A new species of *Trechalea* (Pisauridae: Araneae) from Central Amazonian inundation forests and notes on its natural history and ecology

James E. Carico
Lynchburg College,
Department of Biology,
Lynchburg, VA 24501, USA

Joachim Adis
Max-Planck-Institute for Limnology, Working Group: Tropical Ecology, Postfach 165, D-2320 Ploon, FRG, in co-operation with Instituto Naçional de Pesquisas da Amazônia (INPA), Manaus, Brazil

and

Norman D. Penny
Instituto Naçional de Pesquisas da Amazônia (INPA), Depto. de Ecologia, Caixa Postal 478, 69000 Manaus/AM, Brazil

Summary

The new species of pisaurid, *Trechalea manauensis* Carico, is described. It is found on tree trunks of inundation forests near Manaus, Brazil where it is well camouflaged and capable of adjusting the colour intensity of its body markings to the habitat. This night-active species passively waits for approaching soft-bodied arthropods, its only prey. The main reproduction period occurs between March and June when forests are flooded. Spider egg sacs are parasitised by *Mantispa gracilis* (Mantispidae: Neuroptera) and small hymenopterans (Chalcidoidea). Infestation level of the mantispid is about 2%. The adult mantispid parasite is assumed to be a facultative egg sac boarder or penetrator.

Introduction

Two major inundation forest types are found in the Central Amazon: (1) seasonal *igapó* forests along black-water rivers, e.g. the Rio Negro, and (2) seasonal *várzea* forests along white-water rivers, e.g. the Rio Solimões (Prance, 1979; Sioli, 1956, 1983). Both types are flooded annually for 5-6 months (March/April-August/September) up to several metres but differ in flora and fauna (Adis, 1981, 1984a; Irmler, 1975, 1976, 1979a, b; Prance, 1979; Worbes, 1983). A third inundation forest type, the so-called "mixed-water forest" which is under the temporary influence of both black and white waters, still needs more detailed studies on flora and fauna (Prance, 1979; Erwin, 1983a, b; Fittkau *et al.*, 1975; Irmler, 1975, 1977).

During an ecosystem analysis carried out since 1975 on these biotas (cf. Adis, 1984a, b; Adis & Schubart, 1984), the spider described below was frequently collected from tree trunks in all inundation forests under study, especially during the submersion period.

Study area and methods

The *igapó* forest is situated on the lower course of the Rio Tarumã Mirím (03°02'S, 60°17'W), an affluent of the Rio Negro, about 20 km upstream from Manaus (site description in Adis, 1981, 1984a; Irmler, 1975, 1977).

In the *várzea, Trechalea* was studied at two sites:

a) in a riverine forest on Ilha de Curarí (03°15'S, 59°49'W), located on the right bank of the Rio Solimões, about 15 km upstream from the mouth of the Rio Negro on the Rio Amazonas (site description in Adis, 1981; Irmler, 1975);
b) in an island forest on Ilha de Marchantaria (03°15'S, 59°58'W), the first island in the Rio Solimões, about 15 km above its confluence with the Rio Negro (cf. Irion *et al.*, 1983; Junk *et al.*, 1983).

Additional material was collected in a mixed-water forest at Lago Janauacá (3°30'S, 60°20'W), located near the right bank of the Rio Solimões about 60 km distant from Manaus (cf. Santos, 1980).

All *Trechalea* specimens were hand collected from tree trunks in the study area. During laboratory experiments they were maintained separately in rearing chambers (day temperature 31°C; night temperature 22°C; day length 12 hours, from 06.00 to 18.00).

J. E. Carico described the new species of *Trechalea.* The collections of specimens and field data were made by J. Adis and N. D. Penny.

Trechalea manauensis Carico, new species (Figs. 1-4)

Types: Holotype (♂) and paratype (♀) from Ilha de Marchantaria, Rio Solimões, (near Manaus) Brazil

in white-water region, inundation forest (*várzea*), collected from tree trunks, 28 June 1981 by J. Adis. Deposited in the Systematic Entomology collections of Instituto Naçional de Pesquisas da Amazônia (INPA), Manaus, Brazil. Paratypes (1 ♂, 1 ♀), same locality and date, deposited in the American Museum of Natural History, New York, USA.

Male holotype: Measurements in mm. Carapace moderately low, length 5.5, width 5.3. Sternum length 2.80, width 2.60, unmarked. Labium length 1.18, width 0.98. Palpal endites length 2.12. Chelicerae swollen on anterior face, middle tooth largest of three promarginal equidistant teeth, two distal teeth closest of three subequal retromarginal teeth. Clypeus height 0.60. Both eye rows recurved, ALE, AME, PLE, PME = 0.19, 0.33, 0.55, 0.50; width of PE row 3.45, AE row 1.35; ocular quadrangle height 1.10, width above 1.27, width below 0.83. Leg measurements in Table 1. Colour in various shades of grey. Colour of carapace light, indistinctly marked, with the ocular area dark. Abdomen grey dorsally with three pairs of diagonal maculae, numerous dark setae anteriorly; ventrally light and unmarked, except for a lightly sclerotised genital plate. Palp (Figs. 1, 2).

Female paratype: Carapace moderately low, length 5.7, width 5.5. Sternum length 2.95, width 2.75, unmarked. Labium length 1.20, width 1.05. Palpal endites length 1.95. Chelicerae enlarged on anterior face, teeth as in male. Clypeus height 0.57. Both eye rows recurved, ALE, AME, PLE, PME = 0.20, 0.35, 0.60, 0.55; width of PE row 2.70, AE row 1.45; ocular quadrangle height 1.20, width above 1.38, width below 0.90. Leg measurements in Table 1. Colour of carapace as in male. Abdomen dorsally with indistinct grey mottling, numerous dark setae anteriorly; ventrally light and unmarked. Epigynum (Figs. 3, 4).

Material examined: Brazil, near Manaus: Ilha de Marchantaria (Rio Solimões), *várzea* forest, from tree trunks during inundation, 28 April 1981, (leg. J. Adis), 4 ♂♂, 1 ♀; Ilha de Curarí (Rio Solimões), *várzea* forest, from tree trunks during inundation, 31 March 1976 (leg. J. Adis), 3 ♂♂, 4 ♀♀; Rio Tarumã Mirím, *igapó* forest, from tree trunks during inundation, 28 April 1976, 31 May 1976 (leg. J. Adis) 1 ♂, 1 ♀; Lago Janauacá, mixed-water forest, from tree trunks during inundation, 4 July 1977 (leg. J. Adis), 3 ♀♀.

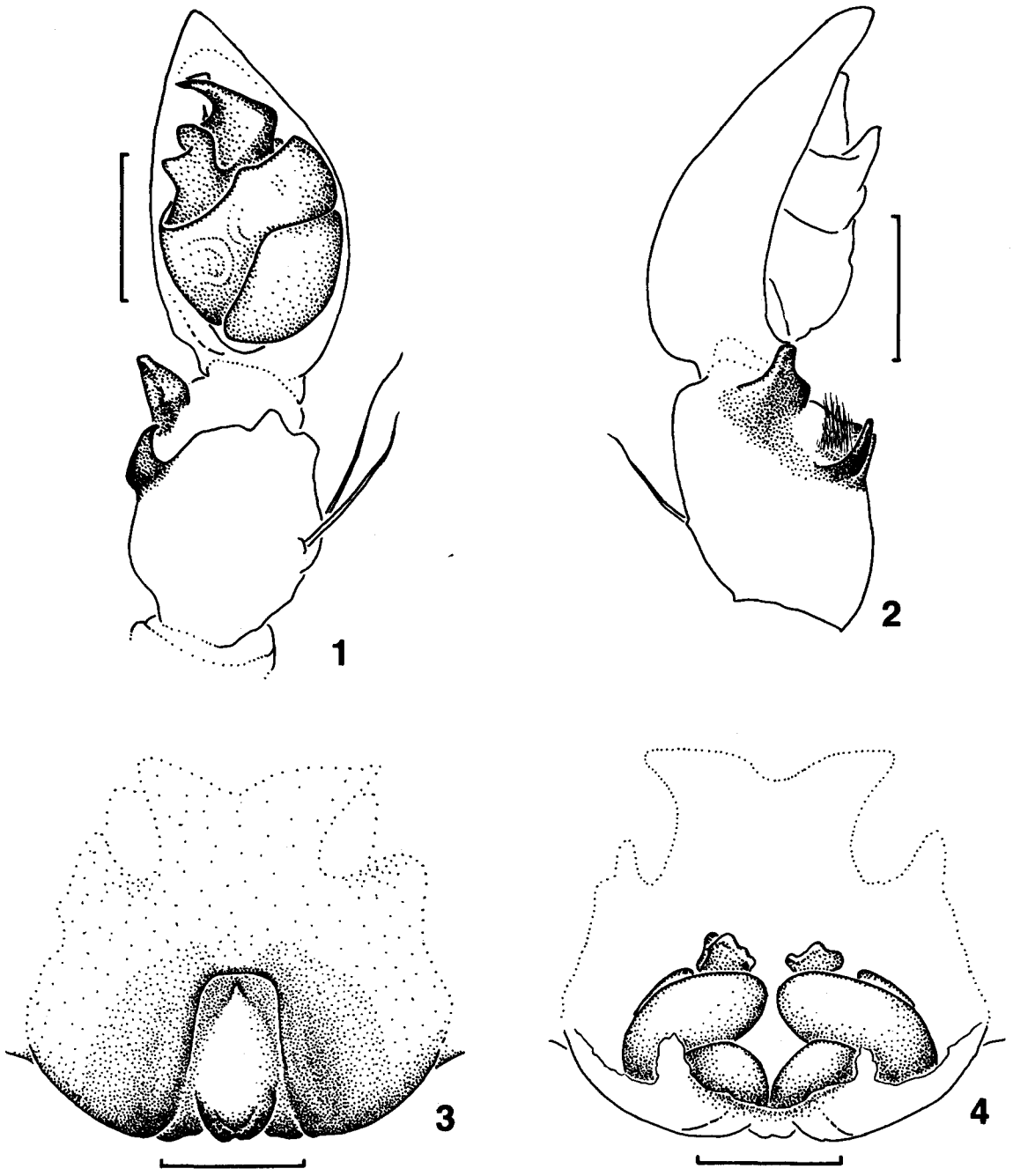
Natural history and ecology

Reproduction

Trechalea manauensis is found on tree trunks of Central Amazonian inundation forests, usually up to 4 m above ground level during the emersion period, and above the waterline during flooding. Females construct egg sacs throughout the period of rising waters and after the water level has reached the bases of the trees. Flooding varies according to local and upriver rainfall patterns, but normally occurs in March or early April. The main reproduction period occurs, therefore, between March and June, i.e. when numerous terrestrial arthropods are found on tree trunks during forest inundation (Adis, 1981) and thus are available as food for the progeny. A few females were observed with egg sacs until October during receding waters and the early part of the emersion period. The hemispherical egg sac (diam. 7.0-8.5 mm) is carried under the abdomen, directly attached to the spinnerets. This unusual maternal behaviour in *Trechalea* was first reported by Berkum (1982) for *T. magnifica* Petrunk. which inhabits small streams in southwest Costa Rica. The egg sac is not reattached to the spinnerets once it is lost by accident. Within 15-20 days the egg sac opens laterally along the suture of its dorsal cover and releases up to 235 young. The progeny concentrate mainly on the egg sac but may also be found on the abdomen of the female (Fig. 5). Under laboratory conditions the egg sac is carried for 17-19 days. All young spiders then leave the female and moult in a simple web which they build in the lower tree-trunk area, preferably in crevices and between buttresses.

	Leg	Femur	Patella-tibia	Metatarsus	Tarsus
Male	I	8.9	11.3	7.7	4.5
	II	9.0	10.9	7.8	4.7
	III	7.5	8.5	6.8	4.5
	IV	9.7	10.8	10.4	6.0
Female	I	8.7	10.7	7.1	3.5
	II	8.7	10.8	7.4	4.4
	III	7.5	8.3	6.9	4.3
	IV	9.7	11.2	10.3	6.0

Table 1: Measurements (in mm) of *Trechalea manauensis* Carico, n.sp.



Figs. 1-4: Genitalia of *Trechalea manauensis* Carico, new species. **1, 2** Male holotype; **3, 4** Female paratype; **1** Palp, ventral view; **2** Palp, retrolateral view; **3** Epigynum, ventral view; **4** Epigynum, dorsal view. Scale lines: male genitalia 1.0 mm, female genitalia 0.5 mm.

Responses to predators

Adults and advanced immature stages of *T. manauensis* normally lie flat against tree trunks and blend in well with the colour of the bark. The spider is capable of adjusting the colour intensity of its markings on legs and carapace to the surroundings. On trunks with dark-brown bark (e.g. in the *igapó*) these markings appear dark and well pronounced, while on trunks with grey-brown bark (e.g. in the *várzea*), the markings appear lighter and less pronounced. Adult males and females changed colour within 30 minutes in the laboratory if transferred from a white to a black, simulated background of cloth. Up to now, the ability to change colour among faunal components of inundation forests was known to occur only in *Hyla raniceps* (Anura: Hylidae). This frog shows a yellowish-green colour when inhabiting floating meadows in front of *várzea* forest but turns brown in forest leaf litter (Hödl & J. Adis, unpubl.). Camouflage seems to be a crucial factor for *T. manauensis* as a defence mechanism against potential diurnal predators like insectivorous birds, lizards and large wasps frequently observed in the inundation forests under study (cf. Adis, 1981). Nocturnal predators include frogs (*Hyla* spp.), large centipedes (Scolopendromorpha) and lycosid spiders which forage for food along tree trunks, especially during forest inundation. Like *Trechalea magnifica, T. manauensis* does not respond to disturbance by small arthropods around it until actually touched (cf. Berkum, 1982). When attacked by large predators, including humans, the spider was observed to escape to the opposite side of the upper trunk region or to the inundated lower trunk area where it remained submerged for 15 minutes with the body covered by a plastron. In the *igapó* study area, surface current was insigificant during forest inundation. When disturbed, *T. manauensis* moved from tree trunk to tree trunk by running on the water surface.

Feeding behaviour

Trechalea manauensis is night-active and was observed feeding on smaller, soft-bodied arthropods, e.g. adult and immature crickets (Grylloidea), grasshoppers (Tettigonoidea), cockroaches (Blattodea) and moths. In the laboratory, spiders also took

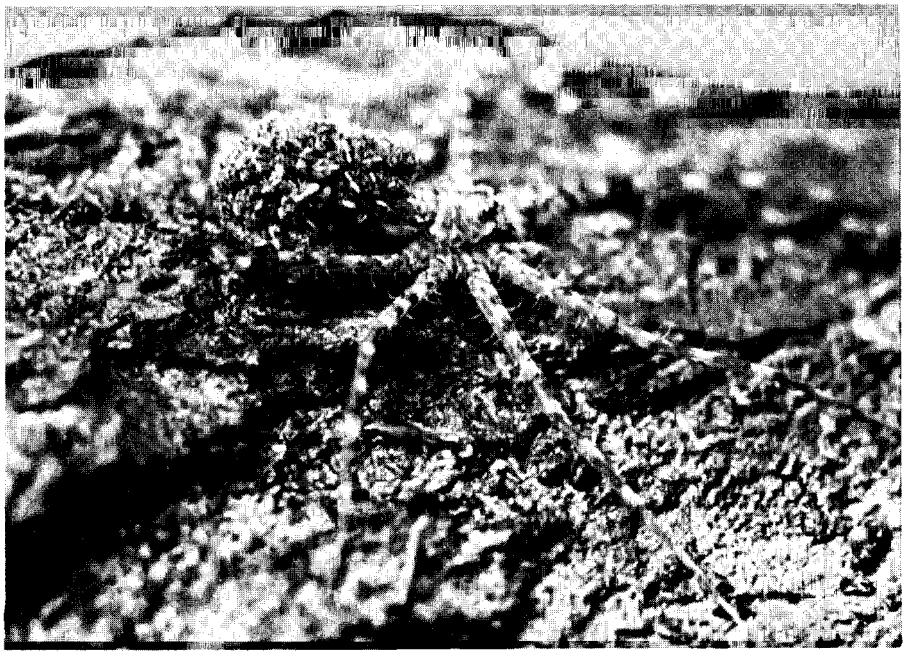


Fig. 5: Female of *Trechalea manauensis* Carico, new species, with progeny on bark of *Pseudobombax munguba* (Bombacaceae) on Ilha de Marchantaria (*várzea*) during forest inundation (photo by J. Adis).

termites, preferably workers of *Nasutitermes* spp. The spider was never observed to feed on shrimps and fish, as reported for other pisaurid species (Berkum, 1982; Carico, 1973; Gudger, 1925; Williams, 1979) but rather waits passively until a prey organism makes direct contact. The prey is quickly seized with the mouthparts and pedipalps. Non-feeding spiders usually lift the leg or body touched by the prey, thus enabling it to pass underneath. In the laboratory, *T. manauensis* did not accept dead insects as reported for *Dolomedes* species (Williams, 1979).

Parasites

The insect parasite *Mantispa gracilis* Erichson, 1839 (Mantispidae: Neuroptera), seems well adapted to the life cycle of *T. manauensis*. This mantispid is rather common in scrub pastures of southern Brazil (Penny & Costa, 1983), but is collected infrequently in the Amazon Basin. However, almost all Amazonian collections have been made in areas of seasonally inundated forests, where most spider hosts would have difficulty living.

The only three mantispids collected in the larval or pupal stage and reared from spider egg sacs were *Mantispa gracilis*. The last attempt to collect immature mantispids was in early April 1983, when 45 egg sacs were collected from female spiders on tree trunks. Of these egg sacs, 18 contained only spider eggs, 25 contained young spiders, 1 contained small hymenopteran egg parasites (Chalcidoidea) in various stages of emergence, and only one contained a mantispid pupa. This rather low level of slightly over 2% mantispid infestation is similar to that found within the same spider population in 1982. Only one mantispid larva or pupa was found in any one egg sac.

Several recent papers have helped elucidate the relationship between spiders and their mantispid parasites (MacLeod & Redborg, 1982; Redborg & MacLeod, 1983a, b; Redborg, 1982a, b). The family Mantispidae is currently divided into two subfamilies (Penny, 1982). The Platymantispinae is probably composed of generalist predators on a wide variety of sedentary arthropods (MacLeod & Redborg, 1982) while species of the Mantispinae, which includes *Mantispa gracilis*, appear to have three different development strategies. Some species of Mantispinae are obligate egg sac penetrators, such as *Mantispa viridis* Walker (Redborg & MacLeod, 1983a), while other species are facultative egg sac penetrators, or boarders of adult spiders. In the latter case, the mantispid larva waits on the body of the adult female spider until she produces the egg sac. Among the facultative adult boarders, larvae of *Mantispa uhleri* attach themselves near the pedicel or enter the book lungs where they feed on the spider's blood (Redborg, 1982a). The direct effect of feeding is to increase development time and decrease adult size, while the indirect effect is loss of an instar during development of females (Redborg, loc. cit.). A third strategy has been observed in the genus *Climaciella*, where larvae *must* board a spider and enter the egg sac at the moment of its formation. *Climaciella* larvae are unable to penetrate a mature egg sac, and when placed within one, will not feed unless previously having boarded a spider (Redborg & MacLeod, 1983a).

Insufficient larval material has been available to rear *Mantispa gracilis* and no larvae as yet have been found on adult *Trechalea manauensis*. However, it is felt that this species is probably a facultative adult boarder or egg sac penetrator because it is morphologically much closer to the *Mantispa uhleri* group of species than to either the *Mantispa viridis* group of species or *Climaciella*. Therefore it is expected that *M. gracilis* may affect to some extent the development of *Trechalea manauensis* in the Central Amazon Region.

Acknowledgements

Our special thanks are due to Vera Bogen for her assistance during field observations and laboratory experiments.

References

ADIS, J. 1981: Comparative ecological studies of the terrestrial arthropod fauna in Central Amazonian inundation-forests. *Amazoniana* 7(2): 87-173.

ADIS, J. 1984a: "Seasonal Igapó-Forests" of Central Amazonian black-water rivers and their terrestrial arthropod fauna. *In* H. Sioli (ed.), *The Amazon – Limnology and landscape ecology of a mighty tropical river and its basin. Monographiae Biologicae.* Junk, The Hague, The Netherlands, *in press.*

ADIS, J. 1984b: Adaptations of arthropods to Amazonian inundation-forests. *Proc. int. Soc. Trop. Ecol.* (VII. Symposium) Bhopal, India 1981, *in press.*

ADIS, J. & SCHUBART, H., 1984: Ecological research on arthropods in Central Amazonian forest-ecosystems, with recommendations for study procedures. *In* F. Golley (ed.), *Research opportunities in ecology in the 1980's.* NATO Conference Series: Ecology, Vol. 6. Plenum Press, New York, *in press.*

BERKUM, F. H. VAN 1982: Natural history of a tropical, shrimp-eating spider (Pisauridae). *J.Arachnol.* **10**: 117-121.

CARICO, J. E. 1973: The nearctic species of the genus *Dolomedes* (Araneae: Pisauridae). *Bull.Mus.comp. Zool.Harv.* **144**: 435-488.

ERWIN, T. L., 1983a: Tropical forest canopies: The last biotic frontier. *Bull.ent.Soc.Am.* **29**(1): 14-19.

ERWIN, T. L. 1983b: Beetles and other insects of tropical forest canopies of Manaus, Brazil, sampled by insecticidal fogging. *In* S. L. Sutton, T. C. Whitmore & A. C. Chadwick (eds.), *Tropical rain forest: ecology and management.* Blackwell, Oxford, U.K., *in press.*

FITTKAU, E. J., IRMLER, U., JUNK, W. J., REISS, F. & SCHMIDT, G. W. 1975: Productivity, biomass and population dynamics in Amazonian water bodies. *In* F. B. Golley & E. Medina (eds.), *Tropical ecological systems. Trends in terrestrial and aquatic research:* 289-311. Springer, New York, Berlin.

GUDGER, E. W. 1925: Spiders as fishermen and hunters. *Nat.Hist., N.Y.* **25**: 261-275.

IRION, G., ADIS, J., JUNK, W. J. & WUNDERLICH, F. 1983: Sedimentological studies of an island in the Amazon River. *Amazoniana* **8** (1): 7-78.

IRMLER, U. 1975: Ecological studies of the aquatic soil invertebrates in three inundation forests of Central Amazonia. *Amazoniana* **5**(3): 337-409.

IRMLER, U. 1976: Zusammensetzung, Besiedlungsdichte und Biomasse der Makrofauna des Bodens in der emersen und submersen Phase zentralamazonischer Überschwemmungswälder. *Biogeographica* **7**: 79-99.

IRMLER, U. 1977: Inundation-forest types in the vicinity of Manaus. *Biogeographica* **8**: 17-29.

IRMLER, U. 1979a: Abundance fluctuations and habitat changes of soil beetles in Central Amazonian inundation forests (Col.: Carabidae, Staphylinidae). *Stud. neotrop.Fauna & Environ.* **14**: 1-16.

IRMLER, U. 1979b: Considerations on structure and function of the "Central-Amazonian Inundation Forest Ecosystem" with particular emphasis on selected soil animals. *Oecologia (Berl.)* **43**: 1-18.

JUNK, W. J., SOARES, G. M. & CARVALHO, F M., 1983: Distribution of fish species in a lake of the Amazon river floodplain near Manaus (Lago Camaleão), with special reference to extreme oxygen conditions. *Amazoniana* **7**(4): 397-431.

MACLEOD, E. G. & REDBORG, K. E. 1982: Larval platymantispine mantispids (Neuroptera: Planispennia): possibly a subfamily of generalist predators. *Neuroptera International* **2**(1): 37-41.

PENNY, N. D. 1982: Review of the generic level classification of New World Mantispidae (Neuroptera). *Acta Amazonica* **12**(1): 209-233.

PENNY, N. D. & DA COSTA, C. 1983: Os Mantispídeous do Brasil. *Acta Amazonica, in press.*

PRANCE, G. T. 1979: Notes on the vegetation of Amazonia. III. The terminology of Amazonian forest types subject to inundation. *Brittonia* **31**(1): 26-38.

REDBORG, K. E. 1982a: Interference by the mantispid *Mantispa uhleri* with the development of the spider *Lycosa rabida. Ecol.Entomol.* **7**: 187-196.

REDBORG, K. E. 1982b: Mantispidae (Insecta: Neuroptera) parasitic on spider egg sacs: an update of a pioneering paper by B. J. Kaston. *J.Arachnol.* **10**: 92-93.

REDBORG, K. E. & MACLEOD, E. G. 1983a: *Climaciella brunnea* (Neuroptera: Mantispidae): a mantispid that obligately boards spiders. *J.nat.Hist.* **17**: 63-73.

REDBORG, K. E. & MACLEOD, E. G. 1983b: The developmental ecology of *Mantispa uhleri* Banks (Neuroptera: Mantispidae). III. *Ecol.Monogr.* **53**: *in press.*

SANTOS, G. M. 1980: Aspectos de sistemática e morfologia de *Schizodon fasciatus* Agassiz, 1829; *Rhytiodus microlepis* Kner, 1859 & *R. argenteo fuscus* Kner, 1859 (Osteichthyes, Characoidei, Anostomidae) do lago Janauacá, AM. *Acta Amazonica* **10**(3): 635-649.

SIOLI, H. 1956: Über Natur und Mensch im brasilianischen Amazonasgebiet. *Erdkunde* **10**(2): 89-109.

SIOLI, H. 1983: *Amazonien. Grundlagen der Ökologie des grössten tropischen Waldlandes.* Paperback der Zeitschrift Naturwissenschaftliche Rundschau: 1-64. Wissenschaftliche Verlagsgesellschaft, Stuttgart.

WILLIAMS, D. S. 1979: The feeding behaviour of New Zealand *Dolomedes* species (Araneae: Pisauridae). *N.Z. J.Zool.* **6**: 95-105.

WORBES, M. 1983: Vegetationskundliche Untersuchungen zweier Überschwemmungswälder in Zentralamazonien – vorläufige Ergebnisse. *Amazoniana* **8**(1): 47-65.