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Insects Associated with Michigan Bumblebees (*Bombus* Spp.)

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INSECTS ASSOCIATED WITH MICHIGAN BUMBLEBEES (*BOMBUS* SPP.)[1]

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Studies of insect associates of bumblebees are not new. For example, Tuck (1896, 1897) reported over 50 species of insects associated with nests of British bumblebees. Sladen (1912) discussed nest associates and parasites of European bumblebees, and Plath (1934) published similar data for American bumblebees. Postner (1952) published more detailed data. He listed over 60 taxa of insects associated with bumblebees near Erlangen, Germany.

Michigan bumblebees may be divided into three groups of species which have northern, southern and cosmopolitan distributions. In an attempt to determine why many species have ranges which terminate within Michigan, a variety of studies, including studies of associations of bumblebees and other organisms, were initiated in the laboratory of T. Wayne Porter at Michigan State University and continued at Adrian College.

The purpose of this paper is to give a preliminary list of the insects found in association with Michigan bumblebees of the genus *Bombus*. This study follows, in part, the format used by Postner in reporting bumblebee associates. More than 50 taxa found in the nests of, on, or as internal parasites of ten species of bumblebees are included. The term taxa is used rather than species because it was not always possible to determine larvae and nymphs to species level. Additional studies of selected species of insects and associated bumblebees are planned.

METHODS

Several collecting methods were used over a period of 10 years. More than 60 nests were examined, most of which were collected at night. About half of the nests were placed in modified Berlese funnels and insects were collected below in 70% ethyl alcohol. Some nests were taken apart piece by piece, and insects encountered were collected and placed in ethyl alcohol. All nests were active immediately prior to examination. Bees were dissected for internal parasites. Insects were determined to the nearest taxa and forwarded for substantiation to the authorities listed in the acknowledgments.

RESULTS

In the following list of taxonomic categories, the Roman numeral behind the name indicates the number of nests in which the particular insect was found. The Arabic numeral indicates the number of specimens obtained. When a number is not present, insects were removed from bumblebees not associated with nests. The bumblebees associated with a particular insect are listed after the numbers following the name of the insect associate.

COLLEMBOLA

ENTOMOBRYIDAE, *Entomobrya assuta* Folson (II,20) *Bombus fervidus, B. americanorum*

E. griseoolivata (Packard) (IV,71) *B. affinis, B. fervidus, B. americanorum*

E. multifasciata Tullberg (IV,6) *B. bimaculatus, B. fervidus, B. americanorum*

Pseudosinella violenta (Folsom) (I,2) *B. americanorum*

P. sexoculata Schott (II,134) *B. bimaculatus, B. americanorum*

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Willowsia buski Lubbock (III,309) *B. americanorum*
W. buski distincta (II,24) *B. americanorum*
W. buski nigromaculata (III,12) *B. americanorum*
HYPOGASTRURIDAE, *Schotella glasgowi* Folsom (I,37) *B. bimaculatus*
ISOTOMIDAE, *Isotoma albella* Packard (I,184) *B. bimaculatus*
TOMOCERIDAE, *Tomocerus flavescens* Tullberg (I,20) *B. americanorum*

ORTHOPTERA

BLATELLIDAE, *Parcoblatta pennsylvanica* (DeGeer) (I,1) *B. bimaculatus*
GRYLLIDAE (Nemobinae), *Allonemobius* sp. (I,1) *B. bimaculatus*

PSOCOPTERA

LIPOSCELLIDAE, *Liposcelis* sp. (VIII, c 30) *B. affinis, B. americanorum, B. bimaculatus, B. fervidus, B. grisceocollis, B. vagans*

HOMOPTERA

CICADELLIDAE, *Erythroneura* sp. (I,1) *B. bimaculatus*

HEMIPTERA

ANTHOCORIDAE, *Xylocoris galactinus* (Fieber) (I,1) *B. bimaculatus*

THYSANOPTERA

THRIPIDAE, *Frankliniella tritici* (Fitch), *Bombus nevadensis*
PALAEOTHRIPIDAE, *Haplothrips leucanthemi* (Schrank) (I,1) *B. bimaculatus*

COLEOPTERA

ANTHICIDAE, *Anthicus* sp. (I,4) *B. fervidus*
CARABIDAE, *Pasimachus* sp. (I,1) *B. americanorum*
CRYPTOPHAGIDAE, *Antherophagus ochraceus* Melsheimer (X,35) *B. affinis, B. americanorum, B. fervidus, B. vagans*
Cryptophagus valens Casey (I,10) *B. affinis*
Cryptophagus sp. (I,1) *B. americanorum*
Cryptophagus sp. (?) or *Antherophagus* sp. (?) (XI,683) *B. affinis, B. americanorum, B. bimaculatus, B. fervidus B. grisceocollis*
Genus unknown (1,1) *B. americanorum*
CUCUJIDAE, *Ahasverus advena* (Waltl) (III,8) *B. americanorum, B. griseocollis*
DERMESTIDAE, *Attagenus* sp. (IV,10) *B. americanorum, B. fervidus*
Genus unknown, *B. terricola*
HISTERIDAE, *Dendrophilus* sp. (II,2) *B. americanorum*
LATHRIDIIDAE, *Enicmus consimilis* (Mannerheim) (I,1) *B. americanorum*
Corticaria sp. (I,1) *B. bimaculatus*
Corticaria sp. (?) (I,1) *B. bimaculatus*
MELOIDAE, Genus unknown, *B. affinis, B. griseocollis*
MYCETOPHAGIDAE, *Typhaea stercorea* (Linnaeus) (III,9) *B. americanorum, B. fervidus, B. griseocollis*
NITIDULIDAE, *Carpophilus* sp. (I,2) *B. bimaculatus*
ORTHOPERIDAE, *Sericoderus* sp. (I,4) *B. bimaculatus*
Sericoderus sp. (?) (I,13) *B. bimaculatus*
STAPHYLINIDAE, Aleocharinae (?) (I,1) *B. americanorum*
Subfamily and genus unknown (II,7) *B. bimaculatus, B. vagans*
TENEBRIONIDAE, *Cynaeus angustus* (LeConte) (I,2) *B. americanorum*
Neatus tenebrioides (Palisot) (IV,50) *B. americanorum, B. fervidus*
Tenebrio molitor Linnaeus (III,24) *B. americanorum*

NEUROPTERA

CHRYSOPIDAE, *Chrysopa* sp. prob. *C. carnea* Stephens, *Bombus* sp.
Chrysopa sp. (?) *Bombus affinis*

LEPIDOPTERA

NOCTUIDAE, *Epizeuxis americalis* (Geunee) (II,5) *B. fervidus, B. griseocollis*
HERMINIINAE, genus unknown (I,3) *B. americanorum*
PYRALIDAE, *Vitula edmandsae* (Packard) (X,1297) *B. affinis, B. americanorum, B. fervidus*
Pyralis farinalis Linnaeus (IV,23) *B. americanorum, B. fervidus*
Hypsopygia costalis (Fabricius) (I,1) *B. fervidus*
TINEIDAE, *Acedes fuscipunctella* (Haworth) (V,11) *B. affinis, B. americanorum, B. fervidus*

DIPTERA

CALLIPHORIDAE (1,1) *B. vagans*
CECIDOMYIIDAE, *Lestodiplosis* sp. (I,1) *B. vagans*
CONOPIDAE, Conopinae, 32 larvae in abdominal cavities of *B. affinis, B. bimaculatus, B. fervidus, B. ternarius, B. terricola*
Myopinae, 1 larva in abdominal cavity of *B. bimaculatus*
MILICHIIDAE, *Leptometopa* sp. (II,16) *B. americanorum, B. vagans*
MUSCIDAE, *Fannia canicularis* (Linnaeus) (III,194) *B. americanorum, B. fervidus*
Fannia sp. (III,120) *B. affinis, B. americanorum, B. fervidus*
Muscina sp. (I,4) *B. vagans*
PHORIDAE, *Dohrniphora* sp. (II,2) *B. americanorum*
PSYCHODIDAE, *Psychoda* sp. (I,1) *B. americanorum*
SARCOPHAGIDAE (III,14) *B. americanorum, B. bimaculatus, B. vagans.* Ten sarcophagid pupae heavily parasitized by *Melittobia* sp. Four larvae were taken from the abdominal cavity of *B. terricola*
Miltogramminae (I,1) *B. bimaculatus*
SCATOPSIDAE, *Scatopse fuscipes* (Meigen) (I,1) *B. fervidus*
Genus unknown (I,5) *B. americanorum*
SCIARIDAE, *Bradysia* sp. (II,2) *B. bimaculatus, B. vagans*

SIPHONAPTERA

CERATOPHYLLIDAE, *Orchopeas leucopus* (Baker) (II,2) *B. bimaculatus, B. fervidus*
HYSTRICHOPSYLLIDAE, *Epitedia wenmanni* (Rothchild) (I,2) *B. americanorum*

HYMENOPTERA

BRACONIDAE, *Apanteles mephoptericis* (Packard) (V,23) *B. affinis, B. bimaculatus, B. fervidus, B. griseocollis*
EULOPHIDAE, *Melittobia chalybii* Ashmead (I, over 500) from *B. vagans* pupa
Melittobia sp. (I, over 1000) from sarcophagid pupa in nest of *B. vagans*
Pediobius sp., near *P. williamsoni* Girault (I,1) *B. bimaculatus*
FORMICIDAE
Monomorium pharaonis (Linnaeus)[4] (I,95) *B. americanorum*
Solenopsis molesta (Say) (I,9) *B. americanorum*
Tapinoma sessile (Say) (I,21) *B. americanorum*
Tetramorium caespitum (Linnaeus) (I,1) *B. americanorum*
VESPIDAE, *Polistes fuscatus* (Fabricius) (I,1) *B. fervidus*

DISCUSSION

Studies of insect associates of American bumblebees have been sparse in comparison to European studies. Plath (1934) dealt with insect associates more than Hobbs (1965, 1967) or Janzen (1971). These references considered bumblebees from Massachusetts, Western Canada and Central America. In Sweden, Hasselrot (1960) observed such insects

[4]This species is established in the Natural Science Building at Michigan State University and entered the nest after it was placed indoors.

as *Aphomia sociella* Linnaeus, *Brachyoma devia* Fallen, *Volucella bombylans* Linnaeus, *Fannia* sp., *Antherophagus nigricornis* Fabricus, and *Lasius niger*. Hasselrot, Sladen (1912) and Cumber (1949) discussed the relationships of insects associated with bumblebees. Skou, Holm and Haas (1963), and Free and Butler (1959) also discussed European bumblebee associates. Our study is most comparable to the work of Postner (1952) in Germany. In both cases, the majority of insect associates were recorded from 30 bumblebee nests. We include data from 30 additional nests which were studied for temperature regulation and other purposes.

The most common groups of insects found in association with German and Michigan bumblebees were the six orders Coleoptera, Lepidoptera, Diptera, Collembola, Hymenoptera and Psocoptera. These frequently associated orders include parasitic insects, scavengers, predaceous insects and a large number of insects for which the food habits are unknown. Six orders found less frequently were Orthoptera, Siphonaptera, Neuroptera, Homoptera, Hemiptera and Thysanoptera. We speculate that Thysanura, Diplura and Strepsiptera will be found in association with some Michigan bumblebees or their nests. The less frequently collected orders may have an accidental or casual relationship to bumblebees. Siphonaptera may be present in nests due to visits by birds or mammals or former utilization of the bumblebee nest as a bird or mammal nest. Thysanoptera and Neuroptera may be distributed by bumblebees but their role in bumblebee nests is unknown. It is conceivable that Orthoptera might be sufficiently numerous to become pests but they were rarely found in our studies.

Collembola have been discussed by Snider and Husband (1966). Although no laboratory studies have been done, Collembola have been reported to be commensals (Postner 1952). Three genera which were found as nest associates in Germany, *Entomobrya, Pseudosinella* and *Tomoceros,* were also found in Michigan. The genus *Willowsia,* not found by Postner, was present in eight nests of *Bombus americanorum.* Of the nine insects found in three or more nests, only *Willowsia buski* and *T. molitor* were found with only one species of bee. Psocoptera were nearly as abundant as Collembola in bumblebee nests. The genus *Liposcelis* was found in Germany and Michigan. Psocoptera may be scavengers.

Coleoptera were very common in nests in Germany and Michigan. Plath (1922) reported *Antherophagus* sp. from "almost every one of 50 nests which I encountered, and in one case over 20 beetles were found." Cryptophagidae, including *Antherophagus ochraceus* Melsheimer, were the most numerous beetles encountered in Michigan bumblebee nests. *Antherophagus nigricornis* Fabricius was one of the most common beetles reported in German bumblebee nests by Postner. Postner cited 15 families of Coleoptera found with German bumblebees while we found 13 families. *Typhaea stercorea* (Linnaeus) (Mycetophagidae) and *Tenebrio molitor* Linnaeus were common to Michigan and Germany.

Lepidoptera were common in several Michigan bumblebee nests. Among the five species found, the pyralids, *Vitula edmandsae* (Packard) and *Pyralis farinalis* Linnaeus, and the tineid, *Acedes fuscipunctella* (Haworth), were most common. Bumblebee nests which had *V. edmandsae* produced more cocoons than nests in which *V. edmandsae* were lacking (Hobbs et al., 1960). Plath (1934) considered *V. edmandsae* "comparatively harmless." We found no *Galleria melonella* (Linnaeus) although Janzen (1971) found this harmful associate in a nest of *Bombus pullatus* in Costa Rica. The European wax moth, *Aphomia sociella* Linnaeus, was considered by Hasselrot (1960) to be a more serious pest.

Diptera were very common in bumblebee nests with 10 families found in this study. *Fannia canicularis* (Linnaeus) was most numerous. Although Hasselrot (1960) and Plath (1934) found *Volucella* sp. (Syrphidae) numerous in some nests, Postner (1952) did not list this family. Hobbs (1967) reported *V. bombycolans* (Linnaeus) attacking live larvae and pupae. Hasselrot (1960) reported that the tachinid *Brachycoma devia* Fallen consumes or parasitizes cocoons of bumblebees. We found no specimens of *Volucella.* Hobbs (1965) reported that *Physocephala texana* (Syrphidae) killed a *B. rufocinctus* queen. Sarcophagidae were removed from the abdominal cavities of several bumblebees. Conopidae were even more numerous and were found in five different species. *Scatopse fuscipes* Meigen (Scatopsidae) was rare but reported from both Germany and Michigan.

Hymenoptera have been mentioned as serious pests of bumblebees by several American and European scientists. Braconidae, Ichneumonidae and Eulophidae were relatively uncommon. However, in a given nest, numbers could be very high. Hobbs (1965) and Plath (1934) indicated that ants are major pests of some bumblebee nests. Since most of our nests were collected at night and since ants do not tend to remain in nests for long periods of time, ants may be under-represented in this study.

We have not included *Psithyrus* spp., social parasites of bumblebees, since we did not encounter them in nests examined and the distribution data of field collected *Psithyrus* spp. will be published later. Plath (1934) reported *Dasyllis grossa* (Asilidae) attacking *Bombus fervidus*. We have not yet observed this. We did not find *Brachycoma* sp. (Tachinidae) found by Plath. We found no Dermaptera, although Holm (personal communication) indicated that they are common in Denmark. We did not find Protura although Postner (1952) reported this group from bumblebee nests in Germany.

There is insufficient evidence to speculate on many of the associations of bumblebees and other insects. Several Diptera and Hymenoptera are internal parasites. Most of the insects that appear to be scavengers in a nest may serve a useful role in removing wastes and debris. Some predaceous insects may function to control populations of scavenger insects. Some insects may serve to keep fungus from overgrowing the nest. Relative humidity is usually more than 60% and the temperature is usually more than 30°C.

We are unaware of insects which are species specific to bumblebees and no other taxonomic group, as are three species of Acarina, *Kuzinia laevis, Pneumolaelaps* spp. and *Locustacarus buchneri*. None of these acarine species survive the winter in nests in Michigan. *K. laevis* deutonymphs and *Pneumolaelaps* spp. females attach to hibernating queens. Insects have not been found on hibernating queen bumblebees. Larval Diptera and Hymenoptera which are internal parasites of bumblebees do not appear restricted to a bumblebee host.

If associations between bumblebees and other insects were close, one would expect these insects to occur wherever bumblebees are found. This may be the case if some parasitic insects are host restricted to bumblebees as is the parasitic mite *Locustacarus buchneri*. *K. laevis*, a fungus, pollen and nematode feeding mite which survives only on hibernating queens, is found from above the Arctic Circle to the equator. Insects which are only casually associated with bumblebees in temperate regions would be absent or reduced in high arctic regions where the climate is less favorable. In contrast, the few species of bumblebees that exist in the tropics of Brazil would have more casually associated insects on the bees and in their nests. Additional observations and experiments with tropical bumblebees are needed to confirm this hypothesis. It is still not possible to give a clear explanation of why there are 17 species of bumblebees in Michigan and six species in Brazil, but the balance of obligate and casual insect associates in and out of the nest may be significant to bumblebee distribution.

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