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## The biology of *Trichopoda pennipes* Fab. (Diptera; Tachinidae),: a parasite of the common squash bug.

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A Parasite of the Common Squash Bug

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HARLAN N. WORTHLEY

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THE BIOLOGY OF TRICHOPODA PENNIPES FAB. (DIPTERA; TACHINIDAE)  
A Parasite of the Common Squash Bug

Harlan N. Worthley

Thesis submitted for the degree of Master of Science  
Massachusetts Agricultural College, Amherst, Mass.

May 1, 1923

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The Biology of *Trichopoda pennipes* Fab. (Diptera; Tachinidae)  
A Parasite of the Common Squash Bug

by  
Harlan N. Worthley

INTRODUCTION

Reasons for the Work

The common squash bug, Anasa tristis de Geer, is an ever-present and often troublesome pest in Massachusetts, and has been a subject for investigation at the Massachusetts Agricultural Experiment Station for the past three years. While studying the life history and habits of this pest, the writer discovered abundant evidence of the presence and activity of the parasite Trichopoda pennipes. A hasty review of the literature showed that comparatively little is known of the life history and habits of this beneficial fly. Much to the surprise of the writer, in view of his own observations, it was found that some authors have even intimated that little good is derived by mankind from the work of this supposedly beneficial species.

Failure of the written records to substantiate observations of the writer furnished the initial stimulus to a study of the habits of the fly, the object of which study being to discover the exact relationship existing between parasite and host. A portion of the following account is the result of these studies.

During the course of the work it was found necessary to confine adults of both sexes in the same cage to induce mating. Some difficulty was experienced at first in determining the sex of living flies, without undue handling, and this led to a study of the external anatomy of the species, the primary aim being the discovery of secondary sexual characters that might be readily recognised.

The scope of this investigation has gradually increased, and in this paper takes the form of an exposition of the external morphological characters of the species. These characters are here designated according to the most widely accepted views of leading workers in insect morphology, and thereby do violence to the terminology in common use among taxonomic workers. This is perhaps unfortunate, but it is unavoidable, if morphological accuracy is to be maintained.

### Methods

In the study of the adult anatomy, pinned dried specimens were used. For the definition of the mouthparts, sclerites of the thorax, and the genitalia, however, it was found necessary to relax the parts and examine them in liquid. For this purpose specimens were soaked for about an hour in cold caustic potash (boiling often causes distortion of the parts) washed in water and treated with acetic acid to stop the action of the caustic potash. They were then placed in

70 percent. alcohol.

The parts were examined under a Zeiss binocular microscope, at magnifications varying from sixteen to sixty-five diameters. Many structures were obscure except under the brightest illumination, and therefore most of the examinations were made in the rays from a powerful lamp. A Ford headlight was mounted on a ringstand and connected through a transformer with the ordinary one hundred and ten volt circuit. This lamp proved to be quite satisfactory, since it was placed on the desk at a distance of two feet from the binocular, allowing plenty of room to work. A lamp of this kind, focussed upon the microscope stage by means of the set-screw in the lamp, throws little light into the eyes and develops little heat, while the object under observation is brought into strong relief.

#### DESCRIPTION

##### Adult

The adult fly is about the size of the common house fly, but it is much more gay in appearance. It may be seen on sunny days hovering about squash plants, or resting with half-spread wings upon the foliage of squash and upon certain wild flowers as well. It is strikingly colored, with deep reddish brown eyes on a head marked with black, gold and silver. The thorax is golden in front, with four longitudinal black stripes, clear black behind, and gray at the sides.

The abdomen is of a brilliant orange color, except at the extreme tip, which is darker. The conspicuous abdomen, and the fringe of feather-like setae along the outer side of the hind tibiae, immediately catch the eye of the observer, and serve to make this species one of the most striking among Tachinid flies.

A discussion of the adult anatomy is complicated by the diversity of terms which may be applied to the different structures. Taxonomists have applied names which, in many cases, are morphologically inaccurate, and morphologists themselves have differed both in the nomenclature and in the interpretation of parts. The source of the terms used in this paper is indicated in the text of the different sections, and in many cases duplicate names for the various structures are given in the list of abbreviations used in the figures.

Head. In describing the head, the terms used are those of Peterson (1916)\*, except the chaetotaxy, which follows Coquillett (1897) and Walton (1909).

Viewed from in front, the head is elliptical in outline, and broader than deep (3.2 mm. by 2.4 mm.). Its most conspicuous feature is perhaps the frontal suture (fs)\*\*, which extends in a dark, shining, inverted U-shaped band from just

\* Dates in parenthesis refer to the bibliography at the end of this paper.

\*\*Letters in parenthesis are those used in labeling the figures, and are explained in the list of abbreviations preceding the plates at the end of this paper.

above the insertion of the antennae to a point midway between the vibrissae (vib) and the curve of the compound eyes (ce), where it tapers out. Within the curve of the frontal suture lies the fronto-clypeus (fc), termed by Coquillett the "facial depression" and by Walton the "facial plate." The tentorial thickenings (tt) arising at each side near the oral margin and running upward nearly to the insertion of the antennae, are easily seen, lying just within the facial or vibrissal ridges, which are not pronounced. The vertex (v) is all that portion of the head, viewed from the front, which lies between the compound eyes, and between these and the frontal suture. At the very top of the vertex is the ocellar triangle, bearing on its raised surface three ocelli (oc). From the region of the ocelli to the frontal suture runs a median broad velvety-black band or "vitta" (mv), which is demarked from the rest of the vertex only by its color, which strongly contrasts with the golden-yellow tomentum of the lateral portions of the vertex. The genae (ge) are those portions of the vertex lying below the ends of the frontal suture, and between the oral margin and the eyes. Their color is silvery-gray, which shades into the gold of the rest of the vertex above, and into the brownish-yellow of the fronto-clypeus.

Viewed from the side the head is quadrate in shape. The post-genae (pge) are those regions behind the genae and extending backward and upward along the curve of the compound eyes to a point midway between the oral margin and the ocellar

triangle. The occiput is designated as that portion of the caudal aspect of the head extending from a line drawn midway across the occipital foramen upward to the vertex. The edge of this area can be seen from the side (ocp).

Chaetotaxy of the Head. On either side of the median vitta is a row of frontal bristles (fb) which, since they bend inward across the vitta, may be called "transfrontals".

Note:-

Here is one instance of the confusion of terms mentioned at the beginning of this paper. The area bearing the frontal bristles, although it has been called the "front" by taxonomists, is morphologically not the front at all, but the vertex. The true front, which lies below the antennae and is fused with the clypeus, also bears a double row of macrochaetae which, to one not a specialist, might readily be mistaken for the frontal bristles. The writer does not recommend here any reconciliation between the terms of the morphologists and the usage of the taxonomists, but merely wishes to point out the true relation of parts. To his mind, any attempt to modify the terminology other than by concerted action among taxonomic workers and morphologists would only result in "confusion worse confounded."

On the ocellar triangle, just behind the anterior ocellus, lie the great ocellar pair (ob), while behind these, and passing between the two lateral ocelli, follow three or more pairs of "lesser ocellar" bristles, which in

T. pennipes are very small. Behind the ocelli and on the edge of the occiput is a transverse row of four macrochaetae. The inner, larger pair are the post-vertical bristles (pvt), and the smaller, outer ones the inner vertical bristles (ivt).

The outer verticals, present in some forms, are not represented in this species. The fronto-orbitals, which lie between the frontal bristles and the curve of the compound eyes, are also absent.

On the fronto-clypeus, disposed along each facial ridge, is a short row of facial bristles, the vibrissal row. The uppermost pair are the vibrissae (vib) which in T. pennipes do not assume their typical position immediately above the oral margin, but are shifted upward to lie halfway between the oral margin and the tips of the antennae. The smaller bristles accompanying the vibrissae extend on either side in a single line along the oral margin to the region of the postgenae, where they mingle with the silvery-white beard which depends from this region. A single row of short macrochaetae extends around the edge of the occiput from the inner vertical bristles downward to the region of the postgenae. These are called the cilia of the posterior orbit (cpo).

#### Appendages of the Head.

Antennae. The antennae (ant) reach halfway between the base of the frontal suture and the oral margin. The first two segments are velvety-black in color, with a silvery sheen. The second segment bears a few macrochaetae. The third segment, which is much larger than the other two, is bean-shaped and varies from black to mouse-colored, with the base sometimes slightly tawny. This segment bears the

arista (ar), a large bristle which is inserted on the outer edge about one third the distance from base to tip of the segment. The arista is practically bare, having but a few very tiny hairs near its base.

Proboscis. The proboscis (pb), usually folded well back in the oral cavity, is a very much modified structure, the parts of which it is very difficult to homologize with the mouthparts of generalized insects. The work of Peterson (1916) on the mouthparts of Diptera was very thorough, and his figures correct and intelligible, but since he derives his hypothetical dipterous mouthparts from a consideration of Orthoptera while Crampton (1921, p. 91) would evolve Diptera from ancestors like Mecoptera, the homologies of dipterous mouthparts still constitute a disputed question.

The membrane of the basiproboscis (bpb) is largely composed of the mentum and sub-mentum, according to Peterson. The maxillary palpi (mxp) lie on this membrane in front. Above the maxillary palpi lie the exposed portions of the tormae (to), and below lie the external plates of the stipes (st). The galeae (ga) lie on the surface, and are continuous with the lower ends of the ental portions of the stipes. The large chitinous internal structure of the basiproboscis is the fulcrum (ful) and is composed of the basipharynx or united portions of the epipharynx and hypopharynx, and the ental portions of the tormae. At the distal end of the basipharynx

lies the hyoid (hy), which articulates with the distal portion of the hypopharynx as well, and through which passes the alimentary canal.

The mediproboscis (mpb) bears a chitinized plate, the theca (the) on its caudal aspect, and the hypopharynx (hyp) and labrum-epipharynx (lep) lie in a chitinized groove on the upper surface of the labium.

The distiproboscis (dpb) is composed of a pair of lobes or labellae, which Peterson interprets as the paraglossae (pg). Crampton, however, calls them the united labial palpi. Various other structures can be seen in the distiproboscis, such as a Y-shaped plate called the furca (fu) and the structures called pseudotrachae (pst).

Thorax. The structure of the thorax in Trichopoda pennipes is typical of the order Diptera as a whole, in which the mesothorax, which is the only wing-bearing segment, is greatly enlarged and distorted, evidently for the purpose of accomodating the great wing muscles. The prothorax (P) is very small, and the metathorax, which bears the halteres (ha), is very much reduced.

In naming the sclerites of the thorax the terminology used by Young (1921), which is largely based on Crampton (1914), is employed.

The dorsal aspect of the thorax is completely covered by the notum of the mesothorax, as defined by Snodgrass (1909a), or the mesonotum. This is divided by two transverse sutures

into three sclerites, the prescutum (psc<sup>2</sup>), scutum (sc<sup>2</sup>) and scutellum (sl<sup>2</sup>). The prescutum, including the humeral calli (hc) is yellow in color, with four longitudinal bands of velvety-black. In the males the yellow coloration extends backward onto the scutum where it merges with the black of that sclerite. The scutellum of both sexes appears black to the naked eye, but under the binocular most specimens show a faint tinge of very dark orange. The scutum is produced laterally into an anterior wing process, the suralare (sur), and a posterior wing process, the adanale (ad). The scutellar bridge of Walton (sb) is seen as a lateral overlapping of the scutellum onto the scutum. Below this is the axillary cord (axc) of Snodgrass (1909a), which is produced to form the margin of the calypteres. A posttergite (pt<sup>2</sup>) is demarked behind the scutellum. The pseudonotum or postnotum of Snodgrass, which he would recommend calling the "postscutellum", in this case is located ventrad of the scutellum, and cannot be seen from above. It is divided into a median plate, the meditergite (mt<sup>2</sup>), and two pairs of lateral plates, the anapleurotergites (aplt<sup>2</sup>) and the katepleurotergites (kplt<sup>2</sup>). Mention may logically be made here of the character recently reported by Malloch (1923) for differentiating muscoid flies. In Malloch's own words "it is invariably possible to distinguish between the Sarcophagidae, Muscidae and Calliphoridae on one hand, and the Tachinidae and Dexiidae on the other, by the shape of the

metanotum. In the last two this is biconvex in profile, there being a small but distinct convexity just below the scutellum which is absent in the other three families known to me." The use of the term "metanotum" by Malloch follows the usage of older taxonomic workers, and is morphologically inaccurate. It is really the meditergite (mt<sup>2</sup>) of the postscutellum which is meant, and the "biconvexity" apparent in Tachinidae and Dexiidae is conditioned by the presence of the posttergite (pt<sup>2</sup>), which, as a glance at the figure will show, lies just below the scutellum. An examination of figures 38, 39, 40 and 41 of Young bears out this point.

The pleural region of the mesothorax is pollinose gray in color, and is much distorted. The pleural suture, which in generalized insects runs a nearly straight course from the coxal cavity to the wing base, thus dividing the pleuron into an anterior episternum and a posterior epimeron, is here bent twice at right angles, so that while the two ends are nearly vertical, the middle is horizontal. In addition a portion of the anepisternum (aes<sup>2</sup>) has been split off from the rest by a secondary invasion of membrane, and has become closely associated with the anepimeron or pteropleurite (ptp<sup>2</sup>). The katepisternum has fused with the sternum to form the sternopleurite (stp<sup>2</sup>). It is the enlargement of this sclerite which has evidently caused the bending of the

pleural suture, and has crowded the meropleurite ( $mep^2$ ), which is composed of katepimeron plus meron, back against the pleuron of the metathorax.

The numerous small plates which lie in the membrane surrounding the base of the wing are very difficult to see, but are easily identified with those sclerites outlined by Crampton (1914) in his ground plan of a typical thoracic segment in winged insects. The tegula ( $tg$ ) lies in the angle between the scutum and the anepisternum. The notale ( $n$ ) is a detached portion of the scutum lying just above the base of the wing. The basalar plates are two in number, the anterior one ( $aba$ ) not demarked from the posterior portion of the anepisternum, the posterior one ( $pba$ ) very small and lying between it and the pleural wing process ( $wp$ ). The subalar plates are two in number, the anterior one ( $asa$ ) lying behind the wing process and above the pteropleurite, the posterior one ( $psa$ ) which is much smaller lying just below a posterior lateral process of the scutum. These basalar and subalar plates are the pre and post paraptera of Snodgrass (1909a).

The tergum of the metathorax, or the metanotum ( $n^3$ ) is reduced to a narrow band connecting the halteres ( $ha$ ), and visible only at the sides where it is produced to form points of attachment for the abdomen. The pleuron of this segment is divided into metaepisternum ( $es^3$ ) and metaepimeron ( $em^3$ ). A spiracle ( $sp$ ) is present just before the

metaepisternum, as before the mesoepisternum. The region around the base of the haltere is so modified that it is impossible to tell whether pre and post alar bridges connect the metanotum with the metapleuron.

Some of the terms used above are different from those in common use among taxonomists. The mesoanepisternum (aes<sup>2</sup>) has been called by dipterists the mesopleura. The mesosternopleurite (stp<sup>2</sup>) is equivalent to the sternopleura of authors, while the meropleurite (mep<sup>2</sup>) plus metapleuron plus metasternum equals the hypopleurite, so-called.

Chaetotaxy of the Thorax. The thorax of T. pennipes is not heavily armed with macrochaetae. However, representatives of most of the groups mentioned by Walton are present. Two humerals (hu) adorn each humeral callus. Posthumerals are wanting, as are anterior acrosticals. The anterior dorso-central rows are represented by two very variable bristles (adc) placed near the hinder margin of the prescutum, while at each rear corner of this sclerite are borne two notopleural bristles (np). On each side, between the notopleurals and the anterior dorso-centrals, lies a single bristle, the presutural (psu).

On either side of the scutum a single bristle (sa) represents the supra-alar row, and another (ia) each intra-alar row. Two post alars (pa) are present, and each of the posterior dorso-central (pdc) and posterior acrostical (pac) rows is represented by a single bristle. It will be seen

that these last four bristles form a transverse row near the hind margin of the scutum. This is called the prescutellar row.

On the scutellum an anterior bristle and a posterior bristle mark the position of the marginal scutellar row (ms). The anterior bristle was seen to be accompanied by a smaller one in one or two specimens. No discal scutellars are present.

The mesanepisternum bears a vertical row of bristles called the mesopleural row (mr), situated just before the membrane which divides it. Below the anterior spiracle are two bristles, one on the prothorax, the propleural bristle (pp), and one on the sternopleurite, which the writer has called the substigmal bristle (ss). The sternopleurite bears typically two sternopleurals (stb), although a third was found to be present on some individuals. A curved row of three to five hypopleurals (hp) is located on the meropleurite. A single pteropleural bristle (ptb) was present in some specimens examined, while others bore as many as four.

#### Appendages of the Thorax.

Legs. The coxa (cx) is tawny in color, with a grayish bloom, while the trochanter (tr) and the proximal portion of the femur (fe) are yellowish. The distal portion of the femur and the tibia (tb) and tarsus (ta) are black.

The claws are yellowish tipped with black, and are fringed with very fine light-colored hairs. There is a bristle-like empodium (ep). The pulvilli (pv) are buff-colored, and in the male are quite large and conspicuous. The first two pairs of legs display no features of particular interest. The tibiae of the hind legs, however, exhibit on the outer side a peculiar row of black, feather-like setae, which stand nearly erect, and the longest of which are at least one third the length of the tibia itself. This row is in reality double, since a row of smaller scales is appressed to the larger ones on the outside. The hind tibia also bears on its inner face a single bristle of a size noticeably larger than any of the surrounding hairs.

Wings. The wings of the female are dusky, with the posterior margin sub-hyaline. Those of all the males examined bear a somewhat variable yellowish area in the forepart of the wing, the extent of which is indicated in figure 5. According to Coquillett (1897) this character is not constant.

The figure of the wing of the female (fig. 6) explains the venation of the wings, while the cells are labeled in the figure of the wing of the male. The chief point of interest in the wing venation of T. pennipes is that  $M_3$  is bullate or weakened basally, making  $M_3$  appear as a stub sticking up from  $Cu_1$ .

Abdomen. The abdomen in both sexes is of a bright orange color, and is destitute of macrochaetae. It is sparsely clothed, however, with short black hairs. Seven pairs of spiracles (sp) are present, borne at the lateral margins of the tergites ( $t_1$ ,  $t_2$ , etc.). Those of the sixth and seventh segments are hidden beneath the posterior edge of the fifth tergite ( $t_5$ ). The tergites of the first and second segments are fused, the fusion being denoted by an area of weaker chitin, which is demarked in the figures by a pair of dotted lines between  $t_1$  and  $t_2$ . The adventitious suture (as) in the first tergite mentioned by Young is readily seen.

The tip of the abdomen in the female is wholly black, this coloration including the fifth tergite and in some individuals extending further forward to include part of the fourth tergite. The terminal abdominal segments of the male in specimens examined by the writer were in no case wholly black, although  $t_5$  and  $t_6$  were darker than those preceding.

Genitalia.\* In both sexes the segments beyond the fifth abdominal may truly be called genital segments. In the male these segments curve downward and come to lie beneath the fifth tergite. In the female those beyond the fifth are telescoped when at rest, being extended for oviposition.

\*The writer has based his description of the genitalia largely on the condition of these structures in generalized insects. It is apparent that the study of a series of dipterous genitalia may reverse some of his decisions regarding the true character of the parts.

In the male the fused tenth and eleventh tergites, which are ventral in position, act as a cover for the aedeagus (ae), being tucked beneath the edge of the fifth sternite ( $s_5$ ) when at rest. When the aedeagus is extruded, however, this flap lifts up, allowing the ninth sternite ( $s_9$ ) to push forth. This latter segment is very much modified. Its fused cerci are median in position and form the aedeagus, a very complicated structure which encloses the membranous penis. At the base of the aedeagus are seen two pairs of lateral projections, called gonopophyses (go), the inner pair of which are hyaline. They are well-chitinized, however, feeling hard to the touch of a dissecting needle. At the base of the aedeagus the ninth sternite is rather more heavily chitinized than elsewhere, resulting in the appearance of a chitinized box (chb) from which the aedeagus protrudes and on which the gonopophyses are borne. This chitinized box also bears a median dorsal hook-like projection, called by the writer the genital prong (gp). The styli of the ninth segment, which in some insects function as outer claspers, are here much reduced in size and are apparently non-functional, since when the genitalia are extruded they barely appear beyond the posterior edge of the eighth tergite. A peculiar structure, which the writer is at a loss to homologize with any genital appendage of generalized insects, appears in the "genital furca" (gf). This is a fork-like chitinized rod which lies between the sides of the ninth sternite, to which it is

connected by muscles. It splits at the base of the aedeagus, one arm extending to either side of the latter organ. Its function is quite evidently that of guiding the movements of the aedeagus.

In the female the eighth segment is a narrow ring, bearing below the median ventral valve (vv) of the ovipositor and laterally the two inner valves (iv). Dorsally this segment seemed to bear a median dorsal valve (dv), but this may prove to be a modified portion of the ninth segment, which is supposed to bear the dorsal valve. This point could not be definitely determined from the dried material at the writers disposal, even after soaking in KOH and gently extending the ovipositor by pushing from within by means of a blunt needle.

Secondary Sexual Characters. The foregoing account of the external anatomy of Trichopoda pennipes contains scattered references to certain differences which were apparent between the two sexes. These differences were constant in a series of eight males and seven females. Scarcely any difference in size could be noticed, the males averaging 8.6 mm. in length, the females 8 mm. Both the largest and the smallest were males, the one 10 mm. long, the other measuring 7 mm. To a certain extent the size of the adult fly is affected by the abundance of food available to the larva which preceded it, and when contained in keys for the identification of species may be found misleading.

Two characters were found by which the sex of living flies can be determined without undue handling. These are the ferrugineous spot in the wing of the male as against the evenly dusky wing of the female, and the black tip of the female abdomen as against the dark orange of that of the male. A minor difference was in the size of the pulvilli, these being shorter than the last tarsal segment in the females, and inconspicuous. In the males the pulvilli were longer than the last tarsal segment, and quite broad and conspicuous. This is a character, however, that is not readily noticed unless a male and a female are examined at the same time, and it is therefore of little practical use, in a taxonomic sense.

### Egg

The eggs of Trichopoda pennipes vary in color from clear shining white to dirty gray, the coloration seeming not to depend on the age of the egg. The individual egg is ovate in outline, being slightly larger at one end. It is strongly convex, and is flattened on the side next the body surface of the host. This flattened surface is covered by a colorless cement, by which the egg is affixed to the body of the host. The egg measures .56 mm. in length by .37 mm. in breadth, and its greatest height is .25 mm. The surface of the chorion appears smooth except under high magnification, when it is seen to be faintly reticulate in

tiny hexagons. The chorion is comparatively thick and "leathery", and remains rigid after hatching. The micropyle appears to be borne on a small papilla at the smaller end of the egg. Eggs which have hatched show a circular hole on the flattened side near the broader end. Since it is this flattened side which is pressed against the host, it is impossible to tell if an egg has hatched without first removing it from the body surface of the host.

### Larva

The larva has not been examined in all instars. When full grown it is a dead-white maggot, with black hook-like rasping mouthparts (mh) and a pair of black anal stigmata. It is quite robust, and although its greatest circumference is about midway of its length, it can hardly be called fusiform, since it tapers away to a point in front, while the anal end is blunt. It is about 10 mm. long by 3.5 mm. in diameter, a surprising size when one considers that the adult host measures but 15 mm. in length.

The structure of the cephalopharyngeal skeleton, and the arrangement of the slits in the anal stigmata vary in the different species, and figures of these organs are therefore included in the plates. No sign of the parastomal sclerites mentioned by Banks (1912) as occurring in certain muscoid larvae could be found in the cephalopharyngeal skeleton of T. pennipes.

### Puparium

The pupa itself has not been observed. The puparium which encloses it, however, is of a deep reddish-black color, cylindrical in shape, and rounded at both ends. It is formed from the skin of the mature larva, and upon it the anal stigmata appear as twin tubercles at the posterior end. The puparia average about 7.5 mm. in length and 3.5 mm. in diameter. At the anterior end, before the emergence of the adult fly, a transverse split occurs, reaching backward nearly a quarter of the length of the puparium. The split then extends around the circumference, this resulting in the formation of two flaps which are pushed aside by the ptilinum of the emerging adult.

Some time after the examinations of the puparium had been finished by the writer, the work of Greene (1922) on the puparia of muscoid flies came to hand. The puparium of T. pennipes is there figured and discussed, and significant characters compared with those of the puparia of other species.

### SYNONYMY

The species was first described by Fabricius (1794) as Musca pennipes, from material secured from the "Carolinas." His subsequently described Thereva hirtipes (1805, p. 219.9), Thereva pennipes (1805, p. 219.8), and Ocyptera ciliata (1805, p. 315.9) have proved to be synonyms. His Dictya pennipes (1805, p. 327.5) is a change of genus from Musca. Other synonyms are Phasia jugatoria Say (1829), and Trichopoda flavicornis and T. haitensis of Robineau-Desvoidy (1830). The genus Trichopoda was erected by Latreille (1829), and both Wiedemann (1830) and Robineau-Desvoidy (1830) soon placed the Musca pennipes of Fabricius in this genus. The T. pyrrhogaster and T. ciliata of Wiedemann (1830) have since fallen as synonyms, Brauer and Bergenstamm (1891) showing that these were but females of the species. The complete synonymy, so far as can be determined by the writer, is included in the bibliography at the end of this paper.

### GEOGRAPHICAL DISTRIBUTION

The genus Trichopoda belongs to the New World fauna. T. pennipes has a wide distribution in both North and South America and among the adjacent islands, according to Townsend (1893), who records it from Argentina, Brazil, Mexico, San Domingo and Jamaica, and in the United States from New England to Florida, along the coast of the Gulf of Mexico to Texas, and in California. He speaks of it also from

Michigan, Illinois, Indiana, and Iowa. It is essentially a lowland form, being most abundant within its range at elevations of five hundred feet or less. Aldrich (1915) states that the species "appears to occur from Argentina north to about the latitude of Kansas, and further north to the eastward, but not in the northwest." Records of its capture in St. Vincent, Porto Rico, and other islands of the West Indies are given in Aldrich's Catalogue (1905).

#### HOSTS

The first record of the life history of Trichopoda pennipes appears to be a note by Packard (1875) of a Tachina fly parasitic upon the squash bug (Anasa tristis de Geer, Hemiptera, Coreidae). While the species is not mentioned, the description points quite conclusively to T. pennipes. A. J. Cook (1889) records the insect by name and gives an account of its habit of parasitising the squash bug. Later authors recording it as a parasite of the squash bug were Coquillett (1897), Chittenden (1899), and Weed and Conradi (1902). For a number of years no other host was known, but Morrill (1910) recorded a rearing of T. pennipes from the Northern Leaf-footed Plant Bug (Leptoglossus oppositus, Hemiptera, Coreidae). Jones (1918) records it as an enemy of the Southern Green Plant Bug or Pumpkin Bug (Nezara viridula, Hemiptera, Pentatomidae), and Watson (1918) also records this host in Florida.

Mr. J. H. Reinhard, entomologist of the Texas Agricultural Experiment Station and a specialist in Tachinidae, says in correspondence with the writer that in Texas T. pennipes is parasitic upon Nezara viridula and Leptoglossus phyllopus. He adds "I have observed adults depositing eggs on the adult Harlequin Bug (Lurgantia histrionica, Hemiptera, Pentatomidae) but have never been able to obtain any emergence of the parasite."

#### LIFE HISTORY

##### The Egg.

The female fly lays its eggs upon the body wall of the host, to which the eggs are firmly attached. The great majority of the eggs are found on the sides of the abdomen and thorax, although they are sometimes seen fastened to the upper surface of the body and the head, and rarely to the antennae and legs.

The length of time necessary for the hatching of the egg was found to be in the neighborhood of thirty hours. To prove this point eggs were removed from the body of a bug as soon as laid, a moistened camel's hair brush proving to be excellent for this purpose, and were isolated in vials. After twenty-four hours the mouth-hooks of each young maggot could be seen rasping away at the inner surface of the egg-shell, and in thirty hours the larva was found protruding from the hole it had scraped in the floor of its prison.

Eggs removed from the body surfaces of bugs thirty hours after oviposition were found to be empty, a hole in the bottom of each, and a corresponding hole in the chitin of the host, testifying to the penetration of the parasite.

#### The Larva.

As stated above, the larva, upon hatching, penetrates the bottom of the egg-shell and burrows directly through the body-wall of the host, regardless of the thickness of chitin at that particular point.

Sufficient dissections of parasitised squash bugs have not been made to enable the writer to state accurately the habits of the parasite within its host, or the number of larval instars. Individuals of three different instars have been observed, and it is probable that there are four in all, as has been stated by Townsend (1908, p. 98) for certain other Tachinid parasites. Dissections seem to show that the larvae while young live in the general body-cavity, no derangement of organs being apparent in these dissections. As the larvae approach maturity, however, they gradually consume the fat body and those organs contained in the abdomen of the host, which was seen to be practically hollow in some adult squash bugs from which parasites had just emerged.

Upon the completion of growth, which requires approximately sixteen days, the larva forces its way out at the posterior end of the body of host, which is still alive, and drops to the ground. This is not the case with the second

generation larvae, which appear to remain within the body of the host throughout the winter, completing their growth when the latter become active in the spring. The host dies within a day or two of the emergence of the parasite.

Emergence through the side of the body, as recorded by Weed and Conradi (1902), has not been observed.

#### The Puparium.

Within a few hours of the time the mature larva quits the host, it burrows into the soil to a depth of one to two inches, and there pupates within the last larval skin, which forms the puparium. The pupa, then, falls in the first class as defined by Thompson (1910, p. 284), and probably has a rapid early development. Dissections of the puparia have not been made, and thus the appearance of the pupa and its rate of development are unknown. The pupal period of the spring generation is approximately a month in length, while that of the summer generation lasts from thirteen to nineteen days.

#### The Adult.

The flies are able to take wing within a few seconds following emergence, and have been observed to mate within twenty-four hours. The length of time which then ensues before oviposition commences is not known, nor has the average number of eggs laid per female been determined. One fly laid thirty-nine eggs in twenty-four hours, and another, when captured in the field, contained over one hundred eggs.

In the cages honey-water on sponges failed to attract the flies. They were captured in the field from the flowers of Wild Carrot (Daucus carota) and Meadow Sweet (Spiraea salicifolia) and would feed from these flowers in the cages. The writer did not learn of Townsend's (1908, p. 110) method of feeding, using dry sugar and sponges moistened with water, until too late.

The behavior of caged females toward the bugs confined with them was interesting to observe. The urge to lay eggs did not appear to be constant. At times the flies would walk about among the bugs, with apparent friendliness, and would even crawl over them without making a menacing movement. At other times a fly would dart at a bug and alight upon its back, and the writer would focus his attention in the expectation that an egg would be laid. The fly would turn this way and that upon the unresponsive host, as if trying to decide where to place the egg, but after a few seconds would walk off, as if having changed its mind, leaving no egg behind. When oviposition actually took place, the act was accomplished with great rapidity, the fly seeming scarcely to come to rest upon its host. That no such speed was necessary could be seen in the lack of interest displayed by the victim, which neither resisted the attack of the fly nor tried to dislodge the egg.

## RELATION BETWEEN PARASITE AND HOST

Various observers have noted the parasitic habit of Trichopoda pennipes and have speculated upon the amount of benefit derived from its activities. Thus Dr. A. S. Packard (1875) says "The larvae are very large, one specimen only occurring in the body of the *Coreus*, which seems apparently healthy, and performs its sexual functions in spite of the presence of so large a parasite." Chittenden (1899) observes that "Although these flies appeared soon after the advent of the bugs and in considerable abundance, they seemed to accomplish little in the direction of reducing the numbers of their host. — — — The parasitised individuals were not noticed to die much earlier than those which succumbed to natural causes." Weed and Conradi (1902) also mention the continued egg-laying of parasitised squash bugs.

About Amherst, Massachusetts, Trichopoda pennipes appears to have two full generations each year (Worthley, 1923). A single adult captured in October may indicate a partial third generation, but it is thought more probable that this was a laggard individual of the second generation.

The emergence and pupation of second generation larvae in the fall was not observed in the cages, and it therefore appears that the parasite passes the winter as a larva within the body of the hibernating host. Development of these larvae is completed in the spring, emergence from the host and pupation occurring during June and July. This emergence is shortly

followed by the death of the host, which, in all cases so far observed, has not been able to commence egg-laying.

Pupae developing from these overwintered larvae begin to yield flies in late June. At this time only adult squash bugs are available, and upon these the flies deposit their eggs. These bugs are individuals which escaped parasitism the previous fall, and have lived to mate and lay eggs. Many of them are actively engaged in oviposition when attacked by the parasite, and these can often complete their egg-laying before the activities of the maggots become fatal. One female squash bug laid a cluster of viable eggs just six days previous to her death from parasitism, showing that the metabolism of the host is not seriously unbalanced until late in the development of the parasite. It is the apparent slight effect of parasitism on the egg-laying bugs which has caused investigators to question the efficiency of the parasitism of T. pennipes.

While parasitised egg-laying squash bugs may be permitted to complete a practically normal existence, as has been shown above, the parasite itself may not be so well favored. Thus adult bugs begin to disappear from the fields about the middle of July, having completed the normal span of life. Parasite flies are actively laying eggs at this time, and often deposit them upon bugs which are destined to die before the parasitic larvae have attained full growth. In such cases the parasite cannot complete its development, and perishes with its host.

Larvae which have been more fortunately situated mature and pass on to the pupa stage during the latter part of July and early August. When these pupae yield adult flies during August and the first part of September, many young squash bugs have become adult, and more have reached the fourth and fifth instars. Upon these bugs the parasite lays its eggs, and it is in this generation that the work of the fly is seen to be effective beyond question, since no parasitised bug appears to live to sexual maturity. Many nymphs (counts have shown about 50 percent.) die before becoming adult, and those which reach the adult state and pass the winter safely in hibernation, are subsequently killed by the parasite in the manner previously stated.

No parasites appear to reach maturity in nymphs which die. In this regard the egg-laying flies seem unable to discriminate closely between nymphs which are sufficiently developed to support the parasite maggots and those which contain too little substance. However, the flies seem to realize that their progeny will find too little nourishment in nymphs younger than the fourth instar, since third instar nymphs were rarely molested in the cages, and parasitised third instar nymphs were not collected in the field.

It was interesting to note that occasionally a nymph would escape parasitism by molting, leaving an unhatched parasite egg on the molted skin. This does not account for any great

loss, however, since the egg of the parasite hatches in thirty hours, while the fourth and fifth instars of the squash bug require about six days and sixteen days respectively for their completion.

But one parasite has ever been observed to issue from one host. Several maggots have been observed to enter one host, but this has always resulted in the early death of the host and of the parasites within.

Collections of squash bugs in the fall give no indication of the true percentage of parasitism, since many nymphs die, and others slough off the empty egg-shells of the parasite with their moulted nymphal skins. In midsummer, however, collections of overwintered adult bugs have indicated a parasitism as high as 80 percent. There is no reason to suppose that the percentage of parasitism may not often run as high among the older nymphs and new adult squash bugs in the fall. Thus it would seem that the activities of Trichopoda pennipes furnish an exceedingly important natural check upon the increase of Anasa tristis.

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EXPLANATION OF FIGURES

Plate I

- Fig. 1. Head of male - front view.
- Fig. 2. Head of male - side view, showing mouthparts.
- Fig. 3. Dorsum of male thorax.
- Fig. 4. Thorax of male - side view.

Plate II

- Fig. 5. Wing of male, showing extent of ferrugineous spot.  
Cells labeled.
- Fig. 6. Wing of female. Veins labeled.
- Fig. 7. Tibia of metathoracic leg, showing fringe of  
feather-barbed setae.
- Fig. 8. Terminal segments of tarsus of male.
- Fig. 9. Abdomen of male - side view.
- Fig. 10. Abdomen of female - side view.
- Fig. 11. Abdomen of male - ventral view.
- Fig. 12. Abdomen of female - ventral view.
- Fig. 13. Male genitalia.
- Fig. 14. Female genitalia.

Plate III

- Fig. 15. Ninth abdominal sternite of male.
- Fig. 16. Egg. a, outline from side; b, from top; c, showing  
hole in ventral surface after hatching.
- Fig. 17. Mature larva.
- Fig. 18. Cephalopharyngeal skeleton of larva. a and b, of  
second stage (?) larva, side and top views;  
c and d, of mature larva, side and top views.
- Fig. 19. Puparium, from the top.
- Fig. 20. Empty puparium, from the side.
- Fig. 21. Anal stigmata of puparium.

Plate IV

- Fig. 22. Dorsal view of male fly, in colors.

# ABBREVIATIONS

1st A	- anal or 6th longitudinal vein
aba	- anterior basalar plate
ad	- adanale
adc	- anterior dorsocentral bristle
ae	- aedeagus
aes <sup>2</sup>	- mesoanepisternum or mesopleura
aex	- axillary excision
al	- axillary lobe
ans	- anal stigmata
ant	- antenna
aplt <sup>2</sup>	- anapleurotergite of postscutellum
ar	- arista
as	- adventitious suture
asa	- anterior subalar plate
AxC	- axillary (or anal) cell
axc	- axillary cord
bpb	- basiproboscis
bu	- button
C	- costal vein
CC	- costal cell
ce	- compound eye
chb	- chitinized box
cpo	- cilia of posterior orbit
CuC	- cubital (3rd basal or anal) cell
Cu <sub>1</sub> C	- 3rd posterior cell
cx	- coxa
dpb	- distiproboscis
dv	- dorsal valve (?) of ovipositor
em <sup>3</sup>	- metaepimeron
ep	- empodium
es <sup>3</sup>	- metaepisternum
fb	- frontal bristles
fc	- fronto-clypeus (facial depression, facial plate)
fe	- femur
fs	- frontal suture
fu	- furca
ful	- fulcrum
ga	- galea
ge	- gena (cheek)
gf	- genital furca
go	- gonopophyses
gp	- genital prong

- ha - haltere
- hc - humeral callus
- hev - humeral cross-vein
- hp - hypopleural bristles
- hu - humeral bristles
- hy - hyoid
- hyp - hypopharynx
- hys - hypostomal sclerite
  
- ia - intra-alar bristle
- iv - inner valve of ovipositor
- ivt - inner vertical bristle
  
- kplt<sup>2</sup> - katapleurotergite of postscutellum
  
- lep - labrum-epipharynx
- lp - lateral plate
  
- M - media
- m - medial (posterior) cross-vein
- M<sub>1</sub> 2 - 4th longitudinal vein
- M<sub>3</sub> Cu<sub>1</sub> - 5th longitudinal vein
- MC - medial (2nd basal) cell
- 1M<sub>2</sub>C - discal cell
- 2M<sub>2</sub>C - 2nd posterior cell
- md - mandibles (great hooks) of larva
- mep<sup>2</sup> - meropleurite
- mh - mouth hooks (or mandibles) of larva
- mpb - mediproboscis
- mr - mesopleural row
- ms - marginal scutellar bristles
- nt<sup>2</sup> - meditergite of postscutellum
- mv - median vitta of vertex
- mvp - maxillary palpus
  
- n - notale
- n<sup>3</sup> - metanotum
- np - notopleural bristles
  
- ob - ocellar bristles
- oc - ocelli
- ocp - occiput
  
- P - prothorax
- pa - postalar bristles
- pac - posterior acrostical bristle
- pb - proboscis
- pba - posterior basalar plate
- pdc - posterior dorso central bristle
- pg - paraglossae
- pge - postgenae

- pp - propleural bristle  
psa - posterior subalar plate  
psc<sup>2</sup> - mesoprescutum  
pst - pseudotrachae  
psy - presutural bristle  
pt<sup>2</sup> - posttergite of mesoscutellum  
ptb - pteropleural bristle  
ptp<sup>3</sup> - pteropleurite or mesoanepimeron  
pv - pulvillus  
pvt - posterior vertical bristles
- R - radius  
R<sub>1</sub> - 1st longitudinal vein  
R<sub>2</sub> s - 2nd longitudinal vein  
R<sub>4</sub> s - 3rd longitudinal vein  
RC - radial (1st basal) cell  
R<sub>1</sub>C - marginal cell  
R<sub>3</sub>C - submarginal cell  
R<sub>5</sub>C - 1st posterior or apical cell  
r-m - radio-medial (anterior) cross-vein
- s - slit  
s<sub>1</sub>, s<sub>2</sub>, etc. - abdominal sternites  
sa - supra-alar bristle  
sb - scutellar bridge  
SC - subcosta (auxiliary vein)  
sc<sup>2</sup> - mesoscutum  
SCC - subcostal cell  
sl<sup>2</sup> - mesoscutellum  
sp - spiracle  
spv - spurious vein  
ss - substigmal bristle  
st - stipes  
stb - sternopleural bristles  
stp<sup>2</sup> - mesosternopleurite (sternopleura)  
sty - stylus  
sur - suralare
- t<sub>1</sub>, t<sub>2</sub>, etc. - abdominal tergites  
ta - tarsus  
tb - tibia  
tg - tegula  
the - theca  
to - tormae  
tr - trochanter  
tt - tentorial thickenings
- v - vertex  
vib - vibrissae  
vv - ventral valve of ovipositor
- wp - wing process

# PLATE I

Fig. 1

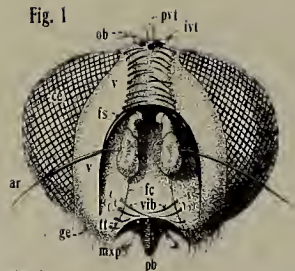


Fig. 2



Fig. 3

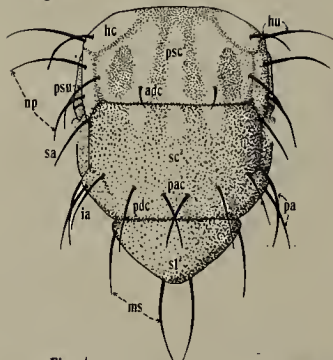
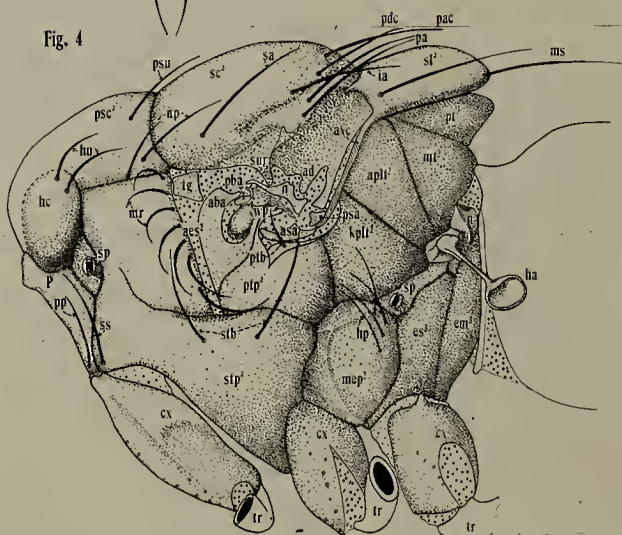


Fig. 4



# PLATE II

Fig. 5

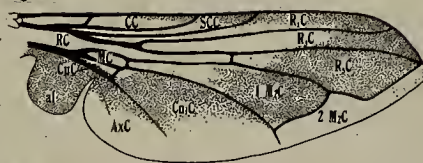


Fig. 6

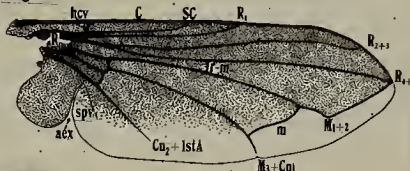


Fig. 9

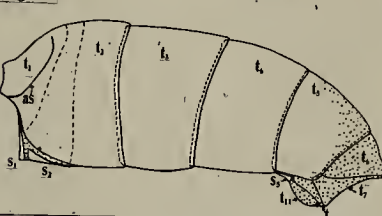


Fig. 11

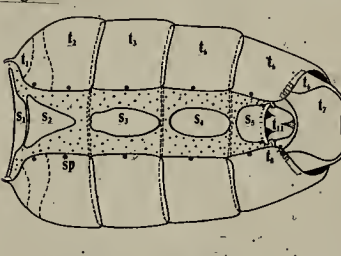


Fig. 13

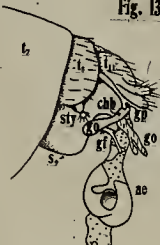


Fig. 7



Fig. 8

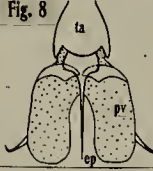


Fig. 10



Fig. 12

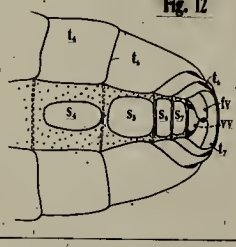
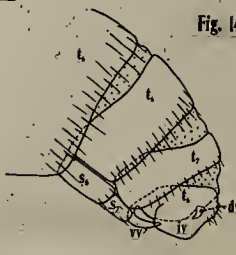


Fig. 14



# PLATE III

Fig. 15

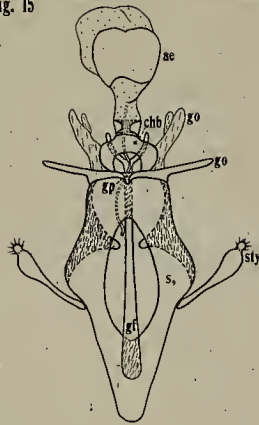


Fig. 16

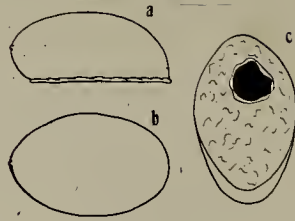


Fig. 17



Fig. 19

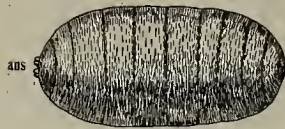


Fig. 18

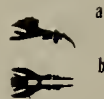


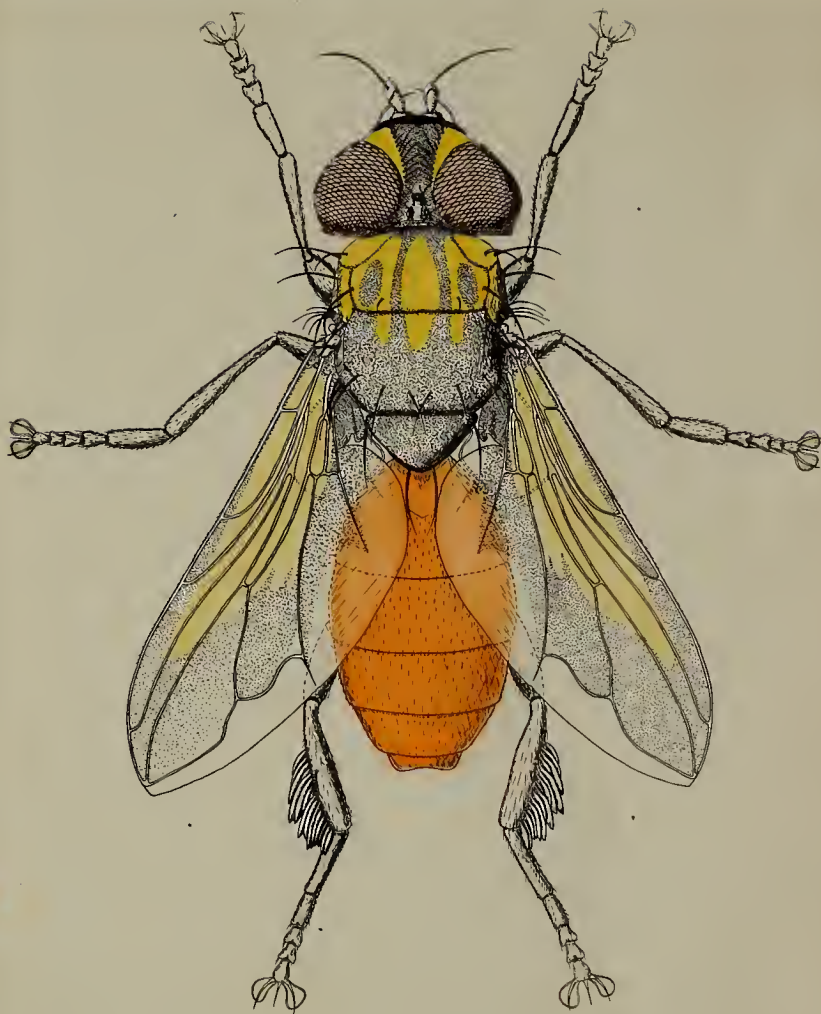
Fig. 20



Fig. 21



PLATE IV



MASSACHUSETTS  
AGRICULTURAL EXPERIMENT STATION

*Contribution No. 7, 1923*

The Squash Bug in Massachusetts

(*Aphis trifolii* Gree.)

WITH NOTES ON THE PUMPKIN AS TO

*Trioxys octa punctata* (Dpt. Ich.)

H. N. WORTHLEY

Reprinted from *Journal of the Entomological Society of America*

Vol. 16, No. 1, 1923, pp. 1-14

TABLE 2. CONTROL OF ROOT MAGGOT IN CABBAGE SEED-BED DURING 1922  
(Mercuric chloride used at rate of 1 ounce to 10 gallons water)

Plat	Row	Number of applications per row	Date of final application	Number of plants counted	Number infested	Number clean	Percentage clean plants
1	1	1	5-12	208	18	190	91.34
	2	2	5-19	218	0	218	100.00
	3	3	5-26	189	0	189	100.00
	4	4	6-2	198	0	198	100.00
	5	5	6-9	177	0	177	100.00
	6	6	6-16	167	0	168	100.00
2	7	1	5-19	178	16	162	91.57
	8	2	5-26	178	8	170	95.50
	9	3	6-2	133	0	133	100.00
	10	4	6-9	152	0	152	100.00
	11	5	6-16	146	0	146	100.00
3	12	1	5-26	153	50	103	67.32
	13	2	6-2	130	45	85	65.38
	14	3	6-9	156	40	116	74.35
	15	4	6-16	209	70	139	66.55
4	16	1	6-2	215	85	130	61.35
	17	2	6-9	247	90	157	63.56
	18	3	6-16	234	61	173	73.45
5	19	1	6-9	210	55	155	73.80
	20	2	6-16	199	56	143	71.85
6	21	1	6-16	177	65	125	65.78
Check				1110	482	628	56.16

PAST PRESIDENT DEAN: The next paper is on "The Squash Bug in Massachusetts," by H. N. Worthley.

## THE SQUASH BUG IN MASSACHUSETTS

By H. N. WORTHLEY, *Amherst, Mass.*

### ABSTRACT

The life-cycle of the squash bug, *Anasa tristis*, in Massachusetts has been worked out and compared with the records for other parts of the country. An attempt to find an efficient insecticide for the destruction of adult bugs without injuring the vines was unsuccessful. Brief notes on a Tachinid parasite, *Trichopoda pennipes* are given.

The squash bug (*Anasa tristis* De Geer) is an ever present pest of cucurbits in Massachusetts. It is locally abundant every year, but causes serious loss only occasionally. The worst damage in Massachusetts appears to occur when overwintered adult bugs are abundant in the spring, sucking the juices of the seedling plants, which are killed outright. Weed and Conradi (5)<sup>1</sup>, p. 15, give an account of a serious outbreak in New Hampshire, in which "as soon as squashes, cucumbers, and other plants of the vine family were out of the ground in spring, the

<sup>1</sup>Numbers in parenthesis refer to "Literature cited."

bugs began to destroy them, coming in such extraordinary numbers as to occasion very general comment." It may be that during a dry, hot August the nymphs also would cause serious loss, but within the writer's experience plants which have escaped destruction by the adults are well able to support the nymphs, due to the tremendous mid-summer growth of cucurbits.

#### SEASONAL HISTORY

The time during which the various stages in the life of the squash bug are present in Massachusetts is shown in the accompanying chart (fig. 2), which is a record of field observations during the seasons of 1920, 1921, and 1922. In addition, the chart is of interest in its record of the year 1921. A glance at the chart will show that all stages were present in the fields for a shorter time than in the other two years, and that all bugs had left the fields at least a month before the first killing frost. This early completion of its seasonal activities seems best explained by the late fall of 1920 and the mild winter and early spring of 1921. These combined to cause a rapid emergence of the overwintered adults, and a subsequent concentration of oviposition in the latter part of June and early July. Since all nymphs had reached the fifth instar by September first, their development was not retarded by the cool September weather, as in average years. The fact that all adults had left the fields nearly a month before the vines were killed by frost seems to indicate that they normally do only a certain amount of feeding before seeking winter quarters.

In 1921, as soon as the peculiarities of the season were evident, a close watch was kept on bugs in the field and on those in breeding cages as well, but no mating or egg laying by the newly developed bugs was observed. It seems safe to say, therefore, that there is never more than one generation of the squash bug each year in Massachusetts, for if it were possible for a partial second generation to develop, it would surely appear in such a season as that of 1921.

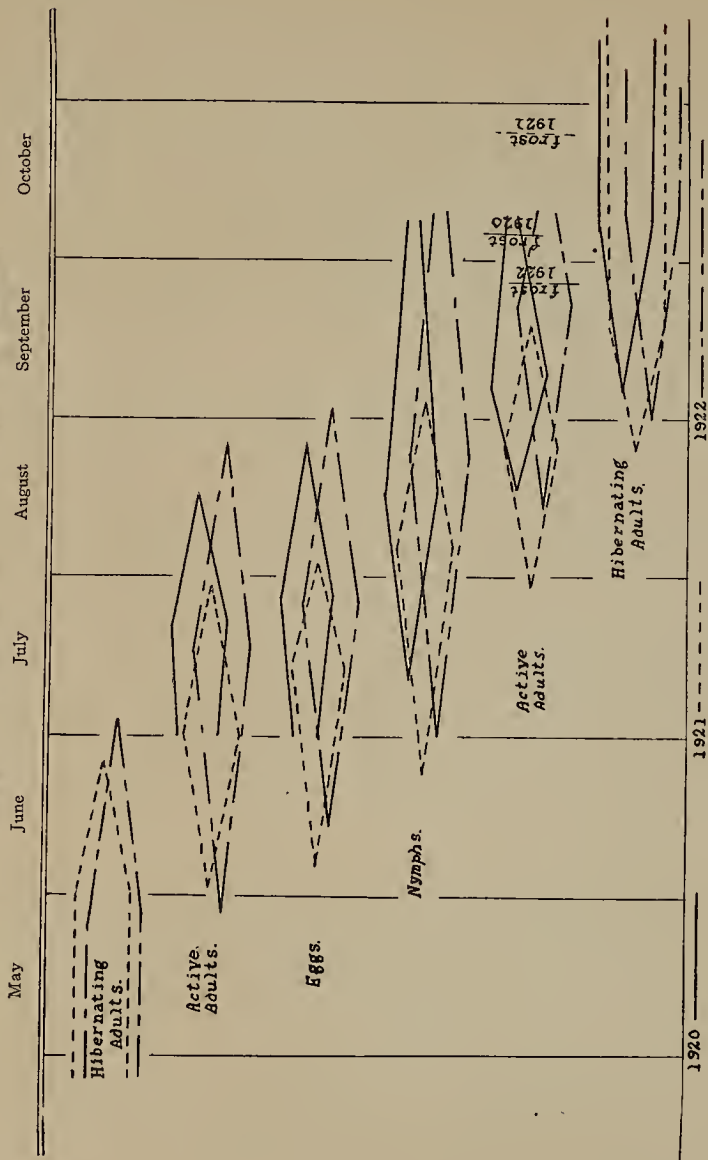
TABLE 1. LENGTH OF DEVELOPMENTAL STAGES OF SQUASH BUG, AMHERST, MASS.

Stage	Number of Individuals	Time days	Average days
Egg	151	11-16	13.7
1st instar	86	3- 4	3.3
2d instar	85	3-11	6.6
3d instar	82	4-13	6.6
4th instar	63	4- 9	6.4
5th instar	59	9-22	16.6

Total from egg to adult 34-75 days, average 53.2 days.

Table 1 is a summary of breeding records obtained in life history cages. The variations exhibited are due in part to temperature differences, but

FIG. 2. SEASONAL HISTORY OF *Anasa tristis* De G. AT AMHERST, MASSACHUSETTS



are also in part individual, since specimens hatching the same day from the same egg cluster and kept in the same cage have been known to become adult as much as fourteen days apart.

A tabulation (Table 2) of the lengths of the various developmental stages shown by the cage records of three seasons at Amherst, compared with the findings of Chittenden (1), p. 24, Weed & Conradi (5), p. 17-18, and Wadley (4), p. 419, is of interest as showing regional variations in the lengths of the different developmental stages.

TABLE 2. DEVELOPMENTAL STAGES OF SQUASH BUG IN DIFFERENT LOCALITIES

Stage	Washington, D. C.	New Hampshire	Kansas	Massachusetts
Egg	9-10 days	11 days	7-17 days	13.7 days
1st instar	3	3	2.1-5.2	3.3
2d instar	8-9	9	6.2-9.2	6.6
3d instar	7-8	8	8.1-13	6.6
4th instar	6	7	10	6.4
5th instar	8	9	12	16.6
Total	41-44 days	47 days	45.4-66.4 days	53.2 days

#### CONTROL MEASURES

Since the chief injury by squash bugs in Massachusetts seems to be that caused by the overwintered adult<sup>1</sup> bugs and because the vines largely cover the ground by midsummer when spraying for the nymphs must be carried on, an effort has been made to find a material which will kill adult bugs without injuring the vines. The investigation has so far proved fruitless, but it may be of value to report the materials tried, and the results obtained. In each test several bugs were treated, placed on a fresh leaf under a lamp chimney covered with cheese cloth, and kept under observation for three days.

Standard Insecticide (Lemon Oil Co., Baltimore, Md.) 1-16, (3) p. 166.

Against adults—no effect.

Sodium sulfide (3), p. 165.

Against adults—no effect.

Sulco-V. B. (Cook & Swan Co., New York City) 1920<sup>1</sup> sample, 1-25.

This material which is a miscible oil, was partially effective against 4th instar nymphs. Adults, however, were unaffected, and the foliage was killed.

Emulsion of CS<sub>2</sub> and liquid soap, equal parts.

Apparently killed all instars and adults very rapidly but all revived within a few hours of the application.

Linseed Oil Emulsion, 1-9, (3), p. 168.

Against adults—no effect.

Linseed Oil Emulsion, 1-9, plus Black-leaf "40", 1-500.

Against adults—no effect.

<sup>1</sup>The year is given because the material called Sulco-V. B. differed markedly in its composition in 1920, 1921 and 1922.

Black-leaf "40," 1-500.

Not effective against nymphs older than 2d instar.

Black-leaf "40," 1-100, plus soap, 1 oz. per gallon.

Not effective beyond 3d instar.

Nicotine sulfate dust (homemade) about 2%.

Not effective beyond 3d instar.

Nicotine sulfate dust (Cal. Walnut Growers' Ass'n. 1921).

Not effective beyond 4th instar.

Nicotine sulfate dust (Dosch 1922) 4%, killed 15% of adults.

Nicotine sulfate dust (Dosch 1922) 2%, killed 15% of adults.

Fish-oil soap (Sterlingworth) 1 lb. in 3 gals. water.

About 80% effective against 3d instar nymphs.

Fish-oil soap, 1 lb. in 3 gals. water plus 3 oz. sulfur.

Partially effective against 4th instar nymphs, ineffective against adults.

Fish-oil soap, 8 oz.; water, 1 gal.; sulfur, 2 oz.; ineffective against adults, and caused severe burning.

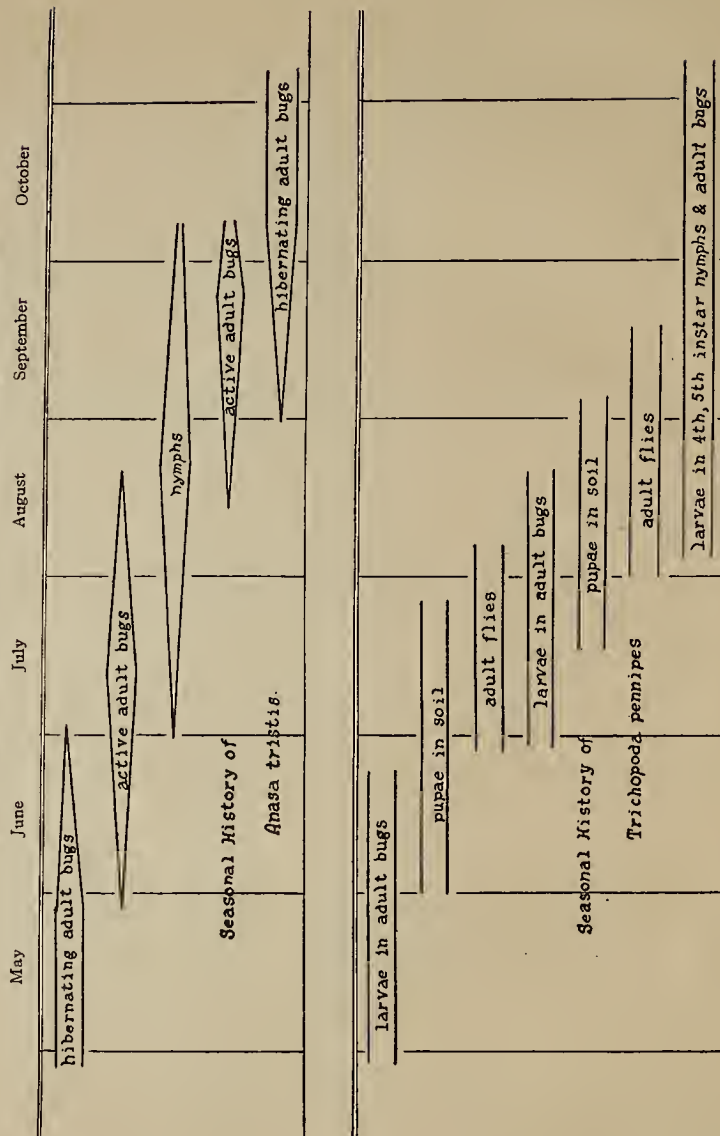
The last-named mixture was reported by F. M. Wadley (4), p. 423, as a satisfactory means of killing adult squash bugs in Kansas. It was hailed with delight by the writer, and given repeated tests. 90% of adult bugs *dipped* in the mixture while it was warm were killed, but only a small percentage of those sprayed with the mixture while warm, and of those dipped or sprayed with the cold mixture, succumbed. In addition, this material caused severe foliage burn.

It will be noted that nicotine sulfate dust killed a few adults in the experiments. Three or four direct puffs were given the bugs, which resulted in a more liberal application than they would ordinarily get in field work. Still, the dust has killed adult bugs, and since there is reason to believe that the dusts will be improved, we may look forward with hope to the production of a material which can be used with safety and success even against an insect which has proved to be as resistant as the common squash bug.

#### THE TACHINID PARASITE, *Trichopoda pennipes* Fabr.

A more extensive paper on the biology of this species is being prepared by the writer, but a few statements may properly be given here. This beneficial fly has two generations yearly in Massachusetts. As many as 80% of overwintered squash bugs have been observed to bear eggs of the parasite. Many of these bugs, however, live to deposit a part, at least, of their eggs.

The accompanying chart (fig. 3) explains the relation existing between parasite and host as it appeared in 1922 at Amherst. For economy in space, the egg stages, which are not significant in this connection, have been omitted. Flies of the second generation lay their eggs upon the

FIG. 3. RELATION OF *Trichopoda pennipes* TO ITS HOST, *Anasa tristis*, AMHERST, MASSACHUSETTS, 1922

older nymphs and adult bugs, and the larvae of this generation pass the winter within the body of the host. None of the bugs parasitized by the second generation flies appear to live long enough to oviposit the following spring. Thus, although the efficiency of the parasite has been questioned, due to the fact that parasitized female bugs have been observed laying eggs, (1) p. 26; (2); (5) p. 21, it would seem that the parasite is capable of causing a considerable reduction in numbers of the host in Massachusetts.

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PAST PRESIDENT DEAN: We will now listen to a paper on "The Onion Capsid," by P. A. Glenn.

### THE ONION CAPSID, *ORTHOTYLUS TRANSLUCENS* TUCKER

By P. A. GLENN, *Chief Inspector, Division of Plant Industry,  
Department of Agriculture, Urbana, Ill.*

## ABSTRACT

The onion Capsid, *Orthotylus translucens*, occurs in Illinois on wild garlic and attacks onions. The life-cycle is briefly summarized and spraying with whale oil soap recommended. Burning over garlic fields and fall plowing are excellent preventives.

This insect pest was seen by the writer at Olney, Illinois, May 15, 1915, on cultivated onion, and was identified for me by C. S. Spooner. The species was described by Elbert S. Tucker from a single male specimen collected in 1894 in Cheyenne Canyon near Colorado Springs. The description was published in Volume IV (old series) XIV (new series) No. 2, University of Kansas *Science Bulletin*, 1907. The type is now in the collection of the University of Kansas. Mr. Tucker makes the

following statement in regard to it: "Otto Heidemann considers the specimen 'near *prasinus* Fallen'. The description of *O. viridicatus* Uhl. agrees very closely, the most notable distinction being the black membranes of that species."

May 15, 1915 is the earliest record of its presence in Illinois. The writer has not been able to find any reference to it in economic literature. Its destructive character as revealed by observations made in the vicinity of Olney in 1915, '16, and '17 warrants its recording it as one of our injurious insects.

Its chief food plant at Olney was wild garlic, commonly but erroneously called "wild onion" by the people of that locality. No doubt it will accept wild onion as a host plant as readily as wild garlic but this has not been verified. It might therefore, more properly be named the "garlic capsid" but since its economic importance depends upon its relation to the cultivated onion I have chosen to suggest that it be named the "onion capsid."

The tops of the onions on which the insects were first seen were at the time killed half way to the ground and later most of the tops were killed to the ground. The same condition prevailed in a number of patches visited. The insects found were all adults. The owners reported that they had appeared very suddenly a few days before my visit, and that this had been a frequent occurrence in former years in that locality. One man reported later that they were also abundant on the "wild onion" growing in his pasture. This gave a clew to the situation and by observations made during the two following years it was learned that wild garlic, which is abundant in that locality, is the natural host plant of the species.

The eggs are deposited in longitudinal slits made in the fruiting stalks of the plant, as shown in Pl. 1, Figs. 1, 2, and 3, from five to twenty eggs being deposited in each slit. The insect hibernates in the egg stage, hatching continues throughout April, adults begin to appear about the first week in May and are to be found until about June 10, and oviposition begins about May 15th and continues until the adults disappear. A few eggs were found in tops of cultivated winter onions, but cultivated onions do not appear to be nearly as attractive to the female for purposes of oviposition as garlic.

The young nymphs are green with orange colored thorax and red eyes, the later stages and the adults are uniform light yellowish green.

The adults are very active flyers and when abundant swarm from wild garlic fields to the cultivated onion and soon suck the life out of

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