Notes on biology and nests of a hover wasp, *Eustenogaster nigra* (Vespidae: Stenogastrinae), in Hong Kong

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Abstract

Active and abandoned nests of *Eustenogaster nigra* Saito & Nguyen, 2006 were collected in Hong Kong. They are described and the results presented in this paper. Additional notes on some aspects of the biology of this species are provided.

Key words:
Eustenogaster nigra, nests, geometry, colony, Stenogastrinae, Vespidae

Introduction

The Stenogastrinae or hover wasps are poorly studied, maybe as a result of the limited geographical distribution of the subfamily, and their shy habits and cryptic nest locations. They are however regarded as a very important subfamily for the study of insect behaviour, having developed behavioural traits marking the early phases of evolution of eusociality in social wasps (Turillazzi, 1991). In fact the Stenogastrinae represent the basal clade of the social Vespidae (Carpenter, 1991).

Plate 1. *Eustenogaster nigra*. Lateral view of a female. (Photo. Author)

Plate 2. *Eustenogaster nigra*. Dorsal view of a female. (Photo. Author)

The primitively eusocial hover wasp *Eustenogaster nigra* Saito & Nguyen, 2006 has been recorded from various localities in Hong Kong by the author. To the author's knowledge it is the only record of a Stenogastrinae species locally, Hong Kong being at the northern edge of the subfamily's geographical distribution. This species has commonly been misidentified as *Stenogaster seitula* (Bingham, 1897), a misspelling of the original designation *Ischnogaster scitula* by Bingham and a synonym of *Eustenogaster scitula* Nguyen & Khuat, 2003. This hover wasp is by no means uncommon locally and can be found all over the territory. This paper is a short description of the species with emphasis on nest structure.

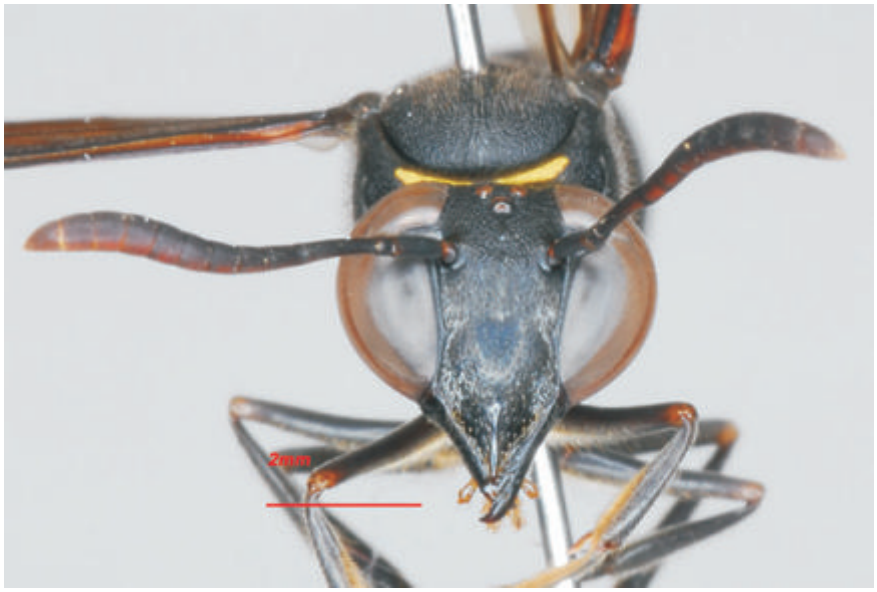

Plate 3. *Eustenogaster nigra*. Head view of a female. (Photo. Author)

Distribution and morphology

This species has so far been recorded only from Thailand, northern Vietnam and China: in Hong Kong, "Yanping" and possibly Yunnan (Carpenter 1996; Saito et al. 2006).

Stenogastrinae can be differentiated from other eusocial wasps by the elongated petiole (first abdominal segment), bulbous thorax and elongated mandibles. They can be confused with solitary potter wasps (Eumeninae) but are readily differentiated by the following characters:

- morphology of the first abdominal segment, elongated with only a slight swelling at the posterior end, rather than notably bulbous as in Eumeninae;
- the projecting and acute or narrowly rounded clypeus rather than not projecting or broadly rounded in Eumeninae; and
- the nesting habits, both in terms of nest location, nest architecture and behaviour (social).

Females measure between 19.5 mm and 21 mm, while males are slightly smaller, rarely exceeding 20 mm. Dimensions are taken from the frons to the second abdominal segment due to the collapse of the final gastral segments in dried specimens.

Eustenogaster nigra locally is mainly black in coloration with a yellow mark on the mesopleuron (second thoracic segment) and an incomplete yellow band on the anterior part of the third metasomal segment, while the posterior half of the first metasomal segment has localised reddish hues. The clypeus is sharply pointed at the apex, eyes are bulbous and only slightly emarginated. The mesoscutum, scutellum, metanotum and propodeum are covered with fine white hairs. Wings are semi-hyaline and not folded longitudinally at rest, contrary to other Vespidae.

Biological notes

Nesting habits and nest morphology

Nests of this species are found in dark and humid places, either close to streams or in abandoned and ruined houses across the territory. They are affixed to their support on the dorsal side of the comb with no pedicel, the first cells having their ends reinforced and thickened, overlapping and enclosing the thread-like substrate: often strands of *Lygodium* sp. (climbing fern) or wires hanging loose from various structures (see plate 4 & 5). A gelatinous substance is placed on the substrate approximately 10 mm above the nest attachment on most nests observed to date (Plate 5). This substance is hypothesised to be an ant guard (Turillazzi, 1991) although it is not always present.

Plate 4. *Eustenogaster nigra*. View of a nest affixed to strands of *Lygodium* sp. Note the peculiar horn like extension build on the apical side of the nest as well as the windows on the tubular entrance vestibule. (Photo. Author).

Plate 5. ***Eustenogaster nigra***. A different nest of the same species. Note the gelatinous substance on the substrate and the fanning structure of the ventral part of the entrance vestibule. (Photo. Author)

The material used appears to be composed of very fine plant material (probably rotten wood pulp finely masticated by the wasp), with fibres less than 1/10 mm in length, mixed with occasional sand grains (very few) and a small amount of possibly salivary secretion. The presence of sand is possibly accidental and most likely the result of contamination due to a material source lying on the ground. The nest envelope and combs are extremely brittle and the whole structure rather fragile. It has been hypothesised that the inherent physical limitations of the nest material in Stenogastrinae may have inhibited the development of large colonies (Hansell, 1981). However, nests have been observed to withstand heavy rain and wind (tropical storm conditions). The nests are overall brown in colour with transverse strips of alternating lighter and darker shades indicating various sources of construction material.

Plate 6. ***Eustenogaster nigra***. An open nest showing larvae at various developmental stages. Note the unique larvae positioning: coiled around the long axis of the cells as opposed to parallel to this as in all other Vespidae. The two yellow masses are in fact pupae which are bend parallel to the long axis. The bottom cell reveals the gelatinous substance that has been deposited despite the lack of any egg.(Photo. Author)

The nest has the shape of an inverted flask in agreement with descriptions of nests in this genus. The envelope (pseudo-envelope) is in fact the continuation of the peripheral cells (Turillazzi, 1991 & 1996). The nest structure can be described as having three main components: a) the entrance vestibule; b) the vestibular chamber and; c) the comb proper.

The entrance vestibule is an elongated tube hexagonal in cross-section; the six surfaces fan out to form the outer layer of the vestibular chamber and intersect with the peripheral cell walls of the comb. Sometimes, the ventral part of the vestibule similarly fans out (Plate 5). The entrance vestibule is formed of the same material as the rest of the structure but is “meshed” with numerous “windows', gaps where no material has been laid. Each summit of the hexagon is reinforced by a ridge that twirls up the sides of the nest, terminating just before the dorsal side of the comb. Regardless of the cell number, there are always six major continuous ridges between the entrance vestibule and the comb's outer rim. These ridges are centred on six peripheral cells, here called base cells. The cells in between, the intercalary cells, may sometime develop a minor ridge when there is more than one intercalary cell between two base cells. The role of these ridges may be structural, giving higher resistance/rigidity to the structure and to the flimsy vestibule while optimising material usage.

The top of the nest reveals the outline of the cells inside, forming as many small near hemispherical bulges as there are cells. It is often crowned by flat crest-like protuberances or keels (Plate 4 & 5) with an unclear function; possibly they act as heat exchange devices and/or mimic dead leaves (Nguyen et al., 2006). These crests are apparently homologous to the ventral fanning structure of the entrance vestibule. These formations follow major and minor ridges but are not always present and clearly built asynchronically with the rest of the nest structure, as revealed by the different material colour (Plate 4 & 5).

All nests dissected to date had between eight and 21 cells with an average of 15 cells (see Table 1 for quantitative data on six nests). The cells are more-or-less hexagonal in section, some being near-circular; the width (cross-section) is even longitudinally (non-conical), the length varying from 13 to 16 mm with a diameter of six to seven mm. The cell walls are on average 0.5 mm thick. The comb occupies the top one-third of the nest. There is no marked variation in cell dimensions and they seem to be similar in size for males and females.

Colony founding and development

The colonies are probably founded by a single inseminated female (haplometrosis) and locally I have never found more than four individuals present in one nest, although up to 11 adults wasps have been recorded in northern Vietnam (Saito et al., 2006). Males are apparently produced throughout the colony cycle and possibly soon after the emergence of the first wasps. It has not been possible locally to determine the relationships within a colony, but it is probable there is no clear hierarchy within this species, as with other Stenogastrinae studied to date.

Saito et al. (2006) noted that unfertilised females and males over-wintered in a (possibly natal) nest, an observation not recorded for any other Stenogastrinae or even Vespidae (although it has been observed locally that some species of Eumeninae do over-winter in their last nesting site). Over-wintering remains to be demonstrated locally for *E. nigra*. However, nests are often re-used even though they have been abandoned the previous season (see Plate 7). This is in fact very unusual in Vespidae, possibly for hygienic reasons. Indeed in most Vespidae, the meconia (faecal matter) ejected by the post-feeding larva accumulates at the bottom of the cell and could be a source of fungal infection and also an attractant to scavenging insects. However, it has been noted that the adults of Stenogastrinae remove the meconia through the cell aperture, thanks to the unique position of the pupa inside (Kojima, 1990), thus eliminating the above problem.

A nest was reared and it was possible to examine the pupal process. There were no pupal caps; at pupation time the cells are merely covered by the active female(s) with a truncated hemispherical extension made of the same material as the rest of the structure, leaving an aperture to the pupating larvae inside, presumably as a way of extracting the meconium. The larva does not spin a complete cocoon but merely applies a thin silk lining on the cell walls.

As with other Stenogastrinae the larva is coiled around the long axis of the cell (Plate 6), in contrast to other Vespidae larvae which are always parallel to the long axis. The pupating larva is positioned with head towards the entrance; the metasoma is bent against the mesosoma.

The bottom of the cell is furnished with a gelatinous substance (homologous to the ant guard). This substance may serve several purposes (Turillazzi, 1991) such as:

- a tool for oviposition: before laying an egg the wasp secretes the substance from the tip of the abdomen which is transferred to the mandibles; she then bends her abdomen, lays an egg on it and deposits the mass in the cell with her mandibles. The egg is often covered by an extra droplet of the same substance, produced by the Dufour's gland;
- a resting substrate for the larvae; and
- a food and liquid store, or rather a way of storing & preserving food. Often this substance is mixed with nectar (Turillazzi et al., 2008).

Five larval instars are recognized within the family (Kojima, 1990), as with species of Vespinae and Polistinae.

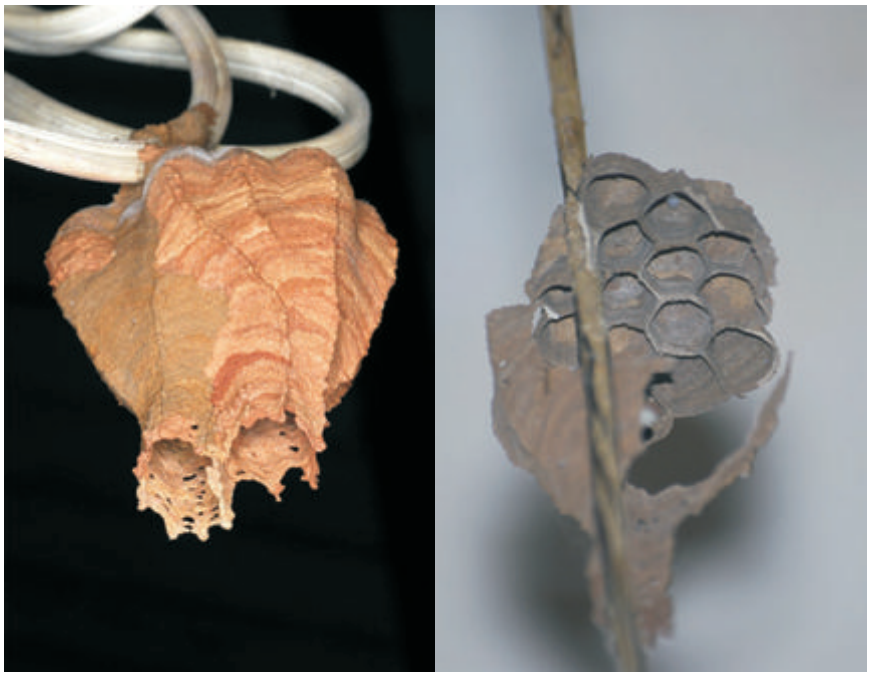

Plate 7. *Eustenogaster nigra*. Re-used nests. The picture on the left shows the additions (in clear) to a nest that was in-occupied the year before the picture was taken. On the right a female has laid eggs in a structure that was partially destructed (Photos. Author)

Food sources

The specific diet of *Eustenogaster nigra* is unknown but the species is probably a specialist scavenger on arthropods caught in spider webs. Krombein (1991) examined the gut contents of larvae of *E. eximia* from Sri Lanka and found that they contained many araneoid fangs, suggesting that this species scavenges not only on arthropods caught in spider webs but on spiders also, most likely commensal individuals of larger species. Experimentally, *E. nigra* larvae readily accepted mashed-up crickets and caterpillars (John X.Q. Lee, pers.comm.).

Natural enemies

No direct record of predation by other wasps has been made locally, however circumstantial evidence suggest that some species of *Vespa* might be active predators of *E. nigra*. I witnessed *V. ducalis* actively searching an area with a cluster of nests, one with a severely damaged envelope, suggesting previous attacks (see plate 7). Hornets and many species of ants are known to attack Stenogastrinae nests (Turillazzi 1991). Predation by vertebrates has not been observed and is not well documented for the subfamily. The cryptic location of the nest as well as its external keels (mimicking leaves) may provide some level of protection against predators using visual clues for food source location.

Very few parasites are recorded from nests of Stenogastrinae (Turillazzi, 1991), and no such incidence has been observed locally.

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Table 1: *Eustenogaster nigra*, nest quantitative data

Nest reference [c]	Date collected	Nest width (mm)	Nest length (mm)	Number of cells	Max. number of adults observed
SLT-1	05/05/2006	27	46	8	[a]
SLT-2	05/05/2006	40	[b]	21	1
SLT-3	05/05/2006	34	55	12	2
SLT-4	05/05/2006	30	50	13	[a]
TPK-3	20/07/2006	28	63	[b]	2
TPK-4	20/07/2006	36	70	21	4
Average 2.25		**32.5**	**56.8**	**1**	**5**

Notes:

a nest abandoned.

b not recorded.

c Nests referenced SLT were collected/observed from Sha Lo Tong village, Hong Kong, UTM: 50Q KK 103 885; 260 m asl. Those referenced TPK from Tai Po Kau Forest Reserve, Hong Kong, UTM: 50Q KK 094 813; 370 m asl

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