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ECOLOGICAL RELATIONSHIPS IN NESTS OF SIX CUBAN ACULEATE WASPS (HYMENOPTERA: VESPIDAE, SPHECIDAE, APIDAE)

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Abstract: Nests of six species of aculeate wasps (Hymenoptera: Vespidae, Sphecidae and Apidae) were studied between 1994 and 1995 at two localities in eastern Cuba. The data recorded for each species included number of cells, prey used for nest supply, inquilines, parasitoids, pathogens, and necrophages. The species (and number of nests) studied were: *Pachodynerus nasidens* (Latreille) (100), *Sceliphron assimile* (Dalhbom) (70), *Zeta confusum* (Bequaert & Salt) (37), *Megachile* sp. (7), *Pachodynerus cubensis* (Saussure) (2), and *Trypoxylon* sp. (1). Relevant information on the relationships between these wasp species and other arthropod taxa is also discussed.
Key words: Hymenoptera, Vespidae, Sphecidae, Apidae, nest characteristics, parasitoids, pathogens, inquilines, Cuba.

Relaciones ecológicas en nidos de seis avispas aculeadas cubanas (Hymenoptera: Vespidae, Sphecidae, Apidae)
Resumen: Entre 1994 y 1995 se estudiaron los nidos de seis especies de himenópteros aculeados (Hymenoptera: Vespidae, Sphecidae y Apidae) en dos localidades de Cuba oriental. Los datos obtenidos incluían número de celdillas por nido, presas utilizadas como suministro para las larvas, inquilinos, parasitoides, patógenos y necrófagos. Las especies (y número de nidos estudiados) fueron: *Pachodynerus nasidens* (Latreille) (100), *Sceliphron assimile* (Dalhbom) (70), *Zeta confusum* (Bequaert & Salt) (37), *Megachile* sp. (7), *Pachodynerus cubensis* (Saussure) (2), y *Trypoxylon* sp. (1). Se discute también información relevante sobre las relaciones entre estas especies de avispas y otros táxones de artrópodos.
Palabras clave: Hymenoptera, Vespidae, Sphecidae, Apidae, características de nidos, parasitoides, patógenos, inquilinos, Cuba.

Introduction

Hymenopterans are among the best studied groups of invertebrates in terms of nesting behaviour, which in turn has allowed comparisons between species and clarification of evolutionary patterns (Berovides *et al.*, 1990) and phylogenetic relationships (Gauld, 1988), as well as contributing to systematic purposes and a better understanding of the Order.

In the last 20 years many researches have been carried out on the ethology and ecology of Cuban hymenopterans, mostly aculeate wasps (see an overview in Portuondo & Fernández, 2003). However, many species still remain without data. The aim of this paper is to describe the characteristics of the nests and some ecological relationships of six wasp species from Cuba: *Pachodynerus nasidens* (Latreille), *P. cubensis* (Saussure), and *Zeta confusum* (Bequaert & Salt) (Vespidae); *Sceliphron assimile* (Dalhbom) and *Trypoxylon* sp. (Sphecidae); and *Megachile* sp. (Apidae).

Materials and methods

Nests of *S. assimile* and *Z. confusum* were collected from walls and roofs of human buildings between January and April of 1994 (Botanical Garden of Santiago de Cuba city: BG) and October of 1994 - October of 1995 (University of Granma: UG).

Nests of *P. cubensis*, *Trypoxylon* sp. and *Megachile* sp. were collected in the BG using pieces of bamboo from 1 to 6 mm in diameter. These devices were used as trap nests, following Freeman (1974); and groups of these traps of all diameters were put together at about 2 m high on trees for 15 days.

All nests were brought to the laboratory and dissected. Hymenoptera species were identified by the first and third authors, the remaining insects by the second, and spiders by the fourth. Statistical analyses were performed using the Statistica for Windows (1993) software. Voucher specimens are housed at the Centro Oriental de Ecosistemas y Biodiversidad, Santiago de Cuba.

Results and discussion

Seventy *Sceliphron assimile* nests were collected (44 in BG and 26 in UG), with 374 cells. On average there were 5.3 cells per nest (range: 1-26), and the differences between BG (5.8 cells, range: 1-26) and UG (4.5 and 1-10) were statistically significant (Duncan test, $p < 0.05$). This may be due to the fact that BG is a much less disturbed site compared to UG, where wasp females tend to build larger nests (i.e. with more cells).

At least 16 species - mostly Arthropoda - were found in these nests, displaying several kinds of ecological associations, and they have been classified as prey, inquilines, parasitoids, pathogens or necrophages.

Sceliphron species use spiders as prey for their nests (Dow, 1932; Franganillo, 1936; Krombein, 1967; Alayo, 1976b; Armas & Alayón, 1986; Jiménez *et al.*, 1992; Genaro, 1994). In this study *S. assimile* carried between 4 and 21 spiders to each cell (BG: X = 8, N = 12; UG: X = 14.2,

N = 13). The differences were mainly related to the size of the prey, but no statistical test was made to corroborate it. Four families and eight species of spiders were found, with about 60 % of specimens and 50 % of species belonging to the Araneidae (Table I). Regarding the collected prey, 90 % were females and less than 1.5 % were juveniles, suggesting a selection toward larger and more conspicuous prey.

The inquilines included species using empty nests of *Sceliphron* for nesting or other purposes. For *S. assimile* Freeman (1974) reported four species (of Vespidae, Sphecidae and Megachilidae) from Jamaica, and Genaro (1994) found seven species (of the same families) in the Botanical Garden of Cienfuegos (Cuba). In our study *P. nasidens* and *Megachile* sp. were found as inquilines; moreover adults and egg sacs of Araneae and adults of Microlepidoptera were observed in empty nests of *S. assimile.*

Four species of *S. assimile* parasitoids were found: *Melittobia* sp. (Eulophidae), *Acroricnus cubensis* (Cresson). (Ichneumonidae), *Chrysis* sp. (Chrysididae) and cleptoparasitic dipterans (Sarcophagidae).These results are similar to those of Freeman (1974), who found *Melittobia chalybii* Ashmead in *S. assimile* nests in Jamaica, and to those of Alayo & Hernández (1978) and Genaro (1994), based on data from Cuba. Dow (1932) and Alayo (1973) also reported the ichneumonid parasitizing the sphecid wasp.

Genaro (1994) found two species of *Chrysis* Linnaeus as parasitoids of some inquilines of *S. assimile*, but not of the sphecid. Jiménez *et al.* (1992) mentioned *Chrysis* sp. and *Sarcophaga* sp. (Sarcophagidae) from Mexican nests of *Sceliphron jamaicense lucae* Saussure.

One species of fungus was observed on the body of some completely developed wasp specimens. Freeman (1974) stated that fungi may grow in this environment because of mud moisturized by prey lymph. Acari, psocopterans and coleopterans (Dermestidae) were studied in the nests, where they were considered as necrophages, although Jiménez *et al.* (1992) considered acari and dermestid beetles as predators.

Analyzing all data, inquilines occupied 38.3 % of *S. assimile* cells, with *Pachodynerus nasidens* using most of them (Table II). This wasp usually divided the cells into 2-3 smaller cells, which explains the total of 180 cells, in agreement with Genaro (1994). Parasitoids and pathogens were found in 30.5 % of the sphecid cells, with *Melittobia* sp. accounting for about half of the cells, and fungi was the second best represented group. It was impossible to identify the cause of death in 23 cells.

Parasitoids and inquilines are shown in Table III. For *P. nasidens* 62 % of mortality was recorded, about twice as much as for *S. assimile*. Freeman (1974) reported the same proportion in Jamaica and considered it as a consequence of the double number of cells, which could explain the rate of mortality. *Melittobia* sp. was the major natural enemy, while members of *Chrysis* and *Acroricnus* Ratzeburg were not observed parasitizing inquilines.

Melittobia sp. was also observed as a hyperparasitoid of Diptera (parasitizing *S. assimile* and *P. nasidens*), agreeing with Krombein (1967), who reported the genus as parasitoid on aculeate hymenopterans and their parasitoids. Alayo and Hernández (1978) mentioned Hymenoptera, Coleoptera and Blattoidea as *Melittobia* Westwood hosts in Cuba.

Two parasitoids were reared in the laboratory from lepidopterous larvae found as prey in *Pachodynerus nasidens* nests: *Alphomelon* sp. and *Orgilus* sp. (Hymenoptera: Braconidae), the latter having been recorded from Cuba only recently (Fernández & Portuondo, 2001). The presence of these species in the nests could suggest that *P. nasidens* is unable to detect lepidopterous larvae parasitized by these koinobiont endoparasitoids.

Also, *Alaptus* sp. (Hymenoptera: Mymaridae), equally found in the nests, is a new record, possibly associated with psocopterans as an egg parasitoid (Alayo & Hernández, 1978).

For *Zeta confusum* 37 nests with 78 cells were collected (30 in BG and 7 in UG). On average, there were 2.1 cells per nest (range: 1-10), and the differences between BG (1.6 cells, range: 1-5) and UG (4.4 and 1-10) were statistically significant (Duncan test, $p < 0.01$). Availability of food for nest supply may explain these differences, because UG is surrounded by grasslands with plenty of lepidopterous larvae. On the other hand BG had a rather complex pattern of vegetation where prey location may be more difficult and time consuming, resulting in smaller nests. Even though UG was a more disturbed place than BG – as explained above - this did not affect *Z. confusum,* because these wasps built their nests well over second floor heights, far higher than *S. assimile*. This latter species usually builds its nest at about 2-3 m high, which is accessible enough for people to remove.

At least 13 species were found in association with *Z. confusum* nests. As with other members of the Eumeninae (Krombein, 1967; Alayo, 1976c), lepidopterous larvae were the prey commonly used at its nests. In our study between 4 and 9 larvae per cell were found (BG: X = 5, N = 4; UG: X = 6.2, N = 10). The differences were mainly related to the size of the prey, but no statistical test was made to corroborate it.

Inquilines, parasitoids, pathogens and necrophagous species were the same as for *S. assimile* (Table IV), but the pattern was rather different. Inquilines of Araneae were the best represented, and *Melittobia* were the most abundant parasitoids. The specimens of *Chrysis* were identified as *C. superba* Cresson.

Two nests of *Pachodynerus cubensis* were observed in bamboo pieces of 5 and 6 mm in diameter. Wasps used mud to build the nests, one having seven cells and the other with eight; the length of the cells was between 13 and 25 mm. The prey used was lepidopterous larvae, as previously reported by Krombein (1967) and Alayo (1976c).

One nest of *Trypoxylon* sp. was observed in a trap nest, with six cells 15-23 mm long. The prey used was spiders (14-27 per cell) in agreement with Alayo (1976b) and Genaro *et al.* (1989). Sarcophagid dipterans were also found as cleptoparasites. Grillo & Valdiviés (1991) reported Cuban nests of *T. subimpressum* Smith in empty galleries of *Elaphidion cayamae* Fisher (Coleoptera: Cerambycidae) in thin twigs of *Citrus* trees.

One nest of *Megachile* sp. was observed in a trap nest, with seven cells made of leaves, agreeing with Alayo (1976a) and Genaro (1996). One parasitoid, *Aprostocetus* sp. (Hymenoptera: Eulophidae), was reared in the laboratory. Scaramuzza (1938) found in Havana two parasites of *Megachile* sp., *Nemognatha vittigera* LeConte (Coleoptera:

Table I: Araneae found in nests of *Sceliphron assimile* at University of Granma, Cuba, 1994-1995.
Tabla I: Araneae encontrados en nidos de *Sceliphron assimile* en la Universidad de Granma, Cuba, 1994-1995.

	Females	Males	Juveniles	Total
SALTICIDAE	--	--	--	2
Phidippus regius C. L. Koch, 1846	2	--	--	2
ARANEIDAE	--	--	--	80
Acanthepeira venusta (Banks, 1896)	1	--	--	1
Gea heptagon Hentz, 1850	18	1	--	19
Neoscona arabesca (Walckenaer, 1841)	49	5	--	54
Cyclosa walckenaeri (O. P. Cambridge, 1889)	5	1	--	6
OXYOPIDAE	--	--	--	39
Oxyopes crewi Bryant, 1948	32	5	2	39
THOMISIDAE	--	--	--	19
Misumena sp.	14	--	--	14
Misumenops sp.	5	--	--	5
TOTAL	**126**	**12**	**2**	**140**

Table II: Inquilines, parasitoids and pathogens of *Sceliphron assimile* at Botanical Garden of Santiago de Cuba (BG, 44 nests, N = 256 cells) and University of Granma (UG, 26 nests, N = 118 cells), 1994-1995. Numbers in parentheses are percentages.
Tabla II: Inquilinos, parasitoides y patógenos de *Sceliphron assimile* en el Jardín Botánico de Santiago de Cuba (BG, 44 nidos, N = 256 celdillas) y la Universidad de Granma (UG, 26 nidos, N = 118 celdillas), 1994-1995. Los números entre paréntesis son porcentajes.

	BG	UG
INQUILINES	98 (38.3)	13 (11.0)
Pachodynerus nasidens	89 (34.8)	11 (9.3)
Megachile sp.	6 (2.3)	--
Araneae	3 (1.2)	2 (1.7)
PARASITOIDS AND PATHOGENS	78 (30.5)	25 (21.2)
Melittobia sp.	35 (13.7)	24 (20.3)
Acroricnus cubensis	5 (2.0)	--
Diptera	4 (1.6)	--
Chrysis sp.	3 (1.2)	--
Fungi	8 (3.1)	--
Unknown causes	23 (9.0)	1 (0.8)

Table III: Parasitoids and pathogens of inquilines of *Sceliphron assimile* nests from the Botanical Garden of Santiago de Cuba (BG) and University of Granma (UG), 1994-1995. Numbers in parentheses are percentages.
Tabla III: Parasitoides y patógenos de inquilinos de los nidos de *Sceliphron assimile* del Jardín Botánico de Cuba (BG) y la Universidad de Granma (UG), 1994-1995. Los números entre paréntesis son porcentajes.

	Pachodynerus nasidens		*Megachile sp.*
	BG (N=180 cells)	UG (N=16 cells)	BG (N=15 cells)
PARASITOIDS AND PATHOGENS	112 (62.2)	12 (75.0)	10 (66.7)
Melittobia sp.	75 (41.7)	12 (75.0)	3 (20)
Diptera	15 (8.3)	----	1 (6.7)
Fungi	6 (3.3)	----	----
Unknown causes	16 (8.9)	----	6 (40)

Table IV: Inquilines, parasitoids and pathogens of *Zeta confusum* from the Botanical Garden of Santiago de Cuba (BG, 30 nests, N = 47 cells) and University of Granma (UG, 7 nests, N = 31 cells), 1994-1995. Numbers in parentheses are percentages.
Tabla IV: Inquilinos, parasitoides y patógenos de *Zeta confusum* del Jardín Botánico de Santiago de Cuba (BG, 30 nidos, N = 47 celdillas) y la Universidad de Granma (UG, 7 nidos, N = 31 celdillas), 1994-1995. Los números entre paréntesis son porcentajes.

	BG	UG
INQUILINES	11 (23.4)	2 (6.4)
Araneae	8 (17.0)	----
Pachodynerus nasidens	2 (4.3)	2 (6.4)
Megachile sp.	1 (2.1)	----
PARASITOIDS AND PATHOGENS	29 (61.7)	10 (32.3)
Melittobia sp.	14 (29.8)	2 (6.4)
Diptera	5 (10.6)	8 (25.8)
Acroricnus cubensis	1 (2.1)	----
Chrysis superba	1 (2.1)	----
Fungi	4 (8.5)	----
Unknown causes	4 (8.5)	----

Meloidae) and *Coelioxys* (*Melanocoelioxys*) *producta* Cresson (Hymenoptera: Megachilidae), and Alayo & Hernández (1978) reported *Megachile poeyi* Guerin as a host of *Leucospis poeyi* Guérin-Méneville (Hymenoptera: Leucospidae). The eulophid is here first recorded for Cuba as a parasitoid of *Megachile* sp.

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