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## Observations on the distribution of the *Anopheles gambiae* complex in Tanzania

A. E. P. MNZAVA, W. L. KILAMA

### Summary

Adult male and female mosquitoes of the *Anopheles gambiae* group of species from fourteen localities in Tanzania were studied using either chromosomal inversions, enzyme electrophoresis or both techniques. The 6481 specimens analyzed consisted of 64.4% *An. gambiae*, 33.6% *An. arabiensis*, and 2.0% *An. merus*, but no *An. quadriannulatus*. *An. gambiae* and *An. merus* are reported from Zanzibar for the first time. *An. merus* was recorded at Buiko, 167 km inland. *An. arabiensis* is the predominant or exclusive species in dry and semi-arid areas. *An. gambiae* predominates or is the only species in humid coastal and humid lacustrine areas.

**Key words:** *Anopheles gambiae* complex; ecological distribution; cytotaxonomy; electrophoresis.

### Introduction

In Tanzania, the *Anopheles gambiae* complex is represented by four sibling species, namely, *An. gambiae*, *An. arabiensis*, *An. merus*, and *An. quadriannulatus* (Mackay, 1935; Muirhead-Thomson, 1951; Kuhlman, 1962; Odetoyinbo and Davidson, 1968; White et al., 1972; Bushrod, 1978).

Although the separation of the *An. gambiae* complex is possible by a combination of morphological criteria, larval adaptation to survival in salt water and by male hybrid sterility tests, the usefulness of these techniques is limited to sampling small populations.

Specific species identification of the *An. gambiae* complex was made by Coluzzi and Sabatini (1968) based on chromosomal paracentric inversions, and by Miles (1979) using gene/enzyme systems. Both of these techniques were utilized in the present work to study the distribution of the *An. gambiae* group of species in Tanzania.

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Table 1. Tanzanian localities with different ecological features where mosquito indoor catches were performed

Locality	Altitude	Mean daily range of temperature	Mean annual rainfall	Seasonal distribution of rainfall	Vegetation types	Remarks
Tawalani	0–100 m	4°C–6°C	1200 mm	Nov.–Dec.; April–June	CSS*	Salt water breeding
Jitengeni (Muheza)	100–200 m	4°C–6°C	1200 mm	Nov.–Dec.; April–June	CSS	Swamps; marshes
Segera	200–300 m	4°C–6°C	1000–1200 mm	Nov.–Dec.; April–June	CSS	Swamps; marshes
Goo	300–400 m	4°C–6°C	1000–1200 mm	Nov.–Dec.; April–June	CSS	Swamps; marshes
Buiko	400–500 m	4°C–6°C	400–600 mm	Dec.; April–May	Semi-arid to arid	Irrigated rice-fields
Lake Manyara	500–1000 m	4°C–6°C	500–600 mm	Nov.–Dec.; March–May	grass lands	Swamps
Matufa (Babati)	1000–1500 m	4°C–6°C	800–1000 mm	Nov.–March	Semi-arid	Rice fields; swamps
Mtera (Iringa)	500–1000 m	4°C–6°C	400 mm	Dec.–March	CSS	W/G**; CSS
Talatala and Tenende (Kyela)	100–200 m	6°C	2400 mm	Nov.–June	Construction of dam for power production	Rice fields; swamps; marshes
Ilonga (Kilosa)	500–1000 m	4°C–6°C	1000–1200 mm	Nov.–Dec.; March–May	CSS	Rice-fields; marshes
Kilama (Ifakara)	500 m	4°C–6°C	1200–1400 mm	Nov.–Dec.; March–May	CSS; W/G	Permanent swamps
Dar es Salaam	0–100 m	2°C–4°C	1000–1200 mm	Oct.–Dec.; March–May	CSS	Swamps
Zanzibar	0–100 m	4°C–6°C	1600 mm	Nov.–Dec.; March–June	CSS	Swamps

\* CSS = cultivated with scattered settlements; \*\* W/G = wooded grass lands

## Materials and Methods

Indoor resting adult mosquitoes were collected by hand catches and by pyrethrum spray catches (WHO, 1975) in houses in fourteen localities in Tanzania with different climatic and topographic features between April 1982 and January 1985 (Table 1). Outdoor collections were undertaken in pits in Matufa (Babati) and on an animal trap in Zanzibar.

Abdomen of half gravid females (Christopher's stage III) were preserved in Carnoy's solution for chromosomal identification and processed, following the method of Coluzzi and Sabatini (1968) and Hunt (1973). Thoraces of females at Christopher's stage III of egg development, of unfed or gravid and of whole males were stored in liquid nitrogen prior to electrophoresis on acrylamide gels according to Green (1977). Staining for *ODH* (Octanol dehydrogenase) and *SOD* (Superoxide dismutase) enzymes was carried out according to Mahon et al. (1976).

## Results

A total of 6481 indoor resting mosquitoes of the *An. gambiae* s.l. were collected by pyrethrum spray catches and hand catches; of which 2608 were identified and successfully assessed by both, chromosomal inversions and electrophoresis, 3216 by electrophoresis only and 657 by the chromosomal technique alone. Of the 6481 specimens, 4181 (64.4%) were *An. gambiae*, 2177 (33.6%) *An. arabiensis* and 123 (2.0%) *An. merus* (Table 2, Fig. 1).

*An. gambiae* occurred with *An. arabiensis* in most of the areas sampled except in Mtera, Lake Manyara and Babati. Likewise, *An. arabiensis* was not recorded in Talatala, Tenende, Ilonga, and Dar es Salaam. *An. gambiae* was recorded in Zanzibar for the first time (Fig. 1).

Table 2. Distribution of species of the *An. gambiae* complex collected resting indoors in areas of Tanzania, identified by electrophoresis and/or chromosomal techniques

Locality	Distance from sea (km)	Total numbers	<i>An. gambiae</i>		<i>An. arabiensis</i>		<i>An. merus</i>	
			Nos.	%	Nos.	%	Nos.	%
Tawalani .....	2	196	148	75.5	14	7.1	34	17.4
Jitengeni .....	31	289	273	94.5	16	5.5	—	—
Segera .....	55	493	391	79.3	54	11.0	48	9.7
Goo .....	67	1721	1501	87.2	218	12.7	2	0.1
Buiko .....	167	951	37	4.0	907	95.3	7	0.7
Zanzibar .....	5	711	554	77.9	125	17.6	32	4.5
Dar es Salam .....	4	218	218	100.0	—	—	—	—
Ifakara (Kilama) ..	287	264	259	98.0	5	2.0	—	—
Kilosa (Ilonga) ...	255	121	121	100.0	—	—	—	—
Iringa (Mtera) ....	400	169	—	—	169	100.0	—	—
Lake Manyara ....	433	243	—	—	243	100.0	—	—
Babati (Matufa) ..	427	426	—	—	426	100.0	—	—
Talatala .....	652	337	337	100.0	—	—	—	—
Tenende .....	652	342	342	100.0	—	—	—	—
Total		6481	4181	64.4	2177	33.6	123	2.0

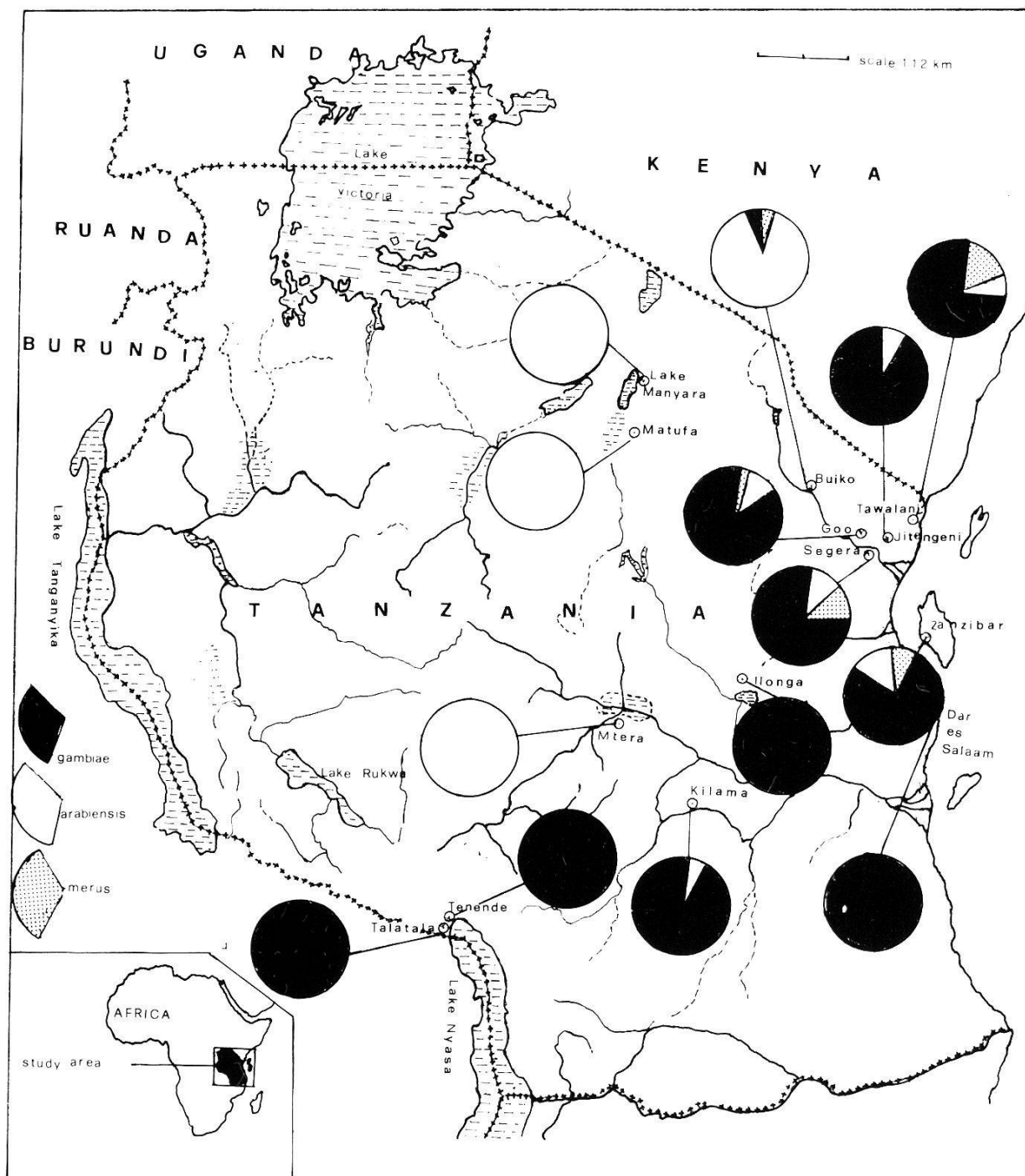


Fig. 1. Map of Tanzania, showing different localities and frequencies of *An. gambiae*, *An. arabiensis* and *An. merus* collected indoors.

*An. merus*, a salt water breeder, was found in samples from Tawalani, Zanzibar, and also far inland in Segera, Goo and Buiko. Like *An. gambiae*, it is being reported in Zanzibar for the first time.

The distribution of *An. gambiae* and *An. arabiensis* was related to distinct ecological features particularly in North-East Tanzania. Whereas *An. arabiensis* proportions increased from the humid coastal area to arid areas inland (7% in Tawalani and 95% in Buiko), the frequency of *An. gambiae* decreased (75% in

Tawalani and 4% in Buiko). In Zanzibar, the proportion of *An. arabiensis* indoor was as low as 18%, whereas in an animal trap, the collection consisted entirely of *An. arabiensis* on chromosomal inversion basis. (The data are not included in this paper because the mosquitoes were collected using a different sampling technique.)

## Discussion

In this study adult *An. gambiae* s.l. were collected in Zanzibar and from seven of Tanzania's 20 mainland regions representing well over the eastern third of the country and various ecological zones. These zones range from the humid coastal areas to the semi-arid hinterland in the northern and central regions, and the lacustrine south west.

The *An. gambiae* species group found in this study were *An. gambiae*, *An. arabiensis* and *An. merus*. This is in agreement with White et al. (1972). We however failed to collect *An. quadriannulatus* from indoor catches or even from outdoor calf-baited traps in Zanzibar. These results therefore do not corroborate those of Odetoyinbo and Davidson (1968) who used male hybrid sterility tests in species identification. As these data are limited in extent we recommend further outdoor baited collections, as the species is both zoophilic and exophilic (White, 1974; Mpofu, 1985).

Whereas previous studies in Zanzibar did not report *An. gambiae* nor *An. merus* (Odetoyinbo and Davidson, 1968) the former now constitutes 78%, and the latter 4.5% of the entire indoor catch from that island (Table 2). *An. arabiensis* (then called species B) which previously constituted the predominant indoor resting species on Zanzibar, now accounts for only 17.6% of the *An. gambiae* complex. The previous malaria eradication programme on Zanzibar which for the most part relied on intradomiciliary residual spraying may have preferentially weeded out the more endophilic *An. gambiae*; the more exophilic *An. arabiensis* was therefore under less selection pressure. The cessation of intradomiciliary residual spraying has eventually allowed reestablishment and predominance of *An. gambiae*.

The presence of *An. gambiae* and *An. merus* on Zanzibar is not surprising. *An. gambiae* typically breeds in fresh water habitats which are ubiquitous during the rains, whereas the abundant *Avicennia* species of mangroves are associated with the breeding of *An. merus*. However, the breeding of this species up-country (Segera, Goo and Buiko), where mangroves and/or brackish water are absent is perhaps associated with high saline water pools which concentrate so during the dry months of the year. On the other hand, all the four sites (Buiko, Lake Manyara, Babati and Mtera), with a predominant *An. arabiensis* are semi-arid with man-made lakes, surrounded by rice fields or swamps.

Ecological conditions are very important in limiting the distribution of species of *An. gambiae* complex in Tanzania. However, other factors such as zoophily/exophily and seasonal prevalences, may well have modified the re-

sults. The possibility that *An. arabiensis* and *An. merus* might have been underestimated in the indoor collected samples and their complete absence in an area like Dar es Salaam and Ilonga (for *An. arabiensis*) support the need for further studies. Longitudinal investigations, including parallel indoor/outdoor collections are therefore planned to elucidate these questions.

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