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## Descriptions, Biology, and Notes on the Identification of Some Trogoderma Larvae

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Beal

P.F. Torchio

1357 *MF*

Descriptions, Biology, and Notes  
on the Identification of Some  
**TROGODERMA**  
**LARVAE**  
(Coleoptera, Dermestidae)

Technical Bulletin No. 1228

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UNITED STATES DEPARTMENT OF AGRICULTURE

*Coleoptera - Dermestidae - Trogoderma*

*- larval descriptions + biology*

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# Descriptions, Biology, and Notes on the Identification of Some **TROGODERMA** LARVAE (Coleoptera, Dermestidae)

By R. S. Beal, Jr.,<sup>1</sup> *entomologist, Entomology Research Division,  
Agricultural Research Service*<sup>2</sup>

For several years members of the dermestid beetle genus *Trogoderma* have attracted widespread attention, particularly since *T. granarium* Everts, the khapra beetle, became established as an introduced pest in Arizona, California, Mexico, and New Mexico. This species has been the object of a control program to remove it as a hazard to stored grain and to prevent its spread to parts of the country where it is not known to occur. Species of *Trogoderma* other than the khapra beetle may also build up to damaging numbers in stored products. Information has been obtained on these species, as well as on *granarium*, during the course of these studies.

This bulletin brings up to date the knowledge of how to recognize and to identify *Trogoderma* larvae. It includes descriptions of previously undescribed or inadequately described larvae of *Trogoderma* species. These descriptions supplement those of several *Trogoderma* larvae I published in 1954 (4).<sup>3</sup> A key for identifying larvae of the Nearctic species of *Trogoderma* and diagnostic notes on larvae of several other *Trogoderma* species are also included.

The following terms refer to the various types of setae on *Trogoderma* larvae. Nudisetae are the smooth setae ordinarily found on beetle larvae. Spicisetae are more or less slender with sharply pointed imbricate scales. Hastisetae are the unique spear-headed setae found on all the known members of the Anthreninae, the subfamily to which *Trogoderma* belongs. Fisciseta is the term proposed for a peculiar type of seta, previously undescribed, on larvae of certain Australian species of *Trogoderma*. It is derived from fiscus, a Latin word for a twig basket, which these setae somewhat resemble. They are greatly expanded terminally into a large club or globose basket consisting of an exterior membrane strengthened by a number of thin longitudinal ribs and irregular transverse fibers, which gave the surface a reticulate appearance. Series of leaf- or spatula-shaped setae

<sup>1</sup> Resigned August 15, 1958. Now with Arizona State University, Tempe.

<sup>2</sup> This study was supported in part by a transfer of funds from the Agricultural Marketing Service.

<sup>3</sup> Italic numbers in parentheses refer to Literature Cited, p. 25.



are located on the margin of the epipharynx in *Trogoderma* and in other Dermestidae. It is not necessary to designate these by a special term, although the relative widths of the middle series are of some taxonomic significance. Often these setae are apically truncate or even emarginate, probably the result of wear, which is of no taxonomic importance.

Several useful taxonomic characters are found in the larval antennae, particularly in the relative lengths of the setae and the segments. To be accurately measured, the specimens should be mounted on slides and examined with a compound microscope. However, with a little practice the relative lengths of the segments and of the setae can be judged accurately enough under the high magnification of a stereoscopic microscope to identify the species. The antenna will protrude if a preserved specimen, which has not become too hard through improper fixation, is gently pressed on the thorax with a suitable tool or the head is lightly squeezed with a fine forceps. When the antenna is exerted its maximum length, the relative lengths of the segments and the setae can be estimated. In this study each segment was measured on the longest side of its sclerotized part.

In order to see the antecostal suture of the eighth abdominal tergum, it is necessary to tease away the hastisetæ of the seventh abdominal segment. When the specimen has been preserved in alcohol, it is easy to confuse a fold in the intersegmental membrane for the antecostal suture. To avoid this, the abdomen should be extended by pressing it gently with a loop or flattened needle. Even with pressure on the abdomen the folds in the intersegmental membrane are not always eliminated. A true antecostal suture is interrupted at the midline. This interruption distinguishes it from a fold in the membrane, which appears as an unbroken line across the median suture.

The following key may be used for fairly mature and fully pigmented larvae. Since specimens may differ greatly in size at maturity and since the number of instars is indefinite, it is difficult to designate just when a larva is sufficiently mature for identification. In general, the key is usable for any specimen that is at least  $3\frac{1}{2}$  mm. long. With experience a worker may be able to identify less mature stages. Unfortunately, with the present knowledge about the species, it is not possible to prepare a key that will permit the identification of immature larvae. The key is designed for use with a stereoscopic microscope except where noted. A few forms can be identified with certainty only after they have been cleared, mounted on a slide, and examined with a compound microscope. Additional notes for identifying teneral specimens are given in the discussions of the species.

*T. angustum* (Solier) has been omitted from the key, because in extensive collecting in the United States no specimens have been found other than those previously recorded (4), and because this species probably has not become established in this country. The larvae of all other *Trogoderma* species known to occur in the Nearctic region have been included, except the larvae of two very rare species—*T. fasciferum* Blatchley from Florida and *T. paralia* Beal from coastal northern California. Their immature stages have not been found.

# KEY TO LARVAE OF NEARCTIC SPECIES OF TROGODERMA

1. Setae of basal segment of antenna less than half as long as elongated second segment of antenna (fig. 2) ----- 2  
 Setae of basal segment of antenna at least three-fourths as long as second segment of antenna (fig. 2) ----- 4
2. Each abdominal tergite near midline bearing numerous appressed, short, somewhat blunt, inwardly directed spicisetae, which are about twice as thick as spicisetae of acrotergite; submedian row of large spicisetae not extending across median area of tergite where these short spicisetae inserted, but interrupted at midline for distance about equal to twice length of tergite. Numerous spicisetae inserted along posterior margin of each abdominal tergite ----- *simplex* (p. 22)  
 Abdominal tergites with very few or no short spicisetae inserted near midline; submedian row of large spicisetae extending completely across tergite or interrupted at midline by space shorter than length of tergite. No spicisetae or only very few scattered spicisetae inserted along posterior margin of abdominal tergites ----- 3
3. Spicisetae of seventh and eighth abdominal tergites noticeably enlarged (about  $1\frac{1}{2}$  times as thick as spicisetae of anterior tergites), short, and grouped in clusters of two or three. Area on seventh abdominal tergum that bears hastisetae not separated from rest of tergum *ballfinchae* (p. 22)  
 Spicisetae of seventh and eighth abdominal tergites not noticeably stouter than spicisetae of anterior tergites; submedian row of large spicisetae on these tergites more or less continuous; spicisetae not in compact separated groups of two or three. Sclerotized area on seventh abdominal tergum that bears hastiseta tuft separated from rest of tergum by narrow membranous area (somewhat as in *Anthrenus*) ----- *primum* (p. 21)  
 4. Coxae with grayish-brown pigmentation over most of ventral surface. All terga with dark grayish-brown pigmentation; pigmentation of eighth abdominal tergum extending across median suture, at least on anterior half of tergite ----- *sinistrum* (p. 15)  
 Coxae cream colored or hyaline over ventral surface; dark pigmentation, if present, limited to apex. Terga with light or dark pigmentation, but if pigmentation dark gray on anterior terga, tends to fade out on posterior terga; at least middle of eighth abdominal tergum and usually most of last two or three terga definitely light brown or cream instead of gray ----- 5
5. Setae of basal segment of antenna almost completely encircling segment, not bunched on mesal side of segment (fig. 2) and extending to apex of second segment or beyond when antenna is fully extended ----- 6  
 Setae of basal segment of antenna bunched on mesal side of segment; one-third or more of outer part of segment bare; setae of basal segment not attaining apex of second segment when antenna extended (if this character questionable, setae of first segment will be clearly bunched on mesal side) ----- 9
6. Antecostal suture absent on eighth abdominal tergum ----- 7  
 Antecostal suture present on eighth abdominal tergum ----- 8
7. Terga uniformly creamy yellow to medium brown. Setae of basal antennal segment exceed apex of second segment when antenna extended ----- *granarium* (p. 4)  
 Thoracic and usually first five or six abdominal terga with sides grayish brown and middle light brown; dark grayish brown occasionally extends across terga or may be nearly lacking. Setae of basal segment of antenna just attaining apex of second segment ----- *teukton* (p. 9)
8. Terga creamy yellow to light brown without areas of darker gray ----- *inclusum* (p. 11)  
 Thoracic and at least first five abdominal terga dark gray or in teneral specimens creamy yellow with grayish sides or with grayish spots, particularly about bases of large spicisetae ----- *glabrum* (p. 6)

9. Setae of acrotergites all long enough to extend across antecostal suture-- 10  
 Anteriormost setae of acrotergites not extending across antecostal  
 suture----- 13
10. Fully pigmented specimens darker on anterior half of mesonotum and  
 metanotum than on pronotum. One or two setae usually present on  
 second segment of antenna  
*sternale maderae, s. aspericolle, s. complex* (p. 16)  
 Fully pigmented specimens uniformly light or dark; pronotum may  
 show some light-colored spots, but ground color of pronotum as dark  
 as anterior half of mesonotum. Setae present or absent on second seg-  
 ment of antenna----- 11
11. Posterior margin of metanotum with numerous spicisetae but without  
 any spicisetae as stout as large erect spicisetae of submedian row;  
 large erect spicisetae of submedian row sparse (fig. 5). One or two  
 setae commonly present on second segment of antenna. Specimens  
 always creamy yellow, never dark----- *sternale plagifer* (p. 16)  
 Posterior margin of metanotum with few spicisetae as stout as large erect  
 spicisetae of submedian row; large erect spicisetae of submedian row  
 fairly numerous (fig. 5). Second segment of antenna without setae.  
 Specimens light or dark----- 12
12. Dorsal terga creamy yellow----- *ornatum* (p. 20)  
 Dorsal terga yellowish brown to medium brown----- *grassmani* (p. 18)
13. Hastisetae usually very sparse on disc of thoracic and anterior abdominal  
 tergites; large erect spicisetae of median row on tergites usually in single  
 series<sup>4</sup>----- *parabile* (p. 11)  
 Hastisetae usually moderately dense across disc of thoracic and anterior  
 abdominal tergites behind row of large spicisetae, except for small area  
 just at midline (fig. 5); large erect spicisetae of median row on tergites  
 in double rank in more mature specimens----- 14
14. Longest spicisetae of acrotergite of first abdominal segment one-third to  
 one-half as long as length of tergite at midline----- *anthrenoides* (p. 18)  
 Longest spicisetae of acrotergite of first abdominal segment four-sevenths  
 as long as to subequal to length of tergite----- *ornatum* (p. 20)

## DESCRIPTIONS AND DISCUSSIONS OF LARVAE OF TROGODERMA SPECIES

### *Trogoderma granarium* Everts

References: Okumura and Blanc, 1955, in Special Report on the Khapra Beetle (California Legislature), p. 89 (in key to species); Howe and Burges, 1956, Bul. Ent. Res. 46: 773-780 (comparison with *T. inclusum* [as *T. versicolor*]); Burges, 1957, Ent. Monthly Mag. 93: 105-110 (biology).

Dorsal surface uniformly creamy white to light brownish yellow or rarely light brown with some grayish pigmentation on sides of tergites. Middle setal series of epipharyngeal margin consisting of two broad inner setae and two narrow outer setae about half as wide as inner setae; inner setae often with longitudinal grooves on apical half. Four papillae in distal sensory cup of epipharynx. Antenna with setae of basal segment 2-2½ times as long as second segment of antenna; setae inserted around circumference of basal segment except on lateral fourth; no spicisetae on basal segment; second segment subequal in

<sup>4</sup> *T. parabile*, *T. anthrenoides*, and *T. ornatum* are sometimes distinguishable only by characters visible in slide-mounted specimens when viewed through a compound microscope. A comparison of these characters will be found in the discussion of the species.

length to basal segment; single seta commonly present on second segment of mature individuals; apical segment  $1\frac{1}{6}$ – $1\frac{1}{3}$  times as long as second segment; basal sensory pores of apical segment located together at about basal fourth, or one pore at basal fourth and other pore between basal third and basal half. First abdominal segment with anteriormost spicisetae of acrotergite not long enough to cross antecostal suture. Few fine spicisetae inserted on tergite anterior to median row of large spicisetae; hastisetae largely limited to lateral areas of tergite; if hastisetae inserted near median line, then only very sparsely so; posterior margin of tergite bearing numerous fine spicisetae and usually several larger spicisetae subequal in diameter to large spicisetae of disc of tergite. Antecostal suture absent on eighth abdominal tergum or represented only by interrupted line. Diameter of large discal spicisetae of eighth abdominal tergite subequal to that of other tergites. Coxae without dark pigmentation.

The larvae of *granarium* are readily placed in the *inclusum* group of species because of the relatively short second antennal segment and because of the long setae nearly surrounding the basal antennal segment. When the antenna is exserted, the setae of the basal segment extend to the apex of the second segment or beyond. The larvae can be separated from all other members of the *inclusum* group except *teukton* by the absence of an antecostal suture on the eighth abdominal tergum. It is difficult to separate *granarium* from *teukton* except by color characters, which are not always reliable, and by characters on the epipharynx, which require dissection and examination under a compound microscope.

The presence of four rather than six papillae in the distal group of epipharyngeal papillae (fig. 1, B) separates *granarium* positively from all other known *Trogoderma* larvae except *glabrum*.<sup>5</sup> Only

<sup>5</sup> To observe this character, it is best to remove the labrum, to which the epipharynx is attached, and to mount it ventral side up on a microscope slide. Hoyer's mounting fluid has been very useful for making rapid examinations and for giving good resolution of the details.

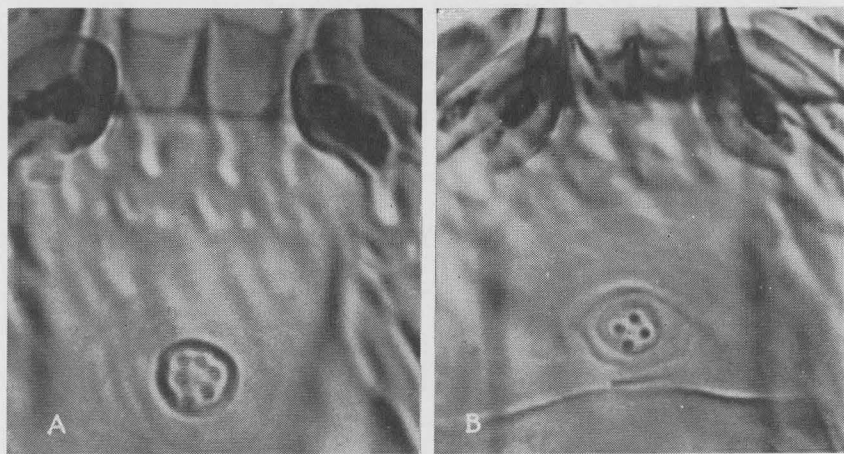


FIGURE 1.—Distal group of papillae on epipharynx of (A) *Trogoderma grassmani* and (B) *T. granarium*.



four papillae are present in *glabrum*, but this species can be distinguished from *granarium* by the presence of an antecostal suture on the eighth abdominal tergum and by the dark gray of all except the teneral specimens. In occasional specimens of *granarium* the distal epipharyngeal papillae are separated into two or three groups instead of the usual grouping of four papillae in a single cluster surrounded by a dark ring. One or two papillae may be separated from the others and each surrounded by a small separate ring. Nevertheless, the total number of papillae for each *granarium* larva is four.

### *Trogoderma glabrum* (Herbst)

References: Beal, 1954, Calif. Univ. Pubs., Ent. 10, pp. 80-83, 95 (description, biology [as *T. boron* Beal]); 1956, Ent. Soc. Amer. Ann. 49: 561-562 (biology).

The dark color of *glabrum* larvae readily separates them from larvae of the most closely related species. Teneral specimens may be confused with *granarium*, *teukton*, and perhaps *inclusum* and *parabile*. The last is distinguished by the longer second antennal segment and by the fact that the setae of the first segment are all on the mesal side. Teneral specimens of *glabrum* almost always have at least small traces of dark pigmentation on the sides of the terga. These are usually sufficient to separate the species from *inclusum*, which never has grayish-brown spots. Usually *inclusum* is a creamy yellow. If it is at all darkly pigmented, it is a uniform yellowish brown rather than creamy with darker grayish spots. Positive separation of *teukton*, *inclusum*, and *parabile* from *glabrum* can always be made by the number of papillae in the distal group of sensory papillae on the epipharynx. *T. glabrum* has four; each of the other three species has six. *T. granarium* has four papillae in the distal group on the epipharynx, but it can be distinguished from *glabrum* by the absence of an antecostal suture on the eighth abdominal tergum.

A dark-colored species that might be mistaken for *glabrum* is *sinistrum*. The relative lengths of the antennal segments are much the same in the two species. However, the coxae of *sinistrum* are darkly pigmented, whereas the coxae of *glabrum* are not. The former also has much longer setae on the acrotergites, the spicisetae at the lateral margins of the tergites are noticeably longer, and the anterior half of the posterior abdominal segments is as darkly pigmented as are the anterior abdominal segments. In *glabrum* the last two or three abdominal terga are usually lighter colored than the anterior abdominal terga, at least toward the midline.

This species is known throughout Europe. In the United States it has been recorded from California, Colorado, Idaho, Illinois, Iowa, Kansas, Minnesota, Missouri, Oregon, Washington, and Wyoming. New records include the following places: Phoenix, Ariz.; New Orleans, La.; Boston, Mass.; Gage and Richardson Counties, Nebr.; Nashua, N.H.; Curry, Quay, Roosevelt, and Union Counties, N. Mex.; Baldwinville, N.Y.; Spartanburg, S.C.; Tyndall, S. Dak.; Houston, Tex.; Alexandria, Va.; and Madison and Milwaukee, Wis. In Mexico *glabrum* has been found at Mexicali, Baja California. It has also been intercepted at Brownsville and Laredo, Tex., infesting ship-

ments from unidentified localities within Mexico. The earliest known record of this species in the Western Hemisphere was in 1934, when it was taken at St. Paul, Minn. Judging from the frequency of *Trogoderma* collections prior to 1934, it could not have become established more than a few years earlier. Probably less than 30 years has been required for its spread over the greater part of the United States and into Mexico.

### *Trogoderma irroratum* Reitter

Reference: Reitter, 1880 (1881), *Naturf. Ver. in Brünn, Verhandl.* 19: 42 (description of adult).

Terga light creamy yellow. Middle setal series of epipharyngeal margin consisting of two broad inner setae and two narrow outer setae one-fourth to one-third as wide as inner setae; inner setae with inconspicuous groove. Distal sensory cup of epipharynx with six papillae. Antenna as illustrated (fig. 2); nudisetae of basal segment equal to length of second segment to twice as long as second segment; one spiciseta sometimes present on basal segment of mature individuals; setae inserted around circumference of basal segment except on dorsolateral fourth; second segment  $1\frac{1}{3}$ – $1\frac{3}{5}$  as long as basal segment; one seta occasionally present on second segment; terminal segment subequal to second segment to  $1\frac{1}{4}$  times as long as second segment. Fine spicisetae of acrotergites of first abdominal segment about one-third to one-half as long as length of tergite at midline; anteriormost setae of acrotergite not extending across antecostal suture. Only very few or no fine spicisetae inserted on tergite anterior to median row of large spicisetae; posterior margin of tergite bearing numerous fine spicisetae and few large spicisetae; hastisetae inserted across entire posterior border of tergite, moderately dense near midline. Antecostal suture present on eighth abdominal tergum. Diameter of large discal spicisetae on seventh and eighth abdominal tergites subequal to diameter of large discal spicisetae on anterior tergites. Coxae without darkly pigmented areas.

Material for this description came from an active culture of the species sent from Egypt by A. Badawy. The specimens were reared to maturity in the laboratory on a diet of pollen. Since the culture was subsequently destroyed to minimize the danger of specimens escaping to become pests in the United States, no further observations were made on the biology of the species.

The larvae of *irroratum* are very similar in appearance to larvae of both *granarium* and *inclusum*. The species can be separated from *granarium* by the presence of an antecostal suture on the eighth abdominal tergum and by six papillae rather than four in the distal sensory cup of the epipharynx. The only apparently consistent character separating *irroratum* from *inclusum* is the number of fine spicisetae inserted on the tergite anterior to the median row of large spicisetae. In *irroratum* there are a few; on the first abdominal tergite of mature specimens there are none or not more than four on a side. In *inclusum* there may be from 10 to 25 spicisetae inserted

a little anterior to the median row of large spicisetæ on the first abdominal tergite. Other Nearctic species may be separated from the Palaearctic *irroratum* by the same characters used to separate them from *inclusum*.

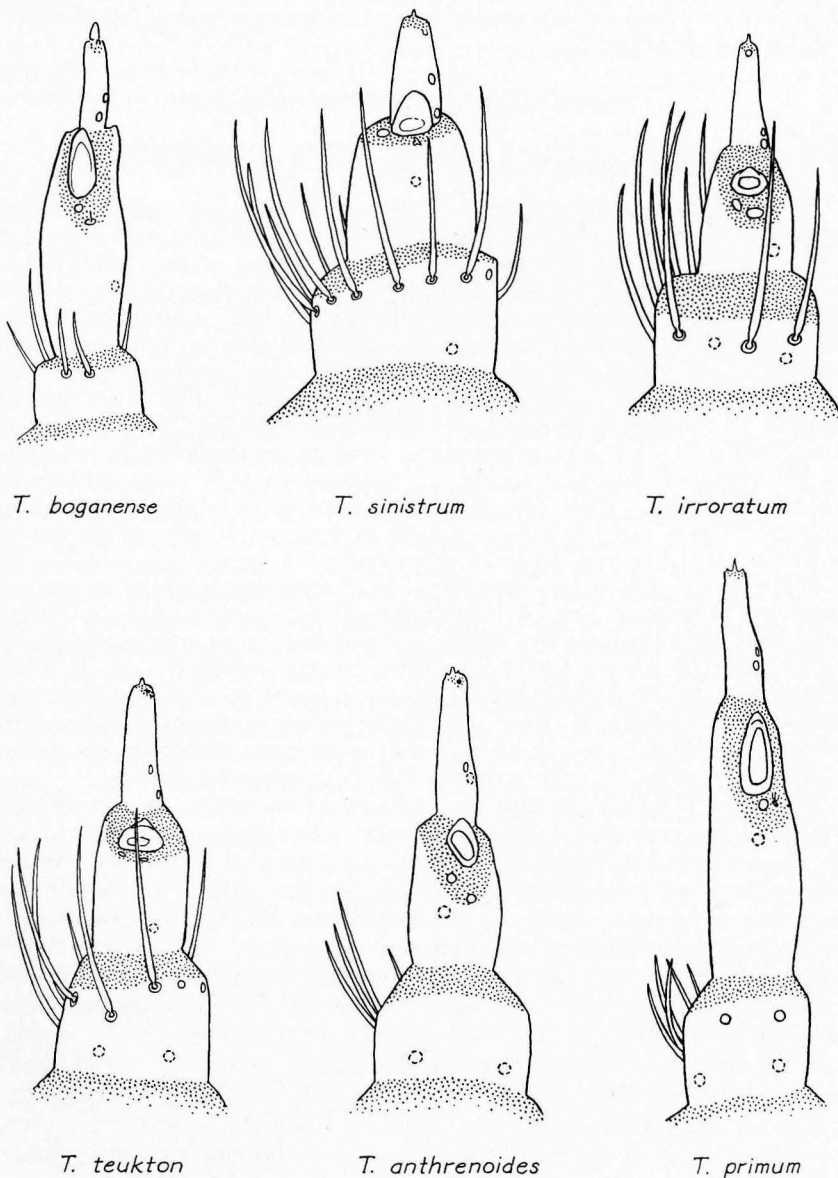


FIGURE 2.—Larval antennae of species of *Trogoderma*.

*Trogoderma teukton* Beal

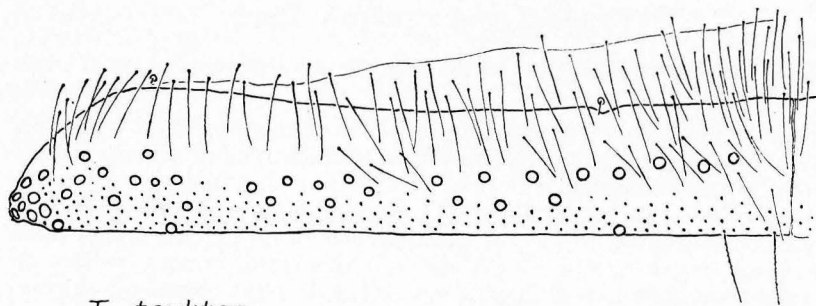
Reference: Beal, 1956, Ent. Soc. Amer. Ann. 49: 565-566 (description of adult, biology).

Terga usually dark grayish brown on sides becoming light yellowish brown toward midline; dark coloration often extended across midline on acrotergite and anterior half of tergite on abdominal segments, less commonly so on second and third thoracic segments; only very rarely does dark coloration of lateral areas of pronotum extend across midline; sixth, seventh, and eighth abdominal tergites creamy yellow on areas bearing brushes of hastisetae. Middle setal series of epipharyngeal margin consisting of two broad inner setae and two outer setae about two-thirds as wide as inner setae; inner setae indistinctly grooved or smooth. Distal sensory cup of epipharynx with six papillae. Antenna as illustrated (fig. 2); nudisetae of basal segment  $1\frac{1}{4}$ - $1\frac{3}{4}$  times as long as second segment; one short spiciseta frequently present on basal segment of mature individuals; setae inserted around circumference of basal segment except on lateral fourth; second segment  $1\frac{1}{3}$ - $1\frac{4}{5}$  times as long as basal segment; setae never present on second segment; apical segment subequal to second segment to  $1\frac{1}{6}$  times as long as second segment. Disposition of setae of first abdominal tergum as illustrated (fig. 3); fine spicisetae of acrotergites long, about two-thirds as long as length of tergite at midline, but anterior-most setae usually not extending across antecostal suture; in large specimens one or two large spicisetae often inserted on acrotergite. A number of fine, short spicisetae inserted on tergite anterior to median row of large spicisetae; posterior margin of tergite bearing numerous fine spicisetae and few larger spicisetae; hastisetae inserted across entire posterior border of tergite, moderately dense near midline. Antecostal suture absent on eighth abdominal tergum or represented only by interrupted line. Diameter of large discal spicisetae of seventh and eighth tergites subequal to diameter of large spicisetae of anterior tergites. Coxae without darkly pigmented areas.

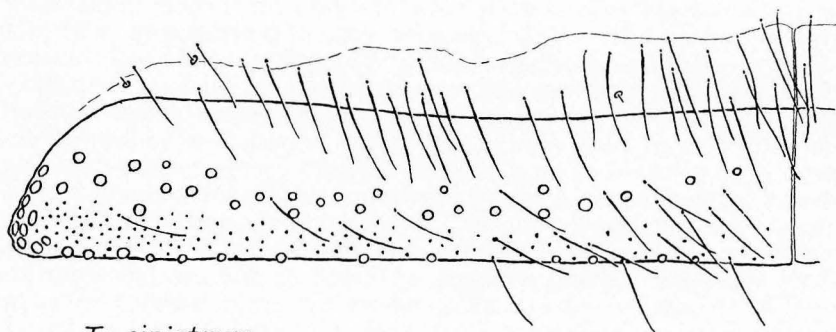
Larvae of this species can usually be recognized by the color of the terga, which are ordinarily much darker on the sides than along the middle, particularly on the pronotum. Teneral specimens of this species may rather easily be mistaken for *granarium*, particularly because both species lack a definite antecostal suture on the eighth abdominal tergum. The second antennal segment is relatively longer in *teukton* than in *granarium*, a character that is constant but difficult to use except with mounted specimens. The relatively denser setae of the abdominal terga of *teukton* are also useful in recognizing teneral specimens of this species. The hastisetae of the first two or three abdominal tergites are much denser toward the midline in *teukton* than in *granarium*, and the spicisetae along the middle of each tergite are much more numerous in *teukton* for specimens of comparable size. However, teneral specimens of *teukton* may be separated from *granarium* with certainty by the presence of six rather than four papillae in the distal group of sensory papillae on the epipharynx.

The absence of a definite antecostal suture on the eighth abdominal tergum of *teukton* separates teneral specimens of this species from *in-*

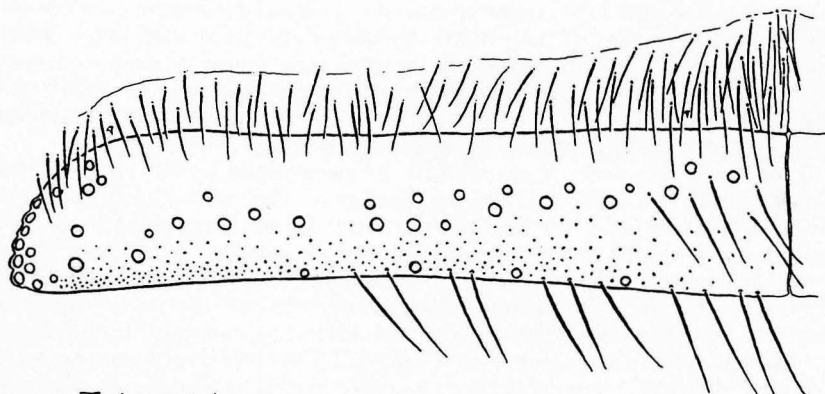




*T. teukton*



*T. sinistrum*



*T. irroratum*

FIGURE 3.—Left half of first abdominal terga of species of *Trogoderma*. Points of insertion of large spicisetae are indicated by circles; the larger the spiciseta, the larger the circle. Points of insertion of hastisetae are indicated by dots.

*clusum*. The same character may be used to separate teneral specimens of *glabrum* from this species.

*T. teukton* has been recorded from Iowa, Minnesota, and North Dakota. New records include the following places: KANSAS: Beloit (G. D. White); Hoxie (H. E. McGregor). MONTANA: Laurel,

Yellowstone County (Bartholf). NEBRASKA: Falls City (T. D. Aitken); Lincoln (R. Staples); North Platte. WISCONSIN: Eau Claire; Mondovi. Dates have not been included with the foregoing data because most of the specimens were taken in the larval stage in stored products. The Wisconsin specimens were infesting dried-milk storage facilities, the Kansas specimens were in stored wheat, and the Falls City specimens were in stored corn.

### *Trogoderma inclusum* LeConte

References: Beal, 1954, Calif. Univ. Pubs., Ent. 10, pp. 83–85 (description, biology [as *T. versicolor*]); Howe and Burges, 1956, Bul. Ent. Res. 46: 773–780 (comparison [as *T. versicolor*] with *T. granarium*); Beal, 1956, Ent. Soc. Amer. Ann. 49: 561, 562–563 (in key to species, distribution).

Larvae of this species closely resemble *granarium* larvae in the characters of the antenna and dorsal setae. *T. inclusum* can be distinguished from *granarium* by the presence of an antecostal suture on the eighth abdominal tergum. It can be positively differentiated from *granarium* by the number of papillae in the distal group of papillae on the epipharynx—six papillae in *inclusum* and four in *granarium*. The characters separating this species from *teukton*, *glabrum*, *parabile*, and *irroratum*, all closely related species, are found in the discussion of each species.

Outside the Nearctic region the species has been known only from Great Britain (5). In August 1958 Vladimír Kalík of Pardubice, Czechoslovakia, submitted to me several specimens of *inclusum* found infesting a granary in Rome, Italy. The distribution of the species in the United States is shown in figure 4 and is discussed under *parabile*.

### *Trogoderma parabile* Beal

References: Beal, 1954, Calif. Univ. Pubs., Ent. 10, pp. 87–89 (description of adult, pupa, larva); 1956, Ent. Soc. Amer. Ann. 49: 561–564 (in key to species, distribution, biology).

In characters used in taxonomic discrimination, this is perhaps the most variable of all the species treated in this bulletin. Because of its wide range of variability it is likely to be confused with several other species. The second segment of the antenna may be so short that when the antenna is distended, the setae of the first segment attain its apex, or it may be so long that the setae of the first segment extend scarcely as far as the middle of the second segment. The fine spicisetae of the acrotergites may be sparse or dense. The large spicisetae of the disc of each abdominal tergite are usually sparse, in not more than one rank, and comparatively short. Occasionally they may be numerous, in a row of about two ranks, and rather long, giving such larvae an altogether different appearance with some resemblance to *granarium*. However, the species may always be separated from *granarium* by the presence of a definite antecostal suture on the eighth abdominal tergum. In a fresh specimen this suture may be difficult to see because of the light pigmentation usual in the species. However, the suture is always plainly visible in a specimen that has been cleared and mounted on a slide.

Larvae of the most common form of *parabile* can be separated from larvae of *inclusum* at a glance because of the sparseness of the large spicisetae on the disc of the tergites of *parabile*. Larvae of *parabile* with the large spicisetae of the tergites more numerous can be separated from larvae of *inclusum* by the distribution of the setae of the first segment of the antenna. In *inclusum* the setae of the first antennal segment almost entirely surround the segment. In *parabile* the setae are inserted only on the mesal side of the segment, and at least the outer third of the segment is left bare.

*T. parabile* can usually be separated from the other closely related Nearctic species, *glabrum* and *teukton*, by differences in dorsal pigmentation. This species is usually a light creamy yellow and very rarely a light brown. When more darkly pigmented, it is not appreciably darker on the sides of the terga than at the midline. Both *glabrum* and *teukton* are usually much more darkly pigmented. Teneral specimens of *glabrum* and fully pigmented specimens of *teukton* are commonly much darker on the sides of the terga than along the midline, or they bear small dark spots of pigmentation on the sides of the terga. Teneral specimens of *teukton* may be as light colored as *parabile* but are not likely to be mistaken for it because of the large number of large spicisetae in the row at the middle of each tergite of *teukton*. Not uncommonly in specimens of *teukton* large spicisetae may even be found inserted on the acrotergites of the mesonotum and metanotum, a condition never found in *parabile*.

Although belonging to different species groups, *parabile* larvae sometimes closely resemble larvae of *ornatum* and of *anthrenoides*. Most *parabile* larvae can be recognized by the sparseness of both the setae of the acrotergites and the large erect setae in the median row on the tergites. The limited number of hastisetae on the disc of the anterior abdominal tergites is also a common characteristic of *parabile*. However, occasional specimens of *parabile* having the setae of the acrotergites rather dense and the large erect spicisetae of the tergites in a row of two ranks may easily be mistaken for *ornatum* or for *anthrenoides*. Furthermore, the hastisetae of the anterior abdominal segments of *ornatum* and *anthrenoides* may occasionally be as sparse as those on typical specimens of *parabile*. Differences in the structure of the setae of the acrotergites may be used to distinguish *parabile* from the other two species if the specimen is mature and if it is cleared and examined under a compound microscope. In *parabile* the setae of the acrotergites look more like nudisetae. They are almost entirely smooth except near the tips of some of the longer setae, where a few imbricate scales may be seen. In *ornatum* and in *anthrenoides* the acrotergites bear typical spicisetae, in which the imbricate scales are present nearly to the base. Fortunately the species may be separated fairly accurately on the basis of their geographic distribution. *T. parabile* is found in dry areas, whereas the other two seem limited to humid areas. Neither *ornatum* nor *anthrenoides* is common in stored products.

The distribution of *parabile* in the United States (fig. 4) corresponds to conditions of relative humidity. In the khapra beetle survey conducted by the Plant Pest Control Division, large numbers of *Trogoderma*, most of them in the larval stage, were collected in various grain-, seed-, and food-storage facilities. The survey shows that the

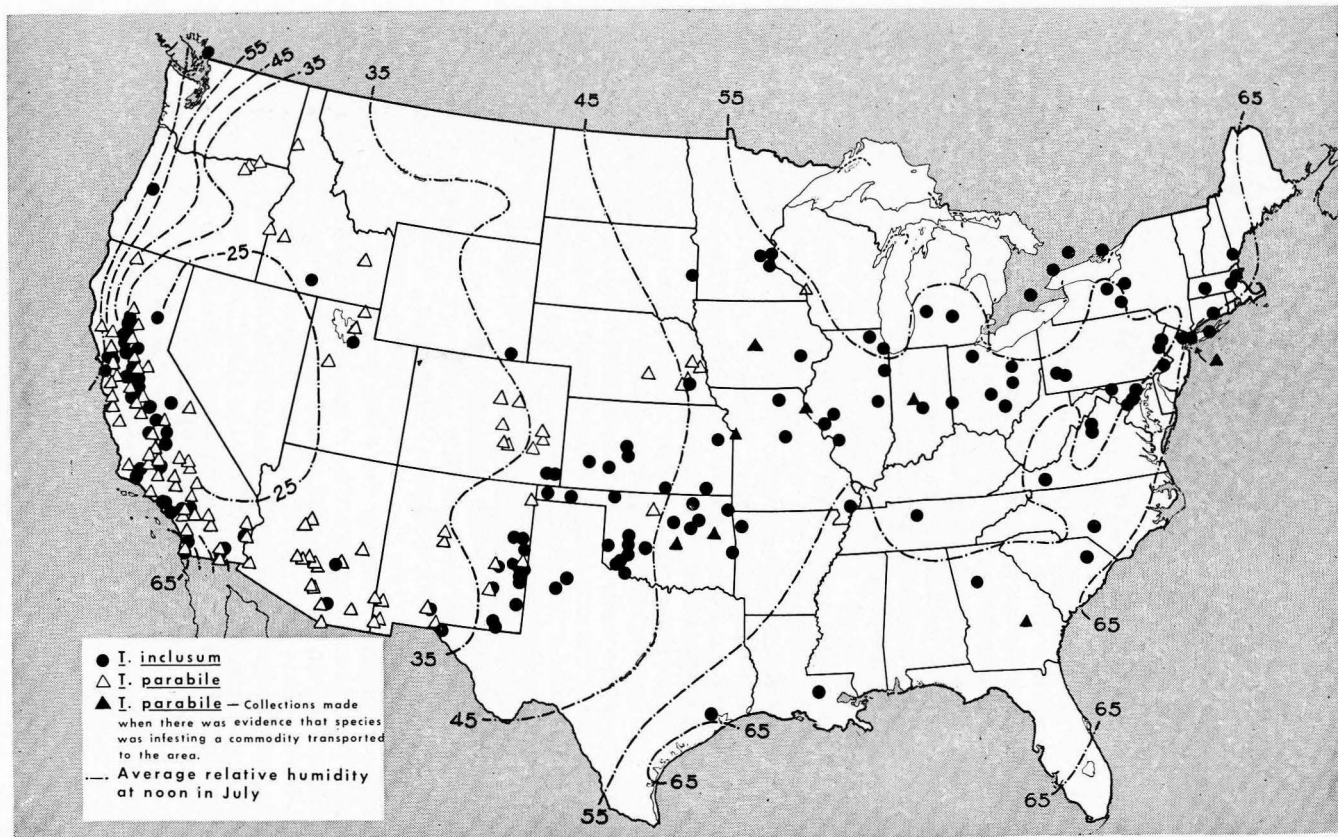


FIGURE 4. Distribution of two species of *Trogoderma* in the United States, showing correlation with local average relative humidities at noon in July.



species occurs throughout the United States but is prevalent only in the drier areas.

A convenient standard against which the distribution of the species may be plotted is the gradients of relative humidity for noon during July.<sup>6</sup> Most collections of the species were made within the gradient of 35 percent. A few collections were made within the gradient of 45 percent. However, with only four exceptions, the collections made in areas of greater relative humidity for this period were in seed houses and stores where there was evidence that the specimens had been recently transported to the area in some commercial commodity. In figure 4 the solid triangles indicate such localities. The open triangles indicate localities where collections were made with no evidence that the specimens had been transported in a recent commercial commodity. The most extreme collection of this sort was from La Crosse, Wis., where the species was taken infesting a milk-drying plant. It is probably of no significance that almost no records of *parabile* were found within the area of less than 25-percent relative humidity, an area enclosing most of Nevada, since very few collections were attempted there.

In contrast to the distribution of *parabile*, the major distribution of *inclusum* falls within the area of more than 35-percent relative humidity. The species is very common from eastern New Mexico across the Central States to Massachusetts. There are relatively few collections from the Southern States, probably owing to a lack of intensive collecting. This species is infrequent in the far northern United States. Whether this is the result of more extreme low temperatures in the area is not known. In Arizona, where a very intensive survey of *Trogoderma* was made, the species is rather uncommon. I estimate from my identifications of specimens from Arizona that 1 collection of *inclusum* is made for about 300 collections of *parabile*. Probably *inclusum* is regularly introduced by commerce into areas of low relative humidity, but it is unable to survive.

The correlation of the distribution of these species with areas of lesser and greater relative humidity is not proof that the distribution is directly related to this factor. There may be only an accidental correlation, or some intermediate agency may be involved, such as a parasite or predator that is itself limited by conditions of relative humidity, or there may be a direct causal relationship. I have been unable to find any factor with which the distribution may be better correlated. It is true that the relative humidity of any area undergoes great diurnal and also seasonal fluctuations. The justification for using "noon during July" as the standard to show the possible correlation of the distribution of these species with degrees of relative humidity is that it represents the approximate relative humidity for the warmest part of the day and the year. This would be the period of greatest activity for the organisms and when they would be most susceptible to differences in relative humidity. Even if there were a direct correlation of the species distribution with factors of relative humidity, the gradients on the map do not show the actual relative-humidity requirements of the species nor do they show the relative humidity of the grain or other product in which the insects

<sup>6</sup> U.S. Dept. Agr. Yearbook 1941 : 734.

may be living. The gradients simply provide a general standard by which damper or drier areas may be indicated.

*T. parabile* is probably widespread outside the United States. Specimens have been intercepted at ports of entry into the United States in various commodities from China, Turkistan, the U.S.S.R., Saudi Arabia, and Mexico.

### *Trogoderma sinistrum* Fall

Reference: Beal, 1954, Calif. Univ. Pubs., Ent. 10, pp. 92-97 (redescription of adult, distribution).

Head medium brown; terga uniformly gray or grayish brown except pronotum frequently with lighter brown anterior margin and sometimes with lighter brown area extending length of pronotum along median suture; sixth to eighth abdominal terga, when denuded, somewhat lighter on areas where hastisetal tufts inserted, but anterior half of these terga as dark as first to fifth abdominal terga. Middle setal series of epipharyngeal margin with two broad, inconspicuously grooved, inner setae and two outer setae about five-sixths as wide as inner setae. Distal sensory cup of epipharynx with six papillae. Antenna as illustrated (fig. 2), except that one to three setae may be inserted on second segment and occasionally both basal sensory pores on terminal segment may be placed at about basal third. Disposition of setae of first abdominal tergum as illustrated (fig. 3); fine spicisetae of acrotergite relatively sparse and long, one-half to three-fifths as long as length of tergite at midline on first abdominal segment but becoming shorter on succeeding segments; setae at lateral margin of tergite attaining length about three-fourths as long as width of entire tergite; setae on posterior margin of tergite rather variable but usually with large spicisetae about half as numerous as large spicisetae of disc of tergite and very few small spicisetae, or less commonly with large spicisetae about one-fourth as numerous as large spicisetae of disc and many more fine spicisetae; hastisetae inserted across entire posterior border of tergite, but rather sparsely near midline. Antecostal suture present on eighth abdominal tergum. Diameter of large discal spicisetae of seventh and eighth abdominal tergites subequal to that of anterior tergites. Coxae with darkly pigmented areas on anterior, lateral, and posterior sides contrasting sharply with ventral hyaline area of coxa.

Material for this description came from an active culture of the species taken from the middle of a pile of wheat in a storage bin in Bawlf, Alberta. Only one other larva was available for study. This was taken in a rye flour mill in Hastings, Minn.

Because of the dark color of this species it is not likely to be confused with any other except *glabrum*. Other very dark species, such as *simplex*, have a very different setal pattern and antennal structure. The darkly pigmented areas on the coxae of *sinistrum* distinguish it from *glabrum*. The coxae of *glabrum* are a light yellowish brown in the darkest specimens. For a discussion of other characters separating these two species, see the remarks following the description of *glabrum*.

*T. sinistrum* seems to be limited to northern and colder parts of North America. It has been recorded from Alaska, Alberta, British

Columbia, Colorado, Illinois, Minnesota, Ontario, Quebec, Utah, and Wyoming. New localities for the species are as follows: Bawlf, Alberta, May 1957 (F. H. Schroeder); Hastings, Dakota County, Minn., April 16, 1957 (T. H. Stewart); Norman County, Minn., June 6, 1923 (A. A. Nichol); Helena, Mont.; Volga, S. Dak.; Kirkman Creek, Yukon, June 13, 1928.

### *Trogoderma sternale* subspecies

References: Beal, 1954, Calif. Univ. Pubs., Ent. 10, pp. 69-77 (description and biology of *T. sternale maderae* Beal); 1956, Ent. Soc. Amer. Ann. 49: 561, 565 (in key to species, biology).

*T. sternale* is divided into six subspecies. The grouping is not wholly satisfactory, and further work needs to be done to elucidate the relationships of these subspecies. I have not seen the larvae of two of them—*s. sternale* Jayne, found along the Pacific Coast, and *s. deserti* Beal, found in the Mojave Desert of California. The subspecies that I have studied can be distinguished from other species of *Trogoderma* by the length of the setae of the acrotergites, which are all long enough to cross the antecostal suture, and by various antennal characters. Most mature specimens of *sternale* possess one or two setae on the second antennal segment, a character that separates the species from all other Nearctic species except *simplex*, *ballfinchae*, *sinistrum*, and *granarium*. All except the last are distinguished by very obvious characters and run out in the key without difficulty. *T. granarium* may or may not have a seta on the second antennal segment, and *granarium* and *sternale* often superficially resemble each other. However, they may be distinguished by the length of the second antennal segment. When the antenna of a fresh specimen of *sternale* is extended, the second segment projects noticeably beyond the setae of the basal segment. When the antenna of a fresh specimen of *granarium* is extended, the short second antennal segment is surpassed by the setae of the basal segment. In addition, the eighth abdominal tergum of *sternale* has a definite antecostal suture, which is lacking in *granarium*. Specimens of *sternale* that do not have a seta on the second antennal segment are difficult to separate from *ornatum* and *grassmani*. Color characters are of use in distinguishing them if the specimens have been out of ecdysis long enough to have become fully pigmented.

*T. sternale maderae*, *s. aspericollae*, and *s. complex* have a grayish pigmentation on each tergite except the pronotum. Usually the pigmentation is confined to the anterior half of the tergite. It may be faint, but in all except the most teneral specimens the anterior half of the mesonotum is visibly darker than the pronotum. In *ornatum* dark pigmentation is lacking, and in *grassmani* the pronotum is as darkly pigmented as the mesonotum, although the pronotum may show some small unpigmented spots. *T. sternale plagifer* is distinguished by its light creamy yellow and the large numbers of fine spicisetae on the tergites anterior to the row of large spicisetae (fig. 5). When viewed under a stereoscopic microscope, the numerous long, fine spicisetae give the larva a very characteristic silky appearance. The row of large spicisetae across the middle of the tergite is short, in a single rank, and the spicisetae are comparatively few. In *ornatum* the large

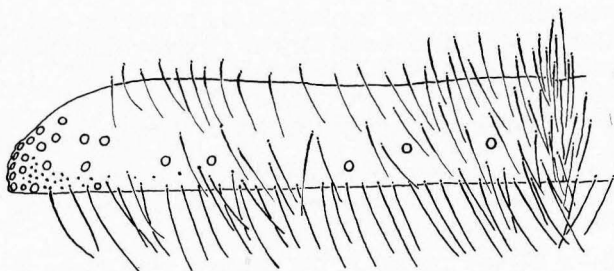
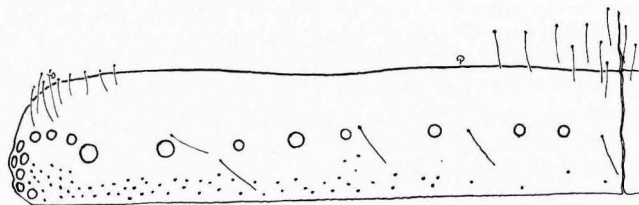
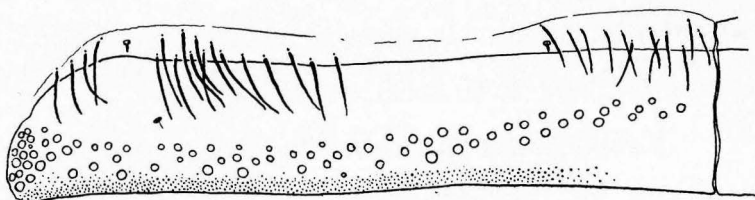
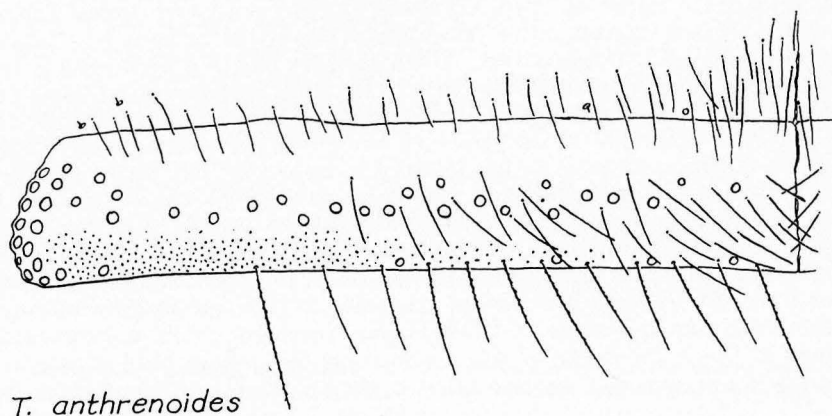
*T. sternale plagifer**T. ballfinchae**T. primum**T. anthrenoides*

FIGURE 5.—Left half of first abdominal terga of species of *Trogoderma*. Points of insertion of large spicisetae are indicated by circles; the larger the spiciseta, the larger the circle. Points of insertion of hastisetae are indicated by dots.



spicisetae across the middle of the tergite are numerous and in a row of two or three ranks. There are very few if any fine spicisetae on the tergite anterior to the row of large spicisetae.

### *Trogoderma grassmani* Beal

References: Beal, 1954, Calif. Univ. Pubs., Ent. 10, pp. 77-79 (description, biology); 1956, Ent. Soc. Amer. Ann. 49: 561-562 (in key to species, biology).

This species is readily placed in the *sternale* group because of the relatively long second antennal segment and because of the length of the fine spicisetae of the acrotergites, which are all long enough to cross the antecostal suture. The absence of setae on the second antennal segment separates it from most mature specimens of *sternale*. Semimature specimens can be distinguished from *sternale* only by color differences. All the terga of *grassmani* are normally medium brown to yellowish brown; the pronotum is as dark as the succeeding terga. In the subspecies of *sternale* that occur within the range of *grassmani*, except in southern Utah, the pronotum is decidedly lighter in color than the succeeding terga. In southern Utah and perhaps in central New Mexico *grassmani* is found in the same area as *sternale plagifer*. Numerous fine spicisetae on the disc of the terga of *s. plagifer* distinguish it from *grassmani*.

This species has been recorded from southern California, Baja California, southern Utah, Arizona, and Durango, Mex. New records for New Mexico include the following places: Floyd, Roosevelt County, January 24, 1957 (Kenneth Joyce); Tucumcari, Quay County, August 6, 1956 (R. M. Eads).

### *Trogoderma anthrenoides* (Sharp)

Reference: Beal, 1960, Coleoptera: Dermestidae. Insects of Micronesia. V. 16, pp. 109-135 (redescription of adult, biology).

Dorsal surface uniformly creamy white to light brownish yellow. Middle setal series of epipharyngeal margin with two broad inner setae and two narrow outer setae about two-fifths as broad as inner setae; inner setae not grooved. Distal sensory cup of epipharynx with six papillae. Antenna as illustrated (fig. 2). Disposition of setae of first abdominal tergum as illustrated (fig. 5). Fine spicisetae of acrotergite variable in length with anteriormost shorter and those inserted near antecostal suture tending to be longer, but with anteriormost spicisetae near midline not long enough to cross antecostal suture; length of fine spicisetae of acrotergite one-third to one-half (or longer in less mature specimens) as long as length of tergite at midline; numerous fine spicisetae on disc of tergite, some anterior to median row of large spicisetae; posterior margin of tergite bearing numerous fine spicisetae and few larger spicisetae about as large and dark as large spicisetae of disc; hastisetae on median half of tergite much less numerous than fine spicisetae. Antecostal suture present on

eighth abdominal tergum. Diameter of large discal spicisetæ of seventh and eighth tergites subequal to diameter of large spicisetæ of anterior tergites. Coxæ without darkly pigmented areas.

This species belongs to the *sternale* species group. It differs from *sternale*, *ornatum*, and *grassmani* in having relatively shorter setæ on the acrotergites of the abdominal segments, but it resembles them in the proportionate lengths of the antennal segments. Except for the relative lengths of the setæ of the acrotergites, it resembles *ornatum* in nearly every respect.<sup>7</sup> The longest spicisetæ of the acrotergite of the first abdominal tergum of *anthrenoides* do not exceed one-half the length of the tergite at the midline. In *ornatum* the longest spicisetæ of the acrotergite of the first abdominal tergum are four-sevenths as long as to subequal to the length of the tergite. *T. anthrenoides* may be separated from *sternale* and *grassmani* by differences in the pattern of dorsal pigmentation, as well as by the more pronounced differences in the lengths of the spicisetæ of the acrotergites. A discussion of the pigmentation of *grassmani* and subspecies of *sternale* follows the descriptions of these species. The differences between *anthrenoides* and *parabile* are analyzed under *parabile*.

*T. anthrenoides* is of minor economic importance. It has been recorded as a pest on dried chili peppers and on stored corn (6). It is not uncommonly found as a pest in dried insect collections.

Larvæ of *anthrenoides* were found in large numbers at Brownsville, Tex., in mud dauber wasp (*Sceliphron*) nests. They were feeding on dried spiders in old cells, dead wasp larvæ, and other insect remains. There was no evidence that they were predatory on the wasps. In the laboratory the larvæ were reared to maturity on pollen, on dried insects, and on dog meal.

Recorded distribution: Hawaiian Islands, Mexico, Panama, and Saipan in Micronesia.

New records: TEXAS: Brownsville, December 11, 1956 (R. S. Beal); Raymondville, December 13, 1956 (Roy C. Page). HAITI: Port-au-Prince, July 7, 1929 (R. C. Smith). PORTO RICO: Bayamón, September 18, 1934 (Anderson); Mayagüez, January 1936 (J. A. Ramos), May 12, 1939 (J. A. Ramos), May 1932 (S. T. Danforth); San Juan, June 4, 1932 (Anderson). VIRGIN ISLANDS: St. John, October 17, 1955; St. Thomas, April 17, 1956. LEEWARD ISLANDS: Antigua, September 29, 1936 (E. A. Chapin and R. E. Blackwelder). TRINIDAD: Port of Spain, November 24, 1935 (R. E. Blackwelder). GUATEMALA: Escuintla, March 1935. COSTA RICA: "Reventazón, Ebene Limón," March 24, 1926 (F. Nevermann); San José, 1,000–1,200 meters, December 21, 1925 (F. Nevermann). COLOMBIA: Medellín (H. Daniel). The species has also been intercepted at United States ports of entry in commodities from Nicaragua and Venezuela.

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<sup>7</sup> The larvæ should be mounted on slides and viewed under the higher powers of a compound microscope to obtain the measurements necessary to distinguish these two species.

*Trogoderma ornatum* (Say)

References: Beal, 1954, Calif. Univ. Pubs., Ent. 10, pp. 66-69 (description, biology); 1956, Ent. Soc. Amer. Ann. 49: 561, 563-564 (in key to species, distribution).

Larvae of this species appear to be nearly identical to larvae of *anthrenoides* except for differences in the relative lengths of the fine spicisetae of the acrotergites. In *ornatum* the longest spicisetae of the acrotergite of the first abdominal segment are four-sevenths as long as to subequal to the length of the tergite. The differences between larvae of *ornatum* and of *grassmani*, the subspecies of *sternale*, and *parabile* are discussed under each species.

Larvae of *ornatum* have been successfully reared to maturity in the laboratory on a diet of dog meal. This suggests that the species may sometimes act as a scavenger in nature. However, the larvae are usually found living as predators. Auten (3) found them in Ohio under bark in the nests of *Aranea frondosa* and *Epeira scolopetaria*, where they were feeding on the eggs of these spiders. The larvae also ate into the egg capsules containing young spiders.

Karl V. Krombein<sup>8</sup> found the larvae on "Plummers" Island, Md., feeding on living wasp larvae of the sphecid *Trypoxylon clavatum* Say and of the vespid *Monobia quadridens* (Linnaeus). The wasp nests had been built in traps set out to attract the wasps. The trap consisted of a stick into which a hole of an appropriate diameter had been bored. After the nests had been built, the sticks were examined in the laboratory. The dermestids had apparently gained access to the nests during their construction. Four larvae were found in an eight-cell nest of the *Trypoxylon*. In three cells the eggs of the wasp had been destroyed, presumably by the dermestids. In the other cells the larvae were evidently killed and eaten by the dermestids. In one cell a wasp larva formed a cocoon, which was later opened for examination. The prepupa in this cocoon had been eaten. Since mortality of prepupae over the winter is very rare, it can be presumed that this prepupa was also killed by the dermestids. In the cells where the eggs had been destroyed, Krombein removed the paralyzed spiders. It may be that if the spiders had not been removed, the dermestids after destroying the wasp eggs would have fed on the spiders and not on the remaining wasp larvae. Larvae of *ornatum* were also found in the nests of the wasps *Trypoxylon striatum* Provancher, *T. rubrocinctum* Packard, and in a vespid nest of an unidentified genus, probably not *Monobia*.

Hamilton (8) said that the larvae of *ornatum* enter the earth to develop and that they do not pupate if prevented from entering the earth. This is not true of specimens that I have reared. Probably in Hamilton's cultures the larvae entered the earth in search of moisture, and those larvae that were prevented from doing so died from lack of adequate moisture.

<sup>8</sup> Personal communication.

*Trogoderma primum* (Jayne)

Reference: Beal, 1954, Calif. Univ. Pubs., Ent. 10, pp. 56-57 (redescription of adult, distribution).

Dorsal surface uniformly creamy yellow. Middle setal series of epipharyngeal margin consisting of two broad inner setae without longitudinal grooves. Distal group of sensory papillae arranged in two closely proximate cups with anterior cup containing four papillae and posterior cup containing two papillae, or arranged in four closely proximate cups, two anterior cups with two papillae each and two posterior cups with one papilla each. Antenna as illustrated (fig. 2). Disposition of setae of first abdominal tergum as illustrated (fig. 5); fine spicisetae of acrotergite all long enough to cross antecostal suture; spicisetae of disc of acrotergite about three-eighths as long as tergite at midline; fine spicisetae almost completely absent on tergite or very few in number; large spicisetae very numerous in row of two or three ranks across middle of tergite; no spicisetae on posterior margin of tergite (always?); hastisetae inserted in dense row along posterior border of tergite, but insertions not extended to midline. Posterior area of seventh abdominal tergum bearing dense hastisetal brush separated from anterior half of tergite by narrow unsclerotized space. Eighth abdominal tergum with well-marked antecostal suture. Diameter of large discal spicisetae of seventh and eighth tergites subequal to diameter of large discal spicisetae of anterior tergites. Coxae without darkly pigmented areas.

This is a very distinct species that belongs with the *simplex* group. The antenna has an exceptionally long second segment, which is very similar to that of *simplex* except that it bears no setae. It also differs from *simplex* in having no small blunt spicisetae on the disc of each tergite and in having a very much denser row of large spicisetae on the disc of each tergite. It differs from all other known *Trogoderma*, because the lateral part of the seventh abdominal tergite that bears the tuft of hastisetae is nearly completely separated from the anterior part of the tergite by a narrow membranous area.

In the description it is stated that there are only two inner setae in the middle series on the epipharyngeal margin. Under low magnification there appear to be two broad inner setae and two very narrow lateral setae. These lateral setae are actually inserted on the opposite (dorsal) surface of the labrum rather than on the inner (epipharyngeal) surface. It is possible that they are homologous with the pair of lateral setae found on either side of the inner pair on other *Trogoderma* larvae and that they have migrated over the lip of the epipharynx.

The description was based on three larval skin casts of specimens I found in spider webbing in an old pump house near Brownsville, Tex. The specimens were reared to maturity in the laboratory on pollen. The species is known only from the southernmost part of Texas and from Woods County, Okla.

### *Trogoderma simplex* Jayne

References: Beal, 1954, Calif. Univ. Pubs., Ent. 10, pp. 57-64 (description, biology); 1956, Ent. Soc. Amer. Ann. 49: 561, 564 (in key to species, biology).

Larvae of *simplex* are the most easily recognized of all Nearctic species of *Trogoderma*. On the middle of each tergite are numerous closely appressed, short, blunt, inwardly directed spicisetae. The absence of large spicisetae of the tergites on this middle area gives the larva a distinctive appearance. This particular arrangement of the setae is not evident in the earlier instars, but it is true of any larva at least half grown.

### *Trogoderma ballfinchae* Beal

Reference: Beal, 1954, Calif. Univ. Pubs., Ent. 10, pp. 65-66 (description of adult).

Head and terga yellowish brown; each thoracic tergum usually with suffused, dark, grayish-brown spots at lateral margin and at middle of each side. Middle setal series of epipharyngeal margin consisting of two broad inner setae and two outer setae three-eighths to one-half as wide as inner setae; inner setae with one or two deep grooves. Distal papillae of epipharynx arranged in anterior cup with four papillae and closely proximate posterior cup with two papillae (fig. 6, A). Antenna similar in configuration to that of *primum* (fig. 2);

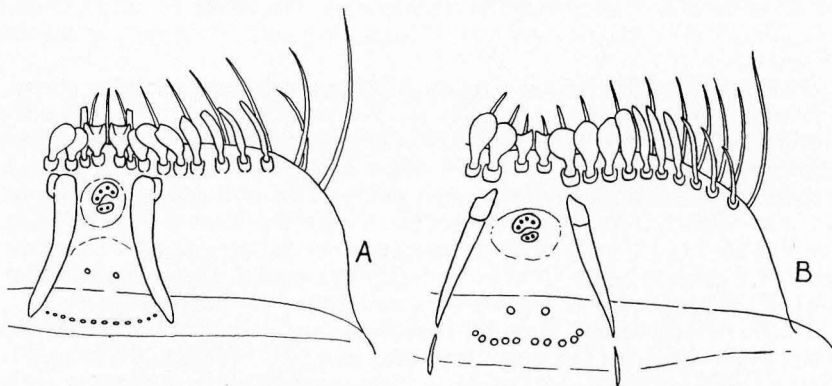


FIGURE 6.—Epipharynx of (A) *Trogoderma ballfinchae* and (B) *T. carteri*.

antennal segments with proportionate lengths 10:25:9; nudisetae of basal segment about two-fifths as long as second segment, inserted on mesal face of segment except for one seta on laterodorsal angle; one seta usually present near apex of second segment. First abdominal tergum with setae disposed as illustrated (fig. 5); no spicisetae on posterior margin of tergite. Large spicisetae of seventh and eighth abdominal tergites noticeably stouter than spicisetae of preceding tergites, about  $1\frac{1}{3}$  times as large in diameter as spicisetae of first abdominal tergite, and usually arranged in four pairs across disc of tergite. Eighth abdominal tergum with well-defined antecostal suture. Terminal spicisetae ("caudal" setae of ninth abdominal tergum) very long, subequal to length of larva. Coxae without darkly pigmented areas.



These larvae are very distinctive, recognizable at once by the remarkably thick spicisetae of the seventh and eighth terga and by the unusually long caudal setae. They are also distinctive in that they lack spicisetae along the posterior margin of the tergites.

Recorded distribution: Oracle and Bill Williams Fork, Ariz., and an unknown locality in Mexico.

New records: ARIZONA: Avondale, June 10, 1958, one larva (W. B. Morrow); Patagonia, July 1, 1958, one adult male (J. B. Ward); Phoenix, January 2, 1958, two larvae (Gose and Robledo); same locality, January 14, 1958, numerous larvae (G. H. Spitler); same locality, May 9, 1958, one larva (Bailey and Sexton); Tempe, two skin casts (R. S. Beal); same locality, January 1959, two larvae (Ivan Jennings). NEW MEXICO: 10 miles west of Lordsburg, July 4, 1956, one adult male (H. and A. Howden). BAJA CALIFORNIA: Mezquital, July 28, 1938, one adult male (Michelbacher and Ross).

The larvae taken in Phoenix were found in old sacks of chickenfeed in a chickenhouse. Whether they were feeding on grain, insect remains, or live insects was not ascertained. In Tempe two skin casts were found in a *Sceliphron* mud dauber nest.

#### AUSTRALIAN SPECIES

The larvae of two Australian species that I studied are remarkably distinct from *Trogoderma* and unquestionably belong to another genus. I am not removing them from *Trogoderma* at present because of my uncertainty concerning the name that might apply to this group. I have not seen adults or larvae of the type of the Australian genus *Psacus* Pascoe, which is said to differ from *Trogoderma* principally in the possession of flabellate antennae and in the lack of a median ocellus in the adult. Possibly the larvae of *Psacus attagenoides* Pascoe (11) are similar to the larvae of these two Australian species and this genus should be taken out of synonymy with *Trogoderma*. The Chilean genus *Ocelliger* Philippi and Philippi (12), described as an anobiid but evidently a genus very near *Trogoderma*, might conceivably receive these species, although its type is more likely a member of the species group to which *T. fasciferum* Blatchley and *ballfinchae* belong.

The most noticeable difference between the two Australian species and other known *Trogoderma* is that in the larvae the large spicisetae of the dorsum are replaced by fuscisetae. Other fundamental differences are the lack of spicisetae on the acrotergites and the structure of the antecostal suture of each tergum, which is thickened and raised with denticles on its posterior margin.

A character that appears to be of generic weight in most sections of the subfamily is the enclosure of the papillae of the distal group of epipharyngeal papillae either in one ring or in two rings. However, in some *Trogoderma* larvae, particularly those of the *inclusum* group, the character varies at a subspecific level. In the Australian species the six papillae are separated into an anterior group of four papillae and a posterior group of two papillae. This same arrangement is found in *ballfinchae* and with some variation in *primum*.

The middle group of setae of the epipharyngeal margin of the Australian species consists of a single pair of broad setae instead of an

inner pair of broad setae and an outer pair of somewhat narrower setae. Near the margin of the labrum is a pair of setae that possibly is homologous with the outer pair of setae of typical *Trogoderma* larvae, but it is more closely associated with the distal row of setae of the labrum. A slight approach to this condition is found in *ballfinchae* and *primum*. In other characters *ballfinchae* appears to lie closer to these Australian species than do other Nearctic species.

### *Trogoderma boganense* Armstrong

Reference: Armstrong, 1942, Linn. Soc. N.S. Wales, Proc. 67, pp. 325-326 (original description of adult).

Head and terga light yellowish brown with anterior half of each tergite darker brown. Epipharynx similar to that of *carteri* (fig. 6, B). Antenna as illustrated (fig. 2). First abdominal tergum as illustrated (fig. 7, A); integument with weakly sculptured reticulate

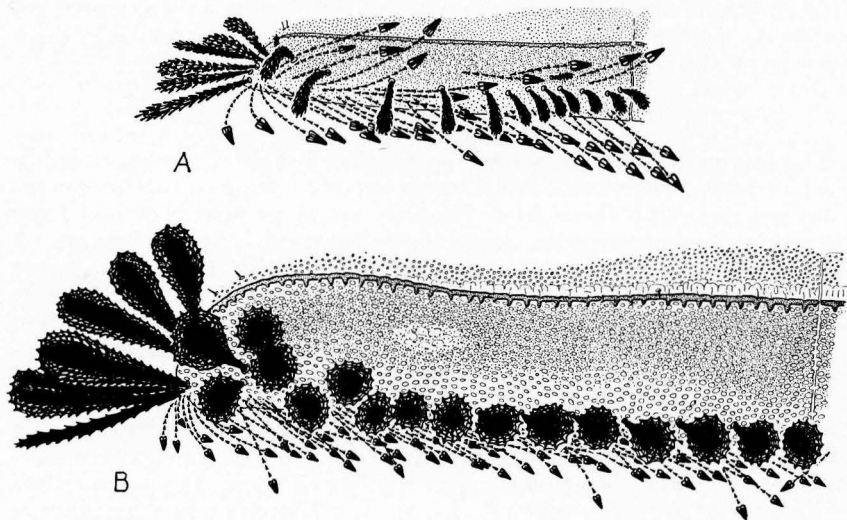


FIGURE 7.—Left half of first abdominal terga of (A) *Trogoderma boganense* and (B) *T. carteri*.

surface; denticles of acrotergal ridge short, not much longer than wide; row of fuscisetae on disc of tergite inserted between middle and posterior third of tergite; fuscisetae of disc strongly club shaped but not globose; some hastisetae inserted on disc of tergite anterior to row of large fuscisetae; numerous hastisetae inserted across entire tergite posterior to row of large fuscisetae.

The larvae of this species were found in mantid egg cases in New South Wales. Other details of its biology are unknown.

### *Trogoderma carteri* Armstrong

References: Armstrong, 1942, Linn. Soc. N.S. Wales, Proc. 67, pp. 328-329 (original description); 1949, *ibid.* 74, p. 108 (biology).

Head and terga light yellowish brown with anterior half of each tergite darker brown except for lighter sublateral spot on each

thoracic tergite and less distinctly on first three or four abdominal tergites. Epipharynx as illustrated (fig. 6, *B*). First abdominal tergum as illustrated (fig. 7, *B*); integument with a microscopically but strongly sculptured, evenly reticulate surface; denticles of acrotergal ridge digitiform,  $1\frac{1}{2}$ - $2\frac{1}{2}$  times as long as wide; row of fuscisetae on disc of tergite inserted at about posterior fifth of tergite; fuscisetae of disc globose with thin pedicel, becoming more club shaped at lateral margin of tergite; no hastisetae inserted on disc of tergite anterior to row of large fuscisetae; numerous hastisetae inserted across entire tergite posterior to row of large fuscisetae.

The cast skins and the single larva on which this description was based do not have the antennae in a condition that permits a complete description. Apparently the antennae are quite similar to those illustrated for *bogannense*.

Armstrong (2) recorded that the larvae of this species were found in mantid oöthecae, in spiders' webs, under loose bark, and in insect collections.

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