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On the natural history and ecology of Pseudoscorpiones (Arachnida) from an Amazonian blackwater inundation forest*

by

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Abstract

The habitats and changes in habitat of 20 pseudoscorpion species in response to up to six months forest inundation are presented. The fauna is divided into 16 nonmigrating and 4 migrating species (2 terricolous and 2 arboricolous species). Adaptations of life-cycle to forest flooding and seasonal tree trunk migration are discussed for *Tyrannochthonius amazonicus, T. migrans* (Chthoniidae), *Brazilatemnus browni* (Miratemnidae) and *Pachyolpium irmgardae* (Olpiidae) based on data from trunk traps (arboreal photo-eclectors), emergence traps on the forest floor (ground photo-eclectors), soil extraction (KEMPSON method), canopy fogging (pyrethrum method) and the collection of epiphytes.

Keywords: **Pseudoscorpiones, soil fauna, inundation forests, Neotropics, Brazil.**

Resumo

Os habitats e mudanças de habitat de 20 espécies de Pseudoscorpiones são apresentados em relação à até seis meses de inundação de floresta. A fauna é dividida em 16 espécies não-migrantes e 4 espécies migrantes, sendo 2 terricolas e 2 arborícolas. Para *Tyrannochthonius amazonicus, T. migrans* (Chthoniidae), *Brazilatemnus browni* (Miratemnidae) e *Pachyolpium irmgardae* (Olpiidae) são discutidas as adaptações de ciclo de vida à inundação de floresta e migração sazonal nos troncos de árvores, baseadas em dados de armadilhas de tronco (foto-eclectores de árvore), armadilhas de emergência no chão da floresta (foto-eclectores de solo), extração de solo (método de KEMPSON), nebulização de copa de árvores (método do piretro) e a coleção de epífitas.

* This study is dedicated to Prof. Dr. Harald Sioli to commemorate his 75th birthday.

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1. Introduction

Rivers in the Central Amazon show annual water-level fluctuations which may be as much as 14 m between high and low water (Rio Negro at Manaus). Consequently vast riparian forest areas representing about 2 % of the Brazilian Amazon region, are flooded for several months of the year. A periodically inundated forest, flooded by regular annual cycles of blackwater rivers is termed seasonal igapó (PRANCE 1979). In 1976 - 77 arthropod reaction to inundation was studied as part of a "minimal program for ecosystem analyses" in the Manaus area (ADIS 1981). Activity density ("Aktivitätsdichte"; SCHWERDTFEGER 1975) of arthropods on the forest floor was detected using ground photo-eclectors and pitfall traps. Arboreal photo-eclectors, mounted on tree trunks, monitored trunk ascent and descent by arthropods. The non-flying and limited-flying arthropod faunas of the seasonal igapó were classified into terricolous and arboricolous groups. They consisted of a) nonmigrants, which chiefly remained either in the trunk and canopy region, or on the forest floor and survived forest inundation; b) migrants, which either moved onto tree trunks and into the canopy before flooding and/or descended to the forest floor during the non-inundation period (ADIS 1981; ADIS & SCHELLER 1984; SCHELLER & ADIS 1984).

Eighteen species of Pseudoscorpiones were reported from the seasonal igapó under study (ADIS 1981; MAHNERT 1979). Out of these, eleven species were considered bark inhabitants of tree trunks, representing the arboricolous nonmigrating group. Six species were considered litter inhabitants, representing the terricolous migrating group which survived the 5 - 6 month inundation period in the trunk/canopy area. However catches from ground photo-eclectors and forest floor pitfall traps did not contain the earliest developmental stages (proto- and deutonymphs). Thus, the life cycle of terricolous Pseudoscorpiones, based chiefly on trunk captures, remained to be confirmed. For this reason, pseudoscorpion distribution in the soil of the seasonal igapó was investigated in 1981 - 1982 at the same study site as that used in 1976 - 1977. Furthermore, occurrence of Pseudoscorpiones in tree crowns was studied by canopy-fogging and the collection of epiphytes (cf. MAHNERT 1985a).

2. Study area and methods

The study site was situated on the lower course of the Rio Tarumã Mirím (03°02'S, 60°17'W), a tributary of the Rio Negro, about 20 km upstream of Manaus. The seasonal igapó possessed buttressed trees up to 35 m high with an almost closed canopy, colonized by numerous epiphytes but had few herbs and no shrubs. Forty-seven tree species at densities between 1,300 and 2,000 trees/ha were recorded in the study area. Ten species had trunk circumferences of $\geqslant$ 100 cm of which *Aldina latifolia* BENTH var. *latifolia* (Leguminosae) was dominant. The clayish-sandy soil was covered by a 5 - 10 cm thick fine humus layer which was penetrated by a matting of roots. A detailed description and characterization of the study area, as well as information on the classification of inundation forest types, is given by ADIS (1981, 1984), IRION & ADIS (1979), IRMLER (1975, 1977) and PRANCE (1979). The igapó under study was submerged under floodwater, up to 3.35 m from March/April to August/September. It was subject to a rainy season (December-May) and a dry season (June - November; RIBEIRO & ADIS 1984). Distribution of Pseudoscorpiones in the soil was studied between September 1981 and February 1982 (non-inundation period). Once a month six 14 cm deep soil samples were taken at random intervals along

a transect using a split corer (= steel cylinder with lateral hinges; diameter 21 cm) driven into the soil by a mallet, and then divided into four subsamples of 3.5 cm each. Animals were extracted from subsamples following the method of KEMPSON et al. (1963). Pseudoscorpiones were collected from tree crowns by fogging canopies with pyrethrum in the early dry season (July 1977, 1979), when the seasonal igapó was completely flooded (ADIS et al. 1984; ERWIN 1983). In addition Pseudoscorpiones were sampled from bromeliads (*Aechmea setigera* MART. ex SCHULT. F., *Streptocalyx poeppigii* BEER) 5 - 25 m above ground in June 1981 and August 1979 (early dry season, igapó flooded) as well as in October 1980 (dry season, igapó not flooded). – All Pseudoscorpiones collected were classified as juveniles (protonymphs, deutonymphs, tritonymphs) or adults (males and females).

Species are listed in alphabetical order by families. The taxonimic work for this paper was done by V. Mahnert, the collection and evaluation of field data by J. Adis.

3. Results and Discussion

A total of 696 Pseudoscorpiones were extracted from soil samples. The majority (89 % of the total catch) were juveniles: 177 protonymphs (25 %), 193 deutonymphs (28 %) and 250 tritonymphs (36 %). There was a 1 : 2 sex ratio of adult males and females. About 83 % of all specimens were caught between 0 - 7 cm depth, irrespective of their developmental stage. The highest population density, of 1,020 ind. m^{-2}, was recorded in January 1982 (0 - 14 cm depth) and the lowest, of 183 ind. m^{-2}, in September 1981, the first month of the non-inundation period. Three species were collected from seasonal igapó soils: *Tyrannochthonius amazonicus* MAHNERT, *T. migrans* MAHNERT and *Brazilatemnus browni* MUCHMORE. Eleven species were obtained from epiphytes and during canopy-fogging (Table 1).

Catch data, together with previous capture data from pitfall traps, ground and arboreal photo-eclectors (ADIS 1981) and various standing crop samples, provided conclusive information on the life cycle, habitat and ecology of pseudoscorpion species from the seasonal igapó.

Table 1: Pseudoscorpiones obtained with canopy-fogging and from epiphytes on trees at Rio Tarumã Mirím. P = protonymphs, D = deutonymphs, T = tritonymphs, M = males, W = females (for further explanation, see text).

family	species	canopy-fogging	epiphytes
Chernetidae	*Americhernes incertus* MAHNERT	W	–
	Ceriochernes amazonicus MAHNERT	–	P,D,T,M,W
	Lustrochernes intermedius (BALZAN)	W	–
	Pachychernes baileyi FEIO	M	D
Chthoniidae	*Tyrannochthonius amazonicus* MAHNERT	T	–
Garypidae	*Geogarypus amazonicus* MAHNERT	T,M,W	T,M,W
Miratemnidae	*Brazilatemnus browni* MUCHMORE	T	–
Olpiidae	*Pachyolpium irmgardae* MAHNERT	P,D,M,W	D,T,M,W
Withiidae	*Dolichowithius intermedius* MAHNERT	M,W	–
	Dolichowithius mediofasciatus MAHNERT	M	–
	Parawithius gracilimanus MAHNERT	–	D,T,M,W

3.1. Migrating Pseudoscorpiones

Chthoniidae: *Tyrannochthonius amazonicus* MAHNERT

T. amazonicus is considered an endemic nocturnal species of the seasonal igapó. Tritonymphs representing "migratory stages" which have survived forest inundation in the trunk/(canopy) region under loose bark (Fig. 1, BE↓), recolonized the forest floor at the beginning of the non-inundation period (September). There they moulted to adults (Fig. 2), reproduced, and the parent generation died (October - January). Few tritonymphs had moulted to adults and subsequently reproduced in the trunk region (i. e. the previous April - August). Trunk descending proto- and deutonymphs were only caught sporadically at the end of the inundation period (Fig. 1, BE↓). Protonymphs were found from October onwards in the soil (Fig. 2). It is presumed that the proto- and deutonymph instars only lasted a short time, like European species (GABBUTT 1967, 1969, 1970). Although both nymphal stages were free living they were relatively inactive, and thus were not caught in pitfall traps (Fig. 1, BoF) and only occasionally in ground photo-eclectors (Fig. 1, E).

New generation tritonymphs presumably occurred from November onwards (Fig. 2). *T. amazonicus* was usually recovered from the upper humus layer with 58 % of all juveniles and adults being caught between 0 - 3,5 cm depth (Fig. 3). Highest population figures were obtained in January, with 655 ind. m^{-2} for juveniles and adults, and 279 ind. m^{-2} for tritonymphs (0 - 14 cm depth). The highest values for protonymphs were recorded in October (226 ind. m^{-2}) and January (168 ind. m^{-2}; Fig. 2). Of all the juvenile stages collected during the non-inundation period, tritonymphs occurred at the highest abundance (Fig. 4). The low number of adults collected suggests that life expectancy is short for both, males and females. The earlier statement (ADIS 1981) that occasional capture of *T. amazonicus* females was due to their production of a brood chamber before laying eggs could not be confirmed. Throughout the dry season, *T. amazonicus* was scarcely ever detected on the soil surface (Fig. 1, E) except for the occasional pitfall capture (Fig. 1, BoF) but with the beginning of the rainy season (in December), tritonymph activity density increased on the forest floor. Numerous animals migrated into the trunk region (Fig. 1, BE↑) and were particularly frequent in arboreal photo-eclectors two to six weeks before forest inundation. Trunk ascents were stimulated by rising wetness on the forest floor and increasing relative humidity in the lower trunk region (cf. Fig. 14 in ADIS 1981). The deutonymphs and adults remaining in the soil (February/March) were forced into the trunk area by inundation of the forest (Fig. 1, BE↑). It is not known whether *T. amazonicus* migrates to the upper crown region. Only one tritonymph was obtained by canopy-fogging during inundation, but this was probably due to the sampling method used (cf. ADIS et al. 1984). No specimens were collected from epiphytes or during standing crop sampling at various heights on tree trunks. During the inundation period (April - August) numbers of tritonymphs were certainly reduced by predatory arthropods in the trunk region. The number of animals caught during descents (Fig. 1, BE↓) was remarkably lower than the trunk ascent number (Fig. 1, BE↑), although some animals may have surmounted the capturing devices, as seen in the "trunk descents" between January and April, 1977 (cf. ADIS & SCHELLER 1984).

Fig.1

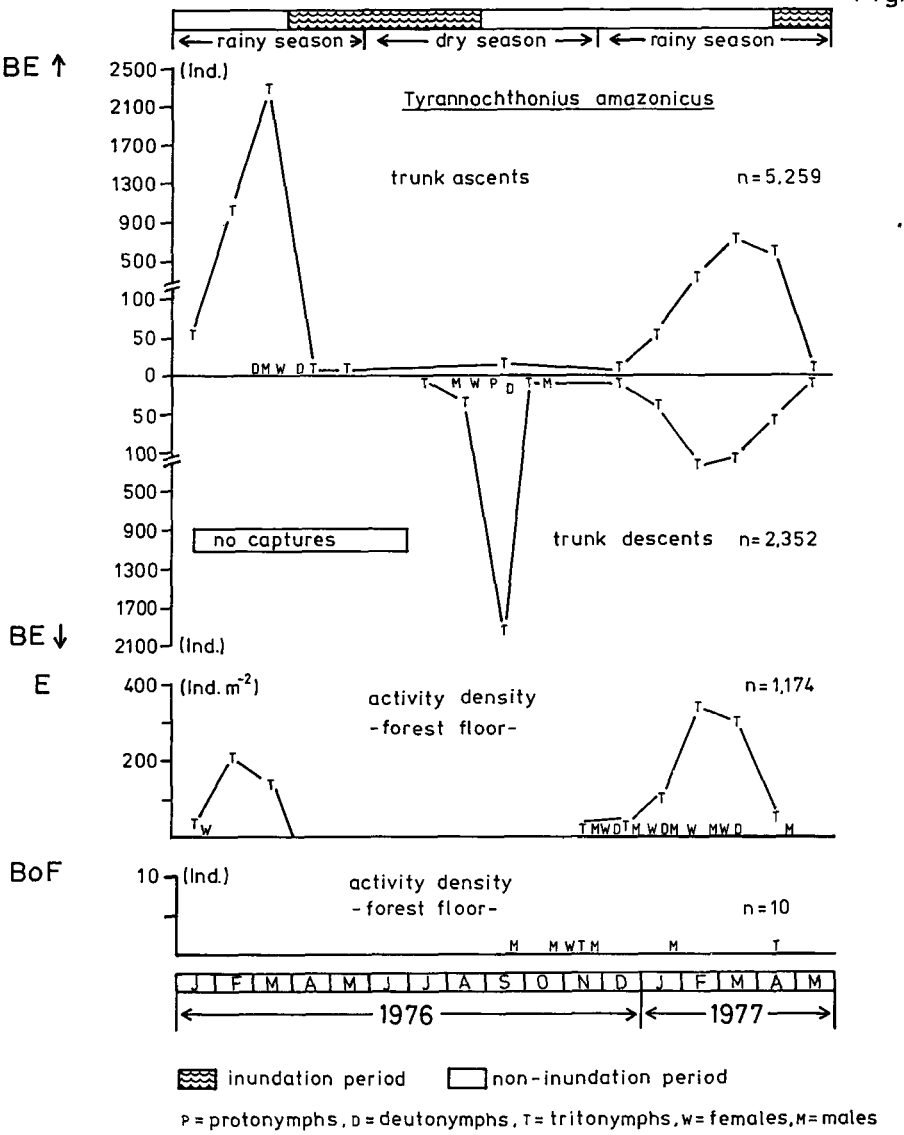


Fig. 1:
Activity density of *Tyrannochthonius amazonicus* (Chthoniidae) on the forest floor (1 - 5 ground photo-eclectors (E; Ind. m^{-2}), 2 pitfall traps (BoF), trunk ascents and trunk descents (3 arboreal photo-eclectors respectively (BE↑, BE↓)) between January 1976 and May 1977 at Rio Tarumã Mirím. (Data from ADIS 1981, modified).

Fig. 2

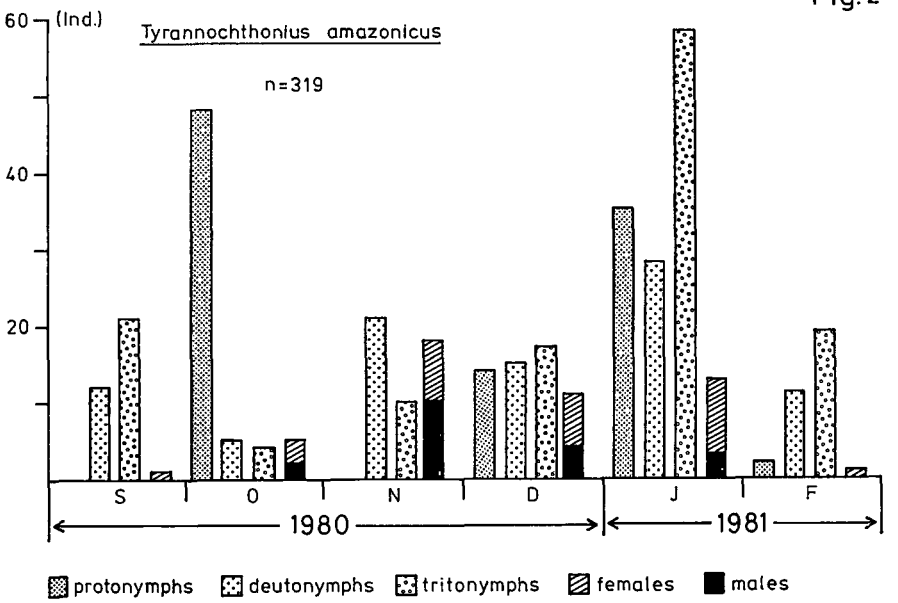


Fig. 3

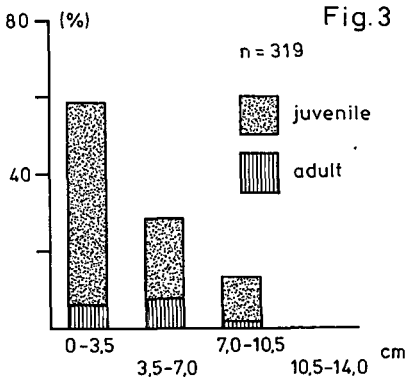
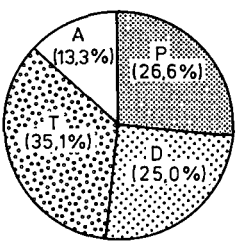


Fig. 4



P=protonymphs, D=deutonymphs
T=tritonymphs, A=adults

Figs. 2 - 4:
2: Temporal occurrence of developmental stages of *Tyrannochthonius amazonicus* (Chthoniidae) in the soil (0 - 14 cm depth). Monthly samples taken during the non-inundation period (September 1981 - February 1982) at Rio Tarumã Mirím.
3: Distribution of *Tyrannochthonius amazonicus* (Chthoniidae) in the soil (%). Samples taken every 3.5 cm to a depth of 14 cm between September 1981 and February 1982 (non-inundation period) at Rio Tarumã Mirím; total catch = 100 %.
4: Percentage of developmental stages of *Tyrannochthonius amazonicus* (Chthoniidae) caught in the soil (0 - 14 cm depth) between September 1981 and February 1982 (non-inundation period) at Rio Tarumã Mirím; total catch = 100 %.

T. amazonicus is considered univoltine. Reproduction occurred on the forest floor and was well synchronized with the non-inundation period. In the soil development from egg to tritonymph took a maximum of four months. The species is a representative of the terricolous migrating arthropod group (ADIS 1981) adapted to annual flooding.

Chthoniidae: *Tyrannochthonius migrans* MAHNERT

T. migrans is the second nocturnal species considered endemic to the seasonal igapó. As in the closely related *T. amazonicus*, migratory tritonymphs survived forest inundation (April - August) in the trunk/(canopy) region. As the water receded they recolonized the forest floor for moulting and subsequent reproduction (Fig. 5, BE↓). However it remains to be shown whether tritonymphs and/or adults have a period of aestivation in the soil throughout the dry season before this (September - November). The progeny (= protonymphs) were only observed from December onwards, the beginning of the rainy season (Fig. 6). In contrast to *T. amazonicus, T. migrans* inhabited the lower humus layer. Eighty-four % of all juveniles and adults were caught between 3.5 - 10.5 cm depth (Fig. 7). Population density of *T. migrans* in the soil was only half that of *T. amazonicus*. Highest numbers were observed in December, 284 ind. m^{-2} for juveniles and adults, 96 ind. m^{-2} for protonymphs and 91 ind. m^{-2} for tritonymphs (0 - 14 cm depth; Fig. 6). No difference was found between the total numbers of specimens caught per nymphal stage during the non-inundation period (Fig. 8). Protonymph to tritonymph development was faster in *T. migrans* than in *T. amazonicus* (Figs. 2, 6), probably being concluded within 4 weeks. Highest tritonymph activity density in ground photo-eclectors was recorded in February, one month earlier than for *T. amazonicus* (Figs. 1, E; 5, E).

As in *T. amazonicus*, the number of tritonymphs in the trunk region was considerably reduced by predatory arthropods during forest inundation. No specimens of *T. migrans* were collected in the upper tree crown with canopy-fogging, from epiphytes or during standing crop sampling. Reproduction occurred on the forest floor, *T. migrans* thus belongs to the terricolous migrating arthropod group (ADIS 1981).

Closely related to *T. amazonicus*, the univoltine *T. migrans* is separated from its potential competitor by spatial, temporal and onthogenetic differences (cf. WOOD & GABBUTT 1978).

Miratemnidae: *Brazilatemnus browni* MUCHMORE

B. browni is a frequent nocturnal species in the Amazon region, inhabiting dryland forests, seasonal igapó forests and blackwater swamp forests, which have permanently waterlogged ground (MAHNERT 1979; MUCHMORE 1975). In primary and secondary dryland forests near Manaus, *B. browni* was only found in the soil and never caught on tree trunks or in the canopy. There was no distinct reproduction period and protonymphs were found throughout the year (ADIS et al. 1985; ADIS & SCHUBART 1985). In the seasonal igapó, *B. browni* had two reproductive periods: a major one in the trunk/(canopy) region during forest inundation (April - August) and a second, minor one, on the forest floor during the non-inundation period. About three times as many animals, predominantly tritonymphs, were caught during trunk descents (Fig. 9, BE↓) as compared to trunk ascents (Fig. 9, BE↑). After recolonizing the forest floor, tritonymphs moulted and reproduced

(Fig. 10). Only a few animals, exclusively adults, were caught within the first two months of the dry season (i. e. September/October). As in *T. migrans* the cause has yet to be determined. First free-living protonymphs of the new generation were recorded in November and first tritonymphs in January (Fig. 10). Brood or moulting chambers (GABBUTT & VACHON 1967; WOOD & GABBUTT 1979a, b) were not observed. Eighty-six % of juveniles and adults were extracted from soil samples during the rainy season (December - February). Their population density was highest in December with 390 ind. m^{-2} (0 - 14 cm depth).

The highest number of tritonymphs was recorded in January with 241 ind. m^{-2} (Fig. 10). *B. browni* was mostly recovered from the lower humus layer with 77 % of all specimens caught between 3.5 - 10.5 cm depth (Fig. 11). More tritonymphs were collected during the non-inundation period than proto- and deutonymphs (Fig. 12). Abundance of adults was low and we assume that the parent generation had died by the beginning of the inundation period (March/April). *B. browni* was scarcely detected on the soil surface. Few animals were caught in ground photo-eclectors shortly before forest inundation (Fig. 9, E) and none in pitfall traps. In contrast to *T. amazonicus* and *T. migrans* in which trunk ascents were initiated at the beginning of the rainy season (December), *B. browni* only commenced migration a short time before the forest floor was inundated (Fig. 9, BE↑). In 1976 the highest capture rates in arboreal photo-eclectors were recorded one week before forest inundation. The high wetness and relative humidity on the forest floor, caused by rising waters, apparently forced all developmental stages into the trunk area (Fig. 9, BE↑; cf. Fig. 14 in ADIS 1981). Some animals must have moved up the trunk with rising water-level, as specimens were caught until June, when flooding had reached its maximum (Fig. 9, BE↑). We presume that tritonymphs moulted to adults in the trunk area where the main reproductive period occurred in April/May. Tritonymphs of the new generation were captured during trunk descents, together with some remaining proto- and deutonymphs, from early July onwards, i. e. six weeks before the start of the non-inundation period (Fig. 9, BE↓). Heavy leaf-fall combined with strong insolation in July/August (ADIS et al. 1979) may have initiated early trunk migration. *B. browni* was not found in epiphytes. Tritonymphs were obtained in low numbers with canopy fogging during forest inundation (in July).

B. browni is considered bivoltine. Originating from adjacent dryland forest soils, this species seems to have colonized and adapted to the seasonal igapó secondarily. Protonymph to tritonymph development lasted a maximum of three months and was so synchronized with water-level fluctuations that migrating tritonymphs stages were attained near the beginning and the end of the non-inundation period. Main reproduction occurred in the trunk region during forest inundation. *B. browni* thus represents the arboricolous migrating arthropod group (ADIS 1981). The species is separated from *T. amazonicus* and *T. migrans* by spatial, temporal and onthogenetic differences (cf. WOOD & GABBUTT 1978).

Fig. 5

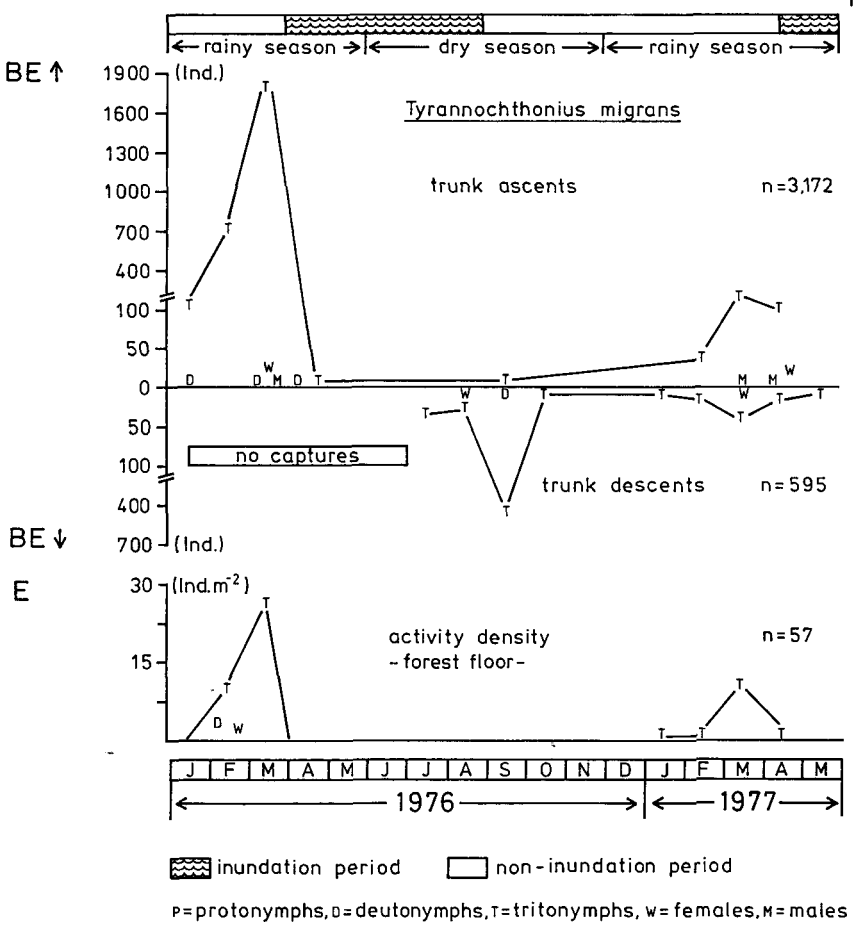


Fig. 5:
Activity density of *Tyrannochthonius migrans* (Chthoniidae) on the forest floor (1 - 5 ground photo-eclectors (E; Ind. m^{-2})), trunk ascents and trunk descents (3 arboreal photo-eclectors respectively (BE↑, BE↓)) between January 1976 and May 1977 at Rio Tarumã Mirím.
(Data from ADIS 1981, modified).

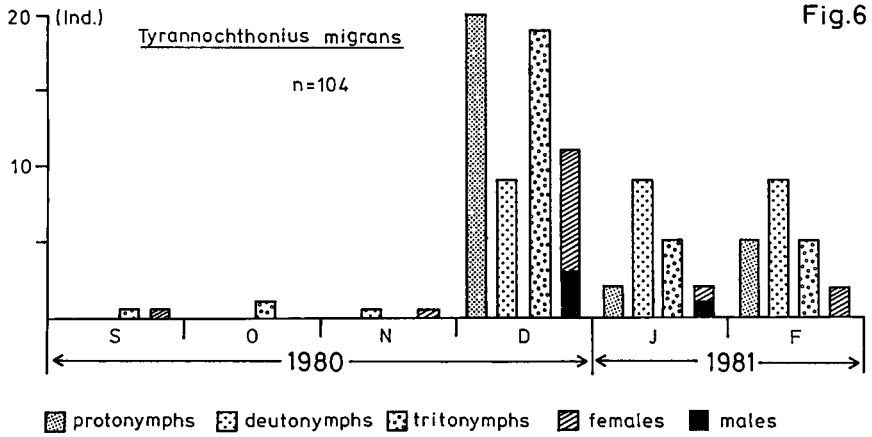


Fig.6

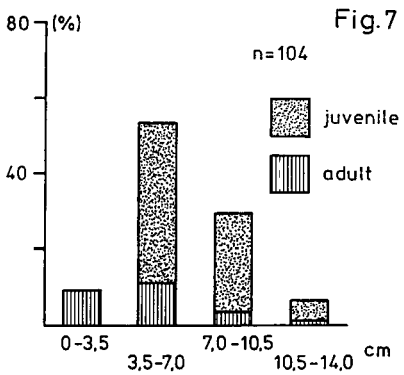


Fig.7

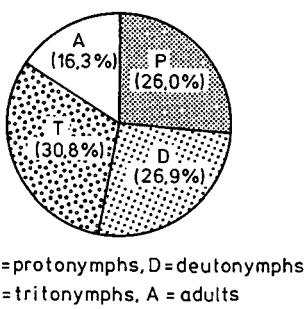


Fig.8

Figs. 6 - 8:
6: Temporal occurrence of developmental stages of *Tyrannochthonius migrans* (Chthoniidae) in the soil (0 - 14 cm depth). Monthly samples taken during the non-inundation period (September 1981 - February 1982) at Rio Tarumã Mirím.
7: Distribution of *Tyrannochthonius migrans* (Chthoniidae) in the soil (%). Samples taken every 3.5 cm to a depth of 14 cm between September 1981 and February 1982 (non-inundation period) at Rio Tarumã Mirím; total catch = 100 %.
8: Percentage of developmental stages of *Tyrannochthonius migrans* (Chthoniidae) caught in the soil (0 - 14 cm depth) between September 1981 and February 1982 (non-inundation period) at Rio Tarumã Mirím; total catch = 100 %.

Fig. 9

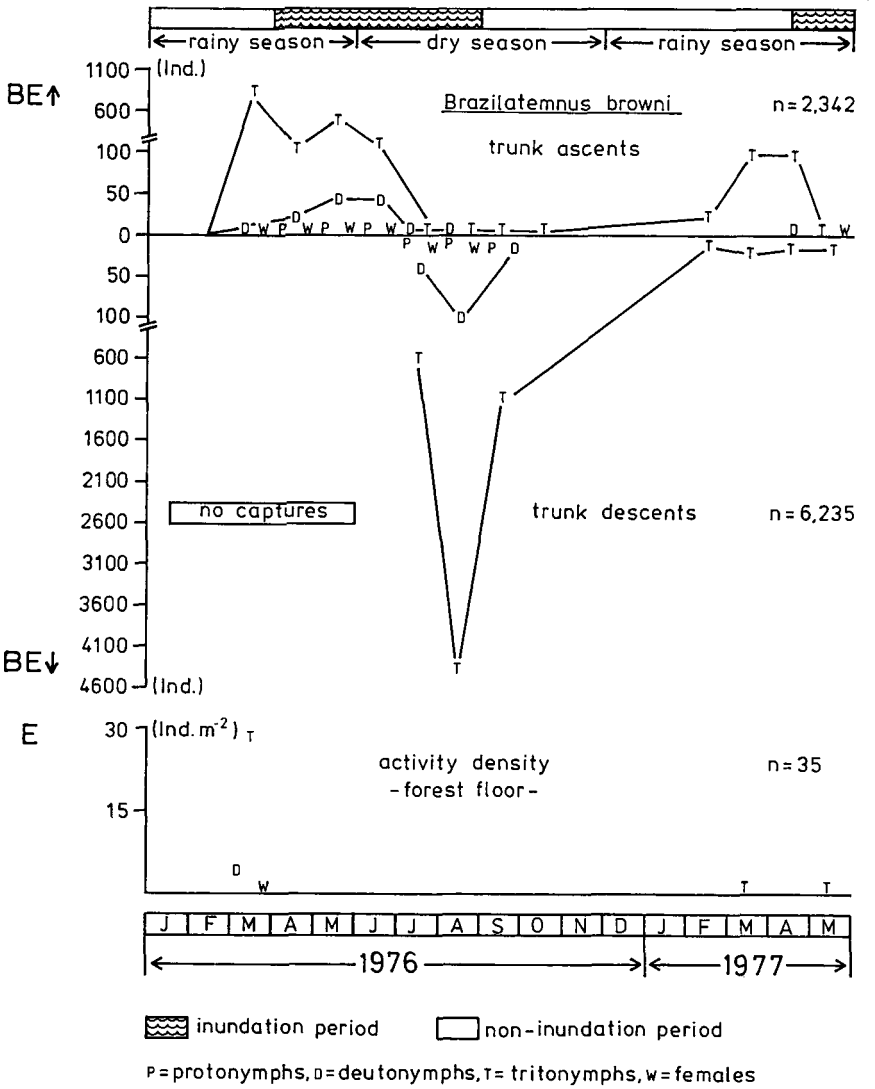
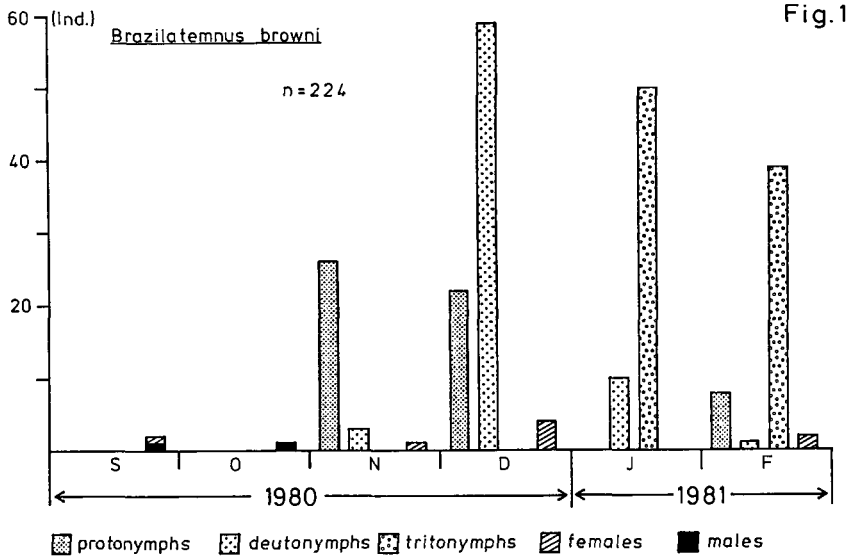
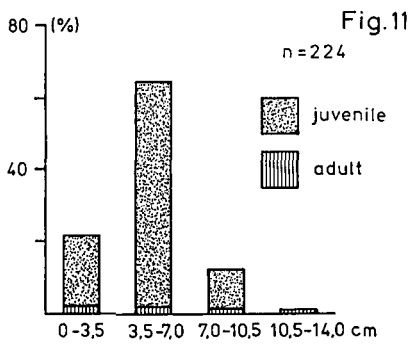
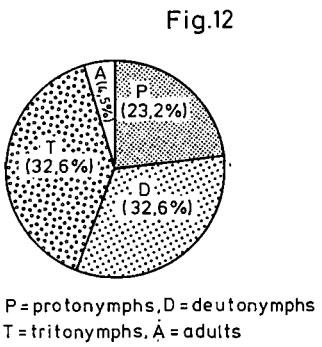


Fig. 9:
Activity density of *Brazilatemnus browni* (Miratemnidae) on the forest floor (1 - 5 ground photo-eclectors (E; Ind. m^{-2})), trunk ascents and trunk descents (3 arboreal photo-eclectors respectively (BE↑, BE↓)) between January 1976 and May 1977 at Rio Tarumã Mirím.
(Data from ADIS 1981, modified).







Figs. 10 - 12:
10: Temporal occurrence of developmental stages of *Brazilatemnus browni* (Miratemnidae) in the soil (0 - 14 cm depth). Monthly samples taken during the non-inundation period (September 1981 - February 1982) at Rio Tarumã Mirím.
11: Distribution of *Brazilatemnus browni* (Miratemnidae) in the soil (%). Samples taken every 3.5 cm to a depth of 14 cm between September 1981 and February 1982 (non-inundation period) at Rio Tarumã Mirím; total catch = 100 %.
12: Percentage of developmental stages of *Brazilatemnus browni* (Miratemnidae) caught in the soil (0 - 14 cm depth) between September 1981 and February 1982 (non-inundation period) at Rio Tarumã Mirím; total catch = 100 %.

Olpiidae: *Pachyolpium irmgardae* MAHNERT

P. irmgardae was caught in low numbers and neither a distinct reproduction period nor a specific habitat were observed. Developmental stages occurred throughout the year on tree trunks, in epiphytes up to 25 m above ground, as well as on the forest floor during the non-inundation period. *P. irmgardae* was also obtained by canopy-fogging (Table 1) but not by soil extraction. It was observed that nymphs built moulting chambers and females constructed brood chambers (Fig. 13; cf. GABBUTT & VACHON 1967; WOOD & GABBUTT 1979a, b). It is possible that these chambers were formed at the beginning of the soil extraction process in the laboratory and animals died in the samples due to worsening abiotic conditions. During the rainy season of the non-inundation period (December - March) all instars, and both sexes, moved from the soil into the trunk area (cf. Fig. 18 in ADIS 1981). They returned to the forest floor at the end of the inundation period (August/September). In all, rather more specimens were caught during trunk descents than trunk ascents (Table 9 in ADIS 1981). Therefore at present, *P. irmgardae* is considered a representative of the arboricolous migrating arthropod group (ADIS 1981). Further studies are needed to show if this species originated in the seasonal igapó and colonized dryland forests secondarily. Until now, *P. irmgardae* has occasionally been found in the soil and on trunks of secondary dryland forests, but as yet not in primary forests (ADIS unpubl.; MAHNERT 1979; MORAIS 1985; RODRIGUES 1985).

Fig. 13:
Pachyolpium irmgardae (Olpiidae) female in a brood chamber collected under loose bark of *Aldina latifolia* (Leg.) with protonymphs prior to hatching from eggs. (The brood chamber was placed in alcohol to clear its normally non-transparent silk cover for photography).

3.2. Nonmigrating Pseudoscorpiones

Sixteen species which are believed to live under loose bark on trunks and/or in epiphytes of trees were collected in the seasonal igapó. Some of them occurred occasionally on the soil surface during the rainy season and were caught in ground photo-eclectors (ADIS 1981). In many cases, they may have been washed down the tree trunks by heavy rains. Most species were caught in low numbers and only preliminary statements on their natural history and ecology are possible at this stage.

Atemnidae: *Paratemnus minor* (BALZAN)

This species was collected under loose bark of trunks to a height of 20 m, in arboreal photo-eclectors (ADIS 1981), but not in epiphytes. Nymphal instars occurred throughout the year and constructed moulting chambers. Females with eggs were found in brood chambers in October and March. One female was recorded in ground photo-eclectors (in December).

Chernetidae: *Americhernes bethaniae* MAHNERT/*A. incertus* MAHNERT

All developmental stages of both species were caught in arboreal photo-eclectors. Somewhat higher capture rates were recorded for *A. bethaniae* during the dry season (cf. Table 8 in ADIS 1981). Females of *A. incertus* were also obtained by canopy-fogging and one male was recorded in ground photo-eclectors (in September).

Chernetidae: *Ceriochernes amazonicus* MAHNERT

This species was only found in epiphytes between 13 - 19 m above ground. All developmental stages were present (Table 1).

Chernetidae: *Lustrochernes intermedius* (BALZAN)

Only one female was obtained during canopy-fogging in July 1979 (cf. MAHNERT 1985b).

Chernetidae: *Pachychernes baileyi* FEIO

All developmental stages were caught throughout the year in arboreal photo-eclectors (ADIS 1981). The species was also collected by canopy-fogging, from epiphytes at a height of 13 m (Table 1) and under loose bark of *Aldina latifolia* (Leg.) up to 20 m above ground. There was no evidence that brood and moulting chambers are constructed. Higher capture rates were recorded during the dry season.

Chernetidae: *Parachernes meinertii* (WITH)/*P. melanopygus* BEIER/*P. plumosus* (WITH)/*P. setiger* MAHNERT

These four species occurred in very low numbers in arboreal photo-eclectors (ADIS 1981). Of *P. meinertii* and *P. setiger* only adult instars were caught while deuto- and tritonymphs of *P. plumosus* were also collected. Protonymphs and a female with eggs of *P. melanopygus* were found under loose bark 7 - 10 m above ground on *Aldina latifolia* (Leg.) trunks during forest inundation (in July).

Garypidae: *Geogarypus amazonicus* MAHNERT

G. amazonicus was initially considered a terricolous migrating species (ADIS 1981). Its absence on the forest floor indicates, however, that the species belongs to the arboricolous nonmigrating group. *G. amazonicus* was caught throughout the year in arboreal photo-eclectors. Higher capture rates were recorded during the dry season. Protonymphs occurred between July and March. Tritonymphs and adults were also found in epiphytes in 13 - 25 m height (June, August, October).

Tridenchthoniidae: *Tridenchthonius brasiliensis* MAHNERT

Only one female was caught in an arboreal photo-eclector (ADIS 1981).

Withiidae: *Dolichowithius intermedius* MAHNERT/*D. mediofasciatus* MAHNERT/ *D. minutus* MAHNERT

These three species occurred in low numbers in arboreal photo-eclectors (ADIS 1981). *D. intermedius* and *D. mediofasciatus* were also obtained with canopy fogging (Table 1). All developmental stages were caught only in *D. mediofasciatus*. Its protonymphs were observed between September and December and the species occurred somewhat more frequently in the lower trunk region during the dry season.

Withiidae: *Parawithius* (*Victorwithius*) *gracilimanus* MAHNERT

Low numbers of protonymphs, deutonymphs and adults of this species were caught during the dry season in arboreal photo-eclectors (ADIS 1981).

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