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**Abstract**

Psocoptera captured in emergence traps, light traps and a Malaise trap at the Reserva Ducke in 1977-78 are enumerated and discussed. Eighty-four species were trapped, mainly in small numbers, and the few common species were present throughout the trapping period. Fewer species were caught in emergence traps than in other trap types. Distribution of Brazilian psocids is briefly discussed.

**INTRODUCTION**

The diversity and ecology of Psocoptera, a group of small insects which feed predominantly on microepiphytes and organic debris on plant surfaces, has been little studied in the tropics. In Brazil, although many Psocoptera have been described from the country, the only substantial biological data are derived from a seven month study of a small area of the Mato Grosso (New, 1973a). The Reserva Ducke samples which form the subject of this account are the first to provide more than sporadic data from an Amazonian rain-forest. They were taken over a longer period than the Mato Grosso samples, and give a framework for attempting to indicate psocid diversity and habitat limitation near Manaus.

The traps and the trapping regime are described in Penny & Arias (1982). The three trapping methods (here designated 'emergence traps', 'light traps' and 'Malaise trap') are inherently likely to capture rather different sorts of psocids and, as it is commonly assumed that many psocids do not take to flight readily, it is likely that beating vegetation would

yield many additional species or, at least, a different relative abundance of species. However, psocids are commonly captured in suction traps in temperate regions and some are known to be attracted to light. Wolda (1977) has indicated that light traps may be used only with severe limitations to indicate the evenness component of tropical homopteran diversity, and similar strictures apply for interpretation of catches of Psocoptera. Wide fluctuations between successive trap catches may be expected as a result of daily climatic fluctuations, and a sampling programme with only one sample a week (or similar interval) may thus reflect many such short-term climatic variation rather than phenological change. Such catches must be interpreted with considerable caution. Similar restrictions apply to Malaise traps. Emergence trap catches may not be influenced by as many external factors, but psocid activity may be affected by, for example, soil waterlogging and dispersion of substrate litter.

With these reservations, a simplistic appraisal of the trap catches may be made. The taxonomy of the collection is treated in part by New (1979, 1980).

**RESULTS AND DISCUSSION**

1760 psocids, representing 84 species, were collected. Few species were common, and many were represented only by single individuals. Emergence traps yielded fewer species and individuals than the other trap types (Table 1). Table 2 indicates that there was low species evenness between emergence traps and either other

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TABLE 1. Total numbers of Psocoptera collected in three trap types, Reserva Ducke, September 1977 -- September 1978.

Trap	No. individuals (N)	No. species (S)	N/S
Emergence	371	13	28.5
Light	662	56	11.8
Malaise	727	46	15.8
Total	1760	84	21.0

TABLE 2. Species overlap of Psocoptera in different types of traps, Reserva Ducke, September 1977 -- September 1978.

	No. species in		
	1 trap type	2 trap types	3 trap types
Emergence	3		
Light	31		
Malaise	22		
			18

trap type, and only 3 species were collected in all three trap types. There was considerably higher species overlap between light and Malaise traps. Temporal distribution of catches is indicated in Fig. 1. The graphs indicate a strong tendency for larger catches to include a greater number of species; peaks for the different trap types do not markedly coincide. Captures in the Malaise trap were relatively high from February to April and from late July to September. Light trap catches were highest in November and December, with some secondary peaks at other times, and emergence trap catches were very low after May. Grossly, then, 'seasonal' trends for the bulked Psocoptera appear to depend on trapping method.

Table 3 is a summary of the families captured in each trap. Undescribed species are included in the species totals. The following notes on richness and biology (necessarily inferred from knowledge

of related species in most cases) treat the above families in sequence.

**Lepidopsocidae.** Members of this family are commonly associated with leaf litter, or with dead foliage on trees, and some are known to fly readily. The species captured are 2 of *Echmepteryx* Aaron, one of them very close to *E. (Thylacopsis) bishopi* New and the other (found only in the Malaise trap) undescribed, and 4 individuals of *Soa violacea* New. Both identified species were described from series from forest litter in the Mato Grosso, but one of the type series of *S. violacea* was from a water trap, possibly indicating a tendency to disperse.

**Psyllipsocidae.** Two specimens of *Psocatropos microps* (Enderlein), a brachypterous and presumed flightless species, were captured in emergence traps. It is extremely unlikely that members of this genus would be captured in the other trap types. The species is very widely dis-

TABLE 3. Numbers of species of each represented family of Psocoptera caught in each trap type, Reserve Ducke, September 1977 — September 1978.

Family	Trap			
	Emergence	Light	Malaise	Total spp.
Lepidopsocidae	1	1	3	3
Psyllipsocidae	1	—	—	1
Musapsocidae	—	1	—	1
Liposcelidae	1	—	—	1
Pachytroctidae	1	—	—	1
Amphientomidae	—	1	1	1
Ptiloneuridae	—	6	5	11
Dolabellopsocidae	2	2	1	2
Epipsocidae	2	15	5	19
Caeciliidae	2	6	9	10
Polypsocidae	1	1	3	3
Ectopsocidae	—	1	1	2
Archipsocidae	1	—	1	1
Lachesillidae	—	1	1	1
Peripsocidae	—	1	2	2
Pseudocaeciliidae	—	2	1	2
Elipsocidae	—	1	1	1
Philotarsidae	—	1	—	1
Myopsocidae	1	4	1	4
Psocidae	—	12	11	17
Total spp	13	56	46	84
Total families	10	16	15	20

tributed, and associated with litter and domestic habitats.

Musapsocidae. The single specimen captured represents a genus (*Musapsocus* Mockford) not previously recorded from Brazil. Little is known of the biology or habitat preferences of members of this genus, but types of several species were collected from dead foliage (Mockford, 1967).

Liposcelidae. Adults and nymphs of one species of *Liposcelis* Motschulsky, a large cosmopolitan genus of apterous psocids, were collected. Many species are known to breed continuously in litter, under bark or in domestic habitats.

Pachytroctidae. Five individuals, 3 of nymphs, of an undescribed species of *Pachytroctes* Enderlein were collected from emergence traps. Pachytroctidae are common in Brazil, but most species are undescribed: many are associated with litter or dead foliage.

Amphientomidae. All 12 individuals captured were adults of *Seopsocus acuminatus* Roesler, a species apparently not recorded since its description from material collected in Santa Catherina. Some of the type series were collected from bark (Roesler, 1940), and many Amphientomidae elsewhere are known to be corticolous.

Ptiloneuridae. The taxonomy of the Ptiloneuridae, and of the other Epipsocidae collected, is treated by New (1980). Most Ptiloneuridae were collected only in very small numbers, many being represented by single specimens. It is known that males of some Ptiloneuridae are attracted to light (New 1972a), and that some species are nocturnal. Little is known of their biology, but their general absence from litter suggests that they are corticolous: New (1972a) suggested that their low incidence in beating samples in the Mato Grosso may have been due to a habit of secreting themselves in crevices during the day. The family is very diverse in Brazil.

Dolabellopsocidae. One of the 2 species collected, a new species of *Isthmopsocus* Eertmoed, was the most abundant psocid collected during this survey (Table 4): it comprised more than 80 per cent of the emergence trap catches, and was common also in the other traps. Few nymphs of the family were found, but the abundance of *Isthmopsocus* in emergence traps indicates that it breeds in ground litter. The other species, *Dolabel-*

*lopsocus ctenatus* (New) was trapped in only small numbers.

Epipsocidae. More species of Epipsocidae were captured than of any other family, and only 2 of the 19 species were earlier known (from other parts of Brazil). Few species were common and the limited data available on Epipsocidae in Brazil suggest that many are predominantly bark-frequenters. Most were captured only at light, but some appear not to be attracted to light. 53 specimens of *Neurostigma xanthoptera*, for example, were captured in the Malaise trap, and none in the light traps.

Caeciliidae. Three individuals of *Dypsocus inka* (Enderlein) were taken in the Malaise trap. The remaining 9 species are all referable to *Caecilius* Curtis s.l., and several are known from elsewhere in Brazil. Most Caeciliidae can be regarded as foliage-frequenting psocids, but some species are clearly associated with trees and others with low vegetation. Four of the present species, including both those from emergence traps, are related to groups usually found on low vegetation.

Polypsocidae. The 3 species captured

TABLE 4. Percentages constituted by selected psocopteran taxa in trap catches, Reserva Ducke, September 1977 — September 1978.

Taxon	Percentage of total catch in		
	Emergence	Light	Malaise
<i>Liposcelis</i> sp.	7.5	—	—
<i>Seopsocus acuminatus</i> Roesler	—	1.2	3.6
<i>Isthmopsocus luridus</i> New	80.8	36.4	25.6
<i>Neurostigma xanthoptera</i> New	2.1	—	7.3
<i>Polypsocus</i> sp. A	—	< 0.1	5.5
<i>Peripsocus</i> sp. A	—	2.8	< 0.4
<i>Scytopsocus</i> sp. A	—	2.4	—
<i>Lophopterygella cincta</i> New	0.3	3.2	0.1
<i>Blaste</i> sp. A	—	2.2	5.7
<i>Blaste</i> sp. B	—	1.2	2.5
<i>Cerastipsocus</i> sp. A	—	< 0.1	7.6
<i>Cerastipsocus</i> sp. B	—	< 0.2	4.1
Thyrsopterinae (3 spp.)	—	—	2.1
<i>Trichadenotecnum continuatum</i> Roesler	—	2.0	—

are *Polypsocus selenius* Roesler (Brazil), *P. griseolineatus* (Enderlein, hitherto known only from Peru), and *P. sp. n. (A)*, and a total of 61 individuals were trapped – 58 of them in Malaise trans. It thus

appears that they are not markedly attracted to light. *Polypsocus* spp. are generally foliage – frequenting psocids.

Ectopsocidae. The two species, together represented by only 3 individuals

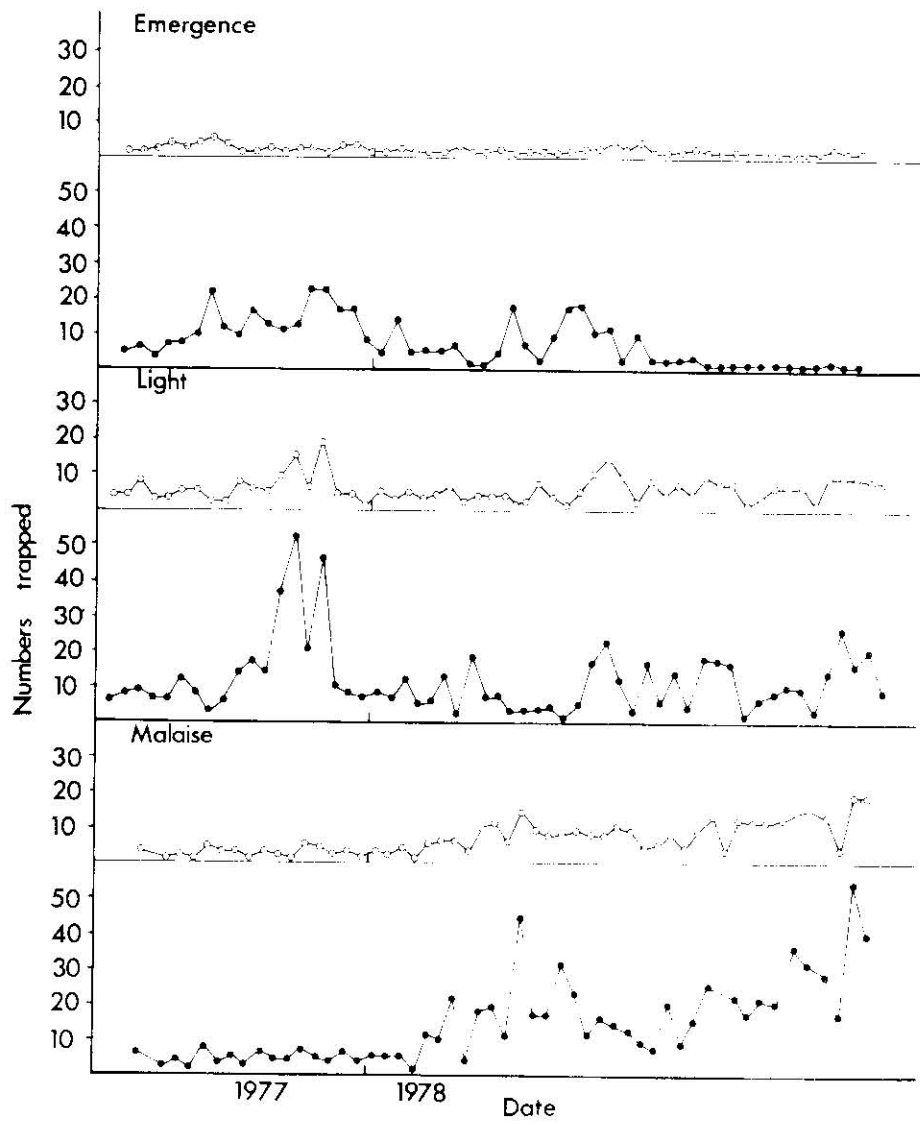


Fig. 1. Numbers of species and individuals of Psocoptera captured in traps at the Reserva Ducke, 1977 – 1978, on each trapping occasion. (●—●, no. individuals; ○—○, no. species).

are presumed to be frequenters of dead foliage. Species of **Ectopsocus** McLachlan appear to be generally scarce in tropical South America, and few species have been recorded.

**Archipsocidae.** The family was represented by 5 individuals of **Archipsocus minutillus** New. The scarcity of Archipsocidae is surprising, as the family is extremely well-represented in Brazil (New 1973b, Badonnel 1978), with 22 species recorded. Most, if not all, species are colonial and live under silken webs on bark, but some are known only from litter.

**Lachesillidae.** Twenty-two individuals of 1 species of **Lachesilla** Westwood, 18 of them in the Malaise trap. Several Brazilian **Lachesilla** spp are known to be associated with dead foliage.

**Peripsocidae.** One species of **Peripsocus** Hagen represented by 22 individuals (19 in light traps), and a singleton of a second species. The genus is not well represented in South America, and it is presumed that most species present are bark-frequenters.

**Pseudocaeciliidae.** Sixteen individuals of a species of **Scytopsocus** Roesler were taken in light traps, together with 5 of **Pseudocaecilius** sp. A further **Pseudocaecilius** was captured in the Malaise trap. Habitats of these taxa are unknown, but are likely to be dead foliage or bark.

**Elipsocidae.** Three individuals of an undescribed species of **Nepiomorpha** Pearman. Elipsocidae, again, are scarce in S. America, and most appear to be bark-frequenters.

**Philotarsidae.** Six specimens of **Aaroniella recta** New and Thornton from the light traps.

**Myopsocidae.** Thirty one specimens of 4 new species (New 1979) taken in light traps, and singletons of the most common species in the other trap types. Probably bark-frequenters.

**Psocidae.** This family is very diverse in Brazil, and most species appear to be associated with bark of trees. Thyrsoptorinae (3 spp.) were collected only in the

Malaise trap, as were a high proportion of Cerastipsocinae, and most other taxa were relatively scarce in the light trap. However, 2 species of **Trichadenotecnum** Enderlein s.l. and 2 of **Steleops** Enderlein were collected in the light trap, and these genera were absent from the Malaise trap catches.

Major differences in captures between the 3 trap types are summarised in Table 4, in which all the more abundant taxa are included. In the absence of direct samples from vegetation over the same period, only limited appraisal of these differences is wise. Clearly the litter psocid assemblage is less diverse than that found on vegetation, and contains a number of taxa not amenable to capture by the other trap types. Several species appear to be attracted to light more than others, but absences from a light trap may also reflect differences in diurnal activity peaks rather than just attraction.

The catches show substantial variations in N/S ratios over the trapping period (Table 5), together with considerable differences in numbers of species captured in different months (Fig. 2). Clear seasonal trends are not evident, but most species were captured in numbers too small to reveal any such trends present. The most abundant species (**I. luridus** New) occurred throughout the period and, in common with many litter psocids, appears to breed continuously. The other more common species (**N. xanthoptera**, **Polypsocus** A, **Blaste** A, **Cerastipsocus** A, B) also occurred over much of the trapping period.

Daily records of rainfall, temperature, insolation and relative humidity were examined, but no obvious correlation between climate and numbers of Psocoptera caught were found. The largest Malaise trap catches occurred after weeks with rainfall ranging from about 30 mm to about 103 mm, with 0.2 fine days, and the smallest catches immediately following a peak also sometimes occurred

TABLE 5. N/S ratio for bulked monthly Catches of Psocoptera, Reserva Ducke, 1977 - 1978.

Trap	Month												
	1977					1978							
Emergence	IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX
Light	4.5	11.4	18.7	12.2	15.5	1.7	2.4	8.2	4	1.5	1.2	1	--
Malaise	2.4	2.6	7.2	6.1	3.2	2.2	4.3	1.7	2.7	1.9	2.3	2.6	5.1
	2.4	1.7	3.1	2.8	1.7	3.9	4.4	4.8	2.8	3.1	2.6	5.2	4.3

after weeks with considerable variation in precipitation (rainfall ca. 13-151 mm, fine days 1 - 3), with similar very small temperature variations.

The light traps, set to capture over 1 night per week, also gave inconclusive data on correlation between catches and 'weather'. The three highest catches all occurred on nights following a day without rain or with little (1.7 mm) rain, but many similar days preceded low trap catches. No correlation with temperature was evident, but median temperatures varies over only a narrow range in the Manaus area. Data on wind speed, lunar phases and cloud cover are not available.

Elton (1973, 1975) has indicated that population densities of many Neotropical rain forest insects are very low, and derived his conclusions from counts from the field layer and low to middle canopy, the region 'sampled' by the present traps. Although the trap catches are selective, it is clear that many psocid species may be scarce. Clearly, there are many species in the area and the high proportion of undescribed species (probably 52/84 or 62 percent) suggests that exhaustive collecting would reveal many more taxa. It is further likely that many are of very limited distribution: although several are similar to (or identical with) species described from Peru, relatively few of the Manaus species were found during an intensive survey of part of the Mato Grosso (New, 1973a). The latter collection contained many taxa not found in the present sam-

ples, but also contained a high proportion (ca 90/137 (115 'forest' species) or 66 percent) of new species.

Only 3 of the 13 emergence trap species are possible 'primary litter frequenters' (New 1969) - *Psocatropos*, *Liposcelis* and *Pachytroctes*, and the others are likely to be mainly casually present after dropping on/from vegetation. A possible exception is *I. luridus*, the large numbers of which suggest a more regular association with litter. However, as it was also common elsewhere, and very few nymphs were collected, it is probably a 'general dead-vegetation' frequenting species. As in the Mato Grosso (New 1973a), the samples reveal a greater number of probable 'bark-frequenters' than 'foliage-frequenters'. Including presumed dead-foliage-frequenting forms, as well as groups more usually associated with living foliage, about 3 times as many bark-frequenters as foliage-frequenters were captured. The greater number (104/116) of forest bark frequenters from the Mato Grosso samples reflects, in part, (a) the greater number of Archipsocidae and (b) a considerable diversity of Liposcelidae, which are not captured by traps such as those used in the Reserva Ducke.

Nearly all families were found in the two surveys, and (neglecting Liposcelidae, Pachytroctidae and Archipsocidae) similar relative richness levels were found. In both, Epipsocetae were abundant, although Ptiloneuridae were more diverse in the Reserva Ducke than in the Mato Grosso

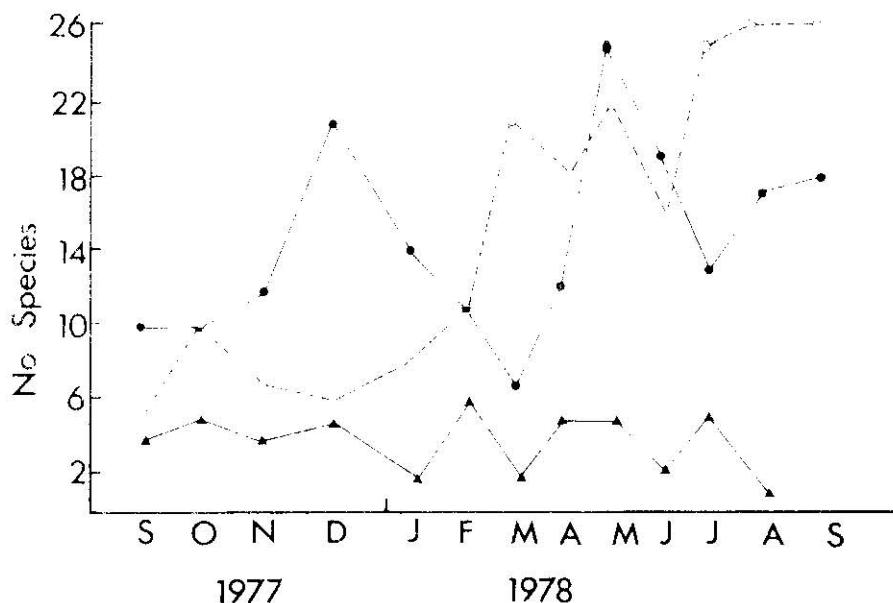


Fig. 2. Numbers of species of Psocoptera captured in traps each month at the Reserva Ducke, 1977–1978. (▲—▲, emergence traps; ●—●, light traps; ○—○, Malaise trap)

(11 spp. cf 4 spp.). The subgenus *Poecilopsocus* of *Thyrsopsocus* Enderlein (3 spp) were the only Thyrsophorinae in the Mato Grosso samples, whereas the present samples include representatives of three genera/subgenera: it appears that the Thyrsophorinae are a predominantly 'tropical forest' group. Many other genera of Psocidae are widely distributed in tropical Brazil. *Seoposocus acuminatus* was not collected in the Mato Grosso, and may also be a 'forest' species.

However, conclusions on distribution of Psocoptera in tropical South America must be very tentative. Many areas have not been surveyed for Psocoptera and, although those of the temperate south of South America are now tolerably well-known (New & Thornton s.d.), the high proportion of new taxa found in the present collection is usual in collections from the tropics. New (1973a) sug-

gested several phenological traits in the Mato Grosso Psocoptera but the present samples do not permit meaningful augmentation of these — due in part to the selective nature of the trapping and the low abundance of most species. Probably, however, the greater climatic constancy of the Manaus region obscures phenological traits which could be revealed by series of beating samples in which psocids are more clearly associated with particular habitats. It is inferred that many of the species may breed throughout the year, as indicated by their presence in traps at intervals throughout the whole of the trapping period.

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## Resumo

São enumerados e discutidos os Psocoptera, capturados em armadilhas de eclosão, armadilhas de luz e uma armadilha de Malaise, na Reserva Ducke, durante os anos de 1977-1978. Oitenta e quatro espécies foram capturadas em número reduzido, e as espécies comuns poucas estiveram presente todo o período de coleta. Com as armadilhas de eclosão, menos espécies foram coletadas do que com qualquer outro tipo de armadilhas. As distribuições geográficas dos psocópteros brasileiros são discutidos resumidamente.

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