

BITING BEHAVIOR OF *ANOPHELES* MOSQUITOES IN COSTA MARQUES, RONDONIA, BRAZIL

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Mosquito collections were made in and near Costa Marques, Rondonia, Brazil, to determine anopheline anthropophilic/zoophilic behavior. Collections from a non-illuminated, bovine-baited trap and indoor and outdoor human-bait collections were compared. Anopheles darlingi and Anopheles deaneorum were more anthropophilic than the other anophelines collected. The remainder of the Anopheles species were collected much more frequently in bovine-baited traps than in human-bait collections. Anopheles darlingi and An. deaneorum were more frequently collected inside houses than the other anopheline species. But, when collections were made in a house with numerous openings in the walls, there were few differences in the percentages of each species biting man indoors versus outdoors. Anopheles darlingi was the predominant mosquito collected, both inside and outside houses, and had the strongest anthropophilic feeding behavior of the anophelines present.

Key-words: *Anopheles* sp. Brazil, Behavior, Anthropophilic. Zoophilic.

The incidence of malaria in the Amazon Basin of Brazil has steadily increased over the last ten years⁷. Marques¹⁰ outlined many of the problems associated with malaria control and environmental and social factors in Brazil which influenced the increasing malaria trends through 1989. But, in addition, vector behavior and feeding preference also affect the intensity of malaria by governing the human-vector contact¹².

Feeding preferences and host behavior have an important influence on the local epidemiology of malaria. For example, malaria prevalence may be less in communities where the principal malaria vector is not strictly anthropophilic and where cattle range between the villages and major breeding sites⁸. In some areas of Brazil, observations indicate that local populations of mosquito species are zoophilic, while in others they are anthropophilic². It is now apparent that these differences are often species differences within species complexes².

In our studies, the host attraction of anophelines to bovines and man were compared to identify differences in species behavior. Residences in the small frontier town (house 1) and in a rural area (house 5) 7 km from Costa Marques were sampled to evaluate the malaria vector potential in different environments⁷.

MATERIAL AND METHODS

Mosquitoes were collected on human-bait (inside and outside houses) and in a non-illuminated bovine-baited trap (Figure 1) near house 1 in the town of Costa Marques (12°26'S, 64°14'W), Rondonia and near a corral at house 5, 7 km from town along road BR 429 leading to Presidente Medici. Detailed descriptions of the areas and houses were provided by Klein and Lima⁷. House 1 was made of wood construction with open eaves and unscreened windows and doors. House 5 was poorly constructed having numerous gaps >2.5 cm between the wall boards. Collections were conducted alternately at house 1 (urban) and then house 5 (rural) for each collection period from April 1987 through September 1987. One volunteer conducted human-bait collections for 40 minutes at the beginning of each hour from 1800 to 0700 h by exposing their feet and lower legs to natural populations of mosquitoes. During the last 20 minutes of each collection hour, the collector aspirated mosquitoes from the non-illuminated bovine-baited trap. All mosquitoes were collected with oral aspirators, transferred to screened 215 cm³ (pint) cartons, killed by freezing and identified as described by Klein and Lima⁷.

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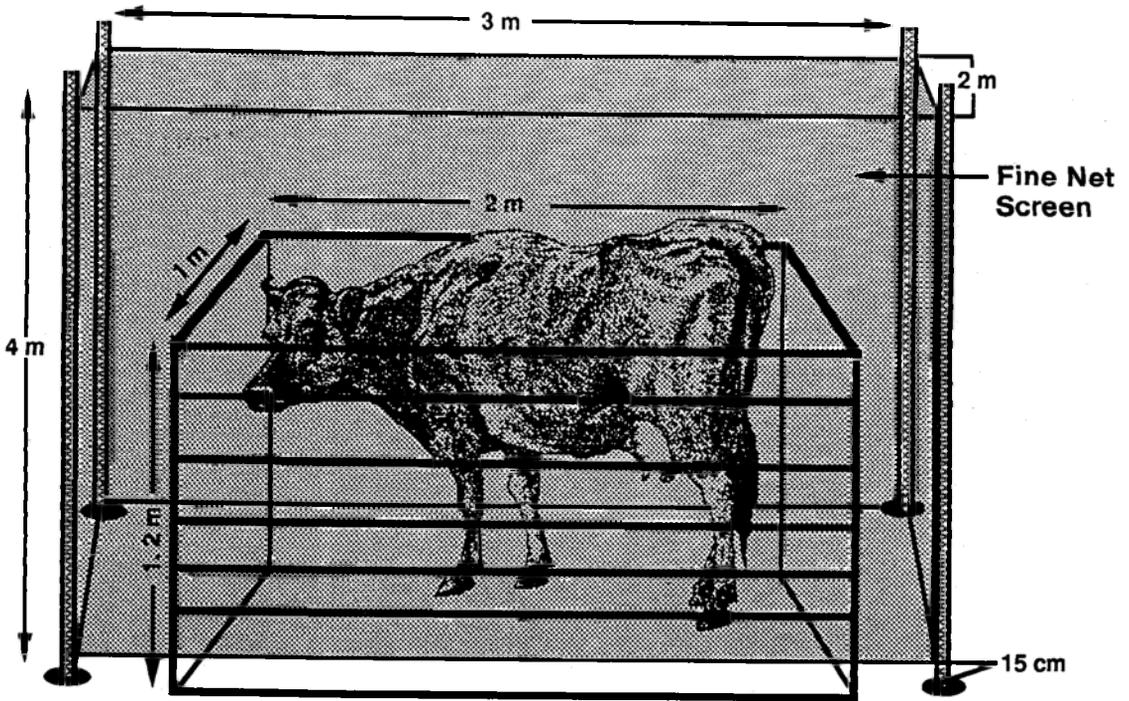


Figure 1 – Schematic drawing of the non-illuminated bovine-baited trap. Anopheline collections from the bovine-baited trap were compared to those from human-bait collections inside and outside houses.

Table 1 – *Anopheles* composition and preference for human-or bovine-bait from April through September, 1987, Costa Marques.

Anopheles	Number mosquitoes collected					
	Urban ¹			Rural ¹		
	House 1		Human (in)	House 5		Human (in)
	Bovine	Human (out)		Bovine	Human (out)	
Subgenus (<i>Nyssorhynchus</i>)						
<i>albitarsis</i>	6	0	2	933	150	71
<i>braziliensis</i>	1	0	0	0	0	0
<i>darlingi</i>	768	2,440	364	518	1,762	507
<i>deaneorum</i>	153	516	98	107	65	39
<i>nuneztovari</i>	0	0	0	5	0	0
<i>oswaldoi</i>	17	10	1	192	27	14
<i>rondoni</i>	2	0	0	0	0	0
<i>triannulatus</i>	10	12	1	34	9	3
Subgenus (<i>Anopheles</i>)						
<i>matogrossensis</i>	20	3	0	7	0	0
<i>mediopunctatus</i>	2	0	0	2	0	0
<i>minor</i>	0	0	0	0	0	1
<i>perassui</i>	0	0	0	2	0	0
Total	384	2,981	466	1,796	2,013	635

¹ n=15 for number of collections.

RESULTS

In the Costa Marques area, 12 species of adult anophelines were collected from bovine- and human-bait (Table 1). Species diversity was much greater in the rural environment than within the town of Costa Marques. *Anopheles darlingi* was the most frequently collected anopheline from human-bait inside and outside houses (81%) in Costa Marques and at house 5 (86%), 7 km from Costa Marques (Figures 2 and 3). *Anopheles deaneorum* was the second most abundant anopheline collected in the town of Costa Marques (18%) and together with *An. darlingi* comprised >99% of the total anophelines collected on human-bait at house 1. Three species, *An. darlingi* (85%), *An. albitarsis* (10%) and *An. deaneorum* (4%) comprised 98% of the anophelines collected in human-bait at house 5. Large differences in the average number of *An. deaneorum* and *An. albitarsis* were observed between house 1 and house 5 (Figure 2). Comparisons between house 1 and house 5 were only made for *An. darlingi* and *An. deaneorum* because other anopheline species were infrequently collected in either bovine or human-bait captures in the town of Costa Marques.

In bovine-bait collections in the town of Costa Marques, 77% of the anophelines collected were *An. darlingi* while 15% were *An. deaneorum*. There was only a slight increase in the percent of the remaining species of anophelines collected on bovine-bait. At house 1, there was little difference in the percentage of *An. darlingi* and *An. deaneorum* collected on human- and bovine-bait (Figure 2). However, 7 km from Costa Marques (house 5), where the diversity of anophelines was much greater, *An. darlingi* only comprised 29% while *An. albitarsis* comprised 52% of the anophelines from bovine-bait collections (Figures 2 and 3). *Anopheles darlingi* and *An. deaneorum* demonstrate a preference for feeding on humans and were collected in houses more frequently than the other anopheline species. *Anopheles albitarsis* collected on bovine-bait was 7X greater than those collected on human-bait (Figure 4). The percentage of *An. oswaldoi* and *An. triannulatus* collected in bovine-baited traps was also greater for the bovine-baited trap.

DISCUSSION

Anopheles darlingi and *An. deaneorum* are likely the most important malaria vectors in Costa Marques based on their seasonal distribution, frequency, endophilic and anthropophilic behavior and susceptibility to malaria parasites^{7 8 9}. However, *An. deaneorum* is only seasonally abundant during the late rainy to early dry season and therefore only augments malaria transmission from May through September in

Costa Marques⁷. Since *Anopheles albitarsis* is zoophilic, not susceptible to *P. falciparum* and less susceptible to oocyst infection by *P. vivax* than *An. darlingi*^{8 9}, we feel that this species is likely a secondary vector. *Anopheles mediopunctatus* is equally susceptible to sporozoite infection by *P. falciparum* but is less susceptible to oocyst infection by *P. vivax* than *An. darlingi* and is only collected in forested areas and is also seasonal (unpublished data). This species may be seasonally important for malaria transmission for persons frequenting or living in forest habitats.

While *An. darlingi* and *An. deaneorum* were both more anthropophilic than other anophelines collected in Costa Marques, a large proportion were collected in the bovine-baited trap (Table 1). In areas where mosquito biting activity is crepuscular and present control measures are not effective, zoophylaxis, or a technique to divert mosquitoes seeking a blood meal away from man, may be effective in reducing human malaria. This must be thoroughly investigated since the degree of anthropophilic behavior, location in relation to breeding sites of the animal bait and potential increase in mosquito density by increased success of blood-feeding also affects the frequency of mosquito bites on man and the infection rate of malaria¹⁴. Schultz¹² demonstrated that people received approximately 40% fewer bites outdoors from *An. flavirostris* and *An. annularis* when the animal bait was placed between the human population and larval habitats or adult resting sites. However, the frequency of mosquitoes collected indoors for *An. flavirostris* and *An. annularis* increased by 1.5X and 11.8X, respectively, when cattle were placed near houses. White and Rosen¹⁵ further demonstrated that there was no difference in the vectorial capacity of *An. gambiae* and *An. arabiensis* when cattle were not present. In the presence of cattle, the vectorial capacity of *An. arabiensis* was much lower than *An. gambiae* because of its zoophilic feeding preference¹⁵. However, Sota and Mogi¹⁴ suggest that by introducing cattle, anopheline population densities may increase through greater success of blood-feeding. This may have an adverse affect by increasing the frequency of mosquito bites on man and the infection rate of malaria.

The vectorial capacity of *An. albitarsis* as well as other species may be reduced dramatically when cattle are present due to their exophilic behavior and its preference for cattle as hosts. In the absence of alternate domestic hosts or high population densities, *An. albitarsis* may become an important vector of *Plasmodium vivax* in rural areas of Costa Marques^{8 11}. Evidence also indicates that in the absence of alternate domestic hosts, *An. triannulatus* and *An.*

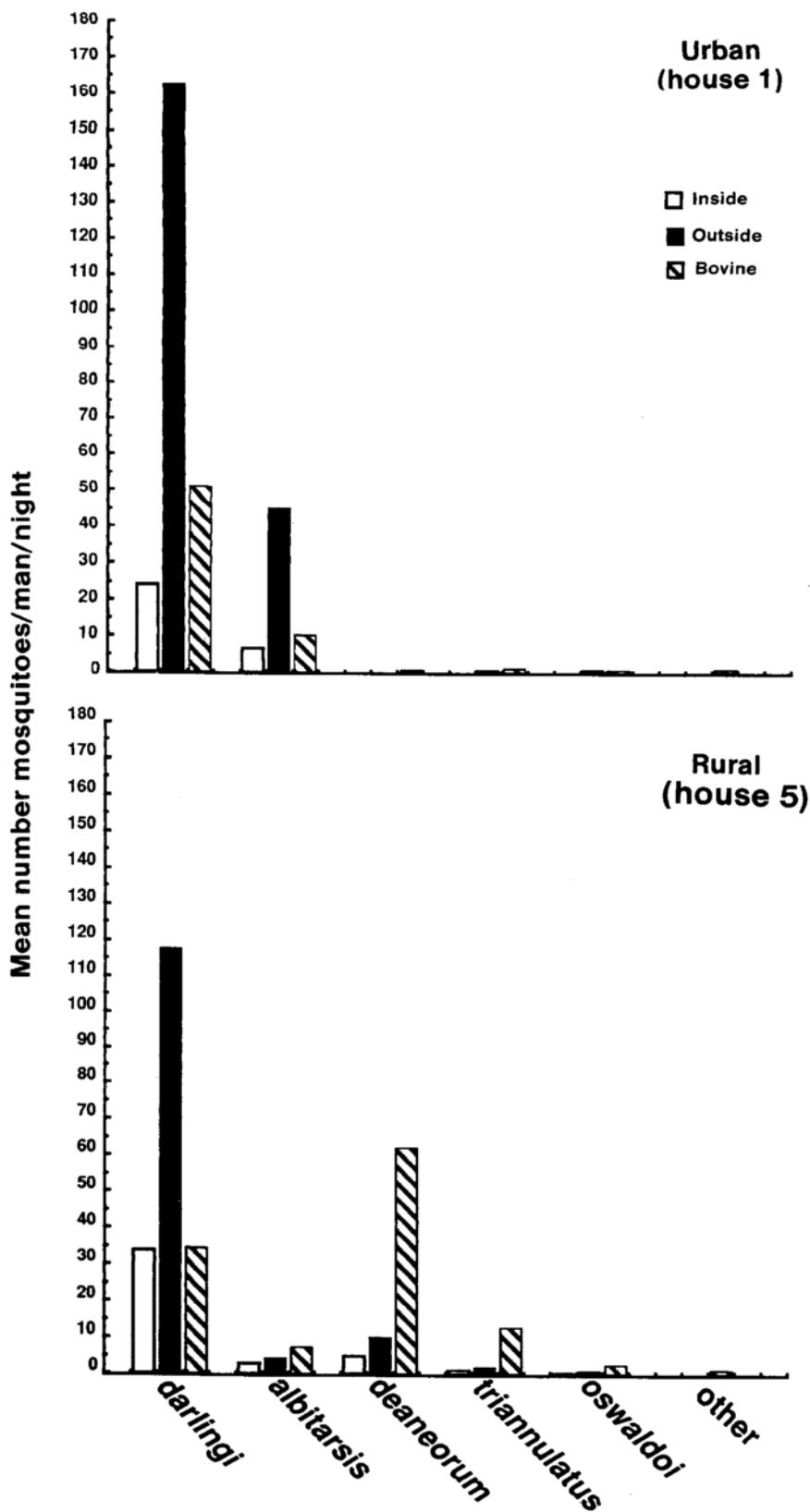


Figure 2 - Mean number of anopheline mosquitoes/man/night in human- and bovine-bait collections at house 1 in Costa Marques and at house 5 along road BR-429 from April through September, 1987.

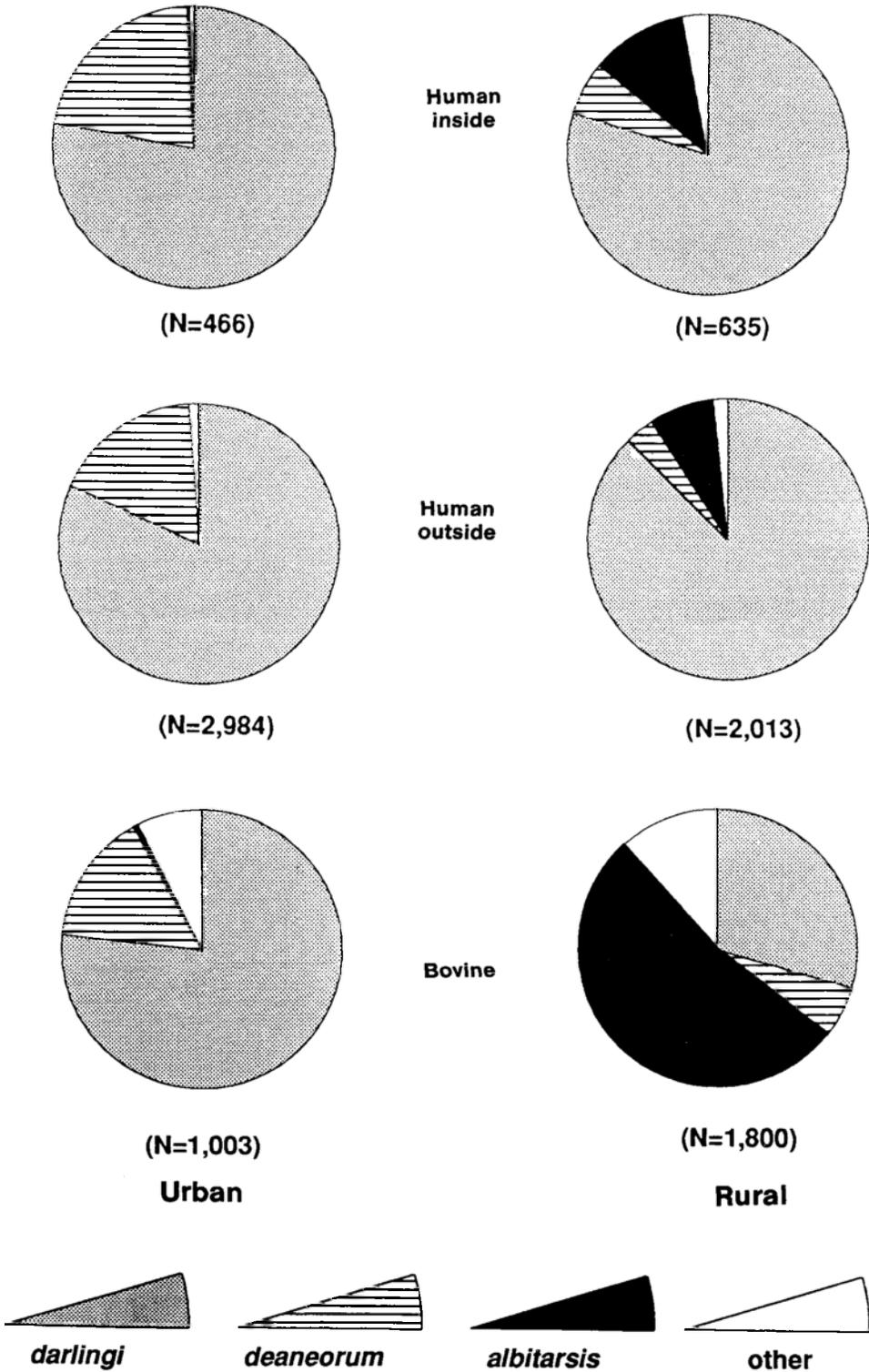


Figure 3 – Percentage of *Anopheles* mosquitoes collected indoors and outdoors on human-bait outdoors and on bovine-bait in the town of Costa Marques (urban) and at km 7 (rural), BR 429, Costa Marques, Rondonia from April through September, 1987.

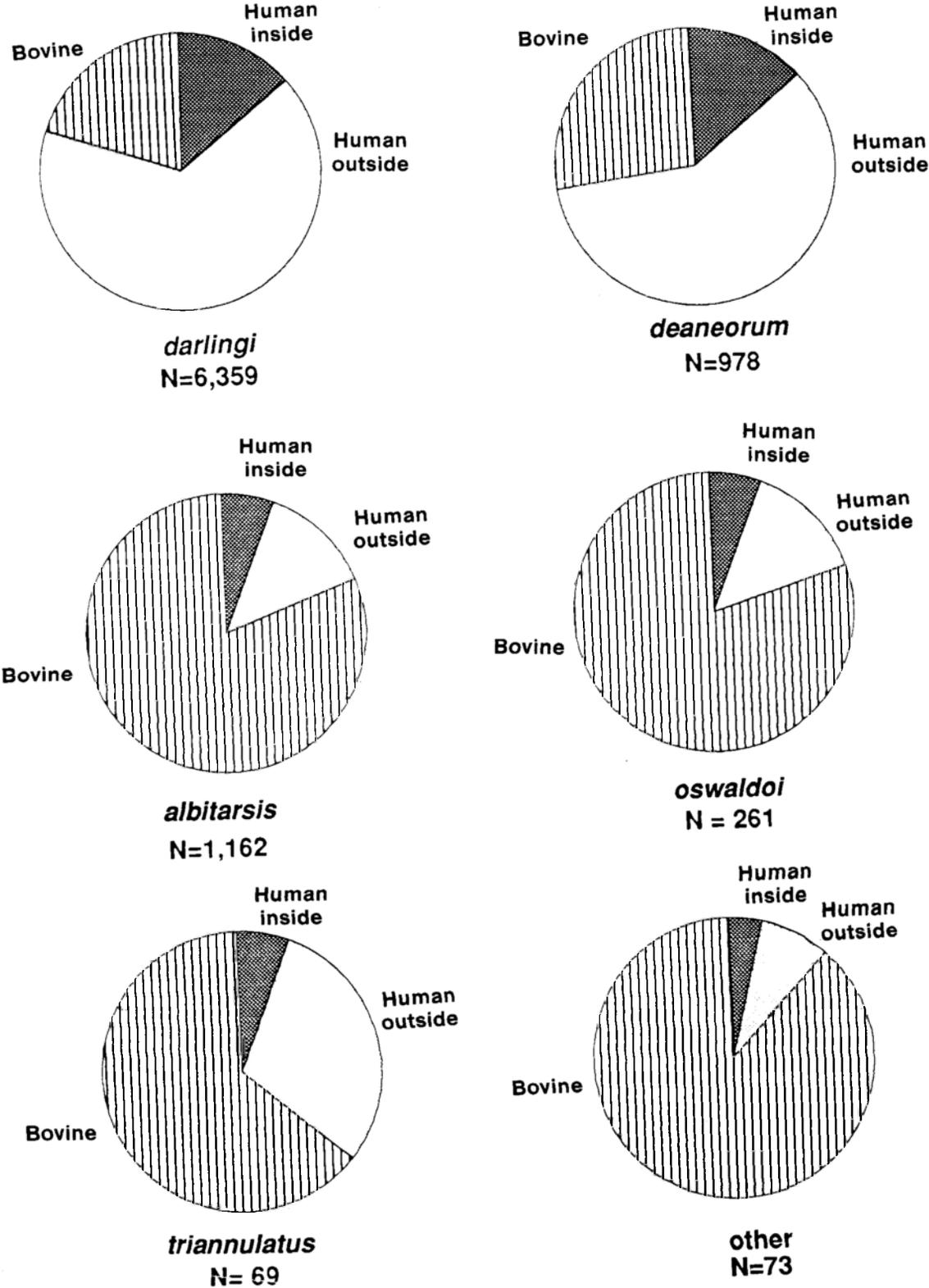


Figure 4 – Comparison of feeding preference of *Anopheles* species collected on human-bait inside and outside houses 1 and 5 on bovine-bait, Costa Marques, Rondonia, from April through September, 1987.

oswaldoi readily bite man. However, their importance in malaria transmission is probably much less because sporozoites were rarely found in the salivary glands of dissected mosquitoes in malaria susceptibility tests^{8,9}.

It is difficult to make generalizations from one location to another because of current taxonomic problems with anophelines in the Amazon region^{2,7}. Data in the literature are often contradictory. For example, Faran and Linthicum⁴ and Charlwood and Wilkes¹ report that *An. triannulatus* is zoophilic, rarely enters houses, but readily feeds on man outdoors, while Gabaldon⁵ reports that this species primarily bites indoors. In our study, *An. triannulatus* rarely entered houses, but was frequently collected in human-bait collections in forested areas and along river margins. A larger percentage of *An. triannulatus* was collected in a bovine-baited trap, indicating a zoophilic preference.

Faran and Linthicum⁴ report that *An. oswaldoi* adults are largely restricted to the forest, and are exophilic and zoophilic. In other studies, populations of *An. oswaldoi* were generally restricted to forest habitats and these mosquitoes readily bite man during the early evening and daytime when the sky was overcast (Klein and Lima, unpublished data).

Shannon and Davis¹³ indicated that *An. albitalarsis sensu lato* did not, as a rule, enter houses as frequently as *An. darlingi*, but it will invade houses in relatively large numbers. In Costa Marques, *An. deaneorum* readily enters houses, is anthropophilic, and is a vector of both *P. falciparum* and *P. vivax*. In contrast, *An. albitalarsis* in Costa Marques is zoophilic, but will also bite man and enter poorly constructed houses with large spaces in the walls⁶.

In summary, zoophylaxis may reduce the vectorial capacity of anopheline human malaria vectors in some areas of Brazil. However, the endophilic/exophilic and anthropophilic/zoophilic behavior of potential vector populations need to be evaluated more closely to determine the effectiveness of this method against malaria. With a strongly anthropophilic species like *An. darlingi*, alternate host availability may have little effect in reducing the incidence of malaria. Additionally, behavioral studies frequently lead to recognition of taxonomic problems and identification of potential vector populations/species. Resolving vector systematic problems ultimately results in a more effective malaria control program by allowing specific vector species to be identified and targeted.

RESUMO

Para determinar o comportamento antropofílico e zoofílico dos anofelinos, foram capturados mosquitos na periferia e na zona urbana de Costa Marques, Rondônia,

Brasil. Foram comparadas as capturas feitas à noite, com iscas bovinas e humanas, dentro e fora de casa. O *Anopheles darlingi* e o *Anopheles deaneorum* foram mais antropofílicos do que os outros anofelinos capturados. O restante das espécies anofelinas foi capturado mais frequentemente nas iscas bovinas do que nas humanas. *Anopheles darlingi* e *Anopheles deaneorum* foram capturados dentro de casa com mais frequência do que as outras espécies anofelinas. Porém, quando a captura foi feita em casas com muitas aberturas nas paredes houve pouca diferença nas porcentagens de cada espécie sugadora de humanos dentro e fora de casa. *Anopheles darlingi* foi o mosquito capturado com mais frequência, dentro e fora de casa, e apresentava maior antropofilia em relação aos outros anofelinos presentes.

Palavras-chaves: *Anopheles* sp. Brasil. Comportamento. Antropofílico. Zoofílico.

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