An agenielline wasp with a particular nest architecture: *Phanagenia* sp.1 (Pompilidae, Pepsinae)

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ABSTRACT

The nesting biology of *Phanagenia* sp.1 using nest trap is presented. I also give a detail description of both females and males. The species is a cavity-renter building a linear succession of cells divided by mud partitions in pre-existing cavities. It preys on spiders in the family Araneidae.

Key words: *Phanagenia* sp.1, Araneidae, tube-renter

INTRODUCTION

Phanagenia is a small genus comprised of African and Oriental species, and a single Nearctic representative *Phanagenia bombycina* (Cresson, 1867) (Wasbauer, 1987). There are eight Oriental species thus far described (Tsuneki, 1989), essentially from Taiwan and Japan, with none previously known from continental China (likely due to our knowledge paucity of the fauna of this region). The species discussed here is a new record for China.

The biology of *Phanagenia* is mostly unknown. *P. bombycina* is the only species for which exists fragmentary information on parasitoids and nest architecture. It is known to build independent mud cells under rocks or bark (Peckham & Peckham, 1898; Peckham & Peckham, 1905; Savin, 1924; Townes, 1957; Krombein and Hurd, 1979b; Evans, 1997).
Species in the tribe Angeniellini are known to display varied nesting behaviours particularly with regards to nest architecture, from globular clusters of independent or agglutinated cells affixed to various substrates (Weaving, 1994; Kurczewski & Edwards, 2012; Barthélémy & Pitts; 2012) to linear successions of cells separated by mud partitions or other debris inside cavities (Weaving, 1994; Evans, 1997; Staab et al, 2014).
Because the present species readily accepts nest traps, I use the terminology of “renters” as accepted by others (Evans & West Eberhard, 1970; Iwata, 1976) to describe its nesting habits. The renting of a linear cavity (tube) where successive cells are built further qualifies its behaviour; this habit is variedly named as “wood-nesting”, “cavity-nester” and “twig-nester” (Krombein, 1967; Evans & West Eberhard, 1970; O’Neil, 2001) but I have chosen here to differ by using “tube-renter” as a more explicit short for the behaviour.

Our current knowledge of the nesting habits of pepsines wasps is still rudimentary, particularly in *Phanagenia* spp. The present description adds information to the life histories of members of the tribe Angeniellini. It is to my knowledge the only detailed account of the nesting habits of the genus *Phanagenia* for which nothing was previously known.

MATERIALS & METHODS

The nesting biology of *Phanagenia* sp.1 was studied using nest traps made from hollow bamboo canes of various lengths and internal diameters, they were cut so that one end was closed by the nodal septum. Each segment was given a unique number and the canes were bound together in bundles of seven. The bundles were placed in and collected from the author’s garden in Sai Kung Country Park, Hong Kong. They were always located in shaded environments, affixed to low branches of various trees. Upon collection these traps were opened using a pen knife to split the bamboo segment, and the contents were recorded. They were then placed individually in Ziploc® bags for brood emergence.
Measurements were taken with precision stainless steel callipers for cells, cell partition dimensions and cocoon wall thickness. At dissection, photographs of each nest and its contents were taken with a Nikon D200 equipped with a Nikkor 60mm macro-lens and a Sunpak D12 ring flash. Images were treated using Nikon Capture NX and Adobe Photoshop CS2 softwares. The habitus pictures of *Phanagenia* sp.1 were taken with Leica M205 C microscope and stacking software LAS v.4. at increments of 20-50 steps.

Spider prey were identified by Dickson Wong Chi Chun, Hong Kong based on photographic records.

RESULTS

I reared four nests of *Phanagenia* sp.1 and their physical data are presented in Table 1.

Phanagenia sp.1 specimens examined, all from the author’s collection:

Females, series of 12 specimens; all Pak Sha O, Hong Kong, (UTM) 50Q KK 242 849, 70m (asl), C. Barthélémy, Refs.: 0499.A.Hy.1, 0496.A.Hy.1a, 0496.A.Hy.1b, M138.C.Hy.1,M066.C.Hy.4, M067.C.Hy.5a, M067.C.Hy.5b, M072.C.Hy.7, M097.C.Hy.3, M118.C.Hy.1a, M118.C.Hy.1a, M138.C.Hy.1.

Males, series of five specimens; all Pak Sha O, Hong Kong, (UTM) 50Q KK 242 849, 70m (asl), C. Barthélémy, Refs: M076.C.Hy.13a, M076.C.Hy.13b, 0496.A.Hy.2, 0497.A.Hy.1, 0535.A.Hy.1.

Specimens where either reared (references starting with a numeral) or caught in a Malaise trap (references starting with M).

DESCRIPTION OF SPECIES

Female Phanagenia sp.1 (Figs. 1-3)
Females 9.3-13mm long (mean = 11.3mm, n = 12) with a forewing span of 8.4-11mm (mean = 9.3mm, n = 12). Body mostly glabrous, save for the clypeus with sparse long setae apically and lateral-central part of pygidium. Body and legs uniformly coloured dark grey. Clypeus convex in lateral view, rounded apically and sinuate laterally. Forewing with vein M of cell 2Rs twice as long as vein M of cell 1Rs. Forewing with hyaline marking along the sides of veins Rs to 1cu-a and covering half of cell 2R1, 2RS, 2M and totally cell 1Rs.

Male Phanagenia sp.1 (Figs. 4-5)
Males 7.5-8.5mm long (mean = 7.9mm, n = 5) with a forewing span of 6.1-8.6mm (mean = 7mm, n = 5). Body covered in very short dense setae, most dense on the lateral sides of mesosoma, the gena and coxae, on clypeus extending above the antennal sockets, most dense below the sockets. In addition apical part of clypeus and mandibles with long sparse setae. Coxae with dense short setae. Legs with short setae less dense than body. Clypeus rounded. For wing with vein M of cell 2Rs 1/3 longer than vein M of cell 1Rs. Forewing markings similar to female, less marked particularly along veins Rs to 1cu-a. Body colouration identical to female, save for forelegs coloured brown to light brown (tarsi).

This is the first record of the genus for Hong Kong and China.

OBSERVATIONS & DISCUSSION

Nest architecture (Figs. 6-9)
In a departure from the known nesting biology of *P. bombycina* (Kurczewski & Edwards, 2012), the present species is a tube-renter and builds cells separated by mud partitions inside bamboo segments, but presumably also in any available linear cavities.

Phanagenia sp.1 uses a mixture of mud/clay to fashion thin cell partitions not too dissimilar to those of *Trypoxylon* spp. (Crabronidae) (Figs.6-7). In three out of four nests examined the mother fabricated a nest plug formed by a series of interspaced partitions, these were 3-12mm apart. A proper vestibular cell was formed on the same nests and was 20-80mm long (Fig.9). Nests of this species have 3-7 cells (mean = 3.8; n = 4) (Table 1), which measure 9-25mm long (mean 13.3; n = 13). This species uses cavities that are 4.5-11.5mm in diameter (mean = 8.7, n = 4), a rather wide range of 1:2.5. My small data set (15 cells, four nests) does not show any correlation between cell length and its rank within the nest and between the number of cells and the length of the cavity.
From the nest architecture of this species consisting of a succession of cells in a linear cavity, one can easily infer that the construction of a cell precedes prey capture as it would be impossible for the female to build any form of partition with a prey item present in the narrow cavity. Only in the first cell would the female place a prey item before construction began, as I never found any preliminary plugs in these cells. Construction before prey furnishing is a characteristic that *Phanagenia* sp.1 seems to share with all nest building pompilids (Shimuzu and Ishikawa 2002).

Prey
As with all other pompilids the mother provides one prey item per cell. As observed, none of the prey had been amputated which is rare amongst the tribe but could be explained by the spider's relatively small size.

The prey of *Phanagenia* sp.1 was ascertained in one instance, although it had been partially consumed and was identified as *Neoscona* sp. or *Araneus* sp., both in the family Araneidae (orb spinning spiders). The prey were mature specimens, but I was unable to ascertain their sexes. The known prey of *P. bombycina* belong to the families Lycosidae (*Lycosa avida* Walck, *L. gulosa* Walck), Salticidae (*Maevia vittata* (Henz)) and Agelenidae (*Agelenopsis* sp.) (Peckham & Peckham, 1898; Savin, 1924; Townes, 1957; Evans & Yoshimoto, 1962; Kurczewski & Kurczewski, 1968; Iwata, 1976; Krombein, 1979) which are all wandering spiders, although Agelenid spiders do weave sheet webs in grass, all have vastly different ecologies to that of Araneidae.

Brood (Fig. 8)
I was unable to determine the development time of the brood. Nests of *Phanagenia* sp.1 collected in late October and December saw the emergence of adults in end of March to mid-April the following year, with the larvae diapausing as pre-pupal larvae in their cocoons.
The double layered cocoons are typically pill shaped (Figs. 6-7). The first layer is a loose assemblage of silk strands that attaches and suspends the cocoon to the cell walls, while the second layer is finely spun silk. The cocoons of *Phanagenia* sp.1 are also firmly attached to the posterior cell partition via the meconium cap. The second layer of the cocoon measures 0.02-0.03mm thick, it is clear white when fresh, turning light brown after a few days.

On the 11 cells containing a live brood of *Phanagenia* sp.1, I obtained a sex ratio of approximately 1:1 female to male (6:5).

Voltinism
Nests of *Phanagenia* sp.1 collected in March had been initiated the previous year and the adult wasps emerged in April. The nests collected in October were possibly the last nests of the year. From this I infer an active period of a minimum of six months, which combined with the assumed immature stage of 3-4 weeks shows that the wasp is multivoltine in Hong Kong with presumably more than three generations per year. The development time is inferred from a local average of solitary tube-renting aculeates.

Natural enemies and brood death
Out of 15 cells one was parasitised (6.66%) by an uni-

dentified species of Chrysididae and three (20%) died for reasons not associated with parasitism, the brood not developing, the egg having probably failed as the prey were intact/unconsumed at opening of the nests. The total brood mortality was 26.66%.
Various parasitoids in the families Ichneumonidae, Eulophidae, Mutillidae and Pompilidae (Muesebeck et al., 1951; Townes, 1962; Krombein, 1963a & b; Krombein & Hurd, 1979a & b) have been reared from *P. bombycina*. Although the record I make here of a chrysidid wasp is not entirely surprising, it nevertheless adds to our knowledge of the life histories of *Phanagenia* spp.

CONCLUSION

The variability of nest biology within the tribe is well illustrated by this genus where vastly different architectures can be found for the two species for which it is known *Phanagenia* sp.1 and *P. bombycina*. The prey taken also shows intra-generic variability implying vastly different hunting grounds and techniques. It is not inconceivable that there may be even further variations within the genus as new descriptions are made.

Although many vespoid wasps have stereotyped behaviours, permitting generalisations of their biologies, the pompilids seem to be an exception and display a large array of variable behaviours, although generally considered “primitive”. Further studies on the life histories of the Oriental and African species of Phanagenia would be most interesting to increase our knowledge of this fascinating family.

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FIGURES & TABLE

Trap reference	Date Collected	No. of Cells	Vestibular cells	Length, mm	Dia., mm	No. Cells Parasitised	Brood mortality (Non-Parasite)	Brood Mortality Total	No. of emerged adults
PSO-085.A2	13-Mar-11	2	?	140	4.5	0	0	0	2
PSO-197.A3	27-Oct-12	3	3	170	11.5	0	0	0	3
PSO-199.A1	27-Oct-12	7	2	167	11.3	1	2	3	4
PSO-248.A2	06-Dec-14	3	1(?)	174	7	0	1	1	2
	Total	**15**	**-**	**-**	**-**	**1**	**3**	**4**	**11**
	Mean	**3.8**	**2.5**	**162.8**	**8.6**	**0.3**	**0.8**	**1.0**	**2.8**
	Max.	**7.0**	**3.0**	**174.0**	**11.5**	**1**	**2.0**	**3.0**	**4.0**
	Min.	**3.0**	**2.0**	**140.0**	**4.5**	**0**	**0**	**0**	**2.0**

Table 1. Nest bionomics of *Phanagenia* sp.1

Figure 1. Lateral habitus of female *Phanagenia* sp.1 (Photo Author)

Figure 2. Head view of female *Phanagenia* sp.1 (Photo Author)

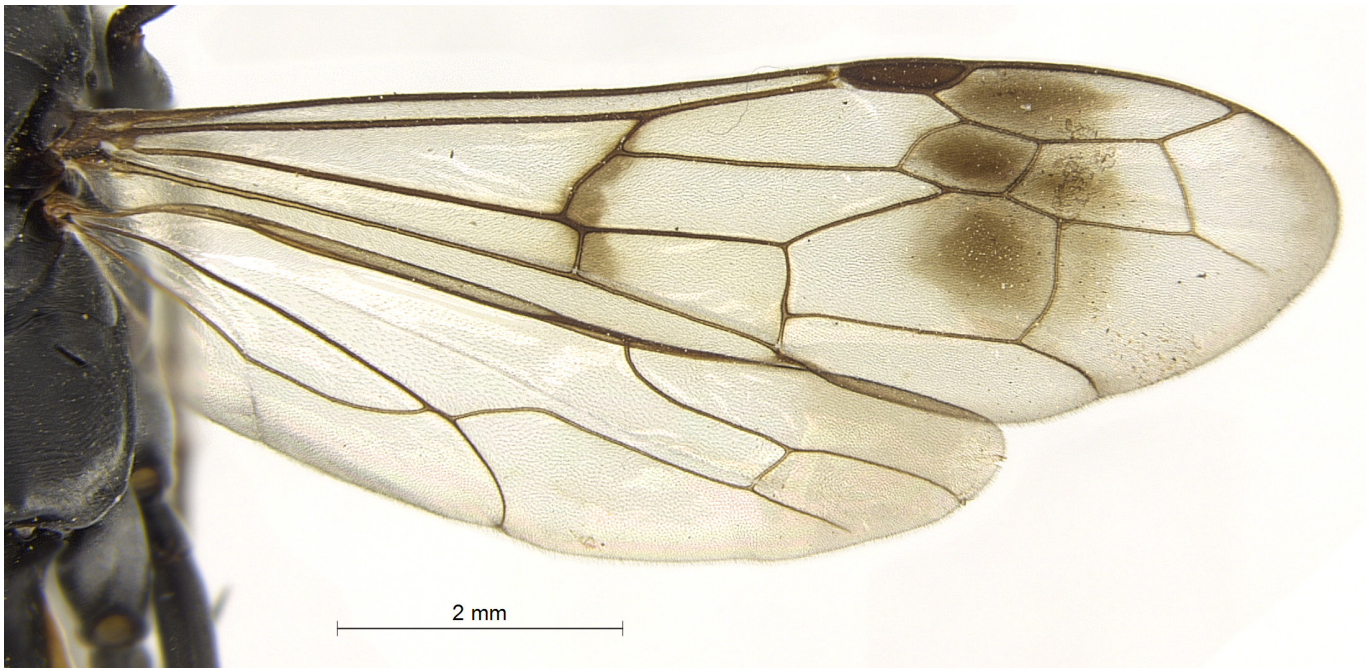

Figure 3. Wing of female *Phanagenia* sp.1 (Photo Author)

Figure 4. Lateral habitus of male *Phanagenia* sp.1 (Photo Author)

Figure 5. Head view of male *Phanagenia* sp.1 (Photo Author)

Figure 6. Typical nest of *Phanagenia* sp.1 at opening of trap, Trap ref. PSO-197.A3. (Photo Author)

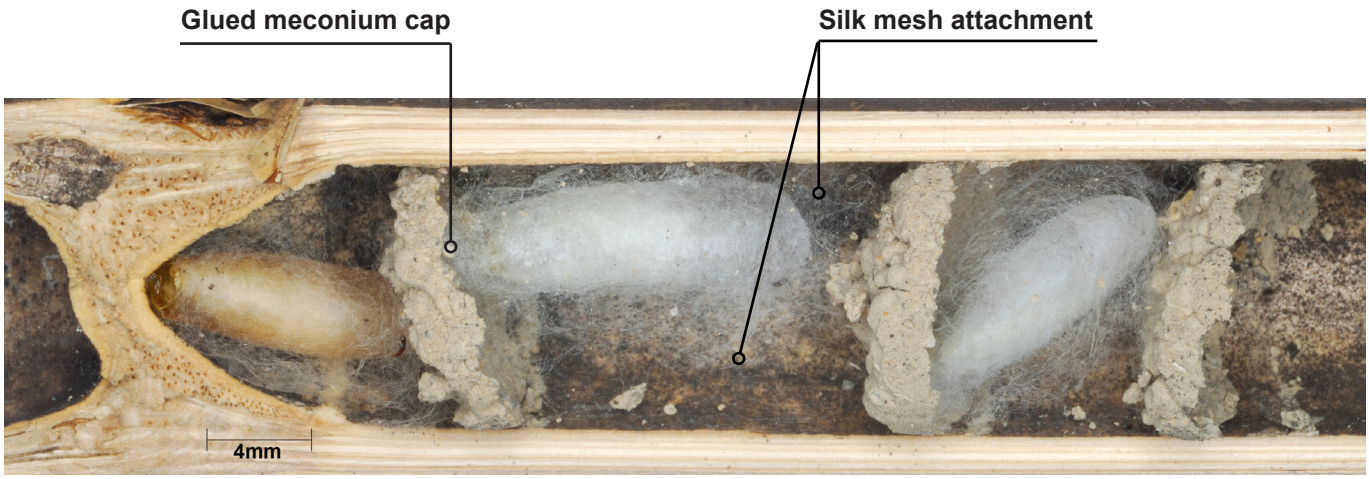

Figure 7. Cell arrangement and cocoons of *Phanagenia* sp.1, Trap ref. PSO-197.A3. (Photo Author)

Figure 8. Brood of *Phanagenia* sp.1, Trap ref. PSO-199.A1. (Photo Author)

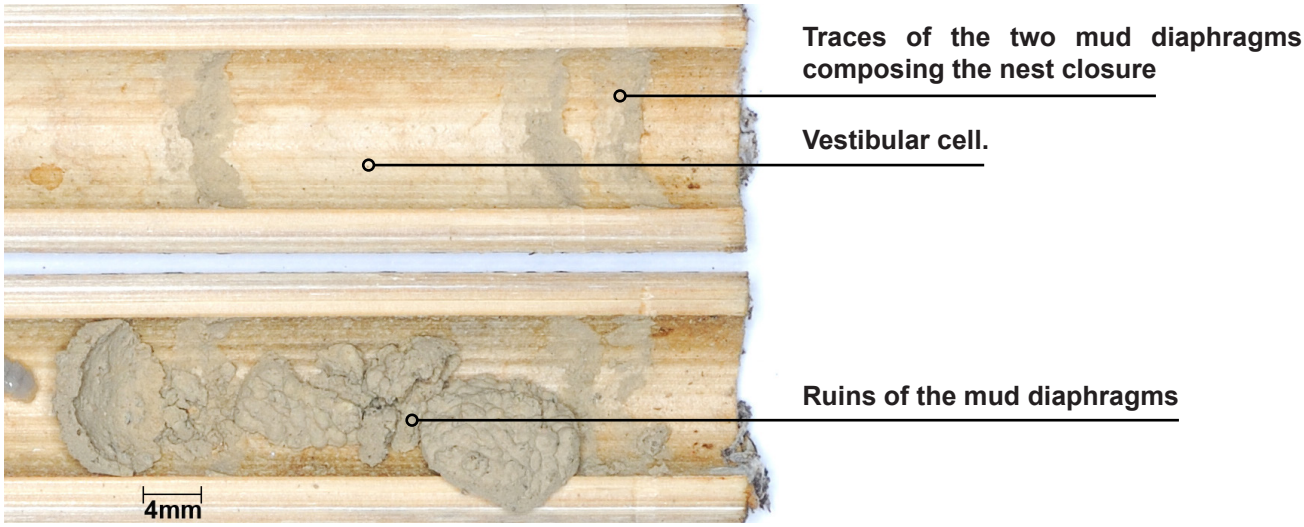

Figure 9. Nest closure of *Phanagenia* sp.1, Trap ref. PSO-199.A1. (Photo Author)