A UNIQUE METHOD OF DEFENSE OF *BREMUS* (*BOMBUS*) *FERVIDUS* FABRICIUS.[1]

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It is a well-known fact that bumblebees, especially the more ferocious species, are quick to attack with sting and mandibles if any vertebrate ventures too close to their nests. Similar punishment is meted out by many species if their nests are invaded by bees which do not belong to the colony, *e. g.* Psithyrus.[2] In this case the fate of the intruder may be shown by describing briefly the behavior of a fair-sized colony of *Bremus impatiens* Cresson when a queen of *Psithyrus laboriosus* Fabricius enters, or is placed in, its nest. As soon as the stranger is detected on or near the comb, a general uproar arises in the colony. The intruder is seized immediately by numerous workers, stung to death, and thrown out of the nest. This, in general, seems to be the behavior of a large number of Bremus species whose habits have been studied. But, as we shall see presently, one of our most common New England bumblebees, *Bremus fervidus* Fabricius, behaves very differently under these conditions.

During the summer of 1921, the writer had under observation 13 colonies of bumblebees belonging to the following species: *Bremus affinis* Cresson, *Bremus bimaculatus* Cresson, *Bremus fervidus* Fabricius, *Bremus impatiens* Cresson, and *Bremus vagans* Smith. Each colony was kept in a glass-covered box which was provided with a flight-hole so that the life of the colony could go on unhindered. On July 24th, the writer noticed a disheveled *Psithyrus laboriosus* queen crawling out from the nest material of colony No. 7 (*B. fervidus*) and removed her to a separate box. She was wet all over, her pile being matted against the integument by a sticky liquid. On the same day a worker of colony No. 8 (*B. impatiens*) which had been placed near

[1]Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University. No. 206.

[2]A genus of bumblebees whose members are social parasites on various species of the genus Bremus, the industrious branch of the bumblebee family (Bremidae).

colony No. 7 (*B. fervidus*) the preceeding evening, was found sitting near the entrance of her nest and, like the Psithyrus queen, was completely covered with a sticky liquid. Whenever this worker attempted to enter the nest, she was immediately attacked by her sisters and driven back. The reason for this strange behavior and the source of the sticky liquid, which the writer at first was unable to account for, were disclosed several days later.

On July 27th a captured *Psithyrus laboriosus* queen was placed in a *Bremus fervidus* nest and the writer was surprised to find that the workers, instead of creating a furore and killing the Psithyrus, as do the workers of *Bremus impatiens*, remained calm and resorted to a more peaceful, but equally effective, method of expelling the intruder. About a dozen workers gathered about the Psithyrus queen, and, after stealthily approaching a little closer, each one placed a small drop of liquid on the intruder with her mouth. The Psithyrus queen did not seem to relish this performance and slowly left the comb, apparently seeking to hide herself. A number of workers followed her and from time to time added more liquid until she was as wet as the Psithyrus queen and Bremus worker referred to above. The experiment was repeated with other *fervidus* colonies and was later (September 13th) demonstrated before the Cambridge Entomological Club. The members of the club were also shown the very different behavior of a *Bremus impatiens* colony under these conditions.

From July 27th to September 24th a large number of other experiments were carried out in order to determine how colonies of *Bremus fervidus* react to other intruders. These experiments may be summed up briefly as follows:

Experiment 1. Introduced: Young queen of *Psithyrus ashtoni* Cresson.

Result: Daubed with liquid like *Psithyrus laboriosus*. No attempts to sting her.

Experiments 2, 3, 4 and 5. Introduced (separately):

Workers of *Bremus affinis, bimaculatus, impatiens,* and *vagans.*

Result: Same as in experiment 1.[3]

Experiment 6. Introduced: Worker from another *fervidus* colony.

Result: Attacked with legs and mandibles. No attempt at daubing.[4]

Experiments 7, 8 and 9. Introduced (separately): Worker honeybee (*Apis mellifica*), male of *Bremus impatiens*, and male of *Polistes pallipes* Lepeletier.

Result: All stung to death and thrown out of the nest. No attempts at daubing.

Experiments 10, 11, 12, 13 and 14. Introduced (separately): Blue bottle fly (*Calliphora vomitoria*), drone fly (*Eristalis tenax*), dragon fly (*Sympetrum rubicundulum*), small cricket (*Nemobius sp.*), and gypsy moth (*Porthetria dispar*).

Result: Same as in experiments 7, 8, and 9.

Experiment 15. Introduced: Katydid (*Conocephalus sp.*).

Result: Stung to death, but also daubed.

Experiments 16, 17, and 18. Introduced (separately): Earth worm (*Lumbricus sp.*), young frog (*Rana sp.*), and mouse (*Mus musculus*).

Result: All stung to death. No attempts at daubing.

From these experiments it will be seen that the workers of a *Bremus fervidus* colony, at least when dealing with insects, vary their method of attack with the nature of the intruder. If stingless, or comparatively weak (*e. g.*, the honeybee), the intruder is seized immediately and stung to death, while daubing is invariably resorted to if the intruder possesses superior fighting ability. What enables *Bremus fervidus* to make these distinctions, it is difficult to say. In this connection it must be stated that

[3]In connection with experiment 4 it may be stated that a worker of *Bremus impatiens*, an exceedingly pugnacious species, sometimes attacks a *fervidus* worker, and may then be stung to death by one or more workers of the latter species, though other members of the colony, even during the struggle, continue to daub the intruder.

[4]Similar results obtain if two *fervidus* colonies are combined. During the course of the summer, the writer made four such combinations (one colony in each case being queenless), but never noticed any daubing.

bumblebees never molest certain intruders, *e. g.* the larvæ of Brachycoma, even though the latter are very deadly to their brood.

At first there was some doubt as to the nature of the liquid which *Bremus fervidus* uses in connection with this interesting behavior, but the writer finally decided that it is honey. This conclusion is based on the following facts: (1) the liquid has a sweet taste; (2) a young *Psithyrus ashtoni* queen which was being daubed (experiment 1), lapped up a drop of liquid which accidentally adhered to some cotton; and (3) the *fervidus* workers themselves lapped up the liquid from the wings of a katydid (expirement 15) after the latter had been stung to death.

This habit of daubing certain intruders with honey recalls an interesting habit of the honeybee. According to Phillips (1921, p. 117), it sometimes happens that lizards or small snakes get into a hive. The honeybee workers seal up such intruders in propolis, a sticky substance which they obtain from trees and other sources. Because of the different nature of the substances used, it seems rather improbable that the habit of the honeybee and the habit of *Bremus fervidus* are related, yet it would be interesting to know whether there is any similarity in behavior while the substances are being applied.

It would also be interesting to ascertain whether any other species than *Bremus fervidus* resort to honey daubing. The writer found no trace of such a habit in his *affinis*, *bimaculatus*, *impatiens*, and *vagans* colonies. Nor is such a habit mentioned by Goedart (1700), Réaumur (1742), Huber (1802), Putnam (1865), Hoffer (1882-83), Kristof (1883), Coville (1890), Härter (1890), Bengtsson (1903), Lie-Petterson (1906), Wagner (1907), Gundermann (1908), Sladen (1912), Armbruster (1914), Bachman (1916), and Frison (1917, 1918), all of whom have paid more or less attention to the behavior of bumblebee colonies. However when we consider that Putnam (1865), who had colonies of *Bremus fervidus* under observation, did not notice this habit, it may well be that it was overlooked in other species.

According to the classifications of Franklin (1912-13) and Sladen (1912), one based on structure and the other on habit,

Bremus fervidus belongs to the Dumoucheli group and to the Pocket-makers, and it therefore is among the representatives of these groups that we should look first for species which are given to honey daubing.

As already mentioned, Bremus colonies are occasionally infested by parasitic bumblebees of the genus Psithyrus. According to Hoffer (1888, p. 132), this sometimes occurs in almost every second colony of certain species. Other Bremus species, on the other hand, never harbor these parasites (Cf. Sladen, 1912, p. 257), and this, as the writer pointed out recently (1922), also seems to be the case with *Bremus fervidus*. It can hardly be doubted that the honey daubing habit of *Bremus fervidus* plays an important role in keeping Psithyrus from breeding in its nests.

In his "Catalogue of British Hymenoptera" Smith (1855, p. 210) makes the following statement in regard to the apparent immunity of certain English Bremus species from Psithyrus infestation: "Although I have taken or examined a very large number of the nests of Bombus [Bremus], I have only occasionally met with the parasites [Psithyrus] in them; but never in the nests of the brown bumble-bees." All of these brown species to which Smith refers (*agrorum*, *distinguendus*, *helferanus*, and *muscorum*), like *Bremus fervidus*, are Pocket-makers. However, Hoffer (1888, p. 132) found that in Austria two of these brown species (*agrorum* and *helferanus*) are frequently victimized by *Psithyrus campestris* Panzer, and Wagner (1907, p. 78) reports that in Russia *Bremus muscorum* suffers severely from the depredations of various species of Psithyrus. *Bremus distinguendus* Morawitz, the other species mentioned by Smith, is very similar to *Bremus fervidus* in structure,[5] coloration, and habit. It is also very closely related to *Bremus latreillellus* Kirby[6] so that Morawitz (1881, p. 238) and Friese and Wagner (1910, p. 75) merely look upon it as a variety of the latter. According to Sladen (1912, p. 257), *Bremus latreillellus* is not preyed upon by any species of Psithyrus; nor has any

[5]Cf. Sladen (1912, p. 187) and Franklin (1912-13, I, p. 392).

[6]Cf. Hoffer (1882-83, II, p. 72); Radowszkowski (1884, p. 77); Sladen (1912, pp. 184, 187); d Lutz (1916, p. 503).

Bremus distinguendus colony ever been reported as victimized by a Psithyrus. These facts lead the writer to surmise that *Bremus distinguendus, latreillellus,* and perhaps also *Bremus fragans* Pallas, may prove to be "Honey-daubers."

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