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Nesting biology and sex ratio in a neotropical spider wasp, *Priochilus captivum* (Hymenoptera: Pompilidae)

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Examination of more than 700 cells of the mud-nesting spider wasp *Priochilus captivum* (Pompilidae) in Trinidad, West Indies showed a nesting success rate of about 85%, unusually high for a solitary wasp. Examination of prey remains from unsuccessful cells showed that almost all prey were jumping spiders (Salticidae). Adult females are larger than males, and the sex ratio at emergence is moderately male biased, as expected. Examination of randomly chosen pairs of offspring from the same nest indicated no skewed sex ratio.

Keywords: nesting success; nest structure; Pompilidae; *Priochilus*; Salticidae; sex ratio

Introduction

The Pompilidae, known as spider wasps, are a family of about 4200 known species of solitary aculeate wasps found worldwide. *Priochilus* is a neotropical genus of 21 known species in the subfamily Pompilinae (Fernández 2000). Of these, *P. captivum* (Fabricius, 1804) is widespread in southern Central America and northern South America, including Trinidad in the West Indies (Evans 1966). Cambra et al. (2004) described nest cells of *P. captivum*, based on 12 nests of up to five cells each. These are made of mud, with some indication that fresh cow dung may also be used. The authors measured distances between three nests and their mud sources, each of about 30 m.

All studied spider wasps hunt only spiders, one prey per offspring, a habit that is assumed to be universal for the family (Iwata 1976: Ch. 6; Fernández 2000; O'Neill 2001). Iwata's (1976: Table 5) review of prey records shows a broad variety of spider families, overall, although many species take only a narrow range of prey. At least fragmentary prey notes are available for eight species of *Priochilus* (Iwata 1976: Table 5; Cambra et al. 2004; Quintero and Cambra 1993; Wilson and Pitts 2007). Prey are known from at least four families, of which the most frequent appears to be Ctenidae. The few prey records for *P. captivum* are from the Ctenidae and Salticidae.

While about half of the studied species of spider wasps hunt for prey before making a nest cell, this habit is unknown in those that nest with plastic material (Iwata 1976: Ch. 6 and Table 5), which is usually mud.

A female solitary aculeate wasp or bee typically has no further contact with a brood cell after it is fully provisioned and sealed. Nesting success – the fraction of cells from which adult offspring emerge – is expected to vary among species and situations. In a study of 11

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solitary aculeates species, including 4 mud nesters, Weaving (1995) found success rates mostly between 30% and 60%. And success in *Trypoxylon nitidum* Smith, 1856 (Crabronidae) can vary substantially according to nesting substrate (Nelson DM and Starr CK, unpublished paper; unreferenced).

The use of a single prey for the development of each larva poses some questions with respect to offspring sex ratio. In most aculeate hymenoptera, there is a distinct size difference between the sexes – usually the female is larger – and nesting females can apportion the mass of larval provision according to offspring sex. In spider wasps and many sphecid wasps, a female is constrained by the one-prey-per-larva rule. It would appear, then, that she cannot closely match the sex of a given offspring to the available prey mass, thereby maintaining the adaptive size difference between daughters and sons, yet in almost all studied species females are larger than males (O'Neill 2001).

My purpose here is to add to what is known of the nesting biology of *P. captivum* and to report its sex ratio at emergence, based on observations in Trinidad, West Indies.

Materials and methods

All results are from nests in my house in Caura Village, Trinidad, West Indies (10°41 N 61°22 W). I collected cells as I found them at various times during 2008–2011, mostly in places that had been undisturbed for some days or weeks. Cells of the same colour, which were clumped together, were assumed to be of the same nest, i.e. built by a single female during a restricted period. However, many cells could not be definitely grouped into nests. Most nests were old and abandoned. A sample of closed cells that appeared to be fresh was sealed individually in plastic vials to associate any emerging wasps.

The success or failure of a given cell was seldom in doubt after the fact, as the emergence of an adult wasp leaves a distinctive round hole in the middle of the cell closure. It is assumed that success or failure of a given cell is already settled at the time of closure, so that sealing cells in vials had no effect.

I opened failed cells to look for spider remains. Where the cephalothorax exoskeleton was reasonably intact, the prey could always be unambiguously identified to family.

Most nests comprised old cells whose (absent) offspring could not be sexed directly. To determine whether individual females tend to produce offspring of just one sex, I reviewed all nests with two or more successful cells whose offspring could be sexed indirectly by emergence aperture diameter. From each nest of just two cells I noted the offspring sex; from each nest with more than two cells, I selected two with the help of a random-numbers table and likewise noted the offspring sex.

Specimens collected in Trinidad and identified as *P. captivum* by R. Wahis or C.K. Starr will serve as vouchers. These are deposited in the American Museum of Natural History, Biology Department of Utah State University and Land Arthropod Collection of the University of the West Indies.

Results

P. captivum nests readily in the house, including in rooms that are in daily use. I have occasionally seen wasps nesting in loose covers on a bed while I was napping on it. Typical nest sites are behind books or appliances, under clothing or other loosely covering material, and in relatively small enclosed spaces, always with cells lying flat on top of a horizontal or near-horizontal surface and hidden from view. On several occasions, I timed

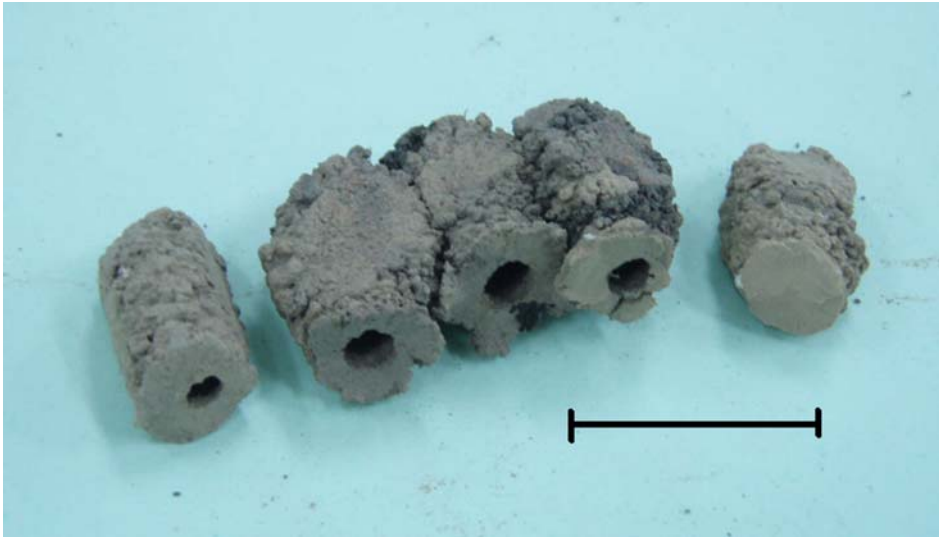


Figure 1. Five nest cells of *Prioehilus captivum*. From left to right: Successful cell that produced a male; three attached successful cells that produced females (note wider emergence holes); closed cell. Scale bar = 1 cm (photo by JN Sewlal).

the flights of females engaged in bringing mud to the nest; the round-trip time was consistently close to 1 minute.

Cells are typically barrel shaped, about 18–21 mm long and 7–12 mm wide, with a flat closure at one end (Figure 1). Cells of a nest usually directly touch each other, but with no wall sharing between them, so these and adjacent cells can easily be separated intact. The nest is often covered with loose dust. While wasps were applying new mud, I never heard the distinctive buzzing characteristic of some mud-nesting sphecids, which evidently serves to compact the mud before it hardens (Hansell 1984:106).

A total of 91 failed cells yielded identifiable prey remains, of which 90 were jumping spiders (Salticidae). The one exception was an orb weaver (Araneidae: prob. *Ocropeira* sp.). The jumping spiders appeared to be similar and may have been mostly of a single species.

Of 743 cells examined from at least 118 nests, 634 (85.3%) were evidently successful. This figure may be slightly inflated if a very few emergence holes made by parasitoids are misinterpreted as those of unusually small males. One cell produced an unidentified ichneumonid with a hole diameter of 1.10 mm.

Females are larger at the whole-body level, as seen by their greater head widths and emergence-hole diameters (Figures 2 and 3). On the basis of the data given in Figure 3, I apportioned, according to sex, all cells of unknown offspring in accordance with the sex ratio of known-offspring cells of their respective emergence-hole diameters. For 633 cells, this leads to an overall estimated sex ratio at emergence of 358.2 (56.6%) males and 279.6 (43.4%) females (Figure 3) for a male/female ratio of 1.28.

A pair of successful cells from each of 101 nests had produced an estimated 85 females and 117 males. Under random association, we expect 17.9 pairs of females, 49.2 mixed-

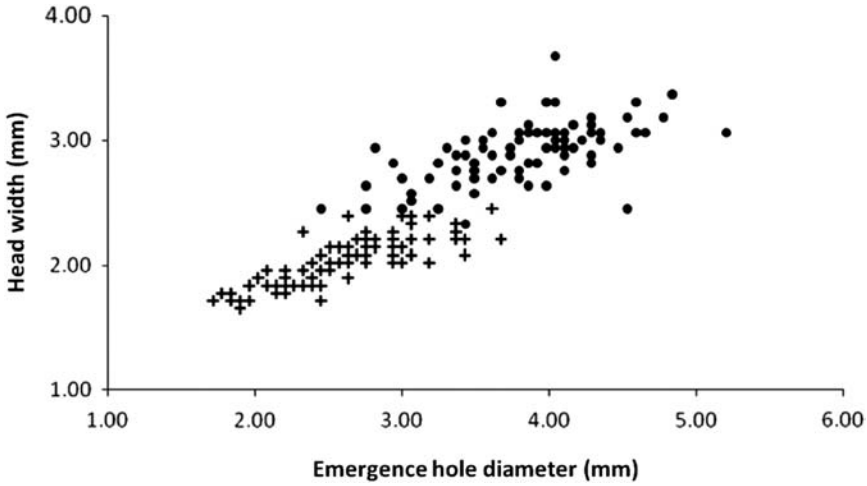


Figure 2. Head width as a function of emergence-hole diameter in 81 males (+) and 90 females (•) of *Priochilus captivum*.

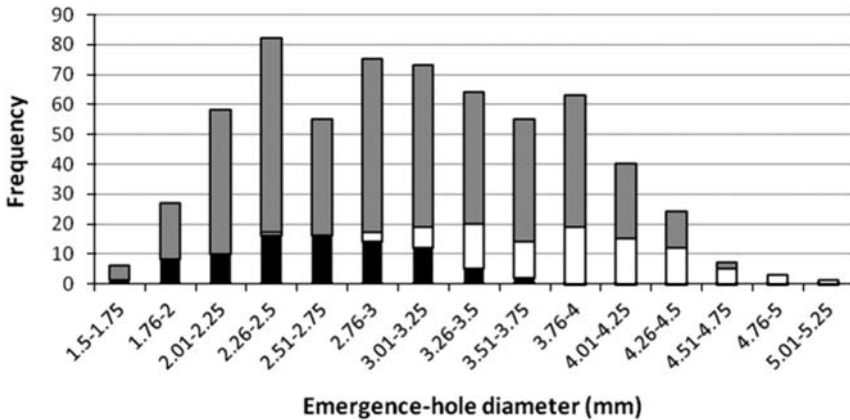


Figure 3. Frequency distribution of emergence-hole diameters of 633 successful *P. captivum* cells. Black: males. White: females. Gray: sex unknown.

sex pairs and 33.9 pairs of males. The observed ratio of 19:47:35 hardly differs from this expected ratio.

Discussion

P. captivum lacks two adaptations associated with economy of nest material in many mud-nesting solitary wasps: cell-wall sharing and mud compaction through buzzing. Although it has not been directly measured, it seems very likely that the ratio of nesting material to body weight is high, compared with that in many mud nesters. The few available data showing short flight distance (Cambra et al. 2004) and short flight time (this paper) are consistent with the idea that mud is cheap for at least some *P. captivum* populations. Furthermore, the habit of nesting on top of broad horizontal surfaces precludes the need for

lightweight or high-strength material. The relatively massive cell walls presumably serve to mask the odour of the contents and provide a physical barrier to natural enemies. This is consistent with the observed high nesting success, although it does not demonstrate that nest structure evolved in response to parasite pressure.

The remains from 91 failed cells are presumably representative prey. In this population, *P. captivum* evidently preys almost exclusively on Salticidae.

The observed male bias in the sex ratio is consistent with the clear sexual size dimorphism. The results from randomly chosen pairs of nest offspring corroborate the null hypothesis of no skewed sex ratio in the population, i.e. individual nesting females do not bias reproduction strongly towards either daughters or sons.

The present data do not allow an estimate of the sex ratio of investment. However, the ratio of mean head width of females/males is 1.16. If we assume that head width is isometric with the body as a whole, a female is estimated to weigh 1.56 times as much as a male. This is not very different from the reciprocal of the numerical sex ratio (1.28 males per female) reported above, consistent with the hypothesis that the population-wide ratio of investment in the sexes is close to 1:1 (Fisher 1958:158–160).

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