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The Triungulin Larva of *Nemognatha (Pauronemognatha) punctulata* LeConte (Coleoptera: Meloidae) with a Description of the Nest of Its Host—*Megachile brevis pseudobrevis* Say (Hymenoptera: Megachilidae)

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ABSTRACT: Two single cell nests of *Megachile brevis pseudobrevis* are described from the Florida Keys and compared with the nests of the nominate subspecies. Both cells contained pupae of the meloid beetle *Nemognatha (Pauronemognatha) punctulata.* This is the first record of a larval host for this species. The triungulin larva of *N. punctulata* is described and a key to the first instar larvae of the subgenus *Pauronemognatha* is presented. Observations indicate that *Borrichia frutescens* is the preferred host plant for the meloid adults and it seems probable that they oviposit mostly on this species.

Two nests of the megachilid bee *Megachile brevis pseudobrevis* Say were discovered at Knights Key, Monroe County, Florida in February 1984. Upon dissection, it was found that each of these single cell nests contained a coarctate pupa of a meloid beetle. Subsequently, the adult beetles emerged and were identified by Dr. R. B. Selander as belonging to *Nemognatha (Pauronemognatha) punctulata,* a species for which no larval host records are available. A return visit to the site in December 1985 enabled observations of the adult meloid to be made and permitted the discovery of over 50 triungulins of the species.

The Nest of *Megachile brevis pseudobrevis*

Both nests were found when adult females of the *Megachile* were observed flying around the tops of tufts of the grass *Andropogon.* The single cell nests were situated near the center of the apical leaf tufts of the grass (Fig. 1). Both cells were similar in shape to those of the nominate subspecies (Michener, 1953) but wider at the base than at the apex, rather than being parallel sided. Dimensions of the two cells are as follows: larger cell, maximum external width (near base) 7 mm, minimum external width 6 mm, minimum internal width 5 mm, length 13 mm; smaller cell, maximum external width 6 mm, minimum external width 5.5 mm, minimum internal width 4 mm, length 12 mm.

The cells were constructed of plant material, as is usual in *Megachile* species. Semi-circular leaf portions were cut from *Bidens pilosa* (Compositae)—the commonest flowering plant at the locality. Additional material was obtained from the white petals of *Bidens* or the purple petals of *Eustoma exaltatum* (Gentianaceae). The latter seemed to be preferred: it was impossible to find intact flowers of this species (which was represented by only a few specimens at the locality), the bees apparently removing fragments of the petals as soon as the flowers opened.

Female *Megachile brevis pseudobrevis* were observed collecting pollen from

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Fig. 1. The two single cell nests of *Megachile brevis pseudobrevis.* a) The larger of the two cells. Petals and leaves of *Bidens pilosa* can be seen making up the outer portion of this cell. b) The smaller of the two cells. This cell was situated in a more exposed position.

flowers of *Borrichia frutescens* (Compositae) and, less commonly, from the more numerous *Bidens pilosa*. The bees also visited various Leguminosae, which were rather uncommon at the site.

Behavior of the Adult Meloid

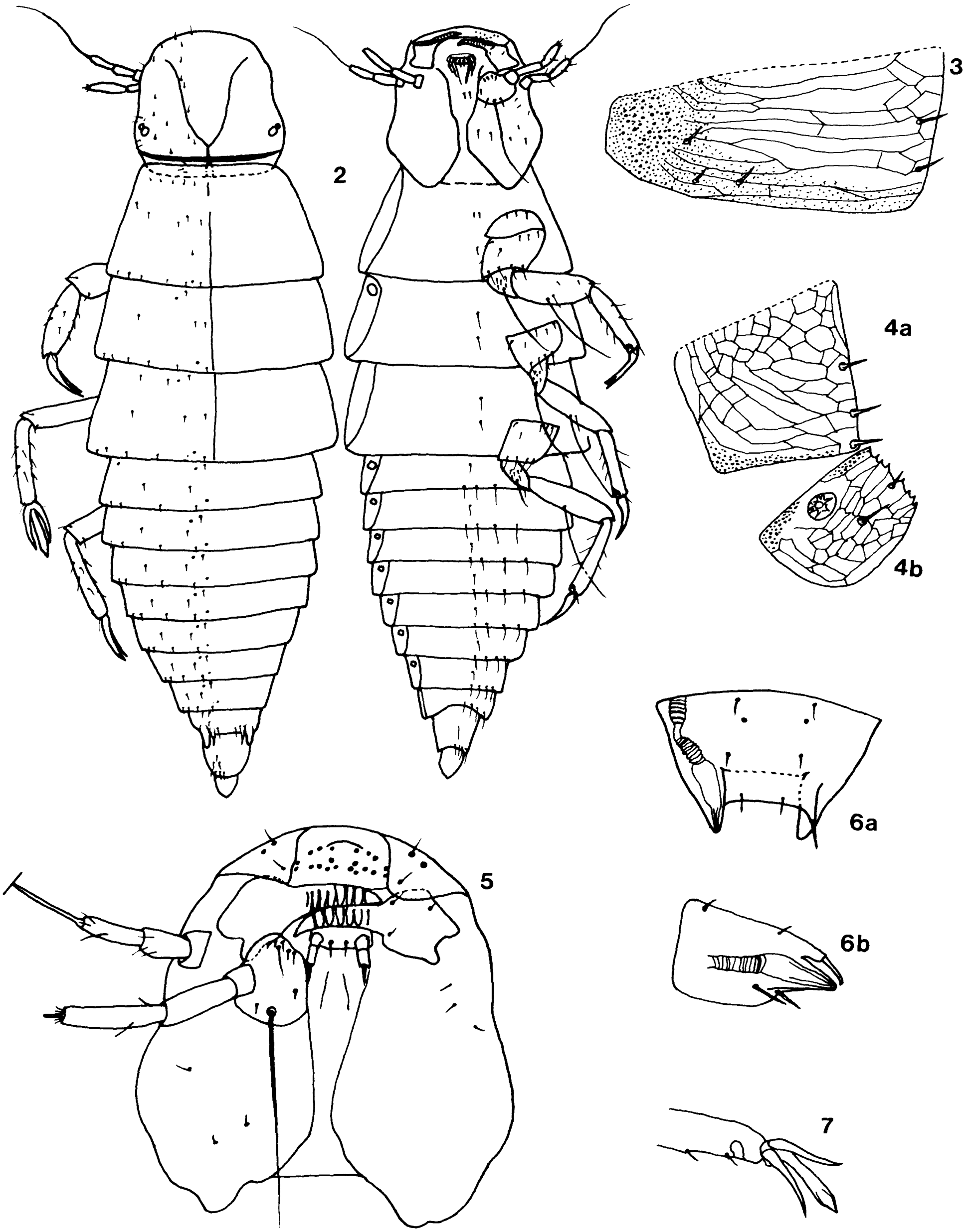
Adults of *Nemognatha punctulata* have previously been recorded from flowers of "Compositae" (Enns, 1956), *Bidens pilosa* (Selander and Bouseman, 1960; Erickson et al., 1976) and *B. pilosa* and questionably *Borrichia arborescens* (Erickson et al., 1976). The earlier collections of this species at Knights Key had been made from *Borrichia frutescens* and this association was confirmed in December 1985.

On 7 December 1985, a thorough survey was made of the portion of the Knights Key campground that had previously produced the beetles. Eight adults were located on flowers of *B. frutescens* and only one on *B. pilosa* despite the numerical superiority of the latter composite species. Six of the adult meloids were found on the same bush of *Borrichia.*

Collections of flower heads of *Borrichia* and *Bidens* were made to see if the apparent association between the beetles with the former plant species resulted in more triungulins being found on the flowers of this species. Ten flower heads of *Borrichia* and 17 of the smaller *Bidens* (thus giving an equal area of flower for the two species) were picked and examined for triungulins. They were collected at random from throughout the study area. Four *Borrichia* flowers but none of those of *Bidens* produced *Nemognatha* triungulins; the association is significant (Fisher's exact test, $P = 0.012$). As a result, subsequent collection efforts were concentrated on the flowers of *Borrichia.*

The Triungulin Larva of *Nemognatha punctulata* (Figs. 2–7)

DESCRIPTION: The description given below follows the pattern of MacSwain (1956): Color orange brown. Body surface reticulate, denser on head, less dense and less strongly so on thoracic and abdominal tergites, weaker still on sternites; reflexed margins of thoracic (Fig. 3) and to a lesser extent, abdominal tergites (Fig. 4a) with elongate reticulation forming an almost striate pattern; coxae and femora reticulate, tibiae with longitudinal reticulations as on lateral margins of thoracic terga; anterior third to half of prothoracic tergum (to just behind median transverse row of setae), lateral margins of thoracic and abdominal terga, dorsal margins of abdominal pleura (Fig. 4b) and anterior and posterior margins of abdominal sterna with small, blunt spicules giving a minutely pustulate appearance (Figs. 3, 4). Form robust, approximately 3.5–4× as long as greatest width. *Head* (Fig. 5) in dorsal view, broader than long, 20:22, broadly rounded in front; transverse elevation distinct, epicranial suture short, one-seventh to one-tenth the length of head; frontal sutures distinct. *Antennae* one-third as long as head, second segment twice as long as first, third segment one and one-half times as long as second, terminal seta five times as long as apical segment. *Mandibles* (Fig. 5) with seven or eight transverse toothlike ridges, four to six apical ridges complete. *Maxillary palpi* one and one-third as long as antennae; first segment short, length and breadth subequal; second and third segments subequal, approximately 4× as long as first segment. *Thorax* one and one-half times as long as maximum width, making up one-half of the total body length; each thoracic tergite subequal



Figs. 2–7. Triungulin larva of *N. punctulata*. 2. Whole body, dorsal and ventral views. Setation for left hand side of larva only has been included in the diagram. 3. Lateral margin of prothorax to show surface sculpture pattern. 4. Lateral view of a) lateral margin of tergite and b) pleuron of first abdominal segment. 5. Head, ventral view, left antenna and maxillary palp and some setation omitted. 6. a) Dorsal and b) lateral views of eighth abdominal tergum. 7. Tarsus and apex of mesothoracic tibia.

in length and width to the others. Mesothoracic spiracle slightly less than one and one-half times the diameter of the first abdominal spiracle. *Abdomen* more slender than thorax, tapering gradually, ninth segment broadly subtruncate at apex, first spiracle approximately one and one-half times the diameter of that of the second abdominal segment; tergites with posterior marginal row of eight setae, median transverse row of four setae; median length of seventh tergite about twice the length of spiracle-bearing elevations of eighth segment; distance between bases of spiracle-bearing elevations slightly greater than the distance between inner base and apex of one elevation; large seta-bearing tubercles dorsal to spiracle-bearing elevations (Fig. 6), tubercle and seta together as long as elevation; one pair of setae between seta-bearing tubercles, two pairs anterior to elevation (Fig. 6), sternites with apical setae from one-third to one-half the length of sternites; posterior margins of sternites and pleura denticulate (Fig. 4b). *Legs* with setae on second and third trochanters subequal, each as long as corresponding femur; tarsal claws more than half as long as tibia, tarsal setae absent (Fig. 7). Mean length of 19 larvae 1.07 mm (SD = 0.09).

MATERIAL EXAMINED: Fifty-five triungulins, Knights Key campground, Monroe County, Florida; 54 specimens collected on 8 December 1985, 10 from the body of one female of *N. punctulata,* one from a male and one from a female of the host *M. brevis pseudobrevis,* most of the remainder from *Borrichia* flowers; one specimen collected in February 1984 from the body of a male of the host bee species. Specimens are deposited in the Royal Ontario Museum and the collection of Professor R. B. Selander, University of Illinois.

KEY: The triungulin of *N. punctulata* can be distinguished from those of other members of the genus by emending the key provided by MacSwain (1956) as modified by Selander (1957) as shown below. The following also serves as a key to the known triungulin larvae of the subgenus *Pauronemognatha.*

1. Abdominal tergites without a median transverse row of setae; frontal sutures diverging at or near transverse basal elevation .... *N. scutellaris*
– Abdominal tergites with a median transverse row of four (rarely two) setae; frontal sutures, when present, diverging at a distance from transverse basal elevation 2
2. Trochanters with all setae shorter than corresponding femora 2a
– Trochanters with some setae at least as long as corresponding femora .. 2b
2a. Abdominal tergites with a median transverse row of two setae and a posterior marginal row of six; epicranial suture faint, discontinuously marked .... *N. nigripennis*
– Abdominal tergites with a median transverse row of four setae and a posterior marginal row of eight; epicranial suture well developed, continuously marked .... *N. selloa*
2b. Mandibles each with more than six transverse toothlike ridges, eighth abdominal tergum with large setose tubercle dorsal to apical elevations (Fig. 6) .... *N. punctulata*
– Mandibles each with less than six transverse toothlike ridges, eighth abdominal tergum without large setose tubercle 3

NOTES: The triungulin of *N. punctulata* can be distinguished from all other members of the genus by the large number of toothlike ridges on the mandibles. All other described *Nemognatha* larvae have five or fewer such ridges. In possessing so many ridges, the larva of *N. punctulata* is more like those of *Tricrania* and *Hornia*. However, it can readily be separated from these two related genera by the presence of four median transverse setae on the abdominal tergites; *Tricrania* and *Hornia* have only two such setae. In addition, the very large setae dorsal to the spiracle-bearing elevations of the eighth abdominal tergite have not been described for any other species. The shape of these setae is of interest. They are very long and robust, slightly decurved and blunt at the tip. Their shape and position suggest that they may function to block the entrance of the corresponding spiracle should the larva become immersed in the food mass. Observations of feeding larvae are required to verify this suggestion.

The triungulin of *N. punctulata* is quite distinct from those of other members of the subgenus *Pauronemognatha*, which only have three toothlike ridges on their mandibles. Additionally, *N.* (*P.*) *nigripennis, scutellaris* and *selloa* have comparatively long elevations on the eighth tergite, such that the distance between them is always less than their length. Thus, from the morphology of the triungulin larva, it would seem that Enns (1956) was correct in placing *N. punctulata* in a species group separate from other North American *Nemognatha.*

Discussion

The nesting biology of the nominate subspecies of *Megachile brevis* has been studied in detail by Michener (1953); a comparison of his findings with those reported here now follows. Michener found single cell nests of this species to be quite common in Kansas where nests were most often situated in dead plant stalks (23 of 36 nests discovered by following individual bees). Other nest sites included a dead curled leaf, a termite hole in a wooden door, various locations on the ground or in holes in the ground. Only one of 109 nests was found on a living plant. The location of this one cell nest was very similar to that of the two nests of *M. b. pseudobrevis* from Florida. The latter nests were located amongst leaves of the grass *Andropogon,* whereas the Kansas nest was located in the center of dense leaves near the top of an abnormal fasciate specimen of *Erigeron canadensis* (Michener, 1953, figs. 29, 30). The small number of nests discovered makes it impossible to determine whether *M. b. pseudobrevis* nests are usually single cell structures or if they are always located amongst the bases of a dense cluster of leaves. However, the examination of over one dozen hollow stems at the same site did not reveal any nests of this subspecies.

Michener (1953) records the nominate subspecies as collecting pollen mostly from legumes and composites in Kansas. Although detailed observations of foraging behavior were not made on *M. b. pseudobrevis,* the females definitely collected pollen from *Borrichia* and *Bidens.* They did visit legume flowers but whether this was for pollen or nectar is not known. Judging from the list of materials used in cell construction by *M. brevis brevis* (Michener, 1953), *M. b. pseudobrevis* uses petals in cell construction at Knights Key more often than does the nominate subspecies in Kansas.

The level of parasitism by the meloid may be quite high: both of the *Megachile* cells were parasitized by *N. punctulata.* However, it is unlikely that *N. punctulata* is host specific on this megachilid species because some of the females collected appeared to be much larger than the bee species. It should be noted that larvae of *Nemognatha* are not known to move from one cell to another to complete their development, unlike some other meloid larvae (MacSwain, 1956). Few nemognathines are host specific: many species have been recorded from the nests of more than one family of bees (Erickson et al., 1976). In particular, the two other members of the subgenus *Pauronemognatha* whose hosts have been recorded, *N. scutellaris* and *N. nigripennis,* have a large number of host species.

Megachilids and anthophorids appear to be the preferred hosts of nemognathines (Erickson et al., 1976). It may be significant that, although over 1600 adults and 50 nests of *Halictus ligatus* were examined at Knights Key (Packer and Knerer, 1986), not a single specimen of *N. punctulata* was found associated with this social halictine. In comparison, only 12 specimens of *M. b. pseudobrevis* were observed and three of them bore triungulins. This is more surprising when one considers that both of these bee species collected pollen from the same sources—*Bidens* and *Borrichia.* Two hypotheses may be suggested to explain the absence of triungulins on *H. ligatus.* 1) Adult *H. ligatus* females actively repel or remove triungulins from their bodies. 2) The triungulins actively discriminate between hosts. Triungulins are generally considered to be indiscriminate in their choice of vectors. However, considering the high mortality that must result from the choice of an inappropriate host, some degree of discrimination should be expected.

This is the first confirmed larval host record for *N. punctulata.* Scaramuzza (1938) recorded *Zonitis vittigera* (referred to as *Nemognatha vittigera*) from the nest of a *Megachile* species in Cuba. However, this meloid species does not occur in the West Indies (Selander and Bouseman, 1960, 1961) and it seems probable that *N. punctulata* was the parasitoid involved (Selander, pers. comm.).

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