

~~Larvae~~ of Melolonthinae

With Keys to Tribes, Genera, and
Species (Coleoptera: Scarabaeidae)

By P. O. Ritcher



University of Kentucky Agricultural Experiment Station
University of Kentucky
Lexington

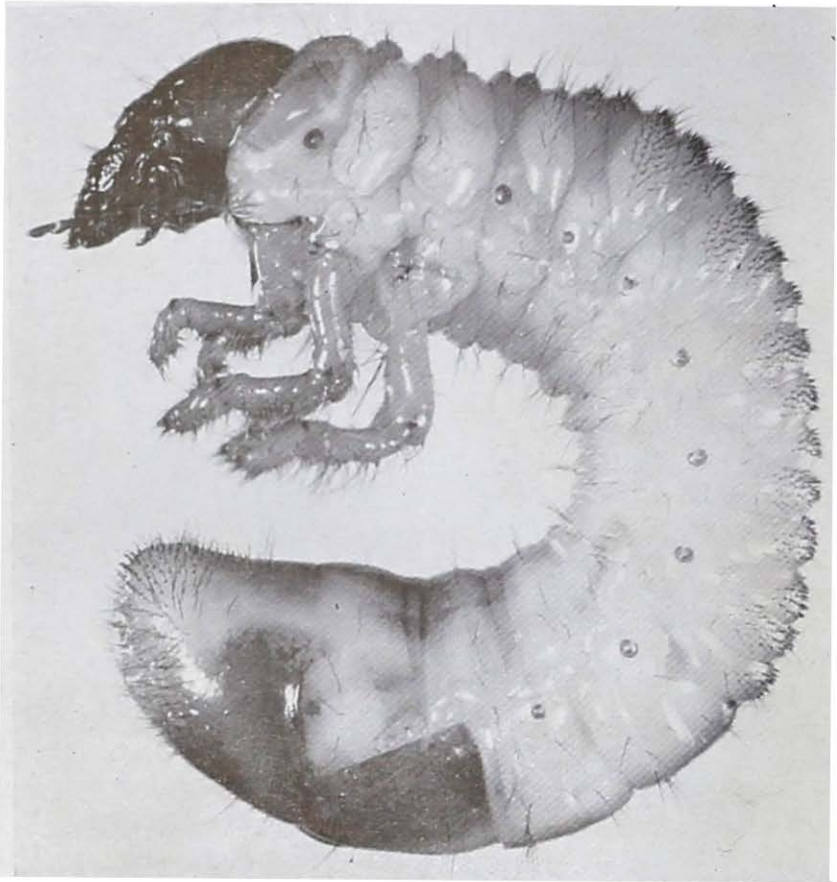


Fig. 1.— Third-stage larva of *Phyllophaga hirticula* (Knoch), left lateral view. Much enlarged.

CONTENTS

	Page		Page
Subfamily Melolonthinae	4	Tribe Macroductylini	15
Key to Tribes of the		Tribe Pachydemini	16
Subfamily Melolonthinae	4	Tribe Plectrini	17
Tribe Sericini	5	Tribe Melolonthini	18
Tribe Dipptaxini	11	Bibliography	26
Tribe Hopliini	12	Plates, with lists of	
Tribe Dichelonycini	13	symbols used	30

Larvae of Melolonthinae

With Keys to Tribes, Genera and Species

(Coleoptera: Scarabaeidae)

By F. O. KITCHER

The scarabaeid subfamily Melolonthinae contains a great many species of small to medium sized leaf-feeding beetles, most of which are nocturnal in habits and dull in color. Species of such common genera as *Phyllophaga*, *Serica* and *Diplotaxis* are usually either brown, reddish-brown or blackish in color. A few species in other genera of the subfamily are brightly colored. Among these are several white-striped species of *Polyphylla* found in the western states, several blue or green species of *Dichelonyx* peculiar to California and the bright green species of *Chlorochiton* found in New Zealand.

The subfamily is world wide in distribution and many of the most injurious species of the family Scarabaeidae belong to this group. Adults of most genera in the subfamily feed extensively on the foliage of trees and shrubs but adults of a few genera attack flowers (*Hoplia* and *Macroductylus*) or fruit (*Macroductylus*). Larvae of species belonging to this subfamily, known universally as white grubs, are subterranean feeders on the roots and underground stems of living plants.

In eastern United States much of the damage done by this group is caused by various species of the genus *Phyllophaga* which is represented by some 150 species. Adult *Phyllophaga*, commonly called May or June beetles, are often so abundant in the North Central States that oak, hickory, and walnut trees are completely defoliated. *Phyllophaga* grubs (Fig. 1) cause extensive damage to the roots of grasses, corn, wheat, strawberries and tree seedlings. They also injure potatoes and vegetable crops. Other genera whose larvae are of economic importance in limited areas are *Polyphylla*, *Serica*, *Diplotaxis*, and the introduced genera *Autoserica* and *Amphimallon*.

Larvae of many species and genera of the subfamily Melolonthinae have been described by workers here and abroad but many still await description. Keys to larvae of the known genera or known tribes have been presented by Hayes (1929), Böving and Craighead (1931), Gardner (1935), van Emden (1941) and others. In the United States Böving (1936, 1942a-c, and 1945) has been most active in describing larvae of the group.

In this bulletin the subfamily Melolonthinae and various tribes

and genera of the subfamily are characterized, based on reared and associated larvae from the collections of the Kentucky Agricultura Experiment Station and the U. S. National Museum. Keys to tribes genera and species are given, based on characters of the third-stage larva and a brief technical description is given of the larvae of many species. Technical descriptions of the many species of *Phyllophaga* have been omitted from this paper since they have been given by Böving (1942) in his detailed study of the genus. This paper is one of a series dealing with various groups of the family Scarabaeidae. Papers on the genus *Phyllophaga* and the subfamilies Rutelinae, Dynastinae, Cetoniinae, Coprinae and Geotrupinae have been previously published (Ritcher, 1940, 1943, 1944, 1945, 1947, and 1948).

SUBFAMILY MELOLONTHINAE

Larvae of the subfamily Melolonthinae may be characterized as follows: Mandible with ventral stridulatory area absent, indistinct or consisting of a patch of minute granules. Scissorial area of mandible with a distal blade-like portion which is separated from a proximal tooth by the scissorial notch. Galea and lacinia of maxilla fused proximally but separated distally; rarely, galea and lacinia separated but tightly fitted together. Lacinia with a row of 3 unci which is usually longitudinal. Antenna 4-segmented. Last antennal segment with a single, oval, dorsal, sensory spot. Anal opening usually angulate or Y-shaped. Lower anal lip usually with a sagittal cleft or groove. Legs well developed, 4 segmented. Each claw bearing 2 setae.

KEY TO TRIBES OF THE SUBFAMILY MELOLONTHINAE

1. Raster with a curved, transverse row of prominent setae anterior to the ventral anal lobes (Fig. 35) or with a prominent oblique row or rows of mustache-like setae, on each side (Fig. 36).....2
 Raster with longitudinal palidia (Figs. 40, 43, 44-47, 51-53) or with palidia absent (Figs. 41, 42 and 49).....3
2. Cardo, maxillary articulating membrane, and many other parts of the body bearing numerous black dots (Figs. 12 and 13). Dorsal anal lobe much smaller than the ventral anal lobes. Raster with a curved, transverse, comb-like palidium (Figs. 35 and 38)....
 tribe *Sericini*.
 Black dots absent. Anal lobes similar in size. Raster with a prominent oblique row or rows of mustache-like setae, on each side, anterior to the ventral anal lobes (Fig. 36) tribe *Diplotaxini*

3. Raster lyre-shaped and without palidia (Figs. 41 and 42).....
tribe *Dichelonycini*
 Raster with or without palidia, if lyre-shaped then with palidia..
4
4. Haptomerum of epipharynx with from 1 to 4 heli (Figs. 19, 20,
 23 and 28)5
 Haptomerum of epipharynx with 5 or more heli (Figs. 16-18, 31
 and 32)6
5. Haptomerum of epipharynx with 4 heli (Fig. 19). All legs with
 well developed claws. Raster with a pair of short, longitudinal
 palidia (Fig. 44).....tribe *Macroductylini*
 Haptomerum of epipharynx with a single helus (Fig. 20). Claws
 of mesothoracic and metathoracic legs reduced in size. Raster
 without palidia (Fig. 49)tribe *Hopliini*
6. Raster, on each side of the septula, with a pair of curved palidia,
 the outer palidium of each pair with pali directed laterad
 (Fig. 47)tribe *Pachydemini*
 Raster without palidia¹ or with a single palidium on each side
 of the septula (Figs. 40, 43, 45, 46, and 51 to 53). Palidium,
 if polystichous, with all pali directed mesad (Fig. 53)7
7. Respiratory plates of spiracles not surrounding bullae
tribe *Plectrini*
 Respiratory plates of spiracles surrounding bullae
tribe *Melolonthini*

TRIBE SERICINI

This tribe is represented in the United States by the native genus *Serica* and one introduced species of the genus *Autoserica*. Species found in Kentucky include *Serica atricapilla* Kirby, *S. evidens* Blatchley, *S. georgiana* Leng, *S. intermixta* Blatchley, *S. loxia* Dawson, *S. mystaca* Dawson, *S. sericea* (Illiger), *S. sponsa* Dawson, and *S. vespertina* (Gyll).²

Larvae of this tribe may be characterized as follows: Head with few setae; anterior and exterior frontal setae absent, posterior frontal setae and setae in anterior angle of frons consisting of a single seta

¹Characteristic of several genera of the tribe Melolonthina which are not known to occur in North America. Among these, according to Böving (1942), are larvae of *Cnemarachis*, *Clemore*, *Anoxia*, and several species of *Ancyloncycha*.

²Material identified by R. W. Dawson, University of Minnesota.

on each side. Eye-spots usually present, black-pigmented. Labrum symmetrical, distally trilobed. Epipharynx (Fig. 23) with a well developed epizygum. Haptomerum with 3 or 4 heli. Plegmatia present; proplegmatia absent. Maxilla with a maxillary stridulatory area consisting of a single row of peg-like teeth. Groups of dark granules present on the cardo and articulating membrane of the maxilla (Figs. 12 and 13), on the prothoracic shield, below the spiracles, on the coxae of the legs, on the sclerites adjacent to the coxae and elsewhere on the body. Thoracic spiracles much larger than abdominal spiracles; arms of spiracular, respiratory plates not constricted. Raster (Figs. 35 and 38) with a single, transverse, slightly curved, comb-like row (palidium) of flattened pali just anterior to the ventral anal lobes. Anal slit Y-shaped with the stem of the Y very much longer than the arms of the Y. Anal lobes densely setose. Dorsal anal lobe much smaller than ventral anal lobes. Teges consisting of a small to large number of hamate setae which are more or less separated anteriorly by a median bare area.

Key to Species of Known Larvae of Tribe Sericini

1. Raster with a teges covering at least the posterior half of the area between the palidium and the anterior margin of the venter of the last abdominal segment (Fig. 35). Teges set with 75 or more setae2
 - Raster with a teges covering less than the posterior half of the area between the palidium and the anterior margin of the venter of the last abdominal segment (Fig. 38). Teges set with fewer than 50 hamate setae5
2. Maxilla with stipes bulbous posteriorly and projecting beyond the cardo (Fig. 12)*Autoserica castanea* Arrow
 - Maxilla with base of stipes not projecting beyond the cardo3
3. Dorsal surface of eighth and ninth abdominal segments each with a rather uniform covering of short fine setae between the anterior and posterior transverse bands of short and long setae. Short fine setae also present laterally between the teges and barbulae on the venter of the last abdominal segment*Serica intermixta* Blatchley
 - Short, fine setae absent on dorsal surface of eighth and ninth abdominal segments between the anterior and posterior transverse bands of setae. Short fine setae absent in region between teges and barbulae4

4. Palidium set with fairly short pali. Teges with a patch of about 45 fairly long, hamate setae, on each side, which are only slightly shorter than the pali*Serica vespertina* (Gyll.)
 Palidium set with fairly long pali. Teges with a patch of 60 or more short setae, on each side.....*Serica sericea* (Ill.)
5. Maxilla with stipes not bulbous posteriorly (Fig. 13).....6
 Maxilla with stipes bulbous posteriorly7
6. Palidium of raster sparsely set with 16 to 23 pali which are about 3 times as long as their greatest width. Head with distinct eye spots*Serica anthracina* Lec.
 Palidium of raster sparsely set with 12 to 18 pali which are more than 4 times as long as their greatest width. Eye spots indistinct or absent*Serica ligulata* Dawson
7. Claw of metathoracic leg only slightly shorter than claws of prothoracic and mesothoracic legs*Serica peregrina* Chapin
 Claw of metathoracic leg much shorter than claws of prothoracic and mesothoracic legs8
8. Claw of metathoracic leg minute*Serica solita* Dawson
 Claw of metathoracic leg short but not minute.....
*Serica curvata* Lec.

Autoserica castanea Arrow, Third-stage Larva

(Figs. 7, 12 and 35)

Description based on the following material:

Ten third-stage larvae dug from soil at Green Farms, Connecticut, November 24, 1941, by J. Peter Johnson.

Maximum width of head capsule ranging from 2.66 to 2.8 mm. Surface of head yellow-brown with shiny, faintly reticulated surface. Eye spots present, black-pigmented. Maxilla (Fig. 12) with greatly swollen stipes which is bulbous proximally and overhangs the cardo. Lacinia with 2 apical unci fused at their bases and a subapical uncus (Fig. 7). Maxillary stridulatory area consisting of a regular row of 17 to 20 long, nearly erect, peg-like teeth which is progressively closer set distally. Teeth absent on proximal third of the stipes. Raster (Fig. 35) with a transverse palidium of 21 to 27 stout pali which are considerably longer and stouter than the tegillar setae. Teges, on each side, with a subtriangular patch of about 50 short, curved hamate setae, the entire teges covering the caudal half of the area between the base of the palidium and the cephalic margin of the last abdominal segment. Claws of metathoracic legs very short.

Serica anthracina Lec., Third-stage Larva

Description based on the following material:

Three third-stage larvae and cast skins of 3 third-stage larvae reared to the adult stage. Seven larvae were found close to the surface of the soil under short grasses in lower ground in the sand hill country near Ben Lomond, California, by L. W. Saylor and P. O. Ritcher. No. 46-10B.

Two third-stage larvae, 1 prepupa and cast skins of 3 third-stage larvae found with pupae which were later reared to the adult stage. Two larvae, 1 prepupa and 6 pupae were found in the soil, from 4 to 6 inches deep, on a high slope at Sigmund Stern Grove, San Francisco, California, by Peter Ting, R. W. L. Potts and P. O. Ritcher, February 26, 1948. No. 46-11A (1).

Maximum width of head capsule ranging from 2.1 to 2.31 mm. Head smooth, light yellow-brown in color. Body yellow. Eyespots present, black-pigmented. Stipes not swollen. Lacinia with 3 unci arranged in a nearly longitudinal row. Maxillary stridulatory area consisting of a single, regular row of 16 to 20 teeth extending nearly to the base of the stipes. Teeth progressively closer set distally with the proximal 7 or 8 teeth separated by a distance as great as 3 times their width. Raster with a sparsely set transverse palidium of 16 to 23 depressed, stout pali which are about 3 times as long as their greatest width. Teges, on each side, very sparsely set with 13 to 20 hamate setae; teges covering less than the caudal half of the area between the palidium and the cephalic margin of the last abdominal segment. Claws of metathoracic leg reduced in size.

Serica curvata Lec., Third-stage Larva

Description based on the following material:

Four third-stage larvae and cast skin of a third-stage larva reared to the adult stage. Larvae collected from soil beneath *Artemisia*, at Oakland, California, March 4, 1946, by P. O. Ritcher. No. 46-7F.

Maximum width of head capsule ranging from 2.5 to 2.87 mm. Surface of head light yellow-brown. Body white. Eye spots present, black-pigmented. Maxilla with stipes bulbous posteriorly, slightly overhanging cardo. Maxillary stridulatory area with a rather closely set row of 19 to 23 fairly long, peg-like teeth which are progressively closer set distally. Raster with a transverse palidium of 19 to 20 fairly long pali. Teges, on each side, sparsely set with 14 to 16 hamate setae, the entire teges covering less than the caudal half of the area between the palidium and the cephalic margin of the last abdominal segment. Claws of metathoracic leg short.

Serica intermixta Blatchley, Third-stage Larva

Description based on the following material:

Eleven third-stage larvae and 4 pupae dug from soil beneath forest leaf mold at Eastport, Michigan, August 9, 1947, by P. O. Ritcher. Pupae reared to the adult stage. Adults identified by R. W. Dawson.

Maximum width of head capsule ranging from 2.45 to 2.6 mm. Head straw-colored. Eye spots present. Stipes slightly swollen. Maxillary stridulatory area consisting of a single, regular, rather closely set row of 20 to 22 peg-like teeth. Teeth progressively closer set distally. Proximal teeth separated by distance less than 3 times the width of a tooth. Raster with a sparsely set, slightly curved, transverse, palidium of 22 to 26 rather short pali which are no longer than many of the tegillar setae. Teges rather thickly set with from 75 to more than 100 hamate setae. Entire teges subtriangular in outline and covering from one-half to two-thirds of the area between the palidium and the cephalic margin of the last abdominal segment. Laterally, among the hamate tegillar setae and the barbulae, are many short, fine setae. Dorsal surface of abdominal segments 8 and 9 with a rather uniform covering of short, fine setae between the anterior and posterior transverse bands of long and short setae. Claws of metathoracic legs about half as long as claws of the prothoracic and mesothoracic legs.

Serica ligulata Dawson, Third-stage Larva

Description based on the following material:

Eleven third-stage larvae and cast skins of 5 third-stage larvae reared to the adult stage. Larvae dug from soil on a hillside beneath *Adenostoma* shrubs at Potwisha, in Sequoia National Park, California, March 25, 1946, by P. O. Ritcher. No. 46-16C.

Four third-stage larvae and cast skins of 4 third-stage larvae, 3 of which were reared to the adult stage. Ten larvae were dug from soil in low ground close to a stream at Potwisha, in Sequoia National Park, California, March 25, 1946, by P. O. Ritcher. No. 46-16B.

Maximum width of head capsule ranging from 2.1 to 2.24 mm. Head yellowish-brown in color. Eye spots absent or very inconspicuous. Stipes not swollen. Lacinia with 3 unci arranged in a nearly longitudinal row. Maxillary stridulatory area (Fig. 13) consisting of a single, regular row of 15 to 18 teeth; proximal 6 to 8 teeth widely separated and fairly long, distal teeth closely set and very short. Raster (Fig. 38) with a single, sparsely set, curved palidium of 12 to 18 depressed pali which are more than 4 times as long as their greatest width. Teges, on each side, sparsely set with 10 to 17 hamate setae. Teges covering less than the caudal half of

the area between the base of the palidium and the cephalic margin of the last abdominal segment. Claws of metathoracic legs much reduced in size.

Serica sericea (Ill.),¹ Third-stage Larva

Description based on the following material:

One third-stage larva from the collection of the Federal Japanese Beetle Laboratory, Moorestown, New Jersey.

Maximum width of head capsule 2.38 mm. Head yellowish-brown. Eye spots inconspicuous. Stipes not swollen. Maxillary stridulatory area with a single, regular, sparsely set row of 15 to 16 peg-like teeth, the proximal 8 teeth separated by a distance twice the width of a tooth at its base. Raster with a transverse palidium of 26 fairly long pali. Teges with a patch of 60 or more rather short hamate setae, on each side. Teges covering the caudal two-thirds of the venter of the last abdominal segment. Claws of metathoracic legs much reduced in size.

Serica peregrina Chapin, Third-stage Larva

Description based on the following material:

Two third-stage larvae from the collection of the Federal Japanese Beetle Laboratory, Moorestown, New Jersey.

Maximum width of head capsule 2.3 mm. Eye spots present. Stipes not swollen proximally. Maxillary stridulatory area with a closely set row of 17 to 20 fairly long, peg-like teeth. Teeth slightly more closely set distally. Raster with a transverse palidium of 15 to 20 pali. Teges, on each side, sparsely set with 15 to 21 hamate setae, many of which are nearly as long as the pali. Teges covering less than the caudal half of the area between the palidium and the cephalic margin of the last abdominal segment. Claws of metathoracic legs only slightly shorter than claws of prothoracic and mesothoracic legs.

Serica solita Dawson, Third-stage Larva

Description based on the following material:

Twenty-eight third-stage larvae and cast skins of 4 third-stage larvae, one of which was reared to the adult stage. Larvae found close to the surface of the soil under short grasses in low ground in the sand hill country near Ben Lomond, California, by L. W. Saylor and P. O. Ritcher. No. 46-10A.

Maximum width of head capsule ranging from 2.3 to 2.45 mm. Surface of head light reddish-brown. Body white. Eye spots present

¹ Described by Sim (1934) under the name *Serica parallela* Casey which is a synonym according to Leng (1920).

Maxilla with stipes slightly swollen proximally. Maxillary stridulatory area with a rather closely set row of 21 to 24 fairly long, peg-like teeth. Teeth progressively more closely set distally. Raster with a transverse palidium of 17 to 24 pali which are about 4 times as long as their greatest width. Teges, on each side, sparsely set with 14 to 21 hamate setae, the entire teges covering less than the caudal half of the area between the palidium and the cephalic margin of the last abdominal segment. Claws of metathoracic legs minute.

Serica vespertina (Gyll.), Third-stage Larva

Description based on the following material loaned by the U. S. National Museum:

One third-stage larva, associated with 2 adults, collected on the shore of Pigeon River, Retreat, North Carolina, June 3, 1893. L-259.

Maximum width of head capsule 2.8. Head yellowish-brown. Eye spots inconspicuous. Stipes not swollen. Maxillary stridulatory area with a single, regular, sparsely set row of 16 to 18 peg-like teeth, the teeth progressively more closely set distally. Proximal 8 teeth separated by a distance about twice the width of a tooth at its base. Raster with a transverse palidium of 23, fairly short, closely set pali. Teges with a patch of about 45 fairly long, hamate setae, on each side, which are only slightly shorter than the pali. Teges covering caudal half of the venter of the last abdominal segment. Claws of metathoracic legs much reduced in size.

TRIBE DIPLLOTAXINI

Several species of *Diplotaxis* occur in Kentucky. Among these are *Diplotaxis frondicola* Say, *Diplotaxis fulvus* Lec., and *Diplotaxis harperi* Blanch.¹ The adults feed at night on the foliage of oak, elm, plum and other trees.

Genus *Diplotaxis*, Third-stage Larva

(Figs. 28 and 36)

Description based on the following material:

Four third-stage larvae collected from bluegrass pasture, behind the plow, north of Versailles, Kentucky, April 5, 1939, by P. O. Ritcher. No. 39-15CC.

Larvae of this genus may be characterized as follows: Head without eye spots. Labrum symmetrical, with a prominent curved transverse ridge. Epipharynx (Fig. 28) with prominent plegmatia; propleg-

¹ Based on identification of material by Mont Cazier of the American Museum of Natural History.

matia absent. Haptomerum with 3 or 4 stout heli in a transvers row. Haptolachus without microsensilla. Maxillary stridulatory are with 10 to 13 blunt teeth. Lacinia with a longitudinal row of unci; distal uncus slightly the largest. Thoracic spiracles more than twice as large as abdominal spiracles. Abdominal spiracles similar in size but decreasing slightly in size caudally.

Anal opening Y-shaped with stem of Y equal in length to the arm of the Y. Anal lobes setose. Lower anal lobes triangular in shape almost equal in size to the dorsal anal lobe. Raster (Fig. 36) posteriorly with an oblique palidium of long mustache-like, acicular setae on each side, just anterior to each lower anal lobe; palidia converging anteriorly. Anterior to each palidium, on each side, is a patch of rather short, hamate, tegillar setae. Ventral surface of prothoracic femora each with a prominent, longitudinal row of 5 spine-like fossorial setae. Claws long on prothoracic and mesothoracic legs, very short on metathoracic legs.

TRIBE HOPLIINI

Only a single species belonging to this tribe is known to occur in Kentucky. *Hoplia limbata* Lec. is fairly common east of Jackson Kentucky, in Breathitt county.

Genus *Hoplia*, Third-stage Larva

(Figs. 20 and 49)

Material studied:

1. Nine third-stage larvae and cast skins of 3 third-stage larvae of *Hoplia cazieri* Boyer reared to the adult stage. Adults identified by Cazier. Larvae dug from soil around grass roots in bottom land near Tesla, California, February 20, 1946, by William Barr, Ray Smith, J. W. McSwain and P. O. Ritcher. No. 46-7C
2. Four third-stage larvae and cast skins of 2 third-stage larvae of *Hoplia equina* Lec. reared to the adult stage. Adults determined by E. A. Chapin. Larva found at roots of gum hedge at Pittsville, Maryland, April 5, 1941, by W. H. Anderson.
3. Twenty-three third-stage larvae and cast skins of 7 third-stage larvae of *Hoplia oregona* Lec. reared to the adult stage. Adults identified by Cazier. Larva dug from low, moist ground with a cover of grass and wild strawberries in the dune area of San Francisco, California, February 26, 1946, by Peter Ting R. W. L. Potts and P. O. Ritcher. No. 46-11B.

Larvae of the genus *Hoplia* may be characterized as follows: Head without eye spots. Labrum symmetrical. Maxillary stridulatory area with a row of 9 to 11 short teeth with anteriorly-directed points. Lacinia with a longitudinal row of 3 unci. Distal 2 unci fused at their bases; subapical uncus much smaller. Epipharynx (Fig. 20) with plegmatia; plegmata quite short. Proplegmatia present or absent

Epizygum absent. Haptomerum with a single helus. Dexiophoba and laeophoba absent. Haptolachus without microsensilla.

Thoracic spiracles and those on abdominal segments 1 to 3 similar in size; spiracles of abdominal segments 4 to 8 much smaller. Anal lobes Y-shaped; stem of Y about half as long as either arm of the Y. Anal lobes setose. Raster (Fig. 49) consisting of a subtriangular tege of approximately 30 to 60 fairly long hamate setae with curved tips. Claws of prothoracic legs large and falcate. Claws of mesothoracic legs much reduced in size. Claws of metathoracic legs minute or absent.

TRIBE DICHELONYCINI

Species belonging to this tribe are most numerous in the states west of the Rocky Mountains. The genus *Coenonycha* is restricted to that region but the genus *Dichelonyx* also occurs in eastern United States. A single specimen of *Dichelonyx linearis* (Gyll.)¹ was jarred from a peach tree at Smithland, Kentucky, on April 7, 1949 by W. D. Armstrong and the writer. This is the only Kentucky record for the genus.

Key to Genera

Raster on each side, with an anterior, dense, triangular patch of very short, stout conical setae. Anal lobes bare, *Dichelonyx*
 Teges with setae rather uniformly distributed. Anal lobes setose.
 *Coenonycha*

Genus *Dichelonyx*, Third-stage Larva

(Figs. 22 and 42)

Material studied:

1. Seven third-stage larvae of *Dichelonyx bucki* Kby. collected at Saskatoon, Sask., Canada, by Kenneth King. Loaned by U.S. National Museum.
2. Eleven third-stage larvae of *Dichelonyx robusta* Fall and cast skins of 6 third-stage larvae reared to the adult stage. These larvae were part of a lot of 54 third-stage larvae and 17 second-stage larvae dug from soil in a grassy flat near the top of Mt. Hamilton, California, February 22, 1946, by L. W. Saylor and P. O. Ritcher. The larvae were from 1 to 7 inches deep in the soil with most of them being found between 3 and 5 inches in depth. No. 46-8A.
3. Three prepupae, 4 third-stage larvae and cast skins of 2 third-stage larvae of *Dichelonyx truncata* Lec. reared to the adult stage. Larvae and prepupae dug from soil beneath *Adenostoma* shrubs in Banning Canyon, 4 miles north of Banning, California, April 5, 1946, by P. O. Ritcher. No. 46-17A.

Larvae of the genus *Dichelonyx* may be characterized as follows: Head without eye spots. Labrum symmetrical. Epipharynx (Fig. 22)

¹ Identified through the courtesy of O. L. Cartwright of the U.S. National Museum.

with plegmatia. Plegmata rather short. Proplegmatia consisting of a single proplegma on each side. Clithra present. Epizygum absent. Haptomerum with a transverse row of 2 to 4 heli. Laeophoba absent. Tormae united. Haptolachus without microsensilla. Maxillary stridulatory area with a sparsely set row of 9 to 12 conical, anteriorly directed teeth. Lacinia with 3 unci in a longitudinal row, the distal uncus slightly the largest.

Thoracic spiracles much larger than abdominal spiracles, arms of respiratory plates not constricted. Raster (Fig. 42) lyriform, posteriorly with a broad tege of long hamate setae having curved tips; raster anteriorly, on each side, with a dense, triangular patch of very short, stout, conical setae. Anal opening Y-shaped with stem of Y only slightly shorter than the arms of the Y. Ventral anal lobes triangular in shape. Anal lobes bare of setae. Claws long and falcate on prothoracic and mesothoracic legs. Claws of metathoracic legs much shorter.

Key to *Dichelonyx* larvae

1. Raster anteriorly, on each side, with a patch of stout, conical setae.
Each patch of setae, posteriorly, short and densely set; setae anteriorly, larger and sparsely set*D. backi* Kby.
Raster anteriorly, on each side, with a patch of stout conical setae which are similar in size2
2. Setae in each patch of uniform density*D. robusta* Fall
Setae in each patch sparsely set distally*D. truncata* Lec.

Genus *Coenonycha*, Third-stage Larva

(Figs. 21 and 41)

Material studied:

1. Twelve third-stage larvae of *Coenonycha pascuensis* Potts. These larvae are part of a lot of 26 third-stage, 6 second-stage, and 1 first-stage larvae and 34 adults dug from the soil of a grassy slope 2 miles west of Byron, California, February 20, 1946, by William Barr, Ray Smith, J. W. McSwain, and P. O. Ritcher. No. 46-7B.
2. Seventeen third-stage larvae of *Coenonycha fusca* McClay. These larvae together with 5 adults were found from 3 to 7 inches deep in the soil beneath sod in a woodland clearing, south of Yosemite National Park, near Bass Lake, California, March 22, 1946, by P. O. Ritcher. No. 46-15B.

Larvae of the genus *Coenonycha* may be distinguished by the following characters: Head without eye spots. Labrum symmetrical. Epipharynx with plegmatia. Plegmata short. Proplegmatia absent. Epizygum present. Haptomerum usually absent. Tormae united.

Haptolachus without microsensilla. Maxillary stridulatory area with a sparsely set row of 9 to 13 sharp pointed conical teeth, projecting anteriorly. Lacinia with a longitudinal row of 3 unci.

Thoracic spiracles much larger than abdominal spiracles. Abdominal spiracles similar in size. Arms of respiratory plates not constricted. Raster lyriform. Teges consisting posteriorly of long hamate setae with curved tips. Anteriorly, on each side, the setae are less curved and are progressively shorter. Anal opening Y-shaped with stem of Y nearly equal in length to each arm of the Y. Ventral anal lobes triangular in shape. Anal lobes setose. Claws of prothoracic legs long and falcate, those of mesothoracic legs slightly shorter. Claws of metathoracic legs very short.

TRIBE MACRODACTYLINI

The genus *Macrodactylus* is represented in Kentucky by *M. subspinosus* (Fab.), the spiny rose chafer. This species is abundant in the eastern part of the state, where the adults often injure young fruit of grapes, apples and peaches during late May and early June.

Genus *Macrodactylus*, Third-stage Larva

(Figs. 19 and 44)

Material studied:

1. Two third-stage larvae of *Macrodactylus subspinosus* (Fab.) collected behind the plow in Taylor county, Kentucky, just south of the Marion county line, April 25, 1939, by P. O. Ritcher. No. 39-15AA.
Two third-stage larvae of *M. subspinosus* collected behind the plow in Knox county, Kentucky, halfway between Barbourville and Corbin, April 10, 1939, by H. G. Tilson. No. 39-15-0.
Two third-stage larvae and cast skins of 10 third-stage larvae of *M. subspinosus* (Fab.) reared to the adult stage. Larvae collected from sod land, behind the plow, 7 miles southeast of Mt. Vernon, Kentucky, April 4, 1940, by P. O. Ritcher. No. 40-12FC.
2. Eighteen third-stage larvae and 5 cast skins of third-stage larvae of *Macro-dactylus uniformis* Horn reared to the adult stage. Larvae dug from soil beneath walnut trees growing in a creek bed in the Davis Mountains, north of Ft. Davis, Texas, January 29, 1946, by P. O. Ritcher.

Larvae of the genus *Macrodactylus* may be characterized as follows: Head with eye spots. Labrum symmetrical. Epipharynx (Fig. 19) with plegmatia. Plegmata rather short. Epizygum well-developed. Zygum absent. Haptomerum with a transverse, slightly curved row of 4 heli. Laeophoba well-developed, fringing the proximal half of the left side of the pedium. Haptolachus with a number of microsensilla. Maxillary stridulatory area with a row of 8 or 9 low

teeth. Lacinia with 3 unci in a longitudinal row; middle unci the smallest. Thoracic spiracles and spiracles on first 5 abdominal segments similar in size; spiracles surrounding the bullae. Raster (Fig. 44) with 2 short, longitudinal, parallel palidia each sparsely set with 5 to 12 compressed, blade-like pali. Tegilla on each side of palidia sparsely set with coarse, hamate setae. Anal opening Y-shaped with stem of Y half as long as each arm of the Y. Anal lobes covered with slender, cylindrical setae. Claws of metathoracic legs not conspicuously shorter than claws of prothoracic and mesothoracic legs.

Key to *Macroductylus* larvae

- Raster with few (1 or 2) or no preseptular, hamate setae
*M. uniformis* Horn
- Raster with 4 to 10 preseptular, hamate setae.....
*M. subspinus* (Fab.)

TRIBE PACHYDEMINI

Genus *Phobetus*, Third-stage Larva

(Figs. 4, 18 and 47)

Description based on the following material:

One third-stage larva associated with an adult of *Phobetus comatus sloopi* Barrett. Adult identified by Cazier. Larva and adult taken behind plow in old pasture sod, 4 miles west of Fallbrook, California, February 9, 1946, by P. O. Ritcher.

Larvae of this genus may be characterized as follows: Head with a rather dense covering of setae. Eye spots absent. Epipharynx with a group of about 14 heli. Zygum present; epizygum absent. Plegmatia present. Proplegmatia absent. Epipharynx with a long phoba bordering each side of the pedium. Haptolochus with numerous microsensilla. Maxillary stridulatory area with a rather closely set row of 14 to 18 truncate teeth. Lacinia with a longitudinal row of 3 stout heli. Scrobis of mandible with a prominent patch of setae. Thoracic spiracles larger than abdominal spiracles which are rather small and nearly alike in size.

Dorsa of abdominal segments 1 to 7 with a dense covering of very short triangular-shaped asperities. Raster lyre-shaped with an oval septula surrounded on each side by 2 curved palidia set with fairly long, stout, depressed pali. Pali of inner palidia pointing mesally, pali of exterior palidia pointing laterally. On each side, anterior to and laterad of each anterior palidium, are a number of short, stout, spine-like setae. Anal opening Y-shaped with ventral stem of Y slightly shorter than the arms of the Y. Claws of prothoracic

and mesothoracic legs long; claws of metathoracic very short. Ventral surfaces of femora of prothoracic legs each with a row of prominent fossorial setae.

TRIBE PLECTRINI

Key to Genera

1. Abdominal spiracles similar in size. Raster with a pair of palidia which are parallel anteriorly and widely divergent posteriorly.
.....genus *Plectris*
- Spiracles on abdominal segments 6 to 8 much smaller in size than those on abdominal segments 1 to 5. Raster with a pair of longitudinal palidia which are not divergent posteriorly.
.....genus *Anoplosiagum*

Genus *Plectris*, Third-stage Larva

(Figs. 8, 16 and 53)

Description based on the following material:

1. Five third-stage larvae of *Plectris aliena* Chapin and cast skin of a third-stage larva associated with reared adult. 2 Larvae collected near Brunswick, Georgia, 1933-34 by Clark. Loaned by U. S. National Museum.
2. Cast skin of third-stage larva of *Plectris sp.* associated with 2 adults. Found in soil at Tacnarembó, Uruguay, by H. L. Parker. No. 619-1. Dept No. 428937. Loaned by U. S. National Museum.
3. Third-stage larva of *Plectris sp.* associated with fragments of adult. Collected at Montevideo, Uruguay, in 1945 (?) by H. L. Parker. No. 961-2. Loaned by U. S. National Museum.

Larvae of the genus *Plectris* may be characterized as follows: Labrum symmetrical with 2 or 3 prominent, transverse ridges which are frequently united by a median, longitudinal ridge (Fig. 8). Maxillary stridulatory area with a single row of 12 to 16 low teeth. Lacinia with a longitudinal row of 3 strong unci which are similar in size. Epipharynx (Fig. 16) roughly pentagonal with protruding anterior lobe. Plegmatia present, well-developed. Haptomerum with 5 or 6 stout heli anterior to which is a lightly sclerotized zygom. Epizygom absent. Dexiophoba extending anteriorly from sclerotized plate along the proximal half of the pedium. Laeophoba well-developed, consisting of about 7 long, distally-forked spines.

Respiratory plates of spiracles curved but not constricted. Prothoracic spiracles much larger than abdominal spiracles. Raster (Fig. 53) with a pair of palidia which are parallel anteriorly and widely divergent posteriorly. Palidia monostichous anteriorly and

distichous or tristichous posteriorly along the lower anal lobes. Anal opening Y-shaped; lower anal lobes divided by a short, distinct cleft. Claws of prothoracic and mesothoracic legs long and falcate; claws of metathoracic legs very short.

Anoplosiagum pallidulum Blanch., Third-stage Larva

Description based on the following material:

Five third-stage larvae collected at the Cuba Sugar Club Experiment Station, Baragua, Cuba, June 3, 1931, by H. K. Plank. Larvae pests of sugar cane. Associated, reared adults determined by Chapin. Larvae loaned by U. S. National Museum.

Larvae of this species may be characterized as follows: Maximum width of head 2.38 to 2.94 mm. Head yellow-brown in color, without eyespots. Head, on each side, with a single exterior frontal seta, a single seta in each anterior angle of the frons, 2 or 3 posterior frontal setae, and a transverse row of 6 to 9 anterior frontal setae. Labrum nearly symmetrical. Epipharynx with well developed plegmata, each with 10 or 11 plegmata. Proplegmata also present, each with 8 slightly curved proplegmata. Epizygum present; zygum absent. Haptomerum with 6 stout heli. Haptolachus with about 12 crepidal punctures (microsensilla). Dexiophoba extending along proximal half of right side of pedium. Laeophoba with 6 or 7 stout, branched processes. Maxillary stridulatory area with a row of 12 to 14 more or less truncate teeth, with points projecting slightly forward. Lacinia with a longitudinal row of 3 stout heli. Respiratory plates of spiracles not constricted and not surrounding bullae. Thoracic spiracles much larger than abdominal spiracles. Spiracles on abdominal segments 1 to 5 nearly alike in size and about half the size of the thoracic spiracle. Spiracles on abdominal segments 6 to 8 very small.

Raster with a pair of longitudinal, feebly curved palidia each sparsely set with 10 to 13 rather short, slightly depressed, pali. Pre-septular hamate setae 2 to 4 in number. Anal opening Y-shaped with stem of Y about one third the length of each arm of the Y. Anal lobes setose. Claws of prothoracic legs long and sharp; claws on mesothoracic legs slightly shorter; claws on metathoracic legs minute.

TRIBE MELOLONTHINI

To this tribe belong our most destructive species of white grubs. The genus *Amphimallon* is represented in the United States by the introduced European chafer, *Amphimallon majalis* (Razoumowski), which is destructive in the state of New York (Butt, 1944). Larvae of several species of *Polyphylla* are common and often destructive in

western North America. However, two species, *Polyphylla occidentalis* (L.) and *Polyphylla variolosa* (Hentz) occur in eastern United States. The only record for Kentucky is based on a single adult of *P. variolosa* (Hentz) collected near Kevil, Kentucky, by Sam Magruder.

The native genus *Phyllophaga*, which includes a great many species of May beetles, reaches its greatest development in eastern United States. In Kentucky alone 40 species are known to occur. These are *Phyllophaga anxia* (Lec.), *Ph. arkansana* (Schffr.), *Ph. balia* (Say), *Ph. barda* (Hn.), *Ph. bipartita* (Hn.), *Ph. crassissima* (Blanch.), *Ph. congrua* (Lec.), *Ph. crenulata* (Froel.), *Ph. delata* (Horn), *Ph. diffinis* (Blanch), *Ph. drakei* (Kby), *Ph. ephilida* (Say), *Ph. fervida* (Fab.), *Ph. forsteri* (Burm.), *Ph. fraterna* (Harris), *Ph. fusca* (Froel.), *Ph. futilis* (Lec.), *Ph. glaberrima* (Blanch.), *Ph. hirticula* (Knoch), *Ph. hirtiventris* (Hn.), *Ph. horni* Smith, *Ph. ilicis* (Knoch), *Ph. implicita* (Hn.), *Ph. inversa* (Hn.), *Ph. jonesi* Sanderson¹, *Ph. karlsioei* Linell, *Ph. kentuckiana* Ritcher, *Ph. marginalis* (Lec.), *Ph. micans* (Knoch), *Ph. pearliae* Davis, *Ph. perlouga* Davis, *Ph. praetermissa* (Hn.), *Ph. profunda* (Blanch.), *Ph. prunina* (Lec.), *Ph. quercus* (Knoch), *Ph. rugosa* (Melsh.), *Ph. sylvatica* Sanderson², *Ph. tristis* (Fab.), *Ph. vehemens* (Hn.), and *Ph. vilifrons* (Lec.).

In Kentucky, of the species mentioned above, *Phyllophaga bipartita*, *Ph. crenulata*, *Ph. ephilida*, *Ph. fraterna*, *Ph. fusca*, *Ph. hirticula*, *Ph. implicita*, *Ph. micans* and *Ph. rugosa* are the main species of economic importance.

Key to Genera

1. Anal opening Y-shaped with stem of Y half as long as each arm of the Y. Palidia strongly divergent posteriorly (Fig. 52).....
genus *Amphimallon*
 Anal opening vaguely angulate, V-shaped or Y-shaped; if Y-shaped, stem of Y less than half as long as each arm of the Y. Palidia not strongly divergent posteriorly2
2. Anal opening vaguely angulate or V-shaped, ventral anal lip without sagittal cleft (Fig. 40). Epipharynx (Fig. 17) without distinct epizygum; dexiophoba fringing right side of pedium. Maxillary stridulatory teeth sharp-pointed, much longer than wide (Fig. 9)genus *Polyphylla*

¹ This species is probably a synonym of *Ph. ilicis* (Knoch) which is a very variable species in Kentucky.

² This species was incorrectly identified as *Ph. corrosa* (Lec.), in Kentucky Bulletin 401 (Ritcher, 1940).

Anal opening V-shaped or Y-shaped; ventral anal lip with a distinct sagittal cleft or groove (Figs. 43, 45, 46, and 51). Epipharynx with distinct epizygum (Fig. 31). Dexiophoba short. Maxillary stridulatory teeth short and truncate (Fig. 10).....
genus *Phyllophaga*

Genus *Amphimallon*, Third-stage Larva (Figs. 11, 32 and 52)

Description based on the following material:

1. One third-stage larva of *Amphimallon majalis* (Razoum.). Collected at Newark, N. Y., April 26, 1942, by H. H. Schwardt.
2. Four third-stage larvae of *Amphimallon majalis* (Razoum.). Collected at Marblertown, N. Y., by F. L. Gambrell.

Larvae of this genus may be characterized as follows. Head (Fig. 11) without eye spots. Epipharynx (Fig. 32) with distinct epizygum. Haptomerum with a group or curved transverse row of 5 to 7 stout heli. Plegmatia present; plegmata short. Proplegmatia present but weakly developed, consisting of 15 or more proplegmata. Læcophoba consisting of about 5 stout, branched processes and fringing posterior third of the left side of the pedium. Dexiophoba present, confined to a short distance anterior to the sclerotized plate. Haptolachus with a few microsensilla. Maxilla with a row of 12 or more stridulatory teeth having anteriorly-directed points. Lacinia with a longitudinal row of 3 stout heli. Thoracic spiracles slightly larger than spiracles on abdominal segments 1 to 5. Spiracles on abdominal segments 6 to 8 much smaller and nearly alike in size.

Anal opening Y-shaped with stem of Y half the length of each arm of the Y. Anal lobes setose. Raster (Fig. 52) with a pair of longitudinal palidia which are strongly divergent posteriorly. Claws of prothoracic and mesothoracic legs long and falcate. Claws of meta-thoracic legs reduced in size.

Genus *Polyphylla*, Third-stage Larva (Figs. 5, 9, 17 and 40)

Larvae of this genus may be distinguished by the following characters. Head without eye spots. Frons with a transverse row of 3 or 4 posterior frontal setae on each side. Labrum symmetrical. Epipharynx (Fig. 17) without epizygum; zygum indistinct. Haptomerum with a group of 15 or more heli. Plegmatia present; plegmata short. Proplegmatia present or absent. Dexiophoba extending along much or all of the right side of the pedium. Haptolachus with or without microsensilla. Maxilla (Fig. 5) with a row of 14 or more fairly long,

conical stridulatory teeth (Fig. 9). Lacinia with a longitudinal row of 3 stout unci.

Anal slit transverse, more or less angular. Ventral anal lobe not cleft. Raster (Fig. 40) with 2 short, longitudinal, parallel palidia. Preseptular hamate setae, numerous. Claws of prothoracic and mesothoracic legs long and falcate, those of mesothoracic leg slightly the smaller. Claws of metathoracic legs minute.

Key to *Polyphylla* larvae

1. Proplegmatia present, well developed. Raster with tegilla extending in front of palidia for a distance equal to one half the length of the palidia *P. occidentalis* (L.).
 Proplegmatia absent or inconspicuous. Raster with tegilla extending in front of palidia for a distance equal to the length of the palidia 2
2. Haptolachus of epipharynx with crepidal punctures (microsensilla) *P. variolosa* (Hentz)
 Haptolachus of epipharynx without crepidal punctures (microsensilla) *P. decemlineata* (Say)

Polyphylla occidentalis (L.) Third-stage Larva

Description based on the following material:

1. One third-stage larva collected at Holland, Virginia, March 21, 1945, by J. M. Grayson. Determined by W. H. Anderson, U. S. National Museum.
2. Seven third-stage larvae collected about sedge roots at Clayton, North Carolina, July 18, 1935, by H. R. Johnson. Associated with reared adults. Larvae loaned by U. S. National Museum.

Larvae of this species may be characterized as follows: Maximum width of head capsule 6.5 mm. Head light reddish-brown in color, finely reticulate. Haptomerum of epipharynx with about 25 heli. Epipharynx with a pair of large, elliptical proplegmatia each of which has more than 35 fine, curved, proplegmata. Each plegmatium with 14 to 16 short plegmata. Haptolachus with about 6 crepidal punctures (microsensilla). Maxilla with a rather irregular, sparsely set row of 18 sharp-pointed stridulatory teeth. Abdominal spiracles progressively smaller in size.

Anal opening broadly V-shaped. Raster with 2 short palidia each sparsely set with 9 to 12 long, sharp, cylindrical pali. Tegilla extending in front of palidia for a distance equal to one half the length of the palidia. Preseptular, hamate setae about 25 to 40 in number. Tegilla occupying slightly less than the caudal half of the area between the lower anal lip and the anterior margin of the last abdominal segment.

Polyphylla variolosa (Hentz), Third-stage Larva

Description based on the following material loaned by the U. S. National museum:

Ten third-stage larvae, found injuring roots of California privet at Lawrence Harbor, New Jersey, October 12, 1941, by Mrs. M. S. Anderson. Larvae identified by W. H. Anderson, U. S. N. M.

Larvae of this species may be distinguished by the following characters: Maximum width of head capsule 6.2 to 6.6 mm. Head light reddish-brown in color, faintly reticulate. Haptomerum of epipharynx with 22 to 25 heli. Epipharynx without proplegmatia, the area covered instead with setae. Each plegmatium with 10 to 12 very short plegmata. Haptolachus with 5 to 10 crepidal punctures (microsensilla). Maxilla with a row of 14 to 18 conical, sharp-pointed, stridulatory teeth. Thoracic spiracles slightly larger than spiracles on abdominal segments 1 to 5 which are similar in size. Spiracles on abdominal segments 6 to 8 progressively smaller.

Anal slit curved, only feebly angulate. Raster with 2 short, nearly parallel, longitudinal paladia each sparsely set with 9 to 15 long, sharp, cylindrical pali. Septula narrow. Tegilla extending forward past the palidia for a distance equal to or slightly greater than the length of the palidia. Preseptular setae more than 50 (50 to 70) in number. Tegilla occupying the caudal half or slightly more of the area between the lower anal lip and the anterior margin of the last abdominal segment.

Polyphylla decemlineata (Say), Third-stage Larva

(Figs. 5, 9, 17, and 40)

Description based on the following material:

Seven third-stage larva and cast skin of a third-stage larva of *Polyphylla decemlineata* (Say) reared to the adult stage. Larvae dug from soil at Greenfield, California, March 28, 1946, by B. B. Richards.

Larvae of this species may be distinguished by the following characters: Maximum width of head capsule 7.8 to 8.66 mm. Head reddish-brown in color, reticulate. Haptomerum of epipharynx with 16 or more heli. Epipharynx (Fig. 17) with or without proplegmatia; proplegmatia, if present, poorly developed and consisting of numerous fine proplegmata. Each plegmatium with 11 to 15 very short plegmata. Haptolachus without crepidal punctures (microsensilla). Maxilla (Fig. 5), with a row of 16 to 18 conical, sharp-pointed, stridulatory teeth (Fig. 9). Thoracic spiracles slightly larger than spiracles on abdominal segments 1 to 4 which are similar in size. Spiracles on abdominal segments 5 to 8 progressively smaller.

Anal opening broadly V-shaped. Raster (Fig. 40) with 2 short, nearly parallel, longitudinal palidia each sparsely set with 7 to 12 long, sharp, cylindrical pali whose tips frequently almost touch those of the opposite palidium. Tegilla extending in front of palidia for a distance equal to the length of the palidia. Preseptular hamate setae more than 50 in number. Tegilla occupying the caudal half or slightly less than the caudal half of the area between the lower anal lip and the anterior margin of the last abdominal segment.

Genus *Phyllophaga*, Third-stage Larva

(Figs. 1-3, 6, 10, 14, 15, 24-27, 29, 30, 31, 33, 34, 37, 39, 43, 45, 46, 48, 50, and 51)

Larvae of this genus may be distinguished by the following characters: Head (Fig. 2) without eye spots. Frons with a transverse pair of posterior frontal setae or a single posterior frontal seta, on each side. Labrum slightly asymmetrical. Epipharynx (Fig. 31) with distinct epi-zygum and zygum. Haptomerum with a group of 6 to 21 heli. Plegmatia present, plegmata rather long. Proplegmatia (Figs. 24-27, 29 and 30) usually present; absent in a few species. Dexiophoba short, extending forward from the sense cone for less than one-third the distance between the sense cone and the heli. Haptolachus often with numerous microsensilla. Maxilla with a row of 10 or more rather short, truncate teeth (Fig. 10).

Anal slit V- or Y-shaped. Stem of Y much shorter than arms of Y. Lower anal lobe usually divided by a sagittal cleft, sometimes divided only by a sagittal groove. Claws of metathoracic legs very small.

Key to *Phyllophaga* Larvae¹

1. Spiracles on abdominal segments 6 to 8 much reduced in size....
.....subgenus *Listrochelus*²
- Spiracles on abdominal segment 8 reduced in size; spiracles on abdominal segments 6 and 7 as large or larger than spiracles on abdominal segments 1 to 52

¹Larvae of many species of *Phyllophaga* are separable by good taxonomic characters. However, study of a large amount of reared material shows considerable overlap and variation in characters commonly used to separate a number of other species, in a few cases even of species whose adults are quite different. Therefore keys to the *Phyllophaga* fauna of a limited area are apt to prove more accurate for a given area than a key to a great number of species.

²Species belonging to this subgenus are found only in the states from Kansas westward.

2. Raster with sparsely set palidia; most pali separated at their bases by a distance greater than the width of a palus at its base (Figs. 46 and 51). Pali often more or less blade-like (compressed) and hooked at tips (Fig. 48)3
 Raster with closely set palidia (Figs. 43 and 45). Pali depressed or cylindrical; tips never hooked (Fig. 50).....15
3. Epipharynx without proplegmata4
 Epipharynx with proplegmata5
4. Articulating skin of maxilia with 9 to 17 conical sensilla (Fig. 6). Palidia nearly parallel, each set with 10 to 12 short, hooked pali*Ph. quercus*
 Articulating skin of maxilla with setae only; sensilla absent (Fig. 3). Palidia strongly curved, each set with 10 to 13 short, rather conical pali; septula oval (Fig. 51).....*Ph. tristis*
5. Each palidium set with 13 or fewer pali.....6
 Each palidium set with 14 or more pali7
6. Each proplegmatium with 2 to 4 broad proplegmata. Each palidium with 6 to 10 pali. Three or fewer preseptular hamate setae *Ph. praetermissa*
 Each proplegmatium with 5 or 6 indistinct, narrow proplegmata. Each palidium with 9 to 13 pali. Three or more preseptular hamate setae*Ph. implicita*
7. Proplegmata usually well developed with 5 to 10 or more proplegmata on each side8
 Proplegmata not curved, often indistinct and may be absent on right side12
8. Pali not distinctly blade-like but tips turn in (Fig. 46). Preseptular hamate setae usually absent. Each proplegmatium with 7 to 9 proplegmata. Head of third-stage larva less than 4.5 mm wide *Ph. ephilida*
 Pali distinctly blade-like (Fig. 48). Preseptular hamate setae numerous. Head of third-stage larva more than 5 mm wide.....9
9. Each palidium set with 14 to 20 pali. Dorso-exterior region of mandible usually bare10
 Each palidium set with 20 to more than 30 pali. Dorso-exterior region of mandible with 3 or more punctures11
10. Proplegmata narrow, slightly curved (Fig. 26).....*Ph. fusca*
 Proplegmata rather broad, many of them strongly curved.....
*Ph. karlsioei*

11. Raster with 4 or more preseptular hamate setae. Right chaetoparia with numerous punctures among the setae.....
 *Ph. anxia*
 Raster with 1 or 2 preseptular hamate setae. Right chaetoparia with a very few or no punctures among the setae.....*Ph. barda*
12. Proplegmatia narrow, each set with 5 to 8 short proplegmata (Fig. 29)13
 Proplegmatia indistinct, may be absent on one side.....14
13. Dorso-exterior region of mandible with 6 to 15 punctures....
 *Ph. fervida*
 Dorso-exterior region of mandible without punctures
 *Ph. vehemens*
14. Each palidium with from 14 to 18 pali.....*Ph. arkansana*
 Each palidium with more than 20 pali*Ph. inversa*
15. Epipharynx with fewer than 11 proplegmata on each side.....16
 Epipharynx with 11 or more proplegmata on each side (Fig. 24)25
16. Each proplegmatium with 3 or 4 small, short proplegmata (Fig. 27).....*Ph. micans*
 Each proplegmatium with 4 to 10 curved proplegmata.....17
17. Pali very long and sharp (Fig. 45); at least 4 times as long as the widths of their bases. Each proplegmatium with 8 or 10 narrow proplegmata18
 Pali shorter, not over 3 times as long as the widths of their bases19
18. Alar lobe of mesothorax with 17 or fewer setae*Ph. balia*
 Alar lobe of mesothorax with 30 or more setae.....*Pt. futilis*
19. Dorso-exterior region of mandible with fewer than 4 setae (Fig. 33)20
 Dorso-exterior region of mandible with 5 or more setae (Figs. 34, 37 and 39)22
20. Proplegmatia with 6 (rarely 7) proplegmata (Fig. 25). Pali fairly long.*Ph. bipartita*
 Proplegmatia with 7 or more proplegmata. Pali rather short (Fig. 43)21

21. Baso-lateral region of mandible with 10 or fewer setae. Head capsule of third-stage larva less than 4.7 mm wide.....
*Ph. fraterna*
 Baso-lateral region of mandible with 12 to 15 setae. Head capsule of third-stage larva at least 4.8 mm wide.....*Ph. hirticula*
22. Proplegmata fairly short, usually fewer than 9 on each side; proplegmata in center of row not over 4 times as long as wide. Head capsule of third-stage larva less than 4.9 mm wide.....
*Ph. kentuckiana* and *Ph. delata*
 Proplegmata long, narrow and strongly curved; 8 to 11 on each side. Proplegmata in center of row at least 6 times as long as wide. Head capsule of third-stage larva usually 5 mm or more in width23
23. Dorso-exterior region of mandible with fewer than 10 setae and not over 30 setae and punctures all together (Figs. 14 and 39)..
*Ph. horni*
 Dorso-exterior region of mandible with 15 or more setae.....24
24. Dorso-exterior region of mandible with 35 or fewer setae and punctures, of which at least two-thirds are setae (Fig. 34). Head capsule of third-stage larva 6 mm or more wide...*Ph. profunda*
 Dorso-exterior region of mandible with 40 or more setae and punctures less than half of which are setae (Fig. 37). Head capsule of third-stage larva less than 5.5 mm wide.....*Ph. rugosa*
25. Maxillary articulating skin with short conical sensilla (Fig 6). Palidia set with 22 or fewer pali*Ph. crenulata*
 Maxillary articulating skin without sensilla. Palidia set with 23 to 27 pali26
26. Proplegmata 11 to 15 on each side. Pali fairly long.....
*Ph. prunina*
 Proplegmata 20 or more on each side. Pali short....*Ph. sylvatica*

BIBLIOGRAPHY

BÖVING, A. G.

- 1936 Description of the larva of *Plectris aliena* Chapin and explanation of new terms applied to the epipharynx and raster. Proc. Ent. Soc. Wash. 38 (8):169-185.
- 1942a Descriptions of the larvae of some West Indian melolonthine beetles and a key to the known larvae of the tribe. Proc. U. S. Nat. 92 (3146):167-176.
- 1942b Description of the third-stage larva of *Amphimallon majalis* (Razoumowski). Proc. Ent. Soc. Wash. 44 (6):111-121.
- 1942c A classification of larvae and adults of the genus *Phyllophaga*. Mem. Ent. Soc. Wash. 2:95 pages.
- 1945 Description of the larva and pupa of the scarab beetle *Anclonycha mindanaona* (Brenske). Jour. Wash. Acad. Sci. 35 (1):13-15.

----- and CRAIGHEAD, F. C.

- 1931 An illustrated synopsis of the principal larval forms of the order Coleoptera. Ent. Amer. 11 (N. S.) (1-4):351 pages.

BOYER, B. L.

- 1940 A revision of the species of *Hoplia* occurring in America north of Mexico (Coleoptera:Scarabaeidae). Microentomology 5 (1):1-31.

BROWN, W. J.

- 1940 Some new and poorly known species of Coleoptera. Canadian Entomologist 72 (9):182-188. Review of genus *Polyphylla*.

BUTT, F. H.

- 1944 External morphology of *Amphimallon majalis* (Razoumowski) (Coleoptera, the European Chafer). Cornell Univ. Agr. Expt. Sta. Mem. 266:18 pages.

CAZIER, M. A.

- 1937 A revision of the Pachydemini of North America (Coleoptera, Scarabaeidae). Pomona College J. of Ent. and Zool. 29:73-87.
- 1940 The species of *Polyphylla* in North America, North of Mexico (Coleoptera:Scarabaeidae). Ent. News 51 (5):134-139.

----- and McCLAY, A. T.

- 1943 A revision of the genus *Coenonycha* (Coleoptera, Scarabaeidae). Amer. Mus. Novitates 1239:27 pages.

DOWNES, W. and ANDISON, H.

- 1941 Notes on the life history of the June beetle *Polyphylla perversa* Casey. Proc. Ent. Soc. Brit. Columbia 330-5-8.

EMDEN, F. I. van

- 1941 Larvae of British beetles. II A key to the British lamellicornia larvae. Ent. Monthly Mag. 71:117-127, 181-192.

ESSIG, E. O.

- 1929 Insects of western North America. Macmillan Company.

FIDLER, J. H.

- 1936 Some notes on the morphology of the immature stages of some British Chafer beetles. *Ann. Appl. Biology* 23:114-132.

FLUITER, H. J. DE

- 1941 Waarnemingen omtrent engerlingen (oerets) en hun bestrijding in *Hevea* -aanplantingen. (Observations on white grubs and their control in *Hevea* plantations.) *Arch. Rubber-Cult.* 25 (2):167-270.

FROST, C. A.

- 1946 *Dichelonyx canadensis* Horn. *Psyche* 53 (1-2):20-21.

GARDNER, J. C. M.

- 1935 Immature stages of Indian Coleoptera (16) (Scarabaeoidea). *India Forest Records (New Series) Entomology* 1 (1):33 pages.

GOLOVIANKO, Z. S.

- 1936 Les larves plus communes des Coleopteres lamellicornes de la partie Europeenne de l'U.R.S.S. *Tabl. Analyt. Fn. U.R.S.S.* (20). *Inst. Zool. Acad. Sci. U. R. S. S.* 65 pages.

GRANDI, G.

- 1925 Contributo alla conoscenea biologica e morfologica di alcuni Lamellicorni fillophagi. *Bolletino del Laboratorio de Zoologia Generale e Agraria della R. Scuola Superiore d' Agricoltura in Portici* 18:159-224.

HALLOCK, H. C.

- 1936 Life history and control of the Asiatic garden beetle. *U. S. D. A. Circ.* 246:20 pages. *Autoserica castanea* Arrow.

HAYES, W. P.

- 1929 Morphology, taxonomy and biology of larval Scarabaeoidea. III. *Biol. Monographs* 12 (2):119 pages.

HEIT, C. A. and HENRY, H. K.

- 1940 Notes on the species of white grubs present in the Saratoga forest tree nursery. *Jour. Forestry* (38)12:944-948.

HORN, G. H.

- 1888 Descriptions of the larvae of *Glyptus*, *Platypssylla* and *Polyphylla*. *Trans. Amer. Ent. Soc.* 15:18-26. Description of larva of *Polyphylla decemlineata* Say.

LLNG, C. W.

- 1920 Catalogue of the Coleoptera of America, north of Mexico, John D. Sherman, Jr., Mt. Vernon, N. Y.

MURAYAMA, J.

- 1927 Systematic description of the larva of *Hoplia aureola* Pall (Col. Lamell.). *J. Chosen Nat. Hist. Soc.* (5):1-8.
- 1931 A contribution to the morphological and taxonomic study of larvae of certain May-beetles which occur in the nurseries of the peninsula of Korea. *Bul. For. Expt. Sta.* 11:109 pages.

POTTS, R. W. L.

- 1945 A new *Coenonycha* from California (Coleoptera, Scarabaeidae). Pan-Pac. Ent. 21 (4):141-143.

PRATT, R. Y.

- 1943 Insect enemies of the scarabaeid *Polyphylla crinita* Lec. (Coleoptera: Scarabaeidae). Pan-Pacific Ent. 19 (2):69-70.

RITCHER, P. O.

- 1940 Kentucky White Grubs. Ky. Agr. Expt. Sta. Bul. 401.
- 1943 The Anomalini of eastern North America with descriptions of the larvae and key to species (Coleoptera:Scarabaeidae). Ky. Agr. Expt. Sta. Bul. 442.
- 1944 Dynastinae of North America with descriptions of the larvae and keys to genera and species (Coleoptera:Scarabaeidae). Ky. Agr. Expt. Sta. Bul. 467.
- 1945a Rutelinae of eastern North America with descriptions of the larvae of *Strigoderma pygmaea* (Fab.) and three species of the tribe Rutelini (Coleoptera:Scarabaeidae). Ky. Agr. Expt. Sta. Bul. 471.
- 1945b Notes on *Phyllophaga barda* (Horn) with a description of the larva (Coleoptera:Scarabaeidae). Proc. Ent. Soc. Wash. 47 (4):97-99.
- 1945c North American Cetoniinae with descriptions of their larva and keys to genera and species (Coleoptera:Scarabaeidae). Ky. Agr. Expt. Sta. Bul. 476.
- 1945d Coprinae of eastern North American with descriptions of larvae and keys to genera and species (Coleoptera: Scarabaeidae). Ky. Agr. Expt. Sta. Bul. 477.
- 1947a Description of the larva of *Pleocoma hirticollis vandykei* Linsley (Coleoptera:Scarabaeidae). Pan-Pacific Ent. 23 (1):11-20.
- 1947b Larvae of Geotrupinae with keys to tribes and genera (Coleoptera:Scarabaeidae). Ky. Agr. Expt. Sta. Bul. 506.
- 1948 Description of the larvae of some ruteline beetles with keys to tribes and species. Annals Ent. Soc. Amer. 41 (2):206-212.

SIM, R. J.

- 1934 Characters useful in distinguishing larvae of *Popillia japonica* and other introduced Scarabaeidae from native species. U. S. D. A. Cir. 334:20 pages.

THOMAS, I. and HEAL, G. M.

- 1944 Chafer damage to grassland in north Wales in 1942-1943 by *Phyllopertha horticola* L. and *Hoplia philanthus* Fuess. I. Notes on population, life history and morphology. Ann. Applied Biol. 31 (2):124-131.

TILDEN, J. W. and MANSFIELD, G. S.

- 1944 Notes on three species of the genus *Coenonycha* Horn (Coleoptera:Scarabaeidae). Pan-Pacif. Ent. 22 (3):115-117.

VIADO, G. B.

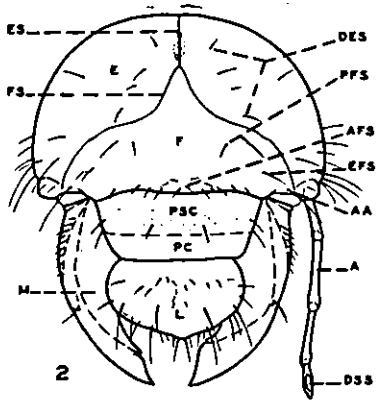
- 1939 External anatomy and diagnostic characters of some common Philippine white grubs. Philippine Agriculturist 28 (5):339-410.

PLATE I

- Fig. 2. *Phyllophaga horni* (Sm.). Head.
 Fig. 3. *Phyllophaga fusca* (Froel.). Left maxilla, ventral view.
 Fig. 4. *Phoebetus comatus sloopi* Barrett. Head.
 Fig. 5. *Polyphylla decemlineata* (Say). Left maxilla, dorsal view.
 Fig. 6. *Phyllophaga crenulata* (Froel.). Right maxilla, ventral view.
 Fig. 7. *Autoserica castanea* Arrow. Distal part of lacinia of left maxilla showing unci.
 Fig. 8. *Plectris aliena* Chapin. Head.
 Fig. 9. *Polyphylla decemlineata* (Say). Maxillary stridulatory teeth of right maxilla.
 Fig. 10. *Phyllophaga hirticula* (Knoch). Maxillary stridulatory teeth of right maxilla.
 Fig. 11. *Amphimallon majalis* (Razoum.). Head.
 Fig. 12. *Autoserica castanea* Arrow. Left maxilla, dorsal view.
 Fig. 13. *Serica ligulata* Dawson. Left maxilla, dorsal view.
 Fig. 14. *Phyllophaga horni* (Sm.). Left mandible, dorsal view.
 Fig. 15. *Phyllophaga horni* (Sm.) Left mandible, ventral view.

SYMBOLS USED ON PLATE I

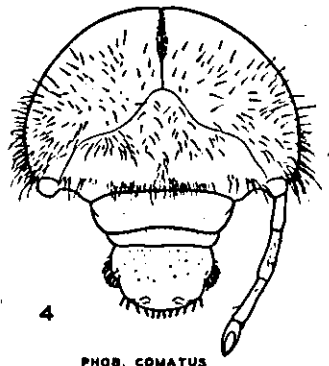
SD—Maxillary stridulatory area	GD—Uncus of galea
A—Antenna	L—Labrum
AA—Seta of anterior frontal angle	LA—Lacinia
AC—Acia	LU—Unci of lacinia
AFS—Anterior frontal setae	M—Mandible
BLR—Baso-lateral region	MP—Maxillary palpus
CAR—Cardo	MAS—Maxillary articulating skin
DER—Dorso-exterior region	MO—Molar region
DES—Dorso-epicranial setae	PC—Preclypeus
DMS—Dorso-molar setae	PSC—Postclypeus
DSS—Dorsal sensory spot	PA—Preartis
E—Epicranium	PTA—Postartis
EFS—Exterior frontal seta	SA—Scissorial area
FS—Epicranial suture	SCR—Scrobis
F—Frons	SD—Maxillary stridulatory area
FS—Frontal suture	ST—Stipes
G—Galea	VP—Ventral process



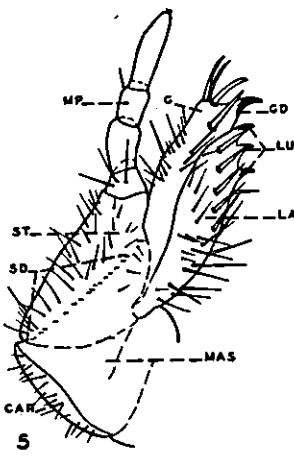
PH. HORNII



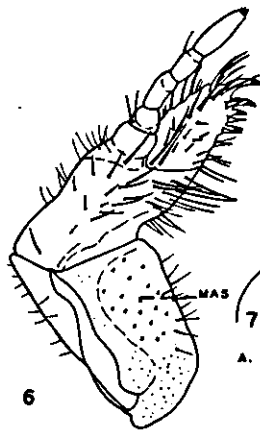
PH. FUSCA



PHOB. COMATUS



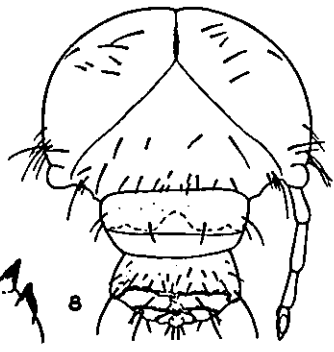
P. DECEMLINEATA



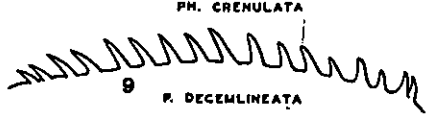
PH. CRENULATA



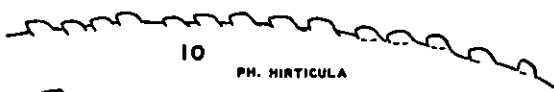
A. CASTANEA



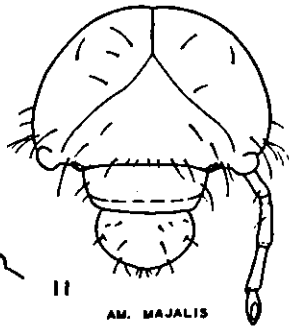
PL. ALIENA



P. DECEMLINEATA



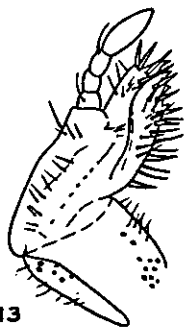
PH. HIRTICULA



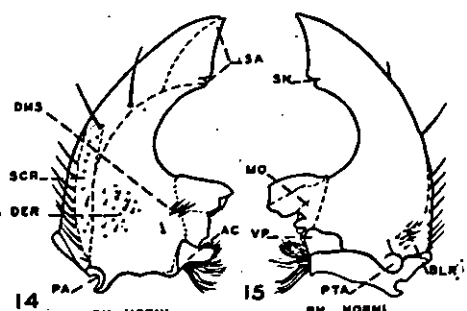
AM. MAJALIS



A. CASTANEA



S. LIGULATA



PH. HORNII

PH. HORNII

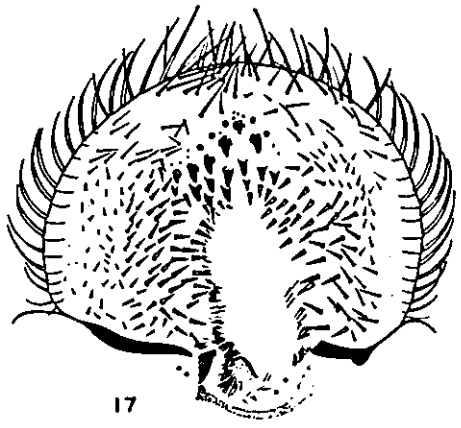
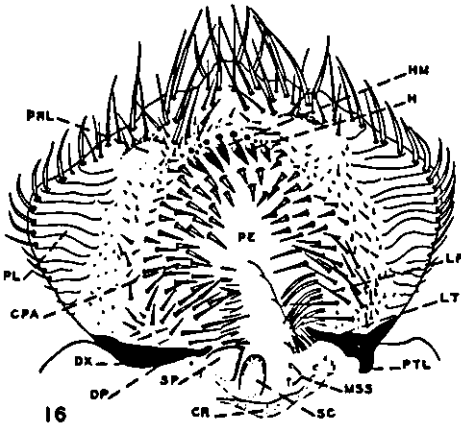
PLATE II

- Fig. 16. *Plectris aliena* Chapin. Epipharynx.
 Fig. 17. *Polyphylla decemlineata* (Say). Epipharynx.
 Fig. 18. *Phobetrus comatus sloopi* Barrett. Epipharynx.
 Fig. 19. *Macroductylus subspinosus* (F.). Epipharynx.
 Fig. 20. *Hopliid equina* Lec. Epipharynx.
 Fig. 21. *Coenonycha pascuensis* Potts. Epipharynx.
 Fig. 22. *Dichelonyx robusta* Fall. Epipharynx.
 Fig. 23. *Phyllophaga fusca* (Froel.). Proplegmatia.
 Fig. 24. *Phyllophaga crenulata* (Froel.). Proplegmatia.
 Fig. 25. *Amphimallon majalis* (Razoum.). Venter of tenth abdominal segment.
 Fig. 26. *Phyllophaga fusca* (Froel.). Proplegmatia.
 Fig. 27. *Phyllophaga micans* (Knoch). Proplegmatia.
 Fig. 28. *Diplotaxis* sp. Epipharynx.
 Fig. 29. *Phyllophaga seruida* (F.). Proplegmatia.
 Fig. 30. *Phyllophaga horni* (Sm.). Proplegmatia.

SYMBOLS USED ON PLATE II

CPA—Chaetoparia
 CR—Crepis
 DP—Dexiophoba
 DX—Dexiotorma
 EZ—Epizygum
 H—Helus
 HM—Haptomerum
 LP—Lacophoba
 LT—Lacotorma

MIS—Microsensilla
 MSS—Macrosensilla
 PE—Pedium
 PL—Plegmatium
 PRL—Proplegmatium
 PTL—Pternotorma
 SC—Sense cone
 SP—Sclerotized plate

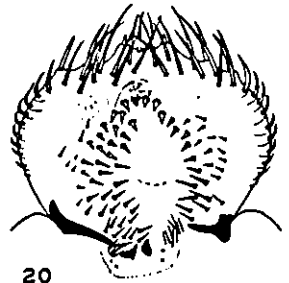
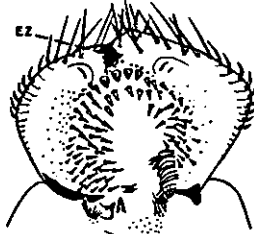
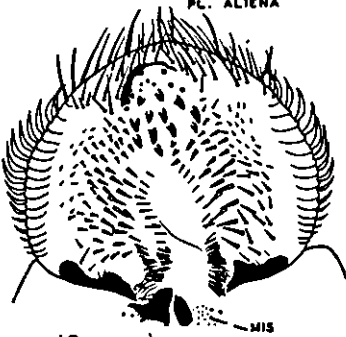


16

17

PL. ALIENA

P. DECEMLINEATA



18

19

20

PH. COMATUS

M. SUBSPINOSUS

K. EQUINA



21

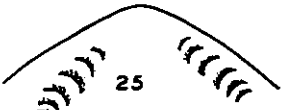
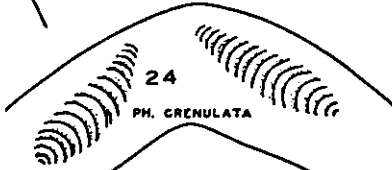
22

23

C. PASCUENSIS

D. ROBUSTA

S. LICULATA

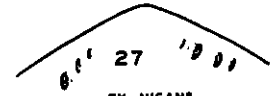
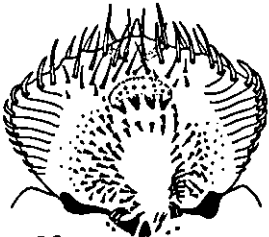


24

25

PH. GRENULATA

PH. BIPARTITA



28

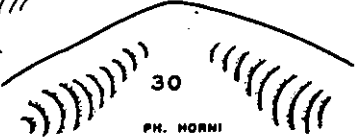
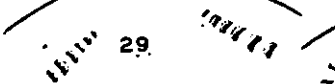
26

27

DIPLOTARIS

PH. FUSCA

PH. MICANS



29

30

PH. FERVIDA

PH. HORNII

PLATE II

PLATE III

- Fig. 31. *Phyllophaga hirticula* (Knoch). Epipharynx.
 Fig. 32. *Amphimallon majalis* (Razoum). Epipharynx.
 Fig. 33. *Phyllophaga hirticula* (Knoch). Dorso-exterior region of mandible.
 Fig. 34. *Phyllophaga profunda* (Blanch.). Dorso-exterior region of mandible.
 Fig. 35. *Autoserica castanea* Arrow. Venter of tenth abdominal segment.
 Fig. 36. *Diplotaxis* sp. Venter of tenth abdominal segment.
 Fig. 37. *Phyllophaga rugosa* (Melsh.). Dorso-exterior region of mandible.
 Fig. 38. *Serica ligulata* Dawson. Venter of tenth abdominal segment.
 Fig. 39. *Phyllophaga horni* (Sm.). Dorso-exterior region of mandible.
 Fig. 40. *Polyphylla decemlineata* (Say). Central portion of raster.
 Fig. 41. *Coenonycha pascuensis* Potts. Venter of tenth abdominal segment.
 Fig. 42. *Dichelonyx robusta* Fall. Venter of tenth abdominal segment.

SYMBOLS USED ON PLATE III

ASYL—Anal slit	LPH—Laeophoba
CPA—Chaetoparia	LT—Laeotorma
CR—Crepis	MIS—Microsensilla
DP—Dexiophoba	MSS—Macrosensilla
DX—Dexiotorma	PE—Pedium
EZ—Epizygum	PL—Plegmatium
HL—Haptolachus	PLA—Palidium
HM—Haptomerum	PLM—Plegma
LAL—Lower anal lobe	PRL—Proplegmatium

PLATE IV

- Fig. 43. *Phyllophaga hirticula* (Knoch). Venter of tenth abdominal segment.
 Fig. 44. *Macroductylus subspinosus* (F.). Venter of tenth abdominal segment.
 Fig. 45. *Phyllophaga futilis* (Lec.). Central portion of raster.
 Fig. 46. *Phyllophaga ephilida* (Say). Central portion of raster.
 Fig. 47. *Phobetus comatus sloopi* Barrett. Venter of tenth abdominal segment.
 Fig. 48. *Phyllophaga fusca* (Froel.). Ventral and lateral views of compressed pali.
 Fig. 49. *Hoplia equina* Lec. Venter of tenth abdominal segment.
 Fig. 50. *Phyllophaga hirticula* (Knoch). Ventral and lateral views of depressed pali.
 Fig. 51. *Phyllophaga tristis* (F.). Venter of tenth abdominal segment.
 Fig. 52. *Amphimallon majalis* (Razoum). Venter of tenth abdominal segment.
 Fig. 53. *Plectris aliena* Chapin. Venter of tenth abdominal segment.

SYMBOLS USED ON PLATE IV

B—Barbula	PLA—Palidium
C—Campus	TE—Tegillum
DAL—Dorsal anal lobe	S—Septula
LAL—Lower anal lobe	

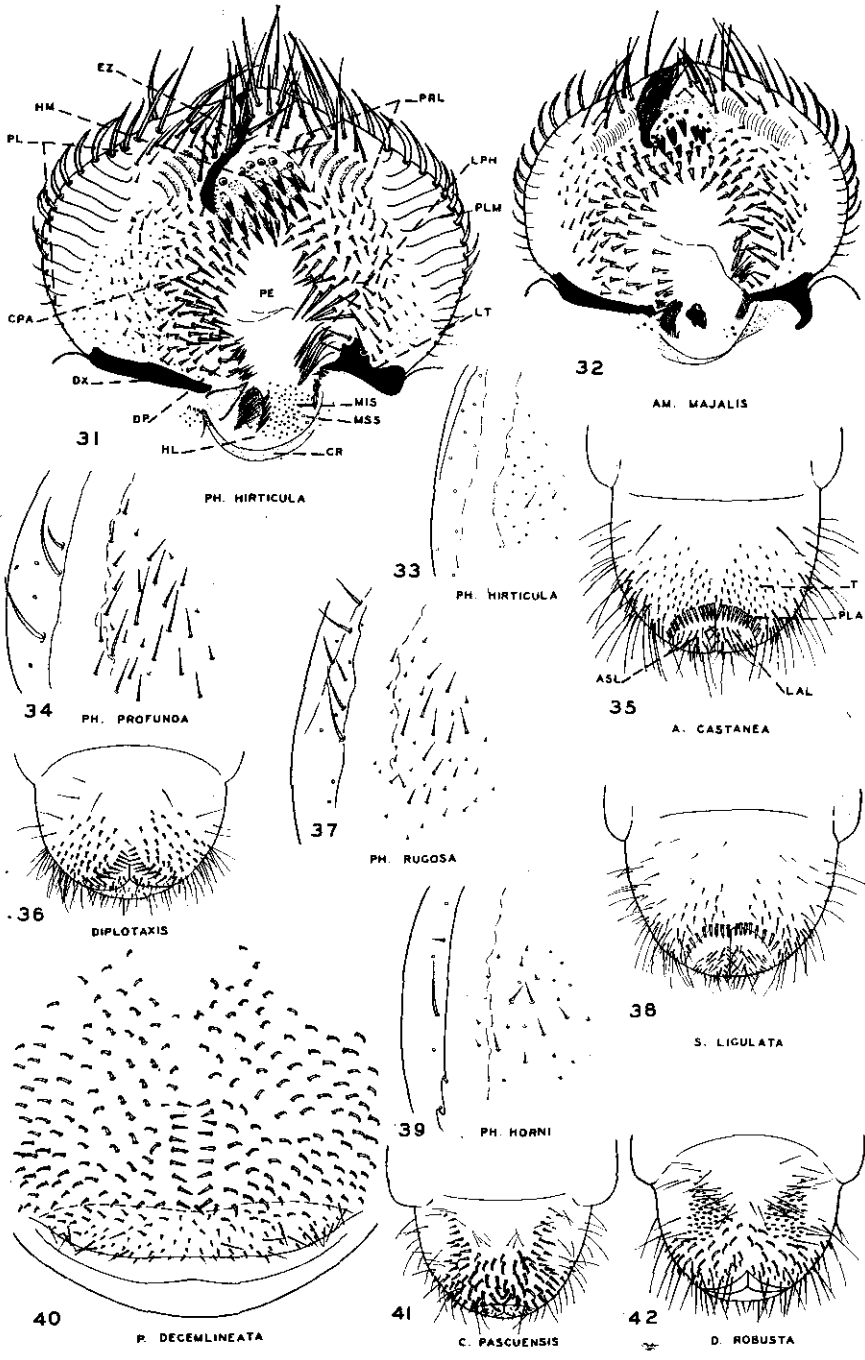


PLATE III

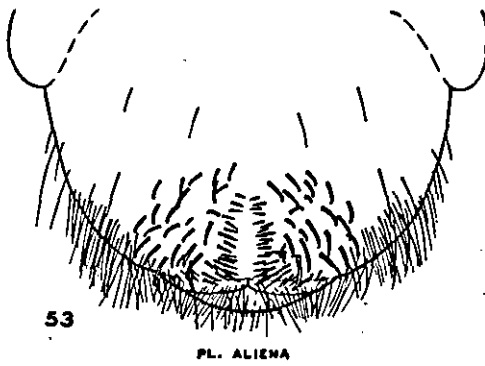
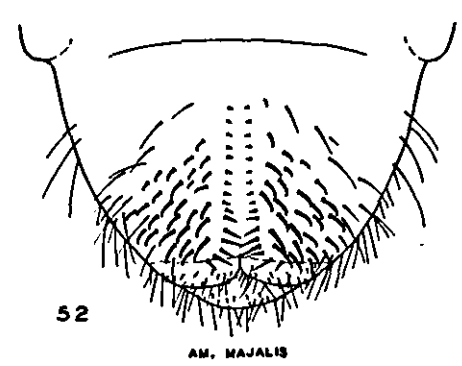
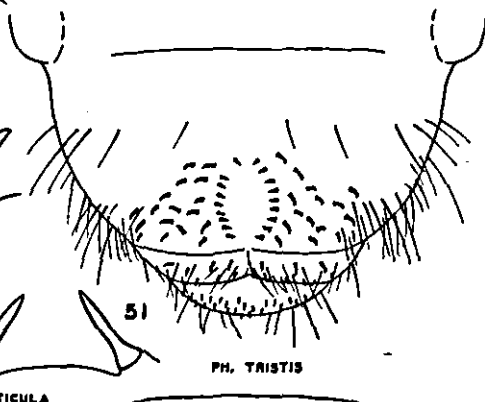
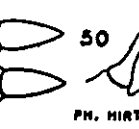
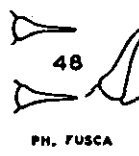
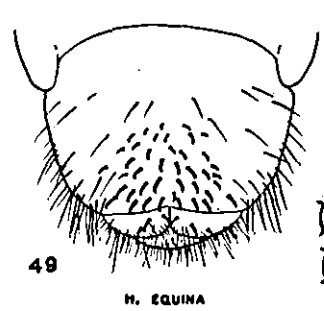
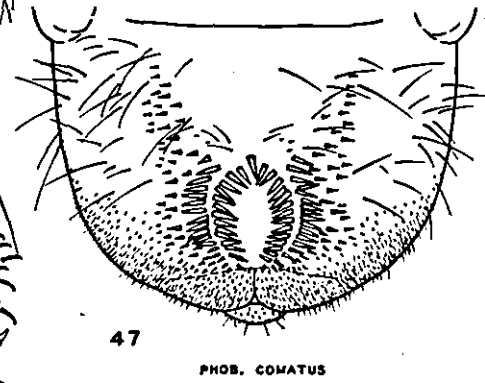
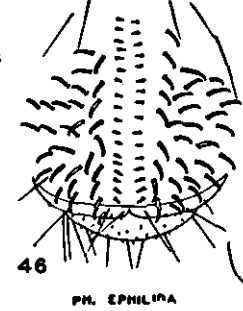
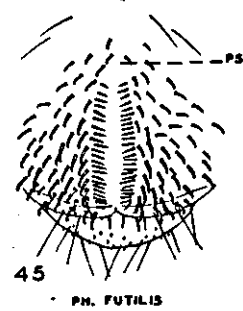
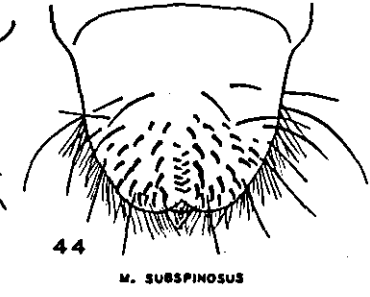
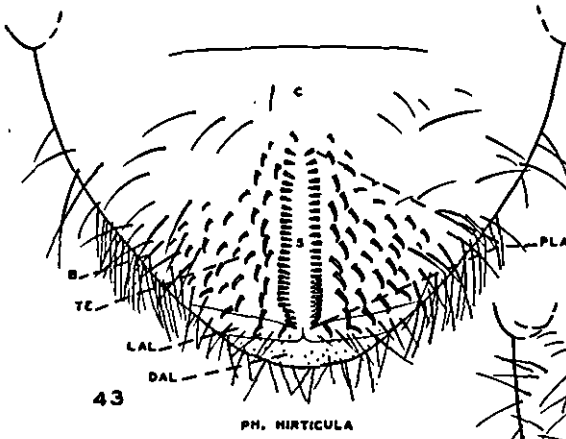


PLATE IV