Revista da Sociedade Brasileira de Medicina Tropical 38(4):336-338, jul-ago, 2005

Preliminary study into the landing behaviour on the human body of morning-biting mosquitoes in Atlantic forest in the State of Santa Catarina (Diptera: Culicidae)

Estudo preliminar sobre o comportamento de pouso no corpo humano de mosquitos de atividade matutina em Mata Atlântica no Estado de Santa Catarina

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ABSTRACT

Mosquitoes (22 species) (0.5%) and Runchomyia reversa *(5%) biting humans in the morning in Florianópolis, State of Santa Catarina, were significantly more common below than above waist and all* Wyeomyia incaudata *were collected below the waist. Short trousers are not recommended, unless using repellents.*

***Key-words*:** *Culicidae*. Runchomyia reversa. Ochlerotatus scapularis. *Protection*. *Landing Behaviour*.

RESUMO

Mosquitos (22 espécies) (0,5%) e Runchomyia reversa *(5%), pousando em humanos pela manhã em Florianópolis, Santa Catarina, foram significativamente mais numerosos abaixo da cintura, e todos os* Wyeomyia incaudata *foram coletados abaixo da cintura. Estes dados reforçam não ser recomendável utilizar calças curtas na floresta, a menos que se usem repelentes.*

Palavras-chaves: *Culicidae*. Runchomyia reversa. Ochlerotatus scapularis. *Proteção. Comportamento de pouso.*

Mosquitoes can transmit several pathogenic agents by the bite to human and to several animals, including *Plasmodium* spp, helminths and arboviruses. Several methods have been proposed for the personal protection of humans, including repellents and special clothes[16]. Since mosquitoes prefer to land and to bite one or another part of the body, a comprehension of this distribution can be useful for protection.

Studies have indicated different behaviors for the various mosquito species (e.g.[3,17]); Service[17] revised thoroughly the studies on bait catches of mosquitoes, including the distribution of bites on the body and factors influencing this, such as the elimination of CO_2, height of flight and smell.

The growing number of people walking in Atlantic forest, for tourism, research and other activities indicates a need for more knowledge on the biting habits of mosquitoes and on means of protection. Despite the continental dimensions and regional differences of Brazil, the distribution of landing on the human body has only been studied in the Amazon forest[3].

The landing behaviour of mosquitoes on the human body was studied in the morning in a secondary Atlantic forest on the Island of Santa Catarina, State of Santa Catarina, in southern Brazil.

Mosquitoes were collected along a trail in a conservation unit in the North of the Santa Catarina Island ("Unidade de Conservação Ambiental Desterro", henceforward abbreviated UCAD; 27º31'50.8" S, 48º30'44.3" W), Municipality of Florianópolis, State of Santa Catarina. The unit has been described elsewhere[15]. Briefly, it has 491.5ha and is covered by dense Atlantic rain forest, partly damaged many years ago, and now in recuperation; the trail is 971 m long, with altitudes varying from 25 to 150m a.s.l. The collectors, one of them (CBM) wearing short trousers (mid thigh), *regatta* shirt and boots with short socks, and the other full clothing, collected mosquitoes landing on each of their bodies using suction and plastic tubes. They walked rapidly along the trail, stopping at ten points, and collecting for seven minutes at each one; the points have been

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Partially financed by CNPq (Proc.-690143/01-0).

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Recebido em: 17/08/04
Aceito para publicação em 3/5/2005

described previously[15]. Collections were started 1-1.5 hours after sunrise, and developed weekly from September to December 2001 (spring). Two collections were done at a point (10) from 7 to 11 a.m., 15 minutes per hour; both were interrupted by strong winds at this hour.

Mosquitoes collected above and below waist were preserved in separate killing bottles, containing ethyl acetate, transferred on the same day to dry boxes, and afterwards fixed, if necessary, to triangles on pins, ready to be identified by the use of keys[4 8 9 10], besides comparison with original descriptions and insects in the collection of *Faculdade de Saúde Pública* of *Universidade de São Paulo*, São Paulo. Data were analyzed by ANOVA with one variable.

A total of 353 female mosquitoes were collected (Table 1). They belonged to 22 species, 17 were classified in Sabethini. The statistical analysis was only performed for the most common species (*Runchomyia reversa* and *Ochlerotatus scapularis*). An additional analysis was performed taking the mosquitoes as a whole.

Ru. reversa was significantly more common below than above the waist (mean: 3 vs. 0.43 mosquitoes/sample; F = 6.56 vs. $F_{crit, 5\%} = 4.0$). The difference for *Oc. scapularis* (mean: 1.09 vs. 0.77 m/sample; F = 2.31 vs. $F_{crit, 10\%} = 2.78$), similar to that of *Ru. reversa*, was not significant even at 10%. The sum of mosquitoes below the waist was significantly higher than above (mean: 3.33 vs. 1.25 m/sample; F = 9.89 vs. $F_{crit, 0.5\%} = 8.11$). Several species (e.g., *Anopheles cruzii*) seem to be more common below the waist, and have even been collected only below it (*Wyeomyia incaudata* and some other *Wyeomyia*).

Table 1 - Distribution of mosquitoes landing on the human body in Atlantic forest during the morning at Florianópolis, State of Santa Catarina, Brazil

Species/ body regions	Above waist	Below waist	Total
Aedes albopictus	1	-	1
Anopheles cruzii	4	15	19
Culex (Melanoconium) sp	-	2	2
Culex (Microculex) sp	-	1	1
Limatus durhami	5	-	5
Ochlerotatus scapularis	32	33	65
Ochlerotatus serratus	4	2	6
Psorophora ferox	3	-	3
Runchomyia reversa	10	94	104
Sabethes (Sabethinus) sp	1	-	1
Sabethes albiprivus	1	-	1
Sabethes aurescens	1	-	1
Shannoniana fluviatilis	3	8	11
Trichoprosopon digitatum	6	6	12
Wyeomyia bourrouli	1	-	1
Wyeomyia (Pho) davisi	1	3	4
Wyeomyia (Den) sp	1	-	1
Wyeomyia (Pho) fuscipes	-	1	1
Wyeomyia (Pho) galvaoi	-	12	12
Wyeomyia (Pho) incaudata	-	37	37
Wyeomyia (Wye) sp	1	-	1
Wyeomyia bourrouli	2	-	2
Wyeomyia (Pho) pallidoventer	-	4	4
Wyeomyia (Pho) palmata	-	2	2
Wyeomyia (Pho) pilicauda	-	1	1
Wyeomyia (Pho) splendida	-	1	1
Wyeomyia (Pho) theobaldi	3	11	14
Wyeomyia (Pho) damaged	5	16	21
Wyeomyia damaged	6	4	10
Culicidae damaged	1	8	9
Total	**92**	**261**	**353**

Results of the species for which it was developed a statistical analysis and for the sum of mosquitoes indicate that it is recommendable to protect mostly below the waist for walking in the morning in this area. Young walkers, mostly students, besides people collecting wood and other materials, frequently use short trousers *(bermudas*) and low boots to walk in the forest. If people insist on leaving their legs exposed, they should apply repellents, preferably those containing deet (N,N-diethyl-meta-toluamide)[5]. Thick socks combined with long trousers offer good protection when the bottoms of the trousers are tucked into the socks[16]; in fact, one of the trainees of our laboratory, who did not do this, was appalled by the entry of a large beetle into his paints. The fact that hard tick larvae *micuins*), snakes, ants and other harmful animals are common in this area, and probably in similar Atlantic forest areas reinforces the need to properly protect the legs, by applying deet both on the skin and on clothing.

Oc. scapularis is probably an important vector of *Dirofilaria immitis* in the State of Rio de Janeiro[7], and this worm is very common (15%) among dogs in the region of Conceição Lagoon[1], some kilometers from the area where this study was developed. Two other species previously reported to be infected with microfilariae of *D. immitis*, *Ae. albopictus*[2] and *Wy. bourrouli*[7], were collected in UCAD, respectively on humans[15] and in a bromeliad[12]. However, since this worm seems to occur mostly in association with dogs, houses and modified environments, the risk in uninhabited forests similar to UCAD is negligible. *Oc. scapularis* was also incriminated as a vector of Rocio virus in the State of São Paulo[4]; this dangerous virus should be investigated in UCAD and other localities in Santa Catarina, before human cases occur.

A study of preferences for body parts in diurnal mosquitoes in the canopy of Amazonian rain forest[3] indicated that *Haemagogus janthinomys* preferred to land on the legs and mostly on the feet, while species of *Sabethes* preferred the head; the bait collector wore only bathing trunks. The study at UCAD included nine collections, totaling 8.6 hours, compared to 255 hours of collections (85 days, three hours per day) in the other study; moreover, the present study was developed on the ground, while in the Amazonian study mosquitoes were collected at 15 or 20 m above ground level. The mean number of mosquitoes collected per hour (sum of collected mosquitoes/hour) were, respectively for the study in Amazon and that in UCAD, 2.9 and 41.6. Thus, the intensity of attack by mosquitoes seems to be much higher in the UCAD study when compared with the Amazonian study.

Sabethes mosquitoes were rare in the present study (0.35/ hour), in comparison with the Amazonian study (2.22/ hour). This rarity of mosquitoes of *Sabethes* in the UCAD study could be due to biological characteristics of the local species and to differences in methods, but it is more probably due to the scarcity of breeding sites. *Sa. aurescens* is currently very common in bamboo holes in 2003[13], at one of the points of collection (n. 9) of[15], while

bamboo internodes perforated by animals and tree-holes are very rare in the area (CB Marcondes- unpublished results). Two small holes (10-15ml of water) in a palm tree cited before[12], near point 8 of[15] have always had immature forms of mosquitoes, including *Sa. albiprivus*, *Sa. purpureus* and *Toxorhynchites* sp. (CB Marcondes: unpublished results). This indicates that the available breeding places in phytotelmata are well exploited by local mosquitoes. The three *Sabethes* mosquitoes were collected around 10:30 a.m., on November 1st, landing above the waist.

Studies on landing behaviour in which mosquitoes are collected for a long period (e. g.[3]) may show a depletion of the quantities collected after a peak of activity in the first few minutes. The rapid movement of the collectors/baits in the study of UCAD, between the points, may have stimulated some diurnal mosquitoes, resting in the vegetation, to bite, as previously observed (see[17], p. 352). This behaviour is similar to that of walkers in the forest, and differences in the methods can impede a precise comparison between these studies.

The application of repellent on feet and ankles prevented bites of *An. arabiensis* on these parts of the body, and reduced by more than three-fold the total number of bites, modifying the proportion of bites on other parts from 18.9 to 100%[6]. Consequently, even with good protection of those parts of the body preferred by the mosquitoes, it is necessary to evaluate the transference of the mosquitoes to other parts; whenever this occurs, a more comprehensive protection is necessary.

More detailed studies on the landing behaviour of mosquitoes and other biting insects must be undertaken in the Atlantic forest, over a longer period and noting the environmental conditions during collection.

ACKNOWLEDGEMENTS

To Drs. Oswaldo Paulo Forattini and Iná Kakitani, and to Mr. Aristides Fernandes, of Faculdade de Saúde Pública of Universidade de São Paulo, for the useful comments, for the checking the identification of some mosquitoes and for training one of the authors (UP). To Dr. Maike Hering Queiroz, of Departamento de Botânica of Universidade Federal de Santa Catarina, for authorization to study the collections in UCAD, and to Mr. Silvânio G. Costa, for the help in the field work.

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