

Diversity of solitary wasps and bees (Hymenoptera: Aculeata) using trap-nests in North Vietnam

Đa dạng các loài ong có ngòi đốt (Hymenoptera: Aculeata) sử dụng bẫy tổ ở miền Bắc Việt Nam

Research article

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By using trap nests, a total of 1,752 nests containing 3,405 provisioned cells of 33 species of solitary wasps and bees belonging to Vespidae, Sphecidae, Crabronidae, Pompilidae and Megachilidae families were collected in North Vietnam. Although the trap-nests are placed throughout the year, the nests were only collected in the period of seven months per year, from mid-April (or early May) to early November. A larger number of the nests (n = 1,607, or 91.72%) were occupied by wasp species and only 145 nests (8.28%) were occupied by bee species. In each family, Vespidae, Megachilidae, Sphecidae, Crabronidae and Pompilidae were represented by 12, 11, 7, 2 and 1 species, respectively. The dominant species were *Pareumenes quadrispinosus, Rhynchium bruneum* (Vespidae) and *Chalybion malignum* (Sphecidae). The nesting activities of wasps in the summer (May to July) were more active than in the autumn (August to early November), while the highest number of nests of bees were recorded in June, October and November.

Tổng số 1.752 tổ chứa 3.405 khoang tổ của 33 loài ong bắt mồi thuộc các họ Vespidae, Sphecidae, Crabronidae, Pompilidae và ong mật họ Megachilidae đã được thu thập trong bẫy tổ ở miềm Bắc Việt Nam. Mặc dù các bẫy tổ được đặt trong cả năm nhưng tổ của các loài ong bắt mồi và ong mật chỉ thu được trong khoảng thời gian từ giữa tháng 4 (đầu tháng 5) đến đầu tháng 11. Phần lớn các tổ được làm bởi các loài ong bắt mồi (1.607 tổ chiếm 91,72%), chỉ có 145 tố chiếm 8,28% được làm bởi các loài ong mật. Số loài làm tổ thuộc các họ Vespidae, Megachilidae, Sphecidae, Crabronidae và Pompilidae tương ứnglần lượt là 12, 11, 7, 2 và 1. Trong đó có ba loài phổ biến là. Pareumenes quadrispinosus, Rhynchium bruneum (Vespidae) và Chalybion malignum (Sphecidae). Hoạt động làm tổ của các loài ong bắt mồi từ tháng 5 đến 7 diễn ra tích cực hơn so với từ tháng 8 đến 11, trong khi đó số tổ của các loài ong mật lại thu được nhiều nhất trong ba tháng 6, 10 và 11.

Keywords: nesting activity, bees, trap nests, solitary wasps

1. Introduction

Aculeate hymenopterans are essential ecosystem components, acting as pollinators and predators. They provide examples of the most sophisticated reproduction and brood caring behaviors among invertebrate animals (Ayasse et al. 2001) [1]. As they are known to be sensitive to environment changes, including anthropogenic impacts and climate change, aculeate hymenopterans may be important as bio-indicators in the study and research on conservation and management of the environment.

Most of wasps (Vespidae, Sphecidae, Pompilidae, Crabronidae) and bee (Megachilidae) are solitary (Evans & Eberhard 1970, Batra 1984) [6, 3]. Many species of solitary wasps and bees nest in hollow stems, holes in logs, and similar natural location. Based on their behavior, the use of nest traps can provised the information with regards to life histories of some solitary bees and wasps. This method has been applied with great success since the mid twenty century in collecting the specimens and studing biology and ecology (Krombein, 1967; Gathmann et al., 1994; Budriene, 2004; Barthélémy, 2012) [10, 7, 5, 2]. This report aims to provide the species composition and the changes in nesting frequency over time of Aculeate hymenopterans using the trap-nests in North Vietnam.

2. Materials and methods

2.1. Study sites

The field research was carried out in North Vietnam during 2013-2014 in 7 sites (table 1).

Table 1. Time and stu	ıdy	sites
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No.	Study sites	Years of sampling	Coordinates	Altitude
1	Nghia Hung District, Nam Dinh Prov- ince (NH)	2014	20°4.9 N 106°11.8 E	1 m
2	Dong Hung District, Thai Binh Prov- ince (DH)	2014	20°31.1 N 106°19.6 E	2 m
3	Red River Delta, Long Bien District, Ha Noi city (RR)	2013-2014	21°03 [°] N 105°51 [°] E	10 m
4	Me Linh Station for Biodiversity, Ngoc Thanh District, Vinh Phuc Prov- ince (ML)	2013-2014	21°23'N 105°42'E	50 m
5	Phu Luong District, Thai Nguyen Province (PL)	2014	21°48 [°] N 105°44.5 [°] E	73 m
6	Tam Dao Town, Vinh Phuc Province (TD1)	2013-2014	21°26.5'N 105°37'E	400 m
7	Tam Dao Town, Vinh Phuc Province (TD2)	2013-2014	21°27.5'N 105°38.5'E	960 m

2.2. Nest traps

A total of 4,700 trap nests were placed at the Red River Delta (n=500), Me Linh (n=1,500), Tam Dao (n=2,000), Dong Hung (n=200), Nghia Hung (n=200) and Phu Luong (n=300). The trap nests, made from stems of bamboo, *Bambus* sp. and reed, *Phragmites* sp. (130 to 550 mm long and 3 to 18 mm in inner diameter, with one end open

and the other end closed with the node) were grouped in bundles with 15 to 35 stems each. The nest traps were placed nearly horizontally under eaves and in wire-mesh fences and hung from tree branches, at height of 0.8 to 3.5 m (figs 1 and 2). The trap-nests were checked every one to three weeks during the activity period of wasps and bees (from April to November in North Vietnam).



Figures 1, 2. Nest traps set under eaves at the Red River Delta (1) and wire-mesh fences at Tam Dao (2)

Nest traps with the closing plug were taken to the IEBR laboratory in Hanoi for further observation. They were kept at room temperature and were opened by gently splitting longitudinally into two halves for the examination of the structure and contents (immatures of wasps, preys and symbionts) of the nests and then were closed again by joined these halves together. Everyday, the nests were checked. The developmental stages (eggs, larval instars, prepupae, pupae) of immatures in provisioned cells were examined under a stereoscopic microscope; prey items were identified and counted; the emergence of symbionts such as parasitic wasps was also recorded.

The naming of wasps and bees were based on Bingham, 1897; Hensen, 1988; Giordani Soika 1994; Nguyen, 2015; Palawski, 2016; van der Vecht 1963 [4, 9, 11, 12, 13].

3. Results and discussion

The 1,752 nests comprised 3,405 provisioned cells and yielded data for 33 species of solitary bees and wasps in five families, Vespidae (Eumeninae), Sphecidae, Crabronidae, Pompilidae and Megachilidae. Refer to table 2 for a summary of the trap data. Twenty-two wasp and eleven bee species were collected, large number of the nests (n = 1,607 nests or 91.72%) were occupied by wasp species; bee species occupied 145 nests, or 8.28%. The number of trap-nests occupied by solitary bees and wasps as found in our study was relatively high compared with data obtained Barthélémy's study in Hong Kong.

No	Species	Sites with the nests collected ^(*)	Number of nests	% of all nests	Number of provisioned cells	Range of the used diame- ter (mm)
Vespi	idae - Eumeninae		1,174	76.01	2,086	· · · · · ·
1	Allorhynchium argenta- tum	ML, PL, TD1, TD2	30	1.71	46	4.5 - 10
2	Anterhynchium flavo- marginatum	NH, RR, ML, PL, TD1, TD2	77	4.39	231	8 - 19.5
3	Apodynerus trolodytes	RR	13	0.74	39	4 - 9
4	Euodynerus nipanicus	RR, PL, TD1, TD2	29	1.66	128	3.5 - 10
5	Euodynerus trilobus	RR	8	0.46	40	3 - 10.5
6	Euodynerus dantici	RR	6	0.34	8	5.5 - 9
7	Euodynerus koenig- manni	TD1	3	0.17	5	4 - 7
8	Euodynerus sp.	TD1	8	0.46	19	8 - 11.5
9	Orancistrocerus aterri- mus	ML, TD1	35	2.00	112	8 - 16.5
10	Pareumenes quadrispi- nosus	ML, PL, TD1	607	34.65	711	5 - 18
11	Rhynchium brunneum	NH, DH, RR,ML, PL, TD1, TD2	344	19.63	717	5.5 - 17
12	Zethus dolosus	ML	14	0.80	30	4 - 11
Sphee	cidae		395	22.55	603	
13	Chalybion bengalense	RR	8	0.46	20	5 - 12.5
14	Chalybion japonicum	ML, TD1	13	0.74	23	5.5 - 9
15	Chalybion malignum	ML, PL, TD1	280	15.98	302	5 - 18
16	Isodontia aurifrons	ML	13	0.74	24	5.5 - 9
17	Isodontia sepicola Isodontia spp.	ML ML, TN, TD1,	4 34	0.23	8 74	11.5 - 17 8 - 17
10		TD2	42	2.45	150	12 20 5
19 Croh	Scellphron deforme	ML, PL, IDI	43	2.45	152	12 - 20.5
20 20	Tryporylon netiolatum	рн мі	8	0.46	63	45-10
20	Trypoxyton periotatium	DH RR ML	0	0.40	05	ч. <i>3</i> - 10
21	<i>Trypoxylon</i> spp.	TD1	19	1.08	60	3.5 - 10
Pomp	bilidae		11	0.63	23	2 5 11
22	Aupiopus spp.	ML, PL, IDI	11	0.63	23	3.5 - 11
mega	Haviadas sp	DЦ	2 2 2	0.20	20	356
23 24	Magachila ampuntata	DH PP	5	0.11	20	5.5 - 0
24 25	Megachile cevlonica		5 4	0.23	13	5 - 15 11 - 12
26	Megachile chlorioaster	ML	3	0.23	23	12 - 17 5
27	Megachile conjuncta	TD1	10	0.57	57	10 - 12
28	Megachile disjuncta	DH, RR	17	0.97	96	8 - 12
29	Megachile hera	TD1	7	0.40	24	4 - 6

Table 2. List of cavity-nesting Hymenoptera species collected using trap-nests in North Vietnam

No	Species	Sites with the nests collected ^(*)	Number of nests	% of all nests	Number of provisioned cells	Range of the used diame- ter (mm)
30	Megachile lanata	TD1	1	0.06	9	9.5
31	Megachile monticola	ML	2	0.11	10	12 - 15
32	Megachile velutina	ML, TD1	29	1.66	94	7 - 14
33	Megachile spp.	RR, ML, PL, TD1, TD2	65	3.71	206	3 - 16
	Total		1.752	100	3.405	

(*) NH: Nghia Hung District, Nam Dinh Province; DH: Dong Hung District, Thai Binh Province; RR: Red River Delta, Long Bien District, Ha Noi city; ML: Ngoc Thanh District, Vinh Phuc Province; PL: Phu Luong District, Thai Nguyen Province; TD1: Tam Dao Town, Vinh Phuc Province, altitude 400m; TD2: Tam Dao Town, Vinh Phuc Province, altitude 960m.

Although the trap nests were placed throughout the year, the nests were only collected in the period of seven months per year, from mid-April (or early May) to early November (fig. 3), with occupation peaks in May and June (nearly 50% of total nests). The lowest occupation

occurred in April and November. The nesting activities of wasps in the summer (May to July) were more active than in the autumn (August to early November), while the highest number of nests of bees were recorded in June, October and November.



Figure 3. Occupation frequency of trap-nests by solitary wasps and bees

Twelve species of eumenid wasps belonging to genera *Pareumenes, Rhynchium, Anterhynchium, Orancistrocerus, Apodynerus, Euodynerus, Zethus, Allorhynchium* occurred in considerable number in the trap-nests. All species provisioned their cells with caterpillars, the number of preys in a cell was considered to depend on the size, the kind of preys and the wasps. The dominant species were *P. quadrispinosus*, *R. bruneum* (1,428 provisioned cells, represent 68.45% of total collected specimens); but two species comprising *R. brunneum* and *A. flavomarginatum* widely distributed, they were collected at all site setting trap-nests.



Figures 4,5. *Pareumenes qudrispinosus*. Content of the nest at opening: The nest containing a prepupa (4) and the nest containing two provisisoned cells with lavae and preys (5)



Figures 6-8. The opening nests of Rhynchium brunneum.

Compared with the results of Barthélémy (2012) [2], the number of eumenid species collected by trapping in North Vietnam (12 species) is more abundant than in Hong Kong (7 species). Between the two studies there was a representative match between the five genus, *Allorhynchium, Anterhynchium, Apodynerus, Pareumenes* and *Zethus.* Two genera *Pararrhynchium* and *Xenorhynchium* obtained in Hong Kong were not recorded in our study. In contrast, genera *Euodynerus, Orancitroserus* and *Rhynchium* were not seen in the tra-nests in Hong Kong. In our study, *P. quadrispinosus* and *R. brunneum* were the dominant species (951 nests containing 1,428 provisioned cells), but in Hong Kong the number of nests of these species were very small (only 6 nests containing 6 provisioned cells of *P. quadrispinosus*) or even absent.

Seven species of sphecid wasps, Chalybion malignum (Kohl, 1906), Chalybion bengalense (Dahlbom, 1845), Chalvbion japonicum (Gribodo, 1883), Isodontia aurifrons (Smith, 1859), Isodontia sepicola (F. Smith, 1859), Isodontia spp., Sceliphron deforme Smith, 1856, were found at five among 7 site setting trap-nests. The females of genera Chalybion and Sceliphron provisioned their cells with spider, while, the females of genus Isodontia provisioned the crickets, locusts and stickers for their broods. The dominant species was C. malignum (280 nests, 302 provisioned cells). This species occurs continuously from mid-April to mid-September with the highest number of nests in May and July, while in other months they maintained low population density. The number of trap-nests occupied by sphecid wasps as found in North Vietnam (7 species) was nearly double compared with data obtained in Hong Kong (4 species).



Figures 9-11. *Chalybion malignum*. A female is picking her prey (9); a cell with larva and preys (10); 5th larva is spining cocoon (11)

Eleven species of megachilid bees belonging to genera Megachile and Heriades were found in trap-nests. The nests of different species were collected at different altitudes; *M. ceylonica* was found at high altitude (960 m) at the centre of the Tam Dao National Park; M. conjuncta, M. hera and M. lanata were found at lower height at the Tam Dao National Park (400 m); *M. chlorigaster* and *M.* monticola only were found at Me Linh, the buffer zone of the Tam Dao National Park (50 m); Nests of M. velutina were collected both at Me Linh and the lower site in Tam Dao; M. ampuntata, M. disjuncta and Heriades sp. were collected at the agro-ecosystems or small gardens (Red River Delta and Dong Hung). All used pollen and nectar to provision their cells. The dominant species was M. velutina; most of the nests were collected in October and November (27 nests, 87 provisioned cells).

Compared with the results of Barthélémy (2012) [2], the number of bee species collected by trapping in North Vietnam is more abundant than in Hong Kong. Genus *Megachile* was recorded in both studies. Two genera *Chalicodoma* (Megachilidae) and *Hylaeus* (Colletidae) obtained in Hong Kong were not recorded in our study.



Figures 12-13. *Megachile velutina*. Two cells in opening nest (12) and two prepupae (13)

4. Conclusion

The wasp and bee communities inhabiting trap-nests in North Vietnam include up to 33 species. The nests were collected in the period from mid-April (or early May) to early November. Most of them are diapause as prepupae during the winter (last November to early next April). The number of species recorded in each site de-pends on landscapes and habitats. The number of species collected in the natural forest (Me Linh and Tam Dao) is more abundant at the agro-ecosystems or small gardens (Red River Delta Nghia Hung and Dong Hung). The female of bees and wasps provisioned nectar and pollen, caterpillars, spiders, crickets, locusts and stickers for their broods. So, the using trap nests are recommended as a means of augmenting the number of bees and wasps as well as control the pests of crop and augmentation of the croppollinating.

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