

Original Article

Nesting biology of a spider wasp *Auplopus* sp. (Hymenoptera: Pompilidae) in Vietnam

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Abstract

Nesting biology of *Auplopus* sp. in Vietnam is presented. Nesting site of *A.* sp. was on the wall corners or on the foundation of a desert house. The nest was constructed with a single row or two rows of 3 - 6 exposed mud cells, one of which was open. Each closed cell was provisioned with a single prey spider whose legs were amputated. The prey spiders were immatures of a species of the genus *Heteropoda*, family Sparassidae. Developmental time of egg, larva, pre-pupa, pupa, and pre-adult was 6 - 7, 13 - 14, 5 - 7, 41 - 43, and 3 - 4 days, respectively. The duration of egg to adult development ranged from 68 to 75 days.

Key words: Biology, desert house, developmental time, immature, *Auplopus*

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INTRODUCTION

Spider wasps (Pompilidae) usually lead solitary lives, although some species are obligate cleptoparasites that lay their eggs in the nests of other pompilids (Wcislo, 1987). Most of the studied species of *Auplopus* build mud cells in sheltered places and provision each cell with a paralyzed spider. Some tropical species exhibit communal nesting behavior (or nest sharing), sometimes constructing nests with up to 95 mud cells (Williams, 1919; Kimsey, 1980; Wcislo *et al.*, 1988). Members of the genus *Auplopus* amputate several or all of the spiders legs to facilitate prey transport and to feed on haemolymph exuding from the amputated legs base (Evans and Yoshimoto, 1962; Krombein, 1991).

Data on the population dynamics and life cycle of *Auplopus* wasps are rare, and consequently broad comparisons are not yet possible. Observations of the interior of the mud cells and time of collection of completed nests are not possible (Zanette *et al.*, 2004). Knowledge of the nesting behavior and biology of Oriental *Auplopus* is very poor and based mostly on isolated observations of individual females or their nests (Krombein, 1991; Barthélémy and Pitts, 2012). In the present

study new data on the biology, nesting site and construction of *A.* sp. are presented. The information on provisioning and oviposition is also reported and compared to that of other *Auplopus* wasps.

MATERIALS AND METHODS

Nest collection and survey were conducted at Co Nhue, Tu Liem North, and Nghia Do, Cau Giay, Hanoi from November 2015 to February 2016. The study sites are desert areas waiting for the city planning and development. A total of eight nests of *A.* sp. have been collected at these sites.

Mud layers of collected nests were removed and eggs of *Auplopus* sp. and prey spiders were put in vials of 2.2 × 6.0 cm in dimension (Fig. 8). Nests and eggs of each nest were marked to avoid confusion. Those vials were kept in the laboratory and checked daily. Emerged adult wasps were pinned, dried and deposited in the Institute of Ecology and Biological Resources (IEBR), Vietnam Academy of Science and Technology (VAST), Hanoi, Vietnam. Identification of the genus was obtained based on publications of Goulet and Huber (1993), Day (1988), and Loktionov and

Lelej (2015). Pictures were taken with a digital camera Canon SD3500 IS.

To date, the actual number of species of the genus *Auplopus* has not yet been known due to deficiency of valid catalog(s)/checklist(s), and no key to their identification is available which makes impossible the identification of the species observed. Therefore the author is herewith providing its description to allow its identification in the future.

Description of *Auplopus* sp.

Female: Body length 9.5 - 11.0 mm, fore wing length 9.0 - 10.5 mm. Body brilliant metallic bluish green except antenna, clypeus, fore and mid legs, coxa, apex of femur, tibia, and tarsus of hind legs black; hind femur red; apex of mandible brownish red. Body covered with short white setae, which are denser on clypeus, gena, and anterior side of scrobe. Clypeus conspicuously convex, with anterior margin rounded medially and sinuate laterally. Pronotal side with obviously impressed triangle. Scutellum and metanotum conspicuously convex; lateral side of metanotum rugose. Propodeum rugose, with furrow across dorsum near base, and two longitudinal carinae on middle dorsum. Vertex, front, pronotum, mesoscutum, scutellum, and metanotum with dense small punctures. Both forewing and hind wing hyaline, with veins black. Gaster polished, impunctate. Pygidial plate polished, with sparsely punctures at apex (Figs. 9-10).

Male: Body length 8.0 - 9.0 mm, fore wing length 8.0 - 8.5 mm. Body black, with pale violet reflection on thorax; anterior side of fore tibia and fore femur, and mid and hind femora red; broad spot at mid mandible, clypeus, band along each eye margins terminating at frons, broad band on anterior side of fore and mid coxa yellow; spot on mid clypeus black; apical band on gastral II-VII terga white; clypeus conspicuously convex in lateral view with the anterior margin rounded medially and oblique laterally. Body with short white setae; setae denser on clypeus, gena, ventral part of pronotum and anterior face of fore coxa (Fig. 11).

RESULTS

Nesting site and construction

Nests of *Auplopus* sp. were built on the wall corners of desert houses within 0.5 - 1.2 m from the ground or on the surface of husk and

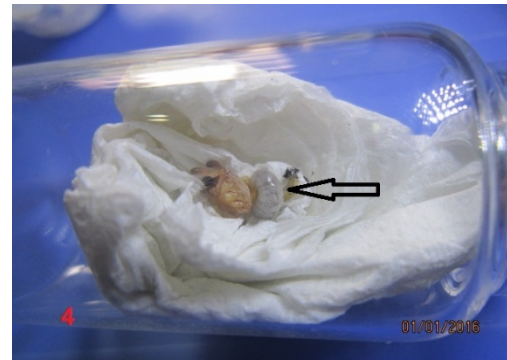
soil-contained plastic bags put on the foundation of a desert house (Fig. 1). Three and five nests of *A. sp.* were built with a single row of 3 - 4 cells and two rows of 5 - 6 cells, respectively. Of which, there was an opening built higher than other cells (Fig.1). The mud used was yellowish or brownish friable soil. The cell was jar-shaped, 5.0 - 6.0 mm in diameter at the apex, 11.0 - 12.0 mm in height. The wall was of 1.0 - 1.1 mm thick. The closure cover was of 0.8 - 1.0 mm thick. The opening that adult wasps carve out was of 3.0 - 3.2 mm in diameter. The interior of cells was smooth and the outer surface was roughened and constructed out of individual mud pellets. All nests of *A. sp.* collected in the present study were newly built showing that the females do not reuse old nests of their species or nests of other species.

Provisioning and oviposition

Each closed cell of *A. sp.* was provisioned with a single prey spider placed in head outward and ventral up. All legs of the spiders had been amputated at the coxal-trochanteral articulation before they were brought to the nest (Fig. 3). The prey spiders of *A. sp.* were identified as an immatures of a species of *Heteropoda*, family Sparassidae (Fig. 2). The wasps' eggs, sausage-shaped, 1.6 - 1.7 mm long and 0.4 - 0.5 mm wide, were obliquely attached near the basal portion on the underside of the abdomen of the prey spider (Fig. 3). Eggs were laid after the provisioning had been completed.

Life cycle

Eggs of *A. sp.*, yellowish white in colour, lasted 6 - 7 days before the larva hatched ($n = 18$) (Fig. 3). Larvae, white in colour, first fed on the spider's abdomen then on the cephalothorax (Figs. 4-6). The prey spider was completely consumed during the larval development. Larvae's black feces were eliminated at the bottom of the cell. The mature larvae wove a cocoon for about two days (Fig. 6). The developmental time of the immature stages was as follows: larvae 13 - 14 days ($n = 17$), pre-pupae 5 - 7 days ($n = 17$), pupae 41 - 43 days ($n = 17$), pre-adults 3 - 4 days ($n = 15$) (Fig. 7). Hence the total duration, from egg to adult, ranged from 68 to 75 days. Emergence of eight females and five males of three nests on 20, 21, 24 and 25 January; seven females and five males of four nests on 28 February, and 1 and 3 March shows that *A. sp.* does not overwinter and can have about four generations per year.



Figures 1-8. *Auplopus* sp.: 1. Nest, 2. Prey spider, 3. Egg, 4- 5. Larva, 6. Pre-pupa, 7. Pre-adult, 8.- Adult wasps



Figure 9. Female *Auplopus* sp., habitus



Figure 10. Female *Auplopus* sp., head, frontal view



Figure 11. Male *Auplopus* sp., habitus

Table I: The recorded prey spiders of *Auplopus* species

No.	The <i>Auplopus</i> species	The prey spider belonging to		Reference
		Genus	Family	
1	<i>A. caerulescens subcorticalis</i> (Walsh)	<i>Clubiona</i> , <i>Trachelas</i>	Clubionidae	Evans and Yoshimoto, 1962; Krombein, 1967; Kurczewski, 1989
		<i>Xysticus</i>	Thomisidae	
		<i>Anyphaena</i>	Anyphaenidae	
		<i>Eris</i> , <i>Phidippus</i> , <i>Platycryptus</i> , <i>Sitticus</i>	Salticidae	
2	<i>A. militaris</i> (Lynch-Arribalzaga)	<i>Corinna</i>	Corinnidae	Zanette <i>et al.</i> , 2004
3	<i>A. semialatus</i> (Dreisbach)	-	Salticidae, Clubionidae, Heteropidae, Anyphaenidae, Ctenidae	Wcislo <i>et al.</i> , 1988
4	<i>A. rossi nigricornis</i> (Arnold)	-	Lycosidae	Gess and Gess, 2014
5	<i>A. femoralis</i> (Arnold)	-	Salticidae	
6	<i>A. personata ornaticollis</i> (Cameron)	-	Clubionidae, Salticidae, Sparassidae	
7	<i>A. bimaculatus</i> (F. Smith)	<i>Thyene</i>	Salticidae	Krombein, 1991
8	<i>A. blandus</i> (Guérin)	-	Sparassidae	
9	<i>A. cyanellus</i> , Wahis	<i>Clubiona</i>	Clubionidae	
10	<i>A. functor</i> , Wahis	<i>Psechrus</i>	Psechridae	
11	<i>A. gnomus</i> (Cameron)	<i>Pardosa</i> , <i>Trochosa</i>	Lycosidae	
12	<i>A. himalayensis</i> (Cameron)	<i>Heteropoda</i>	Sparassidae	
13	<i>A. laeviculus</i> (Bingham)	<i>Pardosa</i>	Lycosidae	
14	<i>A. nitidiventris</i> (F. Smith)	<i>Monaeses</i>	Thomisidae	
15	<i>A. tinctus</i> (F. Smith)	<i>Clubiona</i>	Clubionidae	
16	<i>A. mellipes mellipes</i> (Say)	<i>Pisaurina</i> , <i>Herpyllus</i> , <i>Philodromus</i> , <i>Marpissa</i> , <i>Phidippus</i>	Pisauridae, Gnaphosidae, Thomisidae, Salticidae	Krombein, 1967
17	<i>A. sp.</i>	<i>Heteropoda</i>	Sparassidae	Present report

DISCUSSION

The nesting sites of *A. sp.* here studied are different from those of other *Auplopus*. Evans and Yoshimoto (1962) summarized the available ethological information on the genus. The nests are placed in protected situations such as under stones, beneath overhanging banks in the jungle, in various kinds of cavities, and occasionally in mud nests of other wasps. Kurczewski (1989) found that in New York, USA, *A. caerulescens subcorticalis* (Walsh) nested in pre-existing holes in the concrete cellar

foundation of a house. The nest of this species is also constructed under bark, inside other wasp nests or in a variety of the pre-existing cavities. Barthélémy and Pitts (2012) reported that in Hong Kong, an *Auplopus* nested on a small branch of an unknown bush, on a young branch of a *Citrus grandis* (Merr.) tree, or on wire mesh inside an open garden shed. In Sri Lanka, *A. bimaculatus* (F. Smith) builds its nest against a horizontal section of small rootlet beneath an overhanging bank (Krombein, 1991). In South Africa, the nests of *A. rubirostris* (Arnold) are in pre-existing cavities (vacated

nests of *Hylaeus* sp. (Colletidae)), in the vertical mud wall of a shade house; a nest of *A. rossi nigricornis* (Arnold) is attached to the underside of a large flat stone lying on the ground (Gess and Gess, 2014). In Costa Rica, a nest of *A. semialatus* (Dreisbach) is attached to the long spines on the trunks of pejibaye palm trees (*Bactris gasipaes*, Kunth) that grows in an otherwise open clearing (Wcislo et al., 1988). The nesting sites of *A. sp.* here examined may be a specific feature of this species and hence adds new information about the nesting habits of *Auplopus*.

Evans and Yoshimoto (1962) generally stated that many members of *Auplopus* make mud nests which may consist of a single cell, a linear series of cells in a boring or other cavity, or an aggregation of cells in an irregular mud lump. In South Africa, the nest of *A. rossi nigricornis* consists of nine cells covered by a mud envelope, the nest of *A. femoralis* (Arnold) includes groups of mud cells within the pre-existing cavity, the nest of *A. rubirostris* and *A. vitripennis* (F. Smith) contains up to seven cells discrete and a linear series of cells with mud used only for the construction of partitions and closures. For the nests of *A. vitripennis*, basal plugs and cell partitions are constructed from sand bonded with liquid, probably water, regurgitated at the quarry site. The outer concave surfaces are normally coated with a resinous material resulting in a very hard finish (Gess and Gess, 2014).

In Hong Kong, the nests of an *Auplopus* described by Barthélémy and Pitts (2012) are generally an aggregation of several cells covered by an additional mortar layer. In Brazil, *A. militaris* (Lynch-Arribalzaga) constructs its nests with 1 to 10 mud cells (average = 6). All cells are jug-shaped and have a flattened opening directly toward the trap-nest entrance. The external surface of the cells is typically papillated, reflecting their construction with several tightly arranged mud pellets which varied in color and texture depending on the mud origin. The interior of the cells is always very smooth (Zanette et al., 2004). In New York, USA, the nests of *A. caeruleus subcorticalis* have nine cells. The outer surface of each cell is roughened and characterized by the texture of the individual mud pellets. The interior of the cell is smooth and appeared to be almost polished. The cells are roughly cylindrical in shape and are 0.6 - 0.8 cm long and 0.4 - 0.5 cm in diameter (Kurczewski, 1989). Hence, the nesting construction with 3 - 6 cells and an opening cell

is a specific feature of *Auplopus* sp. different from that of other *Auplopus* species.

Most species of *Auplopus* provision with a single prey spider per cell (Krombein, 1991; Zanette et al., 2004; Barthélémy and Pitts, 2012; Evan and Yoshimoto, 1962; Gess and Gess, 2014; Kurczewski, 1989). This is a common character of the *Auplopus* species. Amputation of legs of prey spiders is also a common feature, although not all species practice it. While *A. bimaculatus*, *A. gnomus* (Cameron), *A. nitidiventris* (F. Smith), and *A. tinctus* (F. Smith) amputate 5-6 legs of the prey spider (Krombein, 1991); *A. sp.* (in the present study); *A. caeruleus subcorticalis*; *A. militaris*; *A. rossi nigricornis*; *A. rubirostris*; *A. femoralis*; *A. vitripennis*; *A. blandus* (Guérin), *A. cyanellus*, Wahis; *A. functor*, Wahis; *A. himalayensis* (Cameron); and *A. laeviculus* (Bingham) are reported as amputators of all of the prey spider's legs (Krombein, 1991; Zanette et al., 2004, Gess and Gess, 2014; Kurczewski, 1989, Evans and Yoshimoto, 1962). Amputation of the prey spider's legs apparently facilitates prey transport and allows to feed on haemolymph exuding from the amputated legs' base (Evans and Yoshimoto, 1962). According to the present study the amputation also helps prey placement in the cells.

The prey spider of the *Auplopus* species belongs to many genera and families as summarized in table 1. *A. personata ornaticollis* (Cameron), *A. caeruleus subcorticalis*, *A. mellipes mellipes* (Say), and *A. semialatus* use upon a diversity of prey spiders, 3, 4, 4 and 5 families, respectively. Thirteen other *Auplopus* species (*A. militaris*, *A. rossi nigricornis*, *A. femoralis*, *A. bimaculatus*, *A. blandus*, *A. cyanellus*, *A. functor*, *A. gnomus*, *A. himalayensis*, *A. laeviculus*, *A. nitidiventris*, *A. tinctus*, and *A. sp.*) use the prey spider of a single family only. The prey of *A. sp.* was similar to that of *A. himalayensis*. Placement of eggs under the spider's abdomen is reported for many *Auplopus* and some species of other genera of the tribe Ageniellini such as *Tachypompilus ferrugineus nigrescens* (Banks), *Macromerella honesta* (F. Smith) (Kurczewski, 1989; Zanette et al., 2004; Barthélémy and Pitts, 2012). This is a common feature for the tribe Ageniellini.

The average duration of development from egg to adult recorded for *A. sp.* differs much from that reported for the other *Auplopus* such as: 7 - 160 days for *A. militaris* (Zanette et al., 2004), about 24 days for *A. caeruleus subcorticalis*, about 35 days for *A. mellipes*

mellipes, and 28 - 32 days for *A. semialatus* (Krombein, 1967; Wcislo *et al.*, 1988). This difference is due to the temperature. The low temperature extends the developmental time of egg, larva, and pupa. Studies on nests of *A. sp.* in the present report conducted within the average temperature under 20 °C.

To date, only *A. mellipes mellipes* has been reported as diapausing (larval diapauses with about 262 days) (Krombein, 1967). The diapause may be an adaptive response to unsuitable nesting conditions (Martins *et al.*, 1999). There is no information about the hibernation of all *Auplopus*. With the average developmental time of about 70 days, this may suggest that *A. sp.* has about four generations per year. The occurrence of more than two generations is reported for *A. militaris* and *A. architectus architectus* (Say) (Evans and Yoshimoto, 1962; Zanette *et al.*, 2004). However, the actual number of generations per year is unknown for the genus.

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