Rev. Biol. Trop. 50(1): 127-134, 2002
www.ucr.ac.cr www.ots.ac.cr www.ots.duke.edu

The natural history of the mud-dauber wasp *Sceliphron fistularium* (Hymenoptera: Sphecidae) in southeastern Brazil

Evandro Camillo
Departamento de Biologia, Faculdade de Filosofia Ciências e Letras de Ribeirão Preto-USP, 14040-901, Ribeirão Preto, SP, Brasil. Fax: 55 16 602 3666; ecamillo@ffclrp.usp.br

Received 14-VIII-2000. Corrected 25-IV-2001. Accepted 05-VI-2001.

Abstract: Nests of *Sceliphron fistularium* were obtained in Colombia and Moji Guaçu, São Paulo, Brazil. Complete nests consisted of 1 to 54 sausage-shaped cells, arranged side by side along a horizontal axis, and found attached to electrical wires (Colombia, n = 7) and walls (Colombia, n = 4 and Moji Guaçu, n = 4). The number of cells per nest ranged from 1 to 54, their length varying from 20.8 to 29.7 mm, and their diameter from 7.6 to 11.7 mm. Brood cells were provisioned with spiders of the family Araneidae. Only *Alpaida veniliae* was collected in Colombia, whereas the most frequent species found in Moji Guaçu was *Micrathena swainsoni* (62.0%) followed by *M. acuta* (23.3%). Adults emerged from June to October. The length and diameter of female and male cells were similar. Nevertheless, females were significantly larger than males. The sex ratio of individuals obtained from nests was 1.16 females : 1 male. A life table was constructed, and details of the life cycle of the wasps and parasitoids are presented. The most common mortality factors were either unknown or due to the parasitoid wasp *Melittobia* sp.

Key words: Sphecidae, wasps, *Sceliphron*, nest structure, spider prey, natural enemies.

The genus *Sceliphron* is found in all of the temperate and tropical continental areas of the world and on many islands. Thirty species are known, and most are found in the Old World. Several species have been introduced to a number of new areas anthropogenically (Bohart and Menke 1976).

Sceliphron females build their mud nests in a variety of sheltered and dry sites, but some are commonly associated with human habitations. A single cell is constructed first, provisioned with spiders, and sealed by a female before work begins on another cell. Typically, more than one cell is constructed to form an aggregate nest. Cells that have not been fully stocked in one day may be temporarily sealed at night. Usually, several cells of a nest are covered with a layer of mud (references in Bohart and Menke 1976, Mitchell and Hunt 1984, Callan 1988, Genaro 1996).

Other biological observations about *Sceliphron*, including collected spider preys, were obtained by Freeman and Parnell (1973), Freeman (1977), Freeman and Johnston (1978), Horner and Klein (1979), Naumann (1983), Mitchell and Hunt (1984), Crawford (1987), Callan (1988), Ferguson and Hunt (1989), Jiménez *et al.* (1992), Early and Townsendi (1993), Hunt (1993), Genaro (1994, 1996) and Volkova *et al.* (1999).

The purpose of this paper is to present some biological data on *Sceliphron* (*Sceliphron*) *fistularium* (Dahlbom, 1843), a poorly understood

species despite the fact it is common in our region and occurs from Mexico to Argentina.

MATERIALS AND METHODS

The nests were obtained in Colombia (Co) and Moji Guaçu (MG), SP, Brazil. A total of 15 nests of *S. fistularium* (9 on 7/14/98 and 2 on 5/5/99 from Co, and 1 on 4/14/99 and 5/14/99 from MG) were collected, taken to the laboratory and placed in plastic boxes (10 x 10 x 3 cm). After emergence the nests were opened to analyze their cells and structure. The prey from cells in which the immature did not develop were removed and preserved in 80% alcohol. Some direct observations were made in the places of nest occurrence.

A life table was constructed showing the various causes of mortality at different stages in the life cycle and the relative number of immature individuals dying from each known cause. The greatest width of the head (GWH) was employed as an estimation of the size of individuals. All the wasps and spiders are deposited in the Entomology Collection of the Biology Department – FFCLRP-USP.

RESULTS

Nests: The mud nests of *S. fistularium* were found on well illuminated surfaces protected from direct sunlight and water; some were very large, with a strong base, being difficult to remove. The nests consisted from 1 to 54 sausage-shaped cells, arranged side by side along a horizontal axis. The number of cells per nest in Co, in the case of aerial nests (in electrical wires), ranged from 1 to 16 ($x = 9.5 \pm 5.4$, $n = 7$), and from 7 to 54 ($x = 25.0 \pm 20.5$, $n = 4$) for those established on the walls of buildings. All nests obtained at MG were found on walls, their number of cells varying from 8 to 14 ($x = 11.2 \pm 2.5$, $n = 4$). There was never more than one row of parallel cells per nest, but it was possible to find other tiers of cells built on top.

The length and the diameter of the female cells (l = 21.2 - 29.8 mm, d = 8.8 - 11.7 mm, n = 11) were statistically similar to those of males (l = 20.8 - 27.7 mm, d = 7.6 – 11.2 mm, n = 4) (Mann-Whitney, $Z = -1.24$ for length, $Z = 0.45$ for diameter, $p > 0.05$). Each cell consisted of numerous, closely packed half arches, and the inner walls were smooth and without lining. During construction and provisioning, cells were accessed via their own entrance hole (d = 7.2 – 7.8 mm, n = 2) which is plugged by females when fully provisioned. The emerging adult cuts its own exit hole at this point. The architecture of four nests of *S. fistularium* is presented in Fig. 1.

The surface of the cluster of completed cells was plastered with additional layers of mud, which may be molded into a distinctive shape. Occasionally a female constructed isolated cell and abandons them before covering. There were sometimes conspicuous differences in coloration of the nests due to different building materials. Frequently, the pellets of mud used for plaster were almost as large as the wasp's head. They were held in the mandibles during the flight to the nesting site where they were placed on the surface using the mandibles. The deposition of mud pellets was accompanied by a clearly audible buzzing. The duration of flights for mud collection varied from 41 to 134 s ($x = 66.9 \pm 24.3$ s, $n = 23$), and the duration for placing them on the surface ranged from 24 to 73 s ($x = 44.9 \pm 12.5$ s, $n = 23$).

Cocoons were dark brown, with a more or less varnished appearance, smoothed, with a rounded posterior end. The other end was black (feces) and thinner. The maximum length of the cocoons varied from 18.0 to 24.7 mm ($x = 22.2 \pm 1.9$ mm, $n = 15$), and the maximum diameter spanned 5.1 to 7.4 mm ($x = 6.4 \pm 0.8$ mm, $n = 15$). Generally, they were supported within the cell by a loose matrix of silken threads.

Collected prey: Cells of *S. fistularium* in Co were provisioned exclusively with individuals of *Alpaida veniliae* (Keyserling, 1865) (Araneidae). Each cell contained from 2 to 5

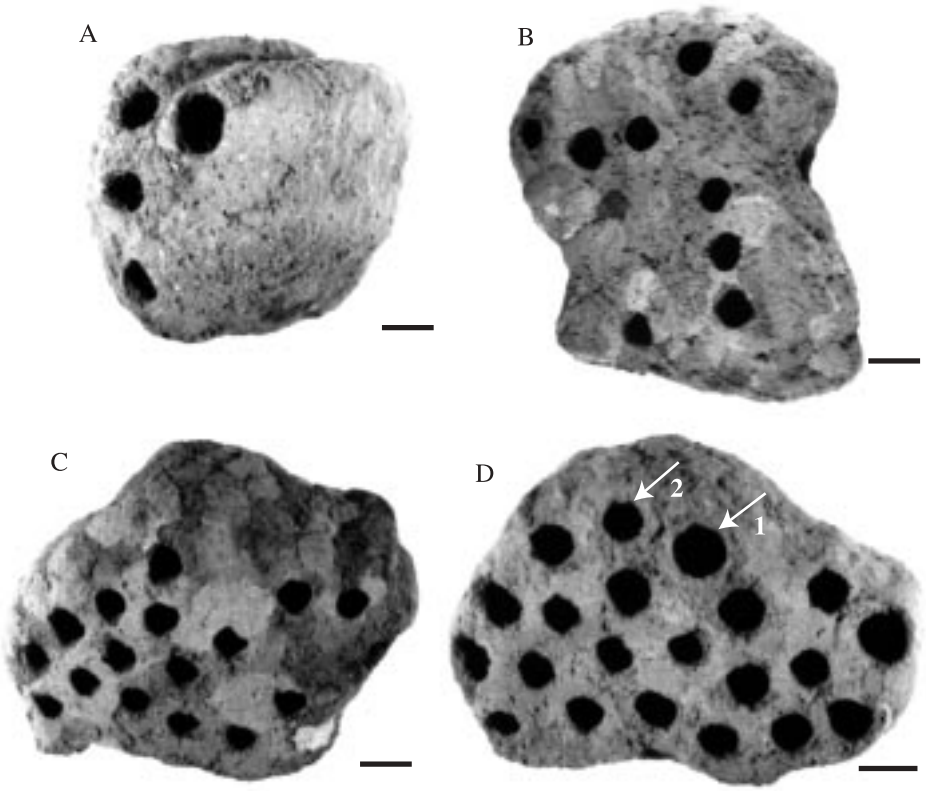

Fig. 1. Nests of *Sceliphron fistularium* showing the arrangement of sausage-shaped cells (A, B, C and D); the different color of building material (B and C); cells in which emerged females (D.1) and males (D.2). Scale bar = 1.0 cm.

spiders (x = 3.5 ± 0.8, n = 16), most cells having 4 (n = 9). In MG (14 cells), Araneidae was also the only family collected; *Micrathena swainsoni* (Berty, 1833) (62.0%) being the most frequent species followed by *M. acuta* (Walckenaer, 1841) (23.3%), this genus being the most predated (85.9%). The percent of female spiders (84.2% in Co and 86.6% in MG) was greater than that of juveniles and males. In MG, no males were collected (Table 1).

Emergencies, adult size, sex ratio and mortality: Adults emerged from June to October with the greatest number of emergencies occurring in September (Fig. 2). Although there was some overlap in size distribution, females (GWH = 3.65 - 4.35 mm, n = 46) were significantly larger than males (GWH = 2.72 - 4.40 mm, n = 42) (Mann-Whitney, Z = 7.27, $p < 0.05$). The sex ratio of individuals obtained from nests was 1.16 females : 1 male, not statistically different from 1:1 ($X^2 = 0.39$, d.f. = 1, $p > 0.05$). Mortality from developmental failure and parasitoids was observed in 47.6% of the provisioned cells. Accidentally damaged and empty cells corresponded to 4.2%, and

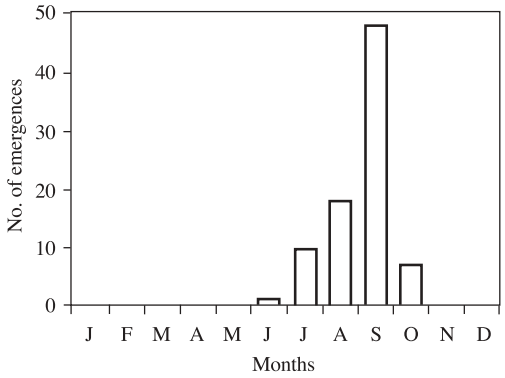

Fig. 2. Monthly number of emergences of *Sceliphron fistularium.*

TABLE 1
Number of spider juveniles (J), males (M) and females (F) collected by Sceliphron fistularium *in Colombia (16 cells) and Moji Guaçu (14 cells)*

Species	Colombia			Moji Guaçu			Total
	J	M	F	J	M	F	
Alpaida veniliae	8	1	48	-	-	-	57
Araneus unanimus	-	-	-	2	-	3	5
Micrathena acuta	-	-	-	5	-	28	33
Araneidae sp.	-	-	-	6	-	-	6
Gasteracantha cancriformis	-	-	-	2	-	3	5
Micrathena aff. *annulata*	-	-	-	-	-	1	1
Parawixia sp.	-	-	-	4	-	-	4
Micrathena swainsoni	-	-	-	-	-	88	88
Total	8	1	48	19	-	123	199

those with dead adults inside amounted to 5.2% of the cells (Table 2).

Life table and mortality factors: The life table was constructed based on 212 cells (Table 3). When the exact cause of death was unknown, it was classified as endogenous mortality. The endogenous causes are probably the result of developmental failure or infection by pathogens and fungi. Endogenous mortality was very high at all stages (except for prepupae) representing 70 of the 121 deaths (57.8%). Death due to the parasitoid wasp *Melittobia* sp. (Eulophidae) was the following most common mortality factor, accounting for 38 deaths (31.4%).

TABLE 2
Adults produced, parasitoids and dead immatures, accidentally damaged and empty cells, and adults in cells in each nest of Sceliphron fistularium

Nest number	Collection date	Nº of cells	Emergences		Parasitoids and dead immatures	Damaged and empty cells	Adults in cells
			Males	Females			
Co 1	7/14/98	12	3	2	5	2	-
Co 5	“	14	4	5	4	1	-
Co 7	“	4	2	2	-	-	-
Co 9	“	1	1	-	-	-	-
Co 10	“	54	8	18	26	1	1
Co 12	“	24	-	1	23	-	-
Co 13	“	12	7	3	2	-	-
Co 14	“	16	2	4	4	1	5
Co 15	“	8	-	3	4	-	1
Co 16	5/5/99	15	-	4	7	-	4
Co 17	“	7	4	-	3	-	-
MG 2	4/14/99	8	1	1	6	-	-
MG 6	5/14/99	12	5	1	5	1	-
MG 7	“	11	1	3	5	2	-
MG 8	“	14	4	2	7	1	-
Total		212	42	49	101	9	11

TABLE 3
Life table for Sceliphron fistularium *showing the percentage mortality and its causes at different stages of the life cycle*

Stages of development	Number entering each x (lx)	Mortality factors (dx F)	Number dying in each x (dx)	(dx) as a % of (lx) (100 qx)	1-(qx) (Sx)
Eggs	212	endogenous	17	8.01	0.919
		no eggs	4	1.88	0.981
		TOTAL	21	9.90	0.900
Larvae	191	Ichneumonidae	1	0.52	0.994
		endogenous	6	3.14	0.968
		Coleoptera	3	1.57	0.984
		TOTAL	10	5.23	0.947
Prepupae	181	*Melittobia* sp.	38	20.9	0.790
		endogenous	10	5.52	0.994
		accident	5	2.76	0.972
		TOTAL	53	29.28	0.707
Pupae	128	endogenous	26	20.31	0.796
Adults in cell	102	endogenous	11	10.78	0.892
Emerged adults	91				

DISCUSSION

All characteristics presented by the nests studied in this work are similar to those observed in other species, although the nest of *S. fistularium* with 54 cells is the largest ever studied.

Naumann (1983) reported that nests of *S. laetum* (F. Smith, 1856) were usually found in shaded or dimly lit sites, protected from direct sunlight and water. He also reported nests of *S. formosum* (F. Smith, 1856) on walls protected from rain, but well illuminated. Callan (1988) observed that *S. formosum* nests were also in a sheltered, well-illuminated situation. Nests of *S. fistularium* studied here were built on well illuminated surfaces protected from direct sunlight and water.

Usually the cells of a *Sceliphron* nest are covered with a layer of mud, but White (1962 in Bohart and Menke 1976) found that only 40% of the *S. spirifex* (Linnaeus, 1758) nests he studied were covered in that manner. He postulated that this trait is being lost because the wasps are becoming more and more associated with the human dwellings which offer more protection for the nest than the earlier ones.

Callan (1988) reported a nest of *S. formosum* not covered with an extra layer of mud. However, that was a small nest (5 cells) or incomplete (nest in construction or abandoned by female), and it had no time to be covered with mud. All nests of *S. fistularium* studied were covered with a layer of mud.

In northern Australia, the mean fecundity of *S. laetum* was 12 eggs per female, which was the mean number of cells per nest (Naumann 1983). This exceeds the 8.1 eggs per female estimate for *S. laetum* in southern Australia (Smith 1979), but is well below the 20 eggs per female observed for *S. assimile* (Dahlbom, 1843) in Jamaica (Freeman 1973). The estimations of mean fecundity for various *Sceliphron* sub-populations in Jamaica are generally in the range of 10-13 eggs per nesting female (in Freeman 1977). If one was to assume that females could live more than six weeks in the field, and that one cell could be completed per day, then a much higher fecundity could be possible (Naumann 1983). According to this idea the mean fecundity of *S. fistularium* was 9.5 for aerial nests and 25 for nests on the wall (Co) or 11.2 (MG).

As adult male spiders are smaller than females, live for short periods of time and are found only during the reproductive season, they are collected in low proportion. Females are

TABLE 4
Percents of spider families collected by Sceliphron *species*

Spider prey	*Sceliphron* species						
	laetum	*formosum*	*jamaicense lucae*		*caementarium*		
	n = ?[a]	n = 80	n = 721	n = 288	n = 747	n = 90	n = 3477
Anyphaenidae	-	-	9.3	-	-	-	-
Araneidae	-	1.25	14.4	99.3	29.0	97.8	87.9
Argiopidae[c]	100	-	-	-	-	-	-
Clubionidae	-	-	11.7	-	-	-	-
Heteropodidae[d]	-	1.25	13.9	-	-	-	-
Loxoscelidae[e]	-	-	< 1	-	-	-	-
Mimetidae	-	-	< 1	-	-	-	< 1
Miturgidae	-	5.0	-	-	-	-	-
Oxyopidae	-	-	6.8	-	5.9	1.1	< 1
Philodromidae	-	-	< 1	-	< 1	-	-
Pholcidae	-	-	<	-	-	-	-
Salticidae	-	92.5	2.1	-	1.0	-	< 1
Selenopidae	-	-	< 1	-	-	-	-
Scytodidae	-	-	< 1	-	-	-	-
Theridiidae	-	-	8.7	-	-	-	-
Thomisidae	-	-	31.5	< 1	65.5	1.1	10.5
REFERENCES[b]	1	2	3	4	5	6	7

[a] n = Number of prey. [b] 1- Naumann (1983); 2- Callan (1988); 3- Jiménez *et al*. (1992); 4- Crawford (1987); 5- Horner and Klein (1979); 6- Genaro (1996); 7- Volkova *et al*. (1999). [c] Actually Araneidae. [d] Actually Sparassidae. [e] Actually Sicariidae.

more vulnerable prey due to their greater exposure and also because of their relatively large abdomens which represent more energy for predators. Provisions consisting of a mixture of juveniles, subadults, or adults males, did not contain as much lipid as provisions consisting of two large adult females (Rehnberg 1987). Thus, the great preference for female spiders observed in this work probably is related to food quality.

In this study in Co, cells were provisioned exclusively with a single species of Araneidae (*A. veniliae*). This observation probably reflects local diversity because in MG, the females of *S. fistularium* captured several species of Araneidae, not showing a significantly preference for a particular one.

Sceliphron females are essentially opportunistic with respect to prey, capturing available spiders near the nest site (Callan 1988). Table 4 shows the prey captured by different *Sceliphron* species in several localities: *S. laetum* exclusively collected spiders of the family Argiopidae (actually Araneidae) (Naumann 1983); Salticidae and Thomisidae were the most frequent families collected by *S. formosum* and *S. jamaicense lucae* (Saussure, 1867), respectively (Callan 1988, Jiménez *et al*. 1992); and *S. caementarium* (Drury, 1773) collected preferentially Araneidae at three sites (Crawford 1987, Genaro 1996, Volkova *et al*. 1999) and Thomisidae at a fourth one (Horner and Klein 1979).

The parasitoids emerging from nests of *S. fistularium* were the same observed in nests of other species. In these, the most frequent parasitoids were also *Melittobia* spp. which were also observed in *S. assimile* (Freeman 1973, 1977, Freeman and Parnell 1973, Hunt 1993, Genaro 1994), *S. laetum* (Naumann 1983) and *S. jamaicense lucae* (Jiménez *et al*. 1992). Other parasitoids in *S. laetum* were Chrysididae, Sarcophagidae and *Anthrax* sp. (Naumann 1983); in *S. jamaicense lucae* were *Chrysis* sp. (Chrysididae), Sarcophagidae and Coleoptera (Jiménez *et al*. 1992); in *S. assimile*

were *Macrosaigon excavatum* (Coleoptera), *Trichrysis mucronata* and *Neochrysis* sp. (Chrysididae) (Hunt 1993); and in *S. caementarium* was Ichneumonidae (Genaro 1966).

ACKNOWLEDGEMENTS

I thank Sérvio Tulio P. Amarante (Museu de Zoologia, USP, São Paulo) who identified the *Sceliphron* species, Antonio D. Brescovit (Instituto Butantan, São Paulo) who identified the spiders' species, Carlos Alberto Garófalo for comments and suggestions and José Carlos Serrano for technical assistance.

RESUMEN

Se obtuvieron nidos de *Sceliphron fistularium* en Colombia y Moji Guaçu, São Paulo, Brasil. Los nidos completos consistieron de 1 a 54 celdas en forma de salchicha, acomodadas lado a lado a lo largo de un eje horizontal, y encontradas adheridas a cables eléctricos (Colombia, n = 7) y paredes (Colombia, n = 4 y Moji Guaçu, n = 4). El número de celdas por nido varió de 1 a 54, su longitud variando de 20.8 a 29.7 mm, y su diámetro de 7.6 a 11.7 mm. Las celdas de cría fueron provistas con arañas de la familia Araneidae. Solo *Alpaida veniliae* fue recolectada en Colombia, mientras que la especie más frecuente encontrada en Moji Guaçu fue *Micrathena swainsoni* (62.0%) seguida por *M. acuta* (23.3%). Los adultos emergieron de junio a octubre. El largo y diámetro de las celdas de hembras y machos fue similar. Sin embargo, las hembras fueron significativamente más grandes que los machos. La proporción de los sexos de los individuos obtenida de los nidos fue 1.16 hembras : 1 macho. Se hizo una tabla de vida y se presentan detalles del ciclo de vida de las avispas y los parasitoides. Los factores de mortalidad más comunes fueron desconocidos o debidos a la avispa parasitoide *Melittobia* sp.

REFERENCES

Bohart, R.M. & A.S. Menke. 1976. Sphecid wasps of the world. University of California, Berkeley. 695 p.

Callan, E.McC. 1988. Biological observations on the mud-dauber wasp *Sceliphron formosum* (F. Smith) (Hymenoptera: Sphecidae). Aust. Entomol. Mag. 14: 78-82.

Crawford, R.L. 1987. Spider prey of the mud-dauber *Sceliphron caementarium* (Sphecidae) in Washington. Proc. Wash. St. Entomol. Soc. 48: 797-800.

Early, J.W. & J.I. Townsendi. 1993. Further New Zealand records of *Sceliphron* (Hymenoptera: Sphecidae). New Zeal. Entomol. 16: 52-54.

Ferguson, C.S. & J.H. Hunt. 1989. Near-nest behavior of a solitary mud-daubing wasp, *Sceliphron caementarium* (Hymenoptera: Sphecidae). J. Insect Behav. 2: 315-323.

Freeman, B.E. 1973. Preliminary studies on the population dynamics of *Sceliphron assimile* Dahlbom (Hymenoptera: Sphecidae) in Jamaica. J. Anim. Ecol. 42: 173-182.

Freeman, B.E. 1977. Aspects of the regulation of size of the Jamaican population of *Sceliphron assimile* Dahlbom (Hymenoptera: Sphecidae). J. Anim. Ecol. 46: 231-247.

Freeman, B.E. & B. Johnston. 1978. Gregarious roosting in the sphecid wasp *Sceliphron assimile*. Ann. Entomol. Soc. Amer. 71: 435-441.

Freeman, B.E. & J.R. Parnell. 1973. Mortality of *Sceliphron assimile* Dahlbom (Sphecidae) caused by the eulophid *Melittobia chalybii* Ashmead. J. Anim. Ecol. 42: 779-784.

Genaro, J.A. 1994. Inquilinos de *Sceliphron assimile*, con énfasis en *Podium fulvipes* (Hymenoptera: Vespidae, Sphecidae, Megachilidae). Carib. J. Sci. 30: 268-270.

Genaro, J.A. 1996. Sobre la nidificación de *Sceliphron caementarium* y primer registro de *Trypoxylon texense* para Puerto Rico (Hymenoptera: Sphecidae). Carib. J. Sci. 32: 243-244.

Horner, N.V. & J.H. Klein Jr. 1979. Spider prey of two mud dauber wasp species in Comanche Country Oklahoma (Hymenoptera: Sphecidae). Environ. Entomol. 8: 30-31.

Hunt, J.H. 1993. Survivorship, fecundity, and recruitment in a mud dauber wasp, *Sceliphron assimile* (Hymenoptera: Sphecidae). Ann. Entomol. Soc. Amer. 86: 51-59.

Jiménez, M.L., R. Servín, A. Tejas & R. Aguilar. 1992. La composicion de presas de la avispa lodera *Sceliphron*

jamaicense lucae en la region del Cabo, México. Southwest. Entomol. 17: 169-180.

Mitchell, P.S. & J.H. Hunt. 1984. Nutrient and energy assays of larval provisions and feces in the black and yellow mud dauber, *Sceliphron caementarium* (Drury) (Hymenoptera: Sphecidae). J. Kans. Entomol. Soc. 57: 700-704.

Naumann, I.D. 1983. The biology of mud nesting Hymenoptera (and their associates) and Isoptera in rock shelters of the Kakadu Region, Northern Territory. Aust. Nat. Parks Wildlife Service Spec. Pub. 10: 127-189.

Rehnberg, B.G. 1987. Selection of spider prey by *Trypoxylon politum* (Say) (Hymenoptera: Sphecidae). Can. Ent. 119: 189-194.

Smith, A. 1979. Life strategy and mortality factors of *Sceliphron laetum* (Smith) (Hymenoptera: Sphecidae) in Australia. Aust. J. Ecol. 4: 181-186.

Volkova, T., R.W. Matthews & M.C. Barber. 1999. Spider prey of two mud dauber wasps (Hymenoptera: Sphecidae) nesting in Georgia's Okefenokee Swamp. J. Entomol. Sci. 34 : 322-327.