Studies on mosquitoes (Diptera: Culicidae) and anthropic environment. 4 - Survey of resting adults and synanthropic behaviour in South-Eastern, Brazil*

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FORATTINI, O.P. et al. Studies on mosquitoes (Diptera: Culicidae) and anthropic environment. 4Survey of resting adults and synanthropic behaviour in SouthEastern, Brazil. *Rev. Saúde Pública*, 27: 398-411, 1993. Resting adults Culicidae were collected from January 1992 through January 1993 in several habitats of the Ribeira Valley region. The diversity of species found among them suggested that the vegetation remaining within human settlements favored the survival and the population increase of some mosquitoes. Among there are: *Ae. scapularis*, *Ae. serratus*, *Cx. (Culex)*, *Cx. nigripalpus* and *Cx. (Melanoconion)* such as *Cx. ribeirensis*. That preservation role may be attributed to the rearing of livestock and the consequent increase in the number of blood sources. These species may be classified as hemisynanthropes and *Cx. oedipus* apparently evolving to the eusynanthropic status. On the other hand, *An. cruzii* showed an asynanthropic behaviour, with a low degree of survival in the modified human environment. Epidemiological implications of the data are mentioned.

Keywords: Mosquitoes. Ecology, vectors.

Introduction

Outdoor sampling of resting adult Culicidae are usually made to obtain females for blood meal analysis and parity rate determination. Searching for natural outdoor resting places is frequently difficult because mosquito populations are normally widely dispersed even when, as happens in some cases, specialized shelters are found. Nevertheless this is considered to be a biased procedure because it may not provide representative samples of the population (Service[24,25] 1977, 1993). Thus, systematic evaluation of natural adult resting places is still needed for many mosquito species, especially in the Neotropical region. The great majority of studies so far carried out have focused on malaria transmission, and we have concentrated on anophelines. Mosquito groups, in which some degree of synanthropy exists, were also studied. A problem is that available data are largely observational (Breeland[1,2], 1972; Navarro et al.[16,17], 1986, 1987; Gomes and Forattini[11], 1990; Natal et al.[15], 1991; RubioPalis and Curtis[23], 1992). More recent researches, largely focusing on the culicids as a whole, have been carried out elsewhere (Reisen et al.[22], 1982; Irby and Apperson[13], 1992). In the Ribeira Valley region some of these studies have already been undertaken, mainly from the point of view of adult feeding preferences, resting places and dispersal patterns (Forattini et al[4,5,6], 1987, 1990).

Generally speaking, the larger part of the available data are related to artificial shelters sampling for the post appetential flight of female mosquitoes. Up to now few attempts have been made to study the resting places of male adults. Generally, species are more easily and reliably recognized, through their male characters (as also is their taxonomic identification) and the collection of males provides the opportunity to improve biodiversity studies. Following the researches programme on mosquitoes and anthropic environment, this paper presents the results obtained from collecting resting adults, paying particular attention to male.

Study area

Resting mosquitoes were collected in three areas consisting of the Experimental Station (ES), Fonte (FT) and Pariquera Mirim (PQM) district. Detailed descriptions of these study sites have been presented elsewhere (Forattini et al.[5,8,9], 1987, 1993). From the environmental and landscape points of view, they are representative of the following:

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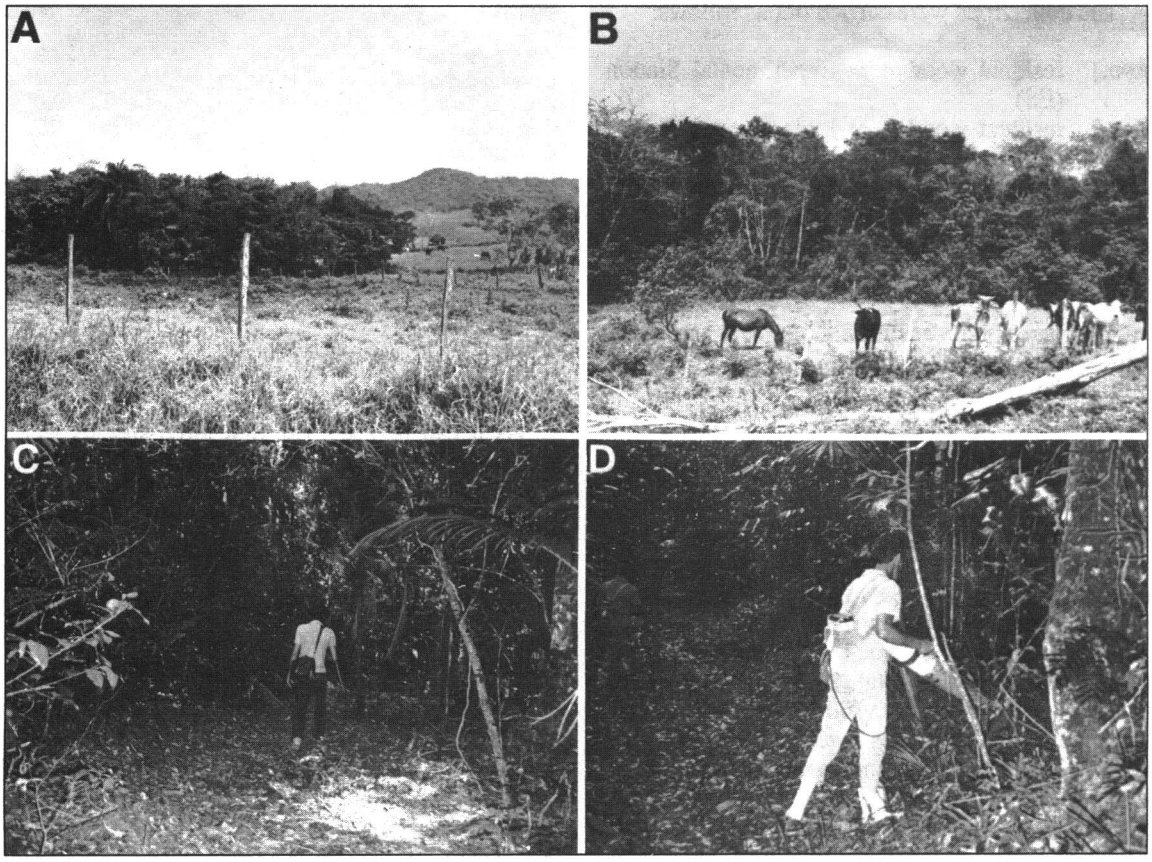

Figure 1. AParíquera Mirim site view, with a secondary bush; B, C - Outside and inside aspects of the secondary bush; D - Sampling with the batterypowered aspirator.

a) ES is a large rural human settlement with a great degree of anthropic modifications, which includes the residual woods (RW) representing remnants of the original rain forest.
b) FT represents the wild regional environment characteristic of the original Atlantic rain forest ecosystem.
c) PQM represents a group of small rural human settlements with secondary growth of bushes that succeded the primitive covering of vegetation. These small sized and low height woods are characterized by the predominance of short slender trees and undergrowth (Figure 1, A, B and C).

Material and Method

Resting mosquitoes were collected from vegetation that could be classified as the natural shelters for adults, inside the wooded environment and at the ecotone between this and the open land, with graminous plants and shrubs up to 1.0 meter high. Sampling was diurnal and fortnightly, through out one year (January 1992 - January 1993). Each collection lasted one hour when, in general, five to ten 5minute collections were made. All the habitats were sequentially visited during each sampling occasion. Samples were collected using a batterypowered aspirator as described by Nasci[14] (1981) (Figure 1,D). In order to provide comparisons, artificial resting places were sampled too. They were represented by the peridomestic environment at the Fonte (FT) household, which has already been described in a previous paper (Forattini et al[8]. 1993).

After each collection the specimens were identified and counted. Pearson's correlation analysis was performed to identify any relationship between monthly dominance and rainfall levels. Biodiversity was calculated as proposed by Fisher et al.[3] (1943). As for domiciliation, the Povolny[19] (1971) classification concepts and the Nuorteva[18] (1963) synanthropic index (b) were collected, as well as the synanthropic ratio (sr). Data on macroclimatic conditions were obtained from monthly records for the 19561985 period (Instituto Oceanográfico da USP[12], 1989).

The collections were carried out as follows:

Asp.1 residual wood A at Experimental Station (ES).
Asp.2 residual wood B at Experimental Station (ES).
Asp.3 secondary bush at the Pariquera Mirim (PQM).
Asp.4 peridomiciliary dwellings at the Fonte (FT).
Asp.5 primitive rain forest at the Fonte (FT).

The taxonomic identifications are presented with the generic and subgeneric names abbreviated according to Reinert[20,21] (1975, 1982).

Results

A total of 22,140 adult mosquitoes (12,790 females and 9,350 males) were collected, and these include 11,805 (53.3%) from the ES; 5,563 (25.1%) from PQM and 4,772 (21.6%) from FT. The identifications obtained are presented in Tables 1 and 2. Of that total, 77.2% (60.5% of the females and practically 100.0% of the males) were identified to species level and 39.5% as belonging to various taxonomic groups, or as yet unknown taxa.

Residual woods (ES) - Of the total specimens collected there, 75.3% were identified as species and the pattern of the most prevalent was as follows (Asp.1 and Asp.2):

Species	%
Aedes serratus	39.0
Culex nigripalpus	17.3
Aedes scapularis	11.7
Cx. declarator	6.1
Cx. mollis	5.9
Cx. lygrus	4.8
Cx. ribeirensis	1.8
Cx. pedroi	0.9
Total	87.5

The monthly percentage distributions of the total number of each of the three most prevalent species are presented in Figure 2 A,B,C. In February a marked decrease was observed for all of these mosquitoes. The particularly dry weather that occurred during that period could, at least to some extent, explain this. Despite the proximity of the irrigation system at ES, the species *An. albitarsis* was virtually absent.

Secondary bush (PQM) - After the collections, 79.6% of the specimens caught were identified to species, and the most prevalent were classified as follows (Asp.3):

Species	%
Aedes serratus	24.8
Culex nigripalpus	17.8
Ae. scapularis	9.0
Ae. nubilus	8.9
Cx. declarator	4.2
Cx. mollis	4.2
Psorophora lutzii	3.6
Cx. lygrus	3.0
Cx. sacchettae	1.5
Cx. ribeirensis	1.1
Cx. pedroi	0.9
Total	79.0

As it can be seen, the first three species were the same as those found in the ES residual woods. In addition, *Ae. nubilus* was significantly present in this secondary bush habitat. The monthly percentage distributions are presented in the Figure 2 A,B,C,D.

Peridomestic environment (FT)- Of the resting specimens collected in this habitat, 93.0% were identified to species, the most prevalent being the following (Asp.4):

Species	%
Culex quinquefasciatus	86.0
Cx. oedipus	6.9
Total	95.9

As expected, *Culex quinquefasciatus* was predominant. In addition, *Cx. oedipus* figures as a significant mosquito found in this environment and therefore deserves of attention. The monthly percentage of regarding these two species is presented in Figure 3A.

Primitive forest (FT) - 71.4% of the specimens collected there were identified to species, among them the most predominant were as follows (Asp.5):

Species	%
Anopheles cruzii	16.0
Culex neglectus	15.9
Aedes serratus	12.3
Ae. hortator (near)	11.8
Psorophora ferox	5.4
Ae. scapularis	4.9
Cx. imitator	4.9
Cx. nigripalpus	3.6
Cx. aphylactus	2.8
Cx. galvaoi	2.5
Total	80.1

Table 1. Resting adults Culicidae collected at the Experimental Station (ES) and Pariquera Mirim (PGM) district, from January 1992 through January 1993.

Species and taxonomic groups	Residual wood A (Asp.1)			Residual wood B (Asp.2)			Secondary bush (Asp.3)			Total		
	♂	♀	T	♂	♀	T	♂	♀	T	♂	♀	T
Aedes (Och)												
crinifer	0	1	1	—	—	—	—	—	—	0	1	1
dupreei (near)	1	0	1	—	—	—	—	—	—	1	0	1
fulvus	4	3	7	6	21	27	—	—	—	10	24	34
hastatus	—	—	—	—	—	—	27	0	27	27	0	27
nubilus	9	0	9	—	—	—	396	0	396	405	0	405
oligopistus	5	0	5	1	0	1	35	0	35	41	0	41
scapularis	141	374	515	85	437	522	107	292	399	333	1.103	1.436
serratus	813	792	1.605	735	1.127	1.862	734	366	1.100	2.282	2.285	4.567
Ae.(Pro)												
argyrothorax	0	1	1	—	—	—	—	—	—	0	1	1
terrens	0	1	1	—	—	—	—	—	—	0	1	1
Anopheles (Ano)												
intermedius	0	1	1	—	—	—	1	1	2	1	2	3
mediopunctatus (near)	1	1	2	0	4	4	1	6	7	2	11	13
An. (Ker)												
cruzii	—	—	—	0	6	6	—	—	—	0	6	6
An.(Nys)												
albitarsis	0	1	1	—	—	—	—	—	—	0	1	1
Coquillettidia (Rhy)												
albicosta	—	—	—	0	2	2	5	1	6	5	3	8
chrysonotum	4	0	4	—	—	—	4	0	4	8	0	8
hermanoi	0	2	2	—	—	—	0	7	7	0	9	9
juxtamansonia	0	1	1	0	1	1	1	1	2	1	3	4
nigricans	—	—	—	—	—	—	5	0	5	5	0	5
venezuelensis	2	18	20	0	2	2	10	18	28	12	38	50
Culex (Aed)												
amazonensis	4	1	5	1	10	11	0	10	10	5	21	26
Cx. (Cux)												
bidens	63	0	63	96	0	96	86	0	86	245	0	245
chidesteri	7	4	11	1	0	1	8	6	14	16	10	26
corniger	0	1	1	1	0	1	0	2	2	1	3	4
coronator	14	30	44	4	0	4	42	6	48	60	36	96
declarator	225	0	225	291	22	313	169	19	188	685	41	726
dolosus	—		—	3	0	3	5	0	5	8	0	8
eduardoi	3	0	3	2	2	4	—	—	—	5	2	7
foliaceus	—	—	—	—	—	—	8	0	8	8	0	8
lygrus	180	0	180	247	0	247	131	0	131	558	0	558
mollis	134	0	134	374	20	394	185	0	185	693	20	713
nigripalpus	452	303	755	369	416	785	324	466	790	1.145	1.185	2.330
saltanensis	3	0	3	—	—	—	—	—	—	3	0	3
usquatus	—	—	—	—	—	—	27	0	27	27	0	27
Cx. (Mcx)												
aphylactus	2	0	2	3	0	3	15	0	15	20	0	20
dubitans	3	0	3	20	0	20	1	0	1	24	0	24
imitator	40	0	40	30	3	33	23	2	25	93	5	98
microphyllus	—	—	—	—	—	—	1	0	1	1	0	1
neglectus	2	0	2	8	0	8	44	0	44	54	0	54
pleuristriatus	—	—	—	1	0	1	—	—	—	1	0	1
reducens	—	—	—	—	—	—	1	0	1	1	0	1
worontzowi	1	0	1	—	—	—	—	—	—	1	0	1
Cx.(Mel)												
aliciae	—	—	—	3	0	3	5	4	9	8	4	12
aureonotatus	—	—	—	—	—	—	3	21	24	3	21	24
bastagarius	0	1	1	—	—	—	13	9	22	13	10	23
caudelli	2	0	2	6	0	6	41	0	41	49	0	49
contei	—	—	—	1	0	1	—	—	—	1	0	1
corentynensis	—	—	—	—	—	—	7	0	7	7	0	7
distinguendus	—	—	—	—	—	—	0	1	1	0	1	1
dunni	2	0	2	—	—	—	7	0	7	9	0	9
ensiformis	2	0	2	—	—	—	8	0	8	10	0	10
evansae	0	1	1	—	—	—	0	3	3	0	4	4
galvaoi	—	—	—	2	0	2	4	0	4	6	0	6
innovator	25	0	25	37	0	37	8	0	8	70	0	70
intricatus	—	—	—	—	—	—	11	3	14	11	3	14
lopesi	—	—	—	—	—	—	1	1	2	1	1	2
misionensis	—	—	—	—	—	—	0	1	1	0	1	1
ocellatus	0	1	1	0	5	5	3	0	3	3	6	9
ocossa	1	4	5	0	4	4	0	1	1	1	9	10
oedipus	4	2	6	1	0	1	4	3	7	9	5	14
pedroi	12	30	42	11	30	41	18	22	40	41	82	123
pereyrai	0	1	1	—	—	—	—	—	—	0	1	1
phlebistus (near)	1	0	1	—	—	—	—	—	—	1	0	1
pilosus	16	0	16	4	0	4	57	1	58	77	1	78
plectoporpe	1	1	2	—	—	—	—	—	—	1	1	2
rabelloi	—	—	—	—	—	—	11	0	11	11	0	11
ribeirensis	13	45	58	39	60	99	14	35	49	66	140	206
sacchettae	3	17	20	10	26	36	21	45	66	34	88	122
serratimarge	—	—	—	—	—	—	2	0	2	2	0	2
spissipes	1	4	5	1	8	9	21	5	26	23	17	40
taeniopus	1	1	2	—	—	—	1	0	1	2	1	3
vaxus	—	—	—	—	—	—	0	4	4	0	4	4
zeteki	19	14	33	0	1	1	11	46	57	30	61	91
Limatus												
durhamii	1	68	69	3	75	78	0	1	1	4	144	148
flavisetosus	0	28	28	2	50	52	2	8	10	4	86	90

Species and taxonomic groups	Residual wood A (Asp.1)			Residual wood B (Asp.2)			Secondary bush (Asp.3)			Total		
	♂	♀	T	♂	♀	T	♂	♀	T	♂	♀	T
Mansonia (Man)												
flaveola	—	—	—	—	—	—	6	1	7	6	1	7
humeralis	—	—	—	—	—	—	1	0	1	1	0	1
indubitans	—	—	—	0	3	3	—	—	—	0	3	3
pseudotitillans	—	—	—	—	—	—	1	0	1	1	0	1
titillans	1	0	1	—	—	—	—	—	—	1	0	1
Phoniomyia												
davisi	—	—	—	0	1	1	—	—	—	0	1	1
flabellata (near)	—	—	—	0	4	4	—	—	—	0	4	4
quasilongirostris	0	1	1	—	—	—	—	—	—	0	1	1
Psorophora (Gra)												
cingulata	1	0	1	—	—	—	5	19	24	6	19	25
confinnis	—	—	—	—	—	—	0	1	1	0	1	1
Ps. (Jan)												
albigenu	0	22	22	0	13	13	14	9	23	14	44	58
discrucians	0	1	1	—	—	—	27	0	27	27	1	28
ferox	0	29	29	0	24	24	5	14	19	5	67	72
lutzii	0	6	6	0	5	5	16	145	161	16	156	172
Ps. (Pso)												
ciliata	—	—	—	—	—	—	1	0	1	1	0	1
saeva	—	—	—	—	—	—	2	0	2	2	0	2
Runchomyia												
cerqueirai	—	—	—	0	1	1	—	—	—	0	1	1
reversa	—	—	—	0	1	1	—	—	—	0	1	1
Sabethes (Sab)	—	—	—	—	—	—	—	—	—	—	—	—
forattinii (near)	0	1	1	—	—	—	—	—	—	0	1	1
Trichoprosopon (Trc)												
digitatum	1	0	1	—	—	—	0	1	1	1	1	2
Uranotaenia												
apicalis	0	1	1	—	—	—	5	4	9	5	5	10
calosomata	—	—	—	—	—	—	5	3	8	5	3	8
ditaenionota	—	—	—	—	—	—	8	5	13	8	5	13
geometrica	1	1	2	—	—	—	8	1	9	9	2	11
mathesoni	0	1	1	0	3	3	4	10	14	4	14	18
nataliae	—	—	—	—	—	—	1	0	1	1	0	1
pallidoventer	—	—	—	—	—	—	0	1	1	0	1	1
pulcherrima	—	—	—	0	1	1	3	1	4	3	2	5
rachoui	—	—	—	—	—	—	1	0	1	1	0	1
Wyeomyia (Den)												
airosai (near)	0	1	1	—	—	—	—	—	—	0	1	1
aporonoma	1	1	2	0	1	1	—	—	—	1	2	3
confusa	2	22	24	0	37	37	1	1	2	3	60	63
mystes	—	—	—	1	0	1	—	—	—	1	0	1
tarsata	—	—	—	—	—	—	0	1	1	0	1	1
Partial (ns)	2.224	1.840	4.064 (68)	2.399	2.425	4.825 (54)	2.784	1.634	4.417 (83)	7.407	5.899	13.306 (108)
Ae. (Och)												
perventor/hortator (near)	—	—	—	0	4	4	0	5	5	0	9	9
Serratus Group	0	419	419	0	547	547	0	419	419	0	1.385	1.385
An.(Ano)												
Punctimacula Group	—	—	—	—	—	—	0	1	1	0	1	1
Cq.(Rhy)												
chrysonotum/albifera	0	6	6	0	13	13	0	10	10	0	29	29
Cx.(Cux)												
Coronator Group	0	245	245	0	537	537	0	239	239	0	1.021	1.021
dolosus/eduardoi (near)	0	1	1	—	—	—	0	2	2	0	3	3
sp.	0	334	334	0	500	500	2	218	220	2	1.052	1.054
Cx.(Mcx)												
Imitator Group	0	47	47	0	26	26	0	83	83	0	156	156
Pleristriatus Group	0	7	7	—	—	—	—	—	—	0	7	7
sp.	0	5	5	0	6	6	1	38	39	1	49	50
Cx.(Mel)												
Atratus Group	0	5	5	0	3	3	0	13	13	0	21	21
Intrincatus Group	—	—	—	—	—	—	0	13	13	0	13	13
Melanoconion Section	—	—	—	0	2	2	—	—	—	0	2	2
Pilosus Group	0	100	100	0	90	90	0	82	82	0	272	272
sp.	—	—	—	0	1	1	0	7	7	0	8	8
Ma.(Man)												
sp.	0	1	1	—	—	—	0	2	2	0	3	3
Ps. (Jan)												
albigenu/varipes	0	1	1	0	1	1	0	5	5	0	7	7
Ur.												
sp.	0	3	3	—	—	—	—	—	—	0	3	3
Wy.(Den)												
airosai/howardi/luteoventralis	—	—	—	0	3	3	0	5	5	0	8	8
felicia/pampeites	0	2	2	0	7	7	—	—	—	0	9	9
mystes/finlayi	—	—	—	0	1	1	—	—	—	0	1	1
Partial	0	1.176	1.176	0	1.741	1.741	3	1.142	1.145	3	4.059	4.062
Total	2.224	3.016	5.240	2.399	4.166	6.565	2.787	2.776	5.563	7.410	9.958	17.368

(ns) - Number of species.

Table 2. Resting adults Culicidae collected at the Fonte (FT) region from January 1992 through January 1993.

Species and taxonomic groups	Household (peridomestic) (Asp.4)			Primitive forest (Asp.5)			Total		
	♂	♀	T	♂	♀	T	♂	♀	T
Aedes (How)									
fulvithorax	—	—	—	2	0	2	2	0	2
Ae.(Och)									
fluviatilis	0	1	1	—	—	—	0	1	1
hastatus	—	—	—	2	0	2	2	0	2
hortator (near)	—	—	—	51	206	257	51	206	257
nubilus	1	0	1	2	0	2	3	0	3
oligopistus	—	—	—	39	0	39	39	0	39
scapularis	0	13	13	20	87	107	20	100	120
serratus	1	0	1	95	174	269	96	174	270
Ae.(Pro)									
argyrothorax	—	—	—	0	5	5	0	5	5
Anopheles (Ano)									
eiseni	—	—	—	1	0	1	1	0	1
intermedius	—	—	—	1	1	2	1	1	2
An. (Ker)									
bellator	0	1	1	0	11	11	0	12	12
cruzii	0	5	5	0	349	349	0	354	354
An.(Ste)									
kompi	—	—	—	3	0	3	3	0	3
Culex (Aed)									
amazonensis	—	—	—	4	0	4	4	0	4
Cx. (Car)									
urichii	—	—	—	1	0	1	1	0	1
Cx. (Cux)									
bidens	3	0	3	4	0	4	7	0	7
chidesteri	1	1	2	—	—	—	1	1	2
corniger	2	4	6	—	—	—	2	4	6
coronator	—	—	—	8	0	8	8	0	8
declarator	—	—	—	19	0	19	19	0	19
lygrus	—	—	—	9	0	9	9	0	9
mollis	2	0	2	44	0	44	46	0	46
nigripalpus	3	5	8	27	51	78	30	56	86
quinquefasciatus	887	482	1.369	—	—	—	887	482	1.369
usquatus	4	0	4	22	0	22	26	0	26
Cx. (Mcx)									
aphylactus	—	—	—	62	0	62	62	0	62
dubitans	—	—	—	3	0	3	3	0	3
imitator	2	1	3	101	5	106	103	6	109
inimitabilis	—	—	—	1	0	1	1	0	1
neglectus	5	0	5	347	0	347	352	0	352
reducens	—	—	—	4	2	6	4	2	6
Cx.(Mel)									
aliciae	5	0	5	2	0	2	7	0	7
bastagarius	0	4	4	—	—	—	0	4	4
contei	1	0	1	—	—	—	1	0	1
distinguendus	1	0	1	2	2	4	3	2	5
dunni	2	0	2	3	0	3	5	0	5
galvaoi	—	—	—	55	0	55	55	0	55
innovator	2	0	2	—	—	—	2	0	2
intrincatus	—	—	—	2	0	2	2	0	2
misionensis	—	—	—	1	1	2	1	1	2
ocellatus	—	—	—	13	14	27	13	14	27
oedipus	23	87	110	—	—	—	23	87	110
pedroi	1	1	2	2	7	9	3	8	11
pilosus	1	0	1	7	0	7	8	0	8
plectoporpe	2	2	4	—	—	—	2	2	4
rabelloi	1	0	1	—	—	—	1	0	1
ribeirensis	1	0	1	0	2	2	1	2	3
sacchettae	—	—	—	1	1	2	1	1	2
vaxus	5	7	12	0	1	1	5	8	13
zeteki	—	—	—	6	23	29	6	23	29
Limatus									
durhamii	0	1	1	0	3	3	0	4	4
flavisetosus	1	0	1	0	5	5	1	5	6

Species and taxonomic groups	Household (peridomestic) (Asp.4)			Primitive forest (Asp.5)			Total		
	♂	♀	T	♂	♀	T	♂	♀	T
Phoniomyia									
davisi	0	1	1	0	3	3	0	4	4
flabellata	0	2	2	0	1	1	0	3	3
longirostris	—	—	—	0	1	1	0	1	1
pallidoventer	—	—	—	0	2	2	0	2	2
quasilongirostris	—	—	—	0	3	3	0	3	3
theobaldi	—	—	—	0	1	1	0	1	1
Psorophora (Gra)									
cingulata	0	2	2	—	—	—	0	2	2
Ps. (Jan)									
albigenu	0	1	1	6	10	16	6	11	17
ferox	0	1	1	0	118	118	0	119	119
lutzii	0	2	2	0	2	2	0	4	4
Runchomyia									
humboldti	—	—	—	0	1	1	0	1	1
reversa	—	—	—	3	29	32	3	29	32
reversa (near)	—	—	—	1	7	8	1	7	8
Sabethes (Sbn)									
undosus/fabricii	—	—	—	0	1	1	0	1	1
Shannoniana									
fluviatilis	—	—	—	0	3	3	0	3	3
Uranotaenia									
calosomata	0	1	1	4	3	7	4	4	8
lowii	0	2	2	—	—	—	0	2	2
mathesoni	0	3	3	0	2	2	0	5	5
pulcherrima	1	0	1	—	—	—	1	0	1
Wyeomyia (Den)									
aporonoma	0	1	1	1	4	5	1	5	6
bourrouli	0	1	1	0	2	2	0	3	3
clasoleuca	—	—	—	0	1	1	0	1	1
confusa	0	2	2	0	53	53	0	55	55
felicia/pampeites (near)	0	1	1	—	—	—	0	1	1
finlayi	—	—	—	1	0	1	1	0	1
shannoni	—	—	—	0	5	5	0	5	5
Partial (ns)	958	635	1.593 (44)	982	1.202	2.184 (65)	1.940	1.837	3.777 (79)
Ae. (Och)									
Serratus Group	0	5	5	0	466	466	0	471	471
Cx.(Cux)									
Coronator Group	0	42	42	0	66	66	0	108	108
sp.	0	26	26	0	95	95	0	121	121
Cx.(Mcx)									
Imitator Group	0	11	11	0	57	57	0	68	68
Pleristriatus Group	0	2	2	—	—	—	0	2	2
sp.	0	1	1	0	120	120	0	121	121
Cx.(Mel)									
Atratus Group	0	1	1	0	4	4	0	5	5
Melanoconion Section	0	1	1	—	—	—	0	1	1
Pilosus Group	0	22	22	0	28	28	0	50	50
sp.	0	2	2	—	—	—	0	2	2
Ph.									
palmata/diabolica (near)	—	—	—	0	5	5	0	5	5
sp.	—	—	—	0	4	4	0	4	4
Ps. (Jan)									
albigenu/varipes	—	—	—	0	1	1	0	1	1
Wy.(Den)									
airosai/howardi/luteoventralis	0	5	5	0	20	20	0	25	25
felicia/pampeites			—	0	5	5	0	5	5
mystes/finlayi	0	2	2	0	4	4	0	6	6
Partial	0	120	120	0	875	875	0	995	995
Total	958	755	1.713	982	2.077	3.059	1.940	2.832	4.772

(ns) - Number of species.

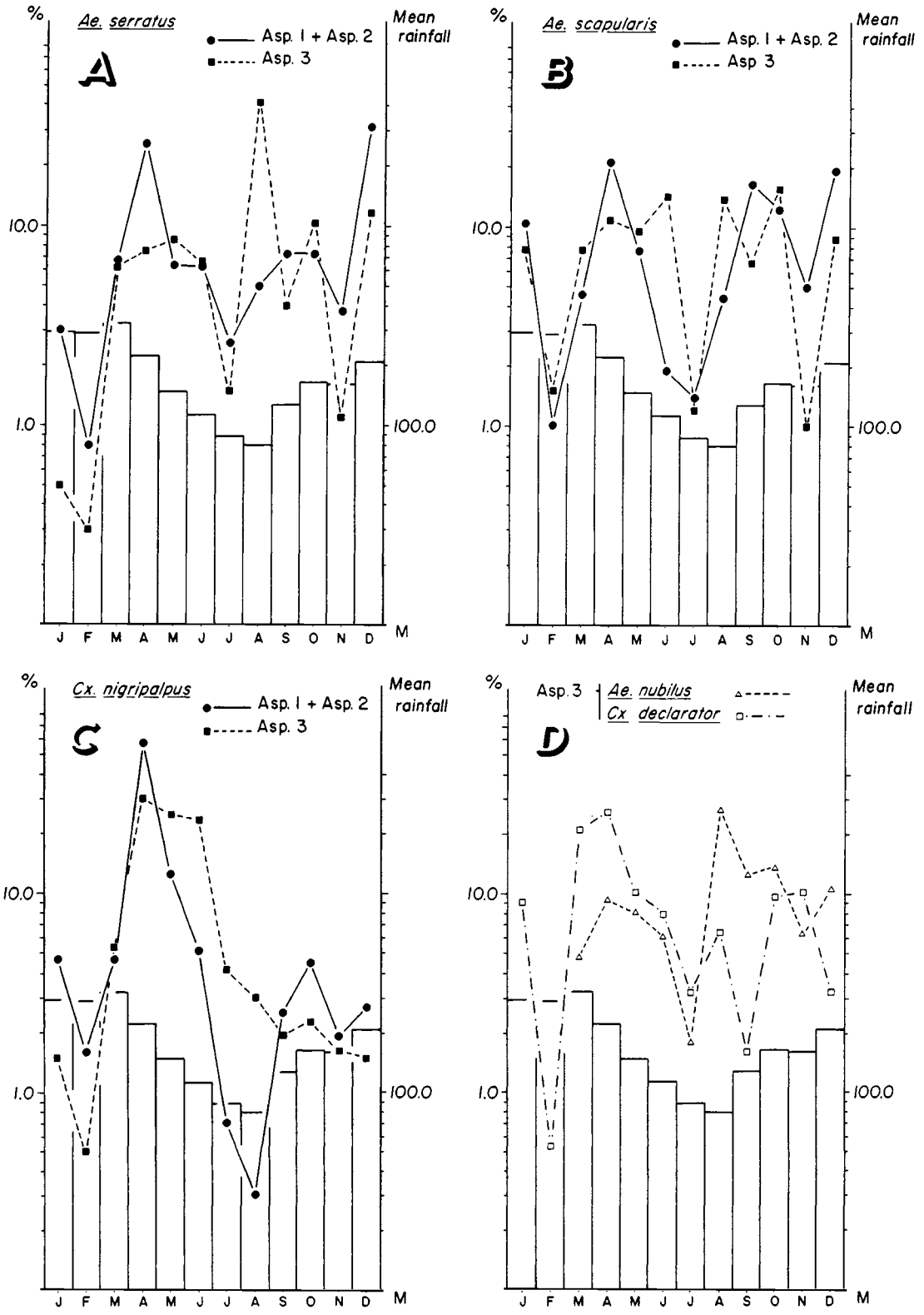

Figure 2. Monthly percentage rates distribution of resting adults caught in the ES residual woods (Asp.1 and Asp.2) and in the PQM secondary bush (Asp.3), from January 1992 through January 1993. Bars represent mean rainfall: A - *Ae. serratus*; B - *Ae. scapularis*; C - *Cx. nigripalpus*; D - *Ae. nubilus* and *Cx. declarator*.

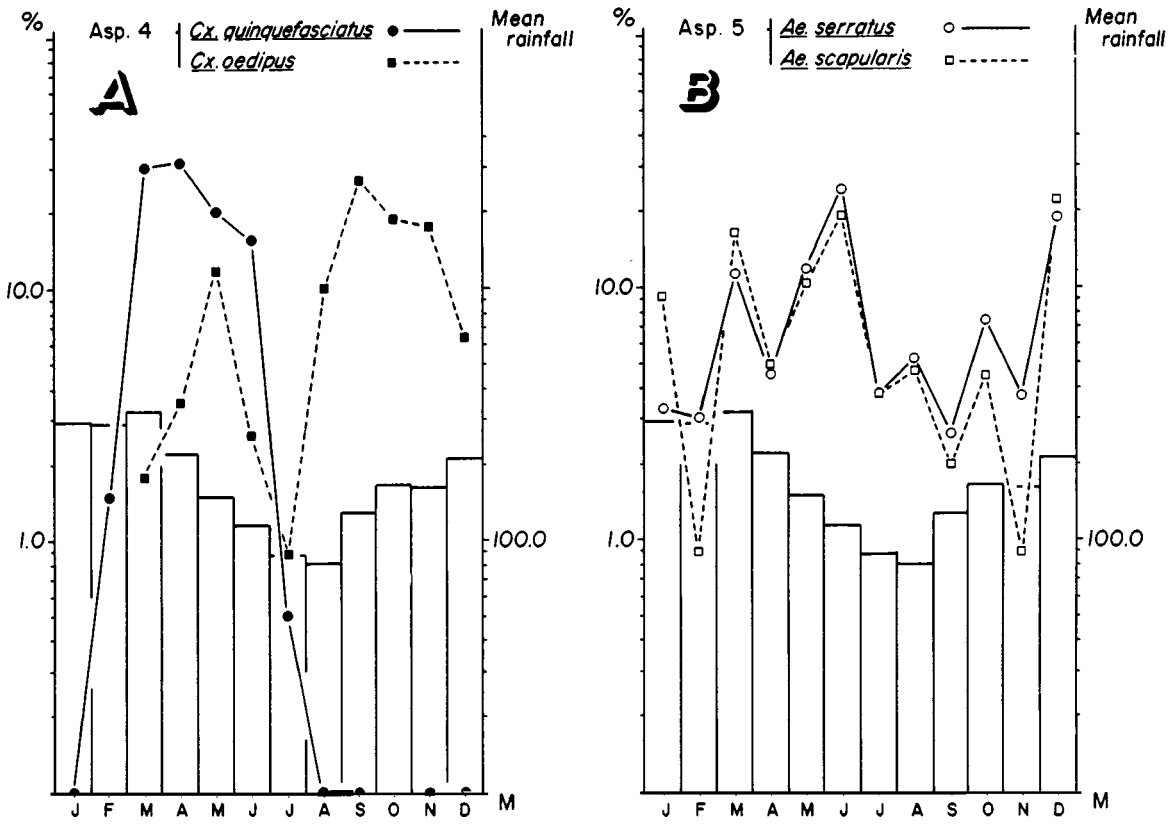

Figure 3. Monthly percentage rates distribution of resting adults caught in the FT region in a peridomestic environment (Asp.4) and at primitive forest (Asp.5), from January 1992 through January 1993. Bars represent mean rainfall means; A - *Cx. quinquefasciatus* and *Cx. oedipus*; B - *Ae. scapularis* and *Ae. serratus*.

The monthly percentage distributions of *Ae. scapularis* and *Ae. serratus* collections are presented in Figure 3B, and suggest a similar trend between them throughout the year.

Biodiversity - The overall biodiversity indices (α), with 95.0% confidence intervals of the number of resting mosquito species (n) collected from many habitats, were 16.0 ± 0.8 for ES plus PQM, and 14.0 ± 0.7 for FT. The comparison among the several sites (Tables 1 and 2) resulted in indices as follows:

Site	n	
ES residual woods		
A (Asp.1)	68	12 ± 0.6
B (Asp.2)	54	8 ± 0.4
PQM secondary bush (Asp.3)	83	14 ± 0.7
FT peridomestic (Asp.4)	44	6 ± 0.3
FT primitive forest (Asp.5)	65	10 ± 0.7

A quantitative difference was recorded between the residual woods and the secondary bush samples (Asp.1, Asp.2, Asp.3). However, analysing the data from woods A and B, shows that the number of species was 82, of which 29 were found only at A, 14 only at B and 39 were common to both sites. Thus, no quantitative difference was found when the total numbers of species collected were compared with those found in the secondary bush (Asp.3), where 83 species were recorded.

As for the FT region, of the total number of 79 species identified, 14 were found only in the peridomestic environment, 35 only in the primitive forest and 30 in both habitats. As expected, a quantitative difference was found among the peridomestic (Asp.4) and the primitive forest (Asp.5) environments. Figure 4 shows the main species percentages on the total number of resting mosquitoes collected at several sites.

Synanthropy - To estimate the degrees of synanthropy, a comparison among the species collected in three different environments was made. Two of them resulted from anthropic activity as settlements, and so were represented by the ES residual woods (Asp.1 + Asp.2),

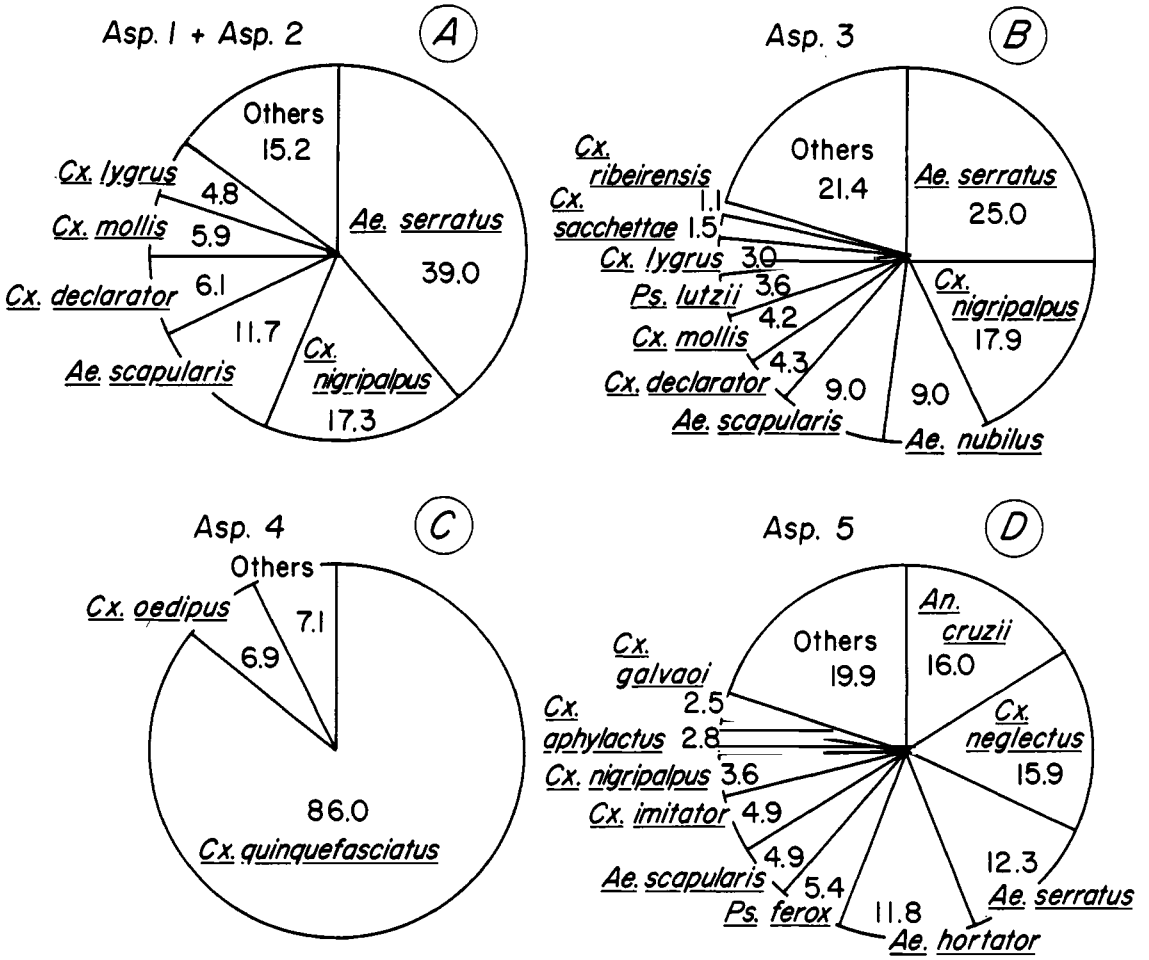

Figura 4. Diagrams of the distribution of main species as percentages of distribution on the total number of resting specimens collected at the several sites; A - Residual woods (ES); B - Secondary bush (PQM); C - Peridomestic environment (FT); D - Primitive forest (FT).

jointly with the PQM secondary bush (Asp.3) and the FT household surroundings (Asp.4). The third was represented by the wild environment of the FT primitive forest (Asp.5). The synanthropic indices (s) for the species collected in these three habitats are presented in Table 3. As can be seen some species showed a higher degree of synanthropy than others, as regards their survival capacity and consequent adaptation to the artificial human environment. An explanation of the meaning of these indices is given in Figure 5.

The synanthropic ratios (sr) were estimated by comparing ES + PQM/FT data, and consequently the results of Asp.1 + Asp.2 + Asp.3 were divided by those of Asp.5. Taking into consideration those species of which at least 100 specimens were collected, the resulting ratios were as follows:

Species	sr
Aedes nubilus	202.5
Culex ribeirensis	103.0
Psorophora lutzii	86.0
Cx. lygrus	62.0
Cx. bidens	61.3
Cx. sacchettae	61.0
Limatus durhami	49.3
Cx. declarator	38.2
Cx. imitator	32.7
Cx. nigripalpus	27.1
Ae. serratus	17.0
Cx. mollis	15.5
Cx. pedroi	13.7
Ae. scapularis	13.4
Cx. coronator	12.0
Cx. zeteki	3.1
Wy. confusa	1.2
Ps. ferox	0.6
Cx. neglectus	0.2
An. cruzii	0.02

Table 3. Synanthropy estimated as a percentage of Culicidae species sampled as resting adults. Indices were calculated by comparisons of the three main environments, according to Nuorteva's (1963) concepts*.

Species	a (%)	b (%)	c (%)	s
Ae. nubilus	99.26	0.24	0.49	+ 98.89
Ae. scapularis	92.28	0.83	6.87	+ 85.82
Ae. serratus	94.41	0.02	5.58	+ 88.84
An. cruzii	1.66	1.38	96.94	94.59
Cx. bidens	97.22	1.19	1.58	+ 96.23
Cx. imitator	47.34	1.44	51.20	3.14
Cx. mollis	93.93	0.26	5.79	+ 88.27
Cx. neglectus	13.30	1.23	85.46	71.54
Cx. nigripalpus	96.44	0.33	3.22	+ 93.38
Cx. pedroi	91.79	1.49	6.71	+ 85.82
Cx. ribeirensis	97.12	0.47	0.95	+ 96.40
Li. durhamii	97.36	0.65	1.97	+ 95.71
Ps. ferox	37.69	1.04	61.78	23.57
Ps. lutzii	97.72	1.13	1.13	+ 97.72
Wy. confusa	52.5	1.66	45.8	+ 7.53

* a Residual woods and secondary bush (Asp.1 + Asp.2 + Asp.3) at the anthropic settlement (ES).
b Peridomestic (Asp.4) environment (FT).
c Primitive forest (Asp.5) as wild environment (FT).
s Synanthropic index $\left(s = \frac{2a + b - 2c}{2}\right)$

With regards to the household environment represented by peridomestic collections (Asp.4), *Cx. quinquefasciatus* was found only there. Because it was confined to that habitat, the synanthropy of this mosquito was clearly at the highest degree. Although *Cx. oedipus* was not found inside the FT forest environment (Asp.5), its synathropy ratio can nevertheless be estimated in the light of the FT peridomestic environment (Asp.4), just as the human domicile and the ES residual woods jointly with the PQM secondary bush (Asp.1 + Asp.2 + Asp.3) constitute the anthropic rural settlement. Thus sr = FT/ES + PQM gave a ratio of 7.9, indicating a degree of synanthropy for that mosquito.

Discussion

The results reported here are concerned with regular sampling of mosquito resting sites. To a certain degree, the results are a reflection of breeding places near which the adults, subsequent to resting after emergence, dispersed through the environment. Therefore the data obtained may suggest the habitats where mosquitoes carry out their activities.

Comparing these results with those previously reported (Forattini et al.[10], 1993) it is remarkable that *An. albitarsis* was practically absent at the resting sites sampled in the two residual woods of the same Experimental Station (ES). On the other hand, *Ae. scapularis* was consistently collected at those sites, as well as at the irrigation system.

Significant monthly correlations with rainfall were found for *Ae. nubilus* ($r = 0.54$; $P<0.05$) and *Ae. serratus* ($r = 0.41$; $P<0.05$), both collected at PQM secondary bush, where they showed a peak associated with the dry season (August) (Figure 2 A and D). Otherwise, the end of the rainy season (March to May) was significantly correlated to *Cx. declarator* ($r = 0.37$; $P<0.05$) collections in the same PQM environment (Figure 2D). Nevertheless, these relations varied according to the habitats and no correlations with rainfall were found in the monthly distribution of these species in the ES residual woods (Asp.1 + Asp.2) and in the FT primitive forest (Asp.5). In addition, *Ae. scapularis* and *Cx. nigripalpus* showed no significant correlations with their monthly collections through the year. In the FT peridomestic environment, significance was found for *Cx. quinquefasciatus* ($r = 0.32$; $P<0.05$) and for *Cx. oedipus* ($r = 0.46$; $P<0.05$), correlated to the wet season (Figure 3A). These results agree with those previously reported (Forattini et al. 1993[9], 1993[10]) which show *Ae. scapularis* as a mosquito occurring throughout the year, both in the anthropic and the primitive environments (Figures 2B, 3B). As for *Culex* species, adults were collected in larger numbers when the rainy season was finishing or starting. This is probably associated with the greater abundance of larval habitats, which tend to be flushed out during heavy summer rains.

The ES plus PQM data indicated higher biodiversity than that observed in the FT primitive environment. The explanation may be found in the influence of vegetation that, even in the human settlements, harbours mosquito species favouring blood sources from cattle and other domesticated animals (Figure 1B). Obviously mosquito species diversity was lower in the household environment, where *Cx. quinquefasciatus* is the dominant species.

It seems evident that a mosquito species group which includes *Ae. nubilus*, *Ae. scapularis*, *Ae. serratus*, *Cx. nigripalpus*, *Cx. ribeirensis* and others (Figure 5) is favored by the installation of human settlements. Natural environmental alterations result in a patchy remnant vegetation that provides resting places for many mosquito species. Inadiction, domestic livestock furnish blood sources. Thus, such mosquito species may find resources good enough to enable them to survive and their population to increase. According to the Povolny[19] (1971) classification, these species may be considered as hemisynanthropes with respect to their synanthropic indices (s) and ratios (sr) (Table 3; Figure 5). The present results support previous observations on *Ae. scapularis* and *Culex* species,

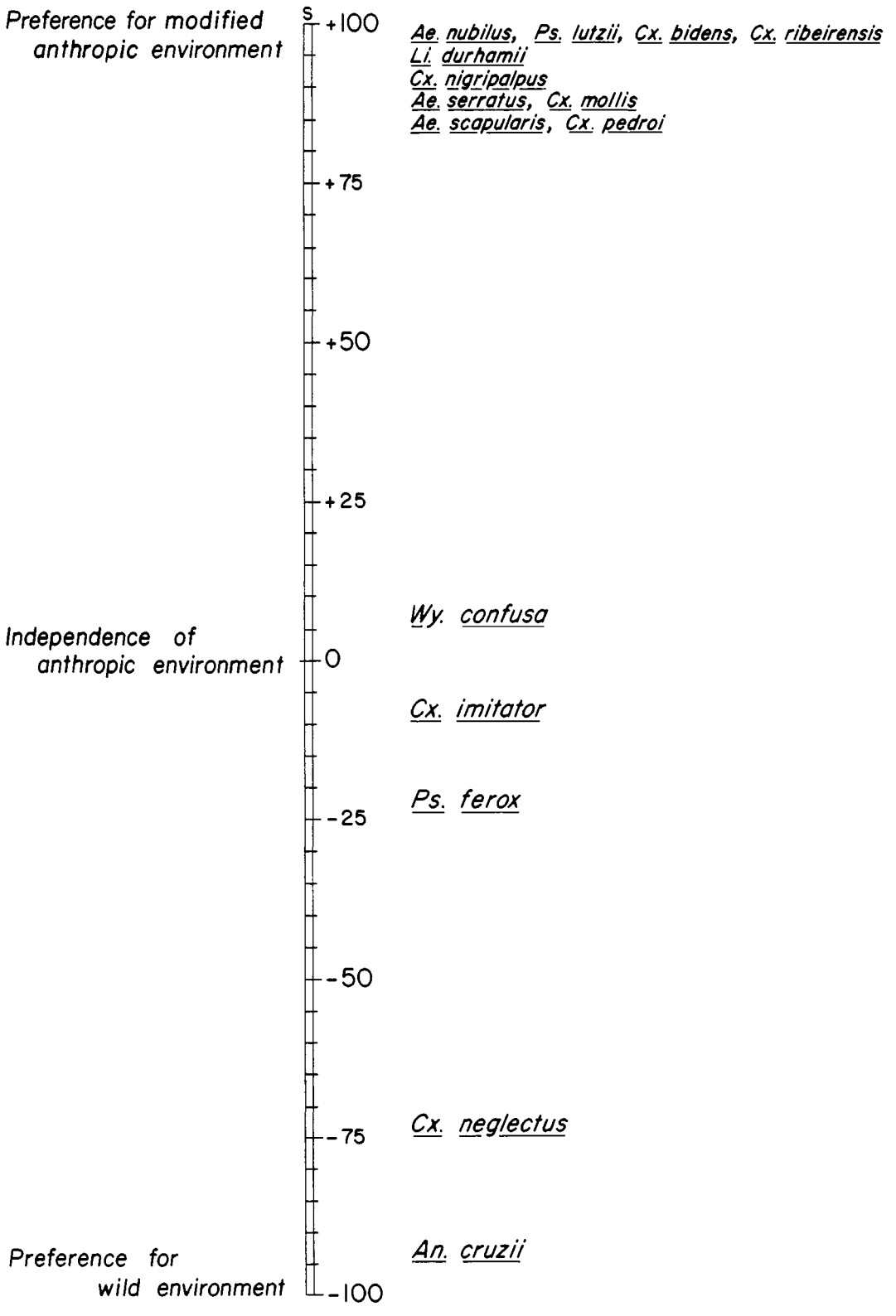

Figure 5. Representation of different degrees of Culicidae synathropic indices (s) as between three habitats, according to the level of anthropic modification of the natural environment.

such as *Cx. ribeirensis* and others (Forattini et al.[4,6,7], 1987, 1990, 1991; Gomes et al.[11] 1990). At the opposite extreme *An. cruzii* may be classified as an asynanthrope mosquito which decreases significantly in accordance with the development of the anthropic alterations to the natural environment. Even when visiting households regularly seeking blood adult females do not remain there, but instead fly after feeding to their natural habitats (Forattini et al.[6,8] 1990, 1993).

As for the peridomestic environment, *Cx. quinquefasciatus* must obviously be considered as an endophilous eusynathropic mosquito. The results obtained here strongly suggest that *Cx. oedipus* may be a local species developing exophilous eusynanthropic behaviour. That is, it may be associated with the manmade environment but without necessarily requiring human habitation. In any case, it is a species deserving further attention.

In conclusion, from the data obtained through these studies it seems pertinent to consider that, from the epidemiological point of view, several species of outdoor mosquito can to develop behavior that brings them into an association with the rural anthropic environment. Furthermore, all the evidence suggests that they may find resources available there for their survival there and population increase. Such aspects as these may have implications for the transmission of infectious diseases, from the foci located in the natural environment to man and livestock.

FORATTINI, O.P. et al. Estudos sobre mosquitos (Diptera: Culicidae) e ambiente antrópico. 4 - Coleta de adultos em abrigos e níveis de sinantropia, na região sudeste do Brasil. *Rev. Saúde Pública*, 27: 398-411, 1993. Relata-se os resultados obtidos com a coleta regular de Culicidae adultos em diversos abrigos naturais e peridomiciliares no período de janeiro de 1992 a janeiro de 1993, em locais do Vale do Ribeira. Mediante os aspectos de biodiversidade, pôde-se observar que, a vegetação remanescente situada no ambiente rural, favorece a sobrevivência e o aumento populacional de algumas espécies. Dentre elas, menciona-se *Ae. scapularis*, *Ae. serratus*, representantes de *Cx. (Culex)* como *Cx. nigripalpus* e de *Cx. (Melanoconion)* como *Cx. ribeirensis*. Esse papel pode-se possivelmente atribuir à criação de animais domésticos nesses locais, o que resulta em maior número de fontes sanguíneas. As espécies foram classificadas como hemisinantrópicas, sendo *Cx. oedipus* mosquito aparentemente evoluindo para hábitos eusinantrópicos. Por sua vez, *An. cruzii* revelou-se assinantrópico, uma vez que mostrou baixo nível de comparecimento nas coletas efetuadas no ambiente modificado pelo homem. Menciona-se a possibilidade de implicações epidemiológicas na transmissão de agentes infecciosos dotados de focos extradomiciliares.

Descritores: Mosquitos. Ecologia de vetores.

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