Notes on the Ecology and Taxonomy of Certain Pupae of the Family Tenebrionidae (Coleoptera)

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The pupae of insects are not as well known as their larvae and imagoes. It is likely that a thorough study of the morphology of pupae would contribute much of value to taxonomy. At present it is not possible to give family characterizations of the pupae of even the larger and otherwise well-known families of Coleoptera. The following key and ecological notes are the result of the personal collections and observations of the writer over the past nine years. Unless otherwise stated, each species was taken in the northern tier of counties (Lake, Porter, Laporte, St. Joseph, Elkhart, Lagrange, Steuben), as well as from both Wayne and Rush Counties. The pupae in each case were named by rearing and determining their imagoes.

ECOLOGY

The Indiana species of the family Tenebrionidae may be placed, on the basis of larval and adult habits, in three groups: (1) grain inhabitants, (2) decaying-wood inhabitants, and (3) fungus inhabitants. The pupae of the first group occur in the open or beneath whatever cover may be at hand; those of the second group occur beneath bark or in burrows in the wood (often the burrows are enlarged to form special pupal cells); the pupae of the third group occur in burrows in the fungi.

Grain-Inhabiting Species

Tenebrio obscurus Fab. and *molitor* L. These species are common around stored grain and grain products. Prior to pupation the larvae tend to wander away from the feeding site and pupation usually occurs beneath loose cover, but if cover is lacking pupation occurs in fully exposed places. Under normal conditions pupation takes place in the spring, but under special laboratory control it may take place in any month. The life cycle has been extensively studied by many workers. Cotton and St. George (1929) summarize the published data on the pupae and give a good bibliography.

Tribolium confusum Jacq. Duv. This is another very common species and is found wherever grain products are carelessly stored. Pupation occurs in the open or beneath whatever cover is available. Under favorable conditions pupation occurs throughout the year. The pupa has been figured by numerous workers.

Alphitophagus bifasciatus (Say). This species was collected only in Rush County, though it probably is common throughout Indiana. It is most likely to inhabit molding grain and subsists largely on the fungus rather than the cereal. Pupation occurs in debris near the source of food. Schiödte (1879) figures and describes the pupa; Chittenden (1917) reports that the pupal stage lasts six days during hot summer weather.

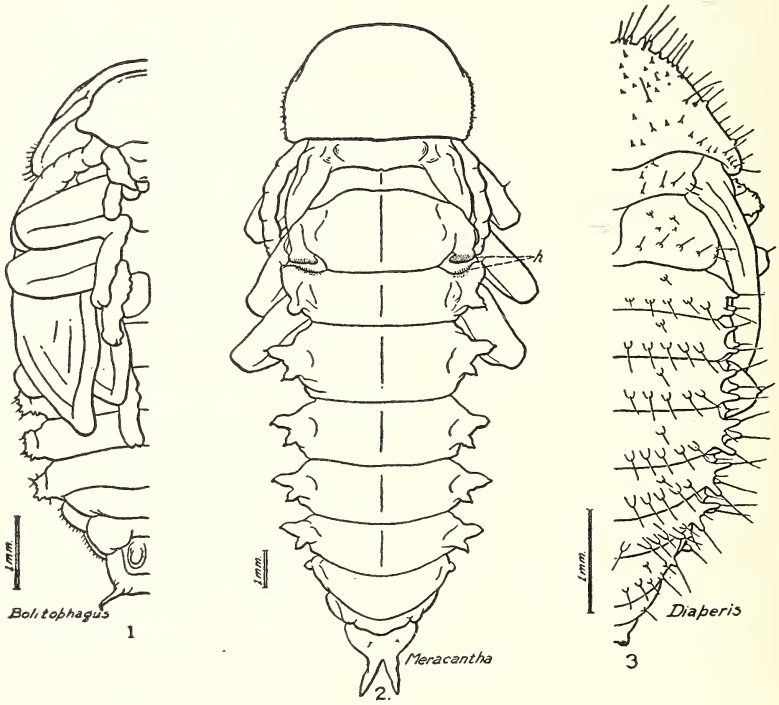

Plate I. Pupae of Tenebrionidae. Scales indicated.

1. *Bolitophagus corticola* Say. Ventral view, right half.
2. *Meracantha contracta* (Beauv.). Dorsal view; h, hinge-like structure.
3. *Diaperis maculata* Oliv. Dorsal view, right half.

Fungus-Inhabiting Species

Bolitotherus cornutus (Panz.). This is an extremely common species. All of its stages occur in woody fungi, in Indiana chiefly in *Fomes applanatus*. Pupation, which occurs from May through August, takes place in tunnels excavated in the fungus by the larva. The pupa was first described by Candèze (1861).

Bolitophagus corticola Say. This is a relatively rare species. The writer's only collection was from Richmond in September. All stages were found in a woody polyporous fungus growing at the base of a living

black locust tree. The pupae were present in the burrows made in the fungus by the larvae. The pupa of this species has never been described.

Diaperis maculata Oliv. This species is fairly common. It inhabits woody and semi-woody fungi but is rarely found in the hard, dry fungi occupied by *Bolitotherus*. Pupation, which occurs in late summer (July

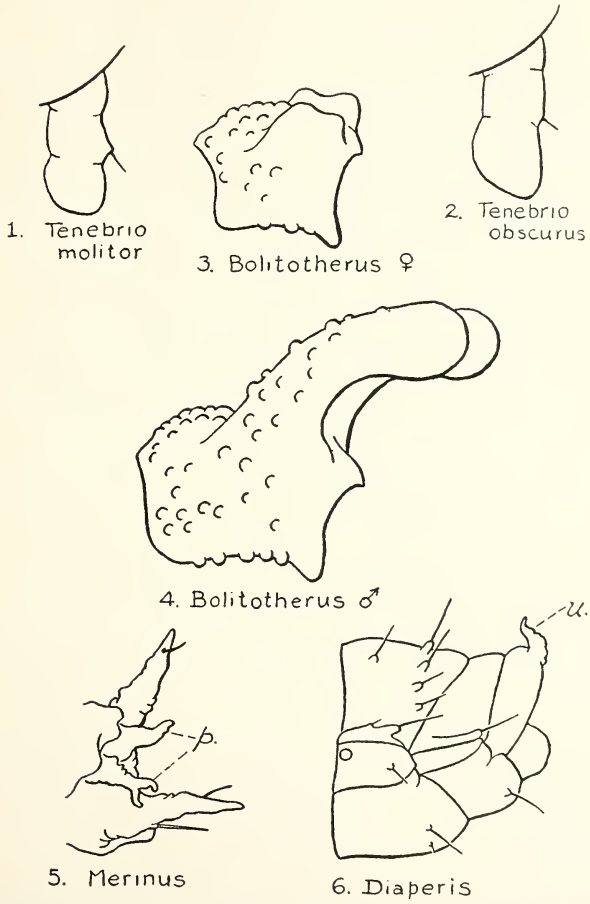

Plate II. Details of Pupae of Tenebrionidae. Not drawn to scale.

1. *Tenebrio molitor* L. Left maxillary palpus, ventral view.
2. *Tenebrio obscurus* Fab. Left maxillary palpus, ventral view.
3. *Bolitotherus cornutus* (Panz.). Pronotum, right view, female.
4. *Bolitotherus cornutus* (Panz.). Pronotum, right view, male.
5. *Merinus laevis* (Oliv.). Ninth segment of abdomen, dorsal view; p, fleshy projections. Drawn from distorted exuviae.
6. *Diaperis maculata* Oliv. Seventh, eighth, ninth, and tenth abdominal segments, right view; u, urogomphus.

through September), takes place in special oval cells with walls made by cementing particles together. Figures of a larva and a pupa prepared by C. V. Riley and published by LeBaron (1874) were erroneously labeled *Diaperis maculata.* Blatchley (1910) in his *Beetles of Indiana* copied the figure of the incorrectly named larva. No authentic account of the pupa has been published.

Wood-Inhabiting Species

Strongylium sp. The immature stages of this genus are represented by a single collection from Richmond. The larvae were found in burrows in the dead, moist branches of living willow trees; a single larva subsequently transformed. Pupation took place in the laboratory on May 25 in an enlarged cell in the wood occupied by the larva. The pupa transformed to the imago after nine days. The pupae of the North American species of this genus have not been mentioned in the literature.

Tenebrio picipes Hbst. This species is most commonly associated with dead wood, though it is also found in a variety of other habitats. St. George (1924) records the larvae in a nest of *Bombus* and on strawberries. Although *T. picipes* is not associated with grain, its cosmopolitan distribution, varying habits, and relation to the mealworms suggest that it might infest grain on occasions. Pupation occurs during July and August beneath the bark of logs or beneath pieces of wood within oval cells formed in the surrounding detritus by movements of the prepupa and pupa. The pupal stage lasts nine days. No accounts of the pupa of *T. picipes* have been published.

Scotobates calcaratus (Fab.) This is a common inhabitant of decaying logs. Pupation was not observed in the field so the natural time and place of pupation are unknown. In the laboratory the larvae pupated during May and June. The pupal stage, in one instance, existed eleven days. Beutenmüller (1891) briefly mentioned the biology of the pupa of *S. calcaratus.*

Merinus laevis (Oliv.). This is a moderately common species, found much more abundantly in the larval than in the adult stage. Pupation occurs in cells in the detritus beneath the bark of logs and takes place in June and July. St. George (1924) gives a detailed description of the pupa of *M. laevis.*

Alobates pennsylvanica (DeG.). The adults of this species are much more abundant than those of *Merinus laevis.* The larva prepares an elongated pupal cell, usually about an inch deep in the wood. Pupation occurs from June through August and the pupal stage lasts eleven to twelve days. The pupae of *Alobates* have not been recorded in the literature.

Xylopinus saperdioides (Oliv.). In Indiana this species is common in both the larval and the adult stages. Pupation takes place in May and June in a cell in the detritus beneath the bark of logs. There are no published accounts of the pupa of *X. saperdioides.*

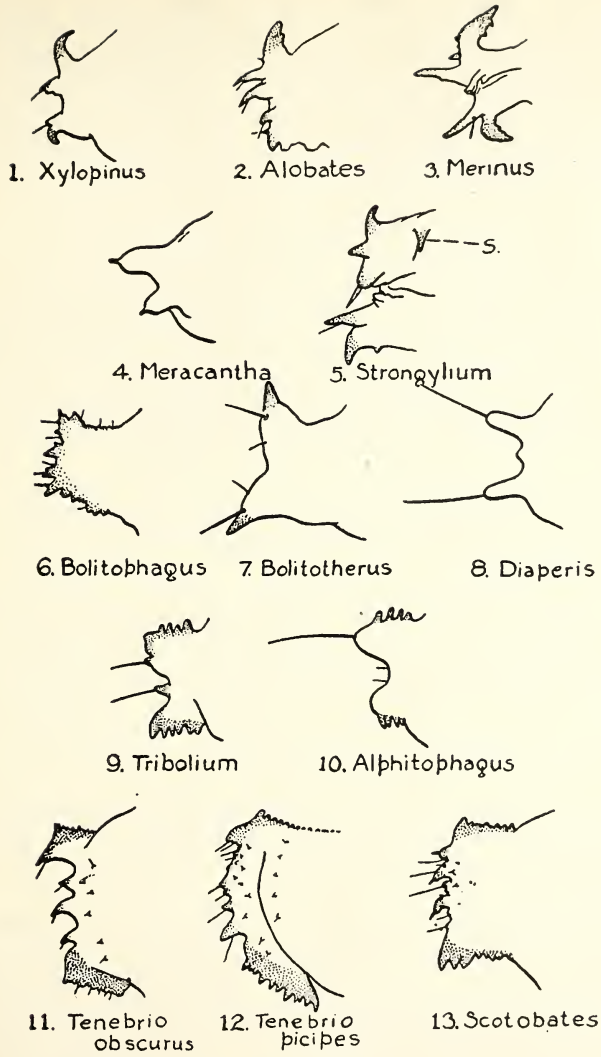

Plate III. Lateral abdominal plates of Pupae of Tenebrionidae; dorsal view of left plate of third abdominal segment, unless otherwise stated. Not drawn to scale. Stippling indicates sclerotization.

1. *Xylopinus saperdioides* (Oliv.). Fourth abdominal segment.
2. *Alobates pennsylvanica* (DeG.).
3. *Merinus laevis* (Oliv.). Fourth abdominal segment. Drawn from distorted exuviae.
4. *Meracantha contracta* (Beauv.).
5. *Strongylium* sp. Ventral view of right plate; s, spine ventral to plate. Drawn from distorted exuviae.
6. *Bolitophagus corticola* Say
7. *Bolitotherus cornutus* (Panz.)
8. *Diaperis maculata* (Oliv.)
9. *Tribolium confusum* Jacq. Duv.
10. *Alphitophagus bifasciatus* (Say)
11. *Tenebrio obscurus* Fab.
12. *Tenebrio picipes* Hbst.
13. *Scotobates calcaratus* (Fab.)

Meracantha contracta (Beauv.). This species is less restricted to decaying timber than the other pupae in this group. Larvae occur beneath bark, chunks, or other cover, as well as in decaying logs; they are capable of making burrows in solid wood. Pupation occurs in April or May beneath the bark of logs or beneath pieces of wood. The pupal stage lasts for about nine days. Hyslop (1915) gives an adequate description of the pupa and discusses its ecology.

TAXONOMY

The following key to the tenebrionid pupae here considered is, so far as possible, based on characters that can be discerned on the pupal exuviae as well as the whole pupa. Obviously, since only a small proportion of the Indiana species of the family are considered, the key is limited in application. It will serve, however, for the majority of specimens collected in wood, since it includes all the more common ones.

KEY TO SOME OF THE PUPAE OF THE FAMILY TENEBRIONIDAE IN INDIANA

a. Second and third thoracic segments together shorter than first abdominal segment; legs and antennae very long; maxillary palpus strongly dilated; first and second abdominal segments with well sclerotized hinge-like structures; lateral plates simple, bifid (plate I, fig. 2; plate III, fig. 4) ..... *Meracantha contracta* (Beauv.)

aa. Characters partly or entirely different

b. Ninth abdominal segment broadly truncate, bearing urogomphi separated at their bases by approximately their length; legs short and stout; elytra reaching to or nearly to claws of metathoracic legs.

c. Prothorax with pair of tubercles, relatively short in females, very long in males; lateral plates bifid (plate II, fig. 3,4; plate III, fig. 7) ..... *Bolitotherus cornutus* (Panz.)

cc. Prothorax without tubercles; lateral plates with several teeth (plate I, fig. 1; plate III, fig. 6) ..... *Bolitophagus corticola* Say

bb. Ninth segment not broadly truncate, urogomphi narrowly separated at their bases.

c. Lateral plates bearing pair of finger-shaped tubercles unsclerotized at their tips; setae long, when borne on tubercles always at the distal end of tubercles

d. Oval in shape; abdominal terga with rows of fleshy setae-bearing tubercles; lateral plates with tubercles about equal and each bearing seta; urogomphi directed dorsad (pl. I, fig. 3; pl. II, fig. 6; pl. III, fig. 8) ..... *Diaperis maculata* Oliv.

dd. More slender and parallel; terga without special armature; lateral plates with posterior tubercle smaller and lacking seta; cranial and caudal margins of plates armed with minute sclerotized teeth; urogomphi directed caudad (pl. III, fig. 10) ..... *Alphitophagus bifasciatus* (Say)

cc. Lateral plates bearing various spine-like processes, always more or less sclerotized at their tips; setae often inconspicuous, usually but not always borne proximad to tips of spines

d. Elytra covering most of metathoracic femora, reaching nearly to ends of metathoracic tarsi; setae moderate, inserted at tips of tubercles and spines; lateral plates with sclerotized and serrated anterior and posterior margins and 2 or 3 short lateral tubercles (pl. III, fig. 9) ..... *Tribolium confusum* Jacq. Duv.

dd. Elytra smaller, leaving much of metathoracic femora exposed and reaching to less than half length of metathoracic tarsi; setae not inserted at tips of spines or tubercles; lateral plates variable

e. With strongly developed spines on abdominal segments ventral to lateral plates; lateral plates with 4 or 5 spines and without cranial and caudal sclerotized margins; body very slender (pl. III, fig. 5) ..... *Strongylium* sp.

ee. Without such strongly developed spines ventral to lateral plates; lateral plates variable; body stouter

f. Lateral plates with cranial and caudal margins sclerotized and serrate

g. Surface nearly glabrous, with only a few, more or less definitely placed setae

h. Caudal sclerotized margin of lateral plates not notably oblique

i. Last article of maxillary palpus dilated (pl. II, fig. 2; pl. III, fig. 11) ..... *Tenebrio obscurus* Fab.

ii. Last aricle of maxillary palpus nearly cylindrical (pl. II, fig. 1) ..... *Tenebrio molitor* L.

hh. Caudal sclerotized margin of lateral plate oblique, its outer angle nearly obsolete, its inner angle prolonged and acute (pl. III, fig. 12) ..... *Tenebrio picipes* Hbst.

gg. Surface evenly and densely covered by short, slender setae (pl. III, fig. 13) ..... *Scotobates calcaratus* (Fab.)

ff. Lateral plates without sclerotized cranial and caudal margins, but with dagger-like spine at cranio-lateral angle

g. Tergum of ninth segment with pair of fleshy projections terminating in single or forked apices (pl. II, fig. 5; pl. III, fig. 3) ..... *Merinus laevis* (Oliv.)

gg. Tergum of ninth segment without special armature

h. Lateral plates with 2 or 3 conspicuous spines between cranial dagger-shaped spine and caudal spine (pl. III, fig. 2) ..... *Alobates pennsylvanica* (DeG.)

hh. Lateral spines of lateral plates smaller and less conspicuous (pl. III, fig. 1) ..... *Xylopinus saperdioides* (Oliv.)

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