THE GENUS METEORUS IN ARIZONA
(HYMENOPTERA: BRACONIDAE)

by

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A Thesis Submitted to the Faculty of the
DEPARTMENT OF ENTOMOLOGY
In Partial Fulfillment of the Requirements
For the Degree of
MASTER OF SCIENCE
In the Graduate College
THE UNIVERSITY OF ARIZONA

1974
STATEMENT BY AUTHOR

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APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

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Professor of Entomology

Date
ACKNOWLEDGMENT

I wish to express my sincere appreciation to Dr. F. G. Werner, Department of Entomology, University of Arizona, Tucson, for his advice and contributions throughout this study. I thank Dr. G. Ware, Head of the Department of Entomology, for his encouragement and guidance during the course of my graduate program. I also wish to thank Dr. R. E. Fye of the U.S.D.A. Cotton Insects Laboratory, Tucson, for his helpful suggestions for laboratory and field investigations. Thanks are also due to Dr. W. L. Nutting, Department of Entomology, University of Arizona, Tucson, for serving on my committee and reviewing this manuscript.

I am indebted to Dr. P. M. Marsh at the U.S. Department of Agriculture, Washington, D.C., for his helpful collaboration in providing specimens of Meteorus needed for this study.

Finally, I wish to thank my wife, Kone Karidia, for her patience and understanding during the course of my study.
Soma Ouattara was born in Bongouanou (Ivory Coast), on January 29, 1940. He attended primary school in Bongouanou and Sindou and graduated from La Salle High School at Ouagadougou, Upper-Volta, in 1963.

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He is married to former Kone Karidia and they have one son.
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ABSTRACT

Three laboratory-raised noctuid larvae [Spodoptera exigua (Hübner), Orthodes melanopis Hampson, and Agrotis ypsilon Rott.], were exposed to mature female Meteorus leviventris (Wesmael) for parasitization.

Meteorus leviventris showed an interest for only its natural hosts, Spodoptera exigua and Agrotis ypsilon, from which larval development of the parasite was obtained. The pupal and adult stages of Meteorus leviventris were difficult to obtain because of the conditions of rearing.

A biological sketch of the genus Meteorus (Hymenoptera, Bracanidae) is developed on the basis of data from laboratory rearing and bibliographical studies.

Eight Meteorus species occurring in Arizona are described, and a simplified key for their recognition is developed.

Descriptions of two new species of Meteorus determined by Muesebeck are also provided.
INTRODUCTION

The genus Meteorus\(^1\) belongs to the subfamily Euphorinae (Hymenoptera, Braconidae). This genus was first described by Haliday (1835: 24), as a subgenus of Perilitus. The genus is characterized as follows: the forewings with three cubital cells; the basal vein straight at anterior end, curving sometimes at posterior end before reaching medius (Marsh 1971:845). The radial cell is longer than the stigma. The posterior wings have a long narrow radiellan cell, which narrows toward the apex (Muesebeck 1923:3). The maxillary palpi are 6 segmented, and the labial 3 segmented (Haliday 1835:24). The number of antennal segments is always more than 18 (Muesebeck 1936:5). Meteorus has the mandibles normal, their tips touching when closed, the opening between mandible and clypeus closed; the labrum not concave. The abdomen is petiolate, the terga separated by more than three distinct sutures, not carapace-like (Marsh 1971:841). The first abdominal tergum is broadened strongly beyond middle; the lateral margins of the second tergum are carinate (Muesebeck 1936:5). The spiracles of the first abdominal tergum are situated on the lateral edge of a sclerotized median plate (Marsh 1971: 841).

Since Foerster's classification (1862:225) the genus Meteorus had been placed in a separate subfamily, the Meteorinae. It was not until 1936 that Muesebeck definitely combined the Meteorinae (having 3

\(^1\) According to Haliday (1835:24), the appellation Meteorus is given to this genus because of its suspended pupal case.
cubital cells) with the Euphorinae (having 2 cubital cells). Muesebeck (1923:7), revising the genus Meteorus described 31 species occurring in North America. The first five species in Muesebeck's classification are now considered as belonging to the genus Zemiotes Foerster by Mason (1973:213).

Most of the species of Meteorus are known to be parasitic chiefly on lepidopterous larvae (Muesebeck 1936:1). This is true of all of the species recorded from Arizona. Some, however, have been recorded as parasitic on coleopterous larvae: M. hypophloei Cushman on Hypophloeus parallelus Melsh., a tenebrionid; M. humilis (Cresson) on another tenebrionid, Platydema ellipticum Fabricus, and on Orchesia castanea Melsh., a melandryid (DeLeon 1933:32); the last species is also attacked by M. terebratus Muesebeck (1923:25).

The broad range of hosts attacked by the members of this genus gives to Meteorus some importance as a controlling factor of some injurious insects. Meteorus leviventris Wesmael parasitizes several cutworms locally (King and Atkinson 1928:171). Meteorus hyphantriae Riley gave very good results against the fall webworm2, Hyphantria cunea Drury (Riley 1886:253). Meteorus loxostegei Viereck is an important endoparasite of the sugar beet webworm, Loxostege sticticalis (Linnaeus) (Simmonds 1947:373), and Meteorus versicolor (Wesmael) was introduced into the United States to control the brown-tail moth, Nygma phaeorrhoea (Donovan), and the satin moth Stilpnotia salicis (Linnaeus) (Muesebeck 1936:2).

2. All common names have been taken from Blinckenstaff 1965.
The effectiveness of such control resides in the fact that Meteorus attacks its host at the larval stage without discriminating sizes (Simmonds 1947:374). Parasitized larvae are affected in their normal development. They are not killed directly, but are prevented from pupating (McGugan 1955:179, Johnson 1959:82).

The life cycle of Meteorus follows the normal pattern of insects with complete metamorphosis, the Holometabola. The pupal stage is spent in a cocoon (Muesebeck 1923:6). Adult Meteorus are found in the field during early spring. They usually overwinter in the host (Simmonds 1947:374).

Species of this genus seem to be widely distributed. Their biology and ecology have been poorly studied, and it is certain that a great number of new species are still undescribed.

The aim of this thesis is to provide a biological survey of the genus Meteorus on the basis of data obtained from laboratory rearing of Meteorus leviventris, to give a taxonomic study of eight species of Meteorus occurring in Arizona, and to propose a description of two species collected by G. Butler and F. G. Werner, and determined by Muesebeck as new species.
METHODS AND MATERIALS

The techniques and approaches used for the biological and taxonomic studies are quite different and can be considered separately.

Taxonomic Study

Most of the Meteorus species used and described are preserved in the collection of the University of Arizona. Eleven identified Meteorus belonging to the following species: fumipennis, indagator, dimidiatus, acronyctae, euschasiae, and hyphantriae, loaned by the United States National Museum, were utilized as reference for more authentic descriptions. The insects were described by observation under a Bausch and Lomb Stereozoom binocular microscope, with 15x eyepieces and 0.7-3x magnification range. The magnification used for the measurement was 40.5x. This corresponds to 0.25 mm for the large divisions of the Whipple ocular micrometer utilized, and 0.05 mm for the small divisions. Dimensions exceeding 2.5 mm, such as the total length of each individual species, have been measured under 19.5x magnification, which gives 0.5 mm for the large divisions and 0.1 mm for the small. The main characteristics of the species have been represented on drawings and diagrams. Wing diagrams were sketched from some specimens in the University of Arizona collection. The wings were softened and mounted on a slide. Their images were projected on tracing paper with a Bausch and Lomb Tri-Simplex microprojector. Other parts such as legs, petiole of the abdomen, head and mouth parts, were drawn from photographs taken with a
Zeiss Contarex\textsuperscript{R} 35 mm camera mounted on an Olympus trinocular stereo-
microscope. Magnifications of 16x, 25x, and 40x were used. The photo-
graphs were produced by:

1. printing on light weight Kodabromide paper. The main characters
   were outlined with a pencil. The print was then placed in a
   solution of potassium ferricyanyde and Kodak\textsuperscript{R} fixer for bleach-
ing. The diagram obtained was then reproduced on tracing paper
   with a KOH-I-NOOR Rapidograph\textsuperscript{R} technical pen.

2. a standard developing and printing process on single weight F-2
   Kodabromide paper. The print was outlined with the KOH-I-NOOR
   Rapidograph pen and reproduced on tracing paper.

**Biological Study**

Adult Meteorus were collected between April 16 and May 26, 1974 from
several field collections in the vicinity of Tucson. No Meteorus spp.
were captured at black light or in sweeping prior to April 14. Lack of
early emergence from hibernation probably accounts for the early ab-
sence. The species collected were determined and sexed. Meteorus
leviventris (Wesmael), which comprised the great majority of the speci-
mens collected, was selected for experimentation. The choice of this
species was also influenced by its broad range of lepidopterous hosts.
After collecting, the Meteorus were transferred to rearing cages of the
type developed and utilized by the U.S.D.A. A.R.S. Cotton Insect Bio-
logical Control Laboratory, located near the University of Arizona Campbell
Avenue Farm. The cage consists of a one pint cylindrical paper food
container screened with nylon organdy on the ends. Each cage was fitted
at the top with a 10 cc inverted vial filled with a 10% levulose solution, which served as diet for the Meteorus. A piece of sponge was inserted into the vial to absorb the levulose solution and allow the insects to feed readily. A second opening at one side of the cage was closed with a piece of cork that could be removed for introduction of larvae (Figures 1, 2). Four cages containing 5 Meteorus per cage (3 females and 2 males) were utilized. Every 2 days 25 laboratory-raised host larvae were introduced in each cage and exposed to parasitization for 24 hours. An average of 200 fourth instar larvae were treated per week.

The larvae were then removed from the cages and placed on diets in 25 ml plastic cups. Each cup contained about 1 ml of lima bean diet. According to Patana (1969:1), the composition and procedures for a gallon blender batch of the diet were as follows:

1. 30 grams gelcarin was suspended in 1200 ml of boiling water.
2. 1200 grams of soaked baby lima beans were placed in the blender.
3. The following dry materials were then added:
   120 grams of brewer's yeast
   12 grams of methyl-para-hydroxybenzoate
   12 grams of ascorbic acid.
4. 4 milliliters of formaldehyde and 1200 ml of hot tap water were added to the above materials.
5. 4 grams of sorbic acid were added.
6. The mixture was blended in an electric blender for four minutes.

3. For convenience, all figures have been placed at the end of the text, p. 50-60.
7. Then the boiling gelcarin mixture was added to the mixture, and blended for about 2 minutes to bring it to 100°F. The hot diet was then dispensed with pressure into 9/10, 1, 8, and 16 ounce cups.

One larva exposed to parasitization was placed in each cup, which was then covered with a paper top and placed in a rearing cabinet. The temperature of the cabinet was 85°F, with a relative humidity of 60 to 70%. Daily observation was made to determine the growth of larvae, and the effect of parasitization. Pupating unparasitized larvae, and dead larvae, were discarded from the experiment.

The following collections of new Meteorus were made to maintain a workable number of parasites in the cages: April 16, UV light, at Old Tucson: 3 Meteorus females. April 26, UV light, Tucson vicinity: 5 Meteorus (3 females and 2 males). May 1, sweeping on alfalfa, at the University of Arizona Experimental Farm: 8 Meteorus (5 females and 3 males). May 13, sweeping on alfalfa, at the University of Arizona Experimental Farm: 12 Meteorus (8 females and 4 males). May 17 and May 26, sweeping on alfalfa at the University of Arizona Experimental Farm: 6 Meteorus (3 males and 3 females) and 9 Meteorus (7 females and 2 males), respectively.

Hosts Utilized

Three species of lepidopterous larvae were utilized as hosts: Spodoptera exigua (Hübner), Noctuidae; Orthodes melanopis Hampson, Noctuidae; and Agrotis ypsilon Rott., Noctuidae. Third, fourth and fifth
larval instars were tested as hosts. The third and fourth instars were fully utilized throughout the experiment.

From April 18 to May 11, 1974, only Spodoptera larvae were utilized. Orthodes and Agrotis were added to the experiment on May 12 and 14, respectively. The larvae of Agrotis and Orthodes were obtained from eggs laid by adult moths collected at UV light on April 25 and 29 at Tucson by Dr. F. G. Werner. The first instar larvae of Orthodes were obtained on May 1, those of Agrotis on May 3, and the third instars were obtained on May 10 and 11. Those stages were utilized for the experiment, and exposed to Meteorus. The experiment can be divided into six series of treatments, corresponding to the introduction of new Meteorus in the cages after a field collection (Table 1).
Table 1. Six series of treatments corresponding to the introduction of new Meteorus in cages after a field collection.

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<th>Date of Collection</th>
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<td>On May 8, four Meteorus larvae were obtained from April 28 series.</td>
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<td>On May 25, one Meteorus larva was obtained from Agrotis larvae from May 12 series but died buried in the medium.</td>
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<td>Treatment Series</td>
<td>Field Collection Source</td>
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<td>Number of Cages</td>
<td>Date of Parasitization</td>
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<td>Sweeping on alfalfa, U.A.</td>
<td>2</td>
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RESULTS AND DISCUSSION

Results

The results obtained were limited to the emergence of *Meteorus* larvae in only two of the six series of treatment in the experiment.

During the night of May 8, 1974, four *Meteorus* larvae emerged from *Spodoptera* larvae parasitized on April 28, 1974. The larvae emerged from the lateral side of the 6th and 9th abdominal segments of the host (Figure 3), but died without spinning any cocoon. Observed under a microscope, the *Meteorus* larva appears to be cylindrical, segmented, curved, and tapered slightly at both ends. The average length measured was 4 mm, and the largest part of the body was 1.5 mm wide (Figures 4, 5, 6). The anterior part was dark, marked dorsally by two large round spots. At the anterior end a long silky thread, used probably for cocoon construction, was emerging.

On May 25, 1974 one larva of the same type emerged from *Agrotis ypsilon* parasitized on May 12, 1974. Host larvae from other treatments pupated normally, without showing any sign of being parasitized.

Discussion

No adult *Meteorus* were obtained, perhaps because of the wet condition of the medium on which they were raised, or due to the fact that parasitized host larvae were in a "pupating cell" formed in the medium at the moment of *Meteorus* emergence. Muesebeck (1923:5) explained that under natural conditions, *Meteorus* spins a cocoon which is suspended
from small branches of trees. In an attempt to create an adequate condition for cocoon spinning according to this habit of the parasite, a piece of filter paper was introduced into each cup containing a parasitized host larva. This paper should have provided support and a dry surface to hang on to the newly emerged Meteorus larva. No noticeable result was obtained. The major handicap was the behavior of the parasitized host larvae, which remained buried in a "pupating cell" most of the time. No dissections of host larvae were made to observe the intermediate stages of Meteorus larvae, because of the limited number of parasitized larvae.

According to Simmonds (1947:374), the egg of Meteorus loxostegei at oviposition is ovoid, elongate, and measures about 0.20 mm long and 0.08 mm in greatest width. DeLeon (1933:35), describing the biology of Meteorus hypophloei, indicated that the eggs of this species are oval in shape, 0.35 mm in length and 0.1 mm wide.

The first instar larva of Meteorus loxostegei described by Simmonds (1947:375), appears to be elongated, twelve-segmented, with a caudal appendage. Simmonds stated that, on hatching, the larvae measured 3 mm in length and that the mandibles of this stage were well developed.

Second instar larvae differed from the first by having small mandibles, and degenerated caudal appendages. The growing larvae of this stage measured 6 mm long and 1 mm wide. When larvae reach the third instar, they are about 6 mm in length and 1.5 mm in width (Simmonds 1947:376).
Parker (1931:98) gave an average time of 24 days for *Meteorus nigricollis* to develop from egg to cocoon, and 21 days from cocoon to adult. In our observations with *Meteorus leviventris*, the times required from egg to last instar larva were 11 days on *Spodoptera exigua*, and 14 days on *Agrotis ypsilon*. Larvae did not develop in *Orthodes melanopis*, which has never been recorded as a host species.

The difficulties encountered in obtaining adult *Meteorus* are probably due to the conditions of rearing.
The members of the genus *Meteorus* are for the most part internal parasitoids of lepidopterous larvae. The success of such parasitism resides in the synchronization of the *Meteorus* life span with that of its hosts. Thus, during winter, the parasite remains within the host and the last larval instar emerges during spring, and spins a cocoon, from which an adult *Meteorus* emerges. Mating occurs after emergence from the cocoon and females oviposit in host larvae of all sizes.

**Oviposition**

Matthews (1974:23) explained that, in search for a host, "parasitoids" are mostly attracted by the habitation which it lives. This attraction, he clarified, is augmented by "chemical and kairomonal odors" released by the host. The kairomonal source is supposed to be located in the mandibular glands. Besides this chemical stimulus, *Meteorus*, like most insects, uses fully its tactile organs for host location and selection. Vinson and Lewis (1965:871) stated that a host larva previously parasitized by a *Meteorus* is usually discriminated against by other females. This rejection, they added, is caused by a change in the host hemolymph, or by the effect of a chemical which is injected by the parasite during the oviposition process. According to Askew (1971:183) the egg is laid in the host hemocoel. Usually one egg is laid at one time (Tobias 1965:500). Patrick and Oatman (1972:991), have demonstrated that oviposition occurs only upon contact with the host larva,
and that some specific chemical or physical properties of the host are required to induce oviposition. They also observed that, during oviposition, the parasite injected a secretion which is supposed to inhibit superparasitism. This secretion might be the same described by Matthews (1974:24) as "Search Deterrent Substance" (S.D.S.). Patrick and Oatman (1972:992) noticed that larvae which failed to receive an egg can sometimes be injected with this secretion, which can act as a deterrent to further oviposition.

**Larval Development**

After hatching the larvae of *Meteorus* develop in a very short time, their growth constantly correlated with the behavior of the host larva. Thus Simmonds (1947:378) remarked that the parasite within the host develops rapidly to the end of the first larval stage, and usually remains in this stage until the pupation process of the host starts. Then the full growth of the parasite takes place until the last larval stage. Simmonds observed also that if the host goes into diapause while the parasite is in the first instar, no further development occurs until the diapause is broken. Parasitized host larvae are easy to recognize. Simmonds (1947:376) noticed that when *Loxostege* is parasitized by *Meteorus loxostegei*, host larvae do not attain the same size as full grown unparasitized larvae. McGugan (1955:179) explained that *Meteorus* influences the development of larvae attacked during the late fifth or early sixth instar. These larvae stop feeding at about the time unparasitized larvae are pupating. Johnson (1959:82) suggested that such retardation in development could be brought about by the concentration of
juvenile hormone. We have observed that, after Meteorus leviventris had emerged from Spodoptera larvae, some parasitized larvae stayed alive for about two weeks without pupating. Usually the larvae die a few days after parasite emergence.

Cocoon

The Meteorus larva spins a cocoon after leaving the host. Muesebeck (1923:6) mentioned that, in most cases, the cocoon is suspended from a support, which can be a twig or a limb. Some species, such as Meteorus loxostegei, lack this suspending thread (Simmonds 1947:377). Cushman (1918:136), describing the cocoon-spinning process of Meteorus hyphantriae, indicated that the material used for cocoon construction is silk spun in a thread. This thread is soft, semiliquid and colorless when first secreted. Then it gradually becomes amber. Riley (1886:254), observing Meteorus hyphantriae, found that the larva spun first "loose, irregular horizontal loops" around its body, forming a "loose cradle," and then finished the inside of the cocoon. He remarked also that if the cocoons are made during a windy time, the threads that suspend them are much longer and can get four inches long. The normal length varies from one and one-half to two inches. The cocoon is usually oval; its size and color are species specific.

According to Strauss (1916:8), the cocoon of Meteorus dimidiatus is brownish, 4 to 5 mm long. Our observations on Meteorus hyphantriae from the U.S. National Museum collection give 5 mm long for the cocoon of this species. The shape is oval and the color brownish. From the same collection, we have also observed that Meteorus indagator has a
brown cocoon measuring 4 mm long. The cocoon of *Meteorus leviventris*, observed in the University of Arizona collection, is stramineous and 4.3 mm long (Figure 7).

**Pupal Development**

The time required for cocoon spinning is variable. Parker (1931:98) found 24 hours for *Meteorus nigricollis* Thompson. Inside the cocoon, the larva pupates. The duration of the pupal stage is influenced by external climatic factors. For *Meteorus nigricollis* 21 days are necessary (Parker 1931:98). The adult emerges by chewing a hole in the anterior end.

**Host List**

The following list shows the broad range of lepidopterous larvae parasitized by the species studied.

*Meteorus acronyctae* Muesebeck

*Acronicta* species (Lep., Noctuidae, Acronictinae) U.S.A. (H.C.)

*Euschausia* species (Lep., Arctiidae, Arctiinae) N. America (H.C.)

*Halisidota ingens* Hy. Edw. (Lep., Arctiidae, Arctiinae) N. America (H.C.2)

*Hyphantria cunea* (Drury) (Lep., Arctiidae, Arctiinae) N. America (H.C.)

*Meteorus arizonensis* Muesebeck

Host not recorded.
Meteorus dimidiatus Cresson

Actebia fennica Tausch. (Lep., Noctuidae, Phalaeninae) Canada
(TH.)

Agrotis orthogonia Morr. (Lep., Noctuidae, Phalaeninae) N. America, Canada (TH.)

Chorizagrotis auxiliaris Grote (Lep., Noctuidae, Phalaeninae) Canada (TH.)

Crymodes devastator Brace (Lep., Noctuidae, Amphipyrinae) Canada (TH.)

Desmia funeralis Hb. (Lep., Pyralidae, Pyraustinae) N. America U.S.A. (H.C.)

Epizeuxis sp. (Lep., Noctuidae, Herminiinae) U.S.A. (H.C.2)

Euxoa ochrogaster Guen. (Lep., Noctuidae, Phalaeninae) Canada (TH.)

Euxoa tristicula Morr. (Lep., Noctuidae, Phalaeninae) Canada (TH.)

Feltia subgothica Haw. (Lep., Noctuidae, Phalaeninae) N. America (TH.)

Platynota stultana Wlsm. (Lep., Tortricidae) U.S.A. (H.C.2)


Tortrix pallorana (Rob.) (Lep., Tortricidae) U.S.A. (H.C.1)

Meteorus euschausiae Muesebeck

Halisidota argentata Pack. (Lep., Arctiidae, Arctiinae) N. America (H.C.)

Halisidota ingens Hy. Edw. (Lep., Arctiidae, Arctiinae) N. America (H.C.)
**Meteorus fumipennis** Muesebeck

Host not recorded.

**Meteorus hyphantriae** Riley

*Acronicta* sp. (Lep., Noctuidae, Acronictinae) N. America (H.C.1)

*Alsophila pometaria* Harr. (Lep., Geometridae, Oenochrominae)

U.S.A., N. America (H.C.)

*Caenurgina erechtea* Cram. (Lep., Noctuidae, Catocalinae) N. America (H.C.)

*Calpe canadensis* Beth. (Lep., Noctuidae, Catocalinae) U.S.A. (TH.)

*Catocala neogama* A. and S. (Lep., Noctuidae Catocalinae) U.S.A. (TH.)

*Datana perspicua* G. and R. (Lep., Notodontidae) U.S.A. (TH.)

*Drasteria erechtea* Cramer (Lep., Noctuidae, Catocalinae) N. America (MU.)

*Buchaetias egle* Dru. (Lep., Arctiidae, Arctiinae) U.S.A. (TH.)

*Grapholitha molesta* Busck (Lep., Olethreutidae, Laspeyresiinae)

U.S.A. (TH.)

*Graptolitha species* (Lep., Noctuidae, Cuculliinae) N. America (MU.)

*Halisidota argentata* Pack. (Lep., Arctiidae, Arctiinae) N. America (H.C.)

*Hemerocampa leucostigma* A. and S. (Lep., Liparidae) U.S.A. (H.C.)

*Hemileuca maia* Dru. (Lep., Saturniidae) N. America (H.C.)
**Heterocampa guttivitta** Walk. (Lep., Notodontidae) U.S.A. (TH.)

**Hyphantria cunea** Dru. (Lep., Arctiidae, Arctiinae) N. America, U.S.A. (H.C.)

**Hyphantria textor** Harr. (Lep., Arctiidae, Arctiinae) N. America (TH.)

**Itame ribearia** Fitch (Lep., Geometridae, Ennominae) U.S.A. (TH.)

**Lithophane sp.** (Lep., Noctuidae, Cuculliinae) U.S.A. (TH.)

**Lithophane antennata** Walk. (Lep., Noctuidae, Cuculliinae) U.S.A. (TH.)

**Malacosoma americana** F. (Lep., Lasiocampidae) N. America (H.C.)

**Malacosoma disstria** Hb. (Lep., Lasiocampidae) N. America (H.C.)

**Nepytia canasoria** (Wlkr.) (Lep., Geometridae, Ennominae) N. America (H.C.1)

**Notolophus antiquus** L. (Lep., Liparidae) U.S.A. (TH.)

**Olene plagiata** (Wlkr.) (Lep., Liparidae) N. America (H.C.1)

**Olethreutes species** (Lep., Olethreutidae, Olethreutinae) N. America (H.C.)

**Paleacrita vernata** (Peck) (Lep., Geometridae, Ennominae) N. America (H.C.)

**Perispasta caeculalis** Zell. (Lep., Pyralidae, Pyraustinae) N. America (H.C.)

**Phigalia titea** Cram. (Lep., Geometridae, Ennominae) U.S.A. (TH.)

**Polygonia interrogationis** F. (Lep., Nymphalidae, Nymphalinae) U.S.A. (TH.)

**Protoleucania albilinea** (Hbn) (Lep., Noctuidae, Hadeninae) N. America (H.C.)
Schizura unicornis A. and S. (Lep., Notodontidae) U.S.A. (TH.)

Vanessa atalanta L. (Lep., Nymphalidae, Nymphalinae) U.S.A. (TH.)

Meteorus indagator Riley

Acrobasis betulella Hulst. (Lep., Pyralidae, Phycitinae) U.S.A. (H.C.)

Acrobasis caryae Grote (Lep., Pyralidae, Phycitinae) U.S.A. (H.C.)

Acrobasis caryivorella Rag. (Lep., Pyralidae, Phycitinae) U.S.A. (H.C.)

Acrobasis comptoniella Huls (Lep., Pyralidae, Phycitinae) U.S.A. (H.C.)

Acrobasis coryliella Dyar (Lep., Pyralidae, Phycitinae) U.S.A. (H.C.)

Acrobasis juglandis Leb. (Lep., Pyralidae, Phycitinae) U.S.A. (TH.)

Acrobasis kearfottella Dyar (Lep., Pyralidae, Phycitinae) U.S.A. (H.C.)

Acrobasis minimella Rag. (Lep., Pyralidae, Phycitinae) U.S.A. (P.M.)

Acrobasis rubrifasciella Pack. (Lep., Pyralidae, Phycitinae)

U.S.A. (H.C.1)

Acrobasis sylviellea Ely (Lep., Pyralidae, Phycitinae) U.S.A.

Dioryctria auranticella (Grote) (Lep., Pyralidae, Phycitinae)

U.S.A. (H.C.2)
Diorystria xanthanobares Dyar (Lep., Pyralidae, Phycitinae) U.S.A. (H.C.)

Evergestis rimosalis Guen. (Lep., Pyralidae, Pyraustinae) U.S.A. (TH.)

Loxostege sticticalis L. (Lep., Pyralidae, Pyraustinae) U.S.A. (TH.)

Mineola indiginella Zell. (Lep., Pyralidae, Phycitinae) U.S.A. (H.C.)

Mineola juglandis (Le Baron) (Lep., Pyralidae, Phycitinae) U.S. U.S.A. (H.C.)

Omphalocera dentosa Grote (Lep., Pyralidae, Pyralinae) U.S.A. (H.C.)

Peridroma margaritosa Haw. (Lep., Noctuidae, Phalaeninae) U.S.A. (TH.)

Tetralopha militella Zell. (Lep., Pyralidae, Epipaschiinae) U.S.A. (H.C.)

Tetralopha platanella Clemens (Lep., Pyralidae, Epipaschiinae) U.S.A.

Tetralopha subcanalis Walk. (Lep., Pyralidae, Epipaschiinae) U.S.A. (H.C.)

Meteorus leviventris (Wesm.)

Achatodes zea Harr. (Lep., Noctuidae, Amphipyrinae) U.S.A. (TH.)

Actebia fennica Tausch. (Lep., Noctuidae, Phalaeninae) U.S.A. (TH.)
Agrotis annexa Treits. (Lep., Noctuidae, Phalaeninae) U.S.A. (H.C.)

Agrotis gladiaria Morr. (Lep., Noctuidae, Phalaeninae) N. America (H.C.)

Agrotis malefida Guen. (Lep., Noctuidae, Phalaeninae) N. America (H.C.)

Agrotis orthogonia Morr. (Lep., Noctuidae, Phalaeninae) N. America (H.C.)

Agrotis ypsilon Rott. (Lep., Noctuidae, Phalaeninae) N. America (H.C.)

Amphidasis cognataria Guen. (Lep., Geometridae, Ennominae) U.S.A. (TH.)

Archanara oblonga Grote (Lep., Noctuidae, Phalaeninae) U.S.A. (TH.)

Chorizagrotis auxiliaris Grote (Lep., Noctuidae, Phalaeninae)
Canada, N. America (TH.)

Chorizagrotis auxiliaris form agrestis (Grote) (Lep., Noctuidae, Phalaeninae) N. America (H.C.)

Chorizagrotis sp. (Lep., Noctuidae, Phalaeninae) N. America (H.C.)

Coleophora malivorella Riley (Lep., Coleophoridae) U.S.A. (TH.)

Colias philodice eurytheme Bdv. (Lep., Pieridae) N. America (H.C.)

Conistra sp. (Lep., Noctuidae, Phalaeninae) U.S.A. (TH.)

Crymodes devastator Brace (Lep., Noctuidae, Amphipyrinae) U.S.A. (TH.)
Euxoa excellens (Grote) (Lep., Noctuidae, Amphipyridae) U.S.A. (H.C.)

Euxoa laetificans Sm. (Lep., Noctuidae, Amphipyridae) U.S.A. (TH.)

Euxoa ochrogaster Guen. (Lep., Noctuidae, Amphipyridae) U.S.A. (TH.)

Euxoa perexcellens Grote (Lep., Noctuidae, Amphipyridae) N. America (TH.)

Euxoa tristicula Morr. (Lep., Noctuidae, Amphipyridae) U.S.A. (TH.)

Feltia subgothica Haw. (Lep., Noctuidae, Phalaeninae) N. America (H.C.)

Feltia subterranea F. (Lep., Noctuidae, Phalaeninae) N. America (TH.)

Gnorimoschema operculella Zell. (Lep., Gelechiidae) U.S.A. (TH.)

Hellula undalis F. (Lep., Pyralidae, Pyraustinae) N. America (H.C.)

Lithophane antennata Walk. (Lep., Noctuidae, Cuculliinae) U.S.A. (TH.)

Lithophane sp. (Lep., Noctuidae, Cuculliinae) U.S.A. (TH.)


Macronoctua onusta Grote (Lep., Noctuidae, Amphipyridae) U.S.A. (TH.)

Oligia fractilinea Grote (Lep., Noctuidae, Amphipyridae) U.S.A. (TH.)
Omphalocera cariosa Led. (Lep. Pyralidae, Pyralinae) N. America

(PH.)

Papaipema arctivorens Hmps. (Lep., Noctuidae, Amphipyrinae) U.S.A. (PH.)

Papaipema cataphracta Grote (Lep., Noctuidae, Amphipyrinae) U.S.A. (PH.)

Papaipema frigida Smith (Lep., Noctuidae, Amphipyrinae) U.S.A. (PH.)

Papaipema nebris Guen. (Lep., Noctuidae, Amphipyrinae) U.S.A. (PH.)

Papaipema purpurifascia G. and R. (Lep., Noctuidae, Amphipyrinae) U.S.A. (PH.)

Peridroma margaritosa Haw. (Lep., Noctuidae, Phalaeninae) N. America (H.C.)

Peridroma margaritosa form saucia Hb. (Lep., Noctuidae, Phalaeninae) N. America, Canada (H.C.)

Prodenia praefica Grote (Lep., Noctuidae, Amphipyrinae) U.S.A. (PH.)

Psorosina hammondi Riley (Lep., Pyralidae, Phycitinae) N. America (PH.)

Scotogramma trifolii Rott. (Lep., Noctuidae, Hadeninae) N. America (H.C.)

Spodoptera exigua Hb. (Lep., Noctuidae, Amphipyrinae) Greece (PH.)

Spodoptera frugiperda A. and S. (Lep., Noctuidae, Amphipyrinae) U.S.A. (H.C.)
Tortrix viridana L. (Lep., Tortricidae) Belgium, Britain, Germany, Hungary (TH.)

Abbreviations

The following abbreviations indicate the sources of publication for the species of lepidoptera listed. The subfamilies are from J. McDunnough (1938 and 1939).

HC  Hymenoptera of America north of Mexico. Synoptic catalog 1951 (Muesebeck and Walkley 1951:90).


MU. Muesebeck 1923.

P.M. Paul Marsh 1974 (personal communication).

RH. Riley and Howard 1890.

TAXONOMY OF THE GENUS METEORUS

Terminology

Head

By definition the face is the area between the antennae and the clypeus. The face is either narrow, or broader at the base of the clypeus than long between insertion of antennae and base of clypeus. The face appears to be either coriaceous or finely rugose. The characters of the clypeus are of significance. Its shape varies from normal and convex, to unusually large and flat. Malar space means in Hymenoptera the area on each side of the head between the proximal end of the mandible and the ventral end of the compound eye. It is given in relation to the basal width of the mandible. Cheek will be used to specify the region between the malar space and the carina genalis. The carina genalis is a ridge which borders the cheek anteriorly. The term ocell-ocular line designates the distance from a compound eye to the nearest lateral ocellus. A considerable variation of the size of the ocelli within a species affects the length of the ocell-ocular line. (Figure 8).

Thorax

The color and sculptural characters of the thorax are of great descriptive value. The lateral wall or pleuron of an adult insect is limited between the tergal and sternal plates. The term propleuron (plural propleura), is the pleuron of the prothorax. Behind the propleura, the mesopleura in Hymenoptera stands for the pieces below the
insertion of the wings, and situated on the lateral surface of the mesothorax. The mesonotum means the upper surface of the mesothorax. The zone along the anterior margin of the episternum of the mesothorax is termed prepectus. The propodeum is the first abdominal segment, incorporated into the thorax (Figure 9).

Wings

The characters of wing venation have been widely used in the description of the different species. The terminology used is that derived from Rohwer and Gahan's (1916:20) description of hymenopterous wings, and employed by Muesebeck (1923:5). The diagram of the wing venation of Meteorus leviventris (Wesmael) illustrates the terminology used in the Key and descriptions (Figure 10).

Abdomen

The first tergite of the abdomen behind the propodeum is the petiole, which is divided into two parts: a narrow basal part, the prepetiole, and a widened apical part, the postpetiole. The presence or absence of dorsal fossae on the petiole serves as a distinct taxonomic character, as well as the meeting and separation of its ventral margins. The sculpturing of the postpetiole consists of longitudinal fine and close striae which may converge or diverge strongly behind. The space between the striae is either granularly roughened or polished and shining. The remainder of the abdomen can show different forms or color patterns.
Synonymies

The genus Meteorus comprises a considerable number of species in the subfamily Euphorinae. By Foerster's classification (1862:225), Meteorus was considered as a member of an independent subfamily, the Meteorinae, characterized by the presence of three distinct cubital cells on the front wings. Similar genera with two cubital cells were considered as Euphorinae. The classification of Foerster was followed by Marshall (1888:1 and 1889:149), and by Ashmead (1900:115). Ashmead grouped under the subfamily Meteorinae, the genera Zemiotes Foerster, Protelus Foerster, Meteorus Haliday (Perilitus Foerster), Sapotrichus Holmgren, and Aridelus Marshall.

Later, different regroupings occurred. Szepligeti, as cited in Muesebeck (1923:4), synonymized Protelus Foerster and Perilitus Foester (not Nees) with Meteorus Haliday, but recognized the other genera in Ashmead's classification. Muesebeck (1923:3) synonymized Sapotrichus Holmgren and Zemiotes Foerster under Meteorus as well, leaving only Meteorus Haliday and Aridelus Marshall of Ashmead's classification. At the time, Muesebeck (1923:4) indicated that "Meteorus alone does not form a natural group distinct from Euphorinae." It was only in 1936 that the same author definitely included the Meteorinae (Meteorus) in the Euphorinae, on the basis of their morphological similarity to certain genera of that subfamily. Muesebeck's interpretation is now generally accepted. However Mason (1973:213) has again removed Zemimotes Foerster from synonymy with Meteorus Haliday.
1. Petiole of abdomen with two dorsal fossae. 
   Ventral margins of petiole usually separated. .......... 2

   Petiole of abdomen without dorsal fossae. 
   Ventral margins of petiole meeting. ................. 3

2(1) Ocelli small (Figure 11). Radius long 
   (Figure 12), its first abscissa almost equal 
   to second. Thorax and abdomen slender. Body 
   black. Antennae 29-segmented ................. **fumipennis** Muesebeck

   Ocelli large (Figure 13). Radius short 
   (Figure 14), its first abscissa usually shorter 
   than second. Antennae 29- to 32- 
   segmented ................................**indagator** (Riley)

3(1) Ventral margins of petiole meeting beyond base. 
   Petiole uniformly black or brown. .............. 4

   Ventral margins of petiole meeting only at base. 
   Petiole always pale basally. Body color usually 
   ferrugineous; postpetiole usually more or less black. .... 7

4(3) Stigma brown, stramineous at base and apex. ............. 5

   Stigma uniformly stramineous and translucent. 
   Recurrent vein always interstitial with first 
   intercubitus. Antennae 26- to 
   36-segmented ................................**leviventris** Wesmael

5(4) Wings usually subhyaline. ..................... 6

   Wings perfectly hyaline, translucent. Rec­
   current vein entering first cubital cell at apex. 
   Antennae 29-segmented ..................... **Meteorus** new species A

6(5) Recurrent vein interstitial with first intercubitus. 
   Antennae 27- to 31-segmented ................... **dimidiatus** (Cresson)

   Recurrent vein entering first cubital cell at apex. 
   Antennae black, 26-segmented ................ **Meteorus** new species B

7(3) Propleura almost entirely rugulose. Petiole smooth; 
   postpetiole finely striate, the striae converging 
   posteriorly. Recurrent vein interstitial with first 
   intercubitus. Nervulus always longer than lower 
   abscissa of basella. Antennae 28- to 35- 
   segmented .................................... **arizonensis** Muesebeck
Propleura mostly smooth, punctate and shining ................................................... 8

8(7) Head flat behind. First abscissa of radius as long as second. Recurrent vein entering second cubital cell. Posterior coxae black or brown at apex. Antennae 30-segmented .... acronyctae Muesebeck

Head no so flat behind. First abscissa of radius not as long as second. .......................... 9

9(8) Nervulus one and half times as long as lower abscissa of basella. Scutellum strongly convex. Antennae 34-segmented ........... euschausiae Muesebeck

Nervulus as long as lower abscissa of basella or slightly longer. Scutellum not strongly convex. Antennae 32- to 38-segmented. .............. hyphantriae Riley

Description of Species

Meteorus acronyctae Muesebeck
(Figures 18, 26)

Meteorus acronyctae Muesebeck 1923: 10, 35, q d'. Type, one female under Cat. No. 24969, in the U.S. Natl. Mus., Washington, D.C. (Shenefelt 1969: 50); type locality "Hell Canyon, New Mexico."


Description. Length, male 3.9 mm, female 3.6 to 4.5 mm. Head ferrugineous, 0.95 mm wide, 0.80 mm long. Ocelli large (Figure 13), 0.10 mm in diameter. Ocell-ocular line 0.12 mm long, almost equal to the diameter of an ocellus. Vertex polished and shining. Head flat behind ocelli. Face glabrous, polished, 0.35 mm long, 0.35 mm wide at base of clypeus. Median field yellow, prominent. Malar space 0.10 mm,
base of mandible 0.10 mm. Antennae piceous, 30-segmented. Scape and pedicel ferrugineous. First and second segments of flagellum equal.

Thorax stout, 1.15 mm wide. Prothorax ferrugineous, shining, glabrous. Mesothorax ferrugineous, mesonotum prominent; parapsidal grooves not "deeply impressed." Mesopleura and prepectus smooth and shining. Scutellum polished, convex. Metathorax rugulose. Metapleura ferrugineous, finely rugulose. Metanotum piceous. Wings hyaline, iridescent. Stigma stramineous, brown along veins; radial cell short. Recurrent vein entering second cubital cell. First abscissa of radius 0.15 mm, second abscissa 0.15 mm; first intercubitus 0.30 mm; second intercubitus 0.20 mm; nervulus 0.20 mm; lower abscissa of basella 0.25 mm; upper abscissa of basella 0.25 mm. Legs ferrugineous; last tarsal segments and pretarsi black. Posterior coxae partially rugulose, ferrugineous at the coxa-trochanter joint. Posterior coxae 0.50 mm, trochanter 0.40 mm, femora 1 mm, tibiae 1.5 mm, tarsi, 1.05 mm long.

Abdomen stout; propodeum black, rugulose; petiole black dorsally, yellow ventrally; petiole without fossae dorsally. Ventral margins meeting at base of petiole. Postpetiole finely and longitudinally striate, striae converging behind; remainder of abdomen black dorsally and stramineous ventrally. Ovipositor sheaths piceous, 1.5 mm long, shorter than abdomen (2 mm long).

Remarks. This species is related to Meteorus euschausiae Muesebeck, from which it can be distinguished easily by its size, which is smaller. The length of M. acronyctae is 4.5 mm, that of M. euschausiae 5.3 mm. The antennae are shorter, 30-segmented, the first and second
abscissae of radius are of equal length (0.15 mm each), and the recurrent vein enters second cubital cell.

**Distribution.** Arizona, Colorado, and New Mexico (Muesebeck and Walkley 1951: 98; Shenefelt 1969: 50).

**Meteorus arizonensis** Muesebeck

(Figures 19, 27)


**Description.** Length, male 4.5 mm, female 5 mm. Head and body color usually ferrugineous. Head 0.90 mm wide, 0.85 mm long; ocelli black, large, 0.10 mm in diameter. Ocell-ocular line 0.25 mm; frons, vertex, and temples smooth. Face finely sculptured. Clypeus not prominent, hairy, 0.20 mm wide at base. Cheeks finely hairy; malar space 0.15 mm; basal width of mandibles 0.15 mm. Antennae ferrugineous, apex piceous. Female antennae 28- to 31-segmented; male 32- to 35-segmented.

Thorax ferrugineous, 1.10 mm wide. Prothorax shining, finely punctate and hairy. Mesonotum shining; parapsidal grooves not deeply impressed; prepectus and mesopleura shining and hairy. Scutellum brown, postscutellum ferrugineous, finely rugulose. Metanotum rugulose, brown, hairy. Metapleura yellowish. Wings subhyaline. Radial cell short; stigma brown, narrow; recurrent vein interstitial with first intercubitus. First abscissa of radius 0.10 mm; second abscissa 0.15 mm. First intercubitus 0.35 mm; second intercubitus 0.20 mm. Nervulus 0.25 mm.
Lower abscissa of basella 0.20 mm; upper abscissa of basella 0.35 mm. Legs ferrugineous to brown. Posterior coxae 0.55 mm, trochanters 0.40 mm, femora 1.25 mm, tibiae 1.6 mm, tarsi 1.30 mm long.

Abdomen stout and polished; propodeum not distinct. Petiole without fossae dorsally; ventral margins of petiole meeting at base of petiole. Postpetiole striate, the striae converging posteriorly. Ovipositor sheaths 1.6 mm, shorter than abdomen (1.9 mm).

Remarks. Similar to *Meteorus hyphantriae* Riley by the ferrugineous body color, and by size. It can be separated from *hyphantriae* by the longer ocell-ocular line, 0.25 mm, the number of antennal segments, 32- to 35-, the smaller size of the thorax, 1.10 mm wide, and the subhyaline wings.


*Metororus* *dimidiatus* (Cresson)

(Figures 20, 28)

*Perilitus* *dimidiatus* Cresson 1872: 83, 9 9. Type, in Philadelphia Academy of Sciences, one female under Cat. No. 1770.1; type locality, "New Jersey."


*Metororus* *noctivagus* Viereck 1905: 281, 9 . Type, in the collection of the University of Kansas, "Lawrence"; one female; type locality, "Lawrence, Douglas County, Kansas."
Description. Length, male 3.6 mm, female 4 mm. Head shining and polished, 0.80 mm wide, 0.75 mm long. Ocelli small, 0.05 mm in diameter. Ocell-ocular line 0.20 mm, four times longer than the greatest diameter of an ocellus. Compound eyes black, very large, 0.25 mm wide. Face narrow, finely hairy; clypeus prominent, hairy, 0.25 mm wide at base. Frons shining; median field brownish. Mandibles piceous except for tips, which are blackish; base of mandibles 0.10 mm wide. Malar space 0.15 mm; cheeks and face yellowish. Antennae yellow to ferruginous, piceous at tips, 26-segmented. Scape as long as first joint of flagellum.

Thorax mostly black or piceous, shining, 0.90 mm wide. Prothorax ferrugineous, finely sculptured and hairy. Mesothorax black, smooth and shining. Mesopleura black, rugulose with a shining band. Mesosternum black; mesonotum with deeply impressed parapsidal grooves. Median surface of mesonotum ferrugineous. Scutellum polished, shining. Postscutellum with longitudinal striae. Metathorax uniformly rugulose and black. Wings brownish; stigma piceous, nearly black, pale along veins. Recurrent vein interstitial with first intercubitus. Radius reaching wing at apex. First abscissa of radius 0.10 mm long; second abscissa 0.15 mm. First intercubitus 0.30 mm; second 0.20 mm. Nervulus 0.20 mm; lower abscissa of basella 0.25 mm; upper abscissa of basella 0.25 to 0.30 mm. Legs yellow to piceous, tarsi black at tips. Posterior coxae 0.50 mm, trochanters 0.40 mm, femora 1.15 mm, tibiae 1.50 mm, and tarsi 1.36 mm long.

Abdomen polished and shining. Propodeum sculptured. Petiole uniformly black, shining, without fossae dorsally; ventral margins not
meeting at base of petiole. Postpetiole finely striate. Remaining segments brownish, tip of abdomen piceous. Ovipositor sheaths 0.16 mm long, shorter than abdomen 0.17 mm.

Remarks. Similar to Meteorus leviventris (Wesmael), but with the stigma brown, the ocelli smaller, 0.05 mm, and the base of the clypeus smaller, 0.25 mm. Meteorus dimidiatus (Cresson) is easily recognized by a black and shining band on the mesopleura, which does not exist on leviventris. The abscissae of cubitus are much longer in dimidiatus; first abscissa of cubitus 0.10 mm, second 0.15 mm.

Distribution. United States and southern Canada (Muesebeck and Walkley 1951: 99).

**Meteorus euschausiae Muesebeck**

(Figures 21, 29)


Description. Length, male 5.1 mm, female 5.3 mm. Head ferrugineous, 1.10 mm wide, 1 mm long. Ocelli 0.10 mm in diameter. Ocellar ocular line 0.15 mm, a little longer than greatest diameter of an ocellus. Face finely sculptured, 0.20 mm long, 0.30 to 0.35 mm wide at base of clypeus. Clypeus prominent, shining and hairy. Malar space short, 0.10 mm. Basal width of mandible 0.12 mm. Cheeks polished and
hairy, buccal area hairy. Antennae piceous, ferrugineous at base, 34-segmented.

Thorax stout, ferrugineous, wider than head, 1.27 mm. Prothorax with a short collar. Propleura smooth and shining. Mesothorax convex; mesonotum punctate, with parapsidal grooves not deep. Prepectus and mesopleura shining and smooth; scutellum prominent; postscutellum ferrugineous and shining. Metathorax brown to piceous, finely rugulose and hairy. Wings hyaline, iridescent. Stigma brown, darker posteriorly. Veins brown. Radial cell short; recurrent vein interstitial with first intercubitus; first abscissa of radius 0.15 mm long; second abscissa of radius 0.25 mm; first intercubitus 0.25 mm; second intercubitus 0.20 mm; nervulus 0.25 mm; lower abscissa of basella 0.20 mm; upper abscissa of basella 0.40 mm. Legs ferrugineous, posterior coxae blackish at apex. Posterior tibiae and tarsi piceous; spurs on posterior tibiae black. Posterior coxae 0.65 mm, trochanters 0.75 mm, femora 1.4 mm, tibiae 1.6 mm, tarsi 1.5 mm long.

Abdomen ferrugineous; propodeum rugulose; petiole often black dorsally, without fossae. Ventral margins meeting at base. Postpetiole brown laterally, striate, the striae converging. Following segments of abdomen ferrugineous, smooth, and shining. Ovipositor sheaths ferrugineous; 1.25 mm, shorter than abdomen (2.5 mm).

Remarks. This species resembles Meteorus acronyctae Muesebeck, but differs from it by its greater size, 5.3 mm against 4.5 mm. The antennae in euschausiae are longer, 34-segmented; those of acronyctae are 30-segmented. The abscissae of radius are 0.15 mm long for the
first and 0.25 mm for the second. In acronyctae they are of equal length, 0.15 mm each. The recurrent vein in euschasiae is interstitial with first intercubitus. In acronyctae it enters second cubital cell.


**Meteorus fumipennis** Muesebeck

(Figures 22, 30)


Description. Length, female 4 mm. Head black, shining, 0.85 mm wide, 0.76 mm long. Head broader than thorax, which is 0.60 mm wide. Vertex polished. Ocelli small, 0.05 mm in diameter (Figure 11). Ocellocular line 0.25 mm, longer than greatest diameter of an ocellus. Face black, punctate, 0.35 mm wide at base of clypeus, 0.25 mm long. Clypeus prominent, shining. Malar space very short, 0.05 mm. Mandibles black except tips, which are ferrugineous; base of mandibles piceous. Occiput black; head not flat behind ocelli. Antennae 29-segmented, basal half ferrugineous, the remainder piceous.

Thorax almost entirely black, slender, narrower than head, tinted with red on the prosternum. Mesonotum with "deeply impressed" parapsidal grooves. Mesoscutum shining, finely punctate posteriorly. Scutellum small, triangular and shining. Mesopleura rugulose, prepectus
smooth. Metanotum rugulose and shining. Wings narrow, not hyaline. Stigma brown, pale at base, large and triangular. Radial cell short, ending before apex of wing. Recurrent vein entering first cubital cell. First abscissa of radius 0.10 mm long; second abscissa 0.05 mm. First intercubitus 0.20 mm; second intercubitus 0.10 mm. Nervulus 0.15 mm. Lower abscissa of basella 0.20 mm; upper abscissa 0.30 mm. Legs ferrugineous. Posterior coxae 0.35 mm, trochanters 0.30 mm, femora 0.9 mm, tibiae 1.30 mm to 1.40 mm, tarsi 1.30 mm to 1.35 mm long. Posterior femora darker than rest.

Petiole of abdomen with two fossae dorsally. Postpetiole finely striate. Remainder of abdomen smooth and polished. Abdomen black except for the third segment, which is brown. Ovipositor sheaths 1.50 mm long, shorter than abdomen, which measures 2 mm.

Remarks. This species is very different from the other species studied because the color is glossy black. The female length is identical to that of _M. dimidiatus_, 4 mm, and sometimes superior to that of _M. leviventris_, 3.5 mm. The malar space, 0.05 mm, is shorter than that of any of the other species described. The recurrent vein enters the first cubital cell. The second abscissa of radius is also the shortest of all species, 0.05 mm.

Meteorus hyphantriae Riley
(Figures 23, 31)


Meteorus oecopsidis Ashmead 1888: 642, ♂. Type, in the U.S. Natl. Mus., Washington, D.C., one male under Cat. No. 2962 (Shenefelt 1969: 71); type locality, "Kirkwood, Missouri."

Meteorus floridanus Ashmead 1888: 642, ♂. Type, in the U.S. Natl. Mus., Washington, D.C., one male under Cat. No. 2963 (Shenefelt 1969: 71); type locality, "Cocoanet Grove, Florida."

Meteorus relativus Viereck 1905: 280, ♂. Type, one male, in the University of Kansas, "Lawrence" (Shenefelt 1969: 71); type locality, "Douglas County, Kansas."

Meteorus triangularis Muesebeck 1919: 115, ♀ ♂. Type, in the U.S. Natl. Mus., Washington, D.C., one female under Cat. No. 22096 (Shenefelt 1969: 71); type locality, "Massachusetts."

Description. Length, male 3.5 mm, female 5 mm. Head yellowish, 1 mm wide, 0.80 mm long. Ocelli large, 0.10 mm. Ocell-ocular line almost equal to greatest diameter of an ocellus, 0.12 mm; compound eyes large, 0.40 mm wide, 0.80 mm long. Face hairy, narrow, 0.30 mm long, 0.25 mm wide at base of clypeus. Malar space short, 0.10 mm; base of mandible 0.10 mm wide. Vertex, cheeks, and frons shining. Head not very flat behind ocelli. Antennae ferrugineous, 32- to 38-segmented.
Thorax ferrugineous, 1.25 mm wide. Prothorax finely hairy. Mesonotum ferrugineous except for the lateral lobes, which are dark; parapsidal grooves not well defined. Scutellum ferrugineous, postscutellum piceous. Mesopleura finely sculptured, shining. Metathorax rugulose and hiary. Wings hyaline, stigma and veins uniformly brown. Radial cell short; recurrent vein interstitial with first intercubitus; first abscissa of radius 0.10 mm; second abscissa 0.35 mm; first intercubitus 0.50 mm; second intercubitus 0.40 mm; nervulus 0.25 mm; lower abscissa of basella 0.25 mm; upper abscissa of basella 0.50 mm. Legs entirely yellow or pale except for the posterior tibiae, which are ferrugineous mesally. Posterior tarsi ferrugineous. Posterior coxae 0.7 mm, trochanters 0.45 mm, femora 1.5 mm, tibiae 2 mm, tarsi 1.3 mm long.

Abdomen ferrugineous; petiole without fossae dorsally. Postpetiole piceous, longitudinally striate. Ventral margins of petiole meeting at base. Third tergite bearing two yellowish triangular spots at base. Other tergites ferrugineous. Ovipositor sheaths 1.25 mm long, half the length of the abdomen, 2.5 mm.

Remarks. This species is similar to Meteorus arizonensis Muesebeck, but can be separated by the shorter ocell-ocular line, 0.12 mm. In M. arizonensis the ocell-ocular line is 0.25 mm. M. hyphantriae Muesebeck has longer antennae, 32- to 38-segmented, wider thorax, 1.25 mm, and hyaline wings. The second abscissa of radius in hyphantriae is 0.35 mm, longer than that of arizonensis, 0.15 mm; the second intercubitus in hyphantriae, 0.40 mm, is twice as long as that of arizonensis, 0.20 mm.
Distribution. All over the United States and Canada (Muesebeck and Walkley 1951: 99).

**Meteorus indagator** (Riley)

(Figures 24, 32)

*Perilitus indagator* Riley 1872: 43, ♀. Type, in the U.S. Natl. Mus., Washington, D.C., one female under Cat. No. 2787 (Shenefelt 1969: 73); type locality, Missouri.


**Description.** Length, male 4 mm, female 5 mm. Head wider than long, 0.80 mm wide, 0.75 mm long, almost glabrous, yellow to ferruginous. Ocelli black, large, 0.10 mm in diameter and touching each other; ocell-ocular line 0.15 mm long, longer than the greatest diameter of an ocellus. Compound eyes piceous, very large, occupying nearly whole side of face. Face very narrow, dullish, minutely sculptured, 0.35 mm wide at base of clypeus. Clypeus prominent, shining. Malar space 0.10 mm, longer than base of mandible, which is 0.05 mm. Mouth parts stramineous except tips of mandibles, which are piceous; cheeks and vertex shining. Head not flat behind ocelli. Antennae stramineous, with 24 segments in female, 29- to 32- in male.

Thorax wider than head, 0.95 mm, yellowish, slightly pubescent.

prepectus shining. Metathorax piceous. Metanotum rugulose. Metapleura regularly and finely rugulose. Wings hyaline, iridescent; veins brown. Stigma brown, with anterior margins yellowish. First discoidal cell petiolate. Radial cell short. Second abscissa of radius 0.15 ml long, little longer than first abscissa, which is 0.12 mm. First intercubitus 0.25 mm; second intercubitus 0.25 mm. Recurrent vein interstitial with first intercubitus. Nervulus 0.20 mm, longer than lower abscissa of basella, 0.15 mm. Upper abscissa of basella 0.20 mm. Legs pale, tarsi brown. Posterior coxae 0.45 mm, trochanters 0.45 mm, tibiae 1.25 mm, tarsi 1 mm long.

Propodeum slightly pubescent, dark, rugulose. Petiole with two deep fossae dorsally, ventral margins not very widely separated. Postpetiole longitudinally and finely striate. Other segments glabrous and polished. Ovipositor sheaths 2.3 mm long, little longer than abdomen (2 mm).

Remarks. This species can be related to _Meteorus acronyctae_ Muesebeck by its color. It differs from _acronyctae_ by its brown stigma, and especially by the petiole having two deep fossae dorsally. The antennae are slender and longer.

**Meteorus leviventris** (Wesmael)

(Figures 25, 33)

**Perilitus leviventris** Wesmael 1835: 46, φ. Type, Academy of Sciences "Bruxelles" one female described (Shenefelt 1969: 76); type locality, "Environ de Bruxelles." Petersen (cited in Shenefelt 1969: 76).

**Perilitus vulgaris** Cresson 1872: 83, σ . Type, one male under Cat. No. 1769.1, in Philadelphia Academy of Sciences (Shenefelt 1969: 77); type locality, "Illinois."


**Meteorus coquilleti** Ashmead 1888: 642. Φ. Type, in U.S. Natl. Mus. Washington, D.C., one male under Cat. No. 2961 (Shenefelt 1969: 77); type locality, "Los Angeles."

**Meteorus mellinervis** Viereck 1903: 95, φ. Type, one female under Cat. No. 4880 in Philadelphia Academy of Sciences (Shenefelt 1969: 77); type locality, "Beulah, New Mexico."

**Meteorus mamestrae** Viereck 1913: 364, σ . Φ. Type, U.S. Natl. Mus. Washington, D.C., one female under Cat. No. 15342 (Shenefelt 1969: 77); type locality, "Rocky Ford, Colorado."

**Meteorus leviventris:** Muesebeck 1958: 19.

**Description.** Length, male 3.5 mm, female 4 mm. Head more or less ferrugineous, 0.75 mm wide, 0.65 mm long. Ocelli 0.10 mm in diameter. Ocell-ocular line 0.15 mm long. Clypeus prominent, finely hairy, measuring 0.40 mm at base. Cheeks polished, apex of mandibles piceous, base of mandibles 0.05 mm wide, shorter than malar space, 0.15 mm. Face
hairy. Frons sculptured, vertex finely hairy; head not flat behind ocelli. Female antennae 26- to 30-, male 29- to 32-segmented. Antennae very long, slender, pale, but piceous at tip.

Thorax 0.80 mm wide, prothorax shining, pronotal ridge distinct; mesothorax moderately rugulose; parapsidal grooves indistinct; prepectus yellow, shining, finely hairy; mesopleura yellow, tinted with brown. Scutellum yellow, finely rugulose and brown at sides. Metathorax rugulose, brownish. Wings hyaline, iridescent, the stigma and veins stramineous, recurrent vein interstitial with first intercubitus. Second abscissa of radius 0.10 mm, little longer than the first 0.05 mm; first intercubitus 0.25 mm long; second intercubitus 0.20 mm; nervulus 0.25 mm; lower abscissa of basella 0.20 mm, upper abscissa of basella 0.35 mm. Legs uniformly yellow or stramineous, tarsi dark. Posterior coxae 0.45 mm, trochanters 0.30 mm, femora 0.95 mm, tibiae 1.35 mm, tarsi 1.10 mm long.

Abdomen polished, darkened beyond the third segment, which is pale. Propodeum distinct, brown; petiole of abdomen without fossae dorsally; ventral margins of petiole touching beyond base of petiole. Postpetiole uniformly brown or black, longitudinally striate, smooth and polished between striae. Ovipositor sheaths 1.7 mm, shorter than abdomen, 1.8 mm, and thick at base.

Remarks. This species is easily separated from Meteorus dimidiatus (Cresson) to which it is related, by its uniformly stramineous stigma. In dimidiatus the stigma is brown. M. leviventris has relatively large ocelli, 0.10 mm in diameter. Those of dimidiatus are
small, 0.05 mm. The base of the clypeus in *leviventris* measures 0.40 mm, and is larger than that of *dimidiatus*, which is 0.25 mm wide. But the abscissae of radius are shorter: first abscissa of radius 0.05 mm, second abscissa 0.10 mm long. The oviposition in *leviventris* is very characteristic, being thicker at base than in *dimidiatus*.

**Distribution.** Europe, Iceland, Greenland, all of United States, and southern Canada (Muesebeck 1958: 19).

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**New Species of Meteorus**

Two species of *Meteorus* identified by Muesebeck as new species are here described. The specimens are kept in the University of Arizona collection.

**Meteorus New Species A**

**Description.** Length, female 4.5 mm. Head and body stramineous. Head 0.95 mm wide, 0.80 mm long. Ocelli large, 0.15 mm in diameter; ocell-ocular line 0.075 mm. Face yellowish, finely hairy, shining, 0.20 mm wide at base of clypeus. Clypeus prominent, shining. Malar space short, 0.07 mm; basal width of mandibles 0.10 mm. Antennae 29-segmented, yellowish, apex piceous.

Thorax pale. Prothorax finely punctate, shining. Mesonotum with parapsidal grooves not deeply impressed. Scutellum prominent, triangular. Metanotum brown, shining, slightly rugose. Wings clear hyaline. Stigma large, triangular, brown, yellow along anterior margins. Radial cell short; first abscissa of radius 0.10 mm, second abscissa
0.20 mm. First intercubitus 0.35 mm; second intercubitus 0.25 mm.
Nervulus 0.25 mm. Lower abscissa of basella 0.25 mm; upper abscissa of basella 0.35 mm. Recurrent vein entering first cubital cell at apex.
Legs pale, tarsi dark at apex. Posterior coxae 0.5 mm, trochanters 0.3 mm, femora 1.1 mm, tibiae 1.2 mm, tarsi 1.1 mm long.

Abdomen pale, brown at apex. Petiole of abdomen without fossae dorsally. Ventral margins of petiole meeting beyond base. Postpetiole brown laterally, and strongly striate longitudinally. Striae converging posteriorly. Ovipositor sheaths 1.1 mm, shorter than abdomen 1.5 mm long.

The description is based on one female of this species collected at Sta. Catalina Mts., Arizona, Hitchcock Highway Mi. 0, on April 19, 1957, by G. Butler and F. G. Werner.

Remarks. This species is similar to Meteorus bakeri Cook and Davis and Meteorus dimidiatus (Cresson). It differs from dimidiatus by the hyaline wings and by the recurrent vein entering the first cubital cell. In dimidiatus, the wings are subhyaline and the recurrent vein is interstitial with the first intercubitus. It is also differentiated from bakeri by the recurrent vein entering the first cubital cell. In bakeri, the recurrent vein always enters the second cubital cell.

_Meteorus_ New Species B

_Description._ Length, male 3 mm. Head and body color piceous to black. Head 0.75 mm wide, 0.60 mm long. Ocelli black, 0.10 mm in diameter; ocell-ocular line 0.12 mm. Head flat behind ocelli. Face piceous, shining, finely hairy. Clypeus prominent, 0.25 mm wide at base.
Malar space long, 0.20 mm; base of mandible 0.10 mm. Antennae black, short, 26-segmented.

Thorax black, hairy. Prothorax punctate, shining. Prepectus hairy and shining. Mesonotum convex with parapsidal grooves deeply impressed. Metathorax rugulose. Wings subhyaline, infumated. Stigma brown, pale along anterior margin. Radial-cell short. First abscissa of radius 0.05 mm, second abscissa 0.20 mm. First intercubitus 0.20 mm; second intercubitus 0.20 mm. Nervulus 0.15 mm. Lower abscissa of basella 0.17 mm; upper abscissa of basella 0.20 mm. Recurrent vein entering first cubital cell at apex. Anterior legs pale, dark at apex of tarsi, posterior legs ferrugineous. Posterior coxae 0.40 mm, trochanters 0.35 mm, femora 0.90 mm, tibiae 1.35 mm, tarsi 1.25 mm long.

Petiole of abdomen black without dorsal fossae, its ventral margins meeting beyond base of petiole. Postpetiole black, striate, striae not converging posteriorly. Third segment of abdomen brownish, the remaining segments black.

The description is based on one male of this species collected at Sabino Canyon, Sta. Cataline Mts., Arizona, on May 5 1971, by F. G. Werner and G. Butler.

Remarks. This species is also related to Meteorus dimidiatus (Cresson) and Meteorus bakeri Cook and Davis. It differs from dimidiatus by the recurrent vein entering the first cubital cell at apex. In dimidiatus the recurrent vein enters the second cubital cell at its base, or is interstitial with the first intercubitus. From bakeri it
differs by the subhyaline wings. In bakeri the wings are hyaline and the recurrent vein enters the second cubital cell.
Figure 1. Rearing cage, with cover in place.
Figure 2. Rearing cage, open.
Figure 3. Emergence spot (E) of Meteorus leviventris larva on Spodoptera exigua larva.

Figure 4. Larva of Meteorus leviventris, newly emerged from Spodoptera exigua, 22x.

Figure 5. Detail of anterior end of larva in Figure 4, showing base of silk strand.
Figure 6. Last instar larva of Meteorus leviventris obtained from laboratory rearing, 24x.

Figure 7. Cocoon of Meteorus leviventris, from University of Arizona insect collection, 13x.
Figure 8. Head of *Meteorus indagator*, in front view.

A - antenna
BC - base of clypeus
BM - base of mandible
CH - cheek
CL - clypeus
F - frons
L - labrum
MF - median field
MS - malar space
O - ocellus

Figure 9. Thorax of *Meteorus arizonensis*, left lateral view.

C - collar
CO - coxa
MSN - mesonotum
MSP - mesopleuron
MTN - metanotum
MTP - metapleuron
P - propodeum
PE - petiole
PG - parapsidal groove
PN - pronotum
PNR - pronotal ridge
PP - propleuron
PR - prepectus
PSC - postscutellum
SC - scutellum
T - tegula
Figure 8. Head of *Meteorus indagator*, in front view.

Figure 9. Thorax of *Meteorus arizonensis*, left lateral view.
Figure 10. Wing venation of *Meteorus leviventris* (terminology of Muesebeck 1923, after Rohwer and Cahan 1916).

Anterior wing veins

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<tr>
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<td>AB</td>
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<tr>
<td>RJ'</td>
<td>medius</td>
</tr>
<tr>
<td>J'I'P</td>
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<tr>
<td>T'U'</td>
<td>brachiulus</td>
</tr>
<tr>
<td>JJ'</td>
<td>basal vein</td>
</tr>
<tr>
<td>KK'</td>
<td>first intercubitus</td>
</tr>
<tr>
<td>LL'</td>
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</tr>
<tr>
<td>K'I'</td>
<td>recurrent vein</td>
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<tr>
<td>TT'</td>
<td>nervulus</td>
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Anterior wing cells

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<td>4</td>
<td>median cell</td>
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<tr>
<td>5</td>
<td>discoidal cells</td>
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<td>6</td>
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<td>7</td>
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Posterior wing veins

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<tr>
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<td>radiella</td>
</tr>
<tr>
<td>GG'</td>
<td>cubitella</td>
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<tr>
<td>RJ'</td>
<td>mediella</td>
</tr>
<tr>
<td>UT'</td>
<td>submediella</td>
</tr>
<tr>
<td>T'U'</td>
<td>brachiella</td>
</tr>
<tr>
<td>JG</td>
<td>upper abscissa of</td>
</tr>
<tr>
<td></td>
<td>basella</td>
</tr>
<tr>
<td>GJ'</td>
<td>lower abscissa of</td>
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<tr>
<td></td>
<td>basella</td>
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<td>nervulus</td>
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Posterior wing cells

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<tr>
<td>15</td>
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<tr>
<td>16+18</td>
<td>discoidellus +</td>
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<td>brachiellus cells</td>
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<td>anellus cell</td>
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</table>
Figure 10. Wing venation of *Meteorus leviventris* (terminology of Muesebeck 1923, after Rohwer and Gahan 1916).
11. Head of *Meteorus fumipennis*, showing small ocelli, 0.05 mm in diameter.

12. Wings of *Meteorus dimidiatu*, showing long radial cell (2).

13. Head of *Meteorus indagator*, showing large ocelli, 0.10 mm in diameter.

14. Wings of *Meteorus indagator*, showing short radial cell (2).
Species characteristics of ocelli and radial cell.
Figure

15. Petiole of *M. arizonensis*.
   a. Ventral view, showing ventral margins meeting at base of petiole.
   b. Dorsal view, showing lack of fossae.

16. Petiole of *M. leviventris*.
   a. Ventral view, showing ventral margins meeting beyond base of petiole.
   b. Dorsal view.

17. Petiole of *M. indagator*.
   a. Ventral view, showing slightly separated ventral margins.
   b. Dorsal view, showing presence of dorsal fossae (F).
Petioles of representative species of *Meteorus*.
Figure

18. Wings of _M. acronycta_ Muesebeck.
20. Wings of _M. dimidiatu_ (Cresson).
22. Wings of _M. fumipennis_ Muesebeck.
23. Wings of _M. hyphantria_ Riley.
24. Wings of _M. indagato_ (Riley).
25. Wings of _M. leviventris_ Wesmael.
Wings of Arizona species of Meteorus.
Figure

26. _M. acronyctae_ Muesebeck, 16x.

27. _M. arizonensis_ Muesebeck, 12x.

28. _M. dimidiatus_ (Cresson), 18x.

29. _M. euschausiae_ Muesebeck, 12x.
Arizona species of *Meteorus*.
Figure

30. *M. fumipennis* Muesebeck, 19x.
31. *M. hyphantriae* Riley, 13x.
32. *M. indagator* (Riley), 13x.
33. *M. leviventris* (Wesmael), 13x.
Arizona species of *Meteorus*, continued.
LITERATURE CITED


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