine: Entom. Blatter, 6: 199.
1911: Titus: Psyche, 18: 74.
1911: Champlain: Psyche, 18: 173.

Curculio trifolii:
1795: Herbst: Nat. Ins. Kafer, 6: 266, tab. 80, no. 5.
1800: Paykull: Fauna Suecica, 3: 232, no. 49.

Rhynchaenus trifolii:
1813: Gyllenhal: Ins. Suec., 1 (pt 3): 111, no. 40.
1827: Gyllenhal: Ins. Suecica, 1(pt. 4, app. 3): 572, no. 40.
1834: Sahlberg: Ins. Fennica, p. 43, no. 33.

Hypera trifolii:
1821: Dejean: Cat. Coll. Coleop., p. 89.
1826: Sturm: Cat. Ins. Sammlung, 1: 157.
1829: Stephens: Sys. Cat. Brit. Ins., p. 169, no. 1726 (?trilineatus).
1831: Stephens: Entomology, 4: 100, no. 20 (?trilineatus).
1868: Villa: Relaz. Sugli Ins. che. devas. il Trifogli, p. 1.

Phytonomus trifolii:
1874: Kaltenbach: Pflanzen Feinde, p. 121.

Phytonomus meles var. *trifolii:*
1874: Kaltenbach: Pflanzen Feinde, p. 124.

Curculio borealis:
1800: Paykull: Fauna Suec., 3: 249, no. 68.

Rhynchaenus borealis:
1813: Gyllenhal: Ins. Suec., 1 (pt 3) :115, no. 43.
1828: Zetterstedt: Faun. Ins. Lapponica, 1: 321, no. 38.
1840: Zetterstedt: Ins. Lapponica, p. 181, no. 44.

Hypera borealis:
1821: Germar: Germ. & Zinck. Mag., 4: 339, no. 7.
1827: Gyllenhal: Ins. Suec. 1 (pt 4, 100. 3): 572, no. 43.
1884: Bargagli: Bul. Ent. Soc. Ital., 16: 167.

Phytonomus borealis:
1858: Matheiu: Ann. Soc. Ent. Belg., 2: 198, no. 206.

Curculio plantaginis:
1802: Marsham: Entom. Brit., 1: 267.

Hypera plantaginis:
1829: Stephens: Cat. Sys. Brit. Ins., p. 169, no. 1725.
1831: Stephens: Entomology, 4: , no. 19.

Curculio stramineus:
1802: Marsham: Entom. Brit., 1: 267, no. 88.

Rhynchaenus stramineus:
1819: Samouelle: Entom. Useful Comp., p. 369.

Hypera straminea:
1826: Curtis: Brit. Entom., 2: no. 116. 10.
1829: Stephens. Sys. Cat. Brit. Ins., p. 169, no. 1727.
1831: Stephens: Entomology, 4: 99, no. .

Hypera picipes:
1821: Dejean: Cat. Coll. Coleop., p. 89.
1833: Dejean: Cat. Coleop. coll. Dejean. Dejena, ed. 2, p. 264.
1837: Dejean: Cat. Coleop. coll. Dejean, ed. 3, p. 287.
1844: (Dohrn) Cat. Coleop. Eur., p. 52.

Hypera picipes:
1829: Stephens: Sys. Cat. Brit. Ins., p. 168, no. 1721.
1831: Stephens: Entomology, 4: 93, no. 15.

Hypera murina:
1829: Stephens: Cat. Sys. Brit. Ins., p. 168, no. 1722 (nec. Fabr.).
1831: Stephens: Entomology, 4: 93, no. 16.

Phytonomus castor:
1910: Smith: Cat. Ins. New Jersey, p. 381 (nec. Lec.).

"300. *C. brevirostris griseus thoracis dorso fusco linea albida, elytirs nigro punctatis, sutura ante apicem albida.*

"*Habitat in Germania. Dom Smidt.*

"*Paullo minor C. corvli. Caput griseum rostro cylindrico, nigro. Thorax supra grisues dorso lato, fusco linea media grisea. Flytra striata, moz grisea. mox magis ferruginea, nigro punctata sutura ante apicem linea distincta, albida. Pedes concolores.*"

Adult: (Plate XXIV, figs. 9, 15, 16; Plate XXX, figs. 4–6). Length 3.5–5 mm. Width 1.7–2.1 mm.

Black or reddish black, elongate-oval, small, sides of elytra nearly parallel; scales cleft to the base, hairs never long and erect.

Head small, finely closely regularly punctured; *front* very narrow, never as wide as the eye, densely pubescent; *beak* long slender, cylindrical, curved, in female longer than thorax; distinct central keel terminating opposite the antennal insertion in a wider smooth portion which possesses an elongate depression, one or more rather regular punctured striæ on the sides; tip reddish, smooth, polished sparsely punctured and with a few long hairs; *eyes* elongate oval, large; *antennæ* yellowish red or red, inserted near apex of beak, scape reaches margin of the eyes, first funicle joint twice as long as second, following except third shorter than broad, seventh very broad, club oval, pointed, densely pubescent.

Prothorax very wide, sometimes one-fourth wider than long, widest about the middle, sides strongly widely rounded, anterior margin narrower than posterior, dorsum almost flat, densely punctured, but punctures distinctly separated by smooth shining part of prothorax; usually rather sparsely covered with metallic gray or pale brown scales, a long central paler line may be generally distinguished, and the sides are uniformly paler, the bands between are often irregular in width.

Scutellum paler, small distinct, narrowly triangulate.

Elytra at base scarcely wider than prothorax in widest part, nearly rectangular, very slightly rounded at sides, humeri rounded somewhat prominent; finely striately punctate, interspaces a very little elevated, scales rather uniform in color over the elytra, but in some specimens the elytra are almost entirely tesselated with dark brown on a paler brown background; sutural scale often darker than others especially in front; all the scales sometimes metallic green or gray or brown gray or even dark brown. Hairs black, dark brown or white placed on interspaces, curved, directed backward, never erect, not placed in regular rows on the interspaces.

Venter not so densely scaled, gray or pale brown, terminal abdominal segment with long gray hairs; third abdominal segment of the male with a shallow impression near the center; intercoxal process of third segment truncately broad but ending in a short triangular point, the segment closely deeply punctured, more so than in any other species studied; mesosternal process between the middle coxæ elevated, narrowly triangular.

Legs short, femora stout, thickened; fore tibiæ of male curved inward, femora scaled in front, remainder of legs hairy, femora darker than tibiæ and tarsi but not black, remainder of legs reddish yellow to nearly black, tarsi usually a little paler.

Egg: White or very pale yellow when first laid, oval, sculptured with fine hexagonal depressions. Length 0.40 to 0.45 mm., width 0.25 to 0.30 mm.

Larva: (Laboulbene 1862, and Brischke 1871): These authors state that the larvæ are deep green, first thoracic segment yellow, a long whitish-yellow median stripe interrupted on the posterior edge of each segment, another paler line below the black spiracles. Head yellow beneath, dark in front, anterior border almost straight, sides rounded, labrum emarginate with eight short stout hairs, mandibles tridentate, brownish, black at tips; prothoracic segment with an rectangular brown or blackish band across it, interrupted in the middle, the other two segments lack this band (as is usual in the other species examined); color of abdominal segments varying from yellow to clear green or dirty yellow, the median line is wide and evident. The first thoracic segment has three rows of fine brownish tubercles (Brischke) the other segment with two tubercles on the front part and six pairs in the second row; the anal segment without tubercles. All the tubercles possess hairs which Laboulbene states are on the tubercles of the dorsum short, stout and clavate at tips; tenth, eleventh and twelfth have longer hairs, not clavate. The second series of enlargements have on the thorax each three hairs.

The description of Laboulbene is long and very complete, but I have quoted here only the essential parts since he states that he had the larvæ of a variety "*Phytonomus meles* var. *trifolii*" and that it is different from the larvæ of *meles*. Personally I believe the variety is only a form that may occur in any generation but it will probably be better to leave a full description of this species until we can secure larvæ in America for the purpose.

Cocoon: According to Laboulbene the cocoon is ovoid or oval, white or amber color and remarkable for its reticulations.

Pupa: Laboulbene only states that there is nothing in particular to describe.

MAP 8. Distribution of *Phytonomus meles* Fab., and *P. maritimus* Titus.

Distribution: Type locality of the Fabrician species was Germany. The species was described from Denmark, by Miller as *C. griseus*.

Capiomont and Petri give its distribution as over all Europe, except Spain and Portugal, and occurring in parts of Siberia and Transkaukasus and along the north coast of Africa.

In the United States I have examined specimens from the following places: New Hampshire; Claremont (R. P. Dow); Massachusetts; Framingham (Frost); Springfield, June 1911 (Titus).

New York: Albany, 9 July, '08 (E. P. Felt); West Point, 28 April, '08, W. Robinson (A. M. N. H.); Westchester County, (Schaeffer); Brooklyn (Schaeffer); Rockaway Beach (Bischoff).

Connecticut: Hamden, 16 May, 1910, A. B. Champlain (U. S. N. M.); New Haven, 28 May, 1910, A. B. Champlain (coll. Conn. Agr. Exp. Sta.); Meriden (Britton in litt. May 29, 1911); Colebrook, June, 1911 (Titus); Hartford, June, 1911 (Titus).

New Jersey: Ramsey, 31 May, 1908 (Schaeffer); Hewit (Schaeffer); Rahway, 23 July (Bischoff); Newfoundland, 30 May (Bischoff); Lake Hopatcong, 30 May (J. A. Grossbeck). Also Mt. View (Bischoff *in litt*).

Mr. E. A. Bischoff writes me that this is the species listed as *Phytonomus castor* in the Smith Cat. Ins. of New Jersey. He states further, "Mr. Dow from New York was the first to collect it at Rockaway Beach and had it identified as *castor*. He was kind enough to let me have a pair; Mr. Grossbeck of New Brunswick collected it at L. Hopatcong and let me have another pair, after which I collected it at Mountain View, Newfoundland, and Rahway, N. J."

Mr. R. P. Dow (in litt. 16 May, 1911) states that he first collected this species in June, 1907, in the "Rockaway Washup." In 1908, he collected specimens in a back lot in Brooklyn and received specimens from Torre Bueno collected in White Plains. Mr. Dow states that he took the same species in Claremont, N. H., "June 23–29, 1909–10."

Food Plants and *Life History:* Gyllenhal and Germar both report the species as feeding on clover in Europe, and Herbst certainly must have taken his *trifolii* from clover. Kaltenbach (1874) notes that it feeds on young shoots of lucern; Brischke reported it as feeding on lucern in Germany, and Laboulbene took it from *Trifolium pratense* in France.

Kleine gives the food plants as *Medicago sativa*, *M. falcata*, *M. lupulina*, *M. media*, *Trifolium pratense* and *T. incarnatum*. It has been reported as causing injury in Germany, Austria and Southeast Russia to lucern.

Dr. E. P. Felt bred his specimens at Albany, N. Y., from red clover.

Dr. Britton very kindly sent me living specimens collected by Mr. Champlain at New Haven, in May. From these I secured eggs. The eggs were deposited on and in the stems and leaf petioles of clover and alfalfa and on blossoms of clover. Five to nine in a place in the stems and singly in the other situations.

Phytonomus nigrirostris Fabricius.

Curculio nigrirostris:
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- 1781: Fabricius: Species Insectorum, 1: 167, no. 33.
- 1783: Herbst: Fuesels Archiv., 4: 69, no. 8, T. 24, fig. 3.
- 1787: Fabricius: Mantissa Insect., p. 100, no. 44.
- 1789: de Villers: Entom. Fauna. Suec., 1: 187, no. 43; 4: 267, no. 43.
- 1790: Brahm: Insektenkalendare, p. lxvii, 78, no. 250.
- 1790: Gmelin: Linn. Syst. Nat., ed. xiii, p. 1744, no. 105.
- 1790: Olivier: Hist. Nat. Ins., 5: 483, no. 55, T. 33, fig. 508, p. 140.
- 1790: Rossi: Fauna Etrusca, 1: 114, no. 292.
- 1792: Fabricius: Entom. Syst., 1 (pt 2): 407, no. 56.
- 1792: Paykull: Monog. Curculionidum, p. 56, no. liii.
- 1794: Herbst: Fues. Archiv (Fr. ed.) p. 119, no. 5, pl. 24, fig. 3a.
- 1795: Fabricius: Nomen. Entom., p. T.
- 1795: Herbst: Nat. Ins. Kafer, 6: 281, no. 254.
- 1795: Panzer: Entom. German., p. 302, no. 19.
- 1795: Panzer: Fauna Germ., p. 36, no. 14.
- 1795: Rossi: Fauna Etrusca, (Hellwig ed.), 1: 121, no. 292.
- 1795: Weber: Nomen. Entomol. sec. E. S. Fab., p. 53.
- 1796: Fabricius: Ind. Alphab., E. S. emend., p. 58.
- 1797: Bergstrasser: Epit. Ent. Fab. Nomen., p. 67.
- 1800: Paykull: Fauna Suecica, Ins., 3: 247.
- 1801: Trost: Kleine Beyt. Entom., p. 39, 428.
- 1802: Marsham: Entom. Brit., 1: 267, no. 89.
- 1804: Latreille: Hist. nat. Crust. et Ins., 11: 131, no. 19.
- 1819: Samouelle: Entom. Useful Comp., p. 205.
- 1855: Nordlinger: Die Kleinen Feinde d. Landw., p. 152.

Rhynchaenus nigrirostris:
- 1801: Fabricius: Syst. Eleuth., 2: 448, no. 53.
- 1802: Fabricius: Ind. G. et sp. Sys. Eleuth., p. 69, no. 448. 53.
- 1805: Illiger: Mag. f. Insektenkunde, 4: 141, no. 53.
- 1807: Olivier: Hist. Nat. Ins., 5: 140, no. 98, pl. 33, fig. 508.
- 1813: Gyllenhal: Ins. Suec., 1 (pt 3): 114, no. 42.
- 1813: Panzer: Ind. Ent. Fauna Germ., p. 190, no. 7.
- 1817: von Beck: Beit. z. baiersch. Insektenf., p. 41, no. 73.
- 1819: Samouelle: Entom. Useful Comp., p. 369.
- 1820: Billberg: Enum. Insectorum, p. 42.
- 1827: Gyllenhal: Ins. Suec. 1: (pt 4, app. 3): 572, no. 42.
- 1828: Boitard: Man. d'Entom., p. 422.

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- 1819: Samouelle: Entom. Useful Comp., p. 205.
- 1821: Germar: Mag., 4: 338, no. 5.
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- 1826: Curtis: Brit. Entom., 2: no. 116, 19.
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- 1834: Sahlberg: Ins. Fennica, 2: 45, no. 35.
- 1848: Walton: Ann. Mag. Nat. Hist. (2) 1: 297, no. 9.
- 1849: Walton: Stett. Entom. Zeit., p. 261.
- 1861: Waterhouse: Cat. Brit. Coleop. p. 71, no. 9.
- 1863: Lacordaire: Hist. Nat. Ins. Coleop., 6: 401.
- 1869: Giebel: Verz. z. Mus. Univ. Halle-Wittenberg, p. 45, no. 52.
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- 1871: Gemminger & Harold: Cat. Coleop. 8: 2384.
- 1871: Brischke: Schrf. d. Naturf. Ges. Danzig, n. f., 2 (pt 3): 24.

1873: Bargagli: Bul. Ent. Soc. Ital., 5: 96.
1874: Redtenbacher: Fauna Austriaca, Kafer, 2: 255.
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1874: Kaltenbach: Pflanzen Feinde, p. 124.
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1910: Kleine: Entom. Blatter, 6: 199.
1910: Smith: Cat. Ins. New Jersey, p. 381.
1911: Webster: Bul. 85 (rev. ed.) Bur. Ent. U. S. D. Agr., pp. 12, figs. 8.
1911: Gibson: 41st Rpt. Ent. Soc. Ont., p. 12.

Curculio variabilis:
1781: Fabricius: Spec. Insect., 1: 67, no. 34.
1787: Fabricius: Mant. Ins., p. 100, no. 45.
1789: Villers: Entom. Fauna Suec., 1: 187, no. 45; 4: 267, no. 45.
1790: Gmelin: Linn. Syst. Nat. ed. xiii, p. 1744, no. 105.
1790: Olivier: Hist. Nat. Ins., 5: 483, no. 56.
1792: Fabricius: Ent. Syst., 1 (pt 2): 407, no. 57.
1795: Fabricius: Nomen. Entom., p. T.
1795: Panzer: Entom. German., p. 302, no. 20.
1796: Fabricius: Ind. Alphab. E. S. emend., p. 58.
1797: Bergstrasser: Epit. Ent. Fab. Nomen., p. 67.

Curculio nigrirostris var. *variabilis:*
1792: Paykull: Monog. Curc., p. 56, liii.
1795: Herbst: Nat. Ins. Kafer, 6: 281, no. 254, var. 4.
1855: Nordlinger: Die Kleiner Feinde Landw., p. 153.

Rhynchaenus variabilis:
1801: Fabricius: Syst. Eleuth., 2: 448, no. 54.
1802: Fabricius: Ind. G. et sp. Syst. Eleuth., p. 69.
1805: Illiger: Mag. f. Insektenkunde, 4: 141, no. 54.
1817: v. Beck: Beit. z. Baiersch. Insektenfauna, p. 42, no. 74.
1822: Illiger: Mag. f. Insektenkunde, ed. 2, 4: 141, no. 54.

Rhynchænus nigrirostris var. *variabilis:*
1813: Gyllenhal: Ins. Suecica, 1 (pt 3): 115, no. 42, var. d.
1828: Boitard: Man. d' Entom., 1: 422.

Phytonomus nigrirostris var. *variabilis:*
1858: Matheiu: Ann. Ent. Soc. Belg., 2: 198, no. 205, var.
1901: Petri: Monog. d. Coleop.—Tribus Hyperini, p. 202.
1901: Petri: Bestim.—Tab. Coleop., Hft. 44, Hyperini, p. 39.

Curculio virescens:
1790: Quensel: Diss. ign. Insect., p. 16.

Curculio fulvipes:
1801: Turton: Gen. Sys. Nat., 2: 215 (syn. by Stephens).
1802: Stewart: Elem. Nat. Hist., 2: 54 (syn. by Stephens).

Phytonomus steirlini:
1868: Capiomont: Rev. d. Hyperides, p. 223.

Hypera steirlini: Gemminger & Harold: Cat. Coleop. 8: 2387.
1871: Gemminger & Harold: Cat. Coleop., 8: 2387.
1871: Kirsch: Berl. Ent. Zeit., 15: 191.

Hypera nigrirostris var. *steirlini:*
1891: Weise in H. R. & W.: Cat. Coleop. Eur., p. 303.

Phytonomus nigrirostris var. *steirlini:*
1901: Petri: Monogr. Coleop. Tribus Hyperini, p. 202.
1901: Petri: Bestim.–Tab. Coleop. Hft. 44, Hyperini, p. 37.
1906: Weise in H. R. & W.: Cat. Coleop. Eur., p. 656.

Erirhinus viridis:
1877: Provancher: Petite Fauna ent. Can., 1: 518.

Phytonomus nigrirostris var. *hirtus:*
1901: Petri: Monogr. Coleop. Tribus Hyperini, p. 165, 202.
1901: Petri: Bestim.–Tab. Coleop. Hft. 44, Hyperini, p. 37.
1906: Weise in H. R. & W.: Cat. Coleop. Eur., p. 656.

Original description: Fabricius, 1775, p. 132, as *Curculio nigrirostris.*
"*nigrirostris. 24. C. longirostris, viridis, rostro atro.*
Habitat in Anglia. D. Banks.

Caput fuscum, rostro cylindrico, atro, nitido. Thorax gibbus, rotundatus, viridis, lineis duabus dorsalibus, fuscis. Elytra tomentosa, viridis, immaculata. Pedes fusci, femoribus simplicibus."

Adult: (Plate XXX, fig. 1). Length 3.5–4.5 mm. Width 1.3–1.7 mm. Yellowish-red to black, elongate-oval or elongate; scales cleft to the base, metallic gray-green, yellowish, gray-brown, green, deep green or blue green, apparently depending upon the maturity of the specimen.

Head densely black, small, closely finely punctured, clothed with fine pale hairs; *front* narrower than eyes; *beak* as long as prothorax or longer (in female especially so), curved, cylindrical, polished, with a median dorsal keel the whole length, interrupted above the antennal insertion by an elongate narrow depression; *eyes* much elongated, narrowed below, an indistinct fovea on the front between the eyes; *antennal groove* narrow, black, punctured; *antennæ* red or yellowish-red, scape reaching almost to middle of eye, first funicle joint not twice as long as second, joints three to seven becoming regularly shorter and broader, seventh broadly oval, club not elongate-oval, dark, densely pubescent, the remainder of the antennæ with many fine white hairs.

Prothorax one-third longer than wide, coarsely punctured, pubescent, the narrow anterior margin polished, sides almost parallel a little widened one-third of distance from anterior margin, posterior edge wider than anterior; clothed with scales deeply cleft, hairs sparse, more on anterior edge and on sides; each puncture on the sides has a scale set in it; dorsum often with a median longitudinal pale green line bounded by rich darker bands of scales that reach to edge, the sides paler.

Elytra elongate-oval, at base slightly rounded, sides nearly parallel, humeri prominent and usually darker; striæ distinctly punctate; interspaces somewhat elevated posteriorly; scales may be uniformly of one color, or the alternate interspaces with scales of different shades of the same color or of different colors, or the elytra spotted with more or less indistinct gray or brown maculæ on a green or gray-brown background, especially along the suture; edges often with pale or reddish-brown scales on the last or last two interspaces, at the apex this coloration extends forward for some distance on each side of the suture; hairs or bristles white or black, varying in length, at base, but uniformly longer behind and usually more erect. There appears to be a tendency in this as in other species having both black and white hairs to have the colors alternating on the interspaces but this is not a fixed rule. Some specimens have a blue green longitudinal stripe on the seventh and eighth, or seventh to ninth interspaces.

Venter on the thoracic portions coarsely punctured, abdominal segments with the punctures finer; intercoxal process of first abdominal segment nearly triangular; mesosternal process angularly elevated between the middle coxæ, narrowly triangular, never linear or parallel sided, last abdominal segment longer than two previous ones, in the male with an impression on the disk.

Legs varying in color, even in matured specimens from red or reddish brown to very dark red or more rarely black; clothed with fine pale or silvery hairs sparsely set, never with scales, except on coxæ; femora stout, anterior tibiæ of male strongly curved with the apical process distinct, claws and upper side of tarsal joints often darker, pads of tarsal joints silvery-white.

Egg: Ovoid pale-greenish, surface distinctly sculptured, not as hexagonal in specimens examined as in *Hyp. punctata* eggs. The eggs darken as incubation progresses and become almost jet black, and shining. "Length, 0.55 mm. to 0.63 mm.; width, 0.35 mm. to 0.36 mm." according to Hyslop and Webster in Bul. 85, 1909. I have not had enough specimens to care to furnish data as to length at the present time, since mine seems to vary more than that given above.

Larvæ: early stages: "The newly hatched larva is 1.25 mm. in length and 0.25 mm. broad. Color white, with pinkish tinge, best seen on ventral surface. Head large with the cervical shield pale brown, the latter divided by a broad median white line, the inverted V-shaped mark on head also white; body with sparsely placed setæ longer and more conspicuous on the anal segments. In a short time the pink tinge disappears, the head becomes black, and the inverted V-shaped line extends across the now black thoracic shield, and along the entire length of the body it is produced in a very delicate, pale median dorsal line. (Described by Wildermuth and Webster)." From Bul. 85, Webster, 1909.

Later stages: "The full grown larva. (Plate XXIV, figs. 26,28, 31). The full grown larva is of a greenish straw color. The inverted white line is still quite visible on the head. Head light brown. The cervical shield has lost its color, but the faint dorsal white line is still noticeable throughout the whole length of the body. The setæ are still prominent, there being four long ones on each segment, those on the last two segments being very long. (Description by Wildermuth and Webster)." From Webster, Bul. 85, 1909.

Cocoon: (Plate XXX, fig. 3). Constructed of very fine white threads intermixed with coarser threads, more nearly globular than cocoon of *P. posticus.* Meshes rather irregular and open, not finely, closely, evenly arranged.

Pupa: (Plate XXX, fig. 2). "Pupa distinctly resembling the adult. Abdomen almost colorless, with a slight tinge of yellow. Head, thorax and appendages increasing in density of black from time of pupation until emergence. A very distinct white line passes through center of dorsal surface of thorax and head, and continues on through the beak where it reaches its greatest width. (Description by Wildermuth)." From Webster, Bul. 85, 1909.

Map 9. Distribution of *Phytonomus nigrirostris* Fab.

Prof. F. M. Webster, of the Bureau of Entomology, very kindly loaned me specimens of the larvæ and pupæ, but the alcoholic specimens are somewhat shrunken and I do not care to attempt a full description of them, hence I have quoted from his bulletin. The tubercles on the larvæ are very distinct and in two rows on most of the segment as in other species, but there are certainly more than four on some of the segments. In the pupa the hairs on the prothorax are rather long, the first four pairs near the margin and equidistant from each other, on the posterior portion are at least three pairs of hairs and two pairs on the dorsum, this would leave one pair missing, the pupæ examined were however alcoholic specimens and may have been rubbed. It is probable that with a sufficient number to study the anal segments would show characters that might be used in separating the species.

Distribution: Type locality "Anglia. D. Banks," Fabricius, 1775. In 1781 Fabricius again described this species, under the name *variabilis* from specimens from "Hamburg. Dom. Schulz." In 1783 Herbst had specimens from Berlin.

Petri and Capiomont record it as occurring over all Europe, British Isles, Egypt, Asia Minor, Caucasus and Transkaukasus, and Algeria. It is mentioned in Hochhuth's "Russland" list but has apparently not been recorded from Siberia. The first published record from America is in Leconte's Rhyncophora in 1876, where he states that it occurs in "Massachusetts and Canada." I have a specimen from Mr. Frederick Blanchard, taken on Mt. Washington, in New Hampshire, in 1874, so that it had doubtless been here for many years previous to that time. Hubbard and Schwarz collected it in eastern Massachusetts in 1873–4. Provancher in 1877 under the name *Erirhinus viridis* described it from Quebec. Since that decade it has been gradually spreading westward and southward. Being a small, rather inconspicuous species it is easily overlooked.

I have seen many specimens from various places and have records of many others which are here included.

Dominion of Canada: New Brunswick (Fletcher, 1884) at Dalhousie.

Prince Edwards Island: Charlottetown (U. S. N. M.).

Ontario: Ottawa (Harrington, 1884); also specimens in coll. Cornell Univ.; Toronto, Nov. (Wickham coll.); 25–5–96, 97, 24–5–97 (Cornell Univ.)

Quebec: Provancher record 1877. Fletcher in 1884 reported a cocoon at "Brome in Eastern Township."

"Can." 1 specimen in U. S. N. M. marked "1874, det. Lec."

United States: Maine: Lewiston, S. Stebbins (Bos. Soc. Nat. Hist.); Monmouth 12–Aug. '03, Wales vi–15 (Frost coll.) "Maine" (Fall coll.)

New Hampshire: Mt. Washington, 1874, (Blanchard coll.); Manchester, 13 July (Wickham coll.); E. Wakefield vi–17 (Hub. & Schwarz, U. S. N. M.); "N. H." (Fall coll.)

Vermont: Bennington Co. (Cornell Univ.)

Massachusetts: "Mass." (Fall coll.); E. Mass. (Hub. & Schwarz); "Mass. 1876" (Leconte coll. M. C. Z.); Amherst 1899 (Fernald rec.); Cambridge, 1873, Henshaw (B. S. Nat. Hist.); Lowell (Wells coll. Field Col. Mus.); Mansfield 5–3, Lynn 19–3 (Hub. & Schwarz, U. S. N. M.); Melrose Hds. Clemons, 23–iv (U. S. N. M.); Concord, Tolman (Wenzel coll.); Wellesley 11 July, Sharon 20 July (Wickham coll.); Lenox (A. M. N. H.); Grafton (Sherriff coll.); Lynn 19–31 (Leconte coll. M. C. Z.); Forest Hills, 14 January 1911 (Titus); Framingham v–15–07, 5–5–09, iv–17–10, vii–20–07, 30–May–05, vii–4–07, May–08, v–8–09, Natick iv–10–09 (Frost coll.); Nantucket Id (Bolter coll.)

Rhode Island: Providence July (Frost coll.)

Connecticut: S. Woodstock, 1888 (Chittenden record). Colebrook (Titus) Je., 1911. Britton (*in litt.* 1911): New Haven, 13 April 1898, 1 June, 1898, 26 June, 1899, W. E. B., 28 June, 1904, E. J. S. Moore, 6 July, 1904, H. L. V., 8 June 1904, W. E. B., 14 June 1909, B. H. W., 21 April, 1911, A. B. C.; West Haven, 27 June, 1905, H. L. V.; Chapinville 26 May, 1904, W. E. B.; Hamlen, 12 May, 1910.

New York: Felt (*in litt.* 1911) states distributed over entire state, and gives following as localities represented in their collections: Albany, Cortland, Denmark, Deer Park, E. Greenbush, Karner, Ithaca, Moshulu, Nassau, Newport, Oswego, Ossining, Poughkeepsie. Peekskill (Cornell Univ.); Peekskill June 98 (Van Dyke); Stony Id. 8–July–96; West Pt. 10–April, 28–April–08, 22–April–08, Babylon 4–June–93 (A. M. N. H.); Potsdam (in many coll. prob. recd. from Houghton); Coney Id. 1891 (Chittenden record); Chittenden (in Webster loc. cit.) says that it did not occur at Ithaca in 1884.

New Jersey: Smith in 1910 list says distributed well over the state. Westville 1–28, 2–25 (Wenzel); Ft. Lee (A. M. N. H.) New Brunswick vi–28, vii–6, Red Bank 5–1, 4–20, Sea Isle City 5–24, 7–4, 7–12, Madison 17–April–98, Atco 6–1, Riverton 5–1, Jamesburg 7–4 (J. B. Smith).

Pennsylvania: Mt. Airy (J. B. Smith coll.); Phila. 11–28–05 (Am. Ent. Soc.); 21–Nov.–08, Hyslop at Marion (Webster 1. c.)

Maryland: Somerset Hts., 1905 (Titus); Plummers Island; Weverton, 20 May '08, C. N. Ainslie (Webster 1. c.); Arundel (Schwarz).

District Columbia: Chevy Chase Circle 6–June–08, Caudell & Ainslie (Webster 1. c.); Washington, common (Webster).

Virginia: Fortress Monroe (Schwarz).

Michigan: Detroit (Schwarz) about 1875.

Indiana: Vigo Co. (Blatchley *in litt.*)

Minnesota: reported by Schwarz (Webster 1. c.)

Food Plants and *Life History:* Gyllenhal (1813) recorded it from "*Ononis arvenisi*". Germar (1821) mentions that the species lives on Dianthus and "in Europæ graminosis." Samouelle (1819) says it occurs in April and May in moist places on banks of ponds. Brischke in 1871 reports it as feeding in north Germany on lucerne and as occurring on "Carex filiformis". 1858 Matheiu had said it injured clover and occurred on *T. agraricum*, Bargagli (1884) gave a short account of its feeding habits on *Trifolium pratense* and notes its occurrence on various Ononis especially *spinosa*, and in the heads of *Buphthalmum salicifolium.* Kaltenbach (1874) reports Hoffman's observations on its habit of feeding in the flowers of *Buphthalmum salicifolium*, the cocoon being spun in the chaff scales, and states also that it feeds in the flower heads of *Trifolium pratense.* Ferrant (1909) gives it as one of the three injurious Phytonomus to lucern in Luxemburg. Kleine in 1910 gives no other food-plants.

The best accounts of the life history have been written by Houghton (1908) and Webster (1909), but there are many points still unknown. In America Fletcher first reported the species from clover as injurious at Dalhousie N. B., in 1884, Harrington the same year reported it as occurring at Ottawa in numbers but not injurious. The eggs are laid in early spring (March, April and May) the period probably extending over about six weeks. They are generally deposited inside the leaf sheath next to the inner epidermis (Webster), only a few in a place. In captivity they may lay eggs in the leaves, petioles, stems, and even on the leaves. The eggs hatch in seven to eight days, the larvæ feeding in the flower buds and heads. The larval period varies from seventeen to twenty days, "the larva molts twice, the first instar occupying three to seven days, the second six to seven days and the third about seven days" (Webster 1. c.) The pupal stage is about six days, the pupa being formed in a pure white rather closely netted cocoon that may be spun on the leaves or near the ground or in flower heads. Food plants reported in America are *Trifolium pratense*, *T. medium*, *Medicago sativa*, *Trifolium incarnatum*, *T. repens* and *T. hybridum*. It will also feed on *Medicago lupulina*. Webster (1909) gives a very complete account of the earlier notices of the species in America. Both Webster and Schwarz believe that the occurrence of the species into the Virginia region is due to a new introduction. Webster discusses the possibility of the species having reached the southern coast through the influence of the return ocean currents, floating in on debris. This appears to me improbable; many persons have tried the effect of salt water on insects and found that it is rare for them to survive longer than a few hours, generally scarcely a few minutes, the first wave killing them or so stupefying them that they are soon lost. It is much more probable that this weevil either entered this region by flight, passing a little further southward year by year or was carried there by means of railroad trains.

Houghton reports a spring flight of the species in April in Delaware.

Enemies: Webster has reported the only insects known to feed on the species. From a specimen collected by Mr. Caudell June 12 near Chevy Chase, on June 23, a small fly issued (from a puparium formed in the cocoon of *P. nigrirostris*), which was determined by C. H. T. Townsend as *Anisia* species near *variabilis* Coq.

A larva taken from a clover head 26 June, 1908, "developed into an adult hymenopterous parasite that emerged July 8, 1908". Determined by J. C. Crawford as *Bracon* sp.

The fungus disease (*Entomophthora sphaerosperma* Fres.) attacks this species. For an account of its manner of attack see under *Hyp. punctata*, p. 411.

Phytonomus posticus Gyllenhal.

Curculio haemorrhoidalis:
1784: Herbst: Fues. Archiv. 5: 78, no. 52 (nec. Fabricius 1775).
1794: Herbst: Fues. Archiv. (French ed.) p. 125, no. 37.
1795: Herbst: Nat. Ins. Kafer, 6: 266, no. 235, T. 80, fig. 4.
1818: Germar: Germ. & Zincker Mag. 3: 369.

Rhynchaenus haemorrhoidalis:
1820: Billberg: Enumeratio Insectorum, p. 42.

Curculio variabilis:
1795: Herbst: Nat. Ins. Kafer, 6: 263, no. 232, T. 80, f. 1 (nec. Fabr. 1781).
1807: Illiger: Magaz. f. Insektenkunde, 6:328.

Rhynchaenus variabilis:
1813: Gyllenhal: Insecta Suec. 1 (pt 3): 104, no. 35.
1820: Billberg: Enum. Insectorum, p. 42.
1827: Gyllenhal: Ins. Suec. 1 (pt. 4, app. 3): 572, no. 35.

Hypera variabilis:
1821: Dejean: Cat. Coll. Coleop., p. 89.
1826: Sturm: Cat. Ins. Sammlung, 1: 157.
1826: Curtis: Brit. Entomology, 2: no. 116. 10.
1829: Curtis: Guide Arr. Brit. Ins. p. 50, no. 18.
1829: Stephens: Sys. Cat. Brit. Ins. p. 169, no. 1731.
1831: Stephens: Entom., 4: 101, no. 25.
1833: Villa: Cat. Coleop. Europ. duplet. in coll.
1844: Villa: Cat. dei Coleop. della Lombardia.
1848: Walton: Ann. Mag. Nat. Hist. (2) 1: 298.
1849: Walton: Stettin. Entom. Zeit., 10: 261.
1853: Murray: Cat. Coleop. Scotland.
1854: Wollaston: Ins. Maderensis, pp. xl., 400.
1861: Waterhouse: Cat. Brit. Coleop., p. 71, no. 11.
1863: Lacordaire: Hist. Nat. Ins. Coleop., 6: 401.
1864: Wollaston: Cat. Coleop. Canaries, p. 328.
1869: Giebel: Verz. z. mus. Univ. Halle-Wittenberg, p. 44, no. 42.
1869: Kraatz: Verz. Kafer Deutsch., p. 52.
1871: Gemminger & Harold: Cat. Coleop., 8: 2388.
1871: Kirsch: Bul. Ent. Zeit., 15: 187.
1873: Bargagli: Bul. Ent. Soc. Ital., 5: 96.
1874: Redtenbacher: Fauna Austriaca. Kafer. 2: 254.
1876: Perris: Larves Coleop., p. 385.
1877: Stein & Weise: Cat. Coleop. Eur., ed. 2, p. 143.
1878: Mocsary: Adatok Z. es Lip. Meg. Faunajahoz, p. 240.
1880: Koppen: Die Schadl. Ins. Russland, p. 209, no. 6.
1880: Rupertsberger: Biol. die Kafer Europ., p. 200.
1882: Baudi, Piccioli & Cavanna: Bul. Ent. Soc. Ital., 14: 75.
1882: Piccioli & Cavanna: Bul. Ent. Soc. Ital., 14: 379.
1883: Weise in H. R. & W. Cat. Col. Eur., ed. 4, p. 159.
1884: Bargagli: Bul. Ent. Soc. Ital., 16: 167–8, 173.
1884: Bargagli: Rass. Biol. Rinc. Europei, p. 100.
1887: Wollaston: Cat. Coleop. Mader. in Brit. Mus., pp. 118, 119, 218.
1888: Bedel: Coleop. Bassin de la Seine, pp. 79, 215, no. 15.
1890: Carpentier: Bul. Ent. Soc. Ital., 22: 275.
1891: Fowler: British Coleoptera, 5: 230, 235.
1891: Weise in H. R. & W.: Cat. Coleop., p. 304.
1893: Bertolini: Bul. Ent. Soc. Ital., 25: 245, no. 16.
1894: Hauser: Deutsch. Ent. Zeit., 38: 25.
1894: Rupertsberger: Biol. d. Kafer, 2: 210, 294.
1896: Heyden: Cat. Coleop. Sibiria, p. 152.
1897: Fauvel: Revue Entom., 16: 463, no. 544.
1903: Everts: Coleop. Neerlandica, p. 605.
1907: Wachsmann: Rovar. Lapok, 14:19.

Phytonomus variabilis:
1826: Schönherr: Curc. disposit. meth., pt. 4, p. 175.
1834: Gyllenhal in Schönherr: Gen. et sp. Curc., 2 (pt 2): 384.
1839: Audouin: Ann. des Sc. nat. (2) 11: 107–8.
1839: Falderman: Neue Mem. Soc. Moscou, 6: 189.
1842: Boheman in Schönherr: Gen. et sp. Curc., 6 (pt 2): 380, no. 69.
1844: Germar: Stett. Entom. Zeit., 3: 101.
1847: Hochhuth: Enum. Russelk. Kauk. et Transk., p. 493, no. 105.
1849: Gaubil: Cat. Syn. Coleop. Eur. et Alg., p. 156.
1849: Redtenbacher: Fauna Austriaca, Die Kafer, p. 435.
1849: (Dohrn): Cat. Coleop. Europ., p. 61.
1851: Hochhuth: Bul. Imp. Soc. Mosc., p. 42.
1853: Zebe: Syn. der Bisher Deutsch. aufgef. Coleop., p. 75.
1855: Jac. du Val: Gen. Coleop. Europ., p. 110 (in part).
1857: Lentz: Neus Verz. Preuss. Kafer, p. 124.
1857: Costa: Pergrinazioni sul Monte Alburno, p.
1858: Dohrn: Cat. Col. Europ., p. 79.
1858: Matheiu: Ann. Ent. Soc. Belg., 2: 198, 200.
1858: Redtenbacher: Fauna Austriaca, Die Kafer, ed. 2, p. 729.
1862: Schaum: Cat. Coleop. Europ., ed. 2, p. 89.
1865: Disconzi: Entom. Vicentia, pp. 79, 81, 126, no. 37.
1865: Thomson: Skand. Coleop., 8: 168.
1867: Kanall: Stett. Ent. Zeit., 28: 123 (? species).
1868: Capiomont: Rev. d. Hyperides, p. 205, 284, fig.
1871: Brischke: Schr. nat. Ges. Danzig, n. f. 2: 23.
1871: Kirsch: Berl. Ent. Zeit., p. 1.
1873: Giard: Traite Elem. d' Entom., 1: 671.
1873: Rondani: Bul. Ent. Soc. Ital., 6: 156.
1876: Lafontjn: Tijd. v. Entom., 20: xxi.
1877: Heyden: Jahrb. Nassau. Verein, 29: 312.
1878: Schneider & Leder: Beit. kennt. Kauk. Kaferfauna, p. 287.
1882: Fabre: Nouv. Souv. Entom. vi, pp. 83–88. (Odynerus spinnipes).
1886: Faust: Horae Soc. Ent. Rossicae, p. 86, no. 146.
1888: Bedel: Ann. Soc. Ent. Fr. (2) Coleop. Bas. Seine, p. 260.
1890: ———: Bul. Ent. Soc. Ital., 22: 275.
1891: Faust: Oefers Finsk. Vetensk. Soc., p. 91.
1891: Seidlitz: Fauna Transsylv. p. 676.
1901: Petri: Monog. Coleop.–Tribus Hyperini, p. 181, 203.
1901: Petri: Bestim. Tab. Coleop. Hft. 44, Hyperini, p. 31, 40.
1906: Weise in H. R. & W. Cat. Coleop. Eur., p. 656.
1908: v. Wanka: Entom. Blatter, 4: 230.
1910: Kleine: Entom. Blatter, 6: 198.
1911: Martelli: Boll. Lab. Zool. gen. e agar. R. Scu. sup. Agric. Portic., 5: 226–30.

Curculio bimaculatus:
1802: Marsham: Entom. Brit., 1: 266, no. 86 (nec. Fabricius 1775).

Rhynchænus pollux:
1813: Gyllenhal: Ins. Suecica, 1 (pt. 3): (*nec.* Fabr., *et al.*).

Rhynchænus posticus:
1813: Gyllenhal: Ins. Suec., 1 (pt. 3): 113, no. 41.
1827: Gyllenhal: Ins. Suec., 1 (pt 4, app. 3): 572, no. 41.
1828: Zetterstet: Faun. Ins. Lapp., 1: 320, no. 37.
1834: Sahlberg: Insecta Fennica, pt. 2, p. 44, no. 34.
1840: Zetterstedt: Ins. Lapponica, p. 179, no. 43.

Hypera postica:
1821: Germar: Germ. & Zincker Mag. 4: 340, no. 10.
1826: Curtis: Brit. Entom., 2: no. 116, 13.
1829: Curtis: Guide Arr. Brit. Ins. p. 50, no. 15.
1829: Stephens: Sys. Cat. Brit. Ins. p. 169, no. 1728.
1831: Stephens: Brit. Entom., 4: 100, no. 22.

1869: Giebel: Verz. z. Mus. Univ. Halle-Wittenberg, p. 44, no. 48.
1869: Kraatz: Verz. Kafer Deutsch., p. 52.
1871: Gemminger & Harold: Cat. Coleop., 8: 2386.
1874: Redtenbacher: Fauna Austriaca, Kafer, 2: 253.
1876: Everts & Leesburg: Tijd. v. Ent., 20: xxxi.
1877: Stein & Weise: Cat. Col. Europ., p. 143.
1883: Weise in H. R. & W. Cat. Col. Eur., p. 159.
1884: Bargagli: Bul. Ent. Soc. Ital., 16: 170.
1884: Bargagli: Rass. Biol. Rinc. Europ., p. 97.

Phytonomus posticus:
1833: Dejean: Cat. Coleop. coll. Dejean, p. 264, ed. 2.
1834: Gyllenhal in Schönherr: Gen. et sp. Curc. 2 (pt. 2): 391, no. 34.
1837: Dejean: Cat. Coleop. coll. Dejean, ed. 3, p. 287.
1842: Boheman in Schönherr: Gen. et sp. Curc., 6 (pt. 2): 383, no. 80.
1847: Hochhuth: Enum. Russelkafer Kauk. et Transk., p. 493, no. 103.
1849: Redtenbacher: Fauna Austriaca, Die Kafer, p. 435.
1849: Lucas: Expl. Sc. de Alg. Ins., 2: 246, no. 1132.
1849: (Dohrn): Cat. Coleop. Europ., p. 61.
1853: Zebe: Syn. d. bisher Deutsch. aufgef. Coleop., p. 75.
1855: Jac. du Val.: Gen. Coleop. Europ., p. 110.
1857: Lentz: Neue Verz. Preuss. Kafer, p. 125.
1858: Dohrn: Cat. Coleop. Europ., p. 79.
1858: Matheiu: Ann. Ent. Soc. Belg., 2: 198, no. 203.
1858: Redtenbacher: Fauna Austriaca, Die Kafer, ed. 2, p. 728.
1859: Belke: Bul. Imp. Soc. Mosc., p. 53.
1862: Schaum: Cat. Col. Eur., ed. 2, p. 89.
1865: Thomson: Skand. Coleop., 8: p. 172, no. 12.
1873: Bertolini: Bul. Ent. Soc. Ital., 25: 245, no. 16.
1874: Siebke: Enum. Ins. Norvegicum, fasc. 1, p. 265.

Hypera variabilis var. *posticus:*
1891: Weise in H. R. & W.: Cat. Coleop. Eur., p. 304.

Phytonomus variabilis aber. *posticus:*
1906: Weise in H. R. & W.: Cat. Coleop. Eur., p. 656.

Hypera murina var. *variabilis:*
1821: Germar: Germ. & Zinck. Mag., 4: 341, no. 11, var. B. (nec. Fabr.).

Phytonomus murinis var. *variabilis:*
1833: Dejean: Cat. Coleop. coll. Dejean, ed. 2, p. 264.
1837: Dejean: Cat. Coleop. coll. Dejean, ed. 3, p. 286.

Hypera sublineata:
1826: Curtis: Brit. Entom., 2: no. 116. 10.
1829: Curtis: Guide Arr. Brit. Ins., p. 50, no. 12.
1829: Stephens: Sys. Cat. Brit. Ins., p. 168, no. 1718.
1829: Stephens: Entomology, 4: 96, no. 11.

Phytonomus sublineatus:
1842: Schönherr: Gen. et sp. Curc., 6 (pt 2): 384, no. 92 (unrecog.).

Hypera villosula:
1826: Curtis: Brit. Entom., 2: no. 116. 21.
1829: Curtis: Guide Arr. Brit. Insects, p. 50, no. 22.
1829: Stephens: Sys. Cat. Brit. Ins., p. 168, no. 1720.
1831: Stephens: Entomology, 4: 97, no. 14.

Phytonomus villosulus:
1842: Schönherr: Gen. et sp. Surc., 6 (pt. 2): 385, no. 94 (unrecog.)
1858: Dohrn: Cat. Coleop. Europ., p. 79.

Hypera picipes:
1826: Curtis: Brit. Entom., 2: no. 116.3
1829: Curtis: Guide Arr. Brit. Ins., p. 50, no. 1.
1829: Stephens: Syst. Cat. Brit. Ins., p. 168, no. 1721.
1831: Stephens: British Entom., 4: 97, no. 15.

Phytonomus picipes:
1842: Schönherr: Gen. et sp. Curc., 6 (pt. 2): 386, no. 95 (unrecog.).
Hypera variabilis var. *picipes:*
1891: Weise in H. R. & W.: Cat. Coleop. Europ., p. 304.
Hypera phaeopa:
1829: Stephens: Sys. Cat. Brit. Ins., p. 169, no. 1729.
1831: Stephens: Entomology, 4: 100, no. 23.
Phytonomus phaeopus:
1842: Schönherr: Gen. et sp. Curc., 6 (pt. 2): 386, no. 97 (unrecog.).
Hypera rufipes: (syn. of Walton, nec. Petri).
1829: Stephens: Syst Cat. Brit. Ins., p. 169, no. 1731. (*nec*. Fabr. *et al*).
1831: Stephens: Entomology, 4: 100.
Phytonomus rufipes:
1842: Schönherr: Gen. et sp. Curco., 6 (pt. 2): 386, no. 98 (unrecog.).
1877: Piccioli: Bul. Ent. Soc. Ital., 9: 228 (?species).
Phytonomus parcus:
1834: Gyllenhal in Schönherr: Gen. et sp. Curc., 6 (pt. 2): 390, no. 33.
1842: Schönherr: Gen. et sp. Curc., 6 (pt. 2): 383.
1855: Jac. du Val: Gen. Coleop. Eur. p. 110.
1858: Dohrn: Cat. Coleop. Eur., p. 79.
1862: Schaum: Cat. Col. Europ., p. 89.
Phytonomus variabilis var. *parcus:*
1868: Capiomont: Rev. d. Hyperides, p. 206.
1901: Petri: Monogr. Coleop. Tribus Hyperini, p. 203.
1901: Petri: Bestim.-Tab. Coleop. Hft. 44, Hyperini, p. 40.
Hypera parca:
1869: Kraatz: Verz. Kaferfauna Deutsch: p. 52.
1869: Giebel: Verz. z. Mus. Univ. Halle-Wittenberg, p. 44, no. 49.
Hypera variabilis var. *parca:*
1877: Stein & Weise: Cat. Coleop. Eur., ed. 2, p. 143,
1883: Weise in H. R. & W. Cat. Coleop., p. 159.
1891: Weise in H. R. & W.: Cat. Coleop., p. 304.
Phytonomus variabilis aber. *parcus:*
1906: Weise in H. R. & W.: Cat. Coleop. Eur., p. 656.
Phytonomus tibialis:
1851: Hochhuth: Bul. Imp. Soc. Mosc., p. 44, no. 42.
1881: Heyden Cat. Coleop. Sibiria, p. 166.
1896: Heyden: Cat. Coleop. Sibiria, p. 152.
Hypera tibialis:
1871: Gemminger & Harold: Cat. Coleop., 8: 2386.
1885: Heyden & Kraatz: Deutsch. Ent. Zeit., p. 282.
1886: Faust: Horae Ent. Soc., p. 146.
Hypera variabilis var. *tibialis:*
1891: Weise in H. R. & W.: Cat. Coleop. Eur., p. 304.
Phytonomus variabilis var. *tibialis:*
1901: Petri: Monogr. Coleop.-Tribus Hyperini, p. 204, p. 182.
1901: Petri: Bestim.-Tab. Coleop. Hft. 44, p. 40.
Phytonomus variabilis aber. *tibialis:*
1906: Weise in H. R. & W.: Cat. Coleop. Eur., ed. 2, p. 656.
Hyperina murina:
1866: Wollaston: Cat. Atlantidum, p. 305 (in part).
Phytonomus variabilis var. *siculus:*
1868: Capiomont: Rev. d. Hyperides, p. 207.
1901: Petri: Monogr. Coleop. Trib. Hyperini, p. 182, 204.
1901: Petri: Bestim.-Tab. Coleop. Hft. 44, Hyperini, p. 40.

Hypera variabilis var. *sicula:*
1871: Gemminger & Harold: Cat. Coleop., 8: 2386.
1877: Stein & Weise: Cat. Col. Eur., ed. 2, p. 143.
1883: Weise in H. R. & W. Cat. Coleop., ed. 4, p. 159.
1891: Weise in H. R. & W.: Cat. Coleop. Eur. p. 304.

Phytonomus variabilis aber. *siculus:*
1906: Weise in H. R. & W.: Cat. Coleop. Europ., p. 656.

Phytonomus variabilis var. *sericeus:*
1868: Capiomont: Rev. d. Hyperides, p. 207.
1901: Petri: Monogr. Coleop. Trib. Hyperini, pp. 182 (sericeas), 203.
1901: Petri: Bestim.-Tab. Coleop. Hft. 44, Hyperini, p. 40.

Hypera variabilis var. *sericea:*
1871: Gemminger and Harold: Cat. Coleop., 8: 2386.
1877: Stein & Weise, Cat. Col. Eur., ed. 2, p. 143.
1883: Weise in H. R. & W., Cat. Col. Eur., ed. 4, p. 159.
1891: Weise in H. R. & W.: Cat. Coleop. Eur., p. 304.

Phytonomus variabilis aber. *sericeus:*
1906: Weise in H. R. & W.: Cat. Coleop Eur., ed. 2, p. 656.

Phytonomus ponticus:
1868: Capiomont: Revis. d. Hyperides, p. 208, no. 46.

Hypera pontica:
1871: Gemminger & Harold: Cat. Coleop., 8: 2386.

Phytonomus variabilis var. *ponticus:*
1901: Petri: Monogr. Coleop. Trib. Hyperini, pp. 183, 203.
1901: Petri: Bestim.-Tab. Coleop. Hft. 44, Hyperini, p. 40.

Phytonomus variabilis var. *austriaca:*
1901: Petri: Monogr. Coleop. Trib. Hyperini, pp. 182, 203.
1901: Petri: Bestim. Tab. Coleop. Hft. 44, Hyperini, p. 40.

Phytonomus variabilis aber. *austriacus:*
1906: Weise in H. R. & W.: Cat. Coleop. Eur. p. 656.

Phytonomus variabilis var. *decoratus:*
1901: Petri: Monogr. Coleop. Trib. Hyperini, pp. 183, 203.
1901: Petri: Monogr.-Tab. Coleop. Hft. 44, Hyperini, p. 40.

Phytonomus murinus:
1907: Titus: Deseret Farmer (Salt Lake, U.) 27 July, p. 7 (no specific name).
1908: Titus: Deseret Farmer, 26 Sep., 3 Oct.
1909: Titus: Journ. Ec. Ent. 2: 148-53.
1909: Titus: Bul. 1, Ext. Dept. Utah Ag. Coll., pp. 4.
1909: Titus: Deseret Farmer: 1 May.
1909: Titus: Utah Independent, 24 June.
1909: Hooker: U. S. D. A. Exp. Sta., Rec., 21: 348.
1909: Bur. Entom. Yearbook f. 1908, U. S. Dept. Agr., p. 569.
1910: Hooker: U. S. D. A. Exp. Sta. Rec., 22: 462.
1910: Ball: Logan Republican (Utah), May.
1910: Blankinship: Salt Lake Tribune, 23 May, figures.
1910: Titus: Bul. 110, Utah Exp. Sta., pp. 17-72, plates 14.
1910: Titus: Journ. Econ. Entom. 3: 459-70.
1911: Webster: Science: n. s., 23: 196-7.
1911: Webster: Journ. Ent. Soc. Wash., 12: 4.
1911: Webster: Cir. 137, Bur. Ent., U. S. Dept. Agr., pp. 9, figs. 10.
1911: Hooker: U. S. D. A. Exp. Sta. Rec. 24: 458.

Original description: Gyllenhal, 1813, p. 113.

"41. *R. posticus: niger, parum cinereo-pubescens, antenis, tibiis, elytrorumque apice ferrugineis, rostro breviusculo, thorace brevi depresso, pectore albido-squamoso.*

"Curculio haemorrhoidalis Herbst, Col. 6. 266. 235, Tab. 80, f. 4.

"Curculio bimaculatus Marsham. Ent. Brit. 1. 266. 86.

"*Habitat in pratorum collibus passim.*

"*Descr. Praecedenti* (*trifolii* which is *praec.* to *plantaginis*) *simillimus, and pro ejus varietate detrita facile habendus, sed paullo major praesertim longior; rostrum brevius, elytrorum apex ferrugineis, et squamulae pectoris non-metallico nitentes. Caput and oculi ut in praecedenti* (*parvum rotundatum nigrum punctulatum, cinereo-pubescens oculis ovatis depressis brunneis*)*; rostrum thoracefere brevius, crassiusculum, arcuatum nigrum punctulatum glabrum. Antennæ ut in priori* (*capite cum rostro longiores, crassiuscules ferrugineae, clava cinereo pubescente*)*. Thoracis structura etjam ut in illo* (*latitudine multo breviore, basi apiceque truncatus, lateribus valderundato-dilatatus*)*, supra depresseus, niger, margine antico supra rufo-piceo, confertissime et paullo profundius punctatus, pilis squamulisque cinereis, versus latera densioribus, adspersus. Elytra thoracis basi dimidii latiora, and illo fere quintuplo longiora, apice compressa, subattentuate, supra convexa, nigro-picea apicem versus plus mimus rufo-ferrigunea, sat profunde* (*p. 114*) *punctato-striata, pilis squamulisque cinereis parcius adspersus. Corpus subtus nigrum, creberrime punctulatum, tenue cinereo-pubescens, ano piceo: pectus pube squamulisque cinereio-albdis, non metallico-nitentibus, tectum. Pedes ut in praecedenti* (*mediocres cinereo-pubescentes*) *femoribus nigro-piceis, tibiis tarsisque ferrugineis.*"

The parts in parentheses I have quoted from the previous species to which he refers in the description.

Adult: (Plate XXXI, figs. 5–8). Length 3–5.1 mm. Width 1–2.4 mm. These measurements are the extreme from over 1000 specimens.

Reddish-black, brown, brownish-black, or black; legs and antennæ always paler; scales cleft about two-thirds of the length, color of pubescence varying from ash-gray to dark brown.

Head with numerous fine punctures, densely covered with pale or gray-brown hairs; *front* never as wide as beak, scarcely as wide as an eye; *eyes* transverse oval, narrower below, slightly prominent; *beak* about two-thirds length of prothorax, narrowed close to eyes, hairy especially beneath and at tip; with a small smooth dorsal keel about one-half the length, followed by a broad smooth triangular dorsal portion that is pointed or nearly so at the tip; a deep narrow longitudinal groove on the base of the wide portion; long narrow punctured striæ on each side beneath the dorsal edge reaching at least three-quarters of the distance to the tip; *antennal groove* deep, narrow, punctured, black; *antennæ* reddish yellow to dark-brown, scape reaching to eyes, shorter than funicle; second joint two-thirds to three-fifths the length of the first; seventh joint as broad as long; club oval, pointed, densely pubescent; mandibles punctured, hairy. Male antennæ inserted near the middle of the groove, female nearer the apex of the beak.

Prothorax usually a little broader than long in female, but in male sometimes scarcely as broad as long, never strongly widened as in *meles*; widest half way between the middle and the anterior edge; sides rounded and swollen, anteriorly strongly rounded, posterior margin wider than anterior; densely roughly finely punctured; dorsum depressed more behind than in front. In perfect specimens the scales form a narrow brown or gray median stripe bordered by wide dark bands, these are bordered by light brown metallic bands which reach down onto the sides, below these again a dark band which extends back onto the humeri, remainder of side and venter pale metallic brown. Pale hairs usually intermixed with scales that form the bands. The entire system of bands or stripes may be obsolete, indistinct or entirely wanting or any one or more of them may be missing, even in specimens recently issued from the pupa.

Scutellum minute triangular, clothed with scales of same color as median thoracic stripe.

Elytra about three times as long as prothorax, almost egg shape, flattened at the base, humeri strongly rounded, convexly prominent, sides sometimes rounded but usually nearly parallel for four-fifths of the length, and then rounded to the tips which are not sharp; finely striately punctured, interstitial spaces very slightly elevated, sometimes the odd-numbered alternate spaces show more strong elevation; scales usually yellowish brown, gray or dark brown but may vary in both direction, hairs black or white or both; even in carefully bred specimens the pattern is extremely variable, passing from those entirely of one color (gray to dark rich brown) to those which are tessellated on almost all the inter-spaces. In some the sutural interspaces are alternately maculated with pale and dark brown and the alternate interspaces more or less marked in the same manner; usually the scales on the last interspace are paler. A broad common darker sutural basal spot is rather general, this may extend for any distance back on the elytra along the suture, the farther back it reaches the broader it is at the base. Some specimens have the hairs alternating black and white on the interspaces, others black on all and more rarely white on all; they are however very uniformly curved backward lying about one-half down and are long or short, but slender and pointed.

Venter with thoracic portion usually clothed with paler scales, more rarely with intermixed hairs; abdominal portion more hairy, especially in female on last two segments; mesosternal middle coxal process narrow almost linear, parallel sides; intercoxal process of third abdominal segment broad and sloping to a point.

Legs: femora usually darker brown than tibiæ or tarsi, clothed more or less densely in front with scales, behind usually sparsely clothed with hairs, tibiæ and tarsi variable in color with rather long pale hairs; front tibiæ slightly curved inward in male, spines on the inside of the middle tibia vary in length, crown of spines very short and blunt.

Stem of *male gentialia* (Plate XXIV, fig. 10), from above narrow, parallel, sides uniformly thickened, gradually curved on the last third to a narrowly rounded point; viewed from the side last two-thirds scarcely curved, point sometimes very slightly turned up. The side view (Plate XXIV, fig. 11) is never as in *meles* strongly curved and from the dorsum there can never be seen the peculiar knob-like point possessed by *murinus* (Plate XXIV, fig. 12).

The coloring and pattern of the scales in this species is so variable that it is difficult to describe; and rarely a few specimens have been observed that were as green beneath as *nigrirostris* and as *gray green* above as *comptus* sometimes appears.

Egg: (Plate XXXV, fig. 8). Oval, rounded at ends, lemon-yellow in color when first laid, very slightly roughened, hexagonally sculptured, at one end the depressions are drawn out until they appear as fine striæ. Two to four days after being deposited a dark spot appears at one end as this enlarges the egg becomes paler in other portions, when ready to hatch it is usually shining black where the larval head is beneath the shell and pale yellow or whitish elsewhere. Length 0.55–0.65 mm. Width 0.32–0.38 mm.

Larvæ: (Plate XXXI, figs. 1–2, Plate XXXII, figs. 1,2,9). First stage: 1.4–1.5 mm. long and 0.36 mm. wide. Head shield dark with only a faint trace of the inverted Y, remainder of body pale dirty yellow with black tubercles of segments distinct. Hairs on anal segments longest, all enlarged at tips. Very faint indication of a dorsal stripe.

Second stage: head darker, inverted Y a dirty white, white median dorsal line distinct, remainder of larva green, lighter than plant on which it is feeding. 3.2–4.8 mm. long by 0.7–1.1 mm. wide.

Third stage: entire larva dark ergreen, sometimes the dorsal white line has a rosy red border as in *Hyp. punctata*. A distinct pale stripe is now present on the side of the body below the spiracles; inverted Y on face clear and white. Length 5 to 5.7 mm., width 1.2 to 1.7 mm.

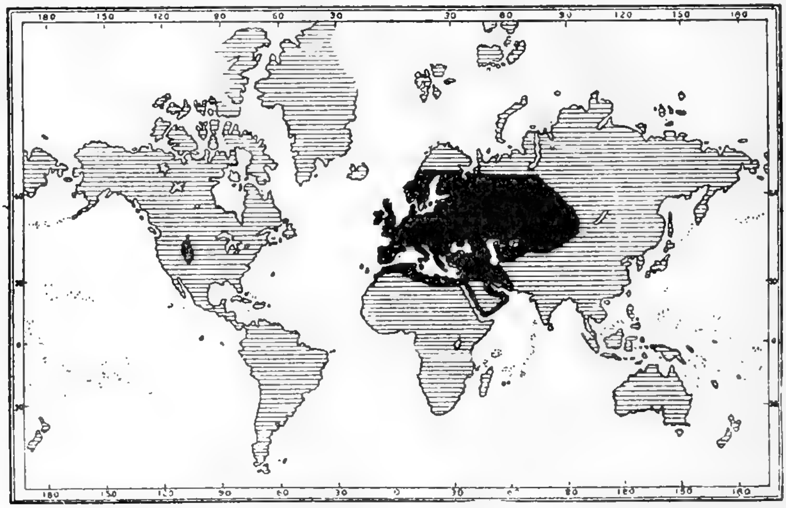
Fourth stage: very little different from the third, larvæ reaches a length of from 7 to 10 mm. and may become as wide as 2.25 mm. The rosy-red of the outer border of the pale median line is much more evident in this stage.

The arrangement of the tubercles is very characteristic. On the first thoracic segment there are three rows (the tubercles are always arranged in pairs on each side of the dorsal line) the first row with 12, the second with 2 and the third with 10. Second segment and all following with at least two rows the anterior of which has but a single pair of tubercles. The posterior on the second segment, 12 tubercles; third segment, 16; fourth and fifth the same; the sixth with 18; seventh with 20; eighth with 16; ninth with 14; tenth with 12, in the posterior, and eight in a middle row; eleventh with 8 in posterior row and 10 in the middle; twelfth with 10 in the posterior row, strongly curved forward in a line. On the sides of the first enlargement below the spiracles are always two hairs situated on tubercles.

Cocoon: (Plate XXXI, figs. 3, 9). varying in size from 4 to 8.5 mm. and occasionly one with one of the axes still longer. Usually oval or globular, depending somewhat on where it is formed. It is composed of pure white threads spun in a rather coarse network, meshes not very regular.

Pupa: (Plate XXXI, fig. 4). Length 4 to 5.5 mm. Width 3 to 4.5 mm.

The newly formed pupa is green and after a few hours pale green, the eyes somewhat darkened at an early stage; the posterior ends of the femora and the anterior ends of the tibiæ are early darkened. Pale dorsal line extending the entire length and onto head but not always the length of the beak. Dorsal rows of transverse setæ enlarged at the tips as in larvæ, hairs on the anal segment rather long and darker than elsewhere on pupa. Prothoracic hairs long, slender, the frontal row not close to the margin, first three pairs in front, fourth on side and fifth far back; central two pairs forming a small square in front of the center, three other pairs in a slight curve near the posterior edge.



Map 10. Distribution over world of *Phytonomus posticus Gyll.*

Distribution: First described by Herbst as *C. haemorrhoidalis* in 1784 from Germany, later by the same author (1795) as *variabilis*, in 1802 by Marsham from England as *C. bimaculatus*. These names were all preoccupied and in 1813 Gyllenhal described it as *R. posticus* from Europe as above noted.

Capiomont and Petri, with other European writers give its distribution as the whole of Europe, southern Siberia, Turkestan, Asia Minor, Persia, Arabia, north coast of Africa, Maderia and Canary Islands and British Isles.

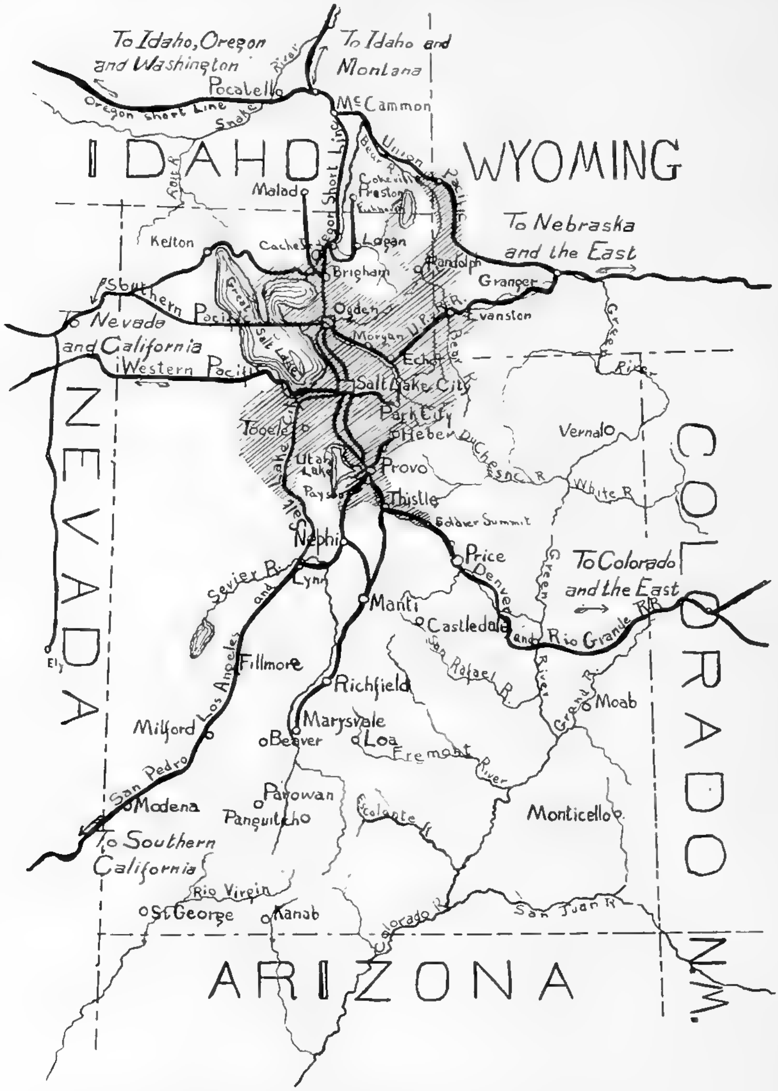
In America it was first reported from Utah, in 1902, and has since been spreading rapidly. Colonies are now known to occur in the adjoining states of Wyoming and Idaho. The accompanying map (map 11) will show the distribution as at present known.

Owing to the extreme variation in size and color there are recorded many synonyms, and doubtless careful working over of the European species will bring to light others. The species has been generally known over Europe as *variabilis*, a name which unfortunately was preoccupied by Fabricius for another insect, also a Phytonomus, in 1781. In the paper in which Herbst described his species he noted that the *variabilis* of Fabricius was merely a variety of *nigrirostris*. This however does not make Herbst's name tenable, the first available name being Gyllenhal's *posticus*.

The species has been reported by most European authors listing Phytonomus.

Life History and *Food Plants:* Little has been written on the life history of this species in Europe, though in late years it has several times been quite injurious. Audouin in describing the collecting habits of *Odynerus spinipes* stated that the larvæ of *variabilis* and *murinus* were living on lucerne (1839). Bargagli in 1884 reported it as seriously injurious in Italy and an editorial in the Bul. Ent. Soc. Ital. 1890, noted that it was a serious pest to clover and alfalfa and briefly describes the egg, larva and cocoon. Koppen (1880) reported serious injury to lucern in Russia. More recently Mr. W. F. Fiske of the Bur. Entomology U. S. Dept. Agriculture told me that the alfalfa regions of south-eastern Russia were being seriously damaged by some kind of a weevil, probably a Phytonomus. The present year Dr. Giovanni Martelli has issued a short contribution to the biology of this species. He states that in April 1909, he observed the medicinal plants in a part of the Gussone park at Portici, Italy, being eaten by larvæ. These he bred and they proved to be "*P. variabilis*". He also observed the species causing injury at Acireale in 1910. He reports it causing serious damage in 1909 at Campobasso and at Acicastello in 1910. The present year it is numerous in many parts of Italy.

Kleine (1910) has reported the following food plants in Europe: *Medicago sativa*, *M. falcata*, *M. media*, and *M. lupulina; Astragalus bayonennsis*, *Phaseolus vulgaris*, *Solanum tuberosum*, *Brassica sp.*, *Rubus vitis ideae* and *Plantago lanceolata*, Bargagli reported finding beetles on *Atriplex patula* at Venice. The *Astragalus* record is probably from Perris.



MAP 11. Showing distribution of *Phytonomus postisus* Gyll., in America and the principal railroads leading out of the infected area. (Adapted from Titus, Bul. 110 Utah Agr. Exp. Sta.)

The following account of its introduction into America and its life history is condensed from that given by the author in Bul. 110, Utah Exp. Sta. 1910, with some additional information secured since that paper went to press and from an article in the

Journ. Economic Entomology, Dec. 1910, which gives technical information not in the bulletin mentioned. The earliest record obtainable of its presence in Utah is its occurrence in the spring of 1904 when it was present on a farm on the east side of Salt Lake City. During the years 1905 and 1906 it spread for several miles. I first saw the beetle and larvæ at work early in July 1907 when I went to Utah as Entomologist; it had not then been reported from America. During the next two years it spread rapidly, reaching a number of outlying districts and probably passed over the first range of the Wasatch Mountains into the Weber valley. During 1909 the greatest extension was to the south and southwest. The weevil reached that year a watershed boundary along these lines. On the south at Olivers there is a gap in this boundary through which the Jordan river flows. In Summit county it passed both up and down the stream a number of miles this year. The boundary lines between Davis and Morgan and between Salt Lake and Summit counties are on the summit of the first range of mountains as may be seen by examining the course of the streams. It will be noticed that this range did not hinder the spread of the insect. The same year it passed to the north by the narrow gap of uncultivated land near the lake border north of Salt Lake City and reached a very fertile and prosperous alfalfa region, that of Davis county. During 1910 the distribution was extensive, especially to the southward into Utah County for a number of miles over a country well supplied with food for the insect. At Provo on the south the mountains again come very close to the lake shore but the insect during the summer of 1910 passed this barrier and reached the south side of the lake, being found as far as Payson (Titus, 1910, Ainslie & Titus, 1911). There is no other barrier to hinder its passage for miles. It has passed the barrier of the short canon between Provo and Thistle and will be able to go easily into the valley southward, the Sanpete and Sevier region growing many acres of alfalfa. In August, 1911, Dr. E. D. Ball took a weevil at Soldier Summit, the highest point in Utah on the Rio Grande railroad. In August, 1911, Mr. V. A. Sadler of the Utah Exp. Sta., took weevils above the Dawson Ranch on Bear Creek, east of Heber. To the north all of Davis and Weber counties have been covered and a few have been found at Collinston, Corinne and Honeyville, Box Elder county. There are many acres of alfalfa throughout the district between Pocatello, Idaho, and Ogden, Utah, including the large and fertile Cache Valley; and to the northwest the lower Bear River and Malad valleys. It has reached the south-west portion of Wyoming at Evanston and Cokeville (H. Smith, 1911), and has been found by Mr. Parks also of the Bureau of Entomology, and by Mr. E. P. Hoff around Bear Lake as far north as Fishhaven, Idaho. There is little food along the Union Pacific railroad for many miles to the east. Westward it has practically reached its limit in the State of Utah, but trains will soon carry it on to the fields of Nevada.

The original Summit and Wasatch county infestations are probably due as much to the moving of camp equipments of the sheep-herders as to any other means. Altitude seems not to affect the weevil and they can probably breed wherever alfalfa can grow, since I have taken larvæ and adults as high as 9,000–9,500 feet in the Wasatch Range. It was probably from this region that they reached Evanston and Lyman, Wyoming.

As with other species of which the life history is known, the beetles are good fliers and distribute themselves readily in this manner. How long these flights may continue is not known, but from the inspection of various districts into which they are moving it is at least possible for them to fly ten to fifteen miles. With this species there are two periods of flight, one in early spring soon after they issue from hibernation, and the other shortly after the adults of the year are appearing in their greatest numbers. The relation of these flights to their life-history may be better understood by consulting the life-history chart in Bul. 110, Utah Exp. Sta. The sense of concealment for protection gives the weevil additional opportunity for distribution since they crawl into any sheltered place. They are often found in fruit packages that are being shipped. Moving of household goods, or in fact any form of freight may give them an opportunity to reach another locality. It is not unusual to find them on the passenger trains going through the infested district and thus they may reach east to the fields of Colorado, Kansas, and Nebraska, and west to Arizona, California, Nevada, Washington and Oregon.

There is practically no danger of distribution in alfalfa seed shipped out of the state, since the weevils even if present, would be screened out in cleaning. At present they do not occur in any region growing seed commercially.

The beetles hibernate in sheltered places of all kinds, roadsides, fences, old orchards, posts, beneath trees in the fallen leaves, in machinery, buildings and haystacks. Some of the adults copulate in the fall. When the first alfalfa begins to grow in the spring the beetles are present and feeding; much is permanently injured by their puncturing the slender stems.

Eggs are laid very early in the year and the egg-laying period is enormously extended. The females mate several times. The males may often be seen sitting on the back of the female and after she has deposited some eggs again mating with her.

The first eggs are laid in or on the leaves, leaf-sheaths, buds or petioles, but later the majority are placed in cavities in the stalks hollowed out by the beak of the female. From one to 28 have been found in a single puncture. The period of incubation is about 10 days.

TABLE I.

Date Laid	Number of Eggs	Days of Incubation										Failed to Hatch
		7	8	9	10	11	12	13	14	15	16	
6 March......	5	3	2	..	..	..	..	..	..	..	..	0
8 March......	30	..	5	..	9	2	..	..	..	..	..	14
21 March......	112	..	9	6	74	8	1	1	1	..	..	12
22 March......	86	1	8	32	34	..	1	..	..	..	..	10
30 March......	27	..	..	..	2	19	4	..	..	..	..	2
9 April.......	38	..	1	..	30	5	..	..	..	..	..	2
15 April.......	7	..	..	..	..	..	..	1	4	..	..	2
16 April.......	60	..	2	11	28	..	9	..	..	..	..	10
18 April.......	140	4	7	14	76	27	8	1	..	..	..	3
19 April.......	19	..	5	5	4	3	..	..	..	..	..	2
23 April.......	246	..	..	8	86	92	8	4	8	4	4	32
25 April.......	138	..	..	15	82	22	10	..	..	..	..	9
10 May........	56	..	..	..	20	20	..	..	..	..	..	16
20 May........	27	..	..	14	9	..	..	..	..	..	..	4
25 May........	33	..	7	5	..	..	..	..	..	..	..	11
31 May........	46	..	9	9	22	2	..	..	..	..	..	4
10 June........	50	..	..	28	20	..	..	2	..	..	..	0
15 June........	16	..	..	9	4	..	..	..	1	..	..	2
24 June........	13	..	..	..	..	..	..	4	1	..	..	8
	1139	8	55	156	500	200	41	13	15	4	4	143

Average hatching period = 10.22+ days.

The young larvæ often feed in the stems for a considerable time, (Plate XXXII, fig. 9), some even passing the second molt there. Later they crawl out and up the stem, concealing themselves in the growing leaf-buds where they feed extensively and effectually stop the growth of the plant. When nearly full grown many feed entirely unprotected on the leaves. At this time the plants in a severely infested region become practically defoliated. The larvæ have the characteristic curled position when feeding and like others of this genus drop to the ground when disturbed.

The first stage is passed in five to eight days; the second in twelve to twenty, third in twelve to twenty-five, and the fourth in one to twelve days.

When full grown they go to or near to the ground and spin their cocoon in a curled leaf or among the debris on the ground. Some even go to other plants nearby and spin up. From 24 to 48 hours after making the cocoon they change to the pupal stage and remain in this for six to fourteen days before emerging as adults. The adult beetle usually spends one or more days in the cocoon before cutting its way out. The cocoon is not usually eaten, only a large enough place to allow the adult to escape being made. The length of life of the adult varies from ten to fourteen months, and some may live over until the second year. I had one female from a lot of eggs hatched in May, 1909, that lived until May 11, 1911. She was mated with one of the same lot, with a son and with a grandson (bred in captivity the winter of 1910–11) and each time laid eggs which were fertile. She laid at least 312 eggs.

The greatest period of emergence is three to four weeks after the first beetles appear from the eggs laid that year. After July or August the weevils feed but little, but up to that time they cause considerable damage by gnawing the parenchyma of the alfalfa and clover stalks.

We have bred the weevil from the following food-plants: *Medicago sativa*, *M. lupulina*, *Melilotus alba*, *M. officinalis*, *Trifolium pratense*, *T. repens*, *T. hybridium*, and *T. incarnatum*. I have several times found them hibernating under leaves of *Astragalus utahensis*. Injuries to wheat and potatoes have been reported but I have not observed them. I have, however, repeatedly seen the adults feeding on ripe strawberries.

Enemies: The enemies in America are very scarce and do little to aid in checking the insect. Several undetermined Carabids feed upon the weevil, its pupa and larva; three Heretoptera, *Acanthorocis musculus*, *Reduviolus roseipennis* Reut. (Det. Otto Heidemann), and *Miris affinis* have been seen eating the eggs, while several species of ants, including *Pogonomyrmex occidentalis* Cress. (Det. W. M. Wheeler), capture the larvæ when crawling on the ground and more rarely ascend the plants for them. Several spiders that frequent alfalfa fields occasionally capture larvæ. Frogs, toads, horned toads, lizards and swifts all do a small part each toward the control. Blackbirds and the western grosbeak often eat them. Even the English sparrow will get one once in a while and very rarely a few are fed to its young. Chickens and turkeys readily feed on them, but soon become satiated and will eat no more until the next day. A vole killed in an alfalfa field where they were very numerous had one beetle in its stomach.

At the present time the Bureau of Entomology is endeavoring to introduce egg-parasites (Mymarids) from Italy, and other parasitic enemies from Europe.

In Europe, Audouin, Girard, Fabre and others have reported the capture of the larvæ of this and another species (*Phytonomus murinus* Fab.) by a wasp, *Odynerus spinipes.* The wasp stings the larvæ and then stores them in its burrows for the feeding of its young. One of the most fascinating of Fabre's papers is upon the life-history and habits of this wasp. Bertolini reports that Carpentier cites a Pteromalus as feeding on this species. A species of Canidia is also reported as parasitic.

Dr. L. O. Howard of the Bureau of Entomology at Washington very kindly sent me a translation of a paper by Dr. G. Martelli of the Experiment Station at Portici, Italy. In it is recorded *Canidia curculionis* Thoms. This species hibernates in its cocoon in the cocoon of the weevil, emerges in February, and deposits its eggs in the small larvæ of the Phytonomus. The weevil larvæ attain maturity and spin their cocoon, the mature parasite then feeds on the internal organs, kills the larvæ and later issues from the skin and spins its own cocoon. This is at first white, but in a day or so becomes dark red and later develops a testaceous brown color with a white band. Its length is 2 to 2.5 mm., and its width over 1 mm. Martelli had adults issue 24 April from parasites born 24 March. He states that the larva matures in 11 to 13 days, the pupa in 2 days and the adult issues from 14 to 16 days later. This gives 27 to 31 days from the egg to adult. There are two generations each year, the second hibernating.

He also records a species of *Eulophus* the adults of which appear about the middle to the end of May. The eggs, from one to six in number, are deposited on the outside of the body of the Phytonomus larva. This parasite may also be hyperparasitic on *Canidia*.

A third parasite recorded is *Pimpla maculator* F., the life-history of which is unknown.

Three hyperparasites are recorded: a *Habrocytus*, a *Chalcid* and *Dibrachis boucheanus*, all living upon the *Canidia*.

Disease: Attempts were made in 1910 by the agents of the Bureau of Entomology to introduce *Entomophthora sphaerosperma* into Utah. It is not yet certain that these were successful and even if introduced it is extermely improbable that the disease will be of any particular value in the arid regions of the West.

INDEX TO SPECIES AND SYNONYMS.

INDEX TO PLANTS.

EXPLANATION OF PLATES.

PLATE XXIV.

1. Maxilla *P. comptus*.
2. Labial palpus. *comptus*.
3. Mandible *comptus*.
4. Mandible of *P. posticus*.

Stem (forceps) of genitalia (dorsal view except 5 and 11).

5. *P. comptus* (side view, New Jersey specimen).
6. *P. comptus*.
7. *P. eximius* (Nebraska specimen).
8. *P. quadricollis* (Aweme specimen).
9. *P. meles* (Connecticut specimen).
10. *P. posticus*.
11. *P. posticus* (side view).
12. *P. murinus* (European specimen).
13. *P. rumicis* (European specimen).
14. *Hypera punctata*.
15. Mandible, *P. meles*.
16. Maxilla, *P. meles*.
17. Antenna, *P. comptus*.
18. Emarginate hair.
19. Emarginate scale.
20. Deeply emarginate scale.
21. Deeply cleft scale.
22. Cleft scale.

Larval segments (dorsal outlines).

23. *P. meles* (redrawn from Laboulbene).
24. 4th segment, *H. punctatus*.
25. 4th segment, *P. posticus*.
26. 4th segment, *P. nigrirostris*.
27. 8th segment, *P. posticus*.
28. 8th segment, *P. nigrirostris*.
29. 1st thoracic, *H. punctata*.
30. 1st thoracic, *P. posticus*.
31. 1st thoracic, *P. nigrirostris*.
32. 8th segment, *H. punctata*.

PLATE XXV.

Hypera punctata Fab.

1. adult dorsal.
2. adult ventral.

(Enlarged 10x).

PLATE XXVI.

Hypera punctata Fab.

1. full-grown larva.
2. cocoon.
3. pupa, ventral.
4. adult, face.
5. pupa, side.

(Enlarged 10x).

PLATE XXVII.

Phytonomus diversipunctatus Schrank.

1. adult side (Greenland spec.)
2. adult face (Greenland spec.)

Phytonomus quadricollis Lec. (type M. C. Z.)

3. adult dorsal.
4. adult side.
5. adult face.

Phytonomus eximius Lec. (type M. C. Z.)

6. adult dorsal.
7. adult side.
8. adult face.

(Enlarged 10x).

PLATE XXVIII.

Phytonomus comptus Say.

1. adult dorsal tessellated form.
2. adult dorsal red form.
3. adult side red form.
4. adult face tessellated form.
5. cocoon (Illinois).
6. pupa (alcoholic specimen).
7. larva (alcoholic, New Jersey).

(Enlarged 10x).

PLATE XXIX.

Phytonomus trivittatus Say.

1. adult dorsal (type of setigerus Lec. M. C. Z.).
2. adult face (type of setigerus).
3. adult side (type of setigerus).
4. adult dorsal (Aweme specimen).
5. adult side (Kansas specimen).

Phytonomus seriatus Mann.

6. adult face.
7. adult dorsal.

Phytonomus maritimus Titus.

8. adult face.
9. adult dorsal.

Phytonomus pubicollis Lec. (type M. C. Z.).

10. adult, dorsal.
11. adult face.
12. adult side.

(All enlarged 10x).

PLATE XXX.

Phytonomus nigrirostris Fab.

1. adult dorsal.
2. pupa (alcoholic).
3. cocoon.

Phytonomus meles Fab.

4. adult dorsal, gray form.
5. adult dorsal, striped form.
9. adult face, striped form.

Phytonomus castor Lec.

7. adult dorsal, type (M. C. Z.).
8. adult side, type (M. C. Z.).
6. adult face, Aweme specimen.

(All enlarged 10x).

PLATE XXXI.

Phytonomus posticus Gyll.

1–2. larvae.
3. cocoon.
4. pupa.
5–6. large and small adults.
7. adult, face.
8. adult, ventral.
9. cocoons (various forms, 2x).

(All but fig. 9 enlarged 10x).

PLATE XXXII.

Phytonomus posticus Gyll.

1. larvae in characteristic feeding position.
2. larvae showing typical curling habit.
3. leaf showing injury.
4. adult injury to stem.
5–7. adult feeding punctures.
8. stem split open showing eggs.
9. young larva coming out of stem.

(Figs. 1–7 adapted from Titus: Bul. 110, Utah Agr. Exp. Sta.)

PLATE XXXIII.

Phytonomus posticus, Gyll.

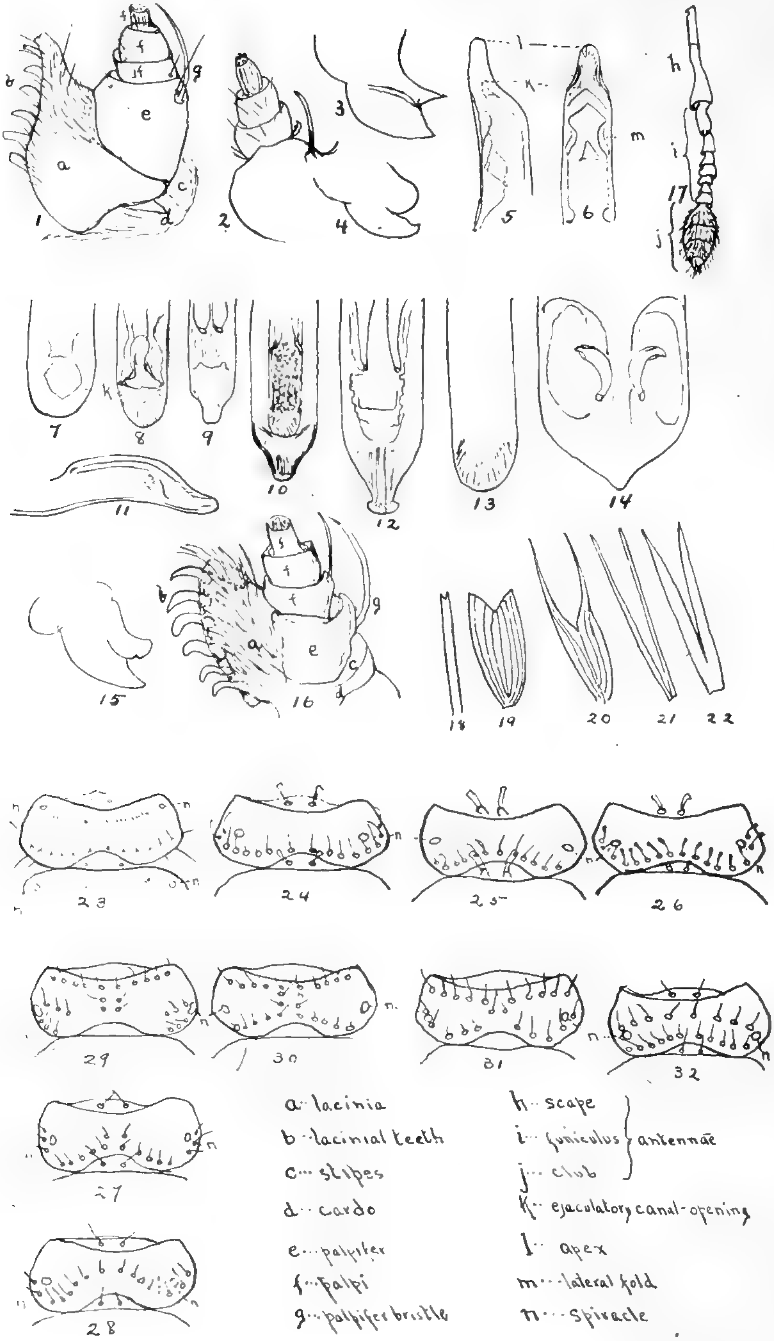
1. Barton gathering machine at work.
2. Hemenway gathering machine.
3. Weevil larvae captured from three acres by Barton machine.

(From Titus, Bul. 110, Utah Agr. Exp. Sta.)

PLATE XXXIV.

Phytonomus posticus. Gyll.

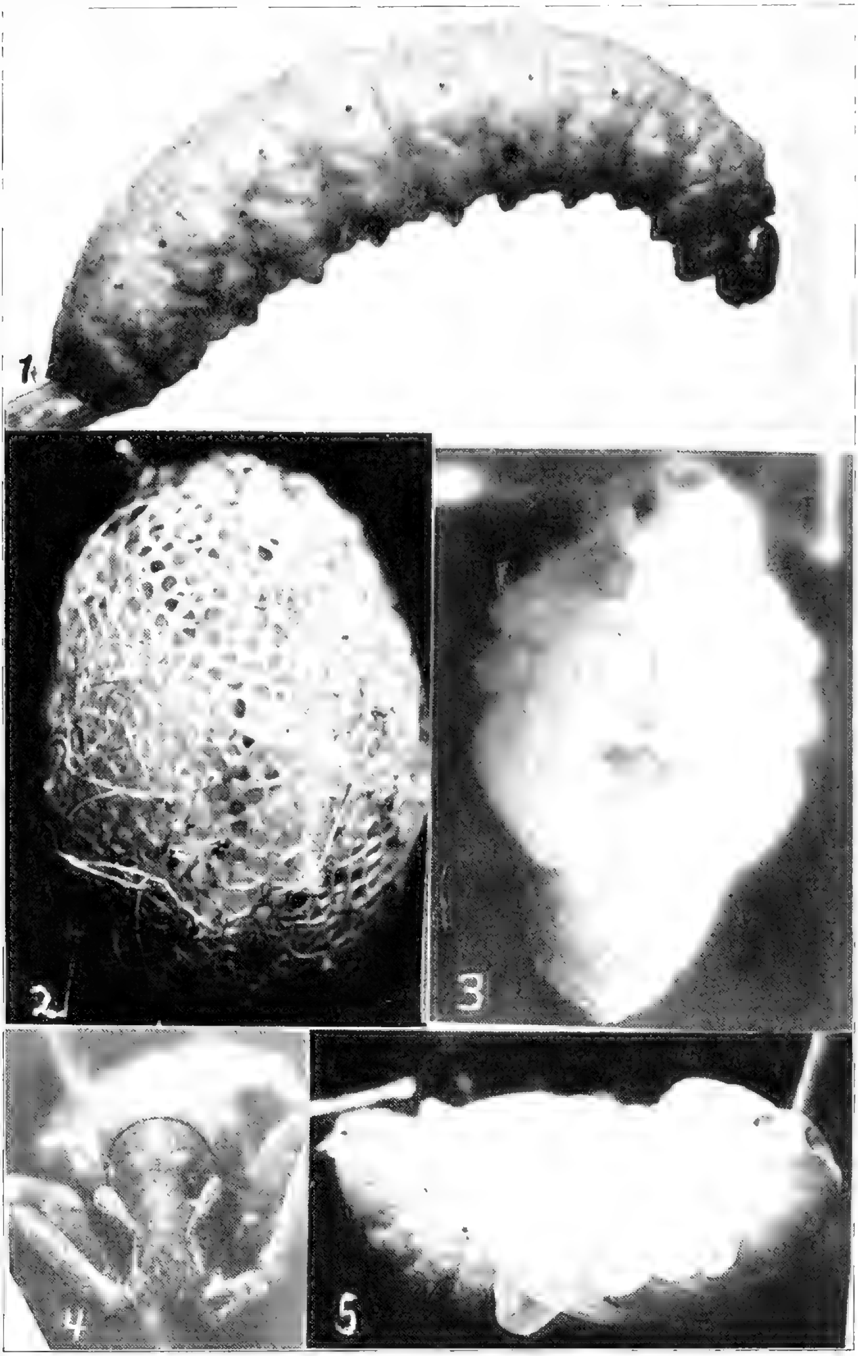
1. Second crop alfalfa on ground harrowed and brush-dragged (Fox place).
2. Second crop alfalfa on untreated ground same date.
3. Typical hibernation quarters on border of field.



a lacinia
b lacinial teeth
c stipes
d cardo
e palpifer
f palpi
g palpifer bristle
h scape
i funiculus
j club
antennae
k ejaculatory canal-opening
l apex
m lateral fold
n spiracle

E. G. Titus.

E. G. Titus.



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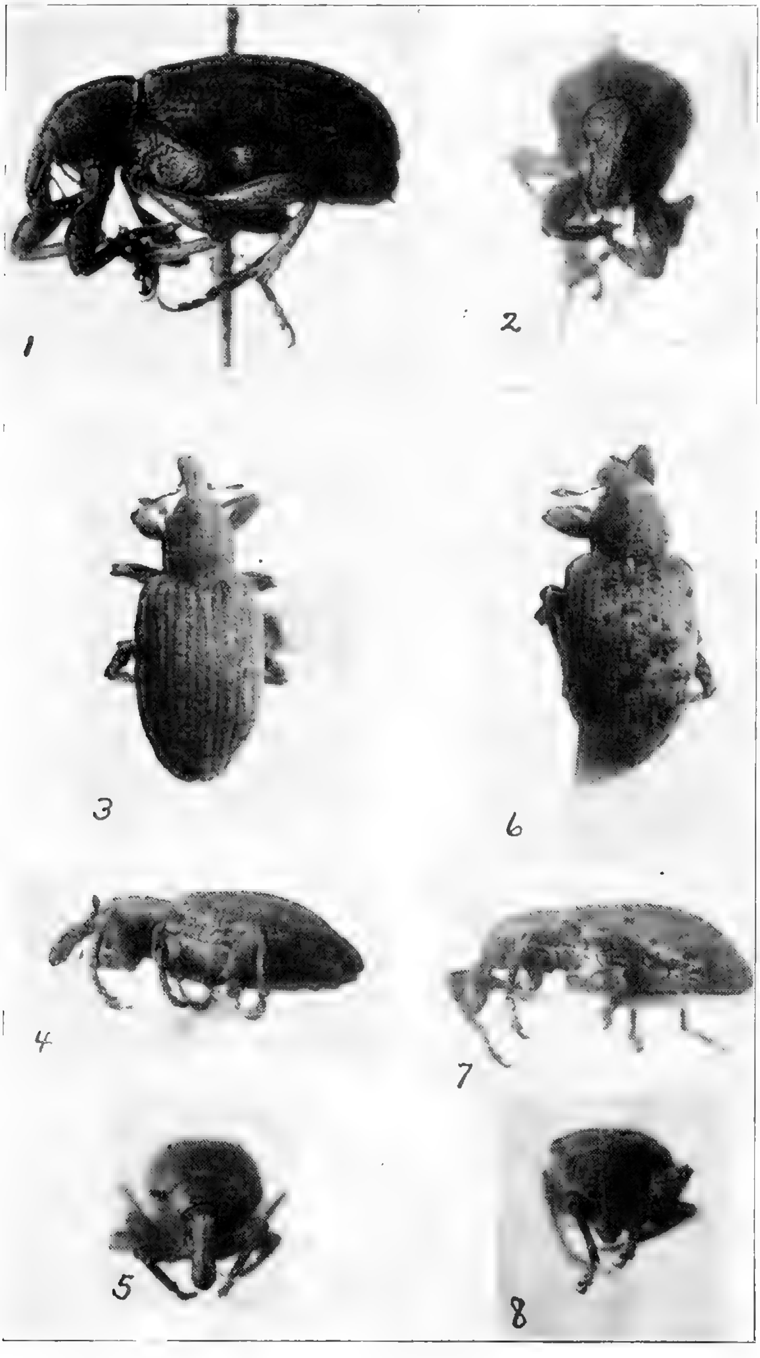

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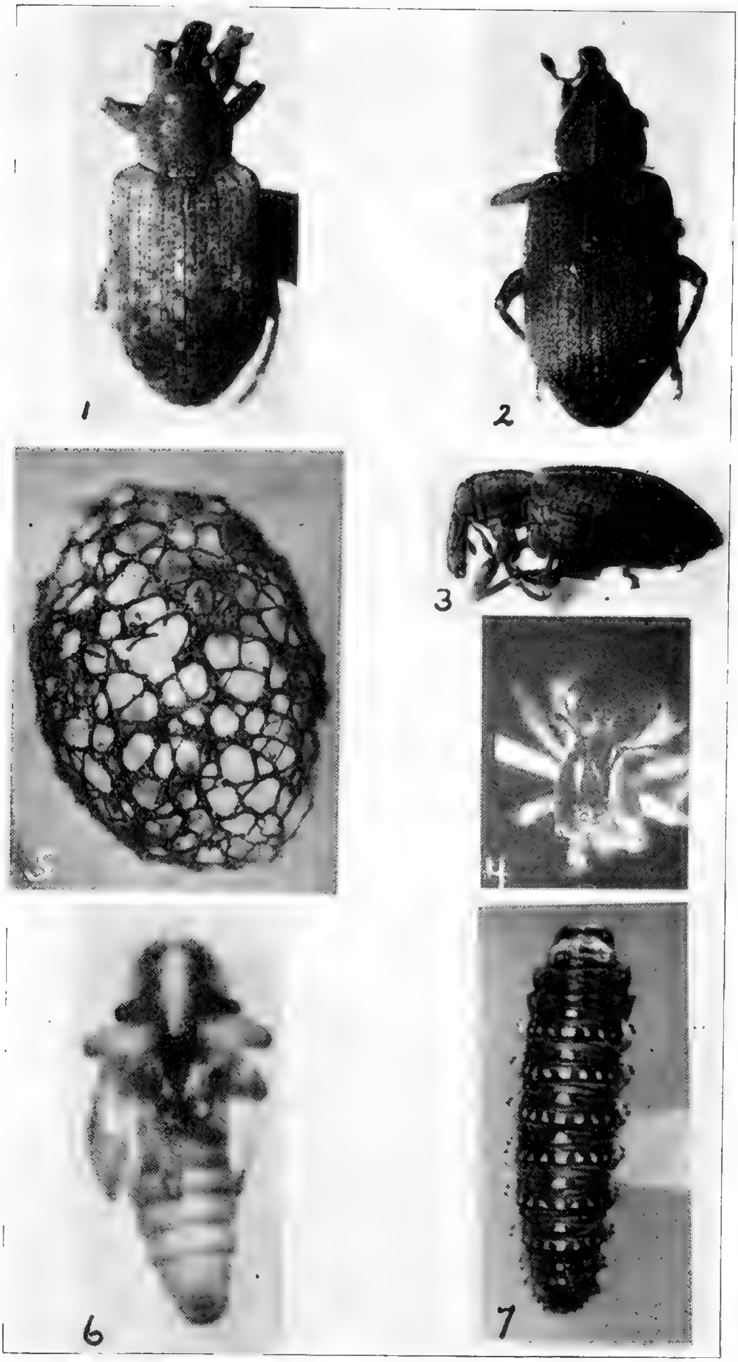

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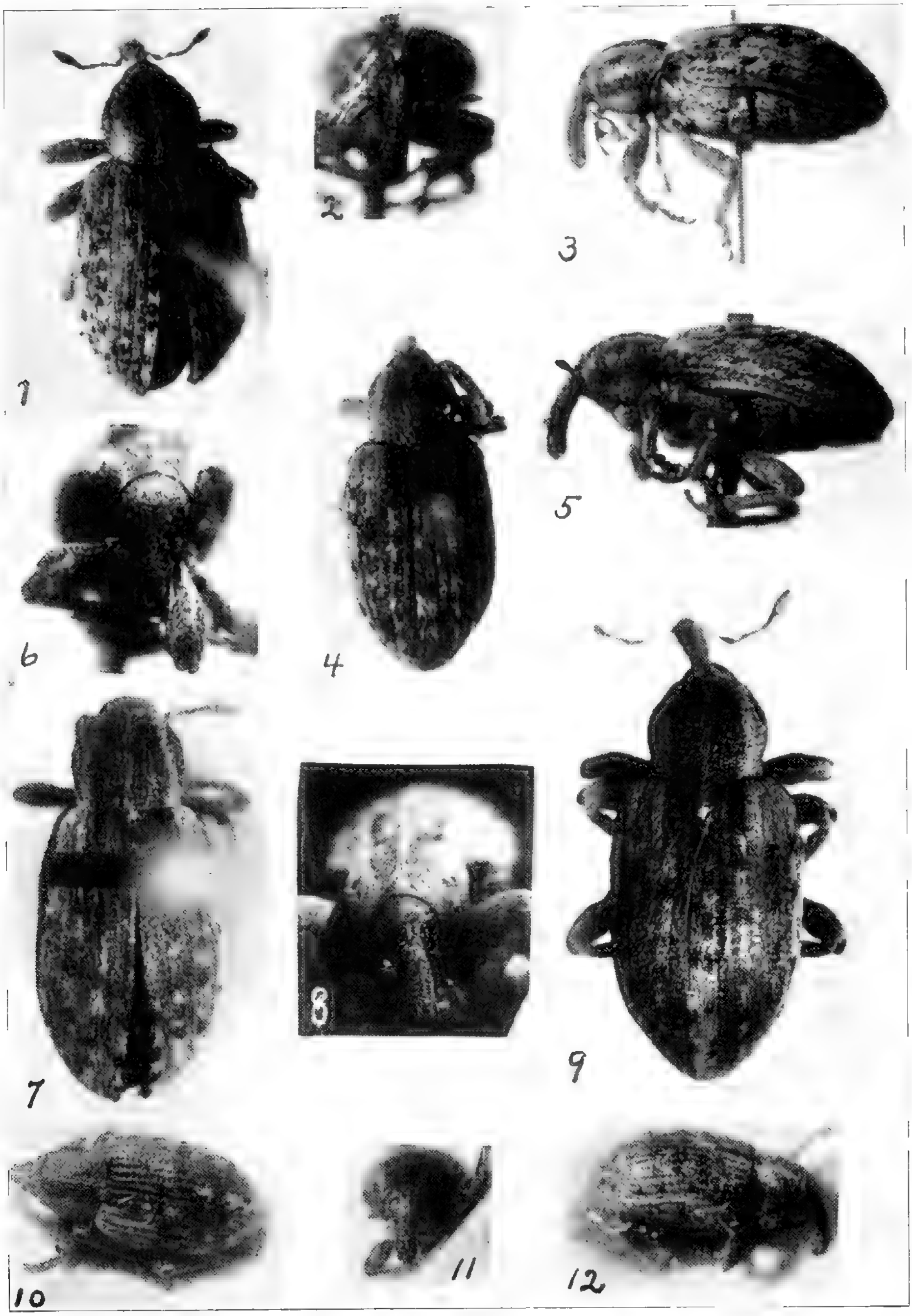

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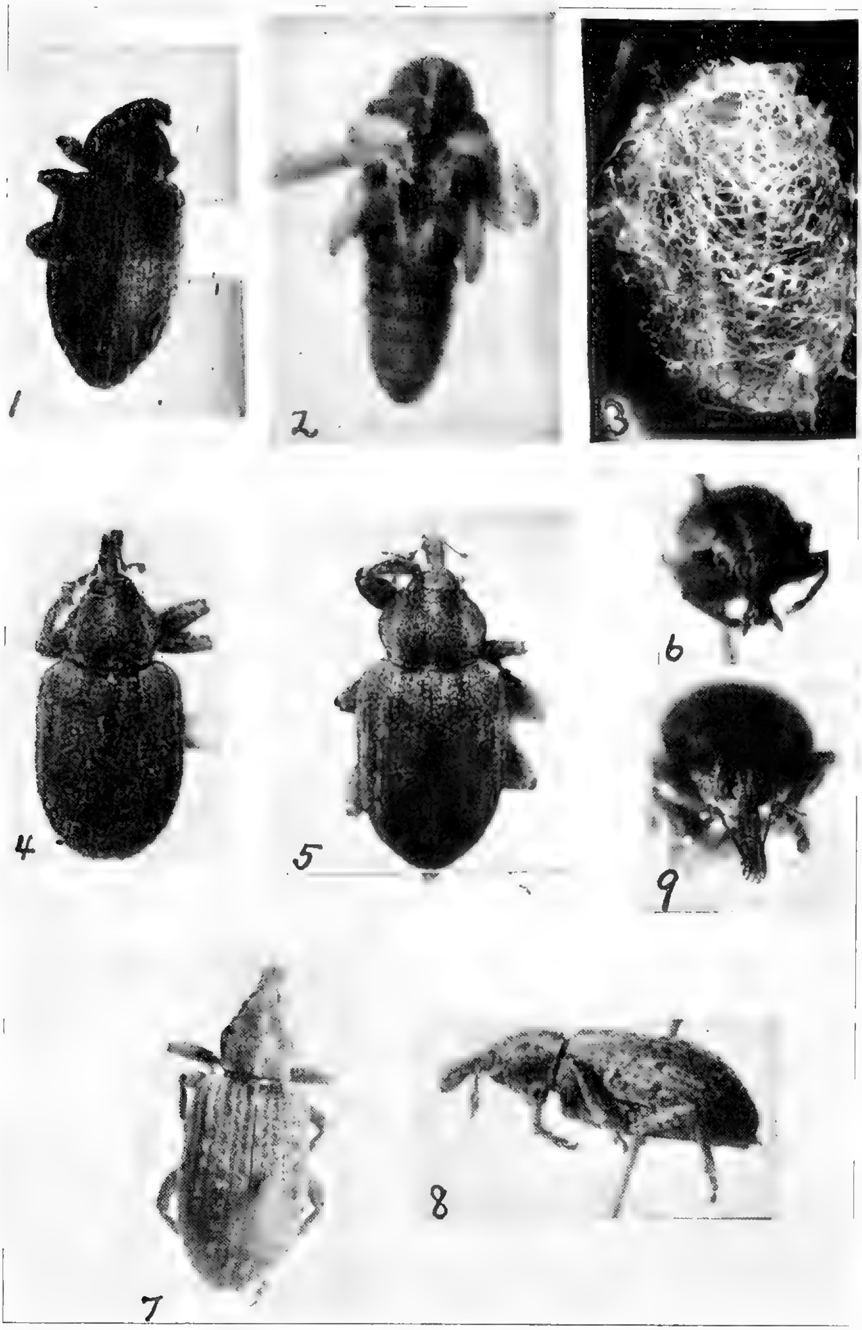

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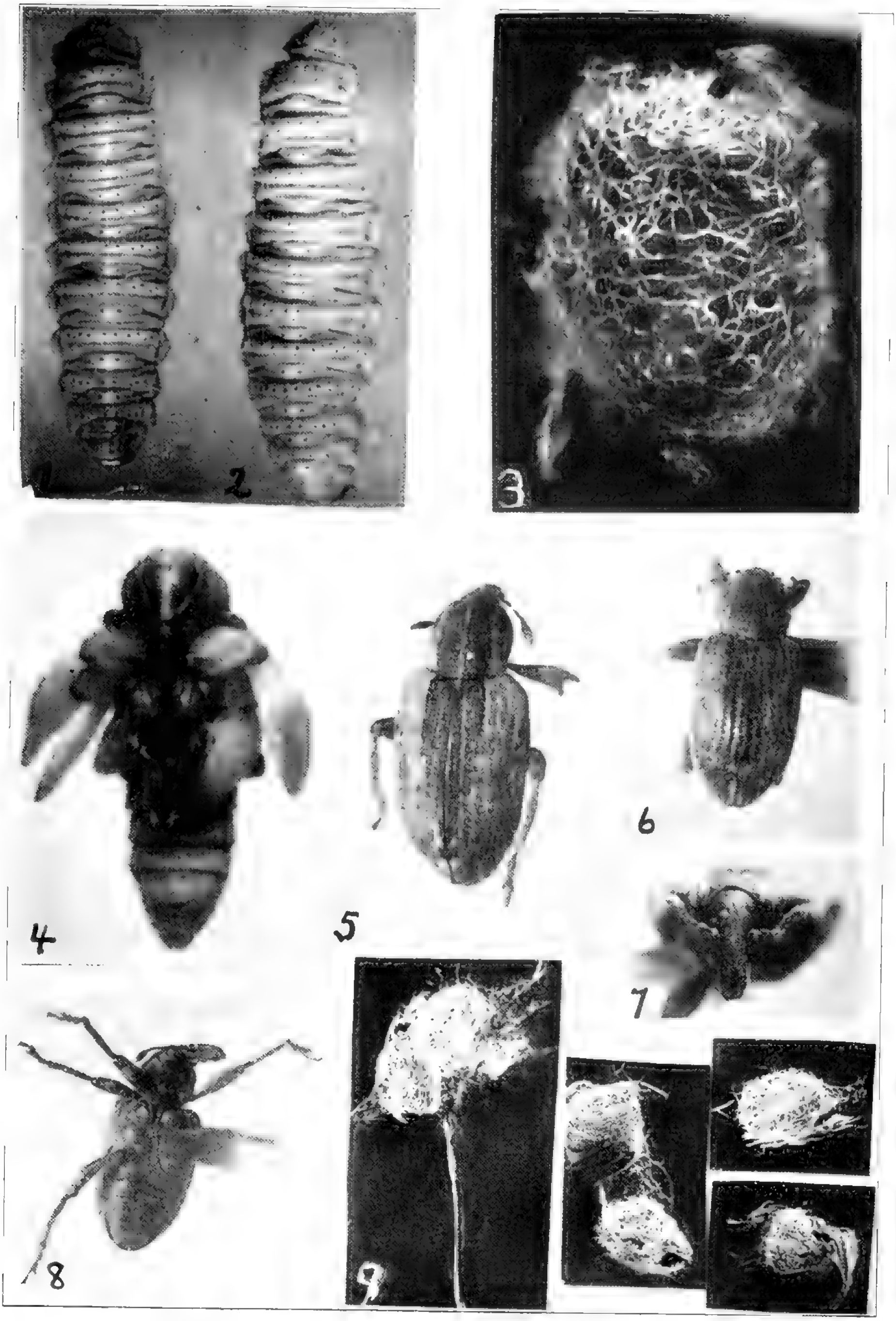

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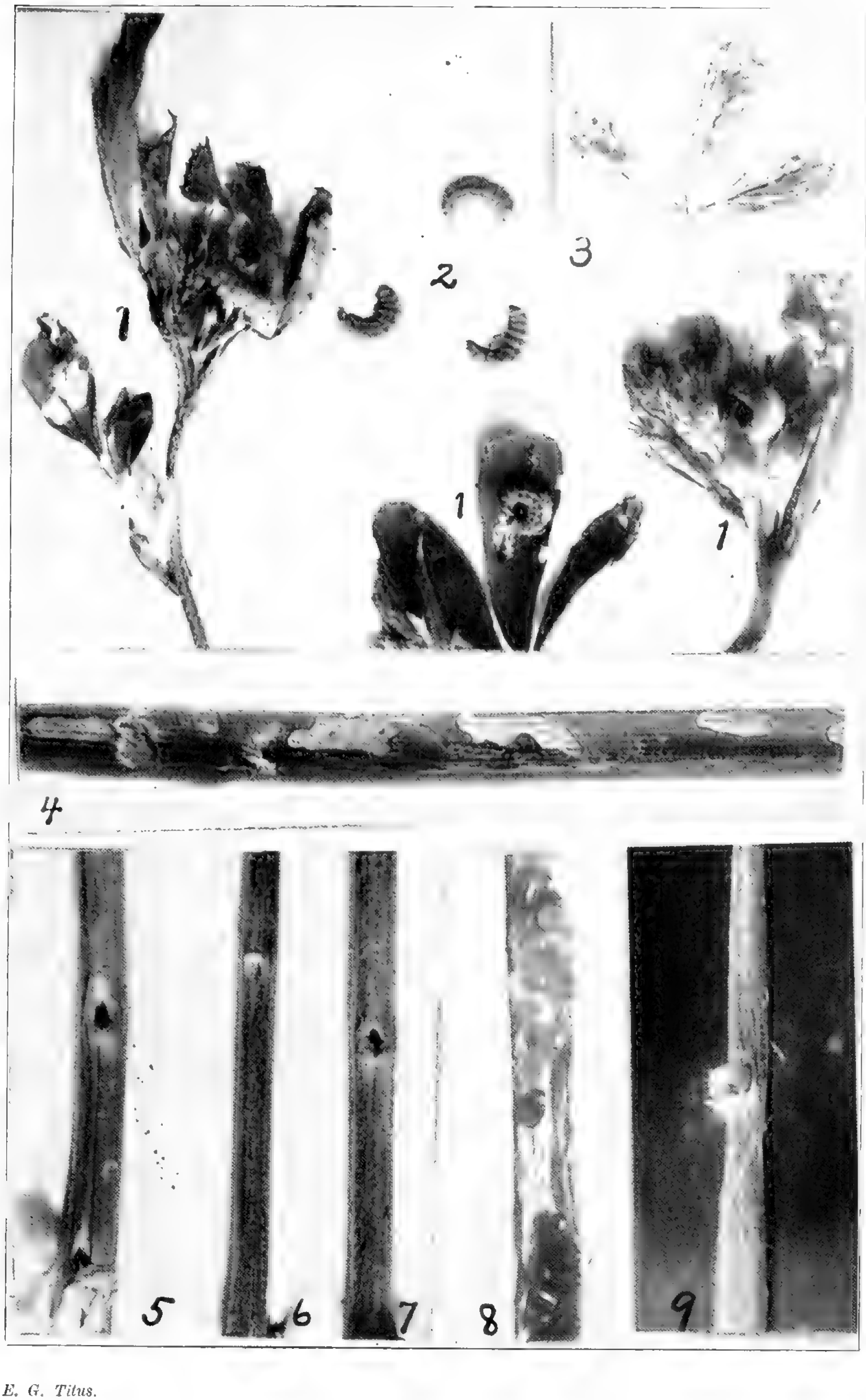

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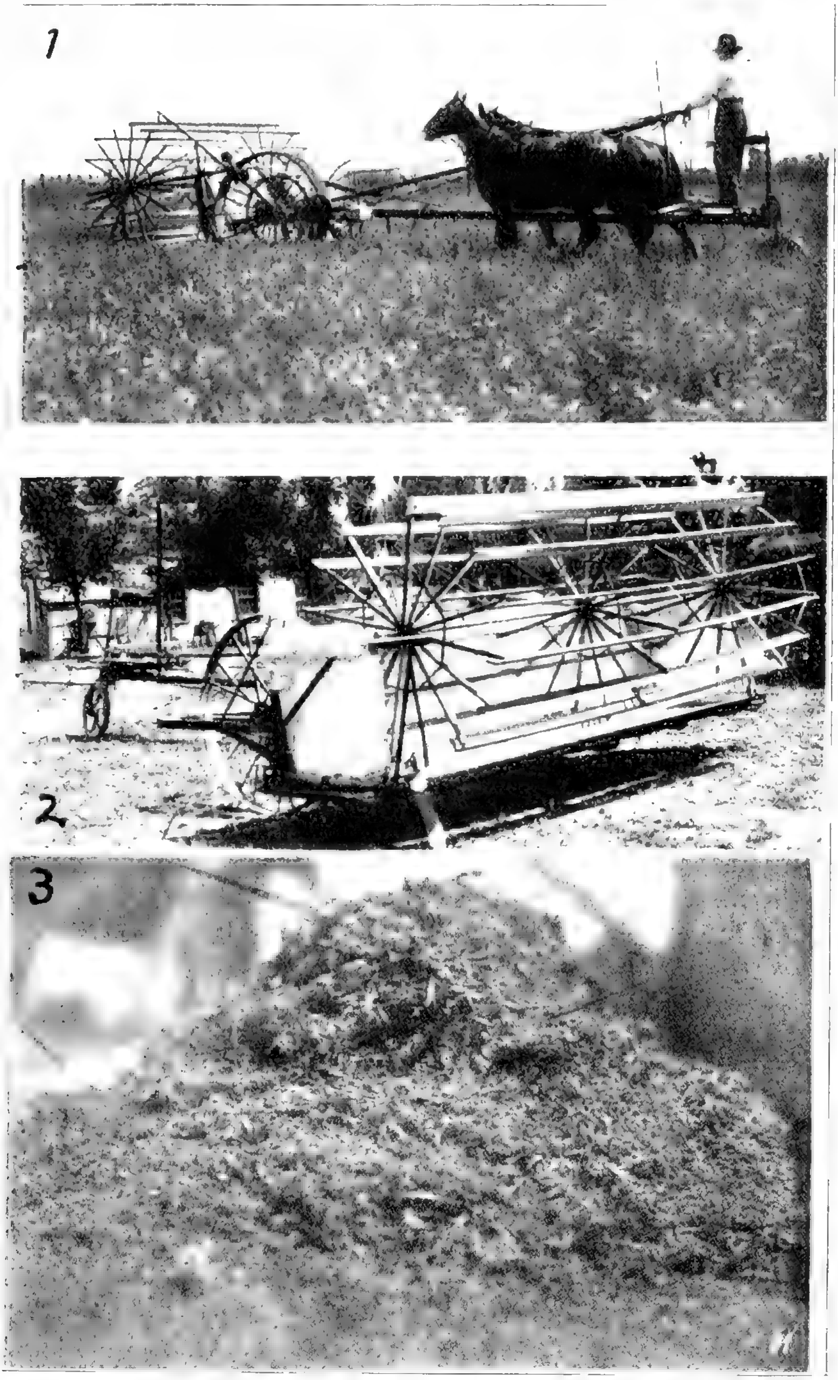

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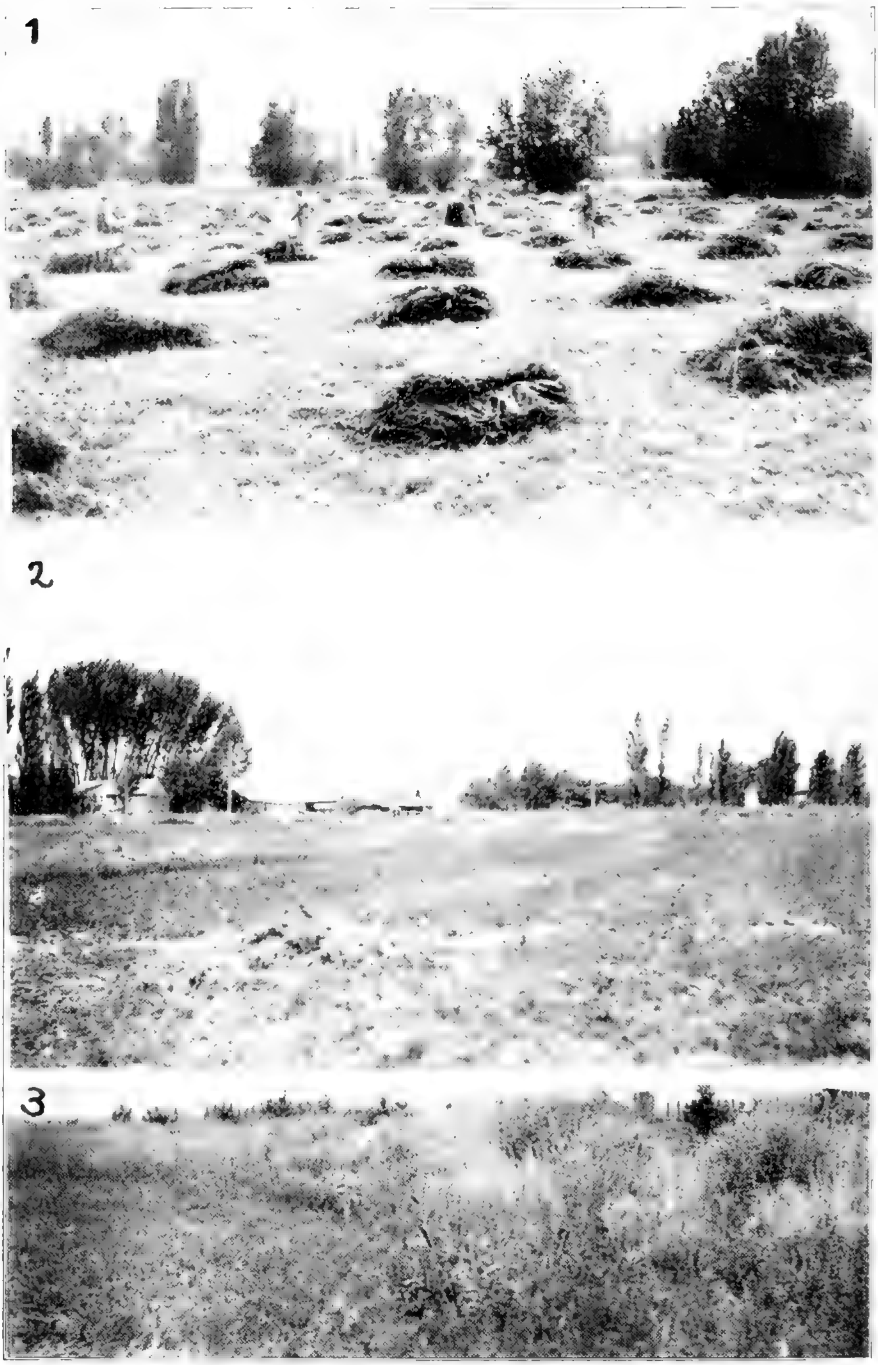

E. G. Titus.

ERRATA, VOL. IV.

Errata to article on Heredity in Adalia by Miriam A. Palmer in September number.

Page 289, 8th line from the bottom should read "*8 humeralis*" instead of "*8 annectans.*"

Page 295, 12th line from the top should read "Plate XXI" instead of "Plate III."

Page 297, 6th line from the bottom should read "Fig. 3, Plate XX" instead of "Fig. 2, Plate XX."

Page 301 and 302 in Explanation of Plates, read "Plate XX" instead of "Plate II"; and read "Plate XXI" instead of "Plate III."

INDEX TO VOLUME IV.

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