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IMPACT OF RAPID URBANIZATION IN ACCRA ON THE BREEDING PATTERNS OF TWO MAJOR MOSQUITO SPECIES IN TRADITIONAL DOMESTIC WATER RECEPTACLES

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Abstract

In a study on the breeding patterns of two major mosquito species in traditional domestic water receptacles (TDWRs) during pre-urbanization and rapid-urbanization periods in Accra, rainfall and larval prevalence of *Culex pipiens quinquefasciatus* and *Anopheles gambiae* s.l. were compared graphically, by scatter and by correlation coefficient. There was a slight positive association between rainfall and larval prevalence of *An. gambiae* during both periods while a positive association between rainfall and larval prevalence of *Cx p. quinquefasciatus* in pre-urbanization times changed to a negative association. Insignificant correlation coefficients between rainfall and larval prevalences indicated that rainfall had no significant impact on the breeding patterns of these mosquitoes in the above receptacles. The change from positive correlation between monthly rainfall and larval prevalence of *Cx p. quinquesfasciatus* during the dry season of the pre-urbanization period to no correlation between these two parameters in the dry season of rapid-urbanization times may not be due to rainfall differences since rainfall levels were almost similar during the dry seasons of the two periods under consideration.

Introduction

Accra has undergone rapid urbanization in recent years particularly since 1961. Because municipal development could not match this rapid urbanization, many peripheral and intra-city shanty towns and slum areas have developed. The result is the creation of new breeding waters and also changes in the nature (especially pollution) of existing ones. This is likely to affect the breeding patterns, breeding intensity, etc., of some of the mosquito species. In this context, a substantial increase in larval prevalence of *Culex pipiens quinquefasciatus* and adaptation of *Anopheles gambiae* s.l. to breeding in these traditional domestic water receptacles have been observed in Accra in recent times (Chinery, 1984).

The aim of this paper is to determine the relationships between rainfall and the breeding patterns of these two maior vectors and also to determine the impact of urbanization on their breeding patterns in traditional domestic water receptacles.

Method of study and results

During pre-urbanization years, the survey of mosquito breeding in Accra was restricted to search for larvae in traditional domestic water receptacles (TDWRs) (mainly barrels, drums, pots and pans) in the compounds of houses several times each month, particularly between 1911 and 1915; 1920 and 1924. A live collection of adults was undertaken on a few occasions (*viz.* 1915, 1919 - 1920, 1920-1921 and 1928-1929).

In the period 1965-1967 (rapid -urbanization period) (Chinery, 1969), an extensive mosquito survey including searches for mosquito larvae in all available water bodies was carried out. During both periods, there was larval control by spraying of oil and insecticides as well as source reduction.

For the purpose of this paper, the means of the larval prevalence (percentage incidence of occurrence of larvae) of *Cx p. quinquefasciatus* and *An. gambiae* s.l. in TDWRs were computed for the years 1920-1922. This is defined as the number of samples with larvae of each of these two mosquito species expressed as a percentage of the total number of larval samples collected during

each month. Larval prevalence served as an index of frequency in breeding or breeding frequency. Rainfall and larval prevalence were compared graphically, by scatter and by correlation coefficients during pre-urbanization times (1920-1922) and during rapid-urbanization times (1965-1967).

Variation in the prevalence of Culex p. quinquefasciatus *larvae*

During the pre-urbanization period, there was an almost positive relationship between rainfall and prevalence of *Cx p. quinquefasciatus* larvae which reached its peak in June, the highest rainfall month (Fig. 1). Apart from an increase in prevalence in August when rainfall declined, there was a positive relationship between these two parameters from September to December, both declining to the lowest levels in December. That this almost positive relationship was not close is indicated

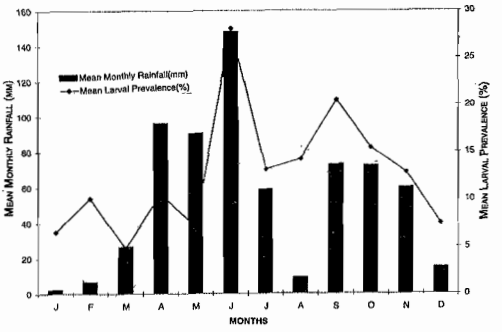

Fig. 1. Relationship between mean monthly rainfall and mean larval prevalence of *Cx p. quinquefasciatus* in traditional domestic water receptacles (1920-1922).

by a low correlation coefficient of +0.3643 (not significant) but this was significant for the dry season months (*viz.* $r = +0.7903$ for $P = 0.01 < 0.001$). This relationship was a linear one (Fig. 2) expressed by the equation $y = 3.9956 + 0.1332 \times$ R^2 = 0.351), indicating the positive impact of rainfall on the breeding of *Cx p. quinquefasciatus* during the dry months and the inability of its breeding to match the level of rainfall in the rainy months. It intercepted the y axis at about 8 per cent prevalence, indicating that breeding of *Cx p. quinquefasciatus* will be appreciable (viz. 3.5%) when rainfall declines to zero, while the large amount of rainfall needed to produce 50 per cent prevalence indicates the depressing effect of substantial dilution of polluted water by rain.

During the period of rapid urbanization, there was generally a negative relationship between frequency in breeding and ranfall (Fig. 3). From a high larval prevalence in January it declined rapidly (as rainfall increased) to the lowest level one month after the peak rainfall level, then generally rising appreciably as rainfall continued to decline before declining finally in December (Fig. 3). That this negative relationship is not close is indicated

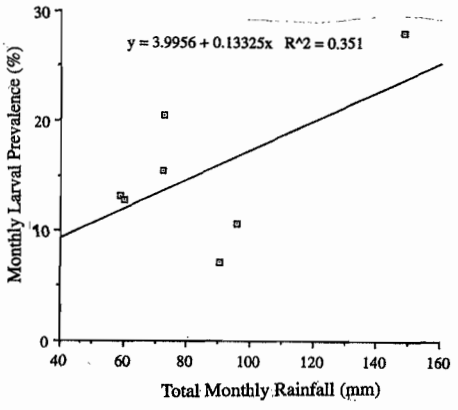

Fig. 2. Relationship between mean monthly rainfall and mean larval prevalence of *Cx p. quinquefasciatus* in traditional domestic receptacles during the pre-urbanization period (1920-1922).

by a low correlation coefficient (-0.2641 not significant). This negative relationship is to be expected because although *Cx p. quinquefasciatus* is capable of breeding in any type of water, it breeds more prolifically in polluted than clean water and since the proportion of receptacles with polluted

water or the intensity of pollution of water in receptacles will decline with increase in rainfall, frequency of breeding of this species will decline as rainfall increased and *vice versa.*

There was considerable increase in the number of receptacles with polluted water in domestic and peri-domestic locations during the period of rapid urbanization (1965-1967) and *Cx p. quinquefasciatus* breeds appreciably in these (non-tradional) receptacles and this must have led to a spill-over of its breeding into traditional domestic water receptacles (TDWRs) during the period of rapid urbanization. The mean monthly larval prevalence of *Cx p. quinquefasciatus* in TDWRs in 1965-1967 was 35.09 per cent compared with 12.57 per cent during pre-urbanization times. With excessive dilution of water in these non-traditional water receptacles, breeding of *Cx p. quinquefasciatus* continued to decline with rainfall.

Variation in the prevalence of Anopheles gambiae *s.l. larvae*

Only a negligible number of *An. gambiae* larvae were found in the samples during the pre-urbanization period. The means, computed from larval prevalence data for the years 1921 and 1922 was 1.64% ± 0.52 SE; almost all the larvae being found during the rainy season. However, the finding of

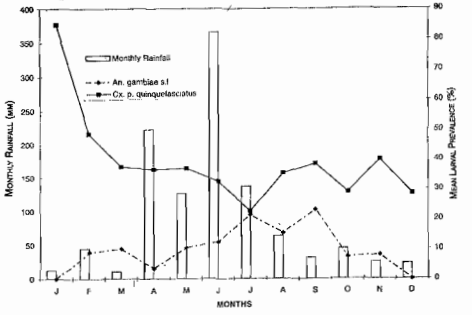

Fig. 3. Relationship between mean monthly rainfall and larval prevalence of *An. gambiae* s.l. and *Cx p. quinquefasciatus* in traditional domestic water receptacles in rapid urbanization period (1965).

this species in 14 per cent and 2.8 per cent of adults collected from offices and houses during 1919 - 1920 and 1921 respectively indicates that it was breeding in its natural habitats common in Accra in the pre-urbanization period. There was a positive association between rainfall and larval prevalences of *An. gambiae* s.l. during pre-urbanization times although larval prevalence reached its lowest level at the peak of the rainy season

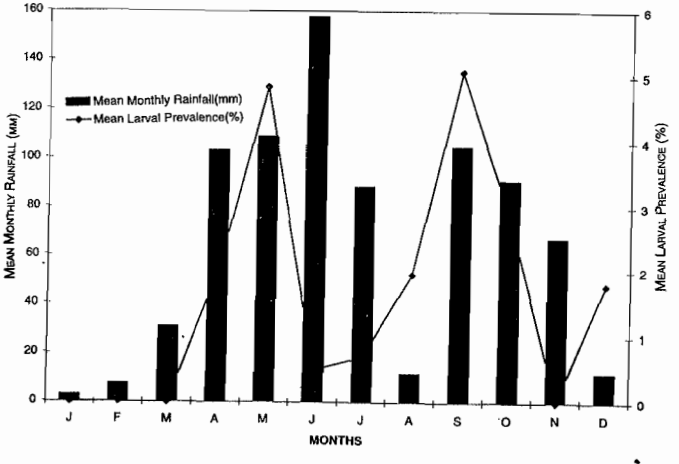

Fig. 4. Relationship between mean monthly rainfall and mean larval prevalence of *An. gambiae* s.l. in traditional domestic water receptacles in pre-urbanization period (1921-1922).

(Fig. 4). However, this positive association was not close as indicated by an insignificant correlation coefficient (*viz.* $r = +0.1184$).

During the period of rapid urbanization, there was a slight positive association between rainfall and larval prevalence of *An. gambiae* s.l (Fig. 3) although its prevalence was not as high as that of *Cx p. quinquefasciatus* at any time. The low correlation coefficient (*viz.* $r = +0.1283$) indicated that this positive relationship was only apparent and not real, implying that breeding of *An. gambiae* s.l. in traditional domestic water receptacles is not significantly affected by rainfall..

Discussion and conclusion

From the above study, it is evident that, on the whole, rainfall had no significant impact on the breeding patterns and frequency of *An. gambiae* s.l. and *Cx p. quinquefasciatus* in TDWRs during both pre-urbanization and rapid urbanization times, although there was a positive correlation between rainfall and breeding frequency of *Cx p. quinquefasciatus* during the dry months of pre-urbanization times. The change from a positive to a negative association between breeding frequency of *Cx p. quinquefasciatus* during pre-urbanization and rapid urbanization times respectively may be due to a substantial increase in the number of water receptacles (*viz.* tin cans, bottles, motor parts, vehicle tyres, pots, pans, etc.) (many of them non-traditional) in both domestic and peridomestic locations during rapid-urbanization times and the intensive pollution of the contained-water due to rapid population increase and population concentrations in certain localities in the city. During pre-urbanization times, non-traditional water containers were rare in both domestic and peridomestic locations and the traditional domestic water receptacles contained mainly clean water in which *Cx p. quinquefasciatus* does not breed prolifically hence the low larval prevalence.

Breeding of *Cx p. quinquefasciatus* in non-trational water receptacles might have augmented its breeding in TDWRs during rapid-urbanization times hence the considerable increase in its prevalence in the latter. With considerable dilution of polluted water in these non-traditional water receptacles during the rains, breeding continued to decline with rainfall and with it the decline in the augmentation of its breeding in TDWRs during the rainy season of 1965. That the change from positive correlation between rainfall and larval prevalence of *Cx p. quinquefasciatus* in the dry season of the pre-urbanization period to no correlation between these two parameters in the dry season of rapid-urbanization times is not due to differences in the amount of rainfall in the two periods under consideration as indicated by almost similar mean dry season rainfall values (*viz.* 30.48 mm ± 11.68 SE in pre-urbanization times and 26.92 mm ± 6.10 SE in rapid urbanization times).

The lack of correlation between rainfall and larval prevalence of *An. gambiae* s.l. in TDWRs (although generally its breeding is associated with rainfall) may be due to its inability to adapt to breeding in TDWRs. This is underscored by low but comparable correlation coefficients between rainfall and its larval prevalence in both periods. The impact of larval mosquito control on the breeding patterns of these two mosquitoes is difficult to determine although it is possible that it may affect their breeding in both periods differently.

Acknowledgement

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