

STUDIES ON PARASITES OF THE SPRUCE BUDWORM,
ARCHIPS FUMIFERANA (Clem.) *

2. Life History of *Glypta fumiferanae*
(Viereck) (Hymenoptera, Ichneumonidae)

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ABSTRACT

All stages of the spruce budworm parasite *Glypta fumiferanae* (Viereck) are described in this paper. Illustrations of all stages are presented.

INTRODUCTION

The reasons for undertaking the study of this insect and the general circumstances surrounding its development are the same as those dealt with in a previous paper (1) to which the reader is referred. A short account of the life history of the host has also been given in the same paper and the technique and methods are essentially the same in each.

The existence of an unpublished manuscript on *Glypta fumiferanae* by Dr. J. D. Tothill (6) was made known to the writer after the essential features contained herein had been worked out. This manuscript was in the files of the Forest Insect Laboratory, Fredericton, N. B., and was made available through the courtesy of Mr. R. E. Balch, Officer-in-charge of the laboratory. The following account of the life history is based on work carried out by the writer, and Tothill's manuscript is referred to only when it is at variance with the former.

From the dissection and rearing of winter-collected larvae it has been demonstrated that the parasite overwinters in hibernating budworm larvae, either as an egg or a very young larva. As in *Apanteles fumiferanae* (1) the time of emergence of adult parasites coincides with the hatching of the budworm eggs. In the spring the parasite develops in the feeding budworm larva and emerges as a full-fed larva from fifth or sixth stage budworms. A detailed description of the stages of *Glypta fumiferanae* is given below. Measurements of each larval stage are presented in the accompanying table (Table 1). The nomenclature of Vance and Smith (7) was adopted in the description of the mouth parts.

TABLE 1
Measurements of *Glypta fumiferanae* (Viereck) (in mm.)

Larval Stage	Length		Width		Head Width		Length of caudal appendage		No. of individuals
	Range	Average	Range	Average	Range	Average	Range	Average	
Early 1st	1.034—1.397	1.272	0.099—0.176	0.136	0.110—0.154	0.125	0.418—0.627	0.524	3
Late 1st	0.825—1.452	1.207	0.088—0.308	0.203	0.088—0.132	0.102	0.066—0.275	0.189	10
Combined 1st	0.825—1.452		0.088—0.308		0.088—0.154		0.066—0.627		13
2nd	0.880—2.585	1.832	0.176—0.528	0.338	0.154—0.330	0.236	0.165—0.407	0.266	29
3rd	1.738—6.569	3.550	0.374—1.321	0.649	0.242—0.714	0.467	0.071—0.352	0.202	26
4th	7.854—11.067	8.979	0.714—2.356	1.544	0.821—1.000	0.946			4

DESCRIPTION OF THE STAGES OF *GLYPTA FUMIFERANAE* (Viereck)

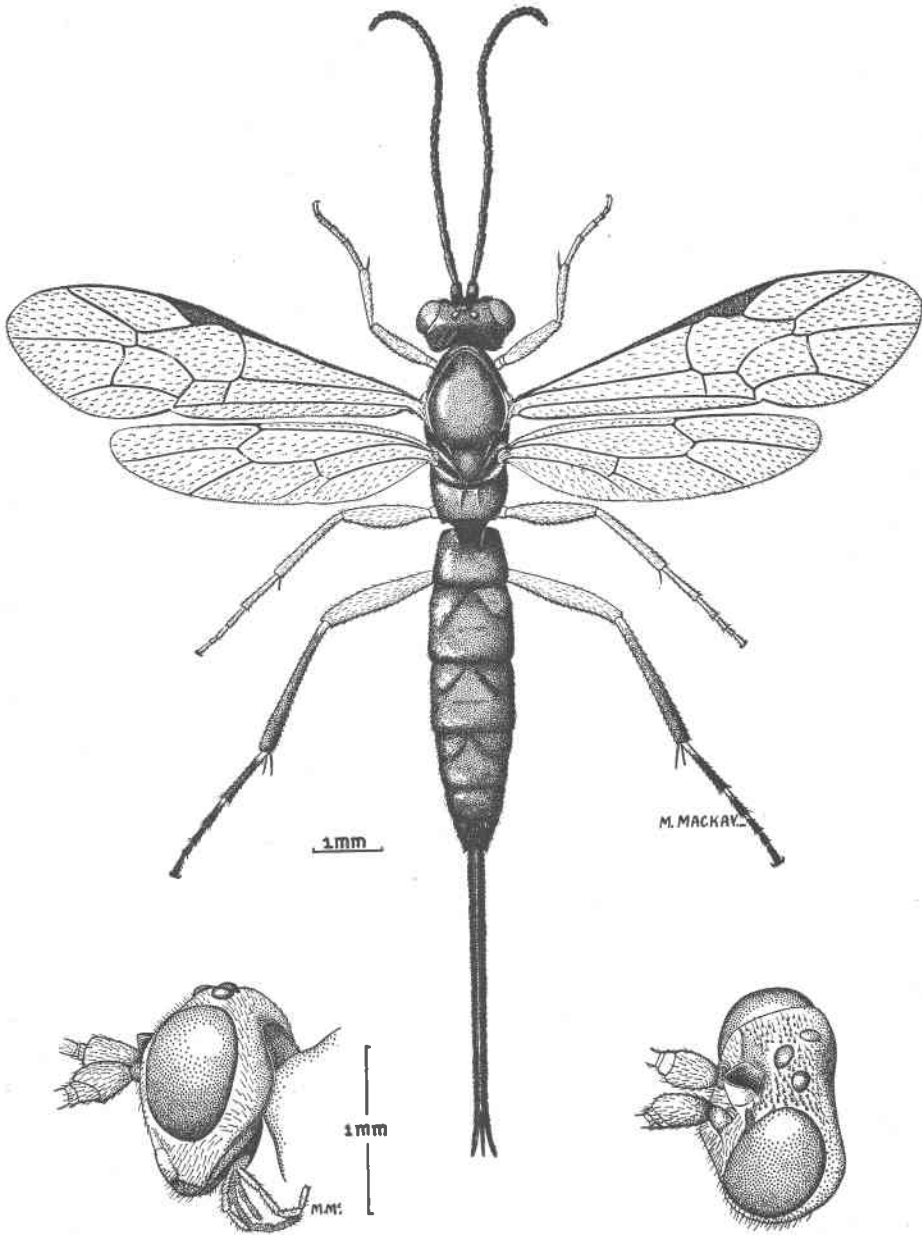
The Adult

The adult of *Glypta fumiferanae* was described by Viereck (8) in 1912 from material reared from the spruce budworm. A dorsal view of the female and details of characteristic head structures are illustrated in Plate X.

As the original description of this species is very short and incomplete, it has been found necessary to redescribe it as below.

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PLATE X



Adult of *Glypta fumiferanae* (Viereck), showing female from dorsal view and details of characteristic head structures.

Female. Length 8 mm., ovipositor sheath length about 4.5 mm. Temples flat or slightly concave, receding posteriorly at an angle of about 30°, rather abruptly rounded posteriorly, broadest above, narrowing strongly below, especially narrow where occipital carina bends outwards above genae to approach the eye, at this point temples distinctly narrower than width of malar space, beyond this point occipital carina evanescent. Eyes strongly convex; width of head including eyes distinctly greater than height. Clypeus strongly convex, apical margin broadly rounded and truncate at middle; malar space one and one-half times as wide as basal width of mandible. Head densely punctate, with a very large prominent tubercle formed by the convergence of the two frontal carinae above antennae, upper surface of tubercle strongly concave. Temples punctate and shining, the punctures less numerous ventrally. Face slightly broader than eye length. Mesoscutum, scutellum and mesopleura densely punctate, shining; speculum highly polished, impunctate; metapleura densely punctate; metapleural tooth prominent. Propodeum punctate, shining, the median longitudinal carinae diverging and incomplete posteriorly, very weak on some specimens; costulae absent; apical transverse carina rather strong and located at about apical three-fourths of propodeum. Basal segments of abdomen very densely punctate and rather dull; slight median elevation on first tergite; basal carinae of first tergite weak and not extending beyond basal third; three apical tergites weakly punctate only at base. Sheath of ovipositor slightly longer than abdomen.

Black; scape and pedicel black; flagellum black at base becoming brown apically. Clypeus dull reddish except at base. Palpi stramineous. Tegulae white. All coxae, front and middle femora testaceous; front and middle trochanters stramineous, hind trochanters brownish. Hind femora testaceous, narrowly blackish apically. Front tibiae and tarsi light testaceous; middle tibiae and tarsi testaceous with a slight blackish tinge which becomes more prominent toward the apex of the legs, apical tarsal segment blackish; hind tibiae and tarsi blackish with narrow basal whitish bands, whitish band on metatarsus wider, no white basal band on apical tarsal segment. Apices of second and third tergites occasionally more or less dull brownish-red.

Male. Length 7.5 mm. Differs slightly from female in having front and middle trochanters light yellowish-white. Reddish coloration on abdomen, when present, may be more extensive than in female, extending from first to fifth tergites; varies from light brown to dull brownish-red.

This species traces to *canadensis* in Cresson's key (4). From *canadensis* it differs in having the apices of the posterior femora only narrowly blackish, not broadly black as in *canadensis*. Also, in *fumiferanae* the frontal cone is much more strongly developed than in *canadensis*. In *canadensis* the propodeal carinae are much more extensively developed, the median longitudinal carinae attaining the apical transverse carina, and the costulae are present; in *fumiferanae* the median longitudinal carinae are weak and incomplete posteriorly and the costulae are absent.

The Egg

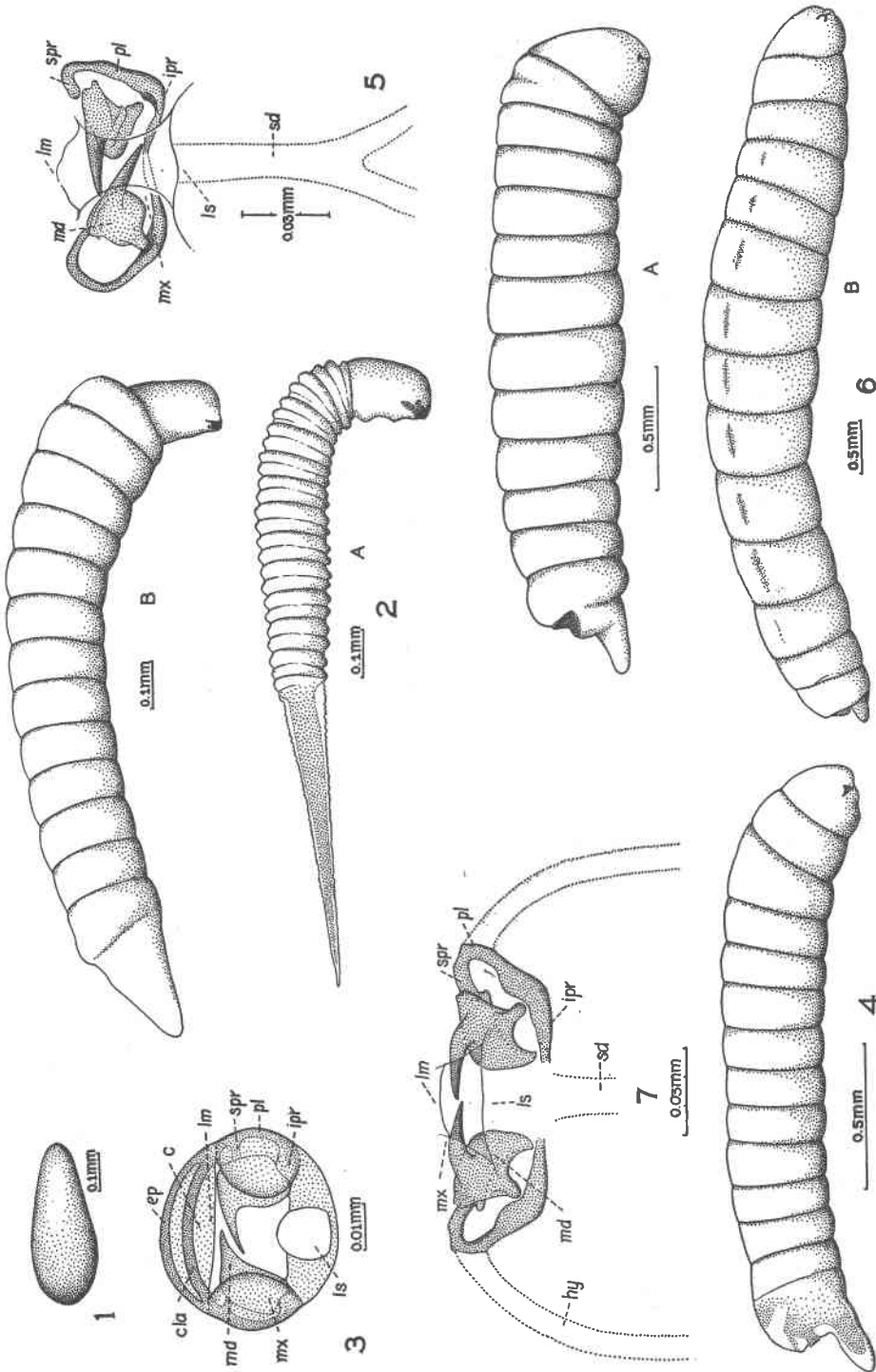
A newly-emerged female adult was dissected and unfertilized eggs (Plate XI, Fig. 1) were removed from the proximal end of the ovarioles. Eggs thus obtained were whitish in colour, more or less elliptical in shape and slightly pointed at one end. They measured 0.43 mm. in length and 0.18 mm. in width at the widest point.

The Larval Stages

First Stage. This stage is characterized by a long, light brown, heavily sclerotized head projecting ventrally. The larva at the end of the first stadium presents a very different appearance from that of the newly-hatched insect. For this reason the writer has divided this stage into early and late first-stage.

The early first-stage larva (Plate XI, Fig. 2A) has a body composed of a head and thirteen segments. The last segment projects posteriorly in a long, narrow, caudal appendage which is almost as long as the remainder of the body. The cuticle in this stage is very wrinkled. The body is soft and cylindrical.

PLATE XI



IMMATURE STAGES OF *GLYPTA FUMIFERANAE* (VIER.)

The late first-stage larva (Plate XI, Fig. 2B) consists, as before, of a head and thirteen body segments. In this particular stage, however, the caudal appendage has shrunk until it is only about one-sixth the total length of the body. Both early and late first-stage larvae are creamy white in colour, with the exception of the light brown head capsule. No spiracles are present in this stage.

Despite this great difference in appearance, the head measurements of the two types cover the same range. Also, in both cases the head projects ventrally and the mouth-parts (Plate XI, Fig. 3) are the same. The cuticle of the head, as has already been noted, is sclerotized and light brown in colour. The mandibles (md) are pointed and each has a heavy base articulating above with a short superior pleurostomal ramus (spr) and below with a broad, heavy inferior pleurostomal ramus (ipr). The inner, lower ends of the inferior pleurostomal rami are projected medially to meet each other. The labiostipites (ls) lie above this central bar. A thin pleurostoma (pl) joins the superior and inferior pleurostomal rami on either side and continues dorsally to form the epistoma (ep) above the clypeus (c). A clypeal arch (cla) is present over the upper border of the clypeus. The small labrum (lm) is very faintly marked off from the larger clypeus. The maxillae (mx) are thin lobes, difficult to distinguish, lying over the base of the mandibles. Neither the silk duct nor its opening were seen on any of the head capsules of this stage which were examined.

Second Stage. Second stage larvae of *Glypta fumiferanae* (Plate XI, Fig. 4) are very different in appearance from the first stage, particularly in the shape of the head and the caudal appendage. In this stage the head is hemispherical in shape and no longer projects ventrally. However, the head and the first three body segments are turned slightly ventrad, so that the anterior part is somewhat curved. The trunk consists of thirteen segments as before, but the caudal appendage now projects somewhat ventrally and is smaller in proportion to the rest of the body, being about one-seventh of the total length. The dorsal part of the thirteenth segment is bent slightly upwards. The larva, including the head, is creamy white in colour. Spiracles are absent.

Tothill states that his second-stage larvae may be a composite of several instars and notes that there is a great range in size and width of the head in the specimens which he examined. However, he points to the fact that there is an "absence of structural differences in the head capsules other than those depending solely upon size", as support for grouping all the specimens as second-stage larvae.

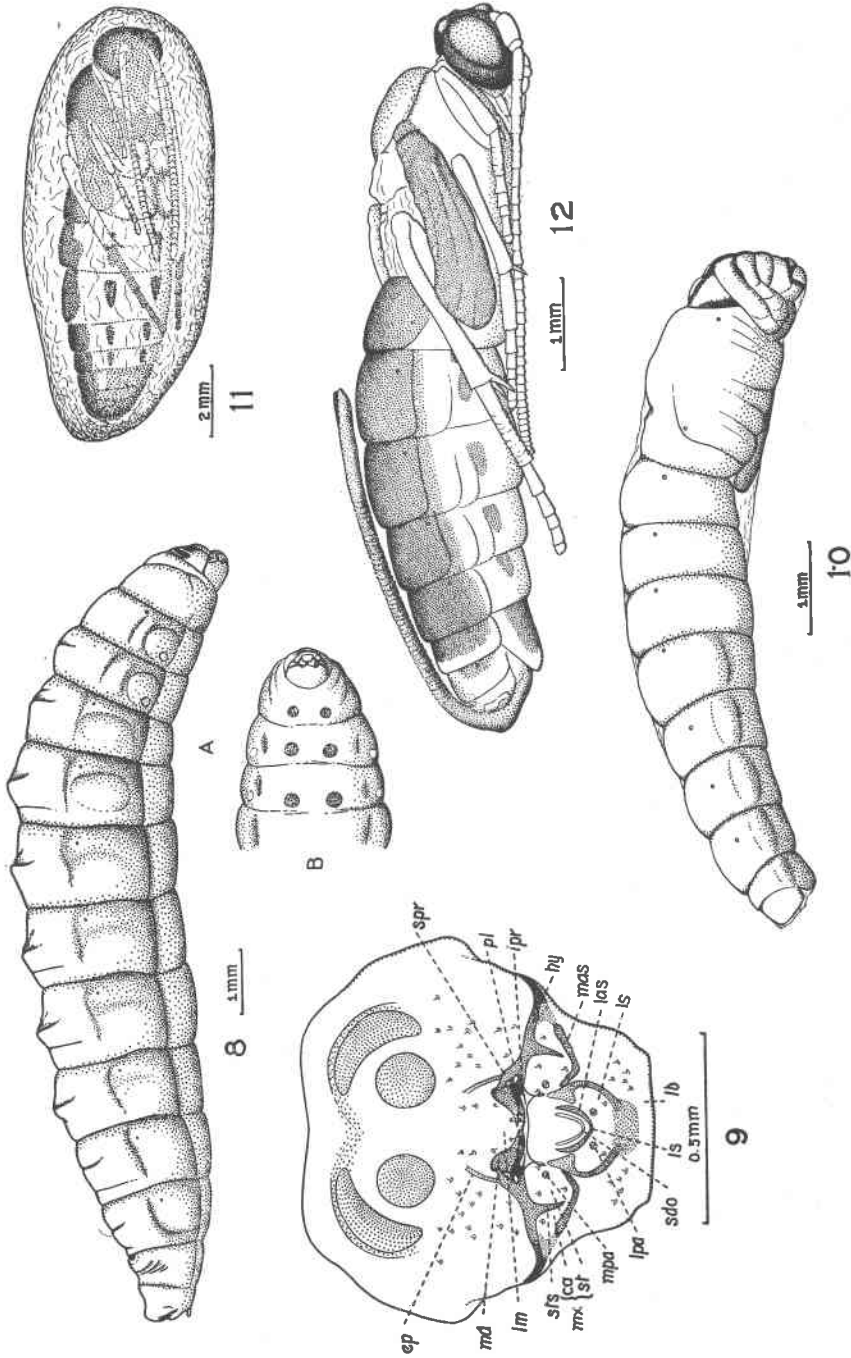
As the writer recognizes four larval stages in comparison with Tothill's three, it seems evident that the second and third stages of the former are represented by the second stage of the latter.

The recognition of four larval stages, as well as the form of the cephalic skeleton of the various stages is in agreement with conditions found by Cameron (2) for *Glypta haesitator* Grav. Crawford (3) also described four larval stages for *Glypta rufiscutellaris* Cress., but did not describe the mouth parts.

The cephalic skeleton of this stage (Plate XI, Fig. 5) is not well developed. A pleurostoma (pl) is present, bearing superior and inferior pleurostomal rami (spr, ipr) which articulate with the mandibles (md). The inferior pleurostomal rami are produced toward the mid line but are now much narrower and more inconspicuous than in the first-stage larva. The epistoma and the clypeal arch are not present. The silk duct (sd) is visible in cleared specimens and appears as a lightly pigmented brown tube which divides into two branches a short distance posterior to the edge of the labiostipites (ls). Labrum (lm), maxillae (mx) and labiostipites are inconspicuous fleshy lobes surrounding the mouth opening.

Third Stage. In this stage the larvae increases greatly in size. Plate XI, Fig. 6A, represents the larva early in the stadium and Plate XI, Fig. 6B, a larva near the end of the third stage. In the early part of this stage the head is bent slightly ventrally; later it points anteriorly as in the succeeding stage. The colour of the larva is the same as that of the second stage. The caudal appendage of

PLATE XII



IMMATURE STAGES OF *GLYPTA FUMIFERANAE* (VIER.)

this stage is again shorter in proportion to the body, being now about one-eighteenth of the total length. As in the second stage it is a small ventral knob on the thirteenth body segment. No spiracles are present in this stage.

Tothill notes the presence of leg, wing, and antennal buds toward the end of his second stage, which most probably corresponds to the writer's third stage.

The cephalic skeleton of the third-stage larva (Plate XI, Fig. 7) is very similar to that of the second stage. A pleurostoma (pl), with superior pleurostomal ramus (spr) articulating with the top edge of the base of the mandible (md) and inferior pleurostomal ramus (ipr) which is again projected medially and bears a groove for the articulation of the knob-like mandibular condyle (co), are the most conspicuous features. The hypostoma is now faintly visible as a bar extending laterally and ventrally on either side from the point on the pleurostoma where the inferior pleurostomal ramus arises. In some cleared specimens part of the silk duct (sd) is visible. The labium (lm), maxillae (mx) and labiostipites (ls) are, as in the second stage, merely inconspicuous fleshy lobes surrounding the mouth opening.

Fourth Stage. The fourth stage larva (Plate XII, Fig. 8A) is grub-shaped and curved, the cylindrical body tapering toward both ends. It is yellow-ochre in colour. The widest point is at the level of the fifth or sixth body segment. The body consists of thirteen segments as before; the dorsal part of the thirteenth segment, which contains the anus is tilted slightly upward. In this stage a pleural membrane separating the dorsal and ventral surfaces is clearly distinguishable for the first time. Dorsal lobes are conspicuous on segments three to nine. The pleural regions are more or less wrinkled and furrowed. The lobes noted by Cameron (2) on the sides of fourth-stage larvae of *Glypta haesitator* Grav. are present in the fourth-stage *fumiferanae* larvae which have not yet emerged from the host budworm larva. Spiracles are visible for the first time. Nine pairs are present and are located near the anterior border of segments two and four to eleven inclusive. Just dorsal to the pleural membrane of segments two and three and near their posterior margins are located round areas, the rudiments of wing buds. Similar areas on the venter of the first three segments mark the position of the leg rudiments (Plate XII, Fig. 8B). The remnant of the caudal appendage, which has been reduced to a very small insignificant knob, is found on the ventral part of the thirteenth segment, below the anus.

The cephalic skeleton of the fourth-stage larva (Plate XII, Fig. 9) is well-developed and sclerotized, the parts being readily seen in a cleared specimen. The basic colour of the head capsule is light brown. The superior and inferior pleurostomal rami (spr, ipr) on each side are joined by the pleurostoma (pl). A short spur projects medially from each inferior pleurostomal ramus. From the pleurostoma the hypostoma (hy) projects laterally and slightly ventrally. Midway along the hypostoma the stipital sclerome (sts) extends ventrally separating the basal maxillary cardo (ca) from the distal maxillary stipes (st). The epistoma (ep) is poorly developed and extends dorsally for a short distance above each pleurostoma but does not make a complete arch above the clypeus. The labrum (lm) is not distinguishable from the clypeus. A narrow, sclerotized bar, not pigmented medially, extends across the edge of the labrum. The heavy, sclerotized basal part of the mandible (md) articulates above and below with the superior and inferior pleurostomal rami respectively. The distal part of each mandible is slightly curved and pointed. The labiostipital sclerome (las) forms a ring ventrally around the labiostipites (ls). The ventral part is not sclerotized as a bar but is pigmented. The dorsal ends of the labiostipital sclerome are enlarged medially. From the labiostipital sclerome on either side the maxillary sclerome (mas) extends at first laterally and ventrally, then bends laterally and dorsally toward the hypostoma. The maxillary and labiostipital scleromes bound the labiobase (lb) dorsally. A U-shaped, pigmented, ligular sclerome (lis) lies in the labiostipital area. Within the area bounded by the ligular sclerome is the curved opening of the silk duct (sdo). One pair of small round papillae is situated

on the labiostipites and also one papilla on each stipes. These are the labial (lpa) and maxillary (mpa) palpi respectively. Each palpus bears two sensillae. A number of setae are present on the head capsule, the largest of which are arranged as follows on the head illustrated: four pairs on the labrum (lm); thirteen on each genal region; three on each maxillary stipes and one on each maxillary cardo; one pair on the labiostipites; five pairs on the labiobase. The antennal rudiments are large, prominent dark-brown areas. Dorsal and lateral to each of these is a large brown area. These areas are joined medially by a more lightly pigmented line.

The Prepupa

The changes observed in *Glypta fumiferanae* during the prepupal stage follow closely those described by Morris (5) for *Exenterus abruptorius*. The spinning of the cocoon is considered as the time of commencement of the prepupal stage. The eonymphal stage appears the same as the fourth-stage larva except for the partial disappearance of the prominent lateral lobes. This stage is not as active as the fourth stage larva. As the eonymph is very similar to the fourth-stage larva in appearance it has not been illustrated.

The pronymphal stage begins when the imaginal eyes are first faintly visible. After this the body of the pronymph (Plate XII, Fig. 10) becomes more curved than previously and the regions of the pupal and imaginal body become differentiated. Constrictions appear between larval segments one and two and between segments four and five, the latter being more distinct. Thus the head, thorax and abdomen are marked off. The thoracic region becomes swollen and more cylindrical than formerly. The lateral lobes almost completely disappear and the imaginal eyes become more prominent. Late in the pronymphal stage the developing antennae, legs and ovipositor can be seen outlined.

The Cocoon

The cocoon of this species (Plate XII, Fig. 11) is very thin, transparent, and white. The pupa may be seen within it. It is spun on the balsam fir or spruce tree where the host larva was feeding and is usually attached to the needles.

The Pupa

The pupa of *Glypta fumiferanae*, of which the female is illustrated (Plate XII, Fig. 12) is of the exarate type. At first it is almost white in colour and has conspicuous brown eyes. The head, dorsal plates of the abdomen, and the ovipositor turn brown after a few days. At the same time the dorsum of the thorax, antennae, palpi, wing buds, tibiae, and tarsi turn to various shades of light brown. These colours gradually become intensified until the adult colour is attained. The pupa measures about 8.5 mm. in length, but there is considerable variation in size, even in individuals of the same sex.

DURATION OF STAGES SUBSEQUENT TO EMERGENCE FROM HOST LARVA

The length of time between issuance of the mature larva from the host and the emergence of the adult parasite may be conveniently broken down into three shorter periods:

(1) Length of time between issuance from host and spinning of cocoon. Males of *Glypta fumiferanae* have been observed to spend length of time varying from less than one day to five days in this stage; females from less than one day to three days. Lack of sufficient data prevents establishment of the exact time usually spent in this phase of the life history.

(2) Length of time between spinning of cocoon and pupation (=prepupal stage=eonymphal + pronymphal phases). Data are available for this stage from Searchmont, Ontario, in 1943 and Black Sturgeon Lake, north of Port Arthur, Ontario, in 1944. At Searchmont 15 males spent an average of 5 days in this stage and 25 females 4 days. At Black Sturgeon Lake 28 males spent an average of 4 days and 36 females 4 days in the cocoon.

Data collected at Black Sturgeon Lake on the pronymphal part of the prepupal stage show that 32 males spent an average of 3 days in this stage and 39 females 3 days.

(3) Length of time between pupation and emergence of the adult (=pupal stage). Data on this stage are available from Chalk River, Ontario, in 1942, Searchmont in 1943, and Black Sturgeon Lake in 1944. Nine males at Chalk River spent an average period of 10 days in this stage; 8 females averaged 11 days. At Searchmont 26 males spent an average of 9 days in the pupal stage and 55 males averaged 10 days. Forty-seven males from Black Sturgeon Lake spent an average of 8 days in this stage; 66 females averaged 9.5 days.

ACKNOWLEDGMENTS

The laboratory studies on *Glypta fumiferanae* (Viereck) were begun at the University of Western Ontario under the direction of Dr. J. D. Detwiler. Field studies were made at the Dominion Entomological Laboratory, Chalk River, Ontario (1942), and field stations near Searchmont, Ontario (1943), and Black Sturgeon Lake, Thunder Bay District, Ontario (1944). The writer is particularly indebted to Dr. C. E. Atwood, formerly of the Forest Insect Unit, Division of Entomology, for his many suggestions and criticisms and for his constant attention and interest in the studies; to Dr. J. D. Detwiler for his suggestions and criticisms, and guidance at the University of Western Ontario; to Dr. M. L. Prebble, Officer-in-Charge of the Forest Insect Laboratory, Sault Ste. Marie, Ontario, who assisted in arranging the final form of the manuscript; and to Miss Magaret MacKay, of the Forest Insect Unit, who prepared the illustrations. Special acknowledgment is also due to Mr. G. S. Walley of the Systematic Unit, Division of Entomology, for identifying adult specimens and for help in preparing the re-description of the parasite adult; and to Mr. D. E. Gray of the Forest Insect unit for many helpful suggestions.

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SYMBOLS USED IN THIS PAPER

c —clypeus	mas—maxillary sclerome
ca —maxillary cardo	md —mandible
cla —clypeal arch	mpa—maxillary palpus
ep —epistoma	mse—maxillary seta
hy —hypostoma	mx —maxilla
ipr —inferior pleurostomal ramus	pl —pleurostoma
las —labiostipital sclerome	sd—Silk duct
lb —labiobase	sdo—silk duct opening
lis —ligular sclerome	se —seta
lm —labrum	spr—superior pleurostomal ramus
lpa —labial palpus	st —maxillary stipes
ls —labiostipites	sts —stipital sclerome
lse —labial seta	

EXPLANATION OF PLATES XI AND XII

Immature stages in life history of *Glypta fumiferanae* (Viereck).

- Figure 1. Egg.
 2. First-stage larva, lateral view.
 A. early first-stage larva.
 B. late first-stage larva.

3. Cephalic skeleton of first-stage larva.
4. Second-stage larva, lateral view.
5. Cephalic skeleton of second-stage larva.
6. Third-stage larva, lateral view.
 - A. larva at beginning of stage.
 - B. larva near end of stage.
7. Cephalic skeleton of third-stage larva.
8. Fourth-stage larva.
 - A. lateral view.
 - B. anterior part, ventral view.
9. Cephalic skeleton of fourth-stage larva.
10. Pronymph, lateral view.
11. Cocoon.
12. Pupa, female, lateral view.

NOTES ON THE ERICOIDES-DUPLICIS GROUP OF THE GENUS
COLEOPHORA (LEPIDOPTERA, COLEOPHORIDAE) *

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Since the appearance of Dr. Braun's article and my own paper dealing with the species of this complicated group of *Aster*- and *Solidago*-feeders in which the forewing maculation is more or less similar, I have paid particular attention in field work, especially in the Maritime Provinces, to securing long series of specimens and, whenever possible, males and females *in coitu*. In consequence I have had before me for study several hundred specimens and have made large numbers of genitalic slides of both sexes with the especial idea of trying to discover adequate characters in these organs whereby the females of the individual species may be separated. While the result in some cases has been fairly satisfactory, in others fresh complications have arisen and forced me to the doubtful conclusion that either the female genitalia in any one species show a very considerable degree of variation — a feature not well borne out by the genitalia of paired captured specimens, where available — or else that in some cases, notably in the *duplicis* complex, where the males show a small apical tooth on the left rod of the aedeagus, several species occur with similar male genitalia but with differential characters in the female organs. The matter is further complicated by the fact that the various forms appear about the same time (in the Maritimes around the middle of August) and fly together; in consequence, the possibility of a certain amount of hybridization is not shut out, although at present I am rather loathe to accept this theory as accounting for the amount of variation in female genitalia. It seems to me that extremely careful breeding will be necessary before the problem can be solved; it may be that we are dealing with so-called 'food-plant species' and that each form is restricted to a single species or to a closely related group of species of either *Aster* or *Solidago*; certain indications have been noted that rather point in this direction. In the following notes I offer the result of my studies up to the present time; they are far from complete and in some cases quite unsatisfactory but may serve to stimulate an interest in the group which will eventually lead us to a proper comprehension of the species involved; unfortunately, due to my pending retirement from the government service I shall be unable to complete the study.

*Contribution No. 2436, Division of Entomology, Science Service, Department of Agriculture, Ottawa.