

6 June

1969a

*Reprinted from the*  
JOURNAL OF THE KANSAS ENTOMOLOGICAL SOCIETY  
Vol. 42, April, 1969, No. 2  
pp. 117-125  
*Made in United States of America*

**NOTES ON THE NESTING BEHAVIOR OF  
PISONOPSIS CLYPEATA AND BELOMICRUS  
FORBESII  
(Hymenoptera, Sphecidae)**

HOWARD E. EVANS

NOTES ON THE NESTING BEHAVIOR OF  
PISONOPSIS CLYPEATA AND BELOMICRUS  
FORBESII  
(Hymenoptera, Sphecidae)<sup>1</sup>

HOWARD E. EVANS  
Museum of Comparative Zoology

ABSTRACT

Four nests of *Pisonopsis clypeata* Fox and one of *Belomicrus forbesii forbesii* (Robertson), all from Jackson Hole, Wyoming, are described. The first species employs pre-existing cavities and makes cells in series, separating them with earthen barriers; the prey consists of spiders, principally of the family Theridiidae. The second species digs a multicellular nest that is provisioned with bugs of the family Miridae. Notes are presented on digging and provisioning behavior, and the larva of *Belomicrus forbesii forbesii* is described and figured.

*Pisonopsis* and *Belomicrus* are poorly known genera of very small digger wasps, not closely related but both belonging to the Larrinae as broadly defined (Evans, 1964). Almost all of what we know of the nesting behavior of these wasps is attributable to the late Francis X. Williams, to whom we owe so much for his keen eye for important facts and for his capacity for presenting his findings in a series of brilliant, profusely illustrated papers. Williams' first major paper on wasps appeared in 1914, following two years of graduate work at the University of Kansas; *The Larridae of Kansas* is surely one of the most monumental master's theses produced anywhere. His last paper on wasps was published more than half a century later, in 1966, and despite Williams' failing health, displays much of his usual capacity for detail as well as his untiring enthusiasm for wasps. Williams was a quiet and modest man, but he has done much—and through his papers will do more—to help and inspire persons to learn more of the lives of insects. I should like to dedicate this paper, inadequate though it is, to F. X. Williams, a man whom I admired more than any other biologist of my acquaintance.

These studies were conducted during the summer of 1967 at the Jackson Hole Research Station, Moran, Wyoming. Both species nested within the limits of a large aggregation of *Philanthus pulcher*, which I have reported on briefly elsewhere (Evans, 1966) and hope to report on more fully at a later date. The soil in the nesting area was a compact, sandy clay containing numerous pebbles, and was relatively

<sup>1</sup> Approved for publication December 6, 1968.

dry during the period of study. Both *Pisonopsis* and *Belomicrus*, like the *Philanthus*, occupied limited areas of bare soil about 10 meters from the banks of the Snake River, about one kilometer east of the Research Station. This is an area in which the extensive glacial outwash plain is contiguous to the alluvial soil along the river, and the nesting areas probably represent places where infrequent past floods have deposited alluvium in irregular patches on the outwash gravels. The vegetation here consists of a great variety of grasses and herbs, some of which invade the nesting areas as isolated clumps.

#### Genus *Pisonopsis* Fox

This genus is restricted to the New World and is represented by only a few species; the three species occurring in the United States were reviewed by Williams (1954), who found *P. birkmanni* Rohwer nesting in the stems of poison hemlock, sage, and oats. The cells were separated by grains of soil and were provisioned with spiders of the family Thomisidae. More recently Parker and Bohart (1966, 1968) have obtained numerous nests in hollow *Sambucus* stems, both naturally occurring ones and "trap stems"; they have reared two parasites from these: the chrysidid *Ceratochrysis antyga* Bohart and the mutillid *Photopsis* sp. Some larvae of *P. birkmanni* were sent to me by Williams, and in my description of these I stated that *Pisonopsis* appeared to belong in the Trypoxyloninae rather than in the Larrinae as previously supposed (Evans, 1959). Later (1964) I suggested that the Trypoxylonini be regarded as a tribe of Larrinae, largely on the basis of larval characters.

*Pisonopsis clypeata* Fox. This species is not uncommon in Jackson Hole, and I was able to study its nesting behavior briefly July 21-27, 1967 (my note numbers 2106, 2112, and 2123). There are two previous reports on its habitat, but neither provides additional information. Linsley, MacSwain, and Smith (1952) found this species entering the burrows of the bee *Diadasia consociata* in California. Encounters between the bees and the wasps usually resulted in the wasp being driven out, but in spite of this, several instances were found in which the *Pisonopsis* had prepared cells in the burrows of the bee, separating the cells with small pebbles and wood fragments. The investigators found provisions in the chimney-like entrance tubes in several nests, but it is not clear whether the cells were in the entrance tube or in the burrow proper. They believe that activities of the wasp during the absence of the bee may cause desertion of the nest by the bee, as nests containing wasp cells generally had only one or a few bee cells.

Curiously, Parker and Bohart (1968) took seven nests of this species in Nevada in *Sambucus* trap stems. Evidently this species is able to exploit tubular cavities both in the soil and in plants. (These trap stems were inserted in the soil at one end, so were not far above the surface and may not have presented a very different stimulus than the *Diadasia* entrance turrets.) The use of burrows either in plants or

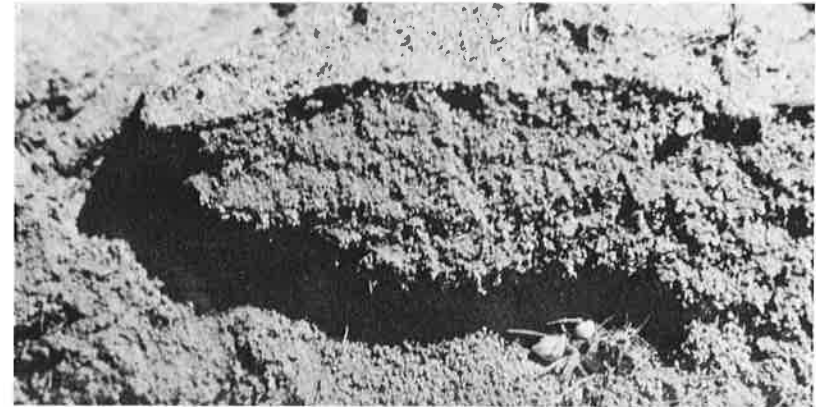


FIG. 1. A nest of *Pisonopsis clypeata* containing a single cell provisioned with theridiid spiders. The closure, consisting of lumps of earth and bits of debris, was removed from the burrow before this photograph was taken.

in the soil is unusual among wasps, but not wholly unknown; for example, the not unrelated wasp *Tryoxylon figulus* (Linnaeus) occupies burrows in sand and gravel banks as well as in hollow twigs and borings in old wood (Richards, 1944). It should be noted that the female *clypeata* has a strongly developed pygidial plate while that of *birkmanni* has none at all; hence *clypeata* may be better adapted for working in the soil.

In Jackson Hole, *P. clypeata* was found nesting only in the ground and in holes without turrets or mounds of earth at the entrance. One hole was vertical and may have been an abandoned burrow of a tiger beetle larva; this hole was only 3 cm deep and was used by the wasp for a single cell. Three other burrows were oblique and may have been *Philanthus* nests that had been started and then abandoned. These burrows were about 6–8 mm in diameter and from 4–7 cm long; they terminated in from one to three cells at a depth of between 2 and 4 cm from the surface above (Figs. 1, 3, 4). The two nests with more than one cell had the cells very close together, more or less in series, the cells separated by partitions consisting of small lumps of earth. The cells were horizontal or nearly so, and measured about  $7 \times 12$  mm, which is rather large for a wasp measuring only 8–10 mm. The large burrow and cell diameter may have been a consequence of the fact that the burrows used had been made by a slightly larger insect.

Evidently the female is able to dig in the soil sufficiently to improve the holes she adopts for nesting. One individual was observed from 1530 to 1600 on July 22 flying repeatedly from a vertical hole, each time dropping a small lump of earth. Most flights were in one direction and terminated 15–25 cm from the nest at an altitude of 10–20 cm. At 1600

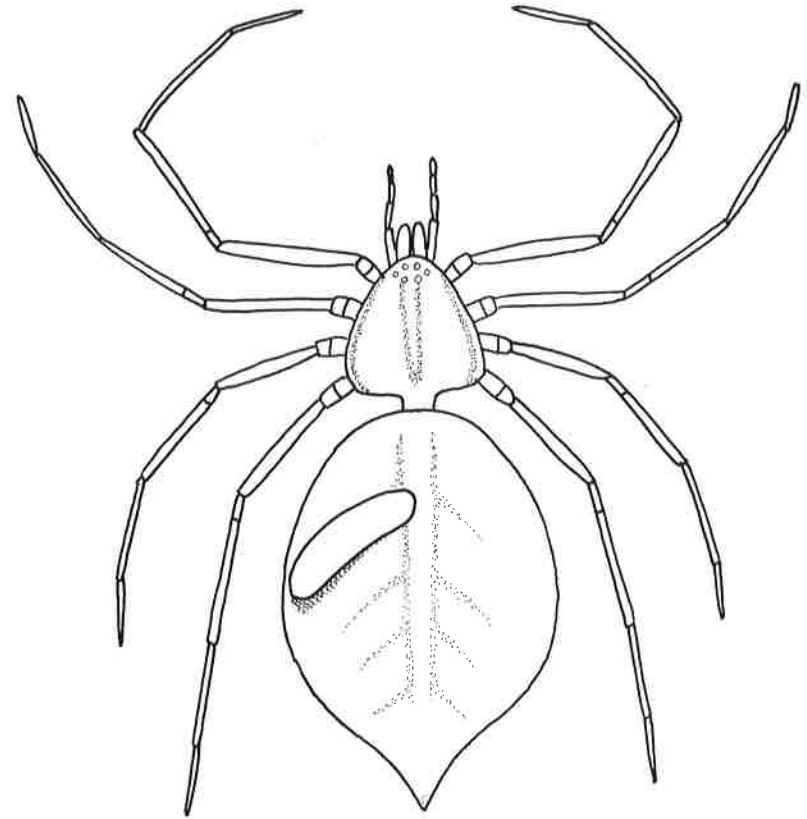


FIG. 2. A female *Chrysso nordica* bearing an egg of *Pisonopsis clypeata*. The egg is fastened at the midline of the spider and is free laterally.

the wasp flew off, leaving the entrance open, and was not seen again that day. Two days later the nest was dug out and it was found that the burrow had been completely filled with small pieces of wood, bits of leaves and plant stems, and lumps of earth.

Females were seen closing their nests on two occasions. In both cases the wasp made several trips from the nest in various directions to distances of 0.5–1.5 m. She then landed on the ground and searched about quickly for small bits of debris or lumps of earth. Having found one, she seized it in her mandibles and flew back to the nest, entered head first, deposited the object, then backed out quickly. None of the lumps was more than about 1 mm in diameter. It took only a few seconds to obtain each particle of soil or debris, and in the course of only a minute or two I watched her make 20 trips. As the burrow became filled, I could see that she rammed and pushed them in with her head, often to

such an extent that lumps of earth were pulverized. When the burrow was filled flush with the surface, she flew over the entrance several times as if "inspecting" the area for evidence of the burrow.

One of the females (no. 2123) was observed carrying in small spiders. The spiders were held in the mandibles, the wasp plunging directly into the open nest entrance and remaining within only a few seconds. The spiders in this and other nests were found to be deeply paralyzed and to be heaped in an irregular pile on the floor of the large cell. The egg of the wasp was in each case glued by one end to the mid-dorsal line of the abdomen of one of the larger spiders toward the bottom of the pile; the free end of the egg extended obliquely either forward or backward (Fig. 2). The egg measured 1.8 mm in length. The number of spiders per cell varied from 9 to 17, with three of the cells having 14 or 15 spiders. I preserved 41 spiders in alcohol and discarded several others which appeared to represent the same species. The spiders saved were identified by H. W. Levi as follows:

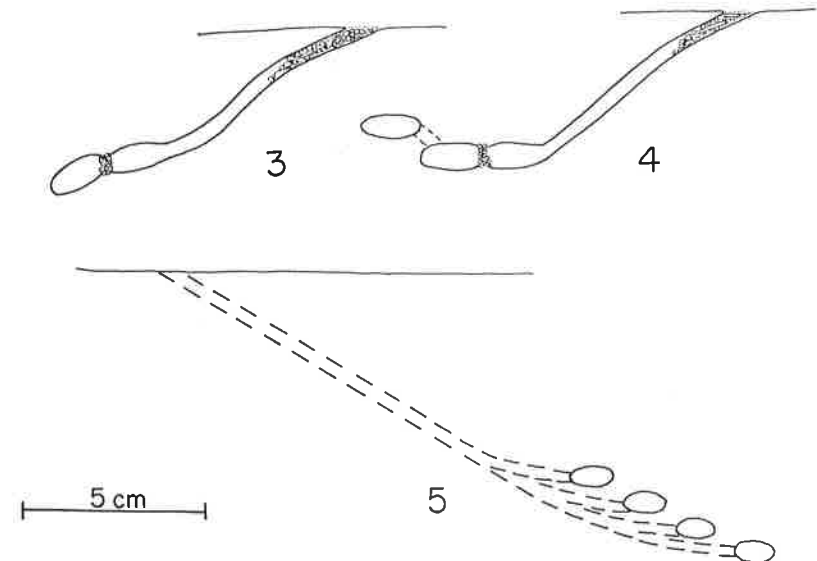
Theridiidae: *Chrysso nordica* (Chamberlin and Ivie), 25 ♀♀; *Theridion rabuni* (Chamberlin and Ivie), 12 ♀♀; *Theridion petraeum* (L. Koch), 3 ♀♀.

Araneidae: *Singa* sp., 1 juvenile.

Dr. Levi informs me that the *Chrysso* is a poorly known spider of northern distribution; it is whitish in color and hence very conspicuous once the cells of the wasp have been exposed. The *Theridion* are smaller and more grayish; they are known to occur under stones. Theridiid spiders were not recovered from the nests of any of the other spider-hunting wasps in Jackson Hole, but *Pisonopsis clypeata* appears to specialize on them.

#### Genus *Belomicrus* Costa

This genus of very small wasps occurs in the Nearctic, Palearctic, and Ethiopian regions, and although more than 50 species have been described, almost nothing is known of the nesting behavior. So far as I know the only published account is that of F. X. Williams (1936) on *B. franciscus* Pate. Although *Belomicrus* has been placed in the tribe Oxybelini of the subfamily Crabroninae, Williams found that *franciscus* digs the nest in the manner of *Anacrabro*; furthermore, this species preys on beetles rather than on flies, the prey of *Oxybelus*. Pate (1940) placed *Belomicrus* in the Oxybelini, but noted that it differs from *Oxybelus* in several important features, especially in having a concave abdominal venter and a distinct psammophore (like *Anacrabro*). He noted the discontinuous distribution of the genus (chiefly western United States, the Mediterranean and Transcasian regions, and South Africa) and remarked that the unusual structural and biological features of the genus suggest that it has had an evolution independent of other genera for some time and has not given rise to any other genera. All of this suggests that further data on nesting behavior, as well as larval characters, are much to be desired.



FIGS. 3-5. Fig. 3. A two-celled nest of *Pisonopsis dylpeata* with the closure intact but cell contents removed. Fig. 4. A similar three-celled nest of the same species. Fig. 5. A nest of *Belomicrus forbesii forbesii* containing four cells. Burrows shown as dashed lines had been filled compactly and could only be approximated.

Williams studied *B. franciscus* at Lone Mountain, San Francisco, California, in the spring of 1930. Individuals were seen at the flowers of "the little sand mat," *Panatacaena ramosissima*, and excavating their burrows in the sand. The sand was loosened with the mandibles and gathered into a ball held between the head and prothorax with the aid of the psammophore; the wasp then "rises obliquely backwards with the load which she releases at the moment of swinging obliquely downwards to her burrow." These flights are repeated many times, the wasp always flying out backwards and scattering the sand some distance from the burrow. Williams did not dig out the nest successfully, but found the prey to consist of melyrid beetles, *Trichochrous antennatus*, which were common on nearby flowers.

*Belomicrus forbesii forbesii* (Robertson). This is one of the commoner fossorial wasps in Jackson Hole and also one of the smallest, females measuring 5-6 mm in length. It is on the wing all summer (July 4-August 26) and may have more than one generation during that time. I have taken females on *Solidago* blossoms and both sexes as prey of *Phylanthus pulcher* (Evans, 1966); in the summer of 1967 I took several additional paralyzed or dead specimens from the nests of *P. pulcher*. It is noteworthy that the only nest of *B. forbesii* I found was

within the limits of a *P. pulcher* colony and while that species was actively nesting (July 21, 1967; my note no. 2111).

This female was first seen digging at 1050. She flew out backward and obliquely upward, exactly as Williams had described for *franciscus*. Each time she flew about 60 cm, about 30 cm high, and dropped a small load of earth. Most flights were in the same direction, directly in front of the hole, which had no mound of earth at the entrance. At 1055 the entrance appeared closed from the inside, but she was active again at 1058; the nest was closed again at 1120, but she was digging once more at 1122. Evidently she loosens soil within the burrow, pushes it out behind her, then moves to the entrance and disperses it by quick, backward flights as described above.

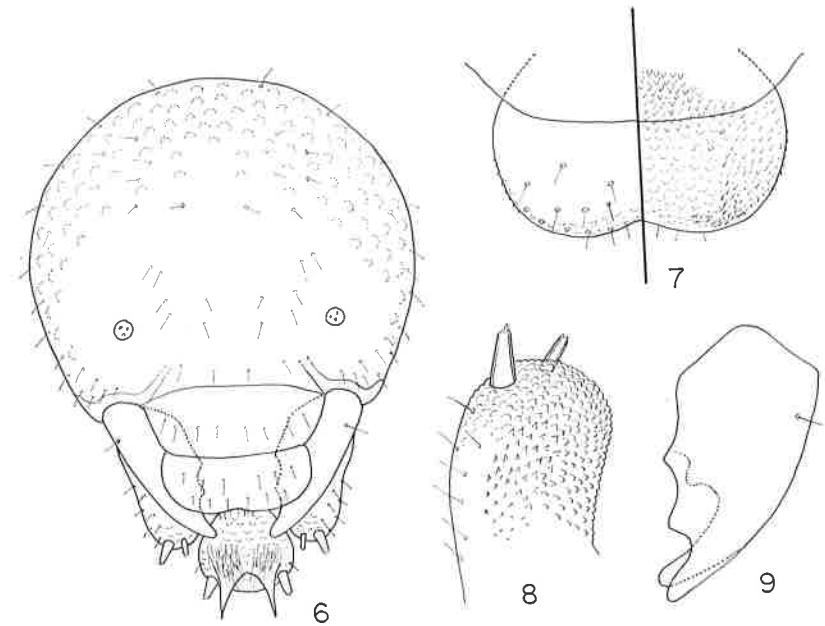
On the following day she was again observed flying out of the burrow carrying soil at 1045. At 1130 she was still digging, but from time to time flew in a circuitous path close to the ground around the nest. At 1230 she was seen bringing in prey, and she continued to bring in prey until at least 1600. The burrow was left open while she was away from the nest, and when she returned she plunged directly in. The prey was held somewhat behind her, possibly being grasped by the hind legs both during flight and upon entry; because of the small size of wasp and prey I could not, however, be certain how the prey was grasped.

Two days later (July 24) the nest appeared closed and no further activity was observed, although another female (or perhaps the same one) was seen on the sand nearby and was taken for identification. The nest was dug out and found to contain four cells in an oblique row, the cells being from 8 to 10 cm from the entrance and 6 to 7 cm in depth from the surface directly above. The cells were not in series and were separated by substantial barriers of soil (Fig. 5). Two of the cells contained prey (5-9 per cell); one of these had a newly hatched larva which was eventually reared to maturity and is described below. The other two were parasitized by miltogrammine flies; the two maggots in one cell were reared successfully, two adult *Senotainia trilineata* Wulp emerging in May, 1968. A fly of this same species was taken at the nest entrance of the wasp on July 22, 1967.

All the prey taken from the cells, as well as one taken from the female as she entered, appeared to belong to one species of bug, *Orectoderus obliquus* Uhler (Miridae) [det. J. L. Herring]. Only two were adults, the remainder last-instar nymphs. The larva consumed its prey by coiling itself over the dorsum of the bug and feeding through the ventral side.

*Description of larva of B. forbesii.* Length about 6.5 mm; form as figured for *Oxybelus* by Evans (1957, Fig. 109) and by Grandi (1961, Fig. 352), the anus distinctly ventral in position, pleural lobes well developed. Integument smooth, minutely spinulose laterally and ventrally, dorsally with transverse rows of small, widely spaced setae.





FIGS. 6-9. Full-grown larva of *Belomicrus f. forbesii*. Fig. 6. Head in anterior view. Fig. 7. Labrum, showing anterior surface on left and posterior or inner surface (epipharynx) on right. Fig. 8. Maxilla, lateral surface at left, mesal surface at right. Fig. 9. Mandible.

Spiracles as figured for *Oxybelus* (Evans, 1957, Fig. 108) except atrial walls almost without sculpturing. Head subcircular, 0.85 mm wide, 0.75 mm high (not including labrum or mouthparts). Head with many short setae, including a transverse row on clypeus. Antennal orbits small, circular; parietal bands not present. Labrum slightly emarginate, bearing 12 setae plus 6 more on medioapical margin; epipharynx strongly spinulose basally, laterally, and along the apical margin, but with a large median area merely papillose. Mandibles robust 5-toothed, the apical two teeth stronger than the others; base with a single strong seta. Maxillae with several strong lateral setae, upper surface spinulose except entire inner margin (lacinial area) merely papillose; palpi slightly longer and thicker than galeae. Labium papillose except for two patches of strong spines, as in *Oxybelus* and *Anacrabro*; spinnerets pointed, much exceeding labial palpi (Figs. 6-9).

*Affinities of Belomicrus as suggested by larval characters and by nesting behavior.* The larvae resemble those of *Oxybelus* very closely indeed, differing chiefly in having the lacinial area wholly papillose and the epipharynx more spinulose medioapically. The latter character was used to distinguish the *Oxybelini* from the *Crabronini* (Evans,

1959), and its breakdown I take as further evidence that the two tribes should be lumped as the tribe Crabronini of the Larrinae. Behavioral resemblances to *Oxybelus* are much less impressive; the prey of *forbesii* is like that of *Anacrabro* (Miridae, Hemiptera), and the manner of digging is strikingly similar and correlated with the presence of a psammophore and (presumably) a ventrally concave abdomen in both genera. It seems probable that the original prey of the Crabronini was Hemiptera and that *Anacrabro* and *Belomicrus* represent groups that have retained their original food preferences while several other genera have switched to Diptera and other insects. It is probable that the resemblances of these two genera in digging behavior and correlated structures are the result of convergence, for larval characters suggest that *Belomicrus* is close to *Oxybelus*, which is also suggested by the metanotal flange and other adult characters. However, Pate may well be right that *Belomicrus* has had an independent evolution for a long time. If *Oxybelus* arose from a *Belomicrus*-like ancestor, then its switch-over to dipterous prey must represent convergence with *Crabro* and its relatives.

## LITERATURE CITED

- Evans, H. E. 1957. Studies on the larvae of digger wasps (Hymenoptera, Sphecidae). Part III: Philanthinae, Trypoxyloninae, and Crabroninae. Amer. Entomol. Soc., Trans. 83:79-117.
- . 1959. Studies on the larvae of digger wasps (Hymenoptera, Sphecidae). Part V: Conclusion. Amer. Entomol. Soc., Trans. 85:137-191.
- . 1964. The classification and evolution of digger wasps as suggested by larval characters (Hymenoptera, Sphecoidea). Entomol. News 75:225-237.
- . 1966. Nests and prey of two species of *Philanthus* in Jackson Hole, Wyoming (Hymenoptera, Sphecidae). Great Basin Natur. 26:35-40.
- Grandi, G. 1961. Studi di un entomologo sugli Imenotteri superiori. Boll. Ist. Entomol. Univ. Bologna 25:1-659.
- Linsley, E. G., J. W. MacSwain, and R. F. Smith. 1952. The bionomics of *Diadasia consociata* Timberlake and some biological relationships of emphorine and anthophorine bees (Hymenoptera, Anthophoridae). Univ. Calif. Pub. Entomol. 9:267-290.
- Parker, F. D., and R. M. Bohart. 1966. Host-parasite associations in some twig-nesting Hymenoptera from western North America. Pan-Pac. Entomol. 42:91-98.
- Parker, F. D., and R. M. Bohart. 1968. Host-parasite associations in some twig-nesting Hymenoptera from western North America. Part II. Pan-Pac. Entomol. 44:1-6.
- Pate, V. S. L. 1940. The taxonomy of the oxybeline wasps (Hymenoptera: Sphecidae), II: The classification of the genera *Belomicrus* and *Enchemicrum*. Amer. Entomol. Soc., Trans. 66:209-264.
- Richards, O. W. 1944. Observations on aculeate Hymenoptera. Proc. Roy. Entomol. Soc. London (A) 19:133-136.
- Williams, F. X. 1914. The Larridae of Kansas. Kansas Univ. Sci. Bull. 8:121-213.
- . 1936. Notes on two oxybelid wasps in San Francisco, California. Pan-Pac. Entomol. 12:1-6.
- . 1954. The wasps of the genus *Pisonopsis* Fox. Pan-Pac. Entomol. 30:235-246.
- . 1966. A spider-hunting wasp found nesting in hollow plant stems (Hymenoptera: Pompilidae, Pepsinae). Wasmann J. Biol. 25:33-47.