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# Seasonal changes in the larval populations of *Aedes aegypti* in two biotopes in Dar es Salaam, Tanzania

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*The seasonal dynamics of larval populations of* Aedes aegypti *was studied in two different biotopes in Dar es Salaam, Tanzania. The first biotope was located on the Msasani peninsula on the coast 6 km north of Dar es Salaam, where* A. aegypti *breeds exclusively in coral rock holes. The population dynamics was studied during both the rainy and the dry season. Seasonal changes in the density of* A. aegypti *larvae depend primarily on variation in rainfall. The population of larvae dropped to zero only for a short time during the driest period while the adult population was maintained at a low level. The second biotope was in an automobile dump in a Dar es Salaam suburb, where* A. aegypti *breeds in artificial containers such as tires, automobile parts, tins, coconut shells, and snail shells. The greater part of the* A. aegypti *population of this biotope is maintained in the egg stage during the dry season. It serves as a focal point for breeding during the dry season : with the coming of the rains, the population expands into the surrounding residential areas. More than 70 % of the larval population developed in tires, 20 % in tins, 5 % in coconut shells, and 1 % in snail shells.*

Whereas yellow fever is largely endemic in West Africa (Chambon et al., 1967) and in Ethiopia (Sérié, 1968), it has occurred only sporadically in East Africa, in Uganda (Haddow, 1965) and Kenya (Lumsden, 1954; Garnham et al., 1946). In Uganda, *Aedes africanus* and *A. simpsoni* were the vectors of yellow fever in a double cycle of transmission among monkeys, and between monkeys and man (Mahaffy et al., 1942; Haddow et al., 1947; Gillett, 1951, 1955).

An epidemic of dengue-like fever affected some of the southern provinces of Tanganyika during 1952 and 1953 (Robinson, 1955; Lumsden, 1955) and *A. aegypti* occurred in very high densities in the huts of the inhabitants and was therefore thought to be the vector. Subsequently Ross (1956) reported the isolation of chikungunya virus from human cases and from *A. aegypti* in the area.

Considering the large number of papers published on different aspects of biology of *A. aegypti*, surprisingly little is known about the seasonal distribution of larvae. Lumsden (1955) made an entomological survey in the Newala district of south-east Tanzania, after the outbreak of dengue-like epidemics in 1952–53, but it was not possible to make a systematic study of the ecology of *A. aegypti* larvae. Other reports dealing with *A. aegypti* larvae in Tanzania mention only the geographical distribution of mosquitos (Harris, 1942; van Someren, 1968), while Teesdale (1956) collected valuable data on the biology of adults in the coastal area of Kenya.

Yellow fever has not been reported from Tanzania, but *A. aegypti* and other *Stegomyia* mosquitos that are known vectors of yellow fever are very common in Tanzania. One of the main objectives of the WHO East Africa *Aedes* Research Unit is to study the distribution and seasonal abundance of mosquitos suspected of being vectors of yellow fever virus.

The effectiveness of large-scale chemical control programmes depends largely on the proper timing of insecticide application. Information on seasonal variations, especially in the larval population density in relation to the environment, is important for the selection of the correct methods and timing of chemical control. It is believed that in this region

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*A. aegypti* exhibits unique breeding habits not seen in other parts of the world.

This paper reports: (1) the seasonal distribution of the rural and urban populations of *A. aegypti* breeding in coral rock holes on the Msasani peninsula and in man-made containers in an automobile dump in the city of Dar es Salaam; (2) estimates of the larval populations and of the mortality of *A. aegypti*; (3) the relationship between the distribution of rainfall and of larval and adult populations of *A. aegypti* in two different biotopes; and (4) the importance of different types of artificial containers in the breeding of *A. aegypti*.

## DESCRIPTION OF THE BIOTOPES

The climate of the Dar es Salaam area is generally hot and humid with small seasonal and daily variations in temperature. The mean daily temperature is about 26°C, the mean seasonal range is 4°C, and the mean daily range is about 8°C. The coolest days and nights are in July and August. The highest temperature ever recorded was 35.2°C in February 1962 and the lowest temperature recorded was 12.8°C in August 1955.

From May to the end of September, Dar es Salaam is in the south-east monsoon season. After a long passage over the sea this air stream becomes very moist and, by comparison with land temperatures, relatively cool. In October, the monsoon moves southwards over the Dar es Salaam area and from October to December there is a short rainy season. From late December to the beginning of March the north-east monsoon blows; it is warm, and gives only a little rain. This is the hottest season of the year as the sun is nearly overhead. From March to May the monsoon moves back northwards and the main rainy season begins. There are thus pronounced seasonal variations in rainfall and winds, although the total rainfall is less than would be expected for an equatorial coast in East Africa, averaging about 1 100 mm a year. The variation in total annual rainfall may be as high as 50% above or below the average.

The Msasani peninsula and Bongoyo Island are located about 6 km north of Dar es Salaam and have been fully described by Trpis et al. (1971). Msasani village is located on the south-western side of the peninsula and a new residential area is under construction on the south-eastern side.

The Buguruni biotope is located in the southern part of Dar es Salaam and has an area of approximately 1 ha; it contains wrecked automobiles, discarded tires, automobile parts, tins, coconut shells, and snail shells and is surrounded by African-type houses. There is a well in the middle of the dump that furnishes drinking-water for the surrounding houses. The dump area is shaded by mango and palm trees (these, which have been introduced, and occur in the following order of abundance: *Mangifera indica, Anacardium occidentale, Cocos nucifera, Pithecellobium dulce*); there are no shrubs. The species of herb and sedge that occur in the surrounding area are found in the following order of abundance: *Acalpha indica, Commelina africana, Assystasia gangetica, Cassia occidentalis, Cyperus* sp.

## METHODS

### *Msasani biotope*

Thirty rock holes of different sizes and in locations were chosen for weekly sampling. Water with larvae was transferred with a pipette to a plastic dish. All the larvae collected were taken to the laboratory for identification of the species and the instar and for a complete count. The water was replaced in the rock holes. The number of holes sampled weekly was reduced to 15 in July 1969, the other 15 being sampled monthly in order to compare the results of weekly and monthly sampling.

During the 6-month period of study it was found that only certain holes were able to hold water. Some of the holes were porous and they either did not hold water at all or they held it only for a short time (a few hours).

The quadrat method was used to study the distribution of the holes able to hold water. The average number of rock holes with water was 34.8/ha during the rainy season in April 1970 and 9.0/ha during the dry season in July 1970.

The data for rainfall were obtained from the closest meteorological station, which is on the coast about 6 km south of the study area. A rain gauge was set up in the biotope in January 1970 and since then rainfall has been measured daily. Comparison of the rainfall figures from two sources for an 8-month period in 1970 revealed only negligible differences.

### *Buguruni biotope*

*A. aegypti* larvae were found in discarded tires, tins, coconut shells, and snail shells in the Buguruni biotope. A complete count of the different types of breeding place was carried out before the study began in April 1969, in order to calculate the larval productivity of *A. aegypti* in the whole automobile dump, and this was repeated in August 1969.

As the opening round the inside of the tires is very narrow and it is impossible to extract all the larvae, 9 tires were chosen and marked for regular sampling. A 15-mm hole was made in the middle of each tire, and the tires were stood up with the holes uppermost. At the time of sampling, the tires were turned upside down and all the water with the larvae flowed into a pan. The larvae were than collected with a pipette and the water replaced after the tire had been returned to its original position. The tires were arranged in groups of three according to diameter (50, 75, or 100 cm) and were sampled weekly.

Nine tins were also marked and grouped according to size (250, 2 000, or 4 000 ml) and were sampled at weekly intervals, as were 9 coconut shells (250–300 ml) and 30 *Achatina fulica* snail shells (60–150 ml).

The number of larvae, their developmental stage, and the state of the breeding site were recorded weekly. The population of *A. aegypti* larvae per hectare was calculated from the mean number of larvae per container and the percentage of containers with water.

For the April–July period the total number of containers in the dump was used in the calculations. For the August–September period the number of containers found in the biotope in August 1969 was used. The rainfall data were obtained from the meteorological station at Dar es Salaam airport, which is about 5 km from the Buguruni biotope. The figures for 1970 obtained from the airport and those obtained from our own rain gauge showed considerable differences for some days during the 8-month period for which a comparison was possible.

## RESULTS

### *Msasani biotope*

The proportion of the rock holes filled with water is shown in Table 1. During the 6-month period of study, only twice (5 August and 30 September) were all the rock holes found to be dry and usually 61–90% of the holes contained some water. Some of the rock holes that contained water were always found to be positive for *A. aegypti* larvae (Table 1).

The daily rainfall, seasonal changes in larval density per hectare, and seasonal changes in the population of female *A. aegypti* as indicated by the 4-hour biting catches are all shown in Fig. 1. The numbers of adults are expressed in numbers caught per man-hour and the numbers of larvae per hectare are shown on a logarithmic scale.

The density of *A. aegypti* larvae was high at the beginning of the study in April because of the heavy rains in March and especially heavy rainfall in April. The larval populations declined in May from 588 to 177 larvae per hectare.

The next peak appeared in late May after more than 20 mm of rain. The population dropped towards the end of June and remained at a very low level until the beginning of August. The small peak on 1 July (56 larvae/ha) was the result of a small shower in the last week of June after a 17-day dry period. After 2 months of very low rainfall (June–July) the 28 mm of rain between 6 August and 9 August produced an increase from zero to 5 290 larvae/ha. Larval density was high until the end of August and then slowly dropped to zero towards the end of September (Fig. 1).

The adult population of females indicated by the 4-hour biting catches (3 men in an orange tent) follows in general the same pattern as the curve for the larval population (Fig. 1). It may be seen that the peak of the larval population on 22 April was followed by a peak in adult population on 29 April. The decrease in the larval population between 22 April and 13 May was followed by a decrease in the adult population between 29 April and 26 May. The small increase in larval density from 13 May, which reached its peak on 26 May, was followed by an increase in the adult population from 26 May to 10 June. The decrease in the numbers of larvae in the period from 26 May to 23 June resulted in a decrease in the adult population between 10 and 23 June. The small peak on 1 July affected the numbers of adults on 9 July. On the occasions when the population of larvae reached zero (4 times during the period 24 June–5 August), the adult population did not drop to zero during the same period. The large increase in the larval population that occurred on 12 August, and the large larval populations that were present until the end of the month, resulted in a considerable increase in the adult population during August and September.

Although the larval density depends on rainfall, the number of larvae produced per millimetre of rainfall varies from season to season. During the rainy season the eggs deposited in rock holes hatch almost immediately after physiological aging. Dur-

Table 1. Condition of the breeding sites and the seasonal distribution of the larval population of *A. aegypti* breeding in coral rock holes

| Month | Day | No. of rock holes sampled | Rock holes with water | | Rock holes positive for *A. aegypti* larvae | | Mean no. of larvae per rock hole | Estimated no. of larvae per hectare | Estimate of larval productivity of the Msasani peninsula |
|---|---|---|---|---|---|---|---|---|---|
| | | | No. | % | No. | % | | | |
| April | 15 | 30 | 12 | 40.0 | 7 | 23.3 | 46.3 | 1 611 | 350 213 |
| | 22 | 30 | 18 | 60.0 | 17 | 56.7 | 52.0 | 1 810 | 393 328 |
| | 29 | 30 | 21 | 70.0 | 20 | 66.7 | 18.0 | 637 | 138 421 |
| | total | 90 | 45 | 56.6 | 44 | 48.8 | 38.7 | 4 058 | 881 962 |
| May | 6 | 30 | 25 | 83.3 | 22 | 73.3 | 16.9 | 588 | 127 831 |
| | 13 | 30 | 22 | 73.3 | 16 | 53.3 | 5.1 | 177 | 38 576 |
| | 20 | 30 | 14 | 46.7 | 12 | 40.0 | 11.4 | 397 | 86 230 |
| | 26 | 30 | 22 | 73.3 | 19 | 63.3 | 22.8 | 793 | 172 459 |
| | total | 120 | 83 | 69.2 | 69 | 57.5 | 14.0 | 1 955 | 425 096 |
| June | 3 | 30 | 23 | 76.7 | 20 | 66.7 | 49.9 | 70 | 14 970 |
| | 10 | 30 | 22 | 73.3 | 22 | 73.3 | 10.0 | 14 | 3 000 |
| | 17 | 30 | 15 | 50.0 | 13 | 43.3 | 7.7 | 11 | 2 310 |
| | 23 | 30 | 10 | 33.3 | 5 | 16.7 | 2.9 | 4 | 870 |
| | total | 120 | 70 | 58.3 | 60 | 50.0 | 17.6 | 99 | 21 150 |
| July | 1 | 15 | 4 | 26.7 | 4 | 26.7 | 39.7 | 56 | 11 910 |
| | 9 | 15 | 8 | 53.3 | 6 | 40.0 | 9.1 | 13 | 2 730 |
| | 15 | 15 | 4 | 26.7 | 3 | 20.0 | 10.2 | 14 | 3 060 |
| | 22 | 15 | 3 | 20.0 | 3 | 20.0 | 1.7 | 2 | 510 |
| | 29 | 15 | 1 | 6.7 | 1 | 6.7 | 4.0 | 6 | 1 200 |
| | total | 75 | 20 | 26.7 | 17 | 22.7 | 12.9 | 91 | 19 410 |
| August | 5 | 15 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 0 |
| | 12 | 15 | 12 | 80.0 | 12 | 80.0 | 152.0 | 5 290 | 715 575 |
| | 19 | 15 | 12 | 80.0 | 10 | 66.7 | 13.0 | 452 | 98 310 |
| | 26 | 15 | 12 | 80.0 | 10 | 66.7 | 6.1 | 212 | 46 110 |
| | total | 60 | 36 | 60.0 | 32 | 53.3 | 42.8 | 5 954 | 859 995 |
| Sept. | 2 | 15 | 9 | 60.0 | 7 | 46.7 | 5.9 | 53 | 11 527 |
| | 9 | 15 | 10 | 66.7 | 3 | 20.0 | 1.4 | 13 | 2 827 |
| | 16 | 15 | 7 | 46.7 | 5 | 33.3 | 31.6 | 284 | 61 770 |
| | 23 | 15 | 2 | 13.3 | 1 | 6.7 | 0.5 | 4 | 8 700 |
| | 30 | 15 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 0 |
| | total | 75 | 28 | 37.3 | 16 | 21.3 | 7.9 | 354 | 84 824 |

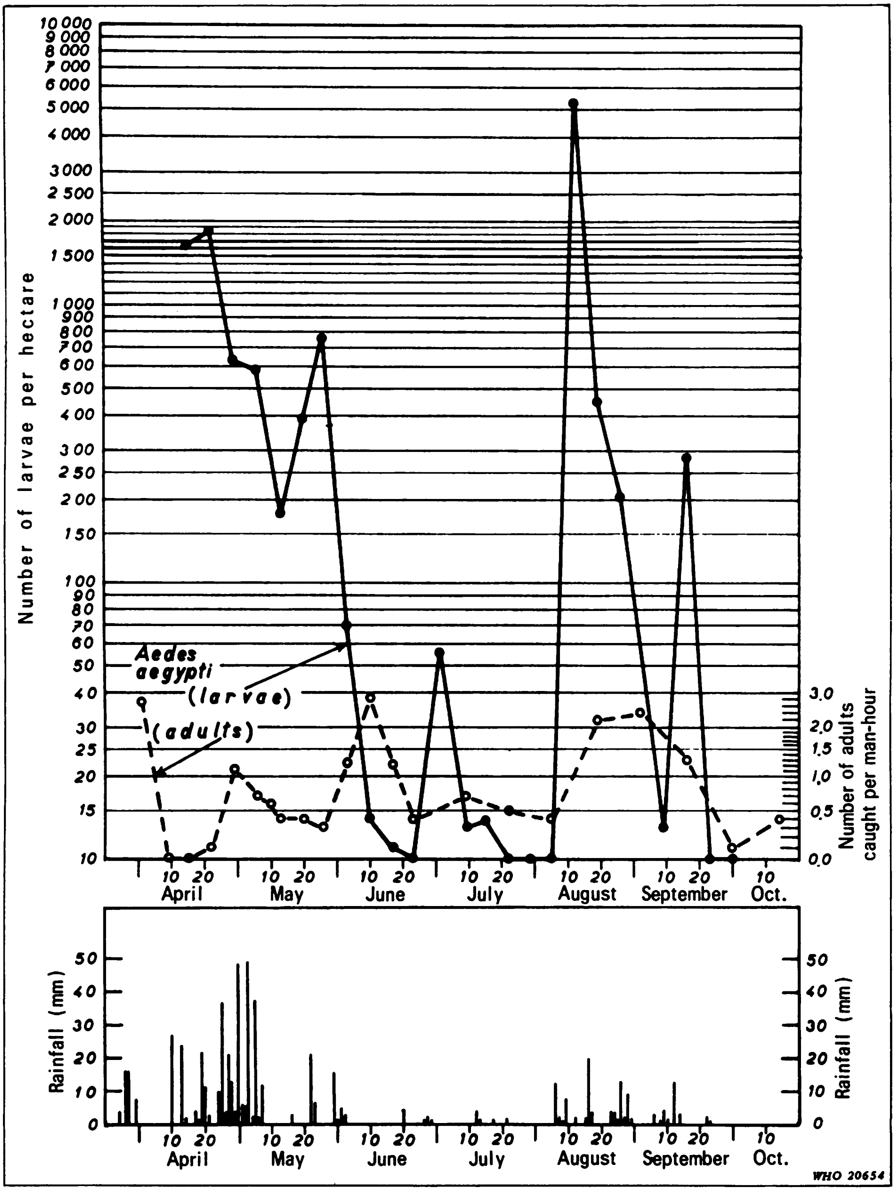


Fig. 1. Seasonal distribution of rainfall and changes in the density of populations of *A. aegypti* adults and larvae in coral rock holes during the dry and the main rainy seasons, 1969.

ing the dry season the eggs accumulate and hatch only when flooded by the intermittent rains.

During the period between 13 June and 5 August, when most of the holes were dry, the population of adults was still at a high level. The females laid their eggs on the walls of almost dry holes and eggs accumulated in the holes for almost 6 weeks. The 28 mm of rainfall between 6 August and 9 August caused a great increase in the larval population at the beginning of that month. It has been found that even 3 mm of rain is enough to flood and hatch some of the eggs that are laid near or in the bottom of the holes.

*Buguruni biotope*

*Seasonal changes in population of larvae.* During April and May, 299.1 and 205.4 mm of rain were recorded at Dar es Salaam airport. Populations of *A. aegypti* larvae were high when this study began on 14 April. Four peaks and four depressions of the population were recorded between April and July (Fig. 2). The first three peaks were probably

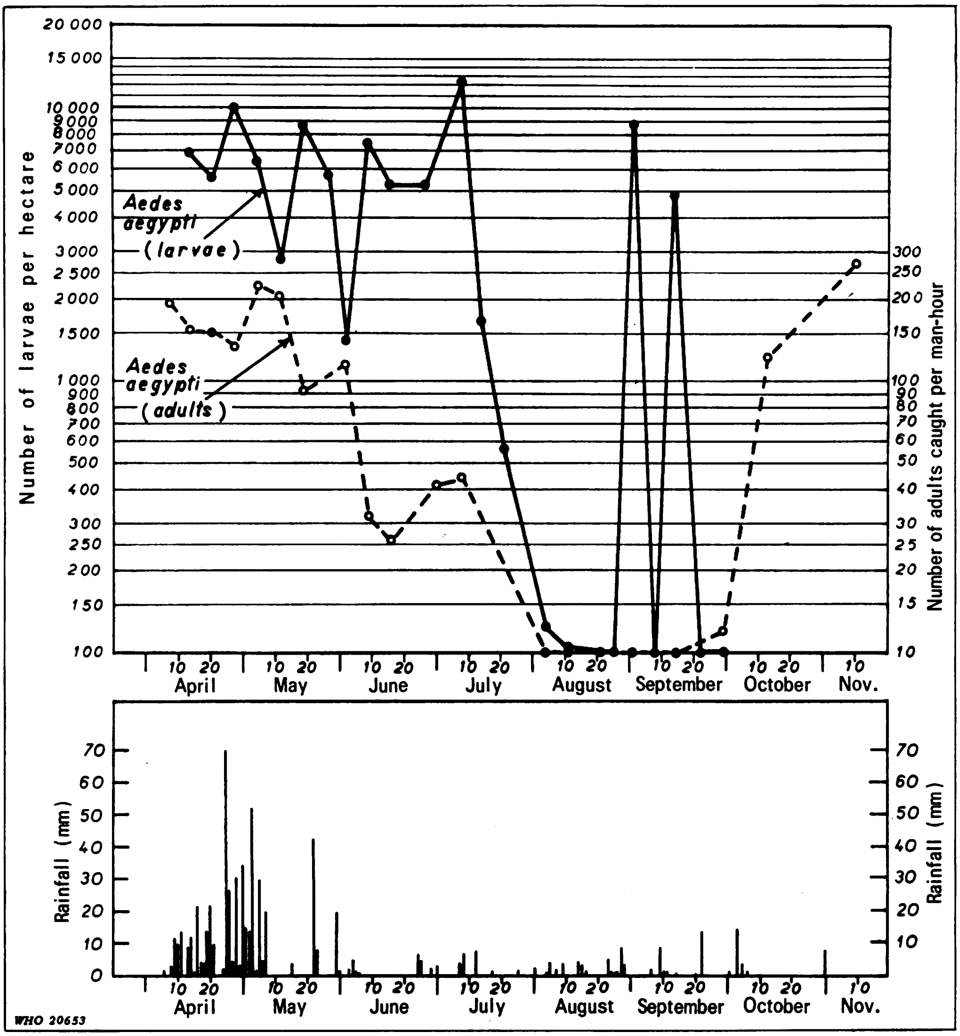


Fig. 2. Seasonal distribution of rainfall and changes in the density of the population of *A. aegypti* adults and larvae in the automobile dump during the dry and the main rainy seasons, 1969.

caused by the high rainfall during April and May. There was not much rain during June and the large number of larvae was not related to the rainfall at the end of June and the beginning of July. However, it is probable that the rainfall in Buguruni was higher than that recorded at the airport. Probably the hatching in July of the eggs accumulated in June caused the increase of the larval population. Most of the containers were dry at the end of July and during August and the larval density in all breeding containers was zero or almost zero. The rainfall at the end of August and beginning of September caused another sharp increase in the larval population.

When the curve for the larval population is compared with that for the adult population (Fig. 2) it can be seen that the first peak of larval density on 28 April is reflected in the peak of adult density on 5 May, and that the next peak in the larval population on 19 May affected the adult density on 2 June. The build-up of the larval population between 2 June and 8 July caused the increase in the adult population between 16 June and 8 July. The decrease in the adult population between 8 July and 25 August is reflected in the drop in the larval population between 8 July and 15 September and the sudden increase in the number of larvae on 2 September had an effect on the build-up of the adult population between 15 September and the beginning of November.

*Breeding in different types of container*

The proportions of containers containing water in the breeding sites of the Buguruni biotope are summarized in Table 2. All the tires contained water from April to June but the proportion filled with water gradually decreased during July and the first week of August. All the tires were dry from 11 August until 25 August, but during September 22–67% of them contained water. There were always some tins with water in them. From 3% to 10% of the coconut shells held water between 14 April and 12 May. Snail shells contained water on 6 of the 24 sampling dates. The frequency distribution of the proportion of breeding containers with water is summarized in Table 3 for the 6-month period of study.

The figures in Table 2 show that more than 70% of the larval population was produced in old tires; 20% developed in tins, 5% in coconut shells, and 1% in snail shells.

*Toxorhynchites brevipalpis* larvae were found regularly in the Buguruni biotope, breeding mostly in tires and tins. The larvae of this species are known to be predators of *A. aegypti* larvae and undoubtedly affected the populations.

*Estimate of mortality of larvae.* By comparing the numbers of first-instar larvae with the numbers of pupae (Beklemišev, 1949; Trpis, 1960), the average mortality of *A. aegypti* larvae was estimated as 83.3% in the Buguruni biotope and as 31.7% in the Msasani biotope.

## DISCUSSION

It is generally believed that *A. aegypti* originated in East Africa, and that they spread from there to other parts of the world (Dyar, 1928; Christophers, 1960). In the present investigations it was found that some populations of *A. aegypti* in the coastal regions of Tanzania breed in coral rock holes, a habit not found in populations of this species elsewhere. The elevated coral reefs are generally uninhabited and are distributed along the whole coast of East Africa and it seems that they play an important role in the breeding of *A. aegypti* in this area. The populations are thought to be wild and according to Mattingly's classification they belong to the subspecies *formosus* and would be labelled as grade F–G according to McClelland's classification of the abdominal colour patterns.[1] It must be stressed that the coral island populations may breed there without any contact with man; however, as soon as man enters the biotope they will readily bite him: from an epidemiological point of view this behaviour widens their vectorial potential.

During the dry periods of August the population of *A. aegypti* larvae on the Msasani peninsula dropped to zero, but the adult population, although low in number, was not eliminated. During the hot dry season the greatest part of the rock hole population is maintained in the egg stage. The embryonated eggs of *A. aegypti* are able to withstand drought in rock holes for as long as 4 months.

It is interesting to note that *A. simpsoni*, another vector of yellow fever, occurs together with *A. aegypti* in the coral rock holes (Trpis et al., 1971). The biting behaviour of the rock hole population of *A. simpsoni* in relation to man is similar to that of *A. aegypti*. Another breeding site in the rock hole biotope is the shells of the terrestrial snail *Achatina fulica* dur-

[1] Hartberg, W. K. (1969) *Genetical assessment of taxonomic characters of* Aedes aegypti *L. in Tanzania* (unpublished document WHO/VBC/69.152).

Table 2. Conditions of the breeding containers and seasonal changes in the population of *A. Aegypti* larvae in the Buguruni biotope

| | | Tires | | | | | | | Tins | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Day | No. of tires sampled | Tires with water | | Tires with larvae | | Mean no. of larvae per tire | Estimated productivity from all tires | No. of tins sampled | Tins with water | | Tins with larvae | | Mean no. of larvae per tin | Estimated productivity from all tins |
| | | | No. | % | No. | % | | | | No. | % | No. | % | | |
| April | 14 | 9 | 9 | 100.0 | 0 | 0.0 | 0.0 | 0 | 9 | 9 | 100.0 | 7 | 77.8 | 22.8 | 5 244 |
| | 21 | 9 | 9 | 100.0 | 3 | 33.3 | 1.7 | 4 321 | 9 | 9 | 100.0 | 4 | 44.4 | 3.4 | 782 |
| | 28 | 9 | 9 | 100.0 | 5 | 55.6 | 2.1 | 5 338 | 9 | 9 | 100.0 | 4 | 44.4 | 14.8 | 3 404 |
| | total | 27 | 27 | 100.0 | 8 | 29.6 | 1.3 | 9 659 | 27 | 27 | 100.0 | 15 | 55.6 | 13.7 | 9 430 |
| May | 5 | 9 | 9 | 100.0 | 1 | 11.1 | 1.7 | 4 321 | 9 | 9 | 100.0 | 3 | 33.3 | 3.9 | 897 |
| | 12 | 9 | 9 | 100.0 | 2 | 22.2 | 0.4 | 1 017 | 9 | 9 | 100.0 | 3 | 33.3 | 5.0 | 1 150 |
| | 19 | 9 | 9 | 100.0 | 3 | 33.3 | 3.2 | 8 134 | 9 | 9 | 100.0 | 6 | 66.6 | 3.2 | 736 |
| | 27 | 9 | 9 | 100.0 | 2 | 22.2 | 2.0 | 5 084 | 9 | 9 | 100.0 | 5 | 55.6 | 2.8 | 644 |
| | total | 36 | 36 | 100.0 | 8 | 22.2 | 1.8 | 18 556 | 36 | 36 | 100.0 | 17 | 47.2 | 3.7 | 3 427 |
| June | 2 | 9 | 9 | 100.0 | 2 | 22.2 | 0.3 | 763 | 9 | 9 | 100.0 | 6 | 66.7 | 2.8 | 644 |
| | 9 | 9 | 9 | 100.0 | 3 | 33.3 | 2.5 | 6 355 | 9 | 9 | 100.0 | 8 | 88.9 | 5.0 | 1 150 |
| | 16 | 9 | 9 | 100.0 | 2 | 22.2 | 2.0 | 5 084 | 9 | 6 | 66.7 | 5 | 55.6 | 1.0 | 157 |
| | 27 | 9 | 9 | 100.0 | 1 | 11.1 | 1.0 | 2 542 | 9 | 9 | 100.0 | 7 | 77.8 | 11.8 | 2 714 |
| | total | 36 | 36 | 100.0 | 8 | 22.2 | 1.4 | 14 744 | 36 | 33 | 91.7 | 26 | 72.2 | 5.1 | 4 655 |
| July | 8 | 9 | 9 | 88.9 | 4 | 44.4 | 5.4 | 12 203 | 9 | 7 | 77.8 | 3 | 33.3 | 0.8 | 143 |
| | 14 | 9 | 7 | 77.8 | 2 | 22.2 | 0.7 | 1 384 | 9 | 7 | 77.8 | 4 | 44.4 | 1.7 | 304 |
| | 21 | 9 | 4 | 44.5 | 0 | 0.0 | 0.0 | 0 | 9 | 9 | 100.0 | 2 | 22.2 | 2.5 | 575 |
| | 28 | 9 | 2 | 22.2 | 0 | 0.0 | 0.0 | 0 | 9 | 9 | 100.0 | 0 | 0.0 | 0.0 | 0 |
| | total | 36 | 21 | 58.3 | 6 | 16.7 | 1.5 | 13 587 | 36 | 32 | 88.9 | 9 | 25.0 | 1.2 | 1 022 |
| August | 4 | 9 | 1 | 11.1 | 0 | 0.0 | 0.0 | 0 | 9 | 4 | 44.5 | 1 | 11.1 | 1.5 | 125 |
| | 11 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 9 | 5 | 55.5 | 2 | 22.2 | 1.0 | 104 |
| | 21 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 9 | 5 | 55.5 | 0 | 0.0 | 0.0 | 0 |
| | 25 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 9 | 2 | 22.2 | 1 | 11.1 | 0.1 | 4 |
| | total | 36 | 1 | 2.8 | 0 | 0.0 | 0.0 | 0 | 36 | 16 | 45.4 | 4 | 11.1 | 0.6 | 233 |
| Sept. | 1 | 9 | 5 | 55.6 | 2 | 22.2 | 5.0 | 8 985 | 9 | 7 | 77.8 | 0 | 0.0 | 0.0 | 0 |
| | 8 | 9 | 3 | 33.3 | 0 | 0.0 | 0.0 | 0 | 9 | 5 | 55.5 | 0 | 0.0 | 0.0 | 0 |
| | 15 | 9 | 6 | 66.7 | 1 | 11.1 | 2.2 | 4 752 | 9 | 5 | 55.5 | 2 | 22.2 | 0.8 | 83 |
| | 22 | 9 | 6 | 66.7 | 0 | 0.0 | 0.0 | 0 | 9 | 7 | 77.8 | 1 | 11.1 | 0.1 | 14 |
| | 29 | 9 | 2 | 22.2 | 0 | 0.0 | 0.0 | 0 | 9 | 2 | 22.2 | 0 | 0.0 | 0.0 | 0 |
| | total | 45 | 22 | 48.9 | 3 | 6.7 | 1.8 | 13 737 | 45 | 26 | 57.8 | 3 | 6.7 | 0.2 | 97 |

Table 2 (continued). Conditions of the breeding containers and seasonal changes of the population of *A. Aegypti* larvae in Buguruni biotope

| Month | Day | Coconut shells | | | | | | | Snail shells | | | | | | | Total estimated larval population of the whole automobile dump |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. of shells sampled | Shells with water | | Shells with larvae | | Mean no. of larvae per shell | Estimated productivity from all shells | No. of shells sampled | Shells with water | | Shells with larvae | | Mean no. of larvae per shell | Estimated productivity from all shells | |
| | | | No. | % | No. | % | | | | No. | % | No. | % | | | |
| April | 14 | 9 | 5 | 55.6 | 5 | 55.6 | 13.8 | 1 378 | 30 | 3 | 10.0 | 3 | 10.0 | 2.0 | 233 | 6 855 |
| | 21 | 9 | 5 | 55.6 | 5 | 55.6 | 5.0 | 499 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 5 602 |
| | 28 | 9 | 6 | 66.7 | 6 | 66.7 | 10.0 | 1 200 | 30 | 1 | 3.3 | 1 | 3.3 | 2.0 | 78 | 10 020 |
| | total | 27 | 16 | 59.3 | 16 | 59.3 | 9.6 | 3 077 | 90 | 4 | 4.6 | 4 | 4.4 | 1.3 | 311 | 22 477 |
| May | 5 | 9 | 3 | 33.3 | 3 | 33.3 | 17.0 | 1 018 | 30 | 1 | 3.3 | 1 | 3.3 | 5.0 | 194 | 6 430 |
| | 12 | 9 | 2 | 22.2 | 2 | 22.2 | 16.5 | 658 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 2 825 |
| | 19 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 8 870 |
| | 27 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 5 728 |
| | total | 36 | 5 | 13.9 | 5 | 13.9 | 8.4 | 1 676 | 120 | 1 | 0.8 | 1 | 0.8 | 1.2 | 194 | 23 853 |
| June | 2 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 1 407 |
| | 9 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 7 505 |
| | 16 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 1 | 3.3 | 1 | 3.3 | 1.0 | 39 | 5 280 |
| | 27 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 5 256 |
| | total | 36 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 120 | 1 | 0.8 | 1 | 0.8 | 0.2 | 39 | 19 448 |
| July | 8 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 12 346 |
| | 14 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 1 688 |
| | 21 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 575 |
| | 28 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 0 |
| | total | 36 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 120 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 14 609 |
| August | 4 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 125 |
| | 11 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 104 |
| | 21 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 0 |
| | 25 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 4 |
| | total | 36 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 120 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 233 |
| Sept. | 1 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 8 985 |
| | 8 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 2 | 6.7 | 0 | 0.0 | 0.0 | 0 | 0 |
| | 15 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 1 | 3.3 | 0 | 0.0 | 0.0 | 0 | 4 835 |
| | 22 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 14 |
| | 29 | 9 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 30 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 0 |
| | total | 45 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0 | 150 | 3 | 2.0 | 0 | 0.0 | 0.0 | 0 | 13 834 |

Table 3. Frequency of occurrence of breeding containers with water in the Buguruni biotope during the 6-month period

| Percentage of containers with water | No. of observations | | | |
|---|---|---|---|---|
| | Tires | Tins | Coconut shells | Snail shells |
| 0 | 3 | 0 | 19 | 18 |
| 1–20 | 1 | 0 | 0 | 6 |
| 21–40 | 3 | 2 | 2 | 0 |
| 41–60 | 2 | 5 | 2 | 0 |
| 61–80 | 3 | 5 | 1 | 0 |
| 81–100 | 12 | 12 | 0 | 0 |

ing the 3-month period of the main rainy season (April–June). *Eretmapodites quinquevittatus* was also frequently found breeding in these shells.

Most cities and some villages have one or more places where wrecked cars and tires are dumped. During the rainy season populations of *A. aegypti* are very large in this type of biotope, which may also contain tins, coconut shells, and snail shells. Large numbers of *A. aegypti* eggs accumulate in the tires during the dry season and the first rain of the wet season causes a large increase in the mosquito population. It is, however, very difficult to measure the absolute density of the population of *A. aegypti* in an automobile dump during the rainy season. The number and condition of the wrecked cars and parts preclude any accurate count and they all contribute significantly to breeding during the rainy season. Thus it must be borne in mind that the larval, and perhaps the adult, population productivity during April and May is probably higher than that shown in Table 2.

Some of the 30 rock holes in the Msasani biotope were sampled weekly and some monthly; no significant differences were found.

It is concluded that a generalized curve for the seasonal distribution of the *A. aegypti* population in the Dar es Salaam area would have three peaks: one in October–November, representing a very large but brief increase; one between March and June, representing in increase as large as the first one and twice as long; and an intermediate peak in January, representing a smaller and shorter population increase.

The application of these results should be of assistance in predicting seasonal changes in the population of *A. aegypti* and thus help to make large-scale chemical control measures more effective.

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## RÉSUMÉ

### FLUCTUATIONS SAISONNIÈRES DES POPULATIONS LARVAIRES D'*AEDES AEGYPTI* DANS DEUX BIOTOPES À DAR ES-SALAM (TANZANIE)

La dynamique des populations larvaires d'*Aedes aegypti* a été étudiée dans deux biotopes à Dar es-Salam.

Le premier biotope est représenté par les anfractuosités de coraux dans la péninsule de Msasani où de nombreux gîtes favorisent la multiplication de l'espèce. Les densités larvaires y fluctuent principalement en fonction du rythme des précipitations. On estime que pendant la saison des pluies, en avril-mai, la population larvaire, par hectare et par mois, est en moyenne de 653 500 larves; en saison sèche, de juin à septembre, elle tombe à 246 300 larves. Les densités maximales de larves et d'adultes sont observées au moment où les précipitations sont les plus abondantes. Les larves ne disparaissent complètement qu'en période de sécheresse très intense (en août) alors que les populations d'adultes se maintiennent à un niveau faible. Les œufs déposés sur les parois des anfractuosités s'accumulent pendant la saison sèche et une pluie relativement faible peut entraîner un accroissement explosif du nombre des larves après plusieurs semaines de sécheresse. Par contre, des précipitations de même importance, pendant la saison des pluies, n'ont que peu d'influence sur les densités larvaires.

Le biotope de Buguruni, dans la banlieue de Dar es-Salam, est un cimetière d'automobiles. *A. aegypti* y trouve des gîtes artificiels (pneus hors d'usage, boîtes de conserves, pièces d'automobiles) et des gîtes naturels (débris de noix de coco, coquilles de mollusques). La courbe des densités larvaires suit en général les variations du régime des pluies. Pendant la saison des pluies, la population larvaire, par hectare et par mois, est en moyenne de 23 200 larves; elle s'abaisse à 12 000 larves pendant la saison sèche. Les larves disparaissent quasi complètement à plusieurs reprises en août et en septembre, et les adultes sont pratiquement introuvables entre le début d'août et la mi-septembre. La majeure partie des populations d'*A. aegypti* subsiste, au stade de l'œuf, pendant la saison sèche. Avec l'apparition des pluies, les moustiques pullulent. Les vieux pneus fournissent plus de 70% des larves, les boîtes de conserves 20%, les noix de coco 5% et les coquilles de mollusques 1%.

Des larves de *Toxorhynchites brevipalpis*, qui exercent une action prédatrice sur les larves d'*A. aegypti*, ont été trouvées en grand nombre dans le biotope de Buguruni. Leur présence entraîne une mortalité estimée à 83% chez les larves d'*A. aegypti*, alors que dans le biotope de Msasani la mortalité larvaire n'est que de 32%.

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