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PRELIMINARY OBSERVATIONS ON THE ANOPHELINE MOSQUITOES OF GOMADIYAGALA A VILLAGE IN THE NORTH WESTERN PROVINCE OF SRI LANKA

BY

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Abstract

Investigations on anopheline mosquitoes were carried out in Gomadiyagala during January-December 1989, *primarily to gather base-line data in relation to a collaborative study between the Entomology Division, Anti-Malaria Campaign and the Department of Zoology, University of Sri Jayewardenepura on the potential for a genetic approach for malaria control in Sri Lanka. Eight anopheline species were recorded from adult catches and lavae sampled.* An. subpictus An. culicifacies *and* An. varuna *were the most predominant species.*

The only stream with two tributaries in the study area was the permanent and very productive anopheline breeding habitat. Larval and adult anopheline densities were related to the rainfall received. The larval densities recorded in drought periods were observed to be significantly higher than those recorded in rainy periods ($t=4.087$, $p<0.01$). *August, September and October that recorded relatively low larval and adult* An. culicifacies *densities appear to be suitable times for field releases of genetically altered* An.culicifacies *in the area for malaria control.*

Key words; Anopheline mosquitoes; *An. culicifacies*

1. Introduction

Anopheles culicifacies Giles, is considered to be the major vector of malaria in Sri Lanka. Several other anopheline species present in the island too have been found to be capable of transmitting the disease (Herath *et al.*, 1983). Residual house spraying with malathion forms the major attack measure against the vector for malaria control in the country.

Development of vector resistance to insecticides has impeded disease control programmes in many countries (WHO, 1980). There is broad spectrum resistance in some anopheline species found in Sri Lanka, and the development of malathion—specific resistance in *An.culicifacies* in some localities has been detected (Hemingway *et al.*, 1988.)

While residual insecticide spraying continues to be the principal vector control methodology, in view of the problem of insecticide resistance and the increasing cost of suitable replacement insecticides attempts are being made to develop an integrated vector control strategy for malaria control in Sri Lanka (AMC, 1987).

Several programmes that have been implemented in the recent past, aimed at socio-economic development of the country, have brought about environmental changes affecting large areas. The use of an integrated vector control strategy necessitates a thorough knowledge of the ecology and biology of malaria vectors in different eco-environmental, epidemiological and geographical situations, for the application of the most suitable vector control methodology (WHO, 1982).

In this paper, are presented some observations based on field and laboratory investigations of the anopheline mosquitoes occurring in Gomadiyagala, a village in the North-Western Province of Sri Lanka. The investigations were carried out primarily to gather base-line data, in respect of collaborative studies in progress between the Entomology Division of the Anti-Malaria Campaign and the Department of Zoology, University of Sri Jayewardenepura, on the potential for a genetic approach for malaria control in Sri Lanka. It is felt that these preliminary observations will add to the present knowledge on anopheline fauna under different eco-environmental situations, of which there appears to be a paucity of data, and may also become useful in implementing an integrated vector control strategy for malaria control.

2. Study Area.

Field investigations were carried out in Gomadiyagala, a village in the North-Western Province and the Ibbagamuwa Health Area, situated approximately 150 km. from Colombo. The village is surrounded in the East and the West by two mountain ranges. Teak and Eucalyptus plantations, that fall within the Pallekelle Forest Reserve form the Northern and the Southern boundaries respectively. The habitat can be considered as a 'deforested area' with some larger trees limited to the hilly areas. (Fig. 1)

The village is inhabited by an approximate population of 200 people. They dwell in more or less semi-permanent structures made of mud walls and thatched roofs. The inhabitants are mostly engaged in 'chena' (slash and burn) cultivation.

A tributary of the Hakwatuna Oya runs through the village joined by two small streams. These water sources form the main permanent breeding habitat for anophelines.

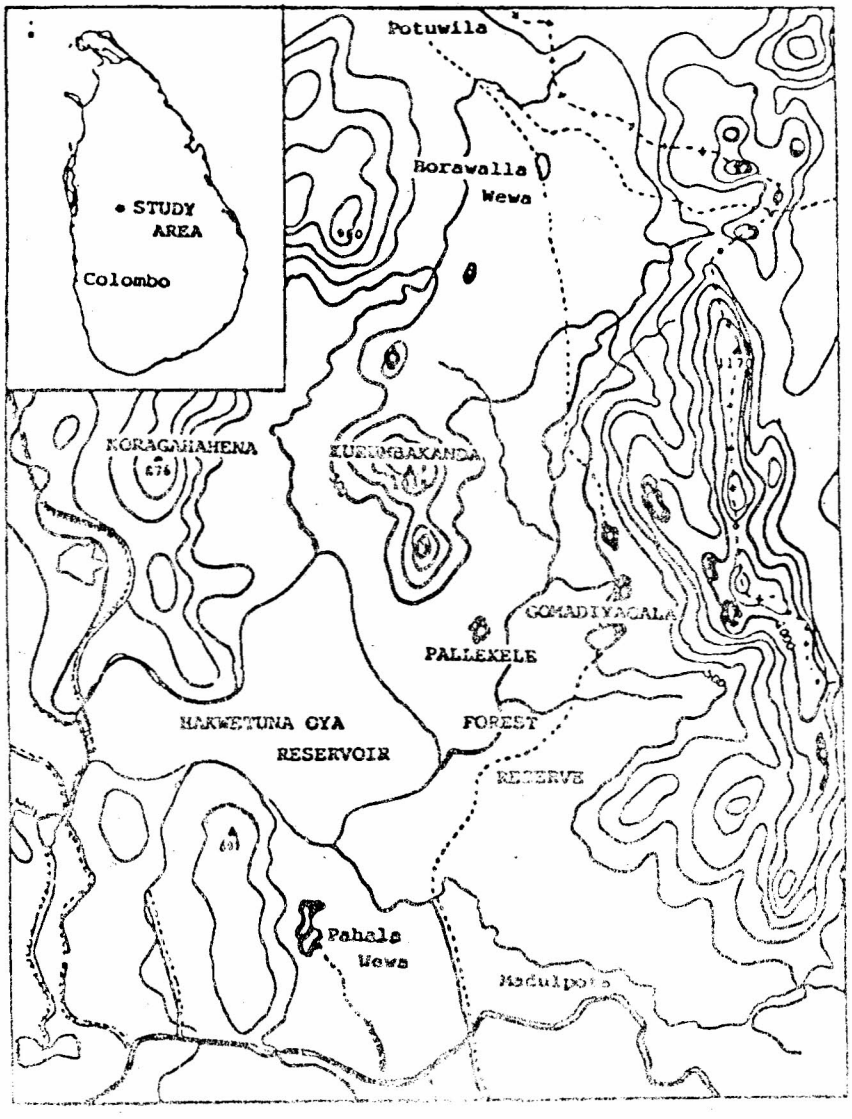

Figure 1 : Map of the study area. The inset shows its position in Sri Lanka.

3. Materials and Methods.

Field investigations were carried out during January to December 1989. Adult and larval collections were carried out at monthly intervals. Adults were obtained from cattle-baited hut collections. Two cadjan huts 210 cm. X 210 cm. X 180 cm. constructed about 500 m. apart were used. Adult collections were obtained during 14 days covering the early and the latter part of each month.

Larval collections were taken at twenty sampling stations, ten along the main stream and five each along the two branches. Larvae were sampled by dipping with a standard ladle. Four spots, two each from both margins were sampled at each station. Larvae were also collected from pools that occurred within the sampling area. The larvae sampled were recorded by instars. Pupal counts were also made. Larvae and pupae collected were transported to the laboratory in plastic bottles and reared to the adult . A rain-gauge was set up in the locality to measure rainfall.

4. Results.

Data on total anophelines obtained by adult catches and larvae and pupae collected during the twelve month period are presented in Table I. The percentages of different anophiline species encountered are depicted in Figure 2.

Table I: Total anopheline mosquitoes collected at Gomadiyagala from January to December 1989.

Anopheline species	Methods of collection		Total
	Catches from Cattle-Baited huts	Reared from Larvae/Pupae	
An.subpictus	2498	123	2621
An. culicifacies	1760	809	2569
An. varuna	538	876	1414
An hyrcanus	97	15	112
An. vagus	109	28	137
Anl annularies	09	02	11
An. pallidus	06	57	63
An. tesselatus	06	09	15
Total	5023	1919	6942

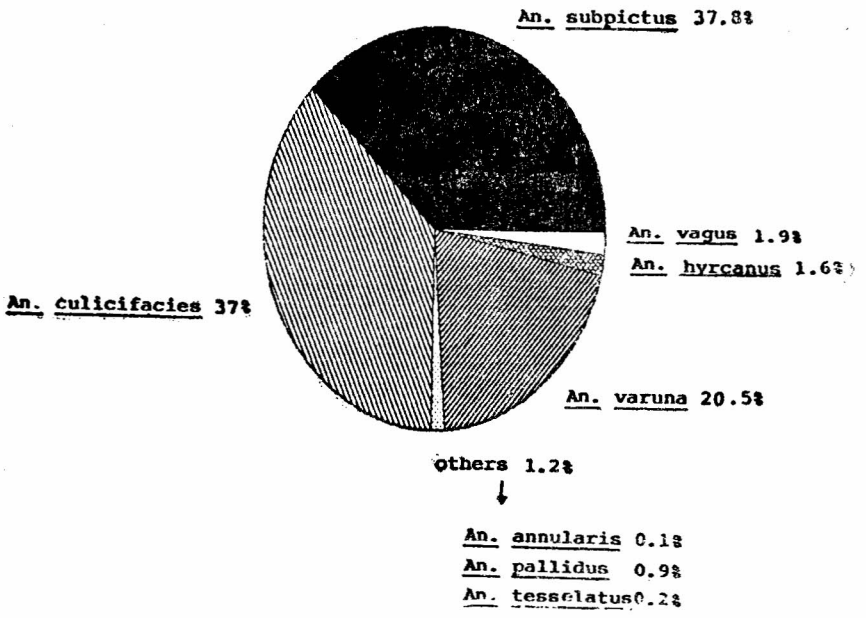

Figure 2 : The percentages of different anopheline species encountered in the cattle-baited hut collections and larvae and pupae sampled at Gomadiyagala from January to December 1989.

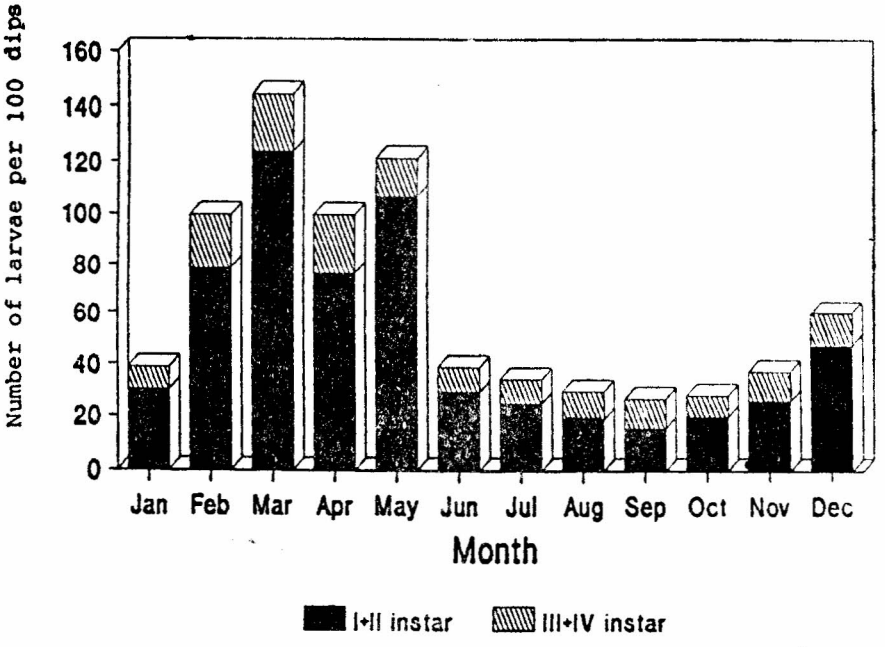

Figure 3 : Anopheline larval densities and the proportion of larvae by instars obtained in monthly sampling at Gomadiyagala from January to December 1989.

Eight anopheline species were encountered. *An. subpictus*, *An. culicifacies* and *An. varuna* were the most predominant species, and formed 37.8%, 37.0% and 20.5% of the total mosquitoes obtained from adult catches and reared from larvae and pupae sampled. 68.5% of the total *An. culicifacies* collected were obtained from cattle-baited hut catches, and 31.5% from larvae pupae reared. The proportions of *An. subpictus* thus obtained were 95.3% and 4.7% respectively. However only 38.0% of the total *An. varuna* obtained were from adult catches while 62.0% were from larval rearing.

Numerical data on different anopheline adults collected monthly from cattle—baited huts are presented in Table II. Table III shows the anopheline larval densities obtained from monthly sampling and the rainfall recorded. The data on larvae sampled are also presented diagrammatically in Figure 3.

Anopheline breeding occurred throughout the period of investigation. Relatively high larval densities were seen during the months of February, March, April and May. Lowest larval densities were recorded during September. The larval samples contained a greater proportion of first and second nstars.

An.subpictus, *An.culicifacies* and *An. varuna* were recorded during every month in mosquitoes encountered in cattle-baited hut collections. High densities of *An.culicifacies* were seen during the month of February, March, April, May, June and December. The highest number of 530 *An.culicifacies* was recorded in April. Low densities of this species were seen during January, and July to November. The lowest number of 21 mosquitoes were observed during September. *An.hyrcanus* and *An.annularis* also occurred in few numbers during several months of the year.

5. Discussion.

Eight anopheline species were encountered at Gomadiyagala. The greater proportion of first and second instar larvae sampled was indicative of continuous breeding in the stream habitat throughout the year. *An.subpictus* *An.culicifacies* and *An.varuna* were the predominant species obtained from adult and larval collections. *An.culicifacies* is known to breed in a variety of breeding places. Prolific breeding of this species has been recorded from sand and rock pools and along slow moving margins of streams and rivers (Carter- and Jacocks, 1929; Carter, 1930 a, 1930 b). In previous studies Rajendran and Jayewickrama (1951) also have observed that these three anopheline species breed well along margins of streams and rivers.

From the results of anophelines obtained from larval rearing, it is seen that *An.culicifacies* was breeding in association with *An.subpictus*, *An. varuna*, and *An.tessellatus*. Similar observations have been made in India (Russell and Rao, 1940), and in Sri Lanka in the recent past (Wickramasinghe, 1984).

The monthly variations of larval and adult anopheline densities observed can be related to the rainfall received. The highest rainfall of 558 mm. was recorded in November whilst the lowest rainfall of 20 mm. was observed during June. There was no rainfall during the months of February, March, April, May and August. It is seen from Table III that relatively higher densities of larvae have been recorded during the months where there had been less or no rains. Table II shows that the number of different anopheline species obtained from cattle-baited hut collections were also relatively higher during these months.

Table II: Number of anopheline species obtained monthly from Cattle-baited hut collections from January to December 1989 :

Month	*An. sub.*	*An. cul.*	*An. var.*	*An. hyr.*	*An. vag.*	*An. ann.*	*An. pal.*	*An. tes.*
January	48	43	11	00	13	00	05	00
February	60	179	69	09	25	03	00	03
March	192	343	219	00	15	03	00	02
April	309	530	57	00	17	00	00	01
May	281	192	19	01	06	00	00	00
June	371	158	06	00	02	01	00	00
July	82	63	08	00	02	01	00	00
August	86	28	36	04	10	00	00	00
September	47	21	17	02	06	00	00	00
October	64	26	19	02	00	00	00	00
November	297	51	28	43	08	01	00	00
December	661	126	49	36	05	00	01	00
Total	2498	1760	538	97	109	09	06	06

An. sub. — *An. subpictus* *An. vag.* — *An. vagus*
An. cul. — *An. culicifacies* *An. Ann.* — *An annularis*
An. var. — *An. varuna* *An. pal.* — *An. pallidus*
An. hyr. — *An. hyrcanus* *An. tes.* — *An.tesselatus*

The larval densities recorded in drought periods were observed to be significantly higher than those recorded in rainy periods ($t=4.087$, $p<0.01$). Statistically significant negative correlation between anopheline breeding and the discharge rate has also been recorded in the Attanagalu Oya. (Wickramasinghe, 1984)

Table II and III also show that while somewhat relatively low larval densities have been recorded during November and December the number of adult mosquitoes collected were high. The low larval densities can be attributed

to flushing of the stream associated with the highest rainfall of 558 mm recorded in November. However breeding in a variety of ground pools formed during the rains would have contributed to the higher adult densities recorded.

Table III: Anopheline larval densities obtained from monthly samplings and rainfall received at Gomadiyagala from January to December 1989.

Month	Number per dip			Rainfall (mm)
	I & II Instars	III & IV Instars	Total	
January	0.299	0.089	0.388	205
February	0.789	0.206	0.995	00
March	1.238	0.205	1.443	00
April	0.767	0.229	0.996	00
May	1.067	0.146	1.213	00
June	0.291	0.098	0.389	20
July	0.246	0.095	0.341	93
August	0.186	0.108	0.294	00
September	0.155	0.111	0.266	82
October	0.195	0.082	0.277	119
November	0.255	0.116	0.371	558
December	0.471	0.129	0.600	34

The number of rainy days and their distribution is of greater relevance to anopheline breeding in stream and riverine habitats than the total rainfall received. The stream in the study area was observed to get flushed after a shower, but suitable conditions for anopheline breeding with slow moving waters appeared soon. Tyssul Jones (1951) has focussed attention on the relation of pooling in rivers and streams leading to malaria epidemics and deforestation of catchment areas of major rivers. In well forested areas, prolonged seepage from the absorbent forest ground will maintain a steady flow over extended periods. Under such situations the flow in streams will not be so dependent on the distribution of rainfall (Tyssul Jones, 1951). Large tracts of forest cover had been cleared for cultivation purposes in and around the study area.

The taxon *Anopheles culicifacies* is known to be a species complex made of four species designated A, B, C and D (Subbarao, 1988). So far only species B has been found in Sri Lanka (Green and Miles, 1980). The different species

are known to exhibit differences in their biological and behavioral characters. Based on the observations of investigations carried out in Northern India, Subbarao (1988) has suggested the possibility of the existence of another sibling species of *An.culicifacies* in Sri Lanka.

The present preliminary studies have indicated the stream habitat at Gomadiyagala to be the main permanent and a very productive anopheline breeding place in the locality. August, September and October that recorded relatively low larval and adult *An.culicifac.es* densities appear to be a suitable period for field releases of genetically altered *An.culicifacies* for malaria control. Field population densities of *An. culicifacies* may be further reduced by eliminating or reducing any ground pools by filling or draining. Investigations in India have shown that species A of *An.culicifacies* was dominant in the hot season and species B during the rainy season (Suguna *et al*, 1983). Additional studies on anopheline mosquitoes in Gomadiyagala and investigations relating to the correct identification of *An.culicifacies*, species present in this locality need further investigation.

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