Research Application Summary

Diversity and colonization of permanent and semi-permanent breeding habitats by *Anopheles* mosquitoes in a semi-arid ecosystem of Baringo district in Kenya

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Abstract

Diversity, occurrence and utilization of mosquito breeding habitats is an essential component of vector ecology and important in designing and implementation of vector management programs. A one year larval survey was conducted to determine utilization of different habitats for mosquito. Larval sampling was conducted weekly. The habitats were classified as permanent or semi permanent and their characteristics documented. Availability of habitats in this semi-arid ecosystem was directly correlated with the seasons. Five mosquito breeding habitats in the area comprised ditch, marsh, canals, culverts and pan dams (pools). Of these breeding habitats 60% were man made while natural habitats accounted for the remaining 40%. Except for canals, other habitats were colonized by *Anopheles gambiae*, *pharoensis* and *funestus*. Both natural and artificial breeding habitats were productive for *Anopheles*, however, the abundance of larvae collected from the habitats was determined by season. Permanence of the habitat had a significant influence on larval productivity and composition of species. There was broad distribution of *A. gambiae* and *A. pharoensis* in all the breeding habitats while *An. funestus* was restricted to permanent breeding habitat-Marsh and dry season. Of the aquatic habitats 80% were potential breeding sites. Permanent and semi-permanent habitats should be equally targeted to control larval stages of mosquitoes in semi-arid areas.

Key words: *A. gambiae*, *A. pharoensis,* mosquito breeding, mosquito habitats, vector ecology

Résumé

La diversité, la présence et l'utilisation des habitats de reproduction des moustiques sont une composante essentielle de l'écologie des vecteurs et important dans la conception et la mise en œuvre des programmes de lutte anti vectorielle. Une enquête d'une année sur les larves a été réalisée afin de déterminer l'utilisation des différents habitats pour les moustiques. L'échantillonnage des larves a été réalisé par

semaine. Les moustiques ont été classés comme permanents ou semi permanents et leurs caractéristiques documentées. La disponibilité des habitats dans cet écosystème semi-arides a été directement corrélée avec les saisons. Cinq habitats de reproduction des moustiques dans la zone comprenant un fossé, un marais, des canaux, des ponceaux et barrages d'irrigation, (piscines). Parmi ces habitats de reproduction, 60% ont été créés par l'homme tandis que les habitats naturels représentaient les 40% restants. Sauf pour les canaux, d'autres habitats ont été colonisés par *Anopheles gambiae*, *Anopheles funestus et pharoensis*. Les habitats de reproduction naturelle et artificielle ont été productifs pour l'anophèle, toutefois, l'abondance des larves recueillies à partir des habitats a été déterminée selon la saison. La permanence de l'habitat a eu une influence significative sur la productivité des larves et la composition des espèces. Il y avait une large diffusion de *A. gambiae* et *A. pharoensis* dans tous les habitats de reproduction tandis que *An.funestus* a été limité à l'habitat de reproduction permanente-en mars et pendant la saison seche. Parmi les habitats aquatiques, 80% étaient des sites de reproduction potentiels. Les habitats permanents et semi-permanents devraient être également utilisés pour contrôler les stades larvaires de moustiques dans les
zones semi-arides.

Mots clés: *A. gambiae*, *A. pharoensis*, la reproduction des moustiques, les habitats de moustiques, l'écologie des vecteurs

Background

Malaria control efforts in Kenya, focus on case management and the use of insecticide treated bed nets. Domestic vector control interventions against adult mosquitoes in the form of insecticide-treated bed nets or indoor residual spraying combined with improved access to effective diagnosis and treatment, have enormous potential to minimise occurrence of malaria. However, a truly integrated approach is what is required to control malaria (Beier *et al*., 1999; Shift, 2002). Underused interventions such as application of larvicides destruction of *Anopheles* larval habitats needs to be brought to the fore front of malaria management. However, little is known about the habitats, abundance and distribution of larvae of the main African malaria vectors. To control mosquitoes, whether adults or larvae, it is crucial to understand the relevant ecology of the target species. This study was conducted over a period of one year between August 2008 and July 2009. It describes the nature of the breeding habitats of malaria vectors in a semi-arid region of

Kenya and their potential of producing larvae in both rainy and dry seasons.

Study Description

This study was conducted in Kamarimar village, Baringo district in the semi-arid Rift Valley Province of Kenya, approximately 250 km North West of Nairobi (045ºN, 36ºE). It has three agro-ecological zones; the highlands, midlands and lowlands. The study village has a population of about 200 inhabitants, living in compounds of 2-3 traditional mud wall houses with corrugated iron roofs or grass thatched. The main activity of the inhabitants is livestock rearing; goats, cows, sheep, and chicken are bred in the village. Crop production is not feasible except around the swamp where onions, tomatoes and cabbages are grown in small plots fed by drainage canals from the swamp. The study was conducted in the drier lowland regions of the district where malaria is the leading cause of morbidity.

Mosquito larvae were sampled during the rainy and dry season. A standard mosquito dipper (350 ml) was used to make 5 - 10 dips at each potential breeding habitat to sample mosquito larvae. Larvae were immediately preserved in 70% ethanol and transported to the laboratory of the Division of Vector Borne Diseases (DVBD) in Marigat. All larvae were examined microscopically, and anopheline larvae further separated from culicine larvae. *Anopheles gambiae, funestus* and *pharoensis* larvae were further identified and separated using morphological features.

Environmental variables were recorded for each habitat and included water depth, distance to the nearest house, vegetation coverage, emergent plant coverage, turbidity and habitat type. Emergent plants included both aquatic and immersed terrestrial vegetation. Plant coverage of a habitat was measured in percentage of water surface covered by estimation. Turbidity was measured by placing water samples in glass test tubes and holding against a white background, and classified as clear, low, medium, and high. The habitat types included marshes, pan dams, culverts, canals and ditches.

Research Application

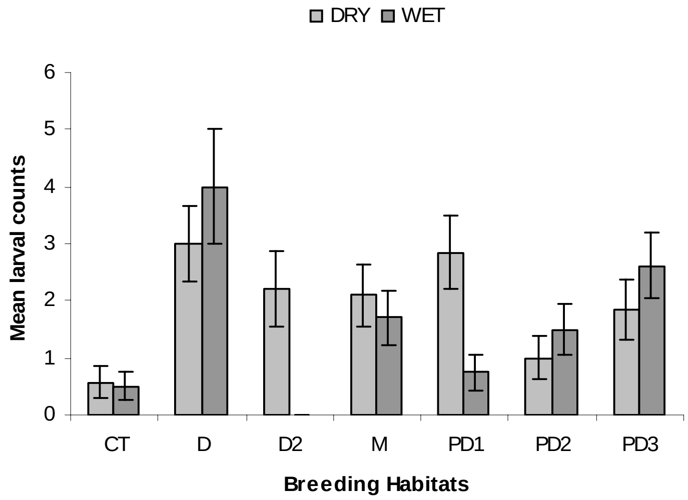
Colonization of breeding habitats. The larval habitats were identified and characterized in two ecological settings of the study area namely Tirion, where there are no permanent water bodies and Kamarimar village lying adjacent to the permanent Loboi swamp. The habitats comprised five different types including marshes, pan dams, canals, ditch, and culverts.

Colonization of the habitats by mosquito larvae was highly variable between seasons. The study revealed that depending on location and season, ditch was readily colonized than other habitats and had the highest mean (4.0 and 3.0) for the rainy and dry seasons respectively. Culverts and marshes were mostly colonized in the dry season. Pan dams were colonized in either seasons. The summary of the larvae means in the differrent habitats are given in Table 1.

Population of the third and fourth instar larval stages revealed seasonal variation in habitat preference (Fig. 1). Culvert was the least preferred and had the lowest larvae means of 0.57 and 0.50 in dry and wet seasons respectively. This may be attributed to high turbidity of the culverts, low vegetation cover (estimated at 10%) and duration it lasted before drying up. Ditch had the highest mean counts during the wet and dry seasons (4.0 and 3.0, respectively). Despite the fact that it was a temporary habitat and lasted for short period, it was the most readily colonized. Clear water, high vegetation cover (80%) non-interference from grazing animals justified its high productivity. The habitat overlapped into early dry season and remained the most productive for *Anopheles* larvae. However, a similar habitat D2 along a riverbed was only productive during early dry season and had a mean of 2.20. The habitat had no mosquito larvae during wet season which may be attributed to persistent overflows from River Chepkornis making it unsuitable for colonization during the wet season. Relatively stability of this habitat, vegetation cover of about 60% and reduced breeding grounds in the area are some of the key factors which may have rendered it a potential breeding ground and subsequent productivity during the early dry season.

Table 1. Means of *Anopheles* larvae collected from different breeding habitats in wet and dry season during the entire period of the study.

Habitats	Dry season		Wet season	
	Mean	Standard error	Mean	Standard error
Culvert	0.57	0.286	0.50	0.250
Ditch	3.00	0.655	4.00	1.000
Ditch2	2.20	0.660	0.00	0.000
Marsh	2.10	0.553	1.70	0.468
Pandam1	2.85	0.639	0.75	0.306
Pandam2	1.00	0.378	1.50	0.433
Pandam3	1.85	0.515	2.62	0.573



Key: CT = Culvert; D = Ditch; M = Marsh; PD = Pan dam

Figure 1. Mean counts of mosquito larvae from breeding habitats in wet and dryseason.

The marsh recorded mean counts of 2.10 during dry season compared to 1.7 in the rainy season, an indication that it is a potential habitat in absence of rain dependent breeding habitats. The marsh received constant water supply from the permanent Loboi swamp. Pan dams showed variable mean larvae densities between seasons. PD2 and PD3 had higher mean larval counts in the wet season compared to the dry season (1.50 and 2.62, respectively). The means were low in rainy season (at 1.00 and 1.85) implying that the two habitats were readily colonized by the vectors during the rainy season. Mean larval counts during the dry season in PD1 was 2.85 and was higher than 0.75 in wet season. The duration taken by a temporary habitat, its location. Plant cover >50% and minimal animal interference contributed to larvae collected from these habitats in both seasons.

Poisson was used to evaluate the effect of seasons, habitats and their interaction on the larval count in the different habitats. There was season and habitat interaction effect on larval counts (Table 2). During late dry season, *A. pharoensis* was the most common species in most habitats totaling 48%, followed by *A. gambiae* constituting 40% of the collections. *A. funestus* was common mainly in the marshes of the swamp; and were mainly detected during dry seasons and constituted only 12 % of the total larval collection.

Recommendation

The study recommends that both permanent and semi permanent breeding habitats should be considered in control of larvae of

Table 2. Effect of interaction between season and habitats on the population of mosquito larvae.

Change	df	Deviance	Mean deviance	Deviance ratio	Approx Chi pr
Season	1	0.971	0.971	0.97	0.325
Habitat	6	34.498	5.750	5.75	<.001
Season. Habitat	5	12.598	2.520	2.52	0.027
Residual	78	241.080	3.091		
Total	90	289.147	3.213		

malaria vectors in all seasons in a semi arid ecosystem since they were numerous and equally colonized.

Acknowledgement

I wish to thank Kenyatta University for registering and supervising my work, *icipe* for offering me laboratory space and equipment. Am grateful to Prof E. Kenya of Kenyatta University for her guidance and advice, RUFORUM for support they offered me. I greatly appreciate assistance from my supervisors.

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