

DERMATOZOONOSIS BY *CULICOIDES*' BITE
(DIPTERA, CERATOPOGONIDAE) IN SALVADOR,
STATE OF BAHIA, BRAZIL

II — *The Bionomics of the Culicoides* *

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(With 11 text-figures)

With our previous paper (5), in which we presented a systematic and morphological study of the species of *Culicoides* collected in Salvador, we began a series of papers on "Dermatozoonosis by *Culicoides*' bite".

In this second paper we present some data concerning the biology of the *Culicoides* under natural conditions.

MATERIAL AND METHODS

The methods of collectings, preservation and identification of *Culicoides* were the same as described in our previous paper (5).

For observation of the seasonal fluctuation, we chose two districts that, for certain reasons, would make our work much easier. From 1959 to 1963 seven hundred and eleven collectings were made for four days in the district of "Graça", in each month. They were performed on the same places, using human as baits. We worked for two hours each day and collected two thousand six hundred and twelve specimens of *Culicoides*.

From 1959 to 1961, five hundred and forty three *Culicoides* were caught in district of Canela, in monthly collectings. Dr. Pedro Sarno, from "Fundação Gonçalo Moniz", transferred them to us.

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For observation of the hourly incidence, eight collectings each one of twenty four hours consecutively were made in district of Graça at different times in the years 1962 and 1963.

We also used the Damasceno trap to collect *Culicoides* on tree trunks, rotten leaves and organical debris, in order to gather some information on possible natural shelters of the adult diptera.

Concerning research on natural breeding places, we examined several samples of liquids obtained from water collections in tree roles, between banana leaves, bromelia and in tin cans or dumps. We kept those samples in Borrel glasses covered with cloth, and for twenty days made daily observation for emerging adults. However, we did not obtain one single specimen of culicoides. We are carrying these observations, which will be subject of a future paper.

The metereological data recorded here were obtained by the "Serviço de Metereologia da Bahia do Ministério da Agricultura" (Table I and II).

AREA UNDER STUDY

The present brief description of Salvador is based on data from the "Instituto Brasileiro de Geografia e Estatística".

The city of Salvador is located in a bay on the Atlantic coast of Brazil, the — "Baía de Todos os Santos" —, at latitude $12^{\circ} 55' 34''$ and longitude $38^{\circ} 31' 12''$. Because of its topography, there is a variety of altitudes, the maximum of which is 119.091 meters above sea level. At sea level there is a big stretch of land that is called "Lower City" and at about 70 meters high most of the "Higher City" is located (Fig. 1 and 2).

The local vegetation is made up of surinan cherry trees and coconut trees, that cover generally sand banks, characteristic of the maritime coast. On the plateaus there are copses (Figs. 3 and 4).

The following are the main aspects of the topography: a) a level plain where the "Lower City" is located that stretches to the inland with low hills and wider plains; b) high hill and narrow esplanades that are on a papallel line with the elements described above; c) hills, mounds and valleys near the mouth of "Rio Vermelho", a small river that crosses the city and flows directly into the Atlantic Ocean; d) a discontinous scarp, stretching for over twenty Kilometers Southwestward and Northwestward, with 60 to 80 meters of level grounds (Fig. 5).

Along the Atlantic, there are areas of marine sedimentation dotted with weather beaten reefs and a large band of sand soil that bordes the beaches as far as "Pituba". Beyond the level of the high tide and parallel to the coast there is a long line of coconut trees (Fig. 4).

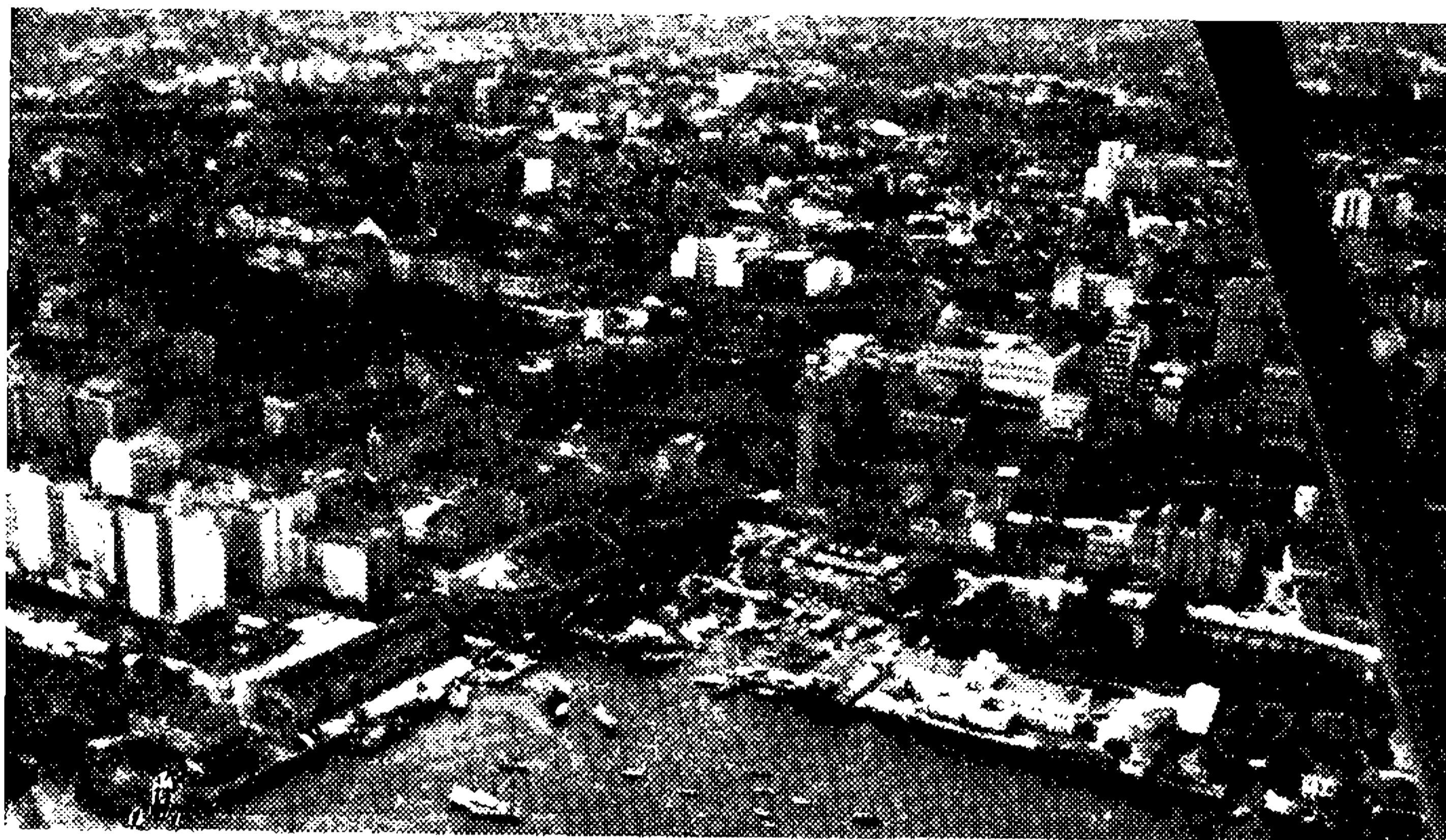


Fig.1

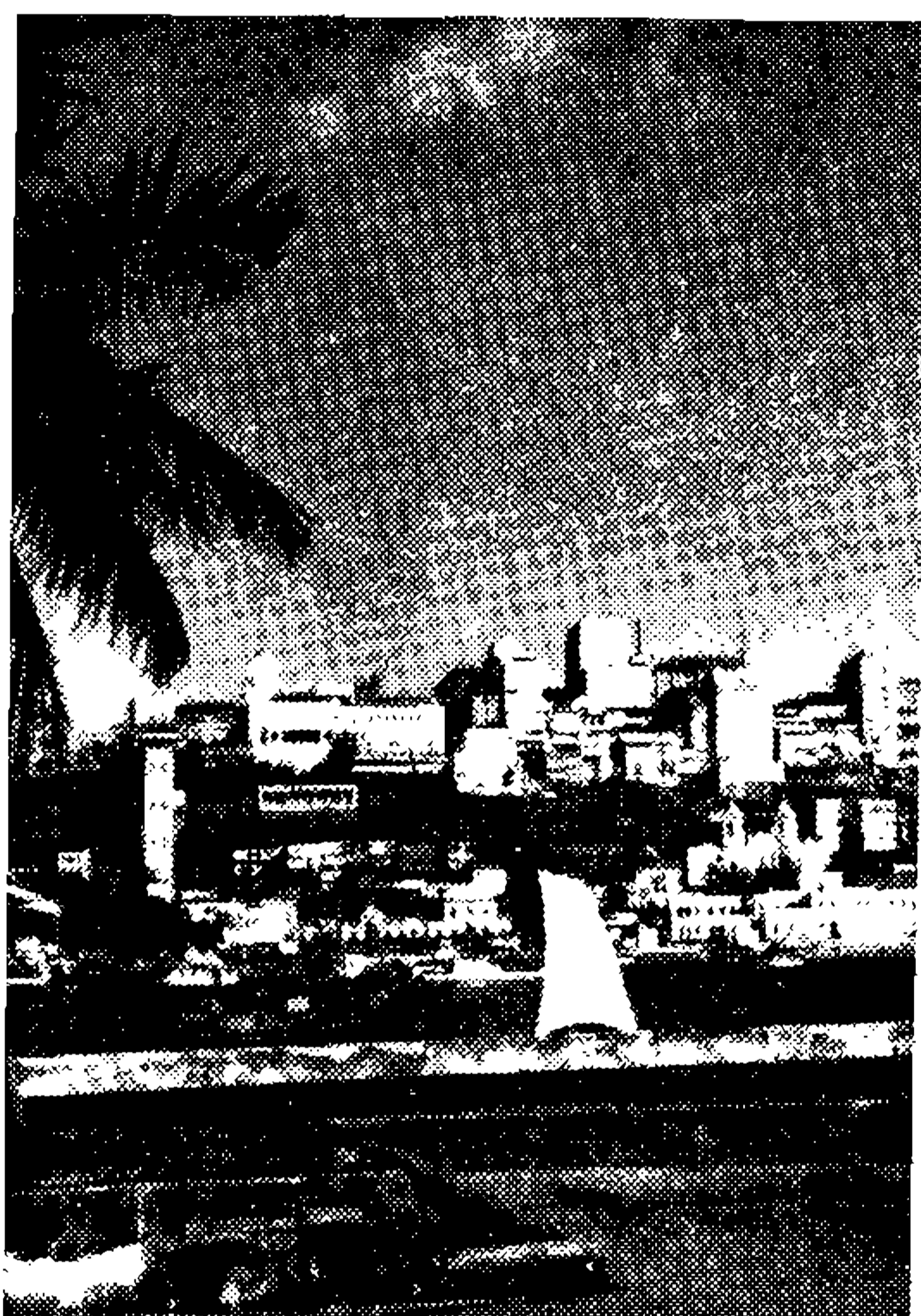


Fig.2



Fig.3



Fig.4

- Fig. 1 — Panoramic view of Salvador.
Fig. 2 — Aspects of "Higher and Lower City" of Salvador.
Fig. 3 — Dunes with characteristic vegetation fixing them.
Fig. 4 — Aspects of the Salvador coast with characteristic coconut trees and copses.

Away from the coast on the main land there are high dunes that are formed by the daily Atlantic breezes whereas characteristic vegetation fixes them (Fig. 3).

Small rivers cross the city such as the "Joanes", and a few creeks as the "Imbirucu", "Itamboata" and "Ipituaja".

The biggest lagoon is the "Dique" (1.7 Kilometers long and 200 meters wide); there are also little ones, such as "Tanque do Meio" and the "Tanque da Conceição".

It rains quite a lot in the city. The rainy season, that people call "winter", goes from April till August. From September to March there is little rain and this period is called "summer".

Generally the highest temperatures are recorded during the months from November to March and the lowest in the month of July. The temperature range shifts from a minimum of 18.7°C to a maximum of 36.6°C.

Summing up, we could say as O. Mangabeira Filho that "the City of Salvador, due to enviromental conditions, is a truly natural insectary".

RESULTS AND DISCUSSION

PREDOMINANCE OF CULICOIDES SPECIES

According to our previous discussion on the subject (5), four species of *Culicoides* are recorded in Salvador. *C. paraensis* (Goeldi, 1905) predominates, making up ninety eight per cent of the specimens collected. For this reason, it deserves special attention in this work. The other three species are mentioned in Table III.

TABLE III

Species of *Culicoides* recorded for Salvador, from 1959 to 1963

SPECIES	N.º of females collected	Percentage
<i>Culicoides</i> (O.) <i>paraensis</i> (Goeldi, 1905).....	2,897	98.2 %
<i>Culicoides</i> (O.) <i>limonensis</i> Crtiz & Leon, 1955	14	0.5 %
<i>Culicoides</i> (C.) <i>flavivenula</i> Costa Lima, 1937.....	34	1.2 %
<i>Culicoides</i> (C.) <i>insignis</i> Lutz, 1913.....	2	0.1 %
TOTAL.....	2,947	100.0 %

PREDOMINANCE OF SPECIES ACCORDING TO THE PLACES OF COLLECTINGS

C. paraensis is mostly found in places far from the coast, although some may be also collected near it. Its density was always high on the different sites of collecting, varying with the time of year.

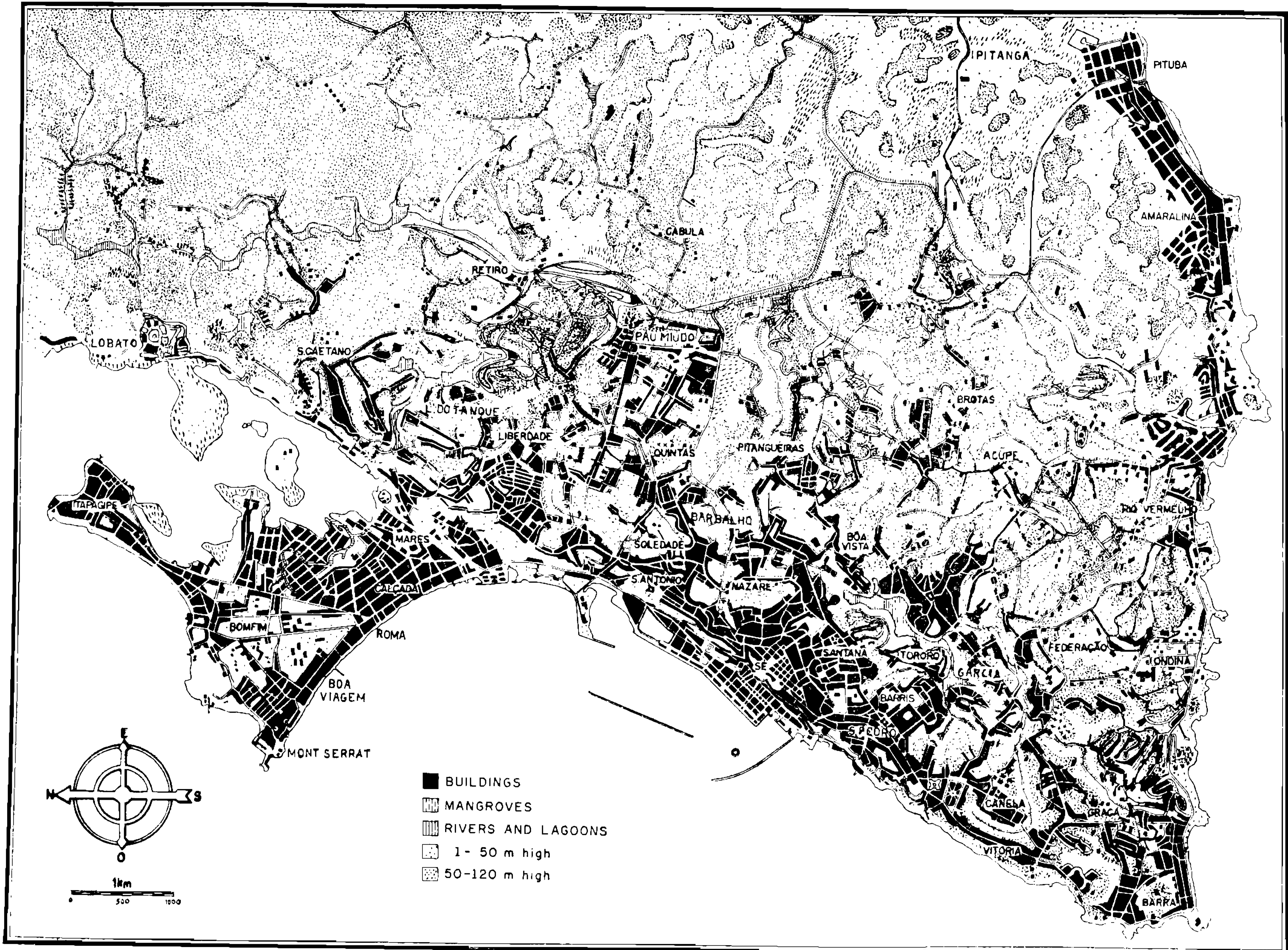


Fig. 5 — Map of Salvador adapted by the Authors from the plan of the Instituto de Saúde Pública da Bahia.

The density of *C. limonensis* was never high and, although it was collected together with *C. paraensis*, its biting activity is limited to certain hours (6 to 8 o'clock A. M.).

C. flavivenula was not collected on places far from mangroves. Its density on such places, however, was very high. Perhaps the number was small because we made few collectings in mangroves.

Only two specimens of *C. insignis* were obtained and they came together with *C. paraensis*.

NATURAL BREEDING PLACES

Unfortunately, there is no observation about the natural breeding places of *C. paraensis*. The examination of several samples of water obtained in different places did not give us any definite results.

In analogy with the well known fact that other species of *Culicoides* do not fly far away from the breeding places of the larvae, we thought that *C. paraensis* probably breeds in places where humidity is high or in pools of water gathered in tree holes, garbage cans and other vessels left on vacant lots or dumps.

HOURLY ACTIVITY

The biting activity of *C. paraensis* begins between five and six o'clock in the morning reaching its highest peak at three different hours during the day: seven o'clock A. M., noon and mainly at five P.M.

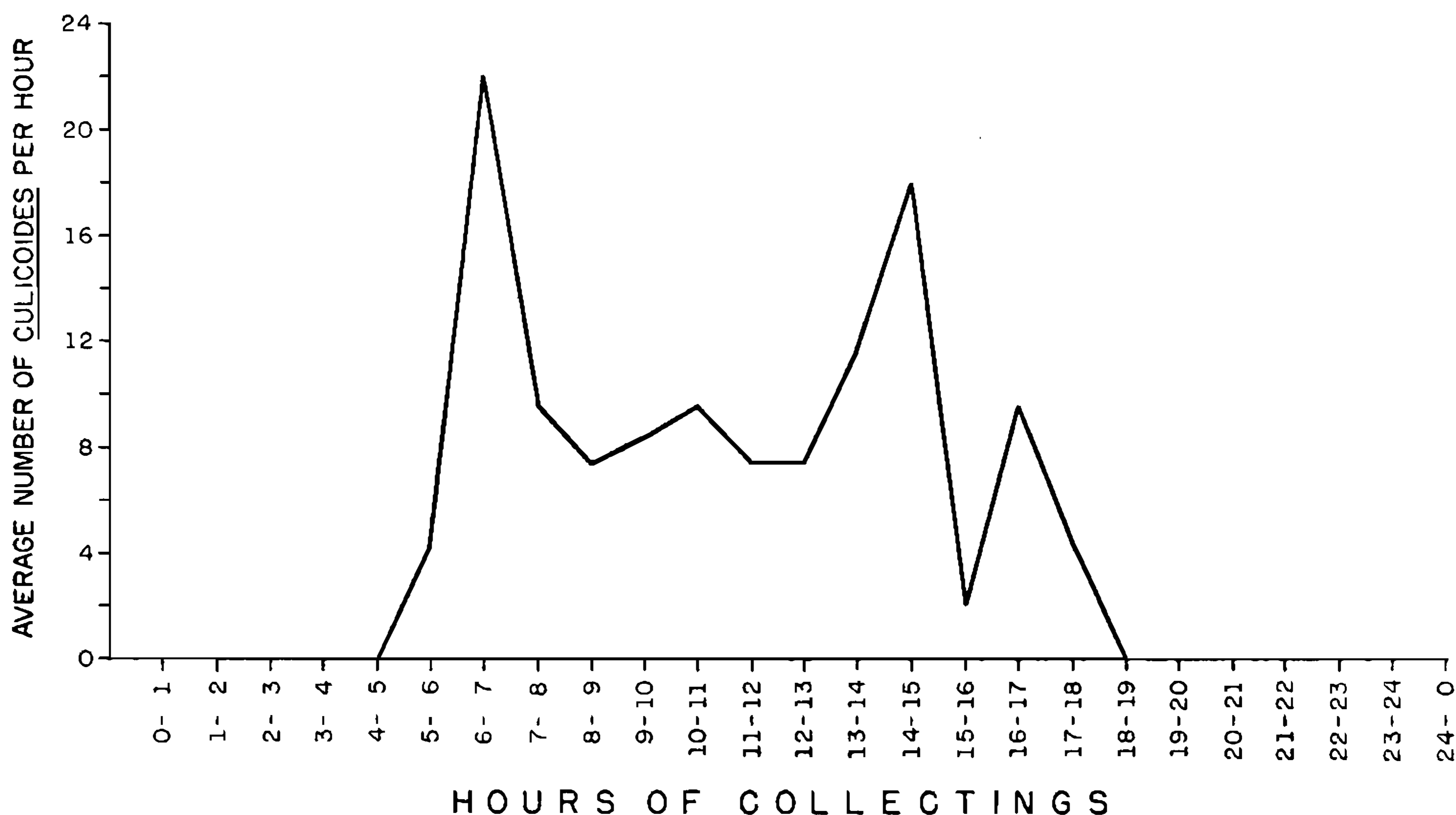


Fig. 6

Fig. 6 — Frequency per Hour of *Culicoides paraensis* in Salvador.

The culicoides remains active for a little while after five o'clock and disappear between six and seven o'clock in the evening (Fig. 6 and Table IV).

Culicoides limonensis appears on the same places where *C. paraensis* are found, but its biting activity is limited to the period from six to eight o'clock in the morning, after which it disappears. In the hours of highest activity their density was always low.

SEASONAL FLUCTUATIONS

The observations were limited only to a through study of *C. paraensis* for reasons mentioned before. As one can see on Table V, this species appears all year round, but it has a very marked seasonal fluctuation, as it is shown on the incidence curves (Fig. 7 and 8) and the meteorological data (Table I and II). Its highest density is observed during the rainiest and coldest months.

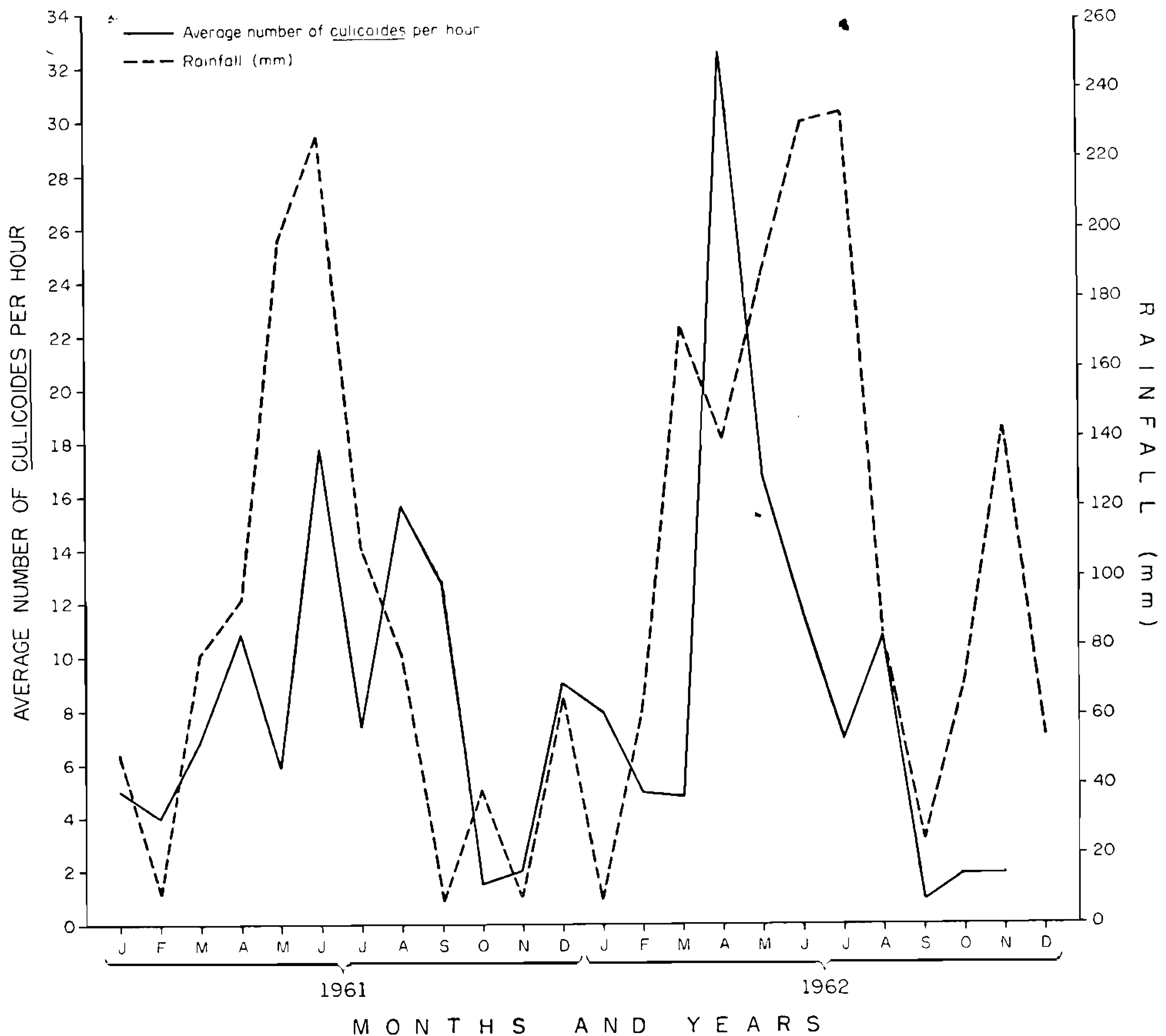


Fig. 7

Fig. 7 — Seasonal fluctuations of *Culicoides paraensis* in Salvador.

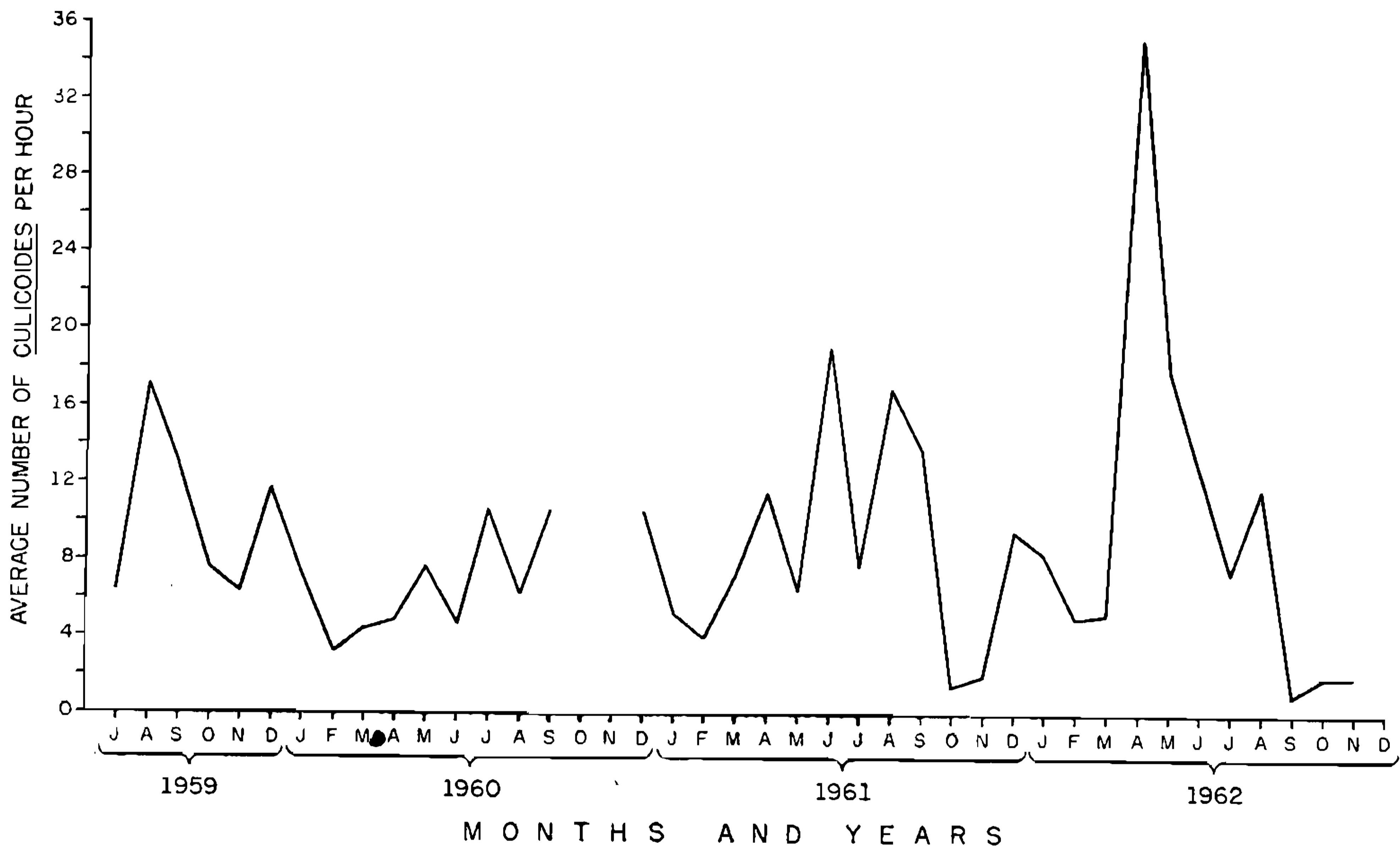


Fig. 8

NATURAL SHELTERS

Although several collectings were undertaken in several possible types of natural shelters, there is little we can say about the subject. The few specimens we collected were found on tree trunks or alighted on walls inside houses.

This contradicts the fact that a great number of culicoides are seen flying around or biting people inside homes. Kettle (4) has demonstrated that some species of *Culicoides* come into the houses for no other reason than to bite man; they are not looking for a natural shelter.

CHOICE OF HOSTS

It is well known that each species of *Culicoides* possesses a band of hosts from which they suck blood (4). We have not made any systematic observations on the biting choice of *C. paraensis*, but we can say for sure that this species has undoubtedly antropophilic habits.

CHOICE OF BITING SPOTS

According to Kettle (4), certain species of *Culicoides* show preference for certain regions of the human body, while others bite any region. Complaints against culicoides bites in Salvador generally refer to the

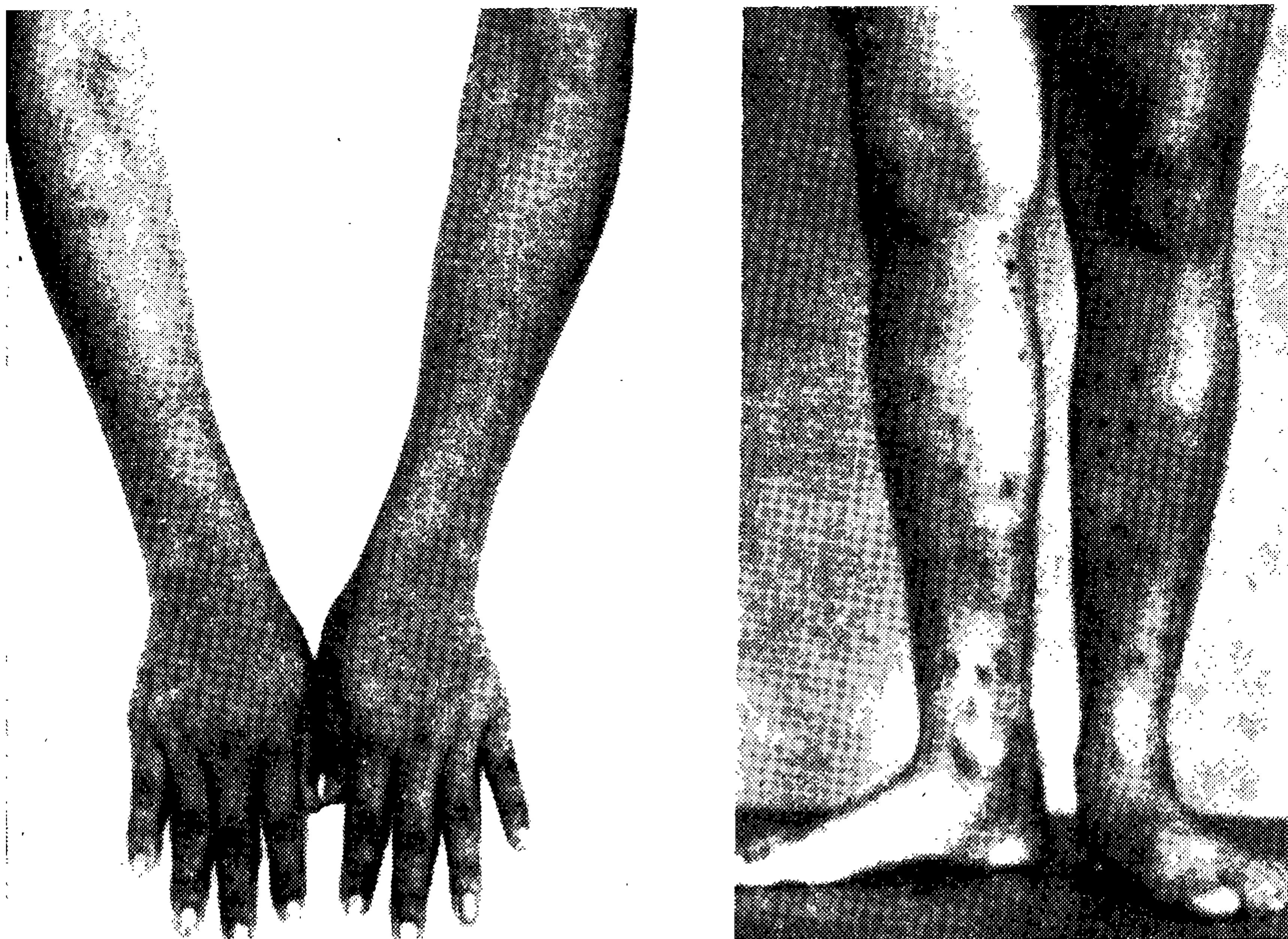


Fig. 8 — Lesions by *Culicoides'* bite on arms and legs of the same child showing the higher density on legs.



Fig. 9 — Lesions by *Culicoides'* bite on arms and legs of a diseased woman showing the higher density on legs.

legs as a favorite biting spot. We observed that most of the lesions on patients were located on lower limbs, although were also detected, in smaller number, on arms, face and other unprotected parts of the body (Figs. 9 to 10).

The following factors may have something to do with such a behaviour: a) — flight altitude — According to Guimarães & Oliveira Rocha (2) the lesions appear more frequently on the legs, because of the low range of the *Culicoides* flight. Against this point of view, we have observed that in houses two or three floors high, persons living on the first floor as well as persons living on the second or third are bitten with the same frequency on the legs. It would be, then, more correct to say that *C. paraensis* has low flight, preferring to fly closer to the ground;

b) — greater exposure of legs — women are specially bitten by *Culicoides*. Perhaps women's style of clothing make it easier for *Culicoides* to bite them on the legs. However, this cannot be considered a main factor because otherwise, arms and face would be equally soft spots (Figs. 9 and 10). We have also observed that children come in second as *Culicoides*' favorite hosts and that they are mostly bitten on their legs, although it is common in this part of the country for children to go naked a great part of time (Fig. 11);

c) — protection against light and air drifts — it is possible that *Culicoides*, in order to feed, try to find places that are protected from light, similarly to what happens with the majority of hematophagous

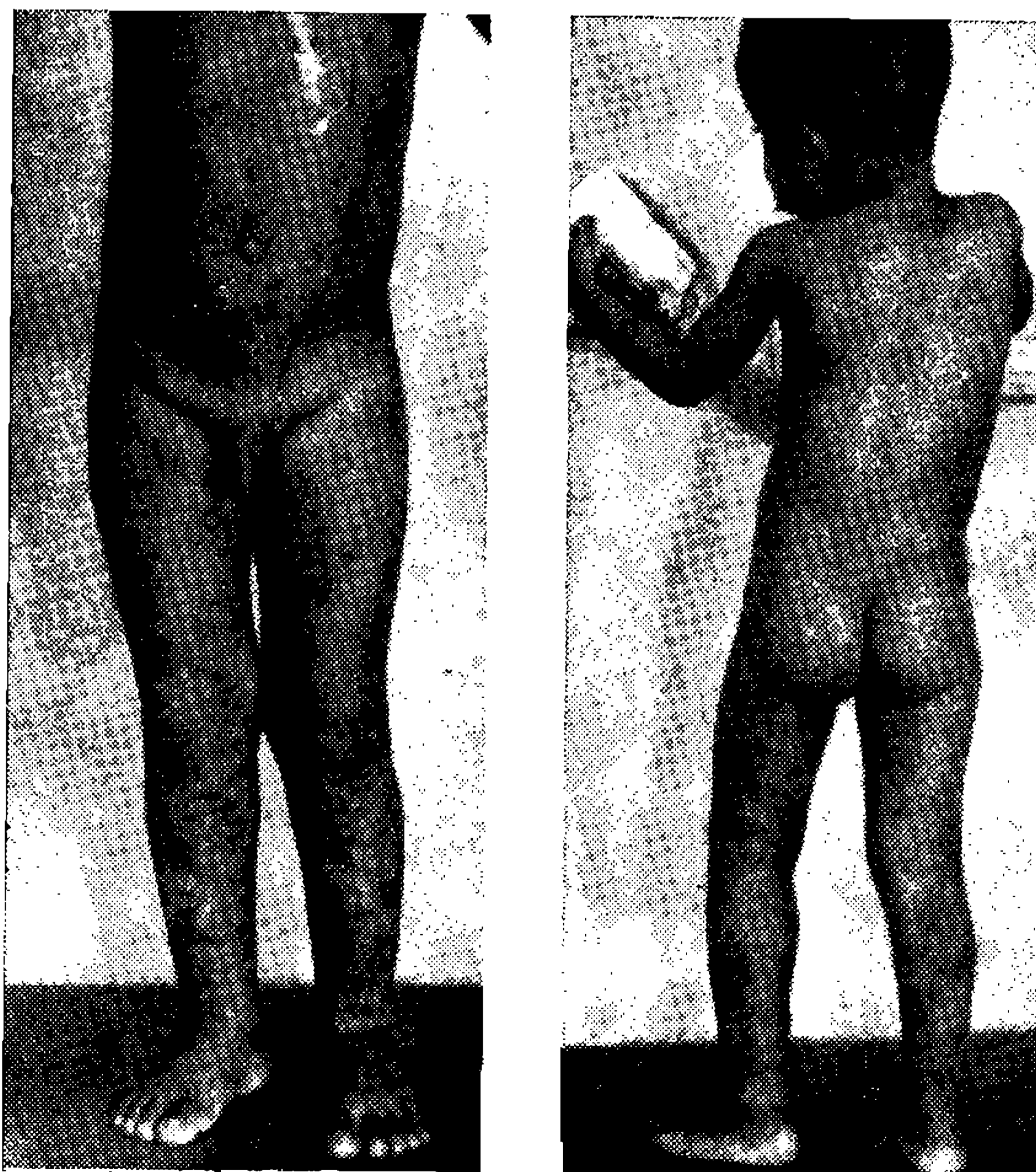


Fig. 10 — Child with lesions caused by *Culicoides* bite showing higher density on the legs.

insects. The lower limbs, because, inside the houses they are usually more protected against light, would be a favorite spot. Also, they are protected from air drifts that could perhaps carry the insect away during its flight. This hypothesis is opened to criticism, since *C. paraensis* even outdoors and in bright light tends to bite more frequently on the legs.;

d) — specific characteristic — we could also think of a specific characteristic, to which all the factors already mentioned would be added. This characteristics would make *C. paraensis* bite other parts of the body only under special circumstances. This characteristics has already been detected for other species of *Culicoides*. It is interesting to mention an example pointed out by Kettle (4) in which he says that *C. furens* and *C. barbosai* are simultaneously active and that the first prefer to bite the legs while the second bites the arms.

RESUMO

Neste segundo trabalho da série “Dermatozoonose pela picada de *Culicoides* em Salvador, Bahia”, os Autores apresentam dados sobre a bionomia das espécies encontradas em Salvador, em condições naturais.

Salientam que devido a localização geográfica e das condições de clima e umidade a cidade de Salvador apresenta condições ótimas para a proliferação do díptero.

Cerca de 98% dos espécimens de *Culicoides* coletados em toda a cidade foi representado pelo *Culicoides (O.) paraensis* (Goeldi, 1903), sendo, por esse motivo, levado em maior consideração.

O *C. paraensis* distribui-se por toda a cidade, decrescendo sua densidade ao nível dos mangues, onde predomina o *C. flavivenula*. Inicia sua atividade entre 5 e 6 horas, tendo 3 picos de maior ocorrência durante o dia: 7 horas, 12 horas e predominantemente às 15 e 17 horas. Desaparece entre 18 e 19 horas.

O *C. limonensis* só ocorre entre 6 e 8 horas, junto ao *C. paraensis*. O *C. paraensis* incide durante o ano inteiro, tendo uma variação estacional nítida. Sua densidade máxima corresponde aos meses chuvosos e mais frios.

Não foi encontrado o criadouro natural das larvas, porém os autores julgam que se criem em ambientes de alta umidade, ou em águas coletadas em tronco de árvores, lixeiras e vasilhames diversos abandonados em terrenos baldios.

Em relação aos hábitos hematófagos, salienta-se que o *C. paraensis* os tem acentuadamente antropófilos.

Foi observado que certos indivíduos possuem uma atratividade especial para o *culicoides*. Em adição, a espécie tem preferências para sugar os membros inferiores. Para a explicação deste fato, os autores julgam que o vôo rasteiro, a proteção contra a luz e correntes aéreas,

e a maior exposição das pernas do hospedeiro, favoreçam uma característica específica que o *C. paraensis* possua para picar os membros inferiores.

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TABLE I

**Meteorological data for Salvador from December through January, 1961
(Obtained from the "Serviço de Meteorologia da Bahia, do Ministério da Agricultura")**

MONTH	Baro- metric readings (mm)	AIR TEMPERATURE (in centigrades)					Relative humidity (%)	Clau- diness (0-10)	RAINFALL		Total evapor- ation (mm)	Total solar radiation (hours)
		Maxi- mum	Mini- mum	Absolute maxi- mum	Absolute mini- mum	Compen- sated average			Total height (mm)	Maxi- mum in 24 hs. (mm)		
January.....	760.6	29.4	24.0	31.2	22.5	26.3	81	6.0	47.9	19.2	155.2	242.5
February.....	761.3	29.3	23.2	30.7	20.6	26.3	81	5.0	7.8	3.9	147.2	260.1
March.....	760.8	29.2	24.3	31.0	22.7	26.7	81	6.0	76.4	25.3	150.4	225.9
April.....	761.3	28.5	23.5	30.2	21.0	25.9	82	6.3	91.0	37.5	117.9	233.4
May.....	762.8	27.4	22.6	29.9	21.0	25.0	84	6.7	194.9	25.2	112.5	214.3
June.....	763.8	26.5	21.6	27.5	21.0	24.0	85	7.0	223.0	30.7	114.2	206.6
July.....	764.9	25.3	20.6	28.2	18.7	23.1	83	6.7	107.8	15.1	130.3	208.6
August.....	765.4	25.6	21.0	27.0	19.4	23.2	82	6.0	77.4	31.4	145.8	233.3
September....	763.7	26.8	21.2	29.0	20.0	24.0	77	4.0	5.8	2.5	157.3	258.1
October.....	763.1	26.9	21.8	28.5	20.1	24.5	78	5.3	39.7	13.1	174.5	277.5
November.....	761.4	28.3	22.1	30.4	20.1	25.2	75	4.3	8.0	3.0	162.1	283.7
December.....	763.2	28.2	23.8	29.9	21.5	25.6	79	6.0	66.4	44.0	154.2	249.6
ANNUAL..	762.7	27.6	22.4	31.2	18.7	25.0	81	5.8	946.1	44.0	1,721.6	2,893.6

TABLE II

**Meteorological data for Salvador from December through January, 1962
(Obtained from the "Serviço de Meteorologia da Bahia, do Ministério da Agricultura")**

MONTH	Baro- metric readings (mm)	AIR TEMPERATURE (in centigrades)					Relative humidity (%)	Clau- diness (0-10)	RAINFALL		Total evapor- ation (mm)	Total solar radiation (hours)
		Maxi- mum	Mini- mum	Absolute maxi- mum	Absolute mini- mum	Compen- sated average			Total height (mm)	Maxi- mum in 24 hs. (mm)		
January.....	760.1	30.3	24.2	33.6	22.8	26.8	80	5.0	6.1	4.6	139.7	268.2
February.....	760.7	29.7	23.9	32.0	23.0	26.5	79	4.3	61.7	48.5	132.8	255.9
March.....	760.9	29.2	24.1	31.8	23.0	26.6	78	5.7	169.9	55.1	128.7	251.5
April.....	761.4	28.5	23.8	30.4	22.5	26.2	77	5.7	138.3	42.2	100.2	238.0
May.....	762.6	27.5	22.9	30.6	21.2	25.1	78	7.0	185.4	34.2	104.0	198.5
June.....	764.2	25.8	22.0	28.6	20.4	23.9	78	6.7	227.7	46.4	108.8	165.6
July.....	765.3	25.2	21.0	28.8	19.0	23.0	80	6.7	230.5	42.0	113.5	191.8
August.....	764.8	25.9	21.2	29.6	19.7	23.4	75	5.7	79.1	17.4	153.6	246.7
September....	764.2	26.6	21.7	29.6	20.0	23.9	75	5.0	24.0	11.9	151.0	229.3
October.....	762.9	27.8	22.5	31.1	21.0	24.9	75	5.0	70.1	21.9	161.0	247.0
November.....	760.9	27.9	23.0	29.4	21.8	25.2	79	5.7	142.5	29.2	146.3	210.7
December.....	760.8	29.0	23.5	31.7	22.5	25.9	78	6.0	54.5	7.7	144.2	242.0
ANNUAL..	762.4	27.8	22.8	33.6	19.0	25.1	78	5.7	1,389.8	55.1	1,583.8	2,745.2

TABLE IV

Frequency per hour of *Culicoides paraensis*, observed in five 24 hour collectings with human baits, in the district of Graça (Salvador — Bahia), at different times during the years of 1962 and 1963

HOUR	HOURLY AVERAGE NUMBER OF SPECIMENS COLLECTED AND DATES					
	2-23-62	6-6-62	6-20-62	2-22-63	2-23-63	Total
0- 1.....	—	—	—	—	—	—
1- 2.....	—	—	—	—	—	—
2- 3.....	—	—	—	—	—	—
3- 4.....	—	—	—	—	—	—
4 - 5.....	—	—	—	—	—	—
5- 6.....	—	4	—	—	—	4
6- 7.....	—	17	2	—	2	21
7- 8.....	—	3	1	4	1	9
8- 9.....	—	6	—	1	—	7
9-10.....	—	3	2	2	1	8
10-11.....	1	4	1	3	—	9
11-12.....	—	4	—	3	—	7
12-13.....	—	6	—	1	—	7
13-14.....	—	3	3	4	1	11
14-15.....	2	2	2	9	2	17
15-16.....	—	1	—	1	—	2
16-17.....	—	7	—	2	—	9
17-18.....	—	1	—	3	—	4
18-19.....	—	—	—	—	—	—
19-20.....	—	—	—	—	—	—
20-21.....	—	—	—	—	—	—
21-22.....	—	—	—	—	—	—
22-23.....	—	—	—	—	—	—
23- 0.....	—	—	—	—	—	—
TOTAL.....	3	61	11	33	7	115

TABLE V
Monthly incidence of *C. Paraensis* in Salvador — Bahia during the years from 1959 to 1962 (Districts of Graça and Canela)

MONTHS	1959			1960			1961			1962			TOTAL		
	No of specimens	Hours spent	Average per hour	No of specimens	Hours spent	Average per hour	No of specimens	Hours spent	Average per hour	No of specimens	Hours spent	Average per hour	No of specimens	Hours spent	Average per hour
January.....	—	—	—	50	7	7	86	16	5	66	8	8	202	31	6,5
February.....	—	—	—	13	4	3	102	23	4	71	13	5	186	40	5
March.....	—	—	—	8	2	4	107	16	7	67	13	5	182	31	6
April.....	—	—	—	18	4	4,5	113	10	11	301	9	33	432	23	19
May.....	—	—	—	35	4	9	36	6	6	267	16	17	338	26	13
June.....	—	—	—	18	4	4,5	106	6	18	139	12	12	263	22	12
July.....	19	3	6	31	3	10	83	12	7,5	67	9	7	200	27	7
August.....	48	3	16	19	3	6	125	8	16	65	6	11	257	20	13
September.....	108	9	12	10	1	10	17	6	13	3	4	1	138	20	7
October.....	54	8	7	—	—	—	6	4	1,5	20	9	2	80	21	4
November.....	58	10	6	—	—	—	10	5	2	15	8	2	83	23	4
December.....	43	4	11	5	0,5	10	123	13	9	—	—	—	171	5	34
TOTAL.....	330	37	9	207	32,5	6	914	125	7	1,081	107	10	2,532	289	9