

Two new species of *Charinus* Simon, 1892 from Brazil with biological notes (Arachnida; Amblypygi; Charinidae)

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Charinus acaraje n. sp. is described from Gruta Pedra do Sino, Santa Luzia, Bahia, Brazil and *Charinus asturius* n. sp. from Morro Pacuíba, Ilhabela, São Paulo, Brazil. *Charinus asturius* is recorded from the most southern locality in South America. *Charinus asturius* is a nocturnal forager that in captivity accepted live termites and *Drosophila* (adults and larvae). The most common defensive behaviours of *C. asturius* were: to flee when disturbed by light or touch, and to autotomize parts or entire legs when manipulated. Most of the reproductive activity of the species probably occurs during the wet-warm season (from October to March). The clutch size ranged from 10 to 15 eggs and the pre-nymphs hatched and remained on the mother's back for 2 weeks. The limited occurrence of *C. asturius* on Ilhabela Island (from 100 to 400 m on only one mountain) and its demands for specific microhabitats make the species threatened and vulnerable to the environmental damage caused by human occupation in the lower lands of the study site.

KEYWORDS: Activity schedule, Amblypygi, cave, foraging, maternal care, Neotropical.

Introduction

The Amblypygi are tropical and subtropical arachnids comprising about 120 species (Weygoldt, 1999). Of the five families, three have representatives in South America: the Charinidae, the Phrynichidae and the Phrynidae. Of these, only the Phrynidae are an exclusively or predominantly Neotropical group; the Charinidae and Phrynichidae have a world-wide distribution (Weygoldt, 1996).

Charinus Simon, 1892, the genus with the largest number of species world-wide, is also the third largest Neotropical genus; only *Phrynus* and *Paraphrynus* have similar species numbers. So far, 12 species have been described from various parts of South America and Mesoamerica. Some of these have originally been described under other generic names, but Delle Cave (1986) synonymized *Charinides* Gravely, 1915, *Speleophrynus* Ravelo, 1975 and *Enantiosarax* Mello-Leitão, 1931, with *Charinus*. We here add two new species to this genus. One of these species is the most southern whip spider in South America and also probably the southernmost member of the genus *Charinus* world-wide.

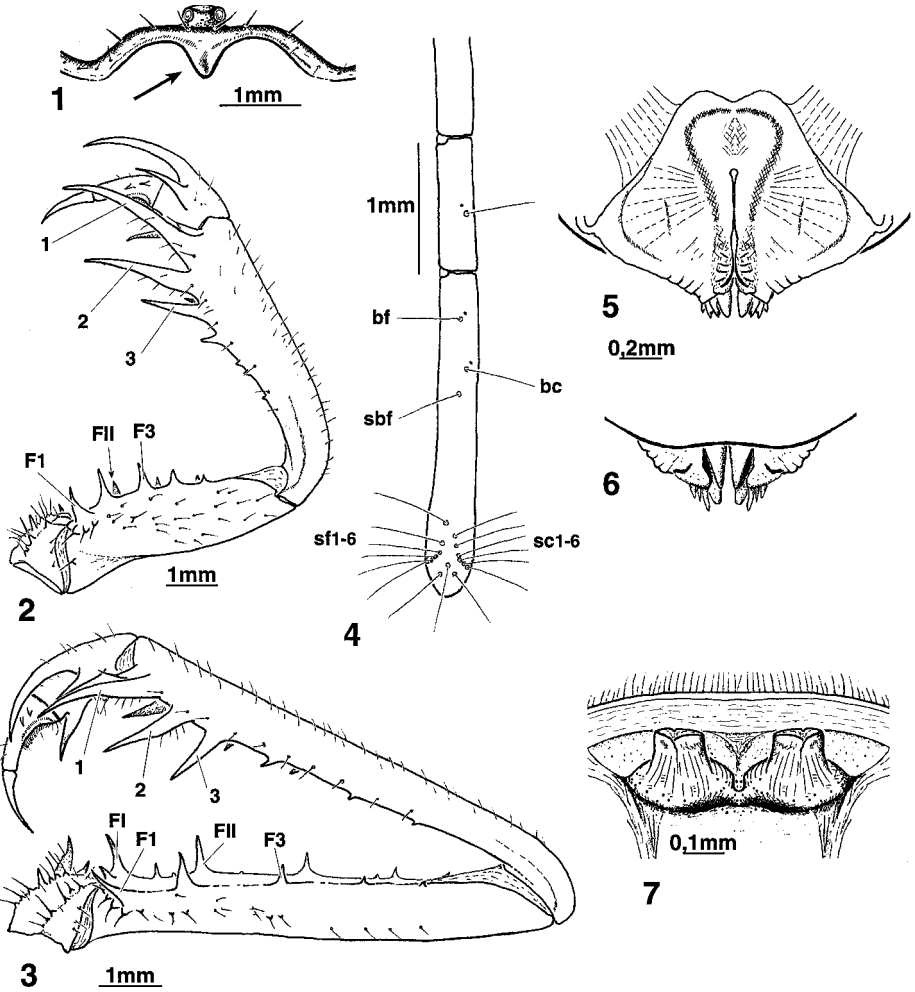
The type-material are deposited at 'Museu de Zoologia da Universidade de São Paulo' (MZSP).

***Charinus asturius* n. sp.**

(figures 1–7, 13, 14)

Diagnosis. Similar and closely related to *Charinus brasilianus* Weygoldt, 1972. It differs from that species by the fact that the trichobothrial rows **sc** and **sf** contain six setae instead of five and by slight differences in the male genitalia. It differs from *Charinus montanus* Weygoldt, 1972 with the same numbers of trichobothria by its more slender appearance and by its pointed, instead of club-shaped, setae.

Description. Carapace (figure 13): 1.4 times wider than long, finely granulated with the typical sculpture; anterior margin rounded, with six strong frontal setae and several finer setae along the anterior-lateral margins; frontal process large and triangular (figure 1), in some specimens directed downwards, in others visible from above. Median eyes well developed; median eye tubercle with two small posterior setae; lateral eyes with little pigmentation, each triad with one strong posterior seta. Chelicera: smooth, with the typical charinid dentition, upper or distal tooth of the internal margin of the basal article bicuspidate, the upper cusp larger, external margin without tooth; fang with a series of up to eight small teeth; internal surface of basal article with a few scattered setae proximally. Pedipalp (figures 2, 3, 13): trochanter with a dorsal row of up to 10 (two to three large) setae, an anterior row with up to 10 (six to seven large) setae and one spine in about the centre of the row; another anterior spine dorsally of the ventral apophysis. Femur with five (six in large males) dorsal and four (five in large males) ventral spines; dorsal spine **F1**, the largest, is situated close to the trochanter–femur joint, at 7–9% of the femur length, it is preceded proximally by a curved row of two strong and two small tubercles, each carrying a seta, ventral spine **FI** is preceded proximally by a small anterior-ventral spine, all spines decrease in length towards the distal end, spine **F6**, if present, is little more than a small tubercle; the protonymph has only the primary spines **F1**, **F2**, **FI** and **FI**. Tibia with six (seven in large males) dorsal and four (five in large males) ventral spines; the three primary dorsal spines **1–3** close together at the distal end of the tibia, distance between **1** and **2** (in large males with elongate pedipalps) less than basal spine diameter, distance between **2** and **3** less than two basal diameters; dorsal spine **1**, the largest, is followed distally by a spinelet carrying a seta, the proximal spine **5** (and **6** if present) are small, tubercle-like; the protonymph has only the three large primary spines **1–3** and the most distal spinelet dorsally and spines **I** and **II** ventrally. Basitarsus with two dorsal and one ventral spine, distal spine **Ta2** about 2.7 times longer than spine **Ta1**. Distitarsus with two small subequal dorsal spinelets above cleaning organ, the distal one slightly larger than the proximal.



FIGS 1–7. *Charinus asturius* n. sp.: (1) Anterior view of the anterior carapace margin with the six setae and the strong frontal process (arrow). (2) Female pedipalp (paratype MZSP 18934). (3) Male pedipalp (holotype MZSP 18930). (4) Distal part of left tibia IV with the trichobothria. (5) Male genitalia, dorsal aspect. (6) Male genitalia, ventral aspect. (7) Female genitalia. 1–3=primary dorsal tibia spines. F1, F3=dorsal femoral spines 1 and 3, F1, FII=ventral femoral spines I and II.

Pedipalp in the male elongate, tibia in the holotype male 1.9 times prosoma length; in the paratype female 0.9 and in the largest female 1.2 times carapace length. First leg: 23 to 24 tibial and 41 tarsal articles. Fourth leg: basitibia IV divided into four articles. Trichobothria (figure 4): each walking leg tibia carries 19 trichobothria. The seta **bc** is much closer to **sbf** than to **bf**; the series **sf** and **sc** each with six setae. Sternum: tritosternum elongate, cone-shaped, with two strong apical setae and several smaller setae; tetrasternum a small, rounded tubercle with several setae, pentasternum even smaller with few small setae, both without any indication of a median furrow; metasternum wide, between fourth coxae, with few small setae. Genitalia: female gonopods (figure 7) short, cone-shaped, with an apical sucker-like prehensile structure, with very little anterior-ventral sclerotization; female genital

operculum rounded posteriorly, with numerous pointed setae in particular along its posterior edge. Male spermatophore organ (figures 5, 6) wider than long, soft, with little sclerotization at the bases of the lateral and dorsal lobes and a weak U-shaped dorsal sclerotization; genital operculum rounded posteriorly, with few strong, pointed setae.

Colour in alcohol. Carapace, pedipalps and chelicerae reddish brown, tergites, sternites and legs paler without pattern or leg annulations, all parts densely decorated with dark, nearly blackish granules.

Etymology. Named in reference to the ship 'Príncipe da Astúria' (Prince of Asturia) that sank near the type locality of the new species, Ilhabela, São Paulo State, Brazil.

Measurements (in mm). Holotype male (MZSP 18930): total length 8.7, carapace length 3.8, width 5.45; distance between lateral eyes 2.5; pedipalp tibia length 7.3, spine 1 1.95, spine 2 1.4, spine 3 0.9; first leg femur 9.5, tibia 17, tarsus 14; second leg femur 6.1, basitibia 4.8, distitibia 2.5, basitarsus 1.1, other tarsal articles 1.0; third leg femur 6.85, basitibia 5.9, distitibia 2.9, basitarsus 1.1, other tarsal articles 1.0; fourth leg femur 5.9, basitibia I 3.3, basitibia II 0.75, basitibia III 1.0, basitibia IV 1.2, distitibia 2.6, basitarsus 1.2, other tarsal articles 1.0.

Paratype female (MZSP 18930): total length 7.25, carapace length 2.6, width 3.6; distance between lateral eyes 1.7; pedipalp tibia length 2.3, spine 1 1.2, spine 2 0.9, spine 3 0.45; first leg femur 5.35, tibia 10, tarsus 9; second leg femur 3.6, basitibia 2.5, distitibia 1.7, basitarsus 0.7, other tarsal articles 0.7; third leg femur 4.15, basitibia 3.1, distitibia 1.9, basitarsus 0.8, other tarsal articles 0.8; fourth leg femur 3.6, basitibia I 1.75, basitibia II 0.45, basitibia III 0.5, basitibia IV 0.7, distitibia 1.75, basitarsus 0.75, other tarsal articles 0.75.

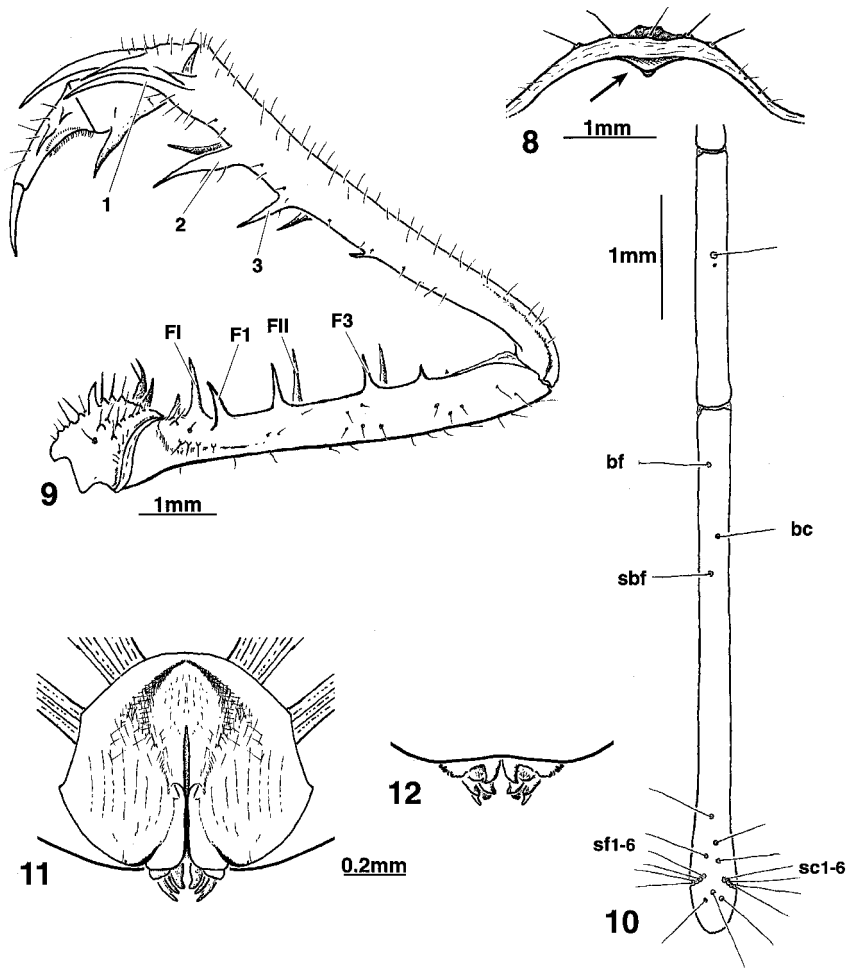
Largest female paratype (MZSP 18934): total length 10.5, carapace length 3.8, width 5.5; distance between lateral eyes 2.65; pedipalp tibia length 4.6, spine 1 2.1, spine 2 1.5, spine 3 0.85; first leg femur 9.25, tibia 18, tarsus lost; second leg femur 6.3, other articles broken; third leg femur 7.15, basitibia 5.95, distitibia 2.8, basitarsus 1.0, other tarsal article 1.0; fourth leg femur 6.0, basitibia I 3.3, basitibia II 0.9, basitibia III 1.1, basitibia IV 1.25, distitibia 2.75, basitarsus 1.2, other tarsal articles 1.1.

Specimens examined. MZSP 18930: male holotype, one female paratype: [Brasil, SP: Ilha Bela, Morro Pacuíba, 23°44'S 45°19'W, G. Machado leg. January 1998]. MZSP 18934: one female with empty egg sac and numerous prenymphal exuviae, paratype [same data as holotype]. MZSP 16900: four males, three females, one immature female, six protonymphs [same locality as holotype, 18 January 1999, R. Pinto-da-Rocha and G. Machado leg.].

***Charinus acaraje* n. sp.**

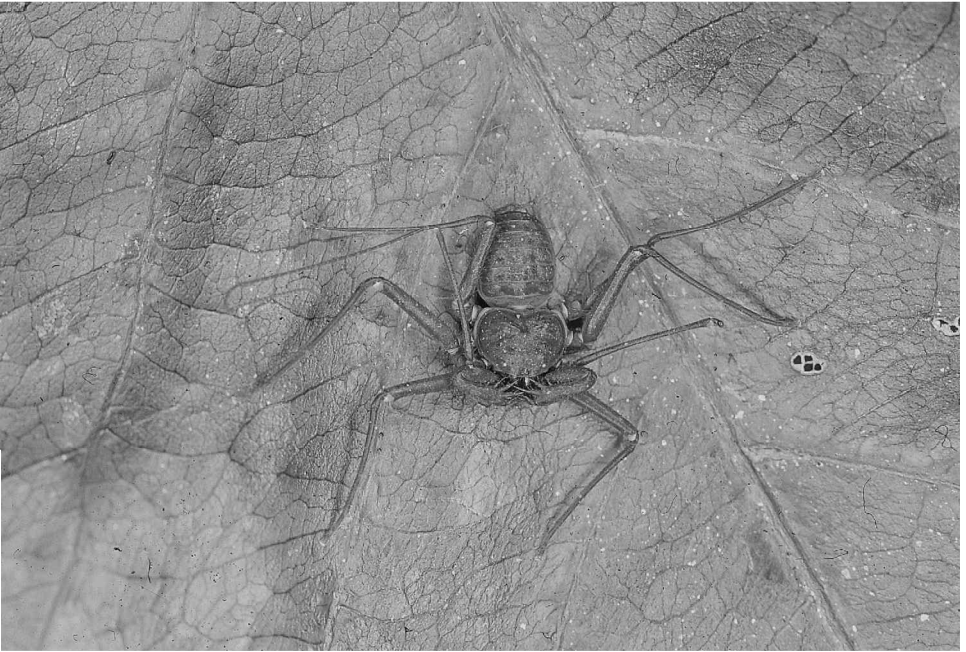
(figures 8–12)

Diagnosis. A cavernicolous species with elongate pedipalps and legs. It is distinguished from most other species by the fact that femoral spine **F1** is not situated close to the trochanter–femur articulation; it is situated at about 26% of the femur length away from the articulation. It is further distinguished from most other species by its inconspicuous and small frontal process and by its extreme elongation of the antenniform legs; individual tibial articles may be up to 1.3 mm long, and by the fact that there are only five, instead of six, frontal setae.



FIGS 8–12. *Charinus acaraje* n. sp. (male holotype MZSP 18929): (8) Anterior view of anterior carapace margin with the five setae, flat median eye tubercle and small frontal process (arrow). (9) Pedipalp. (10) Distal part of tibia IV with the trichobothria. (11) Male genitalia, dorsal aspect. (12) Male genitalia, ventral aspect. Lettering as in figures 1–7.

Description. Carapace 1.4 times wider than long, finely granulated, with the typical sculpture, anterior margin rounded, with five strong frontal setae, one directly in front of the median eye tubercle and two on each side, and some smaller setae; frontal process (figure 8) small, directed downwards and slightly posteriorly, not visible from above; median eye tubercle well developed though small and flat, with one seta at its posterior margin, lateral eyes also small but with lenses and normal pigmentation; a strong seta at the posterior margin of each triad, three more similar setae in oblique row between anterior margin and lateral eyes. Chelicera: smooth, with the typical charinid dentition, all teeth strongly worn, upper or distal tooth with only a small notch between both cusps, internal surface proximally with a S-shaped row of seven fine setae and a few more setae that merge with the ventral fringe hairs. Pedipalp (figure 9): trochanter with a dorsal row of seven (three large) setae, an anterior row of up to 10 (six large) setae and a strong spine in about the



FIGS 13, 14. *Charinus asturius* n. sp.: (13) living male; (14) living female.

centre of the row, and another, larger spine directly above the ventral apophysis. Femur asymmetric, with four dorsal spines on the right and three dorsal spines on the left pedipalp; spine **F1** not directly distal of trochanter–femur joint, instead about 26% of the femur length away from that articulation, preceded on the right femur by a curved row of four small setae, on the left side by an irregular group of

two large and two small setae; **F1** is the largest, spine length decreasing towards the distal end, femur ventral (on both sides) with five spines, the three large spines **F1–FIII** decrease in length distally, spine **F1** is preceded proximally by a smaller secondary spine, which, on the left palpus, reaches nearly the length of spine **F1**, **FIII** is followed distally by a small spine **FIV**. Tibia dorsal with the three primary spines **1–3**, a spinelet distally of spine **1** and another small secondary spine **4** proximally of spine **3** (these latter spinelets are missing on the left pedipalp), distance between primary spines **1–3** larger than basal spine diameters, tibia ventral with only two spines. Basitarsus with one ventral and two dorsal spines, **Ta2** about twice as long as **Ta1**. Distitarsus with two small spines dorsally of cleaning organ, the distal one about 2.5 as large as the proximal one; pedipalp elongate, tibia 1.7 times longer than carapace. Antenniform legs: with 23 tibial articles, tarsus incomplete; elongate, individual tibial segments reach 1.3 mm, basal tarsal segments reach up to 0.8 mm. Walking legs elongate, basitibia IV divided into four articles. Trichobothria (figure 10): each walking leg tibia carries 19 trichobothria. The seta **bc** is closer to **sbf** than to **bf**; the series **sf** and **sc** each with six setae. Sternum: tritosternum elongate and narrow, with two strong apical setae, three large and several smaller basal setae; tetrasternum and pentasternum small rounded tubercles with few setae; metasternum narrow, with only four setae. Male genitalia (figures 11, 12): genital operculum with strong and long setae in the anterior and median part, posterior margin weakly rounded, nearly straight, with few setae; spermatophore organ slightly longer than wide, with little sclerotization around the bases of the posterior lobes and in the anterior-dorsal region.

Colour in alcohol. Carapace, chelicerae, pedipalps and legs light reddish brown, tergites and sternites even lighter, transparent.

Etymology. A noun in reference to one of the most famous dishes of the bahian cooking, the ‘acarajé’.

Measurements (in mm). Total length 9.4, carapace length 3.75, width 5.25, distance between lateral eyes 2.5; pedipalp tibia length 6.25, spine 1 2.0, spine 2 1.7, spine 3 1.1; first leg femur 16.8, tibia 27, tarsus broken; second leg femur 11.3, basitibia 6.4, distitibia 3.5, basitarsus 1.7, other tarsal articles 1.2; third leg femur 10.0, basitibia 8.3, distitibia 4.8, basitarsus 2.3, other tarsal articles 1.4; fourth leg femur 8.8, basitibia I 4.1, basitibia II 1.5, basitibia III 1.45, basitibia IV 2.1, distitibia 4.45, tarsus broken.

Specimen examined. MZSP 18929 male holotype [Brasil, Gruta Pedra do Sino, Santa Luzia, BA, leg B. S. Santos at aphotic zone, 14 October 1997]. No other specimens known.

Discussion

The following species of *Charinus* have been described from the New World: *C. acosta* (Quintero, 1983); Cuba, *C. bordoni* (Ravelo, 1977), Venezuela; *C. brasilianus* Weygoldt, 1972, Brazil; *C. cubensis* (Quintero, 1983), Cuba; *C. decu* (Quintero, 1983), Cuba; *C. gertschi* Goodnight and Goodnight, 1964, Guyana, Surinam; *C. insularis* Banks, 1902, Galapagos; *C. koepkei* Weygoldt 1972, Peru; *C. muchmorei* Armas and Ochoa, 1997, Virgin Islands; *C. montanus* Weygoldt, 1972, Brazil; *C. schirchii* (Mello-Leitão, 1931), Brazil; *C. tronchonii* (Ravelo, 1975), Venezuela; and *C. wanlessi* (Quintero, 1983) Cuba. Of these, *C. schirchii* is presently a *species inquerenda*; the type specimen is lost and the species has never been recorded

again. Together with three species of *Tricharinus* Quintero, 1986, these are the 15 species of Neotropical Charinidae.

Charinus asturius n. sp. is closely related and similar to *C. brasilianus*. It differs from that species mainly by its numbers of trichobothria and by slightly different genitalia. *C. montanus* Weygoldt, 1972, although not similar externally, is also related to these species; it has similar male and female genitalia. It seems, although the female genitalia are not known, that *Charinus acaraje* also belongs to the same group; its male genitalia are similar to those of *C. brasilianus*.

Charinus acaraje, however, differs in various aspects from other species of the genus. It is probably a cavernicolous species (see Pinto-da-Rocha, 1995 for a list of cave species). Its eyes are reduced in size and its legs are elongate, about 1.5 times longer than those of *C. asturius*. Its pedipalps are also elongate, but in a different way. In *C. brasilianus*, *C. asturius* and others, the pedipalp femur is elongated mainly by stretching of the distal part. The primary spines remain proximally, and secondary spines are added distally. In *C. acaraje*, all parts of the femur seem to have stretched. Thus, the first spine seems to have moved distally, and the distances between spines are greater. This is perhaps also the result of cavernicolous life. The pedipalp of *C. acaraje* is thus different from that of most other species. Further, instead of six setae, as in most species, the anterior carapace margin of *C. acaraje* carries only five setae, and the frontal process is small and inconspicuous. This and the non-symmetric pedipalps suggest that the only known specimen may be an abnormal specimen. It should be interesting to study more specimens, and in particular the female, to get a clear picture of the morphology of this species.

Most species of the genus *Charinus* are similar in appearance; their external morphology is nearly identical. However, there are great differences as far as the female genitalia are concerned. The female gonopods, the structures that are used to pick up the spermatozoa from the spermatophore, may have the appearance of soft cushions with an apical, finger-like appendage vestige. This is the plesiomorphic condition. Among the neotropical species, *C. koepkei* belongs to this group (Weygoldt, 1972a), and probably *C. insularis* as well. This type of gonopod also occurs in Old World species and in other charinid and charontid genera. In *C. brasilianus*, *C. montanus* and *C. asturius*, the gonopods are conical and have an apical sucker-like prehensile structure. This condition is certainly apomorphic and joins all species bearing this type of gonopods. A third and very different type has so far been described only for *C. seychellarum* Kraepelin, 1898 (Weygoldt, 1999). Here, the gonopods are missing, and the spermatozoa are transferred into the female genitalia by means of a complex spermatophore reaction. Unfortunately, most authors describing new *Charinus* species have not even mentioned the genitalia. From a taxonomical point of view, such descriptions are nearly worthless, since they only show that a new *Charinus* has been found. Because of this lack of information, it is impossible to arrive at a classification of the various Neotropical Charinidae and at a hypothesis of the evolution and biogeography of *Charinus*. It is not even clear whether *Charinus* is a monophyletic taxon or a paraphyletic or even polyphyletic group.

Notes on behaviour and ecology

Material and methods

Specimens of *Charinus asturius* were collected in February 1999 at Pacuíba Mount, Ilhabela Island (23°47'S, 45°24'W), south-eastern coast of São Paulo State,

south-east Brazil. Approximately 80% of the island is covered by Atlantic Forest (IBGE, 1983) and the climate is warm and wet with maximum rainfall in December (2000 mm) and minimum in August (80 mm).

The specimens collected for behavioural study were 10 females (one ovigerous) and one male. They were maintained singly in plastic containers (16 cm diameter \times 6 cm high) with stones and a wet cotton to maintain the moisture. Individuals were fed two or three times a week with adults and larvae of flies (*Drosophila* spp.) and workers of the termite *Armitermes euamignathus* Silvestri. The animals have never been observed feeding on dead matter.

A preliminary ethogram (4 h of observations) was carried out in March 1999 and three behavioural categories were established: (1) resting, when individuals were inside the shelter; (2) foraging, including hunting activity, prey detection, capture, and eating; and (3) self-grooming, including cleaning of legs and pedipalps. Based on this ethogram the activity schedule of *C. asturius* was quantified at 1 h intervals during a 24-h period. Sampling at each interval consisted of taking note during 10 min of all behaviours exhibited by 10 individuals. Nocturnal observations were carried out with a flashlight covered by a red filter to avoid disturbing the individuals.

Results and discussion

Foraging and activity schedule

During daytime, individuals of *Charinus asturius* were found resting under stones in the field. In the laboratory a similar behaviour was observed, although some individuals remained outside the shelter even during daytime. Approximately 1 h after dusk, most of the individuals were foraging. The majority of these individuals returned to the shelter 3 h after dawn (figure 15). According to this activity schedule individuals of *C. asturius*, as well as other studied species of amblypygids (Cloudsley-Thompson, 1958; Weygoldt, 1994), can be considered mainly nocturnal foragers.

Whereas *C. pescotti* Dunn can be considered a sit-and-wait predator (Gray and Robinson, 1986), individuals of *C. asturius* leave their diurnal retreats and walk on the substratum searching for prey. During foraging, individuals walked with the first pair of legs extended sideways, always pointed toward the direction of movement. Occasionally the individuals stopped and started a leg-waving behaviour that consisted of a circular movement of the first pair of legs above the body without touching the substratum. This behaviour may increase the perception of chemical cues; air vibrations are perceived by the trichobothria on the walking legs and could be related to detection of potential prey since these legs are important sensory structures of the amblypygids (the most important are the trichobothria 1) (Weygoldt, 1972b; Foelix *et al.*, 1975; Gray and Robinson, 1986). In *C. asturius*, as well as in *C. pescotti* and other species of the order (Cloudsley-Thompson, 1958; Gray and Robinson, 1986), the eyes seem to be useless in detecting food (but see Gravely, 1915). After the prey had been touched with the sensorial legs it was taken briskly with a fast movement by the pedipalps and then seized by the chelicerae. The prey was either consumed on the spot ($n=6$) or carried into the shelter ($n=1$).

Defensive responses

The most common defensive behaviour of *Charinus asturius* was to flee when disturbed by light or touch. When manipulated, individuals may also autotomize parts (tibia and tarsus) or entire legs. It is a widespread behaviour among

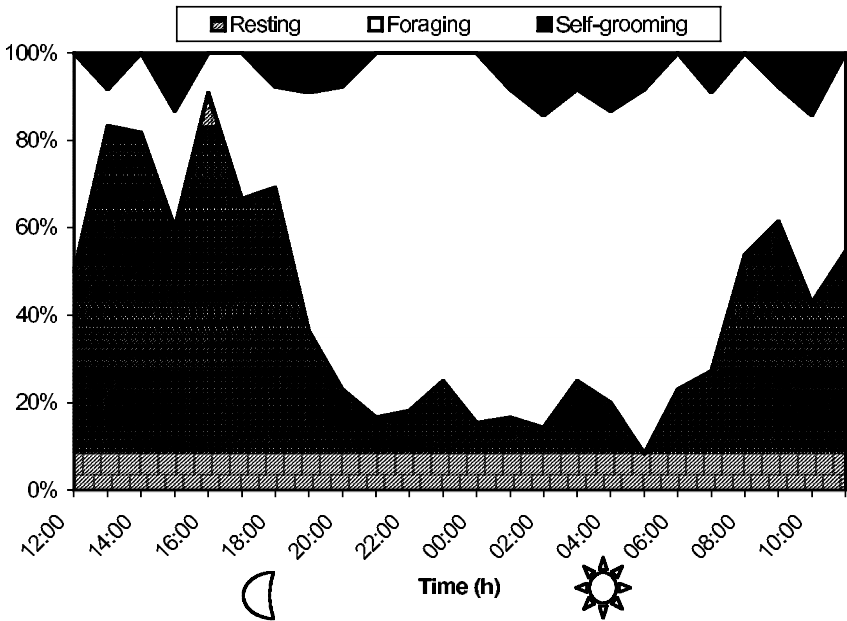


FIG. 15. Activity schedule of 10 individuals of the amblypygid *Charinus asturius* under captivity conditions. The moon and the sun indicate the beginning of dusk and dawn, respectively.

amblypygids (Weygoldt, 1984) and many individuals were found in the field with legs autotomized. This observation indicates that this behaviour can be an important evasive response for the species. Those parts of the legs that can be autotomized (tibia + tarsus) are regenerated at the next moult. This kind of injury can be promoted by both small predators and conspecifics since individuals are very aggressive—at least under captivity conditions. On one occasion two females were put together in a container and the largest attacked, killed and cannibalized the smaller one. In general, agonistic behaviour in amblypygids is highly stereotyped and does not lead to fatal injuries (Quintero, 1979). However, in *C. asturius* and *Heterophrynus alces* Pocock (Weygoldt, 1998), the animals seem to be so voracious that encounters usually lead to immediate aggression and cannibalism.

Maternal care

Most of the reproductive activity of *Charinus asturius* at Ilhabela Island probably occurs during the wet-warm season (from October to March). In the middle of January 1998 a female was found carrying 15 pre-nymphal exuvians on her back. In the same month in 1999 many nymphs were found in the field, suggesting a high juvenile recruitment. On 18 January 1999 a female bearing an egg-sac was collected and maintained in the laboratory. The clutch size was 10 eggs and the egg diameter was approximately 1.5 mm. Both egg and clutch size were very similar to that recorded by *C. pescotti* (Gray and Robinson, 1986). On 16 March 1999 the pre-nymphs hatched and remained on the mother's back for 2 weeks. After this period the non-pigmented pre-nymphs accomplished their first moult, acquired a grey pigmentation on cephalothorax and abdomen, and dispersed. In the following

2 weeks four nymphs disappeared—suggesting that the mother may cannibalize its offspring.

Ecology

The majority of the individuals were found in the field on the undersurface of granitic boulders (from 25 to more than 150 cm diameter), never on the substratum below. Only one individual was found under a tree bark. Although we looked exhaustively for amblypygids on two other mountains at Ilhabela Island, we have not found any individual. The high availability of granitic rocks, which is the preferred microhabitat of *C. asturius*, at the Pacuíba Mount may explain the restricted occurrence of the species in this place. Even along this mount, the altitudinal range of *C. asturius* is from 100 to 400 m. The limited occurrence of *C. asturius* and its demands for specific microhabitats make the species threatened and vulnerable to the environmental damage caused by human occupation in the lower lands of the study site.

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