

Taxonomy, distribution and ecology of the lycosid spiders occurring on the Santa Cruz island, Galápagos Archipelago, Ecuador

Léon BAERT¹ and Jean-Pierre MAELFAIT²

¹ Koninklijk Belgisch Instituut voor Natuurwetenschappen, Vautierstraat 29, B-1000 Brussels, Belgium.

² Instituut voor Natuurbehoud, Kliniekstraat 25, B-1070 Brussels, Belgium.

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ABSTRACT

Two species of lycosid spiders occur on Isla Santa Cruz, the central island of the Galápagos archipelago. The first one can be found from the coastal lagoons up to the wet pampa vegetation at *ca* 600 m of altitude and also at lower altitudes in a number of other islands. The second species is normally confined to the pampa vegetation of the top of the island but, under certain climatological conditions, as for instance wet years, it may descend to the lower lying grassy parts at *ca* 600 m of altitude. Both species can also occur in the same habitat.

The two species occurring parapatrically on the same island show very pronounced morphological differences, for instance, the colour pattern of the carapace, leg length and the shape of the male palpal terminal apophysis. They also behave differently as they normally live in different kinds of habitats.

INTRODUCTION

The spiders and other arthropods of the Galápagos archipelago have been the subject for investigation for almost a decade (Baert 1987, 1990, 1994a, 1994b, 1995a, 1995b; Baert & Maelfait 1982, 1983, 1984, 1986a, 1986b, 1986c; Baert *et al.* 1989a, 1989b, 1989c, 1990a, 1990b, 1990c, 1991, 1992, 1993; Desender 1988; Desender *et al.* 1988, 1989, 1990a, 1990b, 1990c, 1991, 1992a, 1992b; Galiano & Baert 1990; Maelfait & Baert 1982, 1986). The purpose here is to give an overview of the present knowledge of the lycosid spiders of this island group.

MATERIAL AND METHODS

We visited the Galápagos islands on five occasions (in 1982, 1986, 1988, 1991 and 1996). Most small and all major islands and volcanoes were

RESULTS AND DISCUSSION

I. Taxonomy

Banks (1902) described three lycosid species from the material collected during the Hopkins Stanford Galápagos expedition of 1898-1899: *Lycosa snodgrassi*, *Lycosa albermarlensis* and *Lycosa galapagoensis*. *Lycosa snodgrassi* was collected at sea level at Iguana cove (volcano Cerro Azul, Isabela), at Wreck Bay and in the higher cultivated parts of San Cristóbal and in the littoral zone of Floreana. *Lycosa albermarlensis* was found in the wet salt grass growing along the inner edge of the Turtle Point mangrove of Isla Isabela (also known as Isla Albermarle). *Lycosa galapagoensis* was found together with *Lycosa snodgrassi* at Iguano Cove (volcano Cerro Azul, Isabela) and at Wreck Bay and in the higher, cultivated parts of Isla San Cristóbal. Of the *Lycosa* material described by Banks (1902) only the female type specimen of *Lycosa albermarlensis* still exists in the collections of the Museum of Comparative Zoology, Harvard University.

Roewer (1954) put the three species in different genera: *Lycosa snodgrassi* became *Isohogna snodgrassi*, *Lycosa albermarlensis* became *Galapagosa albermarlensis* and *Lycosa galapagoensis* became *Gnatholycosa galapagoensis*. Maelfait and Baert (1986) considered them as *Trochosa* species in their first study on galapagoan lycosid spiders.

At this stage, according to the diagnosis of Dondale and Redner (1990), we consider them as representing the genus *Hogna* (Trochinae). The diagnostic characters are: the uniform height of the carapace, the cymbium with more than two terminal macrosetae, the large embolus arched at its base, the double sickle shaped terminal apophysis running parallel with the embolus and the median apophysis having a spur at its base.

After the first examination of the huge amount of lycosid material, we can distinguish seven different populations (Fig. 1) on the basis of their size, robustness, colour pattern and the shape of their epigyne.

Population 1: found in the grassy vegetation of the highlands of the volcano Sierra Negra and the volcano Cerro Azul, both located in the southern part of Isla Isabela.

Population 2: found in the grassy vegetation of the highland of Isla San Cristóbal.

Population 3: found along the coast and higher parts of various islands (*Hogna cf. albermarlensis*: see below).

Population 4: found in the grassy vegetation of the highlands of the islands Santa Cruz, Santiago (?) and Cerro Azul (?) (*Hogna cf. galapagoensis*: see below).

Population 5: found along the shore in salt grass of Caleta Sapho, Isla San Cristóbal.

Population 6: found in the grassy vegetation of the volcano Alcedo (centre of Isla Isabela) and Isla Santiago (?).

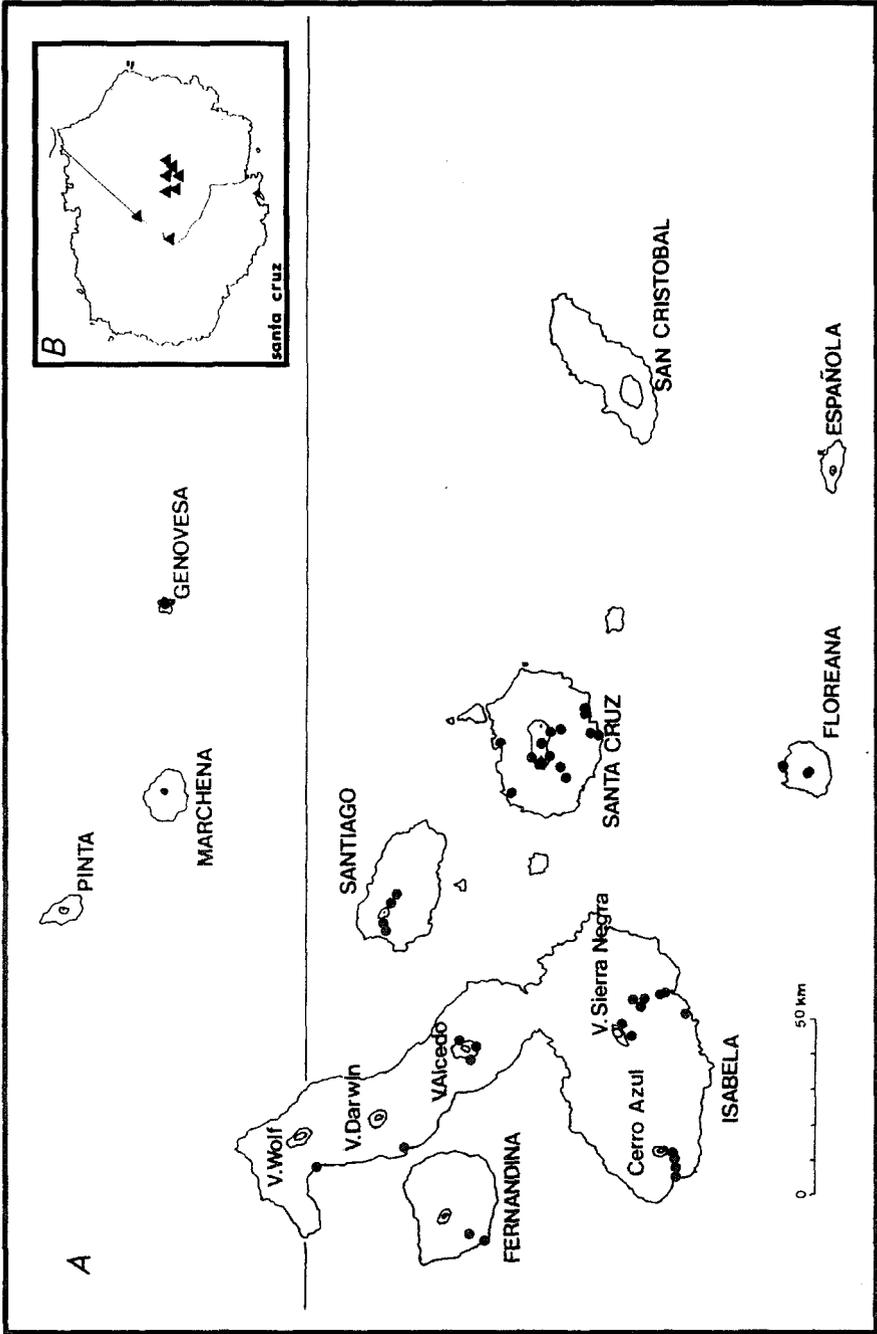


Fig. 2. Distribution of *Hogna cf. albermarlensis* (dots) and *Hogna cf. galapagoensis* (triangles) on Santa Cruz.

Population 7: found in the dry arid zone of Española.

Due to the very high intrademic variation of the above mentioned characters, this division is still unsure. We therefore recently started taking samples from these population that will be investigated for allozyme variation by means of gel electrophoresis.

Based on the above mentioned morphological characters and on the description given by Banks (1902), we consider two of Banks' species to be valid: *albermarlensis* and *galapagoensis*; they will be formally redescribed in a taxonomic publication; *snodgrassi* is probably the same species as *albermarlensis*. Here only the two lycosid populations of Isla Santa Cruz, e.g. *Hogna cf. albermarlensis* and *Hogna cf. galapagoensis* are considered.

II. Morphology

The cephalothorax of *Hogna cf. albermarlensis* is pale brown with a clear broad median and yellow marginal to submarginal bands. The legs are yellowish with brown tarsi; the femora are not or very faintly blotched. The cephalothorax of *H. cf. galapagoensis* is, on the contrary, dark brown to chestnut brown with a broad median pale band and a faint submarginal pale band. The tarsi, metatarsi and tibiae are brown; the femora are yellow but strongly blotched.

The apical terminal apophysis is knifeblade shaped in *H. cf. albermarlensis* while it is needle shaped in *H. cf. galapagoensis*. This difference may indicate that between both species a prezygotic isolation mechanism has evolved to separate both parapatric populations (Maelfait & Baert 1986).

The edges of the median epigynal septum in *H. cf. albermarlensis* are convex, while concave in *H. cf. galapagoensis*. There is however a large variation in the shape of the epigynum in *H. cf. galapagoensis*.

III. Distribution

Hogna cf. albermarlensis is the most widespread species in the archipelago. It is found on nearly every island (Fig. 2, full circles): in the littoral zone and pampa zone of Floreana (alt. 360 m), in the pampa zone of Santiago (between 500 and 900 m), in the salt marshes and from the Culture zone (400 m) up to the pampa zone (1000 m) on the Sierra Negra volcano of Isabela, from the littoral dry arid zone up to 1000 m on the Cerro Azul volcano of Isabela, in the pampa vegetation around the rim of the Alcedo volcano of Isabela, in the salt marsh of the Beagle crater near volcano Darwin (Isabela), in the littoral zone of the Wolf volcano of Isabela, in the salt marsh at Cabo Hammond and in the pampa vegetation at an altitude of 400 m on Fernandina and in the salt marsh inside the Genovesa crater. It was not found on the two other northern islands Marchena and Pinta. It is absent on the most eastern islands San Cristóbal and Española. These last two islands have other distinct lycosid populations. On Santa Cruz (Fig. 2) it can be found from the salt marshes along the coast up to the Miconia zone (550 m): littoral zone,

dry arid zone, transition zone, culture zone, *Scalesia* zone, lower pampa zone and *Miconia* zone. Really high densities are however only attained in the salt marshes along the coast (Tab. 1).

Tab. 1. Number of individuals (males/females) of *Hogna cf. albermarlensis* caught in three pitfall traps operating during the indicated periods at different sites of Santa Cruz.

Site	Altitude	Period	MM/FF
Laguna Andreas	0 m	28.IV-28.V.91	127/36
Bahia Tortuga	5 m	24.III-30.IV.91	5/1
Culture zone	350 m	25.II-12.III.86	6/1
Scalesia zone	570 m	12.II-2.IV.88	0/3
Lower pampa	570 m	12.II-2.IV.88	3/7
Miconia zone	500 m	15.II-2.IV.88	1/2

Hogna cf. galapagoensis is confined to the higher pampa zones of Santa Cruz (Fig. 2, full triangles) where it can reach quite high densities. It lives in the dense *Sphagnum/Lycopodium* bogs and between the grass and low herb vegetation of the pampa zone. Single findings were made at lower altitudes. Both species can occur together in open pampa around 500 m of altitude.

IV. Behaviour

Both lycosid populations have a different way of living. *H. cf. albermarlensis* lives in open habitats and can run very fast over bare ground in the littoral and dry arid zones, where temperatures can rise very high. This species has relatively longer legs than *Hogna cf. galapagoensis*. The last species lives in the higher and cooler region of the island; it moves much slower and is much easier to capture. It crawls through the dense grass and herb vegetation and its hides in the thick carpets of the *Sphagnum/Lycopodium* bogs. *H. cf. albermarlensis* can easily be caught at night with the aid of a head torch. They hide during the hottest time of day, but crawl upon the vegetation once the night falls. The species is nocturnal. On the contrary, *H. cf. galapagoensis* seems to be a day active species as it actively runs about during daytime through the sparse vegetation.

V. Phenology

In 1991 a pitfall trapping campaign was started in co-operation with the Charles Darwin Research Station (CDRS) in the fern-sedge zone on top of the Cerro Crocker of Santa Cruz. This gave a good idea of the phenology of the *H. galapagoensis*-population.

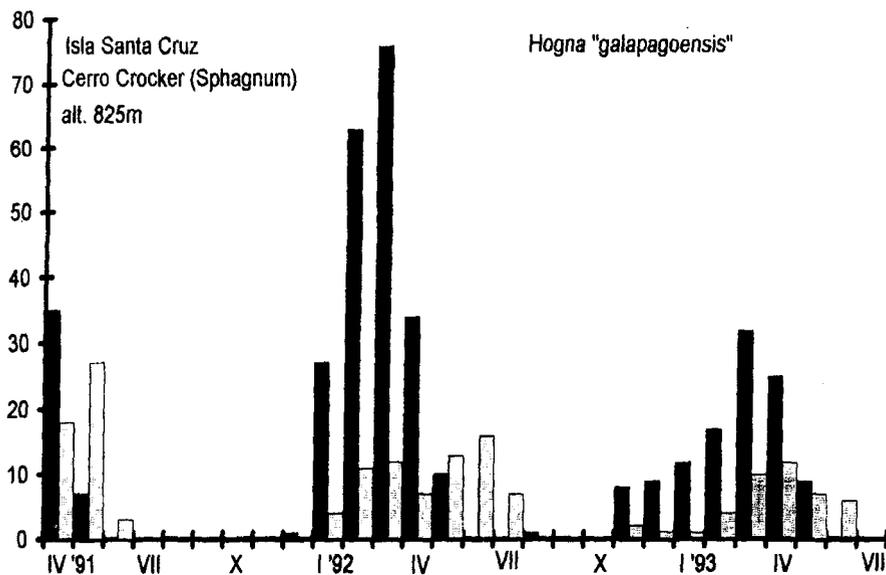
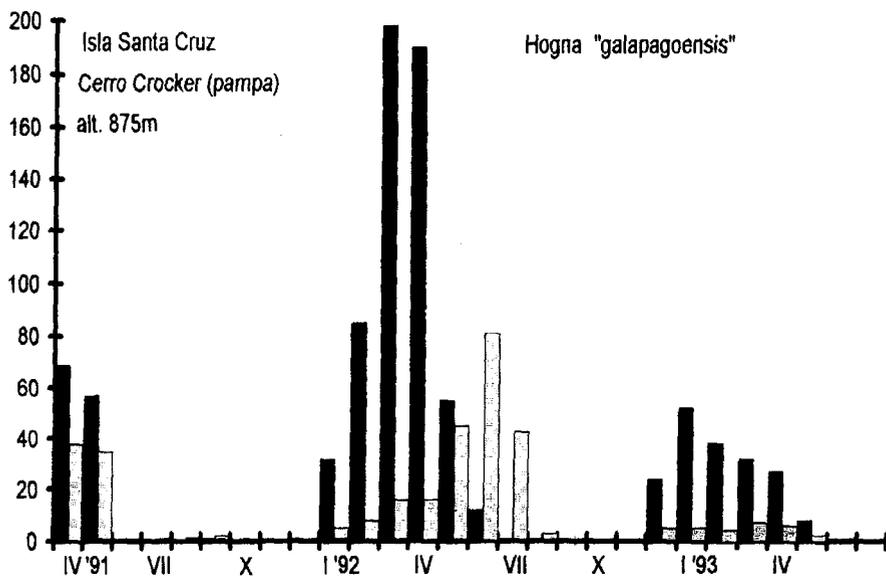


Fig. 3. Seasonal activity (phenology of the life cycle) of males (black) and females of *Hogna cf. galapagoensis* in the pampa and *Sphagnum* vegetation of Cerro Crocker (alt. 875 m), Santa Cruz.

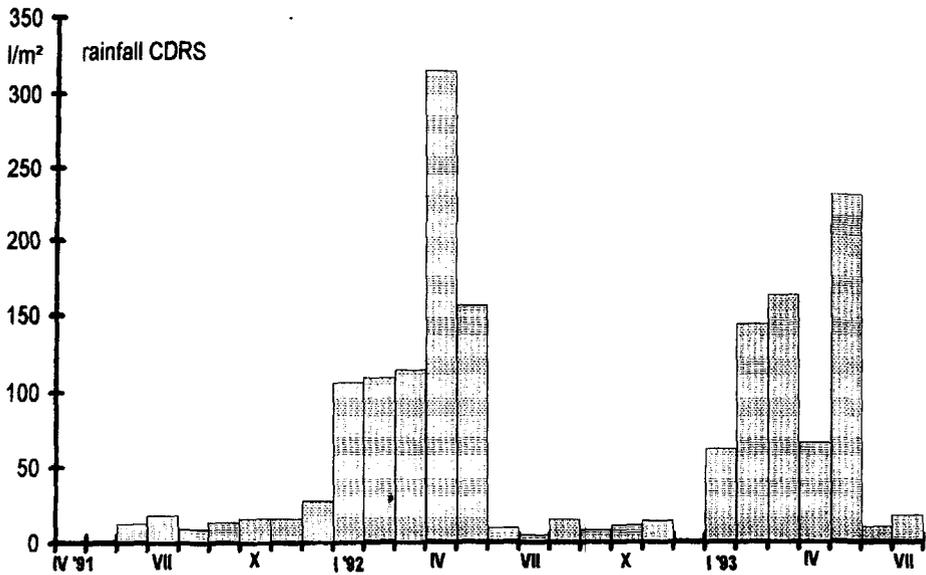
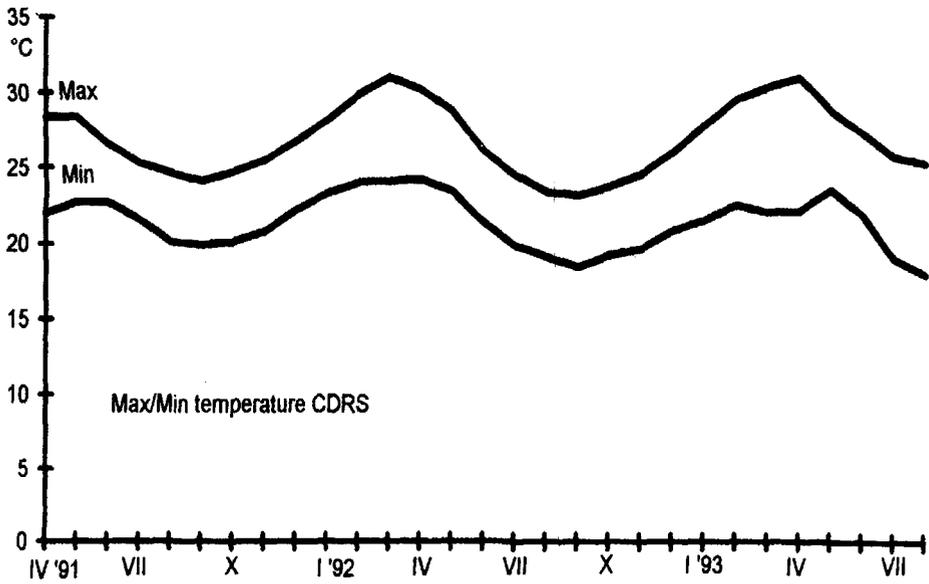


Fig. 4. Rainfall (A) and maximum and minimum temperatures (B) at the CDRS (Santa Cruz) between May 1991 and August 1993.

The sampling started in April 1991 and ended in August 1995. Figure 3 (males full bars) gives the results of the period between April 91 and June 93. Figure 4 gives the meteorological data (mean max. and min temperatures and rainfall) measured in the vicinity of the CDRS. Because the station is located in the dry arid zone, the graph only gives us an idea of the fluctuations of these meteorological factors.

Both males and females start to become active at the beginning of the warm/wet season, e.g. December, when the temperature starts to rise, and lasts the whole wet season till June. This season is characterized by high temperatures, clear skies and occasional heavy rain showers. The following season known as *garúa* (June - December) is characterized by cooler temperatures, lightly overcast skies, nearly no precipitation in the arid zone but with the highlands being almost constantly in fog, the vegetation being constantly wet. The first year of the sampling shows a male activity-peak in March/April and June for the females. The following year the activity began about one month earlier with a male activity peak in January/February and a female peak in April. The females carry their cocoons in May/June but are not very active. They are probably retired in a burrow as *Hogna* and other Trochinae do. Females carrying their spiderlings start to emerge in June/July.

VI. Conclusions

The two *Hogna* species occurring parapatrically on Santa Cruz show remarkable morphological and ecological adaptations to the habitat types (the altitude) in which they live.

It seems that the degree of adaptive radiation in lycosids is higher in the east than in the west of the archipelago. The same phenomenon was observed in the carabid genus *Pterostichus* (Desender *et al.* 1992a). It can be explained by the relative age of the islands, varying in a gradient from east to west.

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