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KEYS TO THE PARASITES OF THE HESSIAN FLY BASED ON REMAINS LEFT IN THE
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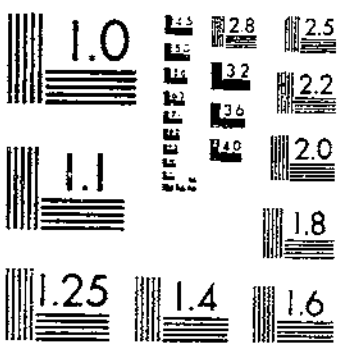

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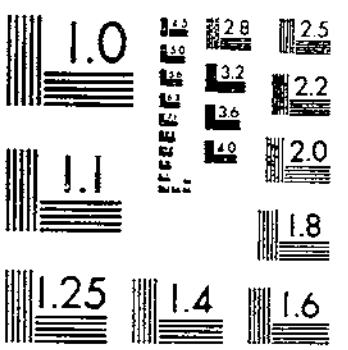

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NATIONAL BUREAU OF STANDARDS-1963-A

TECHNICAL BULLETIN No. 715 January, 1940

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

KEYS TO THE PARASITES OF THE HESSIAN FLY BASED ON REMAINS LEFT IN THE HOST PUPARIUM [1]

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INTRODUCTION

The keys to the parasites of the hessian fly (*Phytophaga destructor* (Say)) herein presented have been used extensively by the writers for a number of years and have proved an invaluable aid in gaging the extent of parasitization by the different species, their relative importance in biological control, and their geographical distribution. They have also served as a means of rapid determination where distinguishing characteristics of the adult were not readily discernible. It is hoped that they may prove of value to other workers in this field of investigation.

Knowledge of the habits of these parasites and of the number of species which attack the hessian fly in different parts of the United States is based on extensive systematic rearing of hessian fly material for more than 20 years by the writers and other entomologists in various parts of the country.

[1] Submitted for publication June 8, 1939.
[2] The photomicrographic plates included in this bulletin were prepared by E. J. Udine of this Bureau.

Twenty species of parasites found in the United States east of the Rocky Mountains have been included, among which are certain ones, such as the European species *Platygaster pleuron* Walker and *Trichacis remulus* (Walker) and the California parasite *Pseuderimerus mayetiolae* Gahan, that have been recently liberated in eastern localities. *Platygaster error* Fitch, *Decatoma amsterdamensis* Girault, *Horismenus texanus* (Girault), and *Pleurotropis benefica* Gahan, all primary parasites of other hosts, have been reared from the hessian fly in only single instances and have been omitted because of their negligible significance.

In using the keys it is recommended that all the contents of the hessian fly puparium from which the parasite has emerged be carefully removed onto a microscope slide in some medium such as cedar oil or alcohol, and covered with a glass cover slip. They can then be examined under any magnification that may be necessary.

After familiarity with the different forms has been attained it will be found that many of the species can be determined quickly and accurately without going entirely through the keys. For instance, among the larval exuvia, that of *Pseuderimerus mayetiolae* is the only one that has conspicuous setae and at the same time straight mandibles, and the genus *Eurytoma* includes the only parasites in the series that have bidentate mandibles. Moreover, the structure of the frontoantennals and other pupal sclerites at once distinguishes many of the species without further examination.

The descriptions of larval exuvia refer only to the last larval instar.

It will be observed that the general key falls into two distinct sections, one of which involves the Serphoidea and the other the Chalcidoidea. Among the Serphoidea the larval exuvia and pupal sclerites are exceedingly difficult to separate from the meconia, and if found would be too mutilated to be of much use. In this section, therefore, the writers have felt justified in resorting to such means of identification as the size and number of the cocoons and the size of the emergence holes, as well as both adult and larval characteristics. It might be explained that all these Serphoidea have but one generation a year and stay within the host during most of the year, and that consequently either living or dead forms, especially of the adult stage, are frequently found inside the host puparium upon dissection. In the chalcidoid section it was not found necessary to use other characteristics than those furnished by the pupal sclerites and meconia.

Only the Chalcidoidea have been dealt with in the supplementary key because it was found impracticable to include larval exuvia of the Serphoidea.

EXPLANATION OF TERMS

The terms used to designate the pupal sclerites have been adopted as far as possible from those of corresponding sclerites or structures of the adult. In those instances where much disparity exists between corresponding sclerites of pupa and adult it was found expedient to apply a composite descriptive term. Figure 1, showing aspects of the pupal stage of the chalcidoid *Eupelmus allynii*, illustrates the

terms used and shows the normal position of the sclerites of a typical chalcidoid pupa before the act of eclosion scatters them. It will be observed that the term "oculoparietal" has been applied to the sclerite which corresponds to the parietal of the adult when united to the plate which covers the compound eye. Where these sclerites are completely separated from each other, as in the case of *Merisus destructor* (pl. 2, *E*, *F*), they have been referred to under the respective terms, parietal and ocular. The term "frontoantennal" has been used as a blanket term to embrace the part of the face which would correspond to the frons of the adult plus those sclerites that cover the proximal portions of the antennae but fused with them in one piece. It will be observed in figure 1, *B* and *C*, that the area of the dorsum which includes the pronotum and mesoscutum is divided bilaterally and the two sclerites are referred to as the schizonotal plates. Other descriptive terms used are self-evident, such as scutellum, abdomen, or proximal or distal portions of the legs.

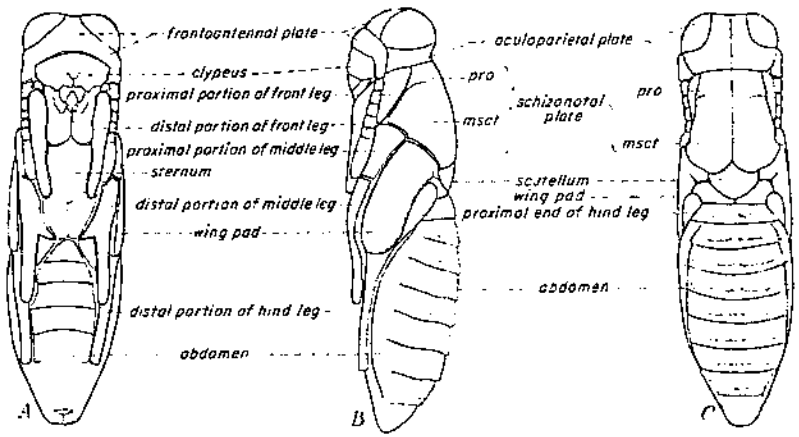

FIGURE 1.—Pupa of *Eupelmus allynii* showing position of sclerites: *A*, ventral aspect; *B*, lateral aspect; *C*, dorsal aspect; *msct*, mesoscutum; *pro*, pronotum.

DESCRIPTIONS OF THE REMAINS

SUPERFAMILY SERPHOIDEA

PLATYGASTER ZOSINE Walker and P. HIEMALIS Forbes

Both *Platygaster zosine* and *P. hiemalis* make characteristic cocoons of tough, flexible material about 1.5 mm. long, broadly ellipsoidal, and pale yellowish brown. From 1 to 23 cocoons (fig. 2) may be found in the host puparium, although less then 3 is a rare occurrence. Sclerites of the pupal exuvium are not found loose in the cocoon. There may be one or several emergence holes through the puparium of the host (fig. 3), and their diameter seldom exceeds 0.6 mm. and averages slightly less than 0.4 mm. Separation of the two species can best be made from the adult stage, which is frequently found in 1 or more of the cocoons. In the adult of *P. zosine* the vertex and face are distinctly transversely rugulose, whereas in *P.*

hiemalis these areas are smooth and shining with faint aciculations running obliquely away from an indistinct median carina. Also, in *zosine* the ovipositor is approximately straight and slightly enlarged and blunt at the apex, whereas in *hiemalis* it is distinctly curved and attenuated.

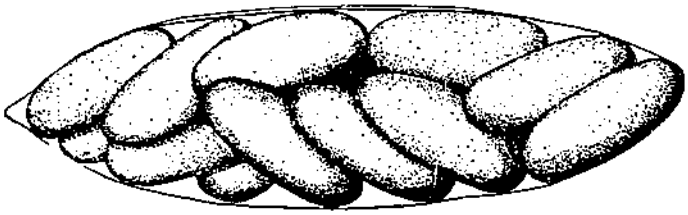

FIGURE 2.—Cocoons of *Platygaster hiemalis* as they appear when removed from the puparium of the hessian fly. ×19½

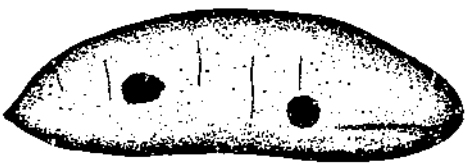

FIGURE 3.—Hessian fly puparium showing emergences holes made by *Platygaster hiemalis*. ×14.

PLATYGASTER HERRICKII Packard, P. PLEURON Walker, and TRICHASIS REMULUS (Walker)

FIGURE 4.—Hessian fly puparium showing emergence hole made by *Platygaster herrickii*. ×22.

Platygaster herrickii, *P. pleuron*, and *Trichacis remulus* also form straw-colored, ovoid cocoons of thin, shiny, tough, elastic material similar to the cocoons of the other serphoids, but always over 2 mm. long. As they are monembryonic and solitary in habit, more than one are rarely found in a host puparium. As with the other serphoids, loose pupal sclerites are not left behind. Emergence holes of *P. herrickii* (fig. 4) average about 0.7 mm. in diameter. These species may best be distinguished from one another in the adult stage, which remains in the cocoon during the larger part of the year. *T. remulus* is characterized by the presence of a distinct tuft of short gray hairs near the apex of the scutellum. *P. pleuron* superficially resembles *P. herrickii* but may be readily distinguished from the latter by the many deep striations on the proximal half of the abdomen on both dorsal and ventral sides (fig. 5).

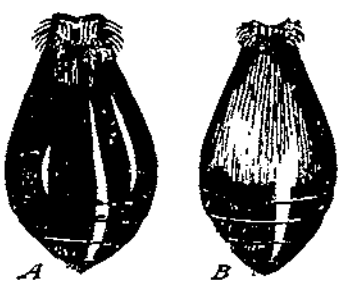

FIGURE 5.—Dorsal surface of abdomen of (*A*) *Platygaster herrickii* and (*B*) *P. pleuron*. ×37.

SUPERFAMILY CHALCIDOIDEA

CALLITULA BICOLOR Spinola

The pupal exuvium of *Callitula bicolor* is transparent straw color; the frontoantennal plate (pl. 1, *A*) is triangular in outline, and the anterior corners are extended by basal portions of the antennae. The lateral edges are somewhat concave near the apex and the surface is coarsely papillose midway between the anterior corners and over most of the posterior half, with a distinct longitudinal suture running from the center almost to the apex, at which point it divides to form a V. The abdomen, sternum, and various other pupal sclerites are usually found in a conglomerate mass, with the abdomen collapsed into a semicircular shape (pl. 3, *T*).

The larval exuvium is elongate, with the setae minute, and the mandibles simple, approximately straight and 0.03 mm. long from apex to condyle. The spiracles are cone-shaped, with from four to seven taendia in the specimens examined.

The meconium ranges in shape and color from a black, amorphous mass with light-brown pellets attached to a dark-brown mass.

CENTRODORA SPECIOSISSIMA (Girault)

The pupal exuvium of *Centrodora speciosissima* is pale, transparent, yellowish brown. The abdomen (pl. 3, *U*) is usually collapsed into a cone-shaped mass which seldom exceeds a length of 0.65 mm. Pieces of antennae (pl. 1, *M*) are usually found detached.

The larval exuvium (pl. 4, *H*) is flattened rather than filiform, and the setae are not in evidence. The mandibles have a heavily sclerotized portion 0.03 mm. long, with both outer and inner edges decidedly curved.

The meconia (pl. 5, *S*) are found scattered about within the host epidermis, and consist of separated subspherical, sometimes flattened pellets with diameters ranging from approximately 0.08 to 0.22 mm. They are pale yellowish brown.

As this species is multiple in habit, it is usual to find many meconia and pupal casts. As many as 19 casts have been found in a single host.

The epidermis of the host larva is left intact except where exit holes are eaten, and appears translucent silvery gray. The exit holes are round, with roughly gnawed edges, and range from 0.1 to 0.45 mm. in diameter. There is usually one exit hole, although occasionally more may be found.

CHEILONEURUS ELEGANS (Dalman)

The pupal exuvium of *Cheiloneurus elegans* is transparent straw color. The frontoantennal plate (pl. 1, *B*) is reduced mostly to the antennal bases, which are sharply bent at the extremities with pronounced emarginations at the middle on both anterior and posterior margins, with the surface of most of the central area distinctly

papillose. The clypeus and mouth parts are often loosely attached to the frontoantennal plate. The abdominal and thoracic sclerites (pl. 3, *F*) are found in a conglomerate mass with one or two leg sclerites usually projecting like empty sleeves. The sutures between the segments of the abdomen are, for the most part, clearly defined.

The larval exuvium is narrow and elongate, with setae minute and mandibles (pl. 4, *I*) curved. The latter are about 0.026 mm. long. The spiracles are cone-shaped with a variable number of taenidia not usually exceeding seven.

Typical meconia consist of a number of pale-brown, subspherical pellets.

Ditropinotus aureoviridis (Crawford)

The pupal exuvium of *Ditropinotus aureoviridis* is transparent straw color. The frontoantennal plate (pl. 1, *C*) is triangular in general outline, with the anterior corners extended by curved bases of the antennae, the lateral edges somewhat concave near the apex, and part of the surface from the lateral margins toward the center finely papillose. There is no longitudinal suture or apical V in evidence, and the clypeus and mouth parts are often attached to the anterior margin. The oculoparietal plate (pl. 2, *A*) has the parietal area finely papillose and sparsely covered with conspicuous setae. The middle leg (pl. 3, *J*) is usually detached but is delicate and transparent, with a tibial spur well defined. The abdominal sclerites (pl. 4, *A*) collapse after eclosion in a manner to form a semicircle of folds.

The larval exuvium (pl. 5, *A*) is elongate, with numerous and long setae, many of them over 0.02 mm. in length. The head has two nodular antennae 0.013 mm. long and the mandibles are very slightly curved, measuring 0.06 mm. from apex to condyle. The spiracles are cone-shaped with from 11 to 16 taenidia.

A typical meconium consists of numerous dark-brown, irregular-shaped pellets, many of which are more or less fused.

Eupelmella vesicularis (Retzius)

In the remains of *Eupelmella vesicularis* the pupal exuvium is transparnt straw color, with the surface finely papillose. The frontoantennal plate (pl. 1, *D*) is triangular in general outline, the anterior corners extended by the bases of the antennae, each of which has a sharp elbow bend, and the lateral edges conspicuously concave near apex. The anterior margin between the antennal bases is nearly straight and the clypeus and mouth parts are often attached. The oculoparietal plate (pl. 2, *B*) is glabrous. The sternum (pl. 2, *L*) is roughly oblong, with a narrow piece projecting cephalad from each corner at the posterior end. The rugulose wing pad (pl. 2, *P*) is usually intact and attached to the schizonotal plate. The scutellum (pl. 3, *A*) has the anterior margin curved and the sides concave, forming an acute angle at the posterior apex. The front leg (pl. 3, *E*) has the proximal area attached like a hook, the middle leg

(pl. 3, *K*) has the proximal end pestle-shaped and the tibial spur prominent, whereas the hind leg has the proximal portion (pl. 3, *O*) detached and the distal portion (pl. 3, *P*) weakly spurred. The abdominal sclerites (pl. 4, *B*) collapse after eclosion in a manner to form a semicircle of folds.

The larval exuvium (pl. 5, *B*) is elongate and sparsely covered by long setae. The mandibles (pl. 5, *C*) are curved and 0.063 mm. long from apex to condyle. The labrum (pl. 5, *C*) has a row of denticles widely and often irregularly spaced. The spiracles (pl. 5, *O*) are cone-shaped, with numerous taenidia.

The meconium usually consists of hard, brown pellets more or less coalesced.

EUPELMUS ALLYNII (French)

The pupal exuvium of *Eupelmus allynii* is dark brown, with the surface densely punctate. The frontoantennal plate (pl. 1, *E*) is triangular in general outline, with the anterior corners extended by the bases of the antennae, each of which bends in a sharp elbow. The lateral edges are concave, and the surface is finely punctate except over the central area, which is coarsely punctate, and the midanterior and midposterior areas, which are sparsely setose. The oculoparietal (pl. 2, *C*) has the parietal portion setose. The sternum (pl. 2, *M*) is oblong, with the corners sharp and nearly right-angular at the anterior end, a short filamentous piece being attached to each corner at the posterior end. The rugulose wing pad (pl. 2, *Q*) is usually intact and is sometimes loosely attached to the schizonotal plate. The scutellum (pl. 3, *B*) is somewhat wider than long, with the anterior margin curved. The distal portion of the front leg (pl. 3, *F*) is slightly club-shaped and bluntly rounded. The middle leg (pl. 3, *L*) has the proximal portion pestle-shaped and usually detached, and the distal portion is characterized by a prominent tibial spur. The hind leg has the proximal portion (pl. 3, *Q*) small, and this is usually detached from the rest of the leg. The distal portion (pl. 3, *R*) is very weakly spurred. The abdominal sclerites (pl. 4, *C*) collapse after eclosion into a semicircle of folds and angles.

The larval exuvium is elongated, with sparse and long setae. The mandibles (pl. 5, *D*) are distinctly curved and measure about 0.07 mm. from apex to condyle. The labrum (pl. 5, *E*) has a row of sharp, closely and evenly placed denticles, usually six in number, and the spiracles (pl. 5, *P*) are cone-shaped and have numerous taenidia.

The meconium usually contains a number of irregular, light-brown pellets, although both color and shape vary with individuals.

EUPTEROMALUS FULVIPES (Forbes)

The pupal cast of *Eupteromalus fulvipes* is translucent straw color. The frontoantennal plate (pl. 1, *F*) is triangular in general outline, with the anterior corners extended by the bases of the antennae and curved slightly inward. A deeply etched median longitudinal suture runs from the center to the posterior apex of this plate, where it

divides to form a V. The surface over most of the apical half is coarsely papillose and somewhat rugulose, with two converging diagonal sutures near the anterior edge and the area between them more or less rugulose. The oculoparietal plate (pl. 2, *D*) is glabrous. The abdominal sclerites (pl. 4, *D*) collapse after eclosion into a semicircle of folds and angles.

The larval cast is elongate, the setae are small and inconspicuous, and the mandibles are approximately straight and about 0.04 mm. long. The spiracles are cone-shaped and have from five to nine taenidia.

The meconium usually consists of a mass of hard, brownish, tightly coalesced pellets.

Eurytoma atripes (Gahan) and E. pidemus (Girault)

The pupal exuvia in *Eurytoma* are translucent straw color, and the sternal sclerites and usually the wing pads and legs unite in a conglomorated mass with the abdominal sclerites (pl. 4, *E*).

The larval exuvia (pl. 5, *F*) are elongate, with long, sparsely distributed setae. The mandibles have a conspicuous extra denticle on the inner margin. The spiracles are cone-shaped.

Merisus destructor (Say)

The pupal exuvium of *Merisus destructor* is pale straw color. The frontoantennal plate (pl. 1, *G*) is triangular in general outline, with the anterior corners extended by the bases of the antennae; a distinct, coarsely rugulose longitudinal suture runs from the center almost to the apex, at which point it divides to form a V. The ocular plate (pl. 2, *E*) is oval and is separated from the parietal (pl. 2, *F*), which is roughly quadrilateral. Both sclerites are glabrous. The abdominal segments (pl. 4, *F*) are indistinguishably crumpled up with the wing, leg, and other sclerites.

The larval exuvium (pl. 5, *G*) is elongate, the setae are minute and inconspicuous, and the mandibles nearly straight and about 0.05 mm. long from apex to condyle. The spiracles are cone-shaped and have about 9 to 14 taenidia.

The meconium is usually a hard, amorphous, speckled, brownish mass.

Merisus febriculosus (Girault)

The pupal exuvium of *Merisus febriculosus* is pale translucent straw color. The frontoantennal plate (pl. 1, *H*) is roughly triangular, with the anterior corners extended by the bases of the antennae, similar in shape to those found in *M. destructor* but slightly longer, and there are a pronounced rugulose area near the center and two short parallel sutures on each side of the median line near the posterior apex instead of the apical V pattern found in *M. destructor* and some of the other parasites. The ocular (pl. 2, *G*) is oval and separated from the parietal (pl. 2, *H*), which is roughly quadrilateral; both sclerites are glabrous.

The larval exuvium (pl. 5, *H*) is elongate, with minute and inconspicuous setae. The mandibles are nearly straight and about 0.04

mm. from apex to condyle. The spiracles are cone-shaped and have about 10 to 15 taenidia.

The meconium is a hard, dark, amorphous mass characterized by the presence of large, conspicuous, cream-colored or white patches.

Merisus mordellistenae Crawford

The pupal exuvium of *Merisus mordellistenae* is pale translucent straw color. The frontoantennal plate (pl. 1, *I*) is triangular in general outline and similar to that of *M. destructor*, with a longitudinal suture from the center almost to the apex, where it divides to form a V. Parallel sutures like those found in *M. febriculosus* are absent.

The larval exuvium (pl. 5, *I*) is elongate, with minute and inconspicuous setae. The mandibles are nearly straight and about 0.04 mm. from apex to condyle. The spiracles are cone-shaped, with from five to seven taenidia in the specimens examined.

The meconium is a hard, dark, amorphous mass characterized by large, conspicuous, cream-colored, or white patches as in the case of *Merisus febriculosus*.

Pleurotropis metallicus (Nees)

The pupal exuvium of *Pleurotropis metallicus* is dark brown to black. The frontoantennal plate (pl. 1, *J*) is subcircular, with the bases of the antennae attached as a short truncated projection on each side of the anterior edge. The surface is finely punctate, with a dark pit on each side of the median line near the anterior edge. The oculoparietal plate (pl. 2, *I*) is glabrous. The sternum (pl. 2, *N*) in two loosely joined pieces forms a crude quadrangle with projecting lobes at the anterior corners. The wing pad (pl. 2, *R*) is closely fused with the schizonotal plate. The scutellum (pl. 3, *C*) has its posterior margin angulated. The distal portion of the front leg (pl. 3, *G*) is club-shaped, with the club end sharply attenuated, and the middle leg (pl. 3, *M*) has a poorly defined tibial spur.

The larval exuvium (pl. 5, *J*) is elongate, with minute and inconspicuous setae. The mandibles are distinctly curved and without a surrounding band of tissue and are about 0.05 mm. long. The spiracles are not cone-shaped.

The meconium is a dark, brownish mass of large pellets more or less fused.

Polyscelis modestus Gahan

The pupal exuvium of *Polyscelis modestus* is transparent straw color. Most of the body sclerites (pl. 4, *G*) are left massed together after eclosion, with the abdominal segments, wing pads, and parts of the leg sclerites usually clearly discernible. The leg sclerites do not have the open sleevelike appearance characteristic of some of the chalcidoids.

The larval exuvium is elongate, with minute setae. The mandibles (pl. 5, *K*) are nearly straight and about 0.04 mm. long. The spiracles are cone-shaped, with not more than six taenidia in the specimens examined.

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The meconium is hard and dark, sometimes made up of pellets more or less fused.

PSEUDERIMERUS MAYETIOLAE (Gahan)

The pupal exuvium of *Pseuderimerus mayetiolae* is pale yellowish, transulucent, and with most of the surface finely papillose. The frontoantennal plate (pl. 1, *K*) is triangular in general outline, with the anterior corners greatly extended by the bases of the antennae, each of which bends as an elbow. The point of juncture of each antennal prolongation and the frontal portion of the sclerite is characterized by a distinct notch, the lateral edges of the frontal portion are slightly concave, and the surface is glabrous and finely but uniformly papillose over most of the area. No median suture is present, but there are characteristic rugulations near the posterior apex. The oculoparietal plate (pl. 2, *J*) has the parietal portion sparsely covered with long setae. The anterior edge of the sternum (pl. 2, *O*) forms a gablelike angle on the median line with the posterior corners each extended by a long filamentlike process. The wing pad (pl. 2, *S*) is usually intact and attached to the schizonotal plate, its surface being finely papillose and slightly rugulose near the base. The scutellum (pl. 3, *D*) is longer than wide, with its posterior margin curved. The front leg (pl. 3, *H*) has its proximal portion attached like a broad hook. The middle leg (pl. 3, *N*) is united into one piece, with the tibial spur well defined; but the hind leg (pl. 3, *S*) has its tibial spur poorly defined.

The larval exuvium is elongate and covered by long, conspicuous setae. The mandibles (pl. 5, *L*) are straight and about 0.046 mm. long from apex to condyle. The spiracles (pl. 5, *Q*) are cone-shaped and characterized by the distal segment being conspicuously larger than the other segments of the spiracle. There are from 10 to 18 taenidia.

TETRASTICHUS CARINATUS Forbes

In *Tetrastichus carinatus* the pupal exuvium is pale translucent straw color. The frontoantennal plate (pl. 1, *L*) is triangular and characterized by a distinct cleft on the middle of the anterior margin. Its surface is papillose near the sides, center, and around the cleft. The mouth parts (pl. 1, *N*) are sometimes attached to the anterior margin of the frontoantennal plate and characterized by two elongate lobes joined near their bases. The oculoparietal plate (pl. 2, *K*) is glabrous but distinctly papillose. The front legs (pl. 3, *I*) are usually separated from the rest of the sclerites after eclosion and are characterized by a small, closely attached segment at the proximal end. The wing pad (pl. 2, *T*) is delicate and is usually attached to a fragment of the schizonotal plate. The abdomen has some of the dorsal sclerites intact and they are not usually collapsed in the form of a semicircle.

The larval exuvium (pl. 5, *M*) is elongate, and has minute and inconspicuous setae. The mandibles (pl. 5, *N*) are distinctly curved and

attached within a surrounding band of tissue, and are from 0.05 to 0.06 mm. long. The spiracles (pl. 5, *R*) are not cone-shaped.

The meconium is predominantly black, and is usually without loose pellets.

GENERAL KEY TO PARASITE FORMS

1. One or more straw-colored cocoons within the puparium; no loose pupal exuvia except in cases of hyperparasitization 2
   No cocoons; loose pupal casts present 6
2. Cocoons (fig. 2) less than 2 mm. long; usually more than two cocoons present; emergence hole (fig. 3) less than 0.49 mm. in diameter 3
   Cocoon more than 2 mm. long; usually one cocoon and never more than two cocoons present; emergence hole (fig. 4) rarely less than 0.5 mm. in diameter; larval mandibles curved 4
3. Mandibles of larva distinctly curved; adult with vertex and face distinctly transversely rugulose; ovipositor essentially straight; slightly enlarged and blunt at apex ..... *Platygaster zosine* Walker.
   Mandibles of larva approximately straight; adult with vertex and face smooth and shining except for some faint aciculations; ovipositor curved and attenuated ..... *Platygaster hiemalis* Forbes.
4. Adult with distinct tuft of short gray hairs near apex of scutellum. *Trichacis remulus* (Walker).
   Adult without tuft of short gray hairs on scutellum 5
5. Many conspicuous longitudinal striations (fig. 5, *B*) along basal half of dorsal and ventral surfaces of abdomen; each ovipositor sheath valve bearing five or six hyaline tubercles. *Platygaster pleuron* Walker.
   Striations not present along basal half of abdomen (fig. 5, *A*); ovipositor sheath valves with not more than three hyaline tubercles. *Platygaster herrickii* Packard.
6. Meconium and exuvium contained within host skin, which remains nearly intact within host puparium except when destroyed by unusual circumstances 7
   Meconium and exuvium not contained within host skin except in cases of hyperparasitization; host remains, if present, pushed to one side 10
7. Pellets of meconium (pl. 5, *S*) separated and distributed in different parts of the host; exuvia from more than one individual; sclerites pale, transparent yellowish brown; abdomen (pl. 3, *U*) usually collapsed into a cone-shaped mass; antennal casts (pl. 1, *M*) sometimes found detached ..... *Centrodora speciosissima* Girault.
   Meconium lodged at or close to one end of host; exuvium from only one individual except in rare cases of secondary parasitism; sclerites not like those described above 8
8. Pupal exuvium black or very dark translucent brown; frontoantennal plate (pl. 1, *J*) subcircular ..... *Pleurotropis metallicus* (Nees).
   Pupal exuvium pale translucent straw color; frontoantennal plate not subcircular 9
9. Frontoantennal plate (pl. 1, *L*) triangular, with a midanterior cleft; front legs (pl. 3, *I*) club-shaped and usually detached from other sclerites; meconium black ..... *Tetrastichus carinatus* Forbes.
   Frontoantennal plate (pl. 1, *B*) not triangular, but with a pronounced emargination along middle axis on both anterior and posterior margins; front legs usually attached to rest of sclerites (pl. 3, *V*), not club-shaped; meconium not black. *Cheiloneurus elegans* (Dalman).
10. Pupal exuvium black or very dark translucent brown 11
    Pupal exuvium pale straw color 12
11. Frontoantennal plate (pl. 1, *J*) with lateral edges convex, surface glabrous; oculoparietal (pl. 2, *I*) glabrous; sternum (pl. 2, *N*) in two loosely joined pieces, with the two anterior corners in the form of lobelike projections; wing pad (pl. 2, *R*) closely fused to schizonotal plate; scutellum (pl. 3, *C*) with posterior margin angulated; distal portion of front leg (pl. 3, *G*) club-shaped, with club end sharply attenuated; middle leg (pl. 3, *M*) with tibial spur poorly defined ..... *Pleurotropis metallicus* (Nees).

Frontoantennal plate (pl. 1, *E*) with lateral edges concave, part of surface setaceous; oculoparietal (pl. 2, *C*) with parietal portion setaceous; sternum (pl. 2, *M*) in one piece, without projecting lobes; wing pad (pl. 2, *Q*) loosely attached and often separated from schizonotal plate; scutellum (pl. 3, *B*) with posterior margin curved; distal portion of front leg (pl. 3, *F*) club-shaped, with club end bluntly rounded; distal portion of middle leg (pl. 3, *L*) with tibial spur sharply defined.

Eupelmus allynii (French).

12. Meconium dark, with conspicuous, large, cream-colored, or white patches 13
Meconium without large, cream-colored, or white patches 14

13. Frontoantennal plate (pl. 1, *H*) with two short, parallel sutures near apex; apical V formation of sutures not present.

Merisus febriculosus Girault.

Frontoantennal plate (pl. 1, *I*) with longitudinal middle suture and apical V distinct; two short, parallel sutures near apex absent.

Merisus mordellistenae Crawford.

14. Sternum, wing pads, and parts of leg sclerites separate from rest of pupal sclerites 15
Sternum and usually the wing pads united in a mass with abdominal sclerites 16

15. Sternum (pl. 2, *L*) roughly quadrangular; frontoantennal plate (pl. 1, *D*) with margins of apical portion sinuous; oculoparietal plate (pl. 2, *B*) glabrous; scutellum (pl. 3, *A*) with apex acute; front leg (pl. 3, *E*) with hooked portion about one-third the length of entire leg sclerite; middle leg (pl. 3, *K*) with proximal end pestle shaped and tibial spur long ..... *Eupelmella vesicularis* (Retzius).

Sternum (pl. 2, *O*) with anterior margin forming a gablelike angle on median line; oculoparietal plate (pl. 2, *J*) with parietal portion setaceous; scutellum (pl. 3, *D*) with apex obtuse; front leg (pl. 3, *H*) with hooked portion about one-half the length of entire leg; middle leg (pl. 3, *N*), not pestle shaped, tibial spur short.

Pseuderimerus mayetiolae Gahan.

16. Meconium predominantly black, no loose pellets present; frontoantennal plate (pl. 1, *L*) triangular, with deep median cleft on anterior margin; oculoparietal plate (pl. 2, *K*) glabrous; front legs (pl. 3, *I*) detached from other segments and characterized by a small, closely attached segment at proximal end.

Tetrastichus carinatus Forbes.

Meconium not predominantly black; frontoantennal plate not like the above; front legs usually attached to other sclerites and not similar in pattern to the above 17

17. Abdomen telescoped into a semicircular, obtusely angled mass 18
Abdomen not like the above 20

18. Frontoantennal plate (pl. 1, *C*) triangular, with no median suture; abdomen (pl. 4, *A*) a delicate, crumpled mass with semicircular pattern ..... *Ditropinotus aureoviridis* Crawford.

Frontoantennal plate with a median suture reaching from middle almost to apical extremity 19

19. Frontoantennal plate (pl. 1, *A*) with margins of apical portion distinctly concave, surface very coarsely papillose; abdomen (pl. 3, *T*) in a semicircular, obtusely angled mass.

Callitula bicolor Spinola.

Frontoantennal plate (pl. 1, *F*) with margins of apical portion not distinctly concave, surface not so coarsely papillose; abdomen (pl. 4, *D*) in a semicircular, obtusely angled mass.

Eupteromalus fulvipes (Forbes).

20. Abdominal segments indistinguishably crumpled up with thoracic segments, wing pads, and most of leg sclerites 21
Segments of abdomen, wing pads, and usually parts of legs clearly discernible 22

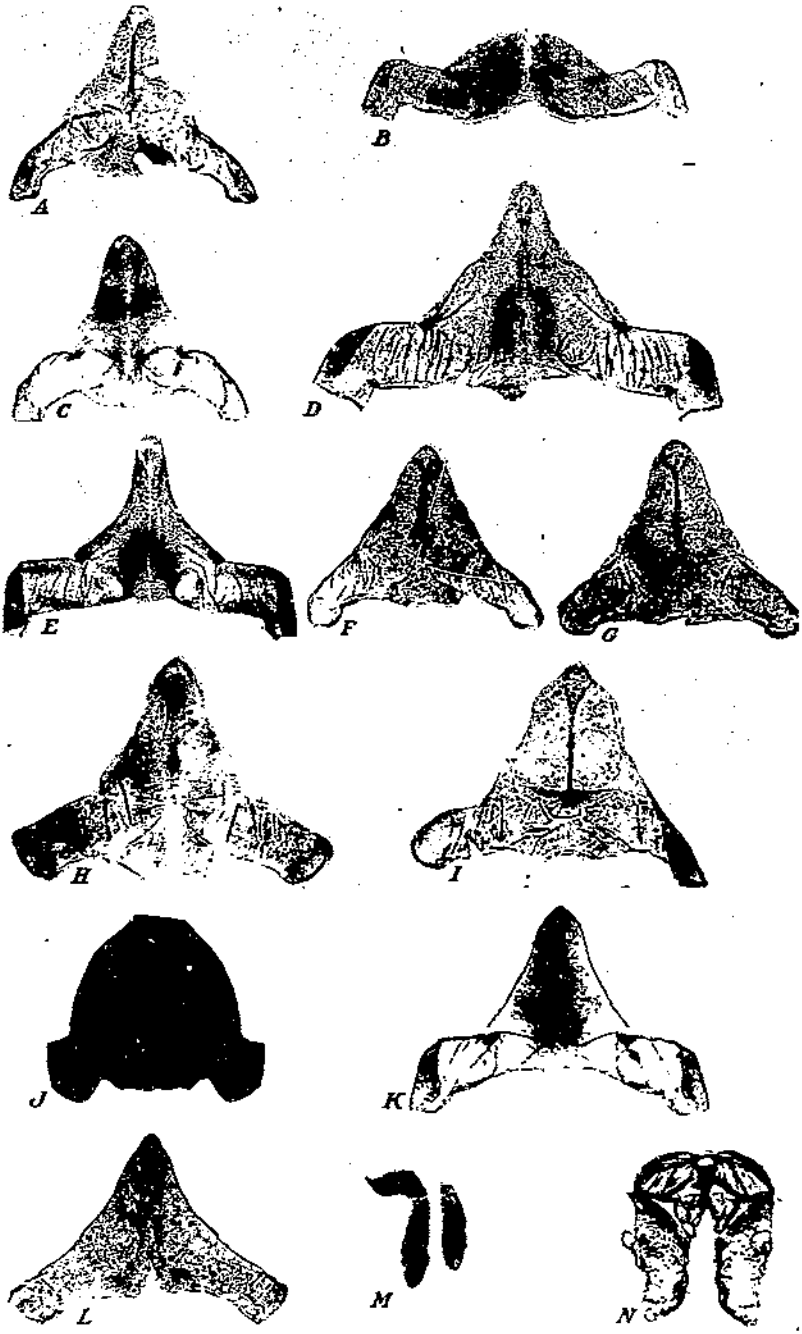
21. Frontoantennal plate (pl. 1, *G*) with a median, coarsely rugulose suture running from middle almost to apex; abdomen (pl. 4, *F*) a delicate conglomerate mass ..... *Merisus destructor* Say.
Frontoantennal plate without a median suture running from middle to apex; abdomen (pl. 4, *E*) with wing pads and legs more discernible than above ..... *Eurytoma* spp.
22. Body sclerites (pl. 3, *V*) with two legs projecting conspicuously, sleevelike and open at ends; frontoantennal plate (pl. 1, *B*) consisting principally of the antennal bases sharply bent at extremities, with a pronounced emargination along middle axis on both margins ..... *Cheiloneurus elegans* Dalman.
Body sclerites (pl. 4, *G*) with projecting legs not sleevelike and distal ends closed; frontoantennal plate not like the above.
Polyscelis modestus Gahan.

SUPPLEMENTARY KEY BASED ON THE CHALCIDOID LARVAL EXUVIA

1. Mandibles distinctly curved 2
Mandibles straight or nearly so 9
2. Setae long and conspicuous; spiracles cone-shaped 3
Setae absent or minute; spiracles not cone-shaped 6
3. Labrum toothed 4
Labrum not toothed 5
4. Teeth of labrum closely adjacent to one another (pl. 5, *E*); mandibles (pl. 5, *D*) distinctly curved; spiracles (pl. 5, *P*) with numerous taenidia ..... *Eupelmus allynii* (French).
Teeth of labrum more widely spaced (pl. 5, *C*); mandibles (pl. 5, *C*) distinctly curved; spiracles (pl. 5, *O*) with numerous taenidia; (entire exuvium shown in pl. 5, *B*).
Eupelmella vesicularis (Retzius).
5. Mandibles (pl. 5, *F*) each with large denticle on inner margin.
Eurytoma spp.
Mandibles (pl. 5, *A*) without denticles on inner margin.
Ditropinotus aureoviridis Crawford.
6. Larval exuvium (pl. 4, *H*) about 0.23 mm. or less in length; not filiform; more than one exuvium present in a host.
Centrodora speciosissima (Girault).
Larval exuvium at least three times as long as the above; usually filiform; seldom more than one exuvium to the host 7
7. Mandibles (pl. 5, *N*) surrounded by encircling band of tissue (entire exuvium shown in pl. 5, *M*, and a spiracle in pl. 5, *R*).
Tetrastichus carinatus Forbes.
Mandibles not surrounded by encircling band of tissue 8
8. Outer edge of mandible (pl. 5, *J*) entirely convex.
Pleurotropis metallicus (Nees).
Outer edge of mandible (pl. 4, *I*) partly concave.
Cheiloneurus elegans (Dalman).
9. Setae long and conspicuous (pl. 5, *L*); spiracles (pl. 5, *Q*) with distal segment larger in proportion to rest of segments than is the case in the other chalcidoids of this key.
Pseuderimerus mayetiolae Gahan.
Setae absent or minute 10
10. Some of spiracles with more than 11 taenidia.
Merisus destructor (Say), *M. febriculosus* Girault.
Spiracles with less than 11 taenidia.
Callitula bicolor Spinola, *Eupteromalus fulvipes* (Forbes), *Merisus mordellistenae* Crawford, *Polyscelus modestus* Gahan.

PLATE 1

A–L, Frontoantennal plates of—*A*, *Callitula bicolor*. *B*, *Cheiloneurus elegans*. *C*, *Ditropinotus aureoviridis*. *D*, *Eupelmella vesicularis*. *E*, *Eupelmus allynii*. *F*, *Eupteromalus fulvipes*. *G*, *Merisus destructor*. *H*, *Merisus febriculosus*. *I*, *Merisus mordellistenae*. *J*, *Pleurotropis metallicus*. *K*, *Pseuderimerus mayetiolae*. *L*, *Tetrastichus carinatus*. *M*, Antennal sclerites of *Centrodora speciosissima*. *N*, Palpi of the mouth parts and supporting segments of *Tetrastichus carinatus*. All greatly enlarged.

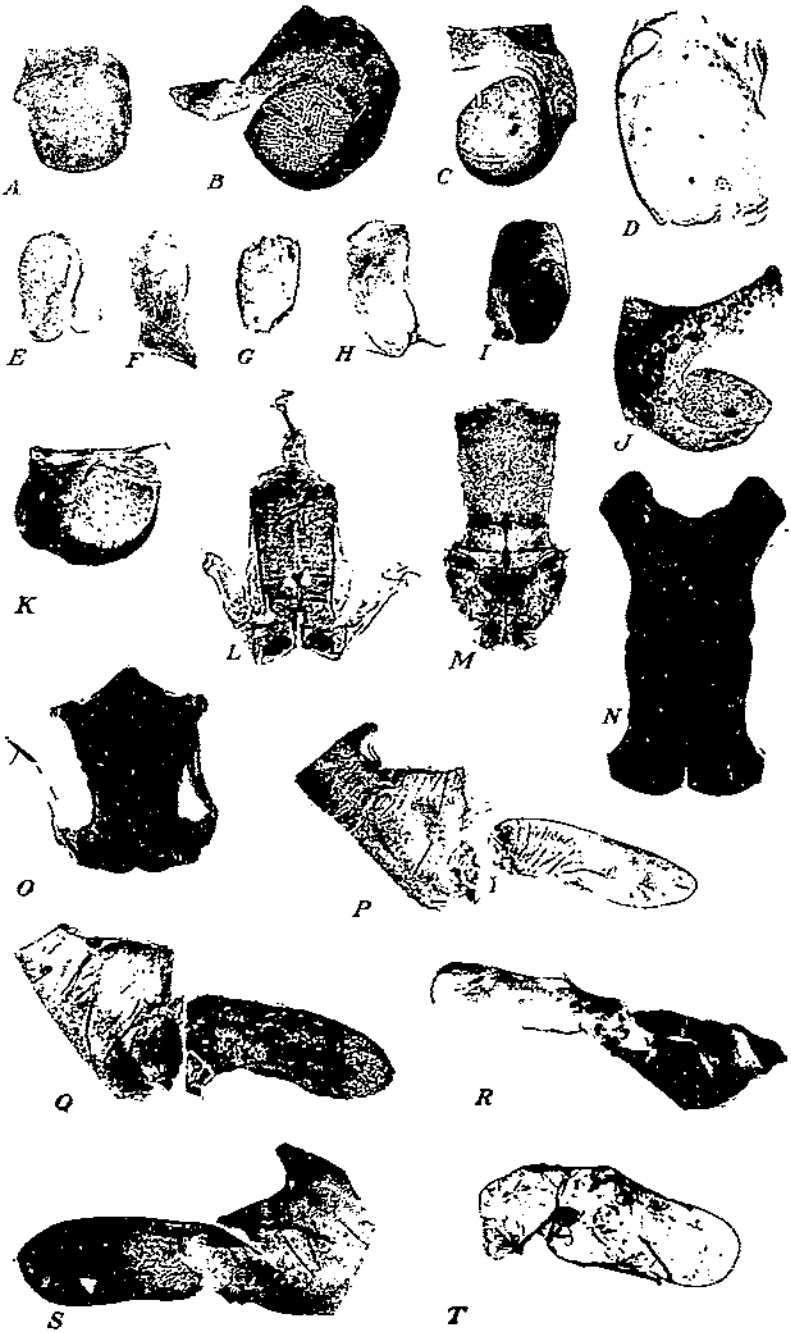


PUPAL REMAINS OF PARASITES OF THE HESSIAN FLY.

For explanatory legend see opposite page.

PLATE 2

A, *Ditropinotus aurcoviridis*, oculoparietal.
B, *Eupelmella vesicularis*, oculoparietal.
C, *Eupelmus allynii*, oculoparietal.
D, *Eupteromalus fulvipes*, oculoparietal.
E, *Merisus destructor*, ocular.
F, *Merisus destructor*, parietal.
G, *Merisus febriculosus*, ocular.
H, *Merisus febriculosus*, parietal.
I, *Pleurotropis metallicus*, oculoparietal.
J, *Pseuderimerus mayetiolae*, oculoparietal.
K, *Tetrastichus carinatus*, oculoparietal.
L, *Eupelmella vesicularis*, sternum.
M, *Eupelmus allynii*, sternum.
N, *Pleurotropis metallicus*, sternum.
O, *Pseuderimerus mayetiolae*, sternum.
P, *Eupelmella vesicularis*, wing pad and schizonotal plate.
Q, *Eupelmus allynii*, wing pad and schizonotal plate.
R, *Pleurotropis metallicus*, wing pad and schizonotal plate.
S, *Pseuderimerus mayetiolae*, wing pad and schizonotal plate.
T, *Tetrastichus carinatus*, wing pad and part of schizonotal plate.
All greatly enlarged.

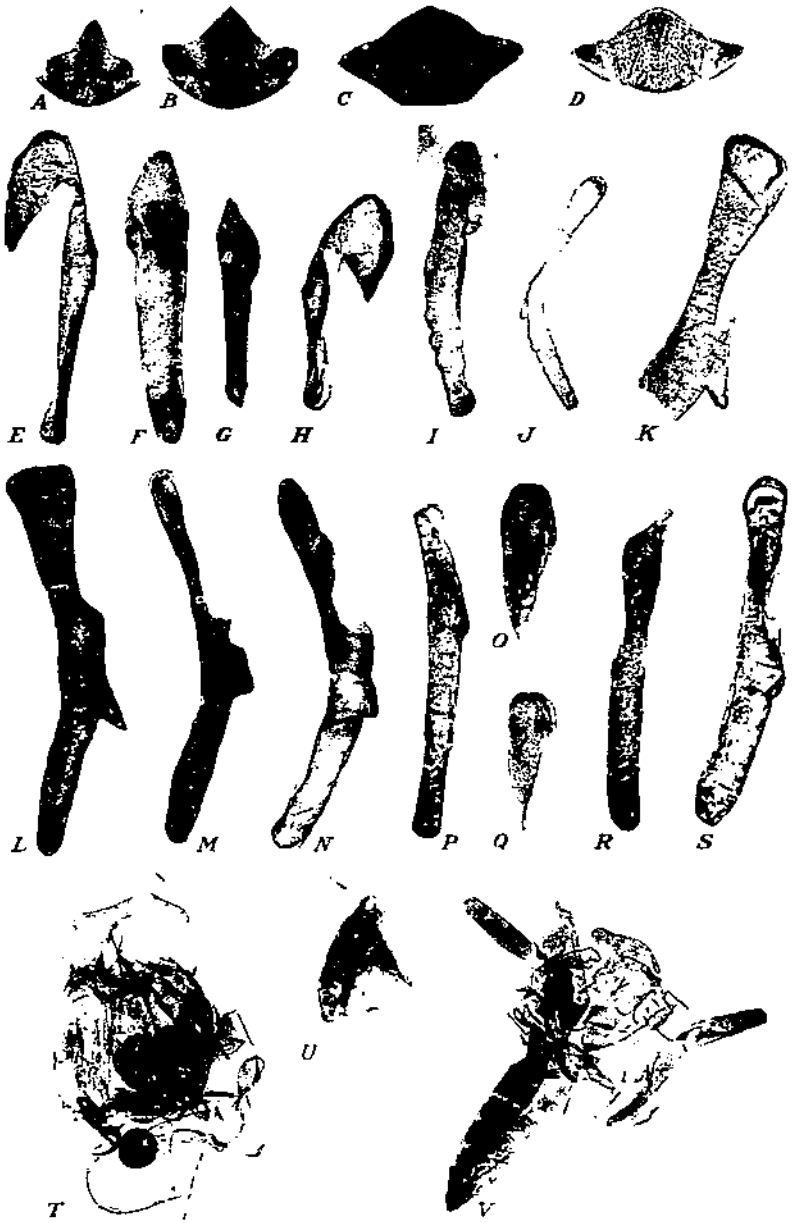


PUPAL REMAINS OF PARASITES OF THE HESSIAN FLY.

For explanatory legend see opposite page.

PLATE 3

A, *Eupelmella vesicularis*, scutellum.
B, *Eupelmus allynii*, scutellum.
C, *Pleurotropis metallicus*, scutellum.
D, *Pseuderimerus mayetiolae*, scutellum.
E, *Eupelmella vesicularis*, front leg.
F, *Eupelmus allynii*, distal portion of front leg.
G, *Pleurotropis metallicus*, distal portion of front leg.
H, *Pseuderimerus mayetiolae*, front leg.
I, *Tetrastichus carinatus*, front leg.
J, *Ditropinotus aureoviridis*, middle leg.
K, *Eupelmella vesicularis*, middle leg.
L, *Eupelmus allynii*, middle leg.
M, *Pleurotropis metallicus*, middle leg.
N, *Pseuderimerus mayetiolae*, middle leg.
O, *Eupelmella vesicularis*, proximal portion of hind leg.
P, *Eupelmella vesicularis*, distal portion of hind leg.
Q, *Eupelmus allynii*, proximal portion of hind leg.
R, *Eupelmus allynii*, distal portion of hind leg.
S, *Pseuderimerus mayetiolae*, hind leg.
T, *Callitula bicolor*, abdominal and other sclerites.
U, *Centrodora speciosissima*, abdominal sclerites.
V, *Cheiloneurus elegans*, abdominal and other sclerites.
All greatly enlarged.

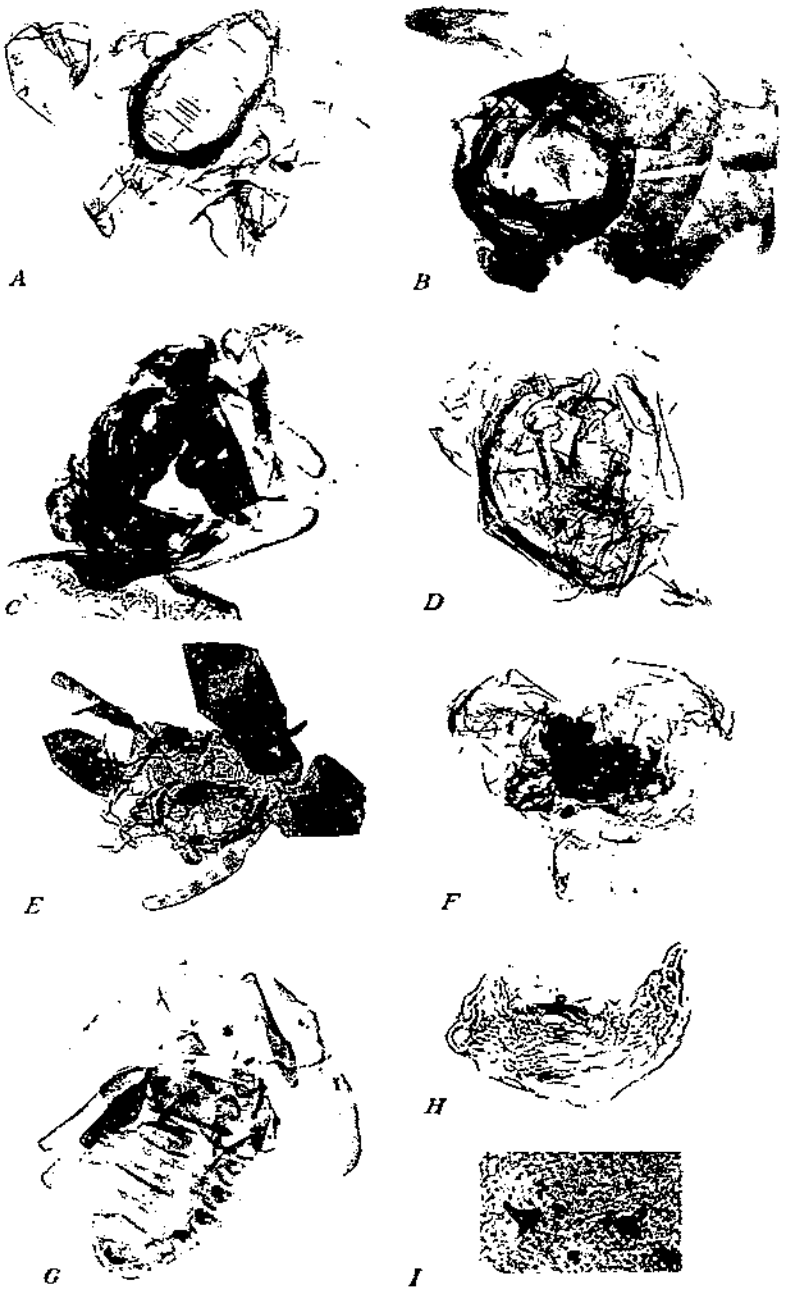


PUPAL REMAINS OF PARASITES OF THE HESSIAN FLY.

For explanatory legend see opposite page.

PLATE 4

A, *Ditropinotus aurcoviridis*, abdominal and other sclerites.
B, *Eupelmella vesicularis*, abdominal and other sclerites.
C, *Eupelmus allynii*, abdominal and other sclerites.
D, *Eupteromalus fulvipes*, abdominal and other sclerites.
E, *Eurytoma*, abdominal and other sclerites.
F, *Merisus destructor*, abdominal and other sclerites.
G, *Polyscelis modestus*, abdominal and other sclerites.
H, *Centrodora speciosissima*, larva.
I, *Cheiloneurus elegans*, mandibles of larva.
All greatly enlarged.

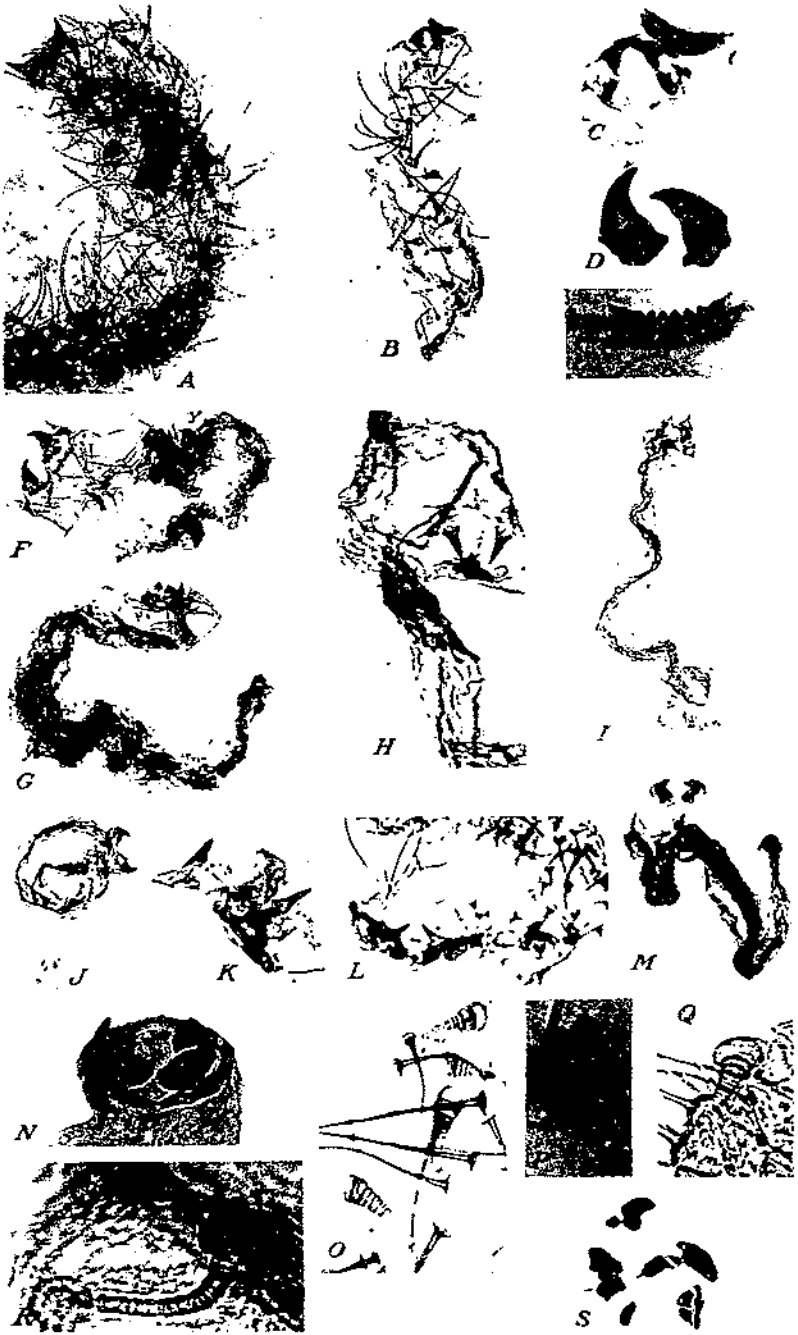


PUPAL AND LARVAL REMAINS OF PARASITES OF THE HESSIAN FLY.

For explanatory legend see opposite page.

PLATE 5

A, *Ditropinotus aureoviridis*, larva.
B, *Eupelmella vesicularis*, larva (labrum has been pushed out of place).
C, *Eupelmella vesicularis*, labrum and mandibles.
D, *Eupelmus allynii*, mandibles.
E, *Eupelmus allynii*, labrum.
F, *Eurytoma*, larva.
G, *Merisus destructor*, larva.
H, *Merisus febriculosus*, larva, showing mandibles.
I, *Merisus mordellistenae*, larva.
J, *Pleurotropis metallicus*, larva.
K, *Polyscelis modestus*, mandibles of larva.
L, *Pseuderimerus mayetiolae*, larva.
M, *Tetrastichus carinatus*, larva.
N, *Tetrastichus carinatus*, mandibles of larva.
O, *Eupelmella vesicularis*, spiracles.
P, *Eupelmus allynii*, spiracle.
Q, *Pseuderimerus mayetiolae*, spiracle.
R, *Tetrastichus carinatus*, spiracle.
S, *Centrodora speciosissima*, particles of meconia.
All greatly enlarged.



LARVAL REMAINS OF PARASITES OF THE HESSIAN FLY.

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