

# BIOLOGICAL NOTES ON FIVE HYMENOPTEROUS PARASITES OF PINE BUD AND STEM MOTHS IN OHIO

WILLIAM E. MILLER

*Department of Entomology, Ohio Agricultural Experiment Station, Wooster*

Incidental to biological investigations of three pine moths, the European pine shoot moth, *Rhyacionia buoliana* (Schifferrmüller), the pitch twig moth, *Petrova comstockiana* (Fernald), and *Rhyacionia rigidana* (Fernald), which does not have a common name, some biological information on larval parasites was obtained. All parasites were in larval or later stages when they came under observation, and therefore detailed life history treatment here is limited to the advanced stages of the several species. The main points considered are length of the pupal stage, the period of emergence, and longevity of adults with and without food.

Numerous instances of parasitization by these hymenopterons are on record, but little has been published regarding their biology. The biological literature treats of only three of the parasites and consists for the most part of papers in which a modicum of information has been included incidentally.

## MATERIALS, METHODS, AND PROCEDURE

Specimens which were reared under observation were recovered from field collections of host larvae in the course of sampling for seasonal history information, while adult parasites were obtained from emergence cages which contained host infested pine tips or twigs. Cork stoppered shell vials 25 by 95 mm were the containers used for holding both adults and immature individuals with their hosts. Usually these containers were occupied singly, but in some cases it was more convenient to keep several specimens in one vial. The vials and emergence cages were housed in a field type insectary at the Ohio Agricultural Experiment Station at Wooster.

Rearing began in June, 1951 and was complete by the end of July. The adult longevity studies ranged from the latter part of May to October, 1951, except in one case which will be noted further on in the text. The method used to provide food for adult parasites was that illustrated by Peterson (1949), consisting of a raisin mounted on a straight pin inserted into the cork used for stoppering a container. Raisins pinned in this manner and moistened periodically usually served for weeks, although occasionally it was necessary to replace some sooner because of contamination by micro-organisms. All living material was examined once daily at a regular hour, and therefore the durations given for stages and other periods are accurate to one calendar day. Most of the computed averages given are rounded to the nearest whole number.

Determinations were made through the courtesy of Mr. C. F. W. Muesebeck and his co-workers in the Division of Insect Identification, Bureau of Entomology and Plant Quarantine, Washington, D. C.

## OBSERVATIONS

Before proceeding with the parasite discussions, the life cycles of the host species will be briefly reviewed. All three of the species undergo their complete development on pine and are intimately associated with the tree in all stages except the adult. *Rhyacionia buoliana* and *Petrova comstockiana* are univoltine, and both hibernate as partly grown larvae. The moths of the latter species issue during May and June, and those of the former during June and July. *Rhyacionia rigidana*

on the other hand produces two generations a year in Ohio and winters in the pupal stage. One moth flight (overwintering generation) occurs in April, and the other (summer generation) in July.

1. *Calliephialtes comstockii* (Cresson)<sup>1</sup> (Ichneumonidae). This species parasitized all three moths to a greater or lesser extent. Five larvae (four males and one female) were reared to the adult stage. They were feeding externally and singly on apparently full-grown host larvae when collected. Following the termination of feeding, whitish, semitransparent, silken cocoons were spun and were completed in less than a calendar day. Cushman (1927) mentions that *C. comstockii* is solitary on full-grown larvae of *Rhyacionia frustrana* (Comstock), but states that the cocoon is light brownish. The parasite larvae in the present observations began voiding their alimentary tracts soon after completing their cocoons. In some cases this process was noted to continue over several days. From the time the cocoons were spun until their occupants transformed to pupae there was an interval (prepupal period) which varied from 3 to 5 days. The time from pupation to eclosion from the cocoon varied between 7 and 11 days, and averaged 9 days. There was some evidence however, that the parasites did not leave the cocoons immediately upon shedding pupal skins but remained quiescent in them for a day or more before issuing. Emergence took place concurrently with that of the host moth in cages containing pine tips infested with *R. buoliana*. Adults also appeared during the respective emergence periods of the other two hosts, but from the summer generation only in the case of *R. rigidana*. The overwintering brood of this species very likely is attacked, but too few infested tips of that generation were observed for a conclusive record. The parasites issued from the first named host between June 14 and July 5 in 1950, and between June 6 and June 28, in 1951 with males emerging slightly ahead of females. Of 82 adults obtained 53 were males and 29 were females, the males outnumbering females almost two to one. Provided with food, 11 males lived from 9 to 52 days, averaging 30 days, and 8 females lived from 3 to 49 days, averaging 24 days. Eight unfed males lived an average of 5 days, varying between 3 and 6 days, and 6 unfed females likewise lived an average of 5 days, but varied between 3 and 7 days. The longevity of the adults provided with food was therefore more than five times as long as that of unfed adults. The last of the parasites obtained from *R. buoliana* in 1951 lived until August 9.

In early May of both years females of this species were seen in the field flying about the tips of young trees infested with *R. buoliana*. The difference of from four to six weeks between this occurrence and the appearance of adult parasites in the emergence cages probably constitutes the time required in nature for development from adult to adult.

2. *Eurytoma tylodermatis* (Ashmead)<sup>2</sup> (Eurytomidae). This parasite was obtained from *R. buoliana*, and also from *R. rigidana*. Seven larvae (three males and four females) were reared under observation to the adult stage. When collected the larvae were feeding externally and singly, six on apparently full-grown host larvae, and one on a pupa. List (1932) discovered a small percentage of the larvae feeding on host pupae of the cherry curculio, *Tachypterellus consors cerasi* List, and on newly emerged, but undersized, adult beetles. He apparently does not think the host was attacked in the pupal stage, however. He states that the injury caused by the parasite to larvae which are near maturity is not so great but that they may enter the pupal stage, or even live to become adults. Parker and Lamerson (1934) also take this view in presenting similar observations made upon the western apple curculio, *T. quadrigibbus magnus* List.

<sup>1</sup>One lot determined by Dr. B. D. Burks, and one by Miss Luella M. Walkley.

<sup>2</sup>One lot determined by Mr. A. B. Gahan, and one by Dr. B. D. Burks.

There was an undetermined interval of several days after termination of feeding by the parasite larvae before their alimentary tracts were voided. On the day following voiding of the alimentary tract the insects were pupae in all cases. No cocoons of any kind were constructed. The pupal period varied between 10 and 12 days for the 7 individuals, and averaged 11 days.

Parasite emergence from caged tips infested with *R. buoliana* began during the latter half of the moth emergence period. In 1950 it occurred between June 21 and July 21, and in 1951 between June 21 and July 16. Some parasites emerged in 1951 from the overwintering generation of *R. rigidana* between April 27 and May 17. Emergence from the summer generation took place within the same periods as from *R. buoliana*. Several individuals which had parasitized the generation of *R. rigidana* soon to enter hibernation issued late in the summer of 1951. Those which were not so far advanced at that time would no doubt pass the winter with the host and make up the spring flight.

Of 113 adult parasites obtained 85 were females and 28 were males, the females outnumbering males three to one. Regarding longevity of adults, 8 males with food lived from 3 to 35 days, averaging 11 days, and 33 females with food lived from 4 to 86 days, averaging 43 days. Pierce (1912) reported that adults of this species obtained from various weevil hosts lived an average of 26 days, with a maximum of 79 days. He gave a sex ratio not differing greatly from that above. The adults in the present observations were seen feeding only at night. Without food four males lived from 4 to 5 days, and 11 females lived from 3 to 12 days, averaging 5 days. Adults provided with food therefore lived about five times as long as unfed males, and fed females decidedly outlived fed males. The last parasites of the 1951 summer flight lived until September 29.

One of the individuals of this species which was reared under observation was taken as a secondary parasite of *R. buoliana*. When developing as such on this host it probably does so through *Calliephialtes comstockii*, a large insect which is relatively abundant, and which develops generally in advance of *E. tylodermatis*. A few other instances of secondary parasitization upon *R. buoliana* were encountered, but the hyperparasites were not reared through and identifications not made. The parasite under discussion however, seems most likely to be the one involved.

When kept in stoppered vials many of the adults of this and the other species were observed to gnaw away portions of the cork stoppers. This was doubtless the manifestation of a behavior which in nature serves to effect their escape from the host chamber.

3. *Hyssopus thymus* Girault<sup>3</sup> (Eulophidae). Representatives of this species parasitized *R. buoliana* and *P. comstockiana*. They fed externally on hosts in the larval stage and occurred gregariously. The size of the parasite colony seems to depend upon the size of the host larva, for in the burrows of 15 parasitized *R. buoliana* larvae of the fourth (hibernating) instar the number of pupae averaged 2.4, varying between 1 and 4, whereas in the later instars of both hosts, the number of adults emerging in 4 cases averaged 11.8, varying between 5 and 21. It should be mentioned that in two of the last mentioned colonies 14 and 24 pupae were counted, but only 12 and 21 adults emerged respectively from these, there being some mortality. The largest of the above colonies was obtained from a larva of *R. buoliana*. Friend et al. (1938) reported that the number of parasite pupae per bud in 1607 buds containing parasitized *R. buoliana* larvae averaged 3, and Friend and Hicock (1936) stated that they reared as many as 19 individuals from a single parasitized larva of this species. Cushman (1927) wrote that from 3 to 10 or 12 individuals develop on a single host of *Rhyacionia frustrana*.

Two larvae reared under observation to the adult stage transformed to pupae

<sup>3</sup>One lot determined by Mr. A. B. Gahan, and one by Dr. B. D. Burks.

on the day following the voiding of their alimentary tracts, and they underwent pupal periods of 12 days. These larvae spun no cocoons of any kind, and no cocoons were observed when pupae were found in the field. At least two generations occur on *R. buoliana* annually, one issuing in the spring and another in the summer during the moth emergence period. There is evidence that two generations occur similarly on *P. comstockiana*, one emerging in April and another in June concurrently with the emergence period of the moths. The winter is passed in the pupal stage in the burrow of the host. Friend et al. (1938) found evidence both in the field and in the laboratory that several generations occur on *R. buoliana*. These authors reported rearing the parasite from egg to adult in from 17 to 18 days at 24 degrees C. and 60 percent relative humidity.

Nineteen adults provided with food in the longevity studies lived from 4 to 90 days. The average length of life of the 19 was computed at 44 days. Seven unfed adults lived for periods of from 1 to 12 days, averaging 4 days. These seven were observed under artificial circumstances however, and not when they would have normally been in the adult stage. They were taken as pupae from mid-winter host collections, brought indoors, and kept at room temperature until emergence occurred and also throughout the longevity observations. The data show that the adults which were fed lived 11 times as long as those not fed. In 1951 the last parasite of the summer generation lived until September 1. Of 15 individuals selected at random for identification, 8 were females and 7 were males. Friend et al. (1938) kept adults of this species alive for five weeks with moist sugar and reported obtaining a preponderance of females.

4. *Agathis pini* Muesebeck<sup>4</sup> (Braconidae). This species parasitized *P. comstockiana*. Larvae were observed feeding singly and externally on apparently full-grown caterpillars. Prior to pupation they spun white silken cocoons. In the insectary in 1951 the parasites issued from June 1 through June 27. In general, emergence lagged somewhat behind that of the host. Males emerged somewhat ahead of females, and of 36 adults obtained 20 were males and 16 were females. Seven unfed male adults lived from 3 to 6 days, averaging 4 days, and 7 unfed female adults lived from 3 to 7 days, averaging 5 days. Eight male adults provided with food lived from 1 to 14 days, averaging 7 days, and 5 female adults provided with food lived from 5 to 10 days, averaging 8 days. The adults receiving food thus lived slightly more than one and a half times as long as unfed adults. The last adult lived until June 29 in 1951.

5. *Perilampus fulvicornis* Ashmead<sup>5</sup> (Perilampidae). This species was found to be a secondary parasite of *P. comstockiana* through *Agathis pini*. Four of the larvae, which were solitary, external feeders, were reared to the adult stage. A period (prepupal period) varying between 1 and 3 days elapsed from the time the gut was voided until pupation took place. The duration of the pupal stage averaged 11 days, varying from 8 to 13 days. In these, as well as in a number of additional cases observed, the immediate host remained alive until after completing its cocoon. The hyperparasites did not themselves construct cocoons but underwent the latter part of their development within the host cocoons.

In 1951 the adult parasites issued over a period of 16 days in the insectary, beginning on June 23. On this date moth emergence was already complete, and emergence of the primary host was nearly so. Provided with food, 4 parasites remained alive in the vials from 5 to 19 days, averaging 12 days, while 7 without food lived from 2 to 8 days, averaging 5 days. The individuals which were fed therefore lived a little more than twice as long as those which were not fed. The

<sup>4</sup>Determined by Mr. C. F. W. Muesebeck.

<sup>5</sup>Determined by Dr. B. D. Burks.

last one lived until July 19. Of 14 adults obtained 6 were females and 8 were males.

Some indication of the length of the life cycle of this species lies in the fact that three lots of host infested twigs had been confined in the insectary for over six weeks, and a fourth lot for over four weeks prior to emergence of the adults.

#### LITERATURE CITED

- Cushman, R. A.** 1927. The parasites of the pine tip moth, *Rhyacionia frustrana* (Comstock). Jour. Agr. Res., 34: 615-622.
- Friend, R. B., and H. W. Hicock.** 1936. Notes on the European pine shoot moth. Jour. Econ. Ent., 29: 210-214.
- Friend, R. B., G. H. Plumb, and H. W. Hicock.** 1938. Notes on the European pine shoot moth in Connecticut. Jour. Econ. Ent., 31: 506-513.
- List, G. M.** 1932. A cherry pest in Colorado. Colo. Agr. Exp. Sta. Bull. No. 385: 54-59.
- Parker, R. L., and P. G. Lamerson.** 1934. Hymenopterous parasites of the western apple curculio in north-eastern Kansas (*Tachypterellus quadrigibbus magnus* List, Coleoptera Curculionidae). Jour. Kan. Ent. Soc., 7: 90-92.
- Peterson, A.** 1949. A manual of entomological equipment and methods, Pts. 1 & 2. 6th ed. Edwards Bros., Ann Arbor, Mich. Pl. 49, fig. 8, with explanatory note.
- Pierce, W. D.** 1912. The insect enemies of the cotton boll weevil. U.S.D.A. Bur. Ent. Bull., 100 (new series). 100 pp.
-