A STUDY OF THE BIOLOGY
AND LIFE HISTORY OF PROSEVANIA PUNCTATA (BRULLE)
WITH NOTES ON ADDITIONAL SPECIES
(HYMENOPTERA : EVANIIDAE)

DISSERTATION

Presented in Partial Fulfillment of the Requirements
for the Degree Doctor of Philosophy in the
Graduate School of The Ohio State
University

By

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1952

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OHIO STATE

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Introduction

The Evanidae are among the least known and most unusual of the parasitic Hymenoptera. The purpose of this study is to summarize the known information about these parasites and to extend this knowledge by investigations on their biology and life history.

References to the evanids were found to be widely scattered in entomological literature and in many cases the publications were not readily accessible. A study of the literature revealed that very little work had been done on the biology and life history of this group of parasites. Previous workers have dealt principally with taxonomy, and only occasionally noted something of biological significance.

Studies were conducted from 1950 through 1952 and a number of observations were made on the hosts of these parasites as well as upon the parasites themselves. Collections were made through as much of Ohio as possible. These specimens were identified by the writer, and then sent to Henry K. Townes or Luella M. Walkley for verification. The descriptions of species and the names used by the writer are based upon the work of Townes (1949).

The author is deeply indebted to several individuals through whose cooperation this study was made possible.

I wish to thank Dr. Carl Venard, Assoc. Professor of Zoology and Entomology, The Ohio State University, under whose supervision this work was conducted and whose many suggestions, comments, and criticisms, have been extremely helpful. Due credit is likewise extended to Dr. Alvah Peterson for his suggestions as to methods of rearing and handling these parasites, and to Dr. Donald J. Borror, Dr. Ralph H. Davidson and Prof. Josef N. Knull of the Department of Zoology and Entomology, The Ohio State University, for their helpful and timely assistance.

The author is grateful to Dr. Henry K. Townes, Professor of Entomology Research, North Carolina State College of Agriculture and Engineering, for his aid and suggestions of methods which might be utilized in studying this group, Miss Luella M. Walkley of the Division of Insect Identification, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture kindly identified numerous specimens.

I also wish to thank Mr. A. C. Miller of the Gulf Research and Development Company of Pittsburgh, Pennsylvania for a supply of roach egg capsules which was made available for this study, and Dr. Edward S. Thomas of the Ohio State Museum for information about the species of roaches found in the areas in which collections of egg capsules were made.

Credit is also due to many students of Entomology at The Ohio State University, especially to Paul Ludwig, Richard D. Alexander, and Charles A. Triplehorn for their contributions of valuable specimens.

Kind appreciation is extended to my wife, June L. Edmunds, who has served both as a valuable assistant and as an inspiration throughout the course of this investigation.

To all others who have rendered assistance in this work, I express my sincere thanks.

The Family Evaniidae

The family Evaniidae consists of a small group of parasitic Hymenoptera which are often called ensign wasps from their habit of carrying the abdomen up-raised. The abdomen is strongly compressed laterally, and is attached to the body by a slender petiole which is inserted on the dorsum of the metathorax. As the wasp moves about, the abdomen moves up and down so that it resembles a small ensign or flag.

These wasps are not considered to be of great economic importance, but they are of some value because they are parasitic on roaches, which they parasitize by attacking the egg capsules dropped by the adults. The wasps are harmless to people but sometimes cause annoyance by their presence in buildings.

The family Evaniidae at present is placed in the superfamily Proctotrupoidea. This family consists of an isolated group of parasitic Hymenoptera most closely related to the Gasteruptionidae. It differs from all but a few Hymenoptera in having the abdomen attached near the top of the propodeum instead of down near the coxae, and from these few, in abdominal structure as follows: the first abdominal segment is cylindrical and slightly arched, and the rest of the abdomen is small, flattened, circular or

subcircular, or subtriangular, and attached to the first segment by a free articulation. The Evaniidae differ from all other parasitic Hymenoptera in having a long anal lobe at the base of the hind wing. The antennae are 13- or 14-segmented, and are inserted on or about the middle of the face.

The Evaniidae according to Ashmead (1901a) consisted of three subfamilies; the Evaninae, the Gasteruptioninae, and the Aulacinae. Muesebeck, Krombein, and Townes (1951), made the Gasteruptioninae and the Aulacinae subfamilies of Gasteruptionidae. This classification is utilized and accepted at the present time in the United States, so the old subfamily Evaninae now constitutes the present family Evaniidae.

Outstanding papers on the nearctic Evaniidae include a classification by Bradley (1908), and a detailed record of the literature by Hedicke (1939). Townes (1949) published an excellent monograph in which he gives adequate descriptions and keys to the known genera and species. In this work he described two new species and has cleared up a great deal of the synonymy that previously existed. Muesebeck, Krombein, and Townes (1951) give a very useful brief summary of the family Evaniidae in the Synoptic Catalogue of the Hymenoptera of America North of Mexico.

Crosskey (1951) published a study on the British Evaniidae. This paper contains some very good illustrations of external morphology and the classification of British species. As some of these species are common to both Britain and the United States, this information is of importance for the study of this family in North America.

Fahringer (1922), a German entomologist, published a few brief notes on the biology of Prosevania punctata (Brullé) in which he stated that he had reared this species from roach egg capsules which he had previously exposed to the wasp. This work did not contain much information on the habits of the adults, or notes on the immature stages. Fahringer also stated that he reared punctata from egg capsules of the German roach. This species of roach was not successfully used as a host by the writer.

Genieys (1924), a French entomologist, worked on the biology of Zeuxevania splendidula Costa. This species is not found in the Nearctic Region, and a comparison of Genieys' results with those of the writer shows that splendidula differs greatly in habits and biology from both our native and introduced species.

At the present time there are four genera and eleven species of Evaniidae described from the Nearctic region. Nine of these species are native, and two have been introduced.

Evania appendigaster (Linn.), one of the introduced species, was probably of oriental origin but now occurs in most of the tropical and subtropical parts of the world. In the United States it is common in Arizona and in the cities of the Gulf and Atlantic States as far north as New York City. The other introduced species, Prosevania punctata is a native of the Mediterranean Region and has been established from New York and Ohio south to Georgia. During the course of this study Prosevania punctata was found abundantly throughout Ohio (Pl. 5, Fig. 2), while Evania appendigaster was not found in this area.

The distribution of our native species of evaniids is not well known. Hyptia harpyoides Bradley has a more northern range than any other evaniid in the Nearctic region. It occurs in eastern United States, and as far west as Minnesota and Kansas. Hyptia thoracica (Blanchard) occurs from the Atlantic States west to Michigan and Kansas. Hyptia thoracica and Hyptia harpyoides are the only evaniids recorded from Canada. Hyptia reticulata (Say) ranges from the Atlantic States west to Michigan and Kansas, it has been collected in southern Mexico. Hyptia femorata Townes at present is known only from Texas, while Hyptia floridana Ashmead has been collected in Florida, Georgia, and Louisiana. Hyptia oblonga Townes has been collected in Arizona, Alabama, Georgia, and Mexico.

The genus Evaniella is represented in the Nearctic region by three species, one widespread in eastern United States and the other two restricted in distribution to New Mexico and California. Evaniella semaeoda Bradley occurs from the Atlantic west to Michigan and Kansas. Along the Atlantic coast it has been collected as far north as Rhode Island, and in the central states as far west as Livingston County, Michigan. Evaniella neomexicana (Ashmead) has been recorded from New Mexico, and Evaniella californica (Ashmead) from California.

The Evaniidae are parasites of roach oothecae. Records of these wasps having been reared from oothecae are mentioned by Ashmead (1901a), Fahringer (1922), Rau (1940), Townes (1949), and Edmunds (1952a and b). Three species of native evaniids Hyptia harpyoides, Hyptia reticulata, and Hyptia thoracica, are known to parasitize wood roaches. Hyptia harpyoides has been recorded as a parasite of Parcoblatta virginica, and Hyptia reticulata and H. thoracica as parasites of Parcoblatta pensylvanica.

The two introduced species of evaniids, Evania appendigaster and Prosevania punctata, are commonly found in buildings, and are parasites of domestic roaches. Evania appendigaster has been recorded as a parasite of the Oriental roach Blatta orientalis Linn., the American roach

Periplaneta americana (Linn.), and the Australian roach Periplaneta australasiae (Fabricus). Prosevania punctata also parasitizes the Oriental and American roaches, and in addition the German roach Blattella germanica (Linn.).

Some evaniid species are not common and their hosts are unknown; this is true for the three species of Evaniella and for Hyptia femorata, Hyptia floridana and Hyptia oblonga.

Methods of Study

Field Studies

Evaniids must be collected in the field as adults or be reared from parasitized oothecae. A knowledge of cockroach habits is necessary to successfully obtain and study their parasites. Investigations on the biology of roaches were made along with studies on the evaniids, to aid in an understanding of the parasites.

Domestic roaches often deposit their egg capsules in areas of buildings which are difficult to reach. The Evaniidae, due to their small size, can enter these areas to parasitize the capsules, but a person cannot collect there. It was found easier and more successful to collect adults of Prosevania punctata, than it was to try to find parasitized egg capsules in buildings. The adults fly to the light and were collected in the windows inside of buildings. These buildings were of various kinds, including private homes, dry-cleaning establishments, and school buildings.

A different technique was necessary for the evaniid parasites of the wood roaches. Specimens of Hyptia were seldom seen or collected in the adult stage, but they could be readily obtained by collecting roach egg capsules and keeping them in closed containers until the parasites

emerged. Parasitized egg capsules were collected in the field, generally from under the loose bark of dead trees. From these capsules were reared out a variety of parasites, including Hyptia thoracica and H. harpyoides.

The wood roach egg capsules can be collected in a variety of places, such as under boards and in piles of cut fire wood, but by far the largest numbers were found under the loose bark of fallen dead trees. The adult roaches seem to have certain places in which they congregate and thus in a small area it was possible for the writer to find as many as 184 egg cases deposited within a few feet of each other under the bark of a tree. The capsules collected in the woods around Columbus, Ohio, sort readily into two sizes. The large capsules are believed to be those of Parcoblatta pensylvanica (De Geer), the only large native wood roach known to occur in this area. The smaller capsules are believed to be those of Parcoblatta virginica Brunner, which is plentiful in the area investigated. Most of the capsules were collected during the winter and early spring when logs and other likely oviposition places could be readily located.

The overwintering stages of the wood roaches were found to be the nymphs, which can be collected in the woods during the winter months. The nymphs overwinter in various

stages of development, ranging in size from very small to some that are in the last nymphal instars. No live adult wood roaches were collected in the winter by the writer. Some of the larger roach nymphs mature in early spring and begin to produce egg capsules in May. The female roach carries the flat yellow-brown ootheca protruding from her posterior end for two or three days before dropping it with no attempt to conceal it. However, the oothecae are sometimes difficult to find, because of the secretive habits of the adults, and because after deposition, seem to deepen in color and resemble their background of dirt and bark. The roaches do not overwinter, either as eggs or nymphs, in the oothecae.

Roach egg capsules collected during the winter months are often found to be broken and empty. These broken capsules can be sorted out under a binocular microscope and discarded. This sorting was done to make it easier to observe parasite emergence, as special attention could then be given to the normal appearing capsules.

After the egg capsules were collected in the field they were candled by holding them in front of a bright light. The light will pass completely through an empty capsule, or show the outlines of an evaniid larva if one is present in the capsule. This method was used on several hundred egg

capsules which were collected over a period of two years, and was found to be very successful.

The following methods were used to collect the roaches necessary for establishing cultures. Small wood roach nymphs were picked up with an aspirator, but larger nymphs and adults had to be quickly caught with the fingers or a pair of tweezers, as they run rapidly to new cover when disturbed. A good time for collecting wood roaches is in the early spring while the weather is still cool, because at this time of year nymphs do not run rapidly and are more easily captured.

Domestic roaches are very abundant in Columbus, Ohio. Roaches for cultures, including American, Oriental, Australian, smoky brown and brown banded, were collected by hand from infested buildings. A simple roach trap, consisting of a large-mouthed glass bottle with the inside walls greased, was employed to replenish the roach cultures. Food was placed in the bottom of the bottle, and the roaches would drop in and could not climb out. The bottle was checked every few days while it was in use and the trapped roaches removed and placed in the cultures.

Adult evaniids occurring in buildings can be collected in the windows, but will often be found walking on the floors or table tops. The wasps can be picked up with an aspirator, or by placing the mouth of a bottle over the wasp

and slipping a piece of paper under the wasp to get it in the bottle. It is difficult to predict where you will find these adults as they move continuously.

Laboratory Methods

Cultures of both Evaniidae and Blattidae were maintained in the laboratory for use in making studies and experiments. Roaches were kept on hand primarily to provide a constant supply of egg capsules for parasitization by the wasps, and to attract parasites for additional study material.

Culturing of Blattidae. Domestic roaches were reared in the basement of the Botany and Zoology greenhouse. Two dozen five-gallon water bottles (Pl. 10, Fig. 1) were used as culture jars. The tops were removed from these bottles by an electrically heated wire wrapped around the bottle where the break was desired. After the top was removed the cut edge was covered with adhesive tape.

The bottom of each jar was covered with about an inch of wood shavings to absorb waste and moisture. To keep the roaches from escaping from these bottles, the sides were greased with vaseline and the top was covered with cheese cloth held in place by a strong rubber band. Water was supplied to the roaches by using small plastic dishes

with tight fitting lids. A hole was drilled through the lid and a roll of dental cotton was inserted through the hole so that about two inches projected down into the dish, and a half inch projected out through the hole. When the dish was filled with water the dental cotton acted as a wick, and provided a constant supply of water. All types of roaches were found to feed readily on dog biscuits, and these were used as food along with bread and apples cut into small pieces.

Cultures of several kinds¹ of roaches were maintained, but only three species were found to be hosts, the American roach, Periplaneta americana (Linn.), the Oriental roach, Blatta orientalis Linn., and the wood roach, Parcoblatta pennsylvanica (De Geer).

The culturing of the wood roach was found to be practical and feasible. Strips of bark, two inches wide and four inches long were cut from fallen trees, and four or five pieces of this bark were placed, one on top of the other, on the floor of the culture bottles. This provided a somewhat natural resting place for the roaches; in other respects they can be cultured in the same manner as the domestic roaches.

¹ Australian, American, Oriental, German, smoky brown, brown-banded and wood roach.

Culturing of Evanidae. Cultures of Prosevania punctata were started from adults collected in the vicinity of Columbus, Ohio. These parasites were never reared in large numbers, but sufficient specimens were obtained to carry out a detailed study. Several dozen adult wasps were captured during a period of about two years. These wasps were placed in a glass-topped rearing cage, (Pl. 9, Figs. 1 and 2) and different kinds of roach capsules were then placed on the floor inside of the cage. Oviposition was observed to take place many times under these conditions.

Several egg capsules were placed on the floor of the cage at the time the evanid was placed in the cage; these capsules were removed daily and a fresh supply was put in their place. The egg capsules which were removed from the cage were placed in small glass jars (Pl. 8, Fig. 2), the mouths of which were covered with fine white organdy held in place by rubber bands. The bottles were then placed in an outdoor insectary and left until the parasites emerged. Some of the bottles were kept in a room in the Botany and Zoology Building. Each bottle was marked with the date on which the egg capsules in it had been exposed to parasitization.

The adult evanids upon emerging were found to require a constant supply of water or they soon died. This moisture

was provided at first by soaking a raisin in water and placing it in a concave slide on the floor of the cage. Later it was found that the plastic dish and dental cotton wick water container, described under the culturing of roaches, was more satisfactory.

No information was available regarding food of the adult wasps, so a mixture of 5 per cent honey in water was placed in the cage in a concave slide, or in a shell vial with a cotton plug. The wasps spent a great deal of time feeding on this honey water mixture and it proved to be satisfactory.

The natural food of our native evaniids was unknown to the writer, so a number of different kinds of flowers were placed in the cage with adult Hyptia. These flowers were put into shell vials which were filled with water. Cotton was packed around the stem at the mouth of the vial to prevent the wasps from crawling down into the vial and drowning. Observations were then made as to the types of flowers the wasps visited. Pollen grains were observed on adults of Prosevania punctata but their source was not determined.

To be sure that the egg capsules used in this study were fresh, female roaches carrying egg capsules were taken

from the large culture jars, and placed in small battery jars with no sawdust in the bottom (Pl. 10, Fig. 2).

These smaller clean jars made it easier to see and collect the egg capsules each day. An adult female roach will form and drop an egg capsule every few days if well supplied with food and water. This assures a constant supply of fresh oothecae for use in the parasite oviposition cage.

Methods of Studying the Immature Stages of Evaniidae. In order to obtain a series of immature stages, the ovipositing female wasps were observed closely when roach capsules were placed inside the oviposition cage. Oviposition was often observed, and it was possible to mark the capsule oviposited into. White waterproof ink was found to be a satisfactory marking material.

Oothecae were removed from the cage after an evaniid had oviposited in them, and were placed in separate vials (Pl. 7, Fig. 1 and 2). Each vial was marked with the date of parasite oviposition. The capsules were then incubated and dissected at definite intervals of time, and the larvae were removed for study.

Since dissection was necessary for the study of the internal phase of the parasite's life, the following method was developed. The egg capsule was held between the thumb and forefinger, and the ridge along one edge of the capsule

was cut away with a very fine scissors. A fine needle was inserted between the edges of the capsule and the edges were gradually spread apart. The contents of the capsule were emptied into a watch glass containing an 0.85 per cent sodium chloride solution. The parasites could then be sorted out of the debris and would remain alive in this solution for some time, and observations and drawings of living material could thus be made.

After observing the larvae in this salt solution, they were transferred to K.A.A.D.² for a short time, usually less than an hour; after being killed in this solution they were preserved (Pl. 8, Fig. 1) in 80 per cent alcohol.

The egg capsules known to be parasitized were examined closely during incubation. It was found that in the late larval stages, if a capsule were held in front of a bright light, the outline of the parasite larva could be seen inside the ootheca.

Methods for Handling Parasites other than Evanidae.

Because of their large size the evaniids were not difficult to observe and handle; however there emerged from the egg

² K.A.A.D. consists of 1 part kerosene, 10 parts of 95% ethyl alcohol, 2 parts acetic acid, and 1 part dioxan. See Peterson (1949).

capsules other smaller parasitic Hymenoptera and Diptera³. These necessitated other methods of study and handling.

A small aspirator was used to collect these smaller parasites when they emerged in the incubation bottles. The bottles were first placed in a refrigerator to slow down the insects' activity, and the parasites were sucked into the aspirator.

These small parasites were then transferred to .8-dram shell vials, 25x95 mm., (Pl. 8, Fig. 1) stoppered with a tight fitting cork. A pin was inserted through the cork so that the point projected inside of the vial for about one fourth of an inch. A raisin was then soaked in water and placed on the end of the pin. Such a raisin would remain soft and moist for several days, and provided the water needed by the insects. To change corks the vial was lightly tapped causing the parasites to drop to the bottom. Then a cork with a fresh raisin on a pin was quickly substituted for the old cork. Roach egg capsules can be placed in the vial in the same manner. Because of the small size of some of the parasitic wasps, the vial

³ Pteromalidae, Systellogaster ovivora Gahan; Eulophidae, Tetrastichus hagenowii (Ratz.), and an undescribed species of Syntomosphyrum; Muscidae, Coenosia (Neodexiopsis) basalis (Stein); Phoridae, Megaselia sp.

was handled with a background of white paper to make it easier to see the insects.

Egg capsules after being exposed to parasitization by the small parasites were removed from the vials, either by exposing the parasites to cold in order to slow their movements, or by waiting until they died. The egg capsules which had been exposed were then placed in vials (Pl. 7, Fig. 1) with cotton stoppers and incubated. Studies were made of these small parasites to determine their relationship to the roaches, or to see if they were hyper-parasites of the Evanilidae.

Biology of the Evanidae

The Adult

Emergence from the Ootheca. Emergence from the ootheca is accomplished in the following manner. The wasp working from the inside of the egg capsule pierces the hard cover with both mandibles. The shiny black mandibles puncture two holes in the wall, and are then closed by the wasp so that the tips meet outside of the egg sac wall, and by an inward pull the wasp breaks a small hole. After making this initial opening, the parasite begins to bite small pieces from around the edge of the opening, thus gradually enlarging it (Pl. 6). While it is chewing, the wasp appears to be laying on its side, so that in biting one mandible is on the outside of the wall and one mandible on the inside. As the hole is enlarged, the head and front part of the thorax becomes visible to the observer.

This chewing makes a ragged circular opening when viewed through a dissecting microscope. The chewed pieces of capsule are dropped from the mouth parts and form a small pile of debris. Part of this debris is on the outside of the ootheca and part is on the inside.

The wasp can be seen moving and stretching as it gradually enlarges the aperture and may make an attempt

to emerge through the hole by pushing with its head. If the opening is too small or not the proper shape, the wasp will pull back into the capsule and begin to cut again. Systematic cutting at the edge of the opening is carried on until the hole is large enough for the passage of the wasp's body. A wasp may make several attempts at emergence before it succeeds.

Finally the front legs are forced through the hole, and the wasp uses these to pull the rest of the body through. Upon emergence from the ootheca, the wings of the adult are fully expanded, the body appears quite as dark and dry as those of older adults, and the wasp runs excitedly about, then stops for a few minutes and combs the wings and antennae with the hind tibiae.

The emergence opening is made at the top side and close to one end. An examination of thirty capsules of Hyptia thoracica shows that the same number of adults emerge from one end of the egg capsule as emerge from the other. In the genus Hyptia, the emergence hole is about 2 mm. in diameter, but the size varies a great deal from specimen to specimen. In Prosevania punctata, a larger wasp, the emergence hole is about 3 mm. in diameter.

Table I. A Typical Emergence Record of Hyptia thoracica
(Blanchard) from a Wood Roach Capsule, Parcoblatta
pensylvanica (De Geer) June 15, 1951.

11:50	Two mandibles break through the cover
12:00	Initial break completed
12:20	Head and thorax clearly visible
12:40	First attempt at emergence
12:55	Emerged from opening.

Total time elapsed - 65 minutes.

Mating Behavior. The evaniid wasps walk continuously about inside any confined area, and whenever a female passes near a male, the male follows along behind the female vibrating the antennae rapidly, while his entire body quivers and shakes. Sometimes two males will show similar excitation over the same female. If the female stops to drink or rest, very often a male will approach her and touch her with his antennae. The usual reaction of the female is to walk or move rapidly away. The male will then run about for a few seconds as though seeking her.

Copulation was observed taking place in a cage containing 12 Hyptia thoracica. A male and female with the abdomens locked together fell from the side of the cage to the floor. Upon landing they still remained attached together for a few seconds. Upon breaking apart the female ran up the side of the cage while the male remained motionless on the floor of the cage. This act of copulation was extremely rapid, lasting only a few seconds.

On July 29, 1951, Richard D. Alexander captured a male Prosevania punctata in the window of his home in Columbus, Ohio. He released this male in the oviposition cage containing other wasps captured previously. This male in walking about in the cage approached an aged and feeble female wasp and repeatedly attempted to copulate with her. After about three minutes another male which had been in the cage for several days approached the two in attempted copulation. The two males then appear to attack each other. They rolled apart from the female and lay on their sides facing each other and fighting by kicking and pushing. Then both again attempted to copulate with the female. This combat behavior lasted for three minutes, after which one of the males walked away. The winning male spent nearly an hour attempting to copulate before leaving the female and the time was interspersed with fights fending off the other

male who kept approaching. The two male wasps were observed to carry on this type of behavior for over two hours.

Oviposition. Oviposition by Prosevania punctata was first described by Edmunds (1952a), who observed oviposition in egg capsules of the American roach, Periplaneta americana. Since that time this evaniid has been found to parasitize egg capsules of the Oriental roach, Blatta orientalis. Haber (1920) gave a description of Evania appendigaster ovipositing into egg capsules of the Oriental roach.

The egg capsules used for oviposition by the parasite may vary in age from some which were deposited only a few minutes before being exposed, to some which were as much as two weeks old.. The wasps seem to oviposit into older capsules as readily as into fresh ones. The particular stimulus that causes oviposition to occur is not known. Hundreds of oothecae were placed in the culture cages, so that the wasp would have access to them. From these numerous egg capsules the parasites would select a few and oviposit into them.

Live female roaches carrying egg capsules were placed in the cages with the wasps. Some of the female wasps paid a great deal of attention to the egg capsules being carried by the roaches, but oviposition was never observed except

in egg capsules which had been dropped by the roach. Very often the American roaches glue their egg capsules into a corner of the cage. These capsules received more attention from the wasp than the cleaner ones which were merely dropped.

When several egg capsules were exposed at the same time in a cage, the reaction of the female wasp was to walk back and forth over the capsules many times. She would push them around with some vigor, turning some of the capsules over and seemingly examining them closely. Many times she would walk away after the first examination, and come back in a short time to examine the same oothecae again. This might go on for some time before oviposition would occur, and many times oviposition would not take place at all.

One female wasp was observed ovipositing into both American and Oriental roach capsules. She examined the Oriental capsules and began ovipositing into one of them. After completing her egg laying in this capsule, she walked around for a few minutes, and then oviposited into the capsule of an American roach.

In the actual act of oviposition the female approaches the egg capsule and examines it very carefully by stroking

it many times with rapidly vibrating antennae. Finally she settles down, usually on her side, lying on the cage floor with her ventral surface facing the long axis of the egg capsule. While in this position the ovipositor is extended and punctures the egg capsule. The usual position of the wasp is to face the flanged edge of the egg capsule, but oviposition has been observed taking place from the opposite side of the ootheca, and in one instance directly down into the side of a capsule. It is assumed that although there is a preferred position for oviposition, the position is not an obligatory one.

The time required for oviposition varied from 16 to 62 minutes. Several of these time lengths were recorded, and are listed below.

Table II. Time Records of Ten Ovipositions by Prosevania punctata (Brullé).

1. 21 minutes	6. 30 minutes
2. 23 minutes	7. 27 minutes
3. 28 minutes	8. 40 minutes
4. 62 minutes	9. 21 minutes
5. 16.5 minutes	10. 24 minutes

In an egg capsule opened a few days after evaniid oviposition was observed an evaniid larva was found, not a newly hatched form. This observation indicates that the adult wasps cannot always detect capsules which have been previously parasitized. The last instar larva found within this capsule appeared normal, and it is assumed that the second egg was eaten by the old larva.

On three different occasions it was noted that within a few hours after evaniid oviposition had taken place the nymphal roaches emerged from these parasitized oothecae. These observations suggest that parasite oviposition may be too late for successful egg development. Oviposition by the wasp must take place before the young roaches are in their last stages of pre-emergence development if a parasite is to be produced.

Feeding Habits of Adults. The feeding habits of the adult evaniids is a subject about which very little is known. Townes (1949) states that five specimens of Hyptia floridana were collected near Miami, Florida, while feeding on the petiolar nodules of Ricinus communis. Crosskey (1951) states that adults of Evania appendigaster emerge in summer, and may be found visiting such flowers as Petroselinum crispum (Mill.) and Foeniculum vulgare Mill.

Robertson (1928) listed the visits of various kinds of insects to a number of species of flowers. His observations show that Hyptia reticulata visited Parsnip, Pastinaca sativa. This plant is in the family Umbelliferae, a group known to be attractive to many of the Ichneumonidae.

Blooms of Asmorrhiza longistylis, a closely related plant, were placed in the cage with a dozen specimens of adult Hyptia thoracica. The insects seemed to be attracted to the flowers and appeared to feed on them.

Adult Prosevania punctata in captivity were fed 5 per cent honey water. They would live on this type of food up to about 20 days after being captured. The wasps become less active as they grew older and remain close by the container of honey water to feed.

Water was found to be a necessity at all times for the adult parasites. The length of life in the rearing cages was much shorter if a constant supply of water was not provided.

Parthenogenetic Reproduction. The production of young by unmated females is known to occur throughout the order Hymenoptera, but there are no published records or observations of parthenogenetic reproduction occurring in the family Evanidae.

Oviposition by an unfertilized female Prosevania punctata and the subsequent emergence of new adults as a result of this oviposition has been observed by the writer.

In October, 1950, a lone female wasp was collected from a window in the basement of a home in Columbus, Ohio. In captivity she oviposited into egg capsules of the American roach, and produced three wasps all of which were males. This observation suggested that parthenogenetic reproduction might occur in the Evaniidae, and was worthy of further study.

In July, 1951, another adult female was captured in the Botany and Zoology Building on The Ohio State University campus. This wasp was given access to a number of Oriental and American roach capsules. Oviposition was observed, and the offspring of this female were four males and three females which were removed from the cage as they emerged. The last of the offspring to emerge was a female, which came from a capsule of Blatta orientalis on January 9, 1952. This female was placed in a cage, and egg capsules were exposed to her in hopes of obtaining evidence of parthenogenetic reproduction. At the time she emerged there were no other adult wasps in the writer's cultures. The wasp emerged inside a small glass jar, over the mouth of which was stretched a covering of fine white organdy. The

wasp on emergence was moved into a glass and organdy cage in which all of the cracks had previously been sealed with wax. These circumstances seem to preclude any possibility that the female could have been fertilized.

The unique and interesting thing to the writer was that the female had not been fertilized and that she began to oviposit within from three to four hours after emerging from the egg capsule. She lived for fourteen days, and was observed ovipositing on several different occasions. The length of time required for the act of oviposition varied from twenty to sixty-seven minutes, showing great variability. Because of the length of time required for ovipositing, oviposition seldom occurred without being observed, and usually took place shortly after fresh egg capsules were placed in the cage.

The egg capsules in which the wasp oviposited were taken from the cage each evening and placed in glass jars which were labeled with the date of parasitization. In cases where oviposition was actually observed taking place, the egg capsules were marked by placing a drop of white India ink on them.

One hundred and twenty-three capsules were exposed to this wasp for parasitization. These consisted of 101 Oriental capsules, and 22 American capsules. Fresh oothecae

were collected from the roach cultures and placed in the cage daily.

On February 7, 1952, one of the marked egg capsules was dissected and found to contain a pupa in an early stage of development. This pupa was twenty-six days old and was pearly white in color except for very light pigmentation in the eyes, and the abdomen showed no segmentation.

On February 28, 1952, 45 days after the virgin female had oviposited, her first progeny emerged from an Oriental roach capsule. Only three parasites emerged, the last eight days later. These three together with the pupa previously dissected out by the writer, made a total of four successes. The adult wasps were all males.

As only four of the seven marked egg capsules were successfully parasitized, the remainder were dissected. Inside of one was found a dried up larva with one-toothed mandibles characteristic of the first instar larva of this species. The capsule was completely empty except for the larva, so that it might be presumed that this particular larva was not successful because it did not have sufficient food to complete its development. Two other marked egg capsules were opened, but the contents were found to be

hard and desiccated, and they yielded no information as to why the parasitism was unsuccessful.

Prosevania punctata reproduces sexually under normal conditions, but appears capable of parthenogenetic reproduction. In the example given above, the parthenogenesis was natural (spontaneous), since it was not induced by any artificial stimulus, and complete, because the offspring reached maturity. Since only males were produced by the unmated female, the Evaniidae have arrhenotokous reproduction.

Overwintering and Group Emergence. The Evaniidae attacking the egg capsules of our native species of roaches overwinter inside of the egg capsule, after first consuming the contents. Hyptia thoracica was found overwintering inside of the ootheca of Parcoblatta pensylvanica and Hyptia harpyoides in those of Parcoblatta virginica. The overwintering stage of Hyptia was found to be the last instar larva. In the late spring of 1951, 31 Hyptia were observed emerging from egg capsules collected in the woods. The emergence occurred from June 10th to June 20th.

Collections of egg capsules in the woods were made in such a way that the oothecae found in one particular place were kept together for study. The evaniids that emerged from these capsules seemed to do so in groups. The

parasites emerged almost simultaneously from those capsules collected in one niche and at a different time than those from capsules collected in a different niche. All of the wasps in the different collections emerged within a period of ten days.

Oothecae collected in a localized area may include several which are parasitized, and the wasps in the capsules all emerge at about the same time. It would seem from the emergence records that the egg capsules are parasitized in groups. This may be due to the habits of the wood roaches, as they seem to congregate in certain areas and often drop their egg capsules close together. It is possible that the adult female evanlid on coming to such a spot would parasitize more than one capsule, and in fairly rapid succession; this might account for group emergence, but such female behavior was not observed.

Prosevania punctata overwinters in the egg capsule of domestic roaches and in the vicinity of Columbus, Ohio, emerges in the last two weeks of May and the first week of June. Under laboratory conditions a generation of Prosevania emerged in January. There is no evidence that such a generation occurs under natural conditions, as there are no records in the museums at Columbus, Ohio, of Prosevania adults being collected between October and May.

The Evanidae as Household Pests. Adult evaniids do not normally attract attention because they are small dark colored insects which superficially resemble a house fly. To a person familiar with insects they are readily recognizable by the long hind legs and the small modified abdomen. When the proper environmental conditions are present (including an abundance of roaches) certain species of these wasps will increase in numbers and may become a nuisance.

For a period of several months during 1951 a family living in Worthington, Ohio, complained a great deal about the evaniid wasps which they would find in the windows and other areas of their home. The presence of the wasps annoyed them, but they did not seem to mind the Oriental roaches which could be found in abundance in their basement. On another occasion in a barber shop in Columbus, Ohio, the barber was observed using a fly swatter to kill what he considered to be flies. These insects were parasitizing the roaches in the basement underneath the shop, and actually aiding in the control of these pests.

The annoyance by these wasps is due to their habits as adults, as they are very active and move about a great deal by walking and flying short distances. This activity is carried on in the daytime as well as at night, and for

this reason they are often noticed when their hosts are not. The real annoyance caused by these wasps is due to a dislike of insects rather than to any harm done. During the course of this study the wasps were handled quite often, and they did not bite or sting or attempt to do so.

Prosevania punctata, the most common evaniid found in Ohio, has been seen in abundance by the writer in several buildings. When the roaches were cleared from these buildings the wasps also disappeared. This was due to the elimination of the host, and because the new organic insecticides seem to be just as effective in killing the parasites as they are in killing the host. These parasites are especially vulnerable because they walk about a great deal in the areas of the home which are normally sprayed in roach control. It will be interesting to observe what effect the new insecticides will have on the future abundance of these parasites. When a building known to contain evaniids was sprayed with 0.5 per cent chlordane solution, a survey was made of the premises daily for several days afterwards, and dead wasps were found along with numerous Oriental roaches. As no dead wasps had been found previously, the death of the parasites was probably due to the insecticide.

General Adult Behavior. The adult wasps continually use the hind legs to rub or clean the sides of their bodies.

The wasps stop, balance themselves on the first two pairs of legs and raise the hind pair up over the back. The hind legs are then rubbed backward along the sides of the body. Occasionally they raise the hind legs in the air and rub them together.

In collecting adult Prosevania it was observed that the usual means of locomotion of the wasps is to walk, and if disturbed, they fly only a short distance and resume walking. This trait was noted also in caged specimens. They continually walk about inside their enclosures, seldom flying. They use their antennae to touch the floor in front of them as they move about, examining any objects they encounter.

Adults of Hyptia are more active than those of Prosevania, and in walking they move their abdomen up and down much more; Prosevania show very little of this abdominal movement, and superficially resemble a house fly. Hyptia adults are smaller, and tend to fly a great deal more than adults of Prosevania; the Hyptia seek shelter in cracks or under bark, and are noticeably more negatively phototropic.

Prosevania punctata is generally collected in buildings, but specimens have been collected outside of buildings, walking along the ground or flying. This is

probably the means by which the species is spread. On several instances adults of this species have been observed out of doors flying and walking about over the glass of a closed window.

In buildings where there is an abundance of roach capsules these parasites probably reproduce for many generations without ever leaving the premises. Such an occurrence happened in a home in Worthington, Ohio. In this case the people were greatly annoyed by the regular, periodic appearance in their living quarters of a number of Prosevania adults. This home was a lucrative source of material for this study.

The Immature Stages

The only stage of the evaniid life cycle that is not spent inside of the roach egg capsule is the short period of adulthood. The length of time from oviposition to the emergence of the adult varies from 51 to 177 days in P. punctata and periods of a year in the genus Hyptia, which seems to have only a single generation.

It was necessary to dissect the roach capsules to study the immature stages of the evaniids, and this dissection resulted in the death of the parasite. Descriptions and drawings of the immature stages were made from preserved specimens.

The Egg. In Prosevania punctata a single egg is deposited in the roach egg capsule. The female wasp inserts her ovipositor through the hard outer covering of the roach ootheca after it is dropped. The parasite egg has been found by the writer between the roach eggs, rather than inserted inside a roach egg. The position of the evaniid egg in the roach egg capsule depends on the position assumed by the wasp in ovipositing, and it varies from capsule to capsule.

The oviposition pattern of Prosevania differs from that of Zeuxevania splendidula Costa, which develops in the egg capsules of Loboptera decepiens Germ. in Europe. Genieys (1924) described splendidula as depositing its eggs⁴ in the capsule of the roach before the cover is completely hardened.

The egg of Prosevania punctata is rather spindle-shaped in outline and is slightly curved (Pl. 2, Fig. 1). Both ends of the egg are smoothly rounded, and the chorion or outer covering is smooth. The egg is grayish white, with the narrow end lighter in color. Clausen (1940) applies the name "hymenopteriform" to this shape of egg.

⁴ Genieys reports that splendidula normally deposits an egg inside of each roach egg contained in the capsule.

The Prosevania egg is about 1.26 mm. in length and 0.25 mm. in width. It appears to be very large to have passed through the slender ovipositor and this size relation might account for the length of time required for oviposition.

In dissecting the abdomen of a wild-caught female wasp, masses of white eggs were found in two ovaries, one ovary contained five eggs and the other nine. These eggs appeared to be in various stages of development, some very small and others ready for oviposition. The eggs inside the abdomen were pearly white in color.

Larval Stages

First Larval Instar. The first instar larva of Prosevania (Pl. 2, Fig. 3), two weeks after oviposition has occurred, is small and almost spherical in shape. It is 3 mm. in length and about the same width, making it appear like a small white ball. There are two lateral ridges on the larva which project out and can be seen easily. On the ventral surface of the first instar larva is a small slightly projecting area around the edge of which is a ring, a little darker in color than the white body of the larva.

The first larval instar has a smooth integument with

no visible spines or setae. Segmentation is difficult to determine on the compact ball-like larva, but is distinct enough for one to make out 12 body segments (including the one with mouth parts). The body is white in color. A pair of light brown mandibles occur on the first segment. They are opposable and are of a simple one-toothed type (Pl. 2, Fig. 2). There are a few small brown patches around the mouth parts. The definitive head is not evident at this stage of development. The digestive, nervous, and tracheal systems appear whitish in color, and are not clear through the body integument.

Subsequent Larval Instars Except Last. Development after the first instar tends toward a typical "hymenopteriform" type. The principal change to the hymenopteriform type seems to occur in the second instar in P. punctata.

The writer was unable to establish positively the number of instars of P. punctata. An attempt to break the larvae into groups on the basis of head capsule was futile. Definitive morphological characters for accurately separating the larvae between the first and last instars are exceedingly difficult to detect and those that exist do not appear to be without exception. The best statement that the writer is able to make is that there are at least three and probably four instars.

Second Instar Larva. After the first larval stage is passed the development of the parasite is very rapid. The mouth parts are of a chewing type and the roach eggs are consumed rapidly. At temperatures of around 80° F. the second instar appears to last no more than a day or two.

The second larval instar, in comparison with the first has become elongated and grayish-white in color. The tracheal and nervous systems are obscured by the development of fat bodies. There are twelve indistinct body segments and a head.

Shortly after transformation the second instar larvae are approximately the same size as fully developed first instar larvae but are longer and more slender. There is little evidence of wings or legs. Mandibles with three denticles have replaced the one simple tooth found in the first instar larva.

Third Instar Larva. The third larval instar (Pl. 2, Fig. 5) is similar to the second larval instar but larger and more robust. White and indistinct tracheal openings are present. The head is well differentiated and easily recognizable, but lacks any sign of eyes. The wing buds and leg buds are evident but are small and difficult to distinguish.

This larval instar appears to be a definite inter-grade between the second and fourth instars. It shows characteristics of wing buds and legs not found in the second instar, but it does not possess the eyes, size, or is as clearly differentiated as the fourth larval instar.

The mandibles of the third instar larva are similar in appearance and shape to those of the fourth instar but are smaller.

Fourth Larval Instar. The last instar larvae are dull creamy white in color. The body is thickest near the mid-region, and is attenuated somewhat at the ends. The head is well developed and bears dark brown sclerotized mandibles which have three denticles (Pl. 2, Fig. 4). There appear to be twelve segments and a head. Each body segment is extended dorsally to form a projection, giving the effect of a series of humps on the back when the larva is viewed laterally. A groove extends down the sides of the body from head to tail, making the larval body appear to be divided into plates (Pl. 2, Fig. 6).

The tracheal system of white tubes can be partially seen through the integument. In some of the larvae a system of indistinct white tracheal openings can be noted between the segments. These tracheal openings are found between each pair of body segments from the first to the

tenth. No tracheal openings were observed between the 10th and the 11th or the 11th and 12th segments. As far as could be determined the larvae of P. punctata have nine tracheal openings on each side of the body.

In this stage of development the wings are evident as sac-like outpouchings of the body, and the legs are discernable as small projections on the ventral side of the first three body segments. The eyes are present but lack pigment.

The larva is completely covered by a clear transparent membrane. This is probably the outer cover which has been distended because of some effect of the killing solution. This membrane is firmly attached around the head region and was very difficult to remove without destroying the specimen.

Several last instar larvae were found to vary from 8.5 to 10.0 mm. in length and from 3.8 to 4.5 mm. in width.

Pupal Stages. Upon dissecting the egg capsule the pupa was observed in all instances resting upon a spongy, homogeneous, gray mass which fills the curved portion of the egg capsule opposite the ridge. This substance was soft, easily broken up, and probably consisted of an accumulation of waste products from the larval stages.

The pupa of P. punctata was found to be of an exarate type, with the wings and legs from from any secondary attachment to the body. The pupa when removed from the egg capsule was found to be covered with a brown membrane which could be removed easily with a needle.

Early Pupal Stage. In the early pupal stage (Pl. 3, Fig. 1) the evaniid is pure white in color except for the eyes; the eyes begin to darken almost immediately, turning red and then black. The wings, legs, and antennae are distinct and well formed. The most distinguishing feature of the early pupal stage is that the abdomen is connected to the thorax by a broad base; there is little or no evidence of the narrow constriction evident in later pupal and adult stages. The abdomen shows no evidence of external segmentation. The mouth parts are evident and well defined but lack pigment. On the underside of the caudal end of the abdomen the external genitalia appear as small white rod-like extensions. The ocelli are indistinct.

Intermediate Pupal Stage. As the pupa develops (Pl. 3, Fig. 2) there is an increase of pigmentation in some parts of the body. The head and thorax turn black, the petiole dark brown, while the abdomen remains white. The legs become dark brown at the base and lighter distally. The antennae remain white. The mouth parts

become pigmented and the mandibles distinct. At this stage of development the abdomen is connected to the thorax by the narrow constricted petiole characteristic of the adult. The abdomen is still round and is just beginning to show the development of plates and segmentation. The ocelli are distinct and are reddish brown in color.

Late Pupal Stage. In the late pupal stage (Pl. 3, Fig. 3) the pigmentation of the body is nearly completed. The last portions of the body to turn black are the antennae, the middle region of the abdomen, and the tips of the legs. The thorax and petiole become black before the abdomen begins to darken. In this late pupal stage there are two rows of dark plates forming on the abdomen. Seven of these plates appear dorsally and seven ventrally, indicating that the abdomen is seven segmented. The segmentation of the abdomen becomes difficult to see after fusion has occurred. The two rows of plates are separated by a white unsclerotized area as seen in Pl. 3, Fig. 3. The ocelli have become black. The external genitalia appear as a group of small projections on the under side of the abdomen. The abdomen is still round but as the sclerites develop the abdomen begins to compress laterally and gradually the white area is covered and enclosed.

The principal external changes that occur in the pupa as it increases in age are: progressive darkening and sclerotization, and distinct segmentation.

Seasonal Abundance

The first adults of Prosevania punctata emerged in the field during the last two weeks of May and the first week of June in 1951. During this three-week period adults were collected in Columbus, Ohio, and roach capsules exposed to these parasites. Oviposition took place into many of these capsules. These oothecae were incubated in a screened insectary under conditions as natural as could be obtained, and were observed closely for any emergence.

The first adult wasp emerged from an egg capsule on July 17, 1951. Eleven wasps emerged during a period of nine days from July 17 to July 26. These capsules had been parasitized in late May or early June, so the parasites were from 50 to 60 days in developing. At approximately the same time that these wasps emerged in the insectary, several additional specimens were collected under natural conditions from buildings. No adults were collected by the writer in the period between broods.

The adult parasites which emerged in the rearing jars were placed in a cage, and again numerous egg capsules were exposed for oviposition. On September 24, an adult Prosevania emerged from a capsule parasitized on July 28, 59 days previously.

By checking all available collection records in the Insect Collection of the Department of Zoology and Entomology of The Ohio State University, the Ohio State Museum, and the writer's personal collection, the following data were obtained. There were no collections of Prosevania punctata earlier than May 12, and the latest (by the writer) was made on October 9. This leaves a period of seven months during the cold part of the year, in which no adults have been collected.

It is assumed from the rearing records and the collection data that in 1951, there were three generations of Prosevania punctata in the vicinity of Columbus, Ohio. The first group emerged in late May and early June, the second group in mid-July, and the third group in late September and the first part of October.

Under laboratory conditions a generation of Prosevania was obtained in January, 1952. There are no collection records of wasps during this time of the year, but it is probable that such a generation could emerge under natural conditions if the environmental conditions were favorable.

The first adult Prosevania punctata in the spring of 1952 was observed and collected on the window of a building on The Ohio State University campus, on June 4, nearly two

weeks later than the earliest record obtained in the spring of 1951.

As far as could be determined, Hyptia has a single generation per year. Hyptia thoracica was found to emerge around the middle of June, from June 10 to June 20. Egg capsules of Parcoblatta pensylvanica collected on August 18, 1951, by C. A. Triplehorn were candled and found to contain evaniid larvae in a fairly advanced stage of development. These larvae overwintered in the egg capsules kept in an insectary and the adults did not emerge until the spring of 1952.

Adults of Hyptia are usually collected during the midsummer months in the woods, on flowers, or feeding on honey-dew. Townes (1949) states that the species of Hyptia appear to have a single generation a year in the north, although rearing records are scanty.

Effect of Parasitism on the Host

The hosts of Prosevania punctata are known to be the egg capsules of both the American and Oriental roaches. This has been established by rearing, and also by observing oviposition by this species into both kinds of capsules. The host of Hyptia thoracica is the egg capsule of the wood roach. Many of these parasites were reared from capsules of the wood roach which had been collected under natural conditions. From these observations, plus those made by other workers on various species, it can be stated that the Evaniidae are primarily parasites of roach egg capsules.

Parasitized egg capsules give no gross external indication of parasitism. The only conclusive method for determining whether an egg capsule is parasitized or not is by dissection. This is particularly true in the younger stages of the parasite before it has consumed much of the contents of the capsule.

Examinations made of egg capsules after the adult wasps have emerged demonstrates a similarity in appearance and the result of parasitism. The entire contents of the capsule are consumed during the period of larval feeding. The evaniid larva is assumed to be an egg predator, feeding

on one after another of the roach eggs. The speed with which this process of feeding is carried on is dependent upon temperature and humidity conditions. The warm temperatures of mid-summer cause the most rapid development. The per cent of parasitism in Prosevania is difficult to determine. It was possible with Hyptia thoracica to determine the per cent of egg capsules which contain over-wintering parasites. During the winters of 1949-50 and 1950-51 extensive collections of egg capsules were made from under the bark of dead trees, as shown in Table III. These capsules were collected in Franklin and Delaware Counties, Ohio. No Evaniidae were reared from capsules collected in 1949-50; however, in the 1950-51 collection 31 evaniids emerged from 458 capsules, giving an approximate parasitism of 6.7%.

A similar collection of 320 egg capsules was made during the months from August, 1951, through May, 1952, as shown in Table IV. These capsules were collected in Franklin, Delaware, and Allen counties, Ohio, under situations similar to those described above. Evaniidae emerged from 9 capsules, giving an approximate parasitism of 2.8 per cent.

The evaniid larva destroys anywhere from 8 to 40⁵

⁵ Piquett and Fales (1952) give the following data on the number of eggs contained in the capsule of various roach species; German - 40, American - 16, Oriental - 8. There is considerable difference in numbers by various authors.

Table III

Parasitism of wood roach egg capsules collected
in Franklin and Delaware Counties, Ohio,
during 1950 and 1951.

Date	Egg Capsules Collected	Capsules Parasitized by Evaniidae	Capsules Parasitized by Other Parasites	Capsules Showing Previous Emergence*
10-29-50	4	0	1	1
3-18-51	58	11	2	1
3-23-51	26	7	1	3
3-28-51	36	0	0	0
4-20-51	140	5	7	3
4-21-51	6	0	0	0
4-27-51	184	7	4	4
5-5-51	3	0	1	0
5-7-51	1	1	0	0
TOTAL	458	31	16	12

*Capsules showing previous emergence are not included in the percentage of parasitism as stated in the body of the paper.

Table IV

Parasitism of wood roach egg capsules collected in
Franklin, Delaware, and Allen Counties, Ohio,
during 1951 and 1952.

Date	Egg Capsules Collected	Capsules Parasitized by Evaniidae	Capsules Parasitized by Other Parasites	Capsules Showing Previous Emergence*
8-8-51	16	2	0	1
10-28-51	5	1	0	1
12-1-51	11	2	3	1
1-15-52	26	0	1	4
3-20-52	148	2	4	22
3-30-52	48	0	5	4
4-27-52	48	0	5	6
5-16-52	18	2	1	4
TOTAL	320	9	19	43

*Capsules showing previous emergence are not included in the percentage of parasitism as stated in the body of the paper.

potential roaches, depending on the number of eggs in the oothecae of the species parasitized. As far as is known, no attempt has been made to utilize these parasites as biological control agents for roaches.

Summary

The Evaniidae are parasitic during their immature stages in the egg capsules of roaches. Prosevania punctata and Evania appendigaster parasitize the egg capsules of domestic roaches. Several species of Hyptia parasitize the egg capsules of wood roaches. The hosts of the genus Evaniella are still unknown.

The evaniid attacks the egg capsule and inserts a single egg after it has been dropped by the roach. The time required for evaniid oviposition varies from 16 to 62 minutes. The immature stages of evaniids are spent in the egg capsule, and the adult emerges by chewing a hole through the wall near one end. The only stage spent outside of the egg capsule is the adult, which in captivity was fed successfully on honey water and flowers.

Oviposition by an unfertilized female Prosevania punctata was noted during this study. A virgin female oviposited into roach capsules shortly after she emerged. The parthenogenesis was natural (spontaneous), and complete. Only male offspring resulted.

Evaniids were found to overwinter in the roach egg capsules. Hyptia thoracica and Hyptia harpyoides overwinter

in oothecae of wood roaches as last instar larvae. Prosevania punctata overwinters as a last instar larva or pupa in the egg capsule of the American or Oriental roach.

The evaniid adult deposits a single egg between the roach eggs inside the ootheca. This egg is spindle-shaped in outline and slightly curved, 1.26 mm. in length and 0.25 mm. in width. The first instar larva is spherical in shape, 3 mm. in length and width. The second instar larva is elongate, a more typical hymenopterous larva. The third instar larva is believed to be similar to the second but is larger with more distinct segmentation and small appendage buds. The fourth larval instar is from 8.5 to 10.0 mm. in length, and 3.8 to 4.5 mm. in width; tracheae open on the first to tenth body segments, the head is well developed, and wing and leg buds are present.

The evaniid pupa is of an exarate type. As it develops the color gradually changes from white to black, and the abdomen constricts at its base to form a narrow petiole.

Hyptia thoracica and H. harpyoides parasitized 6.7% of the native wood roach capsules collected during the winter of 1950-1951, and 2.8% of the capsules collected during the winter of 1951-1952. Three other species of Hymenoptera and some Diptera were also reared from wood roach egg capsules.

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Plate 1

Adult

Figure 1. Prosevania punctata

Lateral view of adult female. 9X

Figure 2. Prosevania punctata

Lateral view of adult male. 9X

Most of the illustrations of the various life cycle stages were drawn with the aid of a camera-lucida attached to one side of a dissecting microscope. This binocular eyepiece had a reading of 12X and the objective used has a power of 1X.

PL. I.

Plate 2

Immature Stages

- Figure 1. Prosevania punctata, Egg. 14X
- Figure 2. Prosevania punctata, Mouthparts
of first instar larva.
- Figure 3. Prosevania punctata, Lateral
view of first instar larva two weeks
after oviposition. 13X
- Figure 4. Prosevania punctata, Mouthparts
of fourth instar larva.
- Figure 5. Prosevania punctata, Lateral
view of third instar larva. 12X
- Figure 6. Prosevania punctata, Lateral
view of fourth instar larva. 10X

PL. 2

Plate 3

Immature Stages

Figure 1. Prosevania punctata, Lateral
view of early pupal stage. 9X

Figure 2. Prosevania punctata, Lateral
view of intermediate pupal stage. 9X

Figure 3. Prosevania punctata, Lateral
view of late pupal stage. 9X

PL. 3

Plate 4

Morphology

- Figure 1. Prosevania punctata, Lateral view of female abdomen cleared in KOH. 12X
- Figure 2. Prosevania punctata, Wings, showing large anal lobe in hind wing. 9X
- Figure 3. Prosevania punctata. Lateral view of female abdomen. 12X
- Figure 4. American roach capsule with P. punctata emergence hole near the end. 9X
- Figure 5. Diagramatic drawing of position assumed by Prosevania punctata while ovipositing. 9X

PL. 4

Plate 5

Distribution

Figure 1. Known distribution of
Prosevania punctata throughout
the United States.

Figure 2. Known distribution of
Prosevania punctata throughout
Ohio where this study was made.

PL. 5

Figure 1.

Figure 2.

Plate 6

Photograph of adult Hyptia thoracica
(Blanchard), chewing an emergence hole
through the wall of an egg capsule of
the wood roach Parcoblatta pensylvanica
(De Geer). From a kodachrome by
D. J. Borror.

Plate 6

Plate 7

Laboratory Methods and Equipment

Figure 1. Vial incubation rack, open. A flat wooden box made of two identical halves which are hinged at the back. On the inside of each half of the box are lateral wooden braces, in which are drilled holes for holding vials.

Figure 2. Vial incubation rack, closed. When closed the identical halves fit together to form a flat small box which can be transported with ease.

Plate 7

Figure 1.

Figure 2.

Plate 8

Figure 1. Vial racks. These racks were used to hold the vials containing preserved materials. In front of the vial racks are three 8-dram shell vials of the type used in studying small parasites.

Figure 2. Glass tumblers, 8 oz. The mouth is covered with cheese cloth held in place by a rubber band. Large numbers of wood roach egg capsules were incubated in this type of container.

Plate 8

Figure 1.

Figure 2.

Plate 9

Figure 1. A fine mesh wire screen cage with a wood frame and a glass top.

Figure 2. Two sleeve cages used for observation of adult Evaniidae. This type of cage was also utilized for oviposition.

Plate 9

Figure 1.

Figure 2.

Plate 10

Figure 1. Two five-gallon glass jars. The bottom of each jar was covered with saw dust. The sides were greased with vaseline, and the top was covered with cheese cloth held in place by a rubber band. These jars were used to culture roaches.

Figure 2. Two five-gallon glass jars and a smaller one-gallon battery jar. The roaches carrying egg capsules were transferred from the larger jars to the smaller one. When the egg capsules were dropped, they could be readily seen and collected.

Plate 10

Figure 1.

Figure 2.

Biography

I, Lafe R. Edmunds, was born in Salt Lake City, Utah, June 22, 1924. I received my elementary and secondary school education in the public schools of Salt Lake City, where I attended grade school, Junior High School, and Senior High School. My undergraduate training was obtained at the University of Utah, from which I received the degree of Bachelor of Science in 1947, and a degree of Master of Science in 1949. I am married, twenty-eight years of age, and have no children.

From 1943 to 1945 I was in the armed forces of the United States. During this time I spent one year at the University of Arkansas in the Army Specialized Training Program, my course of study during this time was general. At the end of the war, I was sent to the University of Sheffield, in England, for a three months course in General Zoology. After the war, in 1950, I was commissioned as an Entomologist, and commanded a Preventive Medicine Company for six months in 1951.

In 1947 I received an appointment to a Graduate Fellowship in the Biology Department of the University of Utah, and in 1949 an appointment as a Graduate Assistant at The Ohio State University, a position which I held for three years. During the year 1942 I was employed as an

Entomologist by the Salt Lake City Mosquito Abatement District, and during the summer of 1941 I worked on grasshopper control for the state of Utah. In August, 1952, I was commissioned as an Assistant Sanitarian, and went on active duty with the United States Public Health Service, a position which I hold at the present time.