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SURVEY OF THE NUMBER OF OVARIOLES IN VARIOUS TAXA OF BEES (HYMENOPTERA: APOIDEA)

JEROME G. ROZEN, JR.

The American Museum of Natural History, Central Park West at 79th Street, New York, New York 10024.

Abstract.—The numbers of ovarioles in 15 taxa of bees are reported for the first time and compared with published accounts for other taxa of bees (Iwata, 1955, 1965; Iwata and Sakagami, 1966).

Ronald J. McGinley and I recently undertook a study of the nesting biology, immature stages, and adult anatomy of the Palearctic bee *Pararhophites orobinus* (Morowitz) in an attempt to determine the taxonomic and phylogenetic relationships of this genus to other long-tongued bees. In the process I compared the ovaries of female specimens preserved in Kahles solution at the American Museum of Natural History with those of various taxa of bees as reported by Iwata (1955, 1965) and Iwata and Sakagami (1966). Although my material did not permit a detailed analysis of oocyte shape and size, it did show that *Pararhophites orobinus* possesses only three ovarioles in each of its two ovaries (i.e. 3:3). Michener (1944), Michener and Moure (1957), and Popov (1949) had all considered *Pararhophites* to be an anthophorid. Iwata and Sakagami (1966) pointed out that the Anthophoridae, as well as the Apidae, normally have four ovarioles in each ovary (i.e. 4:4), although parasitic and social forms of these two families usually have a larger number of ovarioles. Colletidae, Andrenidae, Halictidae and Megachilidae, on the other hand, have three ovarioles per ovary (3:3). After examining *Pararhophites,* I dissected specimens of various taxa of bees (many of them of special systematic interest in my past studies) preserved in Kahles to determine whether the ovaries of other taxa correspond to the published information. Although specimens were few, variation in numbers of ovarioles within a taxon is normally quite limited, so that the numbers given in Table 1 are probably reliable. This paper also offers a few observations and conclusions, in addition to the figures in Table 1.

In general, the number of ovarioles in an ovary (Table 1) corresponded to the account by Iwata and Sakagami (1966). The Melittidae (*Macropis* and *Meganomia*), like other short-tongued bees, also have a 3:3 formula. The Fideliinae (*Fidelia*), considered by me as a primitive offshoot of the Megachilidae, have a 3:3 formula, as do the other megachilids. The parasitic anthophorines of the Nomadinae (*Kelita* and *Oreopasites*) exhibited a formula of at least 5:5 (and have small oocytes) that corresponds to the large number of ovarioles found in the nomadines *Nomada* and *Epeolus,* as reported by Iwata (1955) and Iwata and Sakagami (1966).

Table 1. Number of ovarioles in various taxa of bees.

Taxon	Number of Specimens Examined	Number of Ovarioles
Colletidae		
Diphaglossinae		
Ptiloglossa arizonensis	2	3:3
Andrenidae		
Andreninae		
Megandrena mentzeliae	1	3:2[a]
	1	3:3
Panurginae		
Cephalurgus anomalis	2	3:3
Melitturgula minima	2	3:3
Nomadopsis barbata	2	3:3
Panurgus intermedius	10	3:3
Perdita n. sp. nr. *wootonae*	2	3:3
P. portalis	2	3:3
Melittidae		
Meganomiinae		
Meganomia gigas	2	3:3
Melittinae		
Macropis nuda	2	3:3
Megachilidae		
Fideliinae		
Fidelia villosa	2	3:3
Anthophoridae		
Nomadinae		
Kelita chilensis	1	prob. 5:5
Oreopasites vanduzeei[b]	1	approx. 11 total
	1	prob. 5:5
Anthophorinae		
Exomalopsis solidaginis	5	4:4
Pararhophites orobinus	2	3:3

[a] Although one ovary seemed to have only two ovarioles, I assume that one was obscured but actually present.

[b] Many ovarioles were present in this species. Because at least 11 could be counted in one specimen, I assumed it had an actual count of either 5:5 or 6:6. The other specimen appeared to have 5:5.

The family placement of *Pararhophites,* considered a "primitive" anthophorid by Michener and Moure (1957) and Popov (1949), is suspect because *P. orobinus* has only three ovarioles in each ovary. Such a feature may be plesiomorphic and, therefore, not inconsistent with placing the genus in the Anthophoridae, but various characteristics of the larvae, nesting biology and adults also do not fit the usual anthophorid patterns. McGinley and I will treat this matter elsewhere.

Cursory examination of the internal anatomy of the female metasoma of these taxa revealed considerable variation, not only in ovarian anatomy, egg size, and egg shape, but also in overall ovarian size, and size and configuration of the Dufour's gland, all features that should encourage more thorough study of the internal anatomy of a greater number of taxa of bees.

As an offshot of this investigation, the morphology of the oocytes (Fig. 1) of

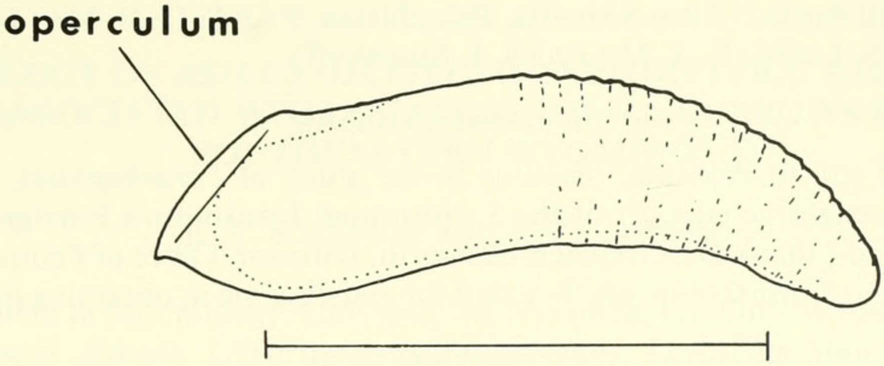

Fig. 1. *Oreopasites vanduzeei,* oocyte, side view with anterior end at left. Scale = 0.5 mm.

the cleptoparasitic *Oreopasites vanduzeei* was of special interest. *Oreopasites,* among other members of the tribe Ammobatini, folds the egg back on itself during oviposition into the cell wall so that the anterior part of the egg comes nearly into contact with the posterior part. The deposited egg is not unlike a sausage bent into a U, and its oblique anterior end (operculum) is flush with the cell wall. In the present study, I observed that the operculum and anterior part of the oocyte were sclerotic and faintly pigmented, whereas the posterior end was transversely corrugated, especially above, and more membranous. Oocytes were only slightly curved and not U-shaped. All oocytes were clearly oriented with their anterior ends pointed anteriorly in the females; and their posterior ends, arranged to descend first through the common oviducts. The corrugations in the chorion of the posterior end of the oocyte probably provide the necessary flexibility for egg bending at oviposition.

Material studied: *Ptiloglossa arizonensis* Timberlake, Portal, Cochise Co., Arizona, September 3, 1982 (J. G. Rozen). *Megandrena mentzeliae* Zavortink, 13 mi NW of Las Vegas, Clark Co., Nevada, May 17, 1980 (J. G. & B. L. Rozen). *Cephalurgus anomalis* Moure & Oliveira, Cosmopolis, São Paulo, BRAZIL, January 27, 1974 (F. C. Thompson), nest #3. *Meliturgula minima* Friese, 22 km ESE of Seeis, SOUTH WEST AFRICA (NAMIBIA), March 15, 1976 (J. G. & B. L. Rozen), all from nest #2. *Nomadopsis barbata* Timberlake, 3 mi S of Hilmar, Merced Co., California, May 3, 1961 (no collector). *Panurgus intermedius* Rozen, Qued Cherrat, 32 km SW of Rabat, MOROCCO, April 21, 1968 (J. G. Rozen & E. Suissa). *Perdita* new species near *wootonae* Cockerell, Ft. Robinson, Dawes Co., Nebraska, August 11, 1972 (J. G. Rozen & R. J. McGinley), from same nest. *P. portalis* Timberlake, 1 mi N Rodeo, Hidalgo Co., New Mexico, August 30, 1970 (J. G. Rozen). *Meganomia gigas* Michener, 52 km SW Omaruru, SOUTH WEST AFRICA (NAMIBIA), March 27, 1976 (B. L. Rozen). *Macropis nuda* (Provancher), Huyck Preserve, Rensselaerville, Albany Co., New York, July 16, 1978 (J. G. Rozen & N. Jacobson), on flowers of *Apocynum. Fidelia villosa* Brauns, 30 km SE Keetmanshoop, SOUTH WEST AFRICA (NAMIBIA), October 23, 1968 (J. G. Rozen). *Kelita chilensis* (Friese), Peñuelas, Valparaiso Prov., CHILE, October 28, 1969 (J. G. Rozen). *Oreopasites vanduzeei* Cockerell, 3 mi S of Hilmar, Merced Co., California, May 3, 1969 (no collector), associated with *Nomadopsis barbata. Exomaloposis solidaginis* Cockerell, 20 mi S Animas, Hidalgo Co., New Mexico, September 13, 1977 (J. G. & B. L. Rozen). *Pararhophites orobinus* (Morawitz), Killi Sarda, 12 km S Quetta, Baluchistan, PAKISTAN, May 14, 1984 (J. G. Rozen, S. Lodhi, R. J. McGinley, I. Stupakoff).

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Literature Cited

Iwata, K. 1955. The comparative anatomy of the ovary in Hymenoptera. Mushi 29: 17–34.

———. 1965. The comparative anatomy of the ovary in Hymenoptera (records on 64 species of Aculeata in Thailand with descriptions of ovarian eggs). Mushi 38: 101–111.

Iwata, K. and S. F. Sakagami. 1966. Gigantism and dwarfism in bee eggs in relation to the modes of life, with notes on the number of ovarioles. Japanese Journal of Ecology 16: 4–16.

Michener, C. D. 1944. Comparative external morphology, phylogeny, and a classification of the bees (Hymenoptera). Bull. Amer. Mus. Nat. Hist. 82: 153–326.

Michener, C. D. and J. S. Moure. 1957. A study of the classification of the more primitive non-parasitic anthophorine bees (Hymenoptera, Apoidea). Bull. Amer. Mus. Nat. Hist. 112: 395–452.

Popov, V. B. 1949. Tribe Pararhophitini (Hymenoptera, Anthophorinae) as an early Tertiary element of the deserts of central Asia and Egypt. Dok. Akad. Nauk. U.S.S.R., new ser., 66: 507–510.