

THE NESTING BEHAVIOR AND
LARVAL MORPHOLOGY OF *PISON KOREENSE*
(RADOSZKOWSKI) (HYMENOPTERA: SPHECIDAE)*

BY JOSEPH K. SHELDON

Department of Entomology, University of Illinois

Introduction

The genus *Pison* has a wide distribution, occurring in most tropical countries and extending into the temperate zones. Turner (1916) lists 50 species occurring in Australia, 17 in the Austro-Malayan Region, 13 in the Oriental Region, nine in the Palearctic Region, nine in the Ethiopian Region, and eleven species from the Americas. The only native species in the U. S. or Canada is apparently *P. laeve* Smith, reported from Georgia (Krombein, 1951).

Pison koreense, a native of Korea, China, and Japan, was apparently introduced into this country after World War II (Krombein, 1958). At the time of Krombein's publication it had been collected from two localities: McLean, Virginia in 1954, and Palisades Park, Illinois in 1957. Since that time it has been reported from Plummers Island, Maryland, and from Michigan (Krombein, 1967). Adults of *P. koreense* are small, black wasps having a wing span of about 10 mm, and may be distinguished from our native sphecoid wasps by their two submarginal cells and reniform eyes which are covered with short dense hairs.

The present study was carried out in east-central Illinois. Information on the nesting behavior and larval morphology of *P. koreense* is presented, and some obvious differences between this species and other members of the genus are noted.

General Ecology

ACTIVITY AND NEST HABITAT — *Pison koreense* was found nesting at two localities in east-central Illinois: in a culvert at Kickapoo State Park and under a bridge one mile east of Urbana. Apparently there is a univoltine life cycle with the adults emerging near the end of July, although additional collecting needs to be done to substantiate this. The wasps are active for only a few weeks and most are gone by the end of August. Krombein (1958) reported that the cells collected by A. D. Cushman at McLean, Virginia, were found inside a photographic tank which was stored under an old

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army barracks. I have also found them building their own cells within the empty cells of *Trypoxylon politum* (Say) nests.

NEST — The nest (fig. 1) typically consists of from one to twelve small, fragile, mud cells. There is no specific arrangement of the cells: they may be constructed side by side, end to end, or in small clusters. Since they are often built in small depressions and cracks, the size of the particular niche available for nesting often determines the number of cells that can be constructed. The cells vary in size from 6-10 mm in length and from 4-5 mm in width.

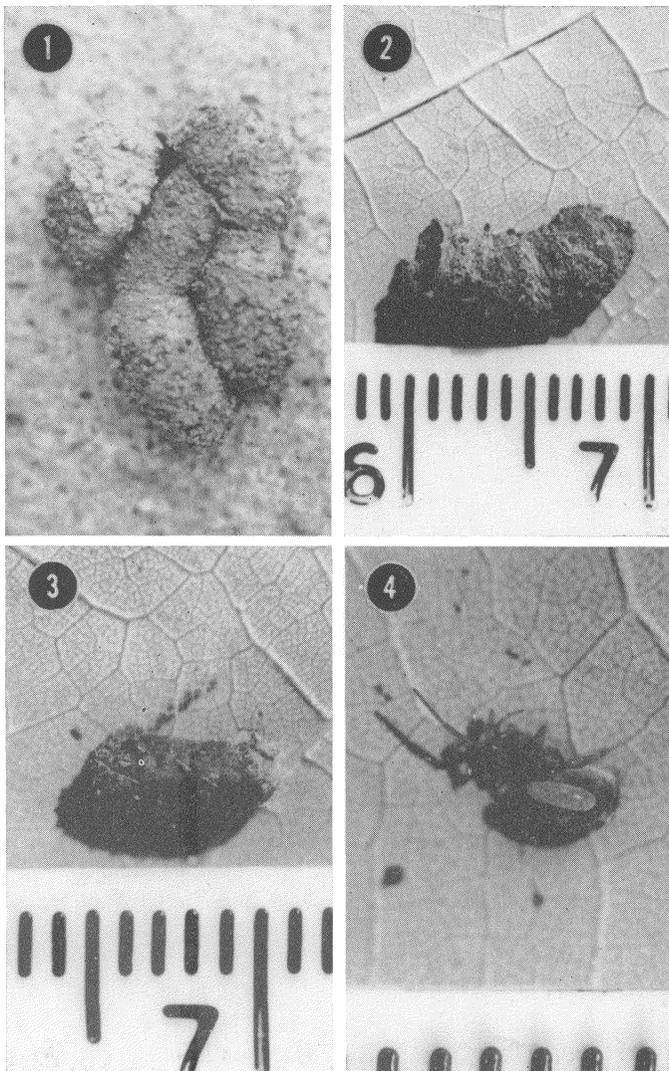
NESTING BEHAVIOR — The full length of the daily activity period is not known. My observations were carried out from August 7th to August 29, primarily in the late afternoon. On two occasions I visited the Urbana nesting site at 8 AM, but there was no apparent activity on either occasion. On August 7th the last female observed was at 5:45 PM, on August 9th at 5:25 PM, and on August 13 at 5:28 PM.

Construction of the cell was observed in its entirety only once (note 158). On this occasion I arrived at the nest at 3:40 PM and found a female in the process of closing the third cell. She was bringing in loads of mud in her mandibles and then, using only her mandibles for manipulating it, was applying it to the cell. It soon became apparent that more than a closure was involved. She was beginning a new cell directly on the end of the old one. It was thus impossible to be certain exactly how many trips were required to construct the new one. From the time that I arrived, however, until the new cell was completed, 19 trips were made for mud. The female of nest 158 spent 75-330 sec away from the cell (mean \pm std. error = 147.7 \pm 22.4, N = 15 observations), and 15-390 sec at the cell (mean \pm std. error = 136.2 \pm 23.0, N = 16 observations).

P. koreense provisions her cells with small spiders, a feature which is apparently characteristic of the genus. Two cells (notes 136 and 158) were observed during the process of provisioning. Although it is difficult to be certain, without photographic evidence, I am convinced that when approaching a cell, the female carries the spider, which she has stung and paralyzed, solely by her mandibles. She approaches quickly and hovers momentarily about a foot in front of her cell before landing near the entrance. She then immediately walks to the cell carrying the spider in her mandibles, enters head

EXPLANATION OF PLATE 5

Fig. 1. — Cluster of five cells of *Pison koreense*. Fig. 2. — Single cell.
Fig. 3. — Cocoon. Fig. 4. — Egg of *P. koreense* on prey.



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first, places the spider in the cell, backs out and flies away without hesitation. Orientation flights were never observed, although my observations were confined to females whose nests were already under construction so that such flights might have been made when the nests were first begun. The spiders are well paralyzed when placed in the cell, although in some cases slight movements of their appendages are noticeable. In the lab the spiders remained fresh and paralyzed for up to thirty days. The length of time involved in provisioning the two cells was noted. The female of cell 136 spent 122-535 sec away from the cell (mean \pm std. error = 350.4 \pm 39.4, N = 10 observations), and 7-25 sec at the cell (mean \pm std. error = 10.6 \pm 1.9, N = 9 observations). The female of nest 158 spent 30-700 sec away from the cell (mean \pm std. error = 186.0 \pm 20.8, N = 10 observations), and 7-127 sec at the cell (mean \pm std. error = 24.0 \pm 11.5, N = 10 observations).

The number of spiders used to provision a cell varies to some extent. Four cells examined prior to the hatching of the larvae contained 31, 22, 20, and 28 (\bar{X} = 25.2) spiders, respectively. All the spiders in these cells were members of the genus *Dictyna* (Dictynidae), the species represented by adults being *D. bellans* Chamberlin (σ and ♀), *D. sublata* Hentz (♀), and *Dictyna* sp. indet. (one ♀). A number of immature *Dictyna* were also found, but these could not be determined to species.

Oviposition was observed once (note 136). In this case the last spider was brought in at 4:48 PM. The female remained for 15 sec with her head in the cell. She then backed out, groomed herself, and sat at the cell opening for 5 min 15 sec, after which she stuck her head into the opening for 3 sec, came out, turned around, inserted her abdomen into the cell, and remained in that position for 1 min 15 sec. After ovipositing she withdrew her abdomen and remained motionless at the opening for 20 sec after which she flew off. At 5:00:10 PM she returned with the first load of mud for the final closure.

The egg is apparently laid consistently in the same position on the prey. In the three cells in which I found an egg that had not yet hatched, it had been laid on the last spider placed in the cell. In each case this spider was one of the larger ones. The egg was laid on the right side of the anterior end of the spider's opisthosoma, oriented so that it was parallel to the midline (fig. 4).

The closure of the nest was viewed in its entirety only once (note 136). After ovipositing, the female flew away and returned at

5:00:10 PM with the first load of mud. On this trip she brought enough mud to nearly close the cell opening. A second load completely sealed the cell. Just before taking flight she paused briefly near the cell and appeared to look around. She returned to the closed cell twice within the next ten minutes but at neither time was any additional mud added to the cell.

Parasites — A large number of adult *Melittobia chalybii* Ashmead (Eulophidae) were reared from a *P. koreense* cocoon collected at Kickapoo State Park, Illinois. The cocoon was from a nest constructed in an unsealed cell of *Trypoxylon politum*.

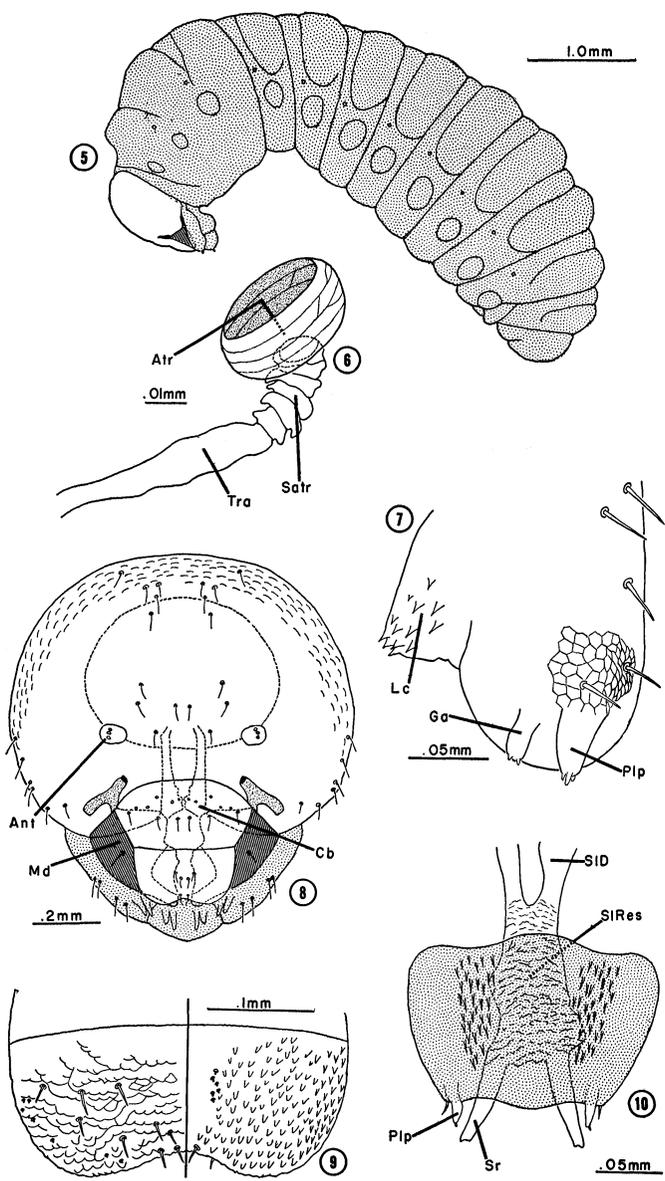
The Immature Stages of *Pison koreense*

Methods — Preparation of the larvae for microscopic study involved making two small punctures in the cuticle and then placing them directly into Nesbitt's fluid (Nesbitt, 1945) for 24-48 hours for clearing, the length of time depending on the temperature. At 60°C less than 24 hours may be required. They were then flushed out, by injecting 70% ETOH into the body cavity through one of the punctures, and stained in a 5% solution of Chlorazol Black E in 75% ETOH for one minute. They were then placed in glycerine for storage and study.

Descriptions were made from cleared, whole specimens, from cleared heads that had been removed and mounted in a depression slide in glycerine, and from mouthparts that had been removed and mounted individually on slides. The spiracle was also mounted in glycerine on a slide. Studies of all but the grossest details employed phase and Nomarski interference contrast microscopy. Measurements were taken with an ocular micrometer and the drawings were made with the aid of a microprojector. Following the procedure of Evans (1956), the description is based on a single specimen. Individual variation is discussed immediately following the description.

EGG — Length approximately 1.3 mm; width 0.5 mm; subcylindrical, with a slight taper at one end and slightly incurved on the side attached to the spider's opisthosoma; color an opaque white (fig. 4).

LARVA-BODY (fig. 5): Based on a diapausing specimen. Length 6.3 mm; maximum width 2.0 mm. Posterior end truncate, anus ventral and slightly sub-apical on the last abdominal segment. Pleural lobes well developed, the thoracic lobes quite protuberant. Posterior annulets on the thorax only slightly swollen, noticeably swollen on abdomen. A few weak setae present on the dorsum and thoracic pleural lobes, very scarce on the venter and restricted to the posterior segments. Spiracles (fig. 6) with ridges on atrial wall corresponding



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to the junctions of the scale-like plates; opening between atrium and subatrium smooth, lacking folds and spines; subatrium with noticeable swellings along its length; prothoracic spiracle slightly larger than others.

HEAD CAPSULE (fig. 8): 0.84 mm wide, 0.74 mm high. Coronal suture and parietal bands not evident. Setae fairly numerous, moderately strong. Antennal orbits transversely ovoid, 0.045 mm in greatest diameter. Clypeus with six moderately strong setae, and ten small circular setaless sensilla, dorsal to these.

MOUTHPARTS: Labrum (fig. 9) 0.30 mm wide, 0.14 mm high at midline, greatest height 0.15 mm; apical margin emarginate medially; surface with low transverse ridges; a number of small sensory cones laterally and with several moderately strong setae. Epipharynx (fig. 9) with two small groups of sensory cones medially; surface papillose, except spinulose laterally. Mandibles with apex rather blunt, two worn apical teeth present; teeth bordering scooped out area worn and indistinct; a single setae near the base; length 0.31 mm, maximum width 0.20 mm. Body of maxillae (fig. 7) rounded apically, sub-papillose; five moderately strong setae. Lacinial lobe angular, spinulose apically. Length of palpi 0.05 mm, of galea 0.04 mm. Labium (fig. 10) with two patches of spinules on oral surface; four strong setae on aboral surface; length of palpi 0.05 mm; spinnerets blunt apically, slightly longer than palpi, united internally with membranous salivary silk reservoir.

VARIATION — Observations on the variation in body length and the number of setae on the clypeus, labrum and maxilla were made. It was found that the length varied from approximately 6.3-7.5 mm (five specimens). The number and position of the setae is also variable: clypeus six to eight setae (three specimens); labrum eleven to twelve setae (two specimens); maxilla five to seven setae (two specimens).

MATERIAL — Five diapausing larvae from cocoons collected under a bridge one mile east of Urbana, Illinois, August 29, 1967 and

EXPLANATION OF PLATE 6

Fig. 5. — Diapausing larvae of *Pison koreense*. Fig. 6. — Spiracle. Fig. 7. — Apex of maxillae, anterior aspect. Fig. 8. — Head, anterior aspect. Fig. 9 — Labrum: anterior surface (left) and epipharynx (right). Fig. 10. — Labium, anterior aspect.

Abbreviations: Ant — antenna; Atr — atrium; Cb — cibarium; Ga — galea; Lc — lacinial area; Md — mandible; Plp — palpus; Satr — subatrium; Sld — salivary duct; SRes — salivary reservoir; Sr — Spinneret; Tra — trachea.

January 22, 1968. Specimens in the Sheldon collection and in the U. S. National Museum.

COCOON — Length 6.0-8.0 mm, width 2.0-2.5 mm; walls 0.02 mm thick, brittle; surface slightly granular, granules consisting of minute pieces of stone; no pores present; one end with a solid plug of dark material; cocoon surrounded by delicate silken threads attaching cocoon to inside of cell.

Discussion

The generic characterization of *Pison* larvae given by Evans (1957: 90) in his Table of Generic and Subgeneric Characters is as follows: "Apex of the maxilla with the surface papillose (fig. 67); maxillary palpi only slightly longer than the galeae; spiracular subatrium elongate, smooth-walled (fig. 66); head strongly roughened on the top and sides and rather strongly setose (fig. 65)." The first two characteristics in this diagnosis apply quite well to *P. koreense* and are sufficient to separate *Pison* from *Trypoxylon* without modification. The spiracular subatrium of *P. koreense*, however, is not smooth-walled (fig. 6), and the head is only moderately roughened on the top and sides, and is only moderately setose (fig. 8). Therefore the third and fourth characters cited by Evans should be modified.

The studies of Micheli (1933), Evans (1957), and Cowley (1962) have provided data on the species *P. atrum* Spin., *P. argentatum* Shuckard, and *P. spinolae* Shuckard, from which *P. koreense* seems to show a number of differences. Only Evans (1957) has presented a sufficiently precise morphological description of the larva to permit a detailed comparison of this stage. The spiracles of *P. koreense* differ from those of *P. argentatum* as described by Evans in having a larger external atrial opening, a number of low ridges on the atrial wall, the opening between the atrium and subatrium smooth, and noticeable swellings along the length of the subatrium. Evans also illustrated the spinnerets of *P. argentatum* as having a common external base. Under phase microscopy I found that in *P. koreense* the spinnerets unite internally with a membranous salivary reservoir which is continuous with the paired salivary ducts. If the reservoir is extensible, it may be that when fully extended the spinnerets would appear to have a common base. In contrast to *P. argentatum*, but like *P. atrum*, *P. koreense* has six sensory cones on the epipharynx. Cowley did not give a description of *P. spinolae* with his two small figures. These are not in agreement with the other descriptions of *Pison*, as they indicate the presence of an obvious coronal suture, a different position of the anus, a differently shaped

labrum, and the presence of two rows of setae on the clypeus rather than one row of setae and one row of setaless sensillae. Obviously a great deal remains to be learned about the species characters and the individual variability of *Pison* larvae.

In addition to the morphological differences between the larvae, there are some interesting differences in adult behavior. Micheli (1933) gave a fairly detailed description of the nest construction of *P. atrum* in a section of bamboo stem 10 mm long and with a bore of 7 mm which he had sealed at one end and placed on the wall of a house. The nest constructed by *P. atrum* within the cavity of the bamboo (see his fig. 11) was linear, with the cells end to end and separated by mud partitions. The side of each partition facing the nest opening was stated to be convex and rough while the inner surface was described as concave and smooth. This seems rather curious as the construction of a partition with these features would appear to be very difficult and is exactly the opposite to that found by Cooper (1957) in *Ancistrocerus antilope* (Panzer) which nests in much the same way as *P. atrum*. Ferton (1910) reported a similar linear, cavity nest in *P. ater* sp. which he found nesting in the hollow stems of *Rubus*, each cell being separated by a mud partition. He did not, however, discuss the shape of the partition. Ferris (1877) reported the rearing of *P. ater* from a *Sceliphron* nest. Iwata (1964) found *P. argentatum* nesting on concrete walls and sometimes on wooden walls and doors of buildings in Thailand. He also found *P. oblitteratum* Smith constructing nests on the rough wall of a room, *P. suspiciosum* Smith nesting in bamboo tubes, and *Pison* sp. (near *suspiciosum*) reconstructing the nest of *Sceliphron madraspatanum* for their own use. *P. koreense*, in comparison, nests in well protected localities (see above), but has not been seen nesting in stem cavities.

The few observations that have been made on the prey of *Pison* indicate that spiders of several families are used, although it is possible that a given species of wasp tends to be quite narrow in its choice of prey. As noted above, I found *P. koreense* provisioning with a number of species of *Dictyna* (Dictynidae). Cowley (1962) in a study of the New Zealand species *P. spinolae* found that the number of spiders per cell in 14 cells varied from 4-15, with a mean of eight. Six genera were represented — all in the family Argiopidae: *Argiope protense*, *Arachnura feredayi*, *Araneus viriditas*, *Araneus crassus*, *Araneus laevigatus*, *Cyclosa trilobata*, *Cyclosa* sp. (undescribed), and *Leucage dromedaria*. Ferton (1908) observed *P. ater* in the act of catching a small spider of the genus *Xysticus* (Thom-

isidae). The specimen was immature, but was considered to probably be *X. lanio*.

There have been few reports of parasitism on *Pison*. In addition to the eulophid parasites *Melittobia chalybii* reared from a *P. koreense* cocoon (see above), Micheli (1933) found dipterous puparia in a cell of *P. atrum*, and Iwata (1964) reports rearing *Chrysis* sp. from the cells of *P. argentatum* and *Melittobia* sp. from *Pison* sp. (near *suspiciosum*).

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