Multiparameter Display System (YSI Environmental, YSI Incorporated, Yellow Springs, USA). Salinity and Total Dissolved solids (TDS) were measured using field hand held equipment YSI EC 300 (YSI Environmental, YSI Incorporated, Yellow Springs, USA).

7.3.2 Larval sampling and larval identification

Larval sampling was done once weekly to generate stage-specific estimates of *Anopheles* and culicine larval densities, invertebrate abundance and diversity. Samples were taken using standard dipping techniques and a plastic dipper (Mosquito Control Service and Supplies, USA) with a wooden ladle was used. Twenty dips were taken from each sub-plot.

The mosquito larvae collected were sorted out according to the sub-families as either anopheline or culicine. The anopheline larvae were grouped according to the instar stage and identified morphologically (Gillies and Coetzcee, 1987). The pupae were maintained in the insectary in cages to develop into adults. The emergent adult mosquitoes were identified by morphological criteria.

7.3.3 Data Management

Statistical analyses were done using SPSS software (Version 11.5 for windows, SPSS Inc., Chicago, IL). Simple descriptive statistics was used to tabulate the larval densities and abundance from the experimental plots. Pearson correlation was used to determine the association between mosquito larvae and the different physicochemical variables measured in the plots during the larval sampling. The relative abundance of *Anopheles gambiae* was calculated as the number of mosquito larvae divided by the number of dips taken from each larval habitat. The dependent variable (relative abundance of a species) was transformed using the log transformation method {Log (x+1)}.

7.4 Results

A total of 21,325 *Anopheles* larvae were collected of which 91.93% (n = 19,604) were early instars and 8.07% (n = 1,721) were late instars. For culicines larvae, a total of 19,926 were collected of which 87.33% (n = 17,401) were early instars and 12.67% (n = 2,525) were late stage instars. A total of 513 pupae were collected. Table 7.1 shows the larval composition for each subfamily of mosquitoes based on each rice growth cycle. From table 7.1, most of the larvae were collected between land preparation and tillering stage. Between flowering and rice maturation, there is a decline of mosquito larvae from the plots. When the rice is harvested, there is an increase in larval abundance in the rice plots.

Figure 4a and 4b shows the weekly anopheline larval fluctuation from February 2004 to March 2005. This figure shows that there is sigmoid increase of anopheline larval densities between transplanting and tillering. When the rice gets into the reproductive stage (Flowering stage), the larval densities decline and this trend continues until the rice is harvested. After harvesting (ratoon), there is a small increase in larval densities, which follows; the larval increase goes on throughout land preparation. Figure 4b further shows that *An. gambiae* larvae are predominant throughout the rice growing cycle while *An. pharoensis* is only found during the tillering stage.

Table 7.2a shows the morphological identification of late stage instars of both *Anopheles* and culicine mosquitoes. Morphological identification of *Anopheles* larvae yielded 84.09% (n = 1,274) *An. gambiae s.l.,* 13.47% (n = 204) *An. pharoensis,* 1.32% (n = 20) *An. rivulorum,* 0.79% *An. funestus,* 0.26% *An. coustani* and 0.07% (n = 1) *An. maculipalpis.* A total of 891 late stage larvae were identified of which 65.66% (n = 585) were *C. quinquefasciatus,* 9.88% (n = 88) *C. annulioris,* 7.30% *C. poicilipes,* 7.18% (n = 64) *C. tigripes,* 0.56% (n = 5) *C. duttoni,* 5.27% (n = 47) *Ae. Aegypti,* 3.48% (n = 31), *Ae. Cumminsii,* and 0.67% (n = 6) *Ae. Vittatus.*

Table 7.2b shows the morphological identification of emergent mosquitoes from the pupae. Most of the emergent mosquitoes were identified as *An. gambiae s.l.* (57.97%, n = 80), *C. quinquefasciatus* accounted for 23.91% (n = 33).

The physicochemical variables and mosquito larval developmental stages where analyzed using Pearson correlation to test for associations of the variables (Table 7.3). Of the 171 correlation coefficients, 71 (41.52%) were statistically significant indicating that there was non-random association between some of the variables tested. For example, rice height was negatively associated with both early and late stage *Anopheles* larvae. Early stage *Anopheles* was strongly associated with late stage *Anopheles*. There was a strong positive association between anopheline larvae and culicine larvae in both the early and late instar stages. Early instars of culicine mosquitoes were associated with turbidity of water. Rice stage was strongly associated with rice height. Turbidity was negatively associated with rice stage and rice height. Two associations could not be computed because at least one of the variables is constant.

Table 7.1 The larval abundance from the experimental plots in the 3 cycles of rice growing

Rice planting cycle	Rice Stage	Early Instars *Anopheles*	Late Instars *Anopheles*	Early Instars Culicines	Late Instars Culicines	Pupae
Cycle 1	Transplanting	5	2	1	0	0
	Tillering	46	38	15	29	12
	Flowering	86	38	81	129	15
	Maturation	21	6	42	21	14
	Harvesting/Ratoon	290	35	3,770	718	31
Cycle 2	Land preparation	726	85	2,476	650	47
	Transplanting	50	6	16	2	3
	Tillering	3,405	678	263	85	199
	Flowering	1,133	132	118	13	13
	Maturation	187	35	468	75	9
	Harvesting/Ratoon	761	0	1,913	159	0
Cycle 3	Land preparation	1,828	14	1,845	164	25
	Transplanting	7,026	135	1,030	12	8
	Tillering	299	49	210	30	3
Total	Land preparation	2,554	99	4,321	814	72
	Transplanting	7,081	143	1,047	14	11
	Tillering	3,750	765	488	144	214
	Flowering	1,219	170	199	142	28
	Maturation	208	41	510	96	23
	Harvesting/Ratoon	1,051	35	5,683	877	31
	Grand Total	**15,863**	**1,253**	**12,248**	**2,087**	**379**

Table 7.2a Shows the morphological identification of late stage instars of *Anopheles* and culicines mosquito larvae

Genera	Species	Sum	Percentage
Anopheles	*An. gambiae s.l.*	1,274	84.09
	An. funestus	12	0.79
	An. pharoensis	204	13.47
	An.rivulorum	20	1.32
	An.maculipalpis	1	0.07
	A. coustani	4	0.26
	Total	**1,515**	**100.00**
Culicines	*C. quinquefasciatus*	585	65.66
	C. Poicilipes	65	7.30
	C. annulioris	88	9.88
	C. tigripes	64	7.18
	C. duttoni	5	0.56
Aedes	*Ae. aegypti*	47	5.27
	Ae. cumminsi	31	3.48
	Ae. vittatus	6	0.67
	Total	**891**	**100**

Table 7.2b The identification of emergent mosquitoes from pupae.

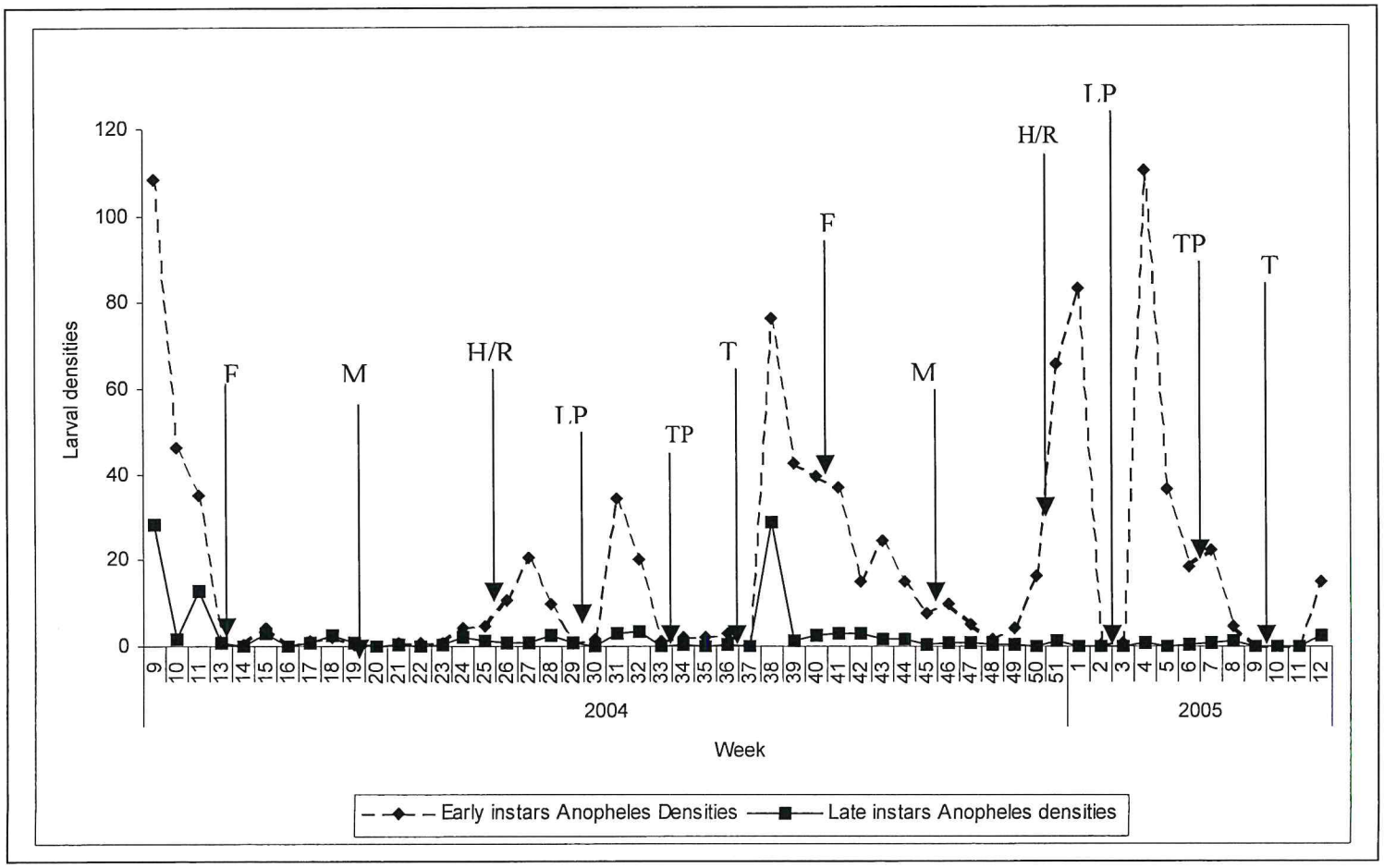
Genera	Mosquito species	Female	Male	Total
Anopheles	*An. gambiae*	76	4	80
	An. coustani	0	4	4
	An. rufipes	2	0	2
Culex	*C. quinquefasciatus*	28	5	33
	C. poicilipes	1	0	1
Aedes	*Ae. taylori*	4	0	4
	Ae. circumluteolus	4	10	14
Total	Total	115	23	138

Table 7.3 Pearson Correlations between mosquito larvae and other physicochemical variable measured at the experimental plots.

	Rice height	Rice stage	#tillers	Depth (cm)	Turb	Other inverts	Anopheles	Culicine	#pupae	Temp (°C)	Cond (mS/cm)	Salinity (ppt)	D. oxygen (%)	DO Conc (mg/L)	DO Charge	pH
Rice stage	0.902**															
#tillers	0.243	0.281														
Depth (cm)	0.188*	0.009	-0.468*													
Turb	-0.445**	-0.352**	0.106	0.050												
Other inverts	-0.146	-0.113	(a)	-0.140*	-0.058											
Anopheles	-0.214*	-0.013	-0.111	0.033	0.183**	0.060										
Culicine	0.036	0.097	0.016	-0.002	0.125*	0.041	0.594**									
# pupae	-0.094	0.027	(a)	0.077	0.042	0.028	0.545**	0.259**								
Temp (°C)	0.071	0.129	-0.189	-0.175**	0.077	0.105	0.198**	0.164**	0.028							
Conduc (mS/cm)	-0.305**	-0.106	0.076	-0.263**	-0.098	0.133*	0.217**	0.081	0.161**	0.275**						
Salinity (ppt)	-0.303**	-0.154*	0.094	-0.242**	-0.090	0.104	0.176**	0.045	0.146*	0.177**	0.962**					
D. oxygen (%)	-0.380**	-0.257**	-0.224	-0.145*	0.060	0.033	0.147*	-0.033	0.100	0.148*	0.115	0.113				
Do Conc (mg/L)	-0.119	-0.146*	-0.208	0.065	0.110	-0.063	-0.083	-0.103	-0.035	-0.198**	-0.593**	-0.530**	0.673**			
DO Charge	-0.673**	-0.472**	-0.108	-0.175**	0.149*	0.003	0.161**	-0.051	0.125*	0.076	0.236**	0.251**	0.910**	0.540**		
pH	-0.369**	-0.328**	-0.204	0.001	0.234**	-0.027	0.114	-0.023	0.109	0.168**	-0.034	-0.023	0.592**	0.464**	0.637**	
PHMV_MV	0.365**	0.312**	0.206	0.012	-0.228**	0.022	-0.121	0.020	-0.110	-0.196**	0.014	0.008	-0.597**	-0.448**	-0.638**	-0.999**

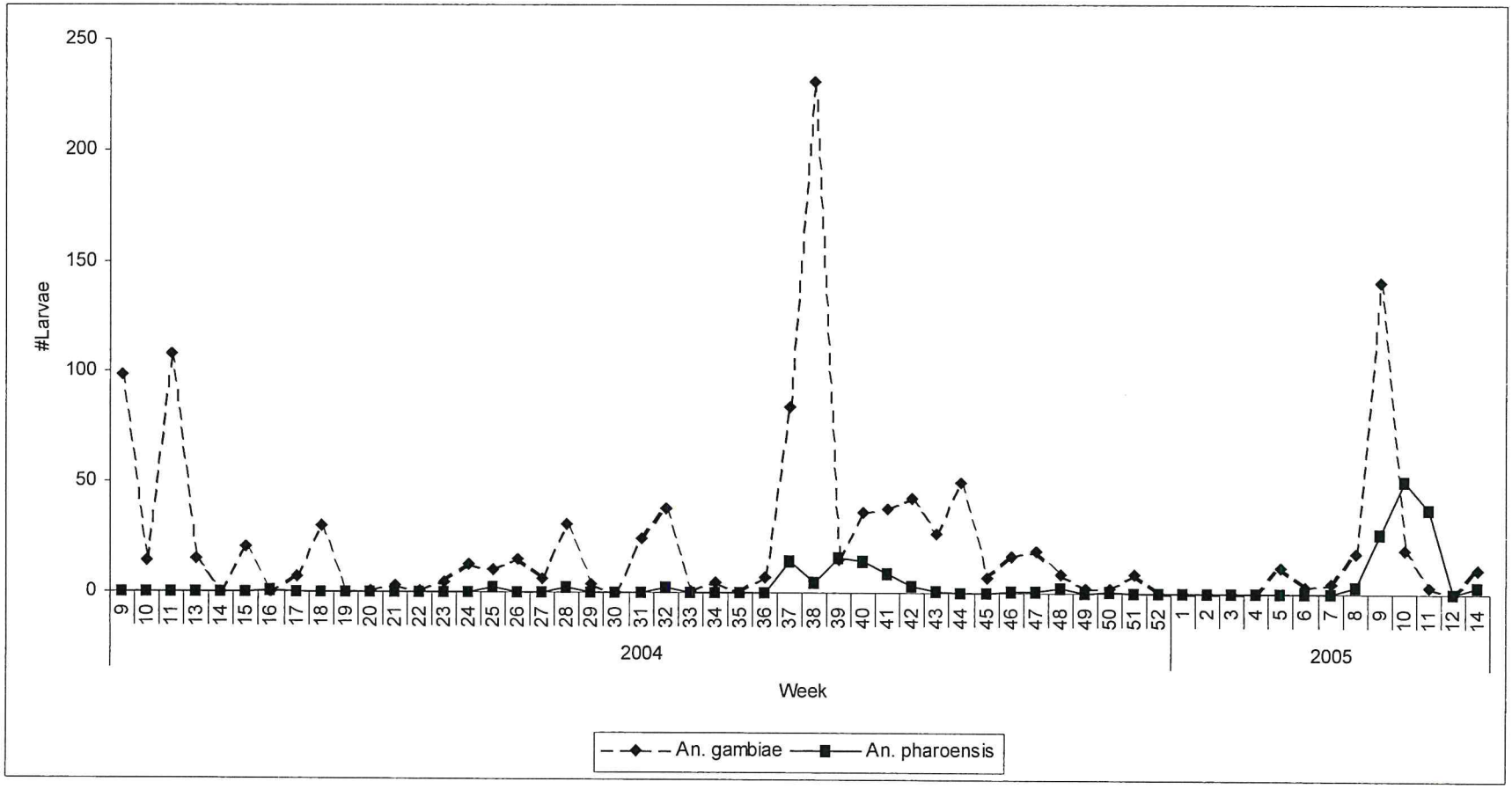
** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
[a] Cannot be computed because at least one of the variables is constant.
Do Conc[b] Dissolved oxygen concentration
DO Charge[c] Dissolved oxygen charge

Figure 4a shows the weekly variation in early and late instars of *Anopheles* mosquito larvae



Foot notes: **F**: Flowering; **M**: Maturation; **H/R**: Harvesting/Ratoon; **LP**: Land Preparation; **TP**: Transplanting; **T**: Tillering

Figure 4b shows the weekly variation *An. gambiae* and *An. pharoensis* identified



7.5 Discussion

This study describes, the rice growing cycle as used by farmers in Mwea Irrigation Scheme and how it influences the larval diversity and abundance. This study shows that most of larvae were collected between land preparation and tillering stage. At these stages of rice development the water is more exposed providing more suitable habitats for oviposition consequently abundance of larvae in the water. Our finding is similar to various studies in schemes (Mukiama and Mwangi 1989, Ijumba et al., 1990, Mutero et al., 2000), which unanimously reveal that *An. arabiensis* normally have one major population peak annually, coinciding with the transplanting of rice seedlings during the main growing season. At transplanting of rice seedling the rice height is small providing good penetration of sunlit to aerate the habitats. Also few days after transplanting there is addition of nitrogenous fertilizers, which were shown to attract *Anopheles* and culicine mosquito to oviposition (Victor and Reuben 2000, Mutero et al., 2004b). For effective control of the mosquito menace in Mwea Irrigation Scheme, consolidated efforts should be leveled against the pre-adult stage between the transplanting and the tillering stage. At these stages the abundance of mosquito larvae is highest, consequently larvicidal pesticides application would yield maximum reduction in adult population. At this stage, the vector control programmes should use integrated vector control mechanisms (Lacey and Lacey 1990) targeting both the adult mosquito populations and larval control. Considering Mwea Irrigation Scheme, the rice growing is in phases; the control should be done all year round based on the rice-growing circle.

Our finding further shows that there was a strong correlation between anopheline and culicine larval abundance at the experimental plots. This indicates that anopheline and

culicine mosquito larvae co-exist in the breeding habitats. These mosquito larvae utilize same habitat for their development, although from these finding, it appears after flowering culicine larval abundance increase significantly. Anopheline larvae are known to breed in open, sunlit habitats (Gillies and Coetzcee 1987), which is provided by early stages of rice cycle, while culicine can breed in both habitats with clear water and foul looking like water. After transplanting, and the addition of fertilizers, the water turbidity is quite low (Mutero et al., 2004b), but as rice grows turbidity changes. After harvesting the water is very turbid due to the rice straws decomposition in the plots. This provides favorable condition for culicine breeding. Based on this finding, larval control using larvicidal agents should use one that targets both the anopheline and culicine larvae.

Morphological identification of the mosquito larvae yielded significantly more *An. gambiae s.l.* larvae than the other species. Further, the identification of emergent mosquito also gave more *An. gambiae s.l.* This indicates that the rice paddy produce more *An. gambiae* mosquitoes than the other species. This means that the rice farmers are exposed more to the malaria risk and there is a possibility of continuous parasite transmission. The implication of this is that, the people living within the scheme should use insecticide treated bednets (ITBN) to minimize the human-vector contact. This would lower the chances of getting the malaria parasites consequently remaining healthy.

In conclusion, these studies show that mosquito control programmes should be emphasized at the beginning of rice growing cycle targeting the developmental stages.

Throughout the rice growing cycle, larvicidal control programmes should go hand in hand with other vector control tools such as insecticide treated bednets.

CHAPTER 8: THE SURVIVAL OF IMMATURE *ANOPHELES* IN MWEA RICE IRRIGATION SCHEME

8.1 Abstract

8.2 Introduction

Anopheles gambiae complex and *An. funestus* complex are the primary vectors of malaria in Mwea rice irrigation scheme. The distribution and abundance of mosquito larvae results from availability of oviposition sites, the oviposition preferences of females, and the ability of the immatures to tolerate and develop after the eggs were laid.

Life tables provide a structured framework for identifying developmental stages most susceptible to mortality and, under some conditions, for inferring sources of mortality (Service 1993). The life tables for the developing immatures can be constructed using either horizontal or vertical methods (Reisen and Siddiqui 1979, Reisen et al. 1982, Service 1993). Horizontal life table methods are appropriate for distinct cohorts that can be followed through time, whereas vertical life table methods are appropriate for populations with overlapping generations and age distributions that remain stationary for the duration of the sampling period. Service (1971, 1973, 1977, 1993) Reisen and Siddiqui (1979) and Reisen et al. (1982) provide extensive discussions about how such information can be analyzed.

In Kenya, Service, (1971, 1973, 1977) and Aniedu and colleagues (1993) studied the survival of immature An. gambiae complex in the larval habitats. The objective of this study is to determine survival of immature *An. arabiensis* in different habitats in Mwea Irrigation Scheme and under the experimental rice growing conditions.

8.3 Materials and Methods

8.3.1 Horizontal and vertical Life Tables

This will be done as described in 3.10 in this thesis.

CHAPTER 9: CONCLUSIONS

1. Rice growing is an important source of mosquito production. Rice paddy and canal are most productive habitats. This study also shows that unplanned rice growing supports more *Anopheles* larvae than planned rice growing system. From the results larval control activities should be initiated at early rice stages and during the rainy season. The unplanned rice system should be better managed and if possible controlled by the management system of the Mwea Irrigation Scheme where water for irrigation is distributed together with those of the scheme.

2. *Anopheles* larval abundance is found to be associated with pH and salinity. These parameters in a rice agro ecosystem are associated with early stages of rice growth cycle, which is associated with larval abundance. For effective control of developmental stages of mosquito larvae, the application of the larvicide should be done after transplantation and the larvicide should persist until the reproductive stage of the rice.

3. Mosquito control programmes should be emphasized at the beginning of rice growing cycle targeting the developmental stages. Throughout the rice growing cycle, larvicidal control programmes should go hand in hand with other vector control tools such as insecticide treated bednets.

4. There is natural regulation for mosquito production in the aquatic habitats. Although the number of emergent mosquitoes decreases due to predation pressure, there is a need to effective control mosquito developmental stages using larvicides such as Bti and Bs.

5. Paddy is the most productive habitat productive habitat type. Most *An. gambiae* emerged from the paddy habitat type.

6. Addition of nitrogenous fertilizer results to a consequent increase of *Anopheles* mosquito larvae. This is the phenomenon which results in the increase of mosquito larvae between transplanting and tillering.

7. There is no succession of *Anopheles* mosquito larvae in the rice paddy but there is more diversity of larvae at the early stages of the rice growing. Most of the *Anopheles* mosquitoes colonize the paddy at the early stages of paddy development. There is more species at the transplanting stage and tillering stage, after which, the other species diminish leaving only *An. gambiae* in the paddy till harvesting.

10.0 REFERENCES

Addae-Mensah, I., and Achieng, G. 1986. Larvicidal effects of six amide alkaloids from Piper guineense. Planta medica 58: 432-439.

Aikawa, M. 1980a. *Host cell invasion by malarial parasites. in: cellular interactions in symbiosis and parasitism* (C. B. Cook, P. W. Pappas & E. D. Rudolph eds.). Ohio University Press, Colombus, USA.: 31-46.

Aikawa, M., and Seed, T.M. 1980b. *Morphology of Plasmodia in: malaria* (J.P. Kreier ed.). Academic Press, New York. 1: 285-344.

Alles, H. K., Mendis, KN., and Carter, R. 1998. Malaria mortality rates in South Asia and in Africa: implications for malaria control. Parasitology Today 14: 369-375.

Alonso, P. L., Lindsay, S.W., Armstrong, J.R.M., Conteh, M., Hill, A.G., Fegan, G., De Francisco, A., Hall, A.J., Shenton, F.C., Cham, K., Greenwood, B.M. 1991. The effect of insecticide treated bed nets on mortality of Gambian children. Lancet 337: 1499-1502.

Aly, C., and Dadd, RH. 1989. Drinking rate regulation in some fresh water mosquito larvae. Physiol. Entomol. 14: 241-56.

Asimeng, E. J., and Mutinga, M.J. 1993. Effect of rice husbandry on mosquito breeding at Mwea Rice Irrigation Scheme with reference to biocontrol strategies. J. Am. Mosq. Control Assoc. 9: 17-22.

Baolin, L. 1988. The effect of *Azolla* on mosquito breeding. Parasitol. Today 4: 328 - 329.

Bazter, D., and Wissinger, SA. 1996. Ecology of insect communities in nontidal wetlands. 41:75-100. Annu. Rev. Entomol. 41: 75-100.

Beach, R. F., Ruebush, T.K., Sexton, J.D., Hightower, A., and Roberts, J. 1993. Evaluation of permethrin-impregnated bed-nets and curtains during seasonal periods of intense malaria transmission in western Kenya. Am. J. Trop. Med. Hyg. 49: 290-300.

Beck, L. R., Rodriguez, M.H., Dister, S.W., Washino, R.K., Roberts, D.R., and Spanner, M.A. 1997. Assessment of a remote sensing model for predicting malaria transmission risk in villages in Chiapas, Mexico,. J. Trop. Med. Hyg. 56: 99-106.

Beehler, J. W., and Mulla, M.S. 1995. Effects of organic enrichment on temporal distribution and abundance of culicine egg rafts. J. Am. Mosq. Control Assoc. 11: 167-71.

Beier, J. C., Killeen, Githure, J.I. 1999. Short Report: Entomologic Inocululation Rates and *Plasmodium falciparum* malaria prevalence in Africa. Ann. J. Trop. Med. Hyg. 61: 109-113.

Beier, J. C., Oster, CN., Onyango, FK., Bales, JD., Sharwood, JA., Perkins, PV., Chumo, DK., Koech, DK., Whitmire, RE., Roberts. CR., Diggs, CL., Hoffman, SL. 1994. *Plasmodium falciparum* incidences relative to entomologic inoculation rates at a site proposed for testing malaria vaccines in Western Kenya. Am. J. Trop. Med. Hyg. 50: 529-36.

Beier, J. C., Perkins, P.V., Onyango, F.K., Gargan, T.P., Oster, C.N., Whitmire, R.E., Koech, D.K., Roberts, C.R. 1990. Characterization of malaria transmission by *Anopheles* (Diptera : Culicidae) in Western Kenya in preparation for malaria vaccine trials. J. Med. Entomol. 27: 570-577.

Beklemishev, V. N. 1930. The importance of colloidal-dispersive substances in the nutrition of the larvae of *Anopheles.* Parazit. sb. 1: 27-36.

Bergquist, N. R. 2001. vector borne parasitic diseases: new trends in data collection and risk assessment. Acta Tropica 79: 13-20.

Blower, J., Cook, LM, Bishop JA. 1981. *Estimating the size of Animal populations.* George Allen and Unwin Ltd., London.

Boudin, C., Robert, V., Carnevale, P., and Ambroise-Thomas, P. 1992. Epidemiology of *Plasmodium falciparum* in a rice field and savanna area in Burkina Faso. Comparative study on the acquired immunoprotection in native populations. Acta Trop 51: 103 -111.

Brasseur, P., Kouamouo, J., Brandicourt, O., Moyou-somo, R., and Druilhe, P. 1998. Patterns of in vitro resistance to chloroquine, quinine and mefloquine of *Plasmodium falciparum* in Cameroon, 1985-1986. American Journal of Tropical Medicine and Hygiene 39: 166-172.

Briegel, H., and Horler, E. 1993. Multiple blood meals as a reproductive strategy in Anopheles (Diptera: Culicidae). J. Med. Entomol. 30: 975-985.

Briet, O. J. T., Dossou-Yovo, J., Akodo, E., van de Giesen, N., Teuscher, T.M. 2003. The relationship beween *Anopheles gambaie* density and rice cultivation in the savannah zone and forest zone of Cote d'Ivoire. Trop. Med. Int. Health 8: 439 - 448.

Bryan, J. H. 1983. Anopheles gambiae and A. melas at Brefet, The Gambia, and their role in malaria transmission. Ann. Trop. Med. Parasit. 77: 1-12.

Burkot, T. R., Graves, P.M., Paru, R., Battistutta, D., Barnes, A., and Saul, A. 1990. Variations in malaria transmission rates are not related to anopheline survivorship per feeding cycle. Am. J. Trop. Med. Hyg. 43: 321-327.

Campbell, A. L., Sullivan, W.W., and Smith, L.W. 1933. The relative toxicity of nicotine, anabasine, methyl-anabasine, and lupinine for culicine mosquito larvae. Journal of Economic Entomology 26: 500-509.

Carpenter, S. R. 1982. Stem flow chemistry : Effects on population dynamics of detrivorous mosquitoes in tree hole ecosystems. Oecologia (Berl.) 53: 1-6.

Case, T. J., and Washino, R.K. 1975. Correlates of mosquito larval densities and survivorship in some northern California rice fields. Proc. Calif. Mosq. Control Association. 43: 155.

Cates, M. D. 1968. The effect of improved rice farming techniques on mosquito populations in central Taiwan. Mosq. News 28: 582 - 585.

Chandler, J. A., Highton, R.B. 1976. The breeding of Anopheles gambiae Giles (Diptera : Culicidae) in rice fields in the Kisumu area of Kenya. J. Med. Ent. 13: 211-215.

Charlese, F. B., Sullivan, W.W., and Smith, L.W. 1995. Use and status of DDT in Zimbabwe. Journal of African Health Sciences 2: 11-69.

Charlwood, J. D., Smith, T., Billingsley, P.F., Takken, W., Lyimo, E.O.K., Meuwissen, , and J.H. 1997. Survival and Infection probabilities of anthropophagic anophelines from an area of high prevalence of *Plasmodium falciparum* in humans. Entomological Research 87: 453-455.

Chinery, W. A. 1984. Effects of ecological changes on the malaria vector *Anopheles funestus* and the *Anopheles gambiae* complex of mosquitoes in Accra, Ghana. Journal of Tropical Medicine and Hygiene 87: 75-81.

Chow, C. Y. 1969. Ecology of malaria vectors in the Pacific. Cah. ORSTOM Ser. Entomol. Med. Parasitol. 2: 93 - 97.

Chrisman, N. R., Cowen, D.J., and Fisher, P.F. 1989. Geographic information systems. In: Gaile G.L., Willmot C.J. Eds Geography in America. Merrill publishing Co.: 776-796.

Christie, M. 1958. Predation on larvae of *Anopheles gambiae* Giles. Journal of Tropical Medicine and Hygiene 61: 168.

Clements, A. N. 1963. *The physiology of mosquitoes.* Oxford: Pergamon: pp393.

Clements, A. N. 1992. The biology of Mosquitoes, Vol.1. London: Chapman & Hall.

Clements, A. N., and Paterson, G.D. 1981. The analysis of mortality and survival rates in wild populations of mosquitoes. Journal of Applied Ecology 18: 373-399.

Colleman, R. E. L., Robert, L., Roberts, L.W. Glass, J.A., Seeley, D.C., Laughinghouse, A., Perkins, P.V., and Wirtz, R.A. 1993. Laboratory evaluation of repellents against four anopheline mosquitoes (Diptera: Culicidae) and two phlebotomine sandflies (Diptera: Psychodidae). Journal of Medical Entomology 30: 499-502.

Collins, F. H., and Washino, W.K. 1980. The effects of irrigation water source and crop rotation on the abundance of *Culex tarsalis* in California rice fields. *Proceedings of California Mosquito and Vector Control Association* 48: 103 - 108.

Collins, F. H., Petrarca, V., Mpofu, S., Brandling-Benneth, AD., Were, JB., Rasmusssen, MO., and Finerty, V. 1988. Comparison of DNA-Probe and cytogenetic methods for identifying field collected *Anopheles gambiae* complex mosquitoes. Am. J. Trop. Med. Hyg. 39: 545-50.

Coluzzi, M., Petrarca, V., Di Deco, MA. 1984. Heterogeneities of the malaria vectorial system in tropical Africa and their significance in malaria prevention and control. Bulletin of the World Health Organization. 62: 107-113.

Coluzzi, M., Petrarca, V., Di Deco, MA. 1985. Chromosomal inversion intergradation and incipient speciation in *Anopheles gambiae.* Boll. Zool 52: 45-63.

Coluzzi, M., Sabatini, A., Petrarca, V., Di Deco, MA. 1979. Chromosomal differentiation and adaptation to human environment in the *Anopheles gambiae* complex. Trans. R. Soc. Trop. Med. Hyg. 37: 483-497.

Coosemans, M. H. 1985. Comparaison de l'endemie malariebbe dans une de riziculture et dans une zone de culture du coton dans la plains de la Ruzizi, Burundi. Annales de la societe Belge de Medecine Tropicale 65: 187 - 200.

Costantini, C., Song-gang Li, Della Torre, A., Sagnon N'fale, Coluzzi, M and Taylor, , and C. 1996. Density, survival and dispersal of *Anopheles gambiae* complex mosquitoes in a West African Sudan Savanna village. Medical and Veterinary Entomology 10.

Costern, J. W., Cheng, KJ., Geesey, GG., Ladd, TI., Nickel, JC. 1987. Bacterial biofilms in nature and disease. Ann. Rev. Microbiol.. 41: 435-64.

Craig, M. H., Snow, RW., and De Le Sueur. 1999. African climatic model of malaria transmission based on monthly rainfall and temperature. Parasitology Today 15: 105-111.

Curtis, C. F., and Townson, H. 1998. Malaria-existing methods of vector control and molecular entomology. British Med Bull 54: 311-325.

Dadd, R. H., and Kleinjan, JE. 1976. Chemically defined dietary media for larvae of the mosquito Culex pipiens (Diptera: Culicidae): Effects of colloid texturizers. J. Med. Enomol 13: 285-91.

Danislozano, R., Rodriguez, M., Arrendondojimenez, J., Hernandezavila, M., and Mallorca, C. 1997. Aquatic insects associated with *Anopheles albiamus* (Diptera: Culicidae) breeding sites in southern Mexico. Environ. Entomol. 26: 828-838.

De Meillon, B. 1934. Observations on *Anopheles funestus* and *Anopheles gambiae* in the transvaal. Publications of the South African Institute for Medical Research 6: 195.

Dye, C., and Hasibeder, G. 1986. Population dynamics of mosquito borne disease: Efffects of flies which bite some people more frequently than others. Trans. R. Soc. Trop. Med. Hyg. 80: 69-77.

Fisher, I. J., Bradshaw, WE., and Kammeyer. 1990. Fitness and its correlates assessed by intra- and interspecific interactions among tree-hole mosquitoes. J. Anim. Ecol. 59: 819-829.

Garnham, P. C. 1966. *Malaria parasites and other haemosporidia.* Blackwell Scientific Publications, Oxford.

Garret-Jones, C. 1964. Prognosis for interruption of malaria transmission through assessment of the mosquito's vectorial capacity. Nature 204: 1173-1175.

Getis, A., and Ord, J.K. 1992. The analysis of spatial association by use of distance statistics. Geographical analysis 24: 189 - 206.

Gillett, J. D., and Smith, J.G. 1972. *Common African Mosquitoes and their medical importance.* William Heinemann Medical Books Ltd. London.

Gillies, M. T. 1955. The pre-gravid phase of ovarian development in *Anopheles funestus*. Annals of Tropical Medicine and Parasitology 49: 320-325.

Gillies, M. T. 1961. Studies on the dispersion and survival of *Anopheles gambiae* Giles in East Africa, by means of marking and release experiments. Bulletin of Entomological Research. 52: 99-127.

Gillies, M. T. 1972. Some aspects of mosquito behaviour in relation to transmission of parasites. Zoological Journal of Linnean Society 51 (Supplement): 69-81.

Gillies, M. T., and Coetzee, M. 1987. A supplement to anophelinae of Africa south of Sahara(Afro-tropical region). Publication of the South Africa Institute of Medical Research 55: 1-143.

Gillies, M. T., and De Meillon, B. 1968. The Anophelinae of Africa South of the Sahara, 2nd Edition. Publication of the South Africa Institute of Medical Research 54.

Gimnig, J. E., Ombok, M., Kamau, L., Hawley, WA. 2001. Characteristics of larval anopheline (Diptera: Culicidae) habitats in Western Kenya. J. Med. Entomol 38: 282-288.

Gimnig, J. E., Ombok, M., Otieno, S., Kaufman, MG., Vulule, JM., Walker, ED. 2002. Density-dependent development of *Anopheles gambiae* (Diptera: Culicidae) larvae in artificial habitats. J. Med. Entomol 39: 162-172.

Githeko, A. K., Service, MW., Mbogo, CM., Atieli, FK., and Juma, FO. 1993. *Plasmodium falciparum* sporozoite and entomological inoculation rates at the Ahero rice irrigation scheme and the Miwani sugar-belt in Western Kenya. Ann. Trop.med parasitol 87: 379-91.

Githeko, A. K., Service, MW., Mbogo, CM., Atieli, FK., Juma, O. 1994. Origin of blood meals in in door and out-door resting malaria vectors in Western Kenya. Acta Tropica 58: 307-316.

Goonasekere, K. G. A., and Amerasinghe, F.P. 1988. Planning, design and operation of irrigation schemes - their impact on mosquito-borne diseases. *Vector-borne disease control in humans through rice agroecosystem management. Proceedings of the workshop on Research and Training needs in the field of integrated vector borne diseases control in Rice Agroecosystem of developing countries, 9 - 14, March, 1987.* International Rice Research Institute, The Philippines: 41 - 50.

Greenwood, B. M. 1989. Impact of culture and environmental changes on epidemiology and control of malaria and babesiosis. Part 3. The microepidemiology of malaria and its importance to malaria control. Trans. R. Soc. Trop. Med. Hyg. 83: 25-29.

Greenwood, B. M. 1991. An analysis of malaria parasites in infants: 40 years after MacDonald - A response. Tropical Disease Bulletin 88: R1-R3.

Grillet, M. E. 2000. Factors associated with distribution of *Anopheles aquasalis* and *Anopheles oswaldoi* (Diptera: Culicidae) in a malarious area, Northern eastern Venezuela. J. Med. Entomol. 37: 231-238.

Gubler, D. J. 1998. The resurgent vector-borne diseases as a global health problem. Emerging Infect. Dis. 4: 442-450.

Gupta, S., Snow, R., Donnelly, C., and Newbold, C. 1999. Acquired immunity and postnatal clinical protection in childhood cerebral malaria. Proc R Soc Lond B Biol Sci 266: 33-38.

Haddow, A. J. 1942. The mosquito fauna and climatic of native huts at kisumu, kenya. Bulletin of Entomological Research. 33: 91.

Harrison, B. A., and Scanlon, J.E. 1975. Medical entomology studies - II: The subgenus *Anopheles* in Thailand. Contributions of the American Entomological Institute 12: 1 - 307.

Hawley, W. A. 1985. The effects of larval densities on adult longevity of mosquito. *Aedes sierriensis*: Epidemiological consequences. J. Anim. Ecol. 54: 955-64.

Hess, A. D., and Hayes, RO. 1970. Relative potential of domestic animals for zooprophylaxis against mosquito vectors of encephalitis. Am.J. Trop. Med. Hyg. 19: 327.

Highton, R. B., Bryan, H., Boreham, PFL., Chandler, JA. 1979. Studies on the sibling species *Anopheles gambiae* Giles and *An. arabiensis* Patton (Diptera : Culicidae) in the Kisumu area, Kenya. Bull. Ent. Res. 69: 43-53.

Hinman, E. H. 1932. The role of solutes and colloids in the nutrition of anopheline larvae. A preliminary report. Am J Trop Med. 12: 263-71.

Howland, L. J. 1930. Bionomical investigation of English larvae with special reference to their algal food. J. Ecol. 18: 81-125.

Huff, C. G. 1963. Experimental research on avian malaria. Advances in Parasitology 1: 1-65.

Ijumba, J. N., and Lindsay, S.W. 2001. Impact of irrigation on malaria in Africa: Paddies paradox. Med. Vet. Entomol. 15: 1-11.

Ijumba, J. N., Mwangi, RW., and Beier, JC. 1990. Malaria transmission potential of *Anopheles* mosquitoes in Mwea-Tebere irrigation Scheme, Kenya. Med. Vet. Entomol. 4: 425-32.

Jondiko, I. J. O. 1989. A mosquito larvicide in *Spilanthes mauritiana.* Phytochemistry 25: 2289-2290.

Joshi, G. P., Service, MW., and Pradhan, GD. 1975. A survey of Species A and B of the *Anopheles gambiae* Giles complex in the Kisumu area of Kenya prior to insecticidal spraying with OMS-43 (fenitrothion). Ann. Trop. Med. Parasitol. 69: 91-104.

Kabiru, E. W., Mbogo, CM., Muiruri, SK., Ouma, JH., Githure, JI, Beier, JC. 1997. Sporozoite loads of naturally infected *Anopheles* in Kilifi District, Kenya. J. Am.. Mosq. Contr. Assoc. 13: 259-262.

Keiser, J., Utzinger, J., and Singer, B.H. 2002. The potential of intermittent irrigation for increasing rice yields, lowering water consumption, reducing methane emissions, and controlling malaria in African rice fields. J. Am. Mosq. Con. Assoc. 18: 329 - 340.

Kettle, D. S. 1992. *Medical and Veterinary Entomology.* Centre for Agriculture and Biosciences International. Wallingford, UK.: pp 99-136.

Killeen, G., Fillinger, U., Kiche, I., Gouagna, LC., Knols, BG. 2002. Eradication of *Anopheles* gambiae from Brazil: Lessons for malaria control in Africa. The Lancet Infect Dis 2: 618-27.

Killeen, G. F., McKenzie, FE., Foy, BD., Schieffelin, C., Billingsley, PF., Beier, JC. 2000a. A simplified model for predicting malaria Entomologic Inoculation Rates based on Entomologic and Parasitologic parameters relevant to control. Am. J. Med. Hyg. 62: 535-544.

Killeen, G. F., McKenzie, FE., Foy, BD., Schieffelin, C., Billingsley, PF., Beier, JC. 2000b. The potential impact of integrated malaria transmission control on entomologic inoculation rate in highly endemic areas. Am. J. Med. Hyg. 62: 545-551.

Kitron, U., and Spielman A. 1989. Suppression of transmission of malaria through source reduction: anti-anopheline measures applied in Israel, the United States and Italy. Review of infectious Diseases 11: 391-406.

Kitron, U., Bouseman, J.K., and Jones, C.J. 1991. Use of the ARC/INFO GIS to study the distribution of Lyme disease ticks in Illinois. Prev. Vet. Med 11: 243 248.

Kitron, U., Pener, H., Costin, C., Orshan, L., Greenberg, Z and Shalom, U. 1998. Geographic Information System in malaria surveillance: Mosquito breeding and imported cases in Israel. American Journal of tropical Medicine and hygiene 50: 550-556.

Klinkenberg, E., Van der Hoen, W., Amerasinghe, FP. 2004. A malaria risk analysis in an irrigated area in Sri Lanka. Acta Trop 89: 215 - 225.

Koella, J. C., and Lyimo, E.O. 1996. Variability in the relationship between weight and wing length of *Anopheles gambiae* (Diptera: Culicidae). J. Med. Entomol. 33: 261-264.

Kramer, V. L., and Garcia, R. 1989. An analysis of factors affecting mosquito abundance in California wild rice fields. Bull. Soc. Vec. Ecol. 14: 87 - 92.

Lacey, L. A., and Lacey, C.M. 1990. The medical importance of riceland mosquitoes and their control using alternatives to chemical insecticides. J. Am. Mosq. Control Assoc. 6: 1-93.

Laird, M., and Miles, J.W. (eds). 1985. *Intergrated Mosquito Control Methodologies: Vol 2, Biocontrol and other Innovative Components, Future Directions x111.* Academic Press, London and New York, 369pp.

Lawrence, A. L., and Cynthia, A.L. 1990. The medical importance of the rice land mosquito and their control using alternatives to chemical insecticides. Journal of American Mosquito Control Association 2: 1-69.

Leeson, H. S. 1931. Anopheline mosquitoes in southern Rhodesia. The London School of Hygiene and Tropical Medicine, London, UK.

Lengeler, C. 2000. Insecticide treated bednets and curtains for preventing malaria. Cochrane Database Systematics Review. 2: cd000363.

Leonardo, K. B., Mitaku, S., Skalsounis, A.L., Ravelomamaintsoa, N., Tillequm, F., Knock, M, and Le Bras J,. 1994. I*n-vitro activities of acridone alkaloids against P. falciparum vol 5*. Saunders, London, p1169-1171.

Lindsay, S., Ansell, J., Selman, C., Cox, V., Hamilton, K. and Walraven, G. 2000. Effect of pregnancy on exposure to malaria mosquitoes. The Lancet 335: 1972.

Lyimo, E. O., and Koella, JC. 1992. Relationship between body size of adult *Anopheles gambiae* and infection with the malaria parasite of *Plasmodium falciparum.* Parasitology 104: 233-7.

MacDonald, W. W. 1967. The influence of genetic and other factors on susceptibility to parasites. in "genetics of Insect Borne Diseases". JW. Wright, Pal, R. Editors. Elsevier, Amsterdam.

MARA. 1998. *Towards an Atlas of Malaria Risk in Africa.* Medical Research Council, South Africa.

Maradufu, A., Lubega, and R, Dorn, F. 1978. Isolation of 5-E-ocimenone. A mosquito larvicide from *Tagetes minuta.* Lloydia 41: 181-183.

Marques, A. C. 1986. Migrations and the dissemination of malaria in Brazil. Memorial Instituto Oswaldo Cruz 81: 17-30.

Martens, P., and Hall, I. 2000. Malaria on the move: human population movement and malaria transmission. Emerging Infectious Diseases 6: 103-109.

Mbogo, C. M., Baya, N.M., Ofulla, A.V.O., Githure J.I. and Snow, R.W. 1996. The impact of permethrin-impregnated bednets on malaria vectors of the Kenyan coast. Med. Vet. Entomol. 10: 251-259.

Mbogo, C. M., Snow, RW., Kabiru, EW., Ouma, JH., Githure, JI., Marsh, K., and Beier, JC. 1993a. Low-level *Plasmodium falciparum* transmission and the incidence of severe malaria infection on the Kenyan Coast. Am. J. Trop Med 49: 245-253.

Mbogo, C. N. M., Kabiru, EW.,Muiruri, SK., Nzovu, JG., Ouma, JH., Githure, JI., Beier, JC. 1993b. Blood feeding behavior of *Anopheles gambiae s.l.* and *Anopheles funestus* in Kilifi District, Kenya. J. Am. Mosq. Control Assoc. 9: 225-227.

Mbogo, C. N. M., Snow, R.W., Khamala, C.P.M., Kabiru, E.W., Ouma, J.H., Githure, J.I., Marsh, K., Beier, J.C. 1995. Relationships between Plasmodium falciparum transmission by vector populations and the incidence of severe disease at nine sites on the Kenyan coast. Am. J. Trop. Hyg. 52: 201-206.

Mbogo, C. N. M. K., E.W., Muiruri, S.K., Nzovu, J.M., Ouma, J.H., Githure, J.I., Beier, J.C. 1993c. Bloodfeeding behaviour of Anopheles gambiae s.l. and Anopheles funestus in Kilifi district, Kenya. Journal of the American Mosquito Control Association 9: 225-227.

McCrae, A. W. 1984. Oviposition by African malaria vector mosquitoes. II. Effects of site tone, water type and conspecific immatures on target selection by freshwater *Anopheles gambiae* Giles *sensu lato.* Annals of Tropical Medicine and Parasitology 78: 307-318.

McGregor, I. A. 1964. Studies in the acquisition of immunity to *Plasmodium falciparum* infections in Africa. Trans. R. Soc. Trop. Med. Hyg. 58: 80-92.

Metcalf, C. L., Flint, W.P., and Metcalf, R.L. 1962. *Destructive and useful insects: their habits and control. 4th Edn.* McGraw Hill Book Company, New York, p998-1009.

Minakawa, N., Mutero CM, Githure JI, Beier JC, and Yan, G. 1999. Spatial distribution and habitat characterisation of anopheline mosquito larvae in western Kenya. Am. J. Trop. Med. Hyg. 61: 1010-1016.

Mogi, M. 1978. Population studies on mosquitoes in the rice field area of Nagasaki, Japan, especially *Culex tritaeniorhynchus.* Tropical Medicine 20: 173 - 263.

Mogi, M. T., Okazawa, I., Miyagi, S., Sucharit, W., Tumrasvin, T., Deesin, T., and Khamboonruang, C. 1986. Development and survival of anopheline immatures (Diptera: Culicidae) in rice fields in nothern Thailand. J. Med Entomol. 23: 244 - 250.

Mokany, A., and Shine, R. 2002. Pond attributes influence competitive interactions between tadpoles and mosquito larvae. Austral Ecol. 27: 396-404.

Mokany, A., and Shine, R. 2003. Oviposition site selection by mosquitoes is affected by cues from conspecific larvae and anuran tadpoles. Austral Ecology 28: 33-37.

Molineaux, L. 1997. Nature's experiment : What implications for malaria prevention? Lancet 349: 1636-1637.

Mosha, F. W., and Petraca, V. 1983. Ecological studies on *Anopheles gambiae* complex on the Kenya coast. Trans. R. Soc. Trop. Med. Hyg. 77: 344-345.

Moyle, P. B. 1976. *Inland fisheries of Carlifornia.* University press, Berkely, p10-30.

Muirhead-Thomson, R. C. 1945. Studies on the breeding places and control of *Anopheles gambiae* var *melas* in coastal districts of Sierra Leonne. Bulletin of Entomological Research 36: 185.

Muirhead-Thomson, R. C. 1951. The distribution of Anophelinae mosquito bites among different age groups- a new factor in malaria epidemiology. Brit. Med. J. 1: 1114.

Mukiama, T. K., Mwangi, R.W. 1989a. Seasonal population changes and malaria transmission potential of *Anopheles pharoensis* and the minor anophelines in Mwea Irrigation Scheme, Kenya. Acta Tropica 46: 181-189.

Mukiama, T. K., Mwangi, R.W. 1989b. Field studies of larval Anopheles arabiensis Patton of Mwea Irrigation Scheme, Kenya. Insect Sci. Applic. 10: 55-62.

Mutero, C. M., Blank, H., Konradsen, F., and van der Hoek, W. 2000. Water management for controlling the breeding of *Anopheles* mosquitoes in rice irrigation schemes in Kenya. Acta Trop 76: 253-263.

Mutero, C. M., Kabutha, C., Kimani, V., Kabuage, L., Gitau, G., Ssennyonga, J., Githure, J., Muthami, L., Kaida, A., Musyoka, L., Kiarie, E., Oganda, M. 2004a. A transdisplinary perspective on the links between malaria and agroecosystems in Kenya. Acta Trop 89: 171 - 186.

Mutero, C. M., Mosha, FW., and Subra, R. 1984. Biting activity and resting behaviour of *Anopheles merus* Donitz (Diptera : Culicidae) on the Kenyan Coast. Ann. Trop. Med. Parasit. 78: 43-47.

Mutero, C. M., Ng'ang'a PN., Wekoyela, P., Githure, J., Konradsen, F. 2004b. Ammonium sulphate fertiliser increases larval populations of *Anopheles arabiensis* and culicine mosquitoes in rice fields. Acta Trop 89: 187 - 192.

Mwabu, G. M. 1991. Economic Development and malaria prevalence. An empirical analysis with reference to Kenya. In Malaria and development in Africa. A cross-sectoral approach. American Association for the Advancement of Science, Sub-Saharan Program. Under cooperative agreement with USAID 167-180.

Mwangangi, J. M., Mbogo, CM., Nzovu, JG., Githure, JI., Yan, G., and Beier JC. 2003. Blood meal analysis for anopheline mosquitoes sampled along the Kenyan coast. J. Am. Mosq. Control Assoc. 19: 371-375.

Nasci, R., and Mitchell, CJ. 1994. Larval diet, adult size, and susceptibility of *Aedes aegypti* (Diptera: Culicidae) to infection with Ross River virus. J. Med. Entomol. 31: 123-126.

Oaks, S. C., Mitchell, VS., Pearson, GW., and Carpenter, CJ. 1991. *Malaria: Obstacles and opportunities.* Washington DC; National Academy Press.

Okenu, D. M. N. 1999. An integrated approach for malaria control in africa. Malaria and Iinfectious Diseases in Africa 10: 4-13.

Okinyo, D. 2002. *Bio prospecting for phytochemicals for Anopheles gambiae larvae control.* Msc thesis, Kenyatta University.

Omumbo, J., Rapuoda, B., Le Sueur, MHC., and Snow, RW. 1998. Mapping malaria transmission using Geographical information systems (GIS): an example form Kenya. Ann. Trop med. Parasitol. 92: 7-20.

Onori, E., and Grab, B. 1980. Indicators for the forecasting of malaria epidemics. Bulletin of the World Health Organization 58: 91-98.

Oomen, J. M. V., de Wolf, J., and Jobin, W.R. 1994. *Health and Irrigation. Incorporation of Disease-Control measures in irrigation, a multi-faceted task in Design, Construction, operation.* Publication 45. International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands.

Overgaard, H., Tsuda Y., Suwonkerd W., Takagi M. 2002. Characteristics of *Anopheles* minimus (Diptera: Culicidae) larval habitats in Northern Thailand. Environ. Entomol. 31: 134-141.

Palchick, S., and Washino, R.K. 1985. Factors affecting mosquito larval abundance in northern California fields. Proc. Calif. Mosq. Control Association. 52: 144 - 147.

Parker, B. M. 1982. Temperature and salinity as the factors influencing the size and reproductive potentials of *Aedes dorsalis* (Diptera : Culicidae). Ann. Entomol. Soc. Am. 75: 99-102.

Paulson, S. L., and Hawley, WA. 1991. Effect of body size on the vector competence of field and laboratory populations of Aedes triseriatus for La Crosse virus. J. Am. Mosq. Control Assoc. 7: 170-175.

Peterson, J. J., and Chapman, HC. 1969. Chemical factors of water in tree holes and related breeding of mosquitoes. Mosq. News 29: 29-36.

Petrarca, V., Beier, J.C. 1992. Intraspecific chromosomal polymorphism in the Anopheles gambiae complex as a factor affecting malaria transmission in the Kisumu area of Kenya. Am. J. Trop. Med. Hyg. 46: 229-237.

Petrarca, V., Beier, J.C., Onyango, F., Koros J., Asiago, C., Koech, D.K., Roberts, C.R. 1991. Species composition of the Anopheles gambiae complex (Diptera : Culicidae) at two sites in western Kenya. J. Med. Entomol. 28: 307-313.

Prothero, R. M. 1977. Disease and mobility: a neglected factor in epidemiology. International Journal of Epidemiology. 6: 259-67.

Rajagopalan, P. K., Jabulingam, P., Sabesan, S., Krishnamoorthy, K., Rajendran, S. and Gunasekaran, K. 1986. Population movement and malaria persistence in Rameswaram Island. Society of Science and Medicine 22: 879-86.

Rajendran, R. 1987. Mosquito larval density in relation to agricultural practices. *Alternatives to synthetic insecticides in integrated pest management system.* Center for Research in Medical Entomology, Madurai, India.

Rao, T. R. 1984. The anophelines of India. (Revised Edition). *Indian Council of Medical Research, New Delhi.*

Rawlings, P., Curtis, C.F., Wickramasinghe, M.B. and Lines, J. 1981. The influence of age and season on dispersal and recapture of *Anopheles culicifacies* in Sri Lanka. Ecological Entomology 6: 307-319.

Reisen, W. K., Azra, K., and Mahmood, F. 1982. *Anopheles culicifacies* (Diptera: Culicidae): horizontal and vertical estimates of immature development and survivorship in rural Punjab Province, Pakistan. J. Med. Entomol. 19: 413-422.

Reisen, W. K., Mahmood, F., Azra, K. 1981. *Anopheles culicifacies* Giles : adult ecological parameters measured in rural Punjab province, Pakistan using capture-mark -release and dissection methods, with comparative observations on *An. stephensi* Liston and *An. subpictus* Grassi. Res. Popul. Ecol. 23: 39-60.

Rejmankova, E., Roberts, DR., Harbach, RE., Pecor, J., Peyton, EL., Manguin, S., Krieg, R., Polanco, J., Legters, L. 1993. Environmental and regional determinants of *Anopheles* (Diptera: Culicidae) larval distribution in Belize Central America. Environ. Entomol. 22: 978-992.

Rejmankova, E., Savage, HM., Rejmanek, M., Arredondo-Jimenez, JI., Roberts, DR. 1991. Multivariate analysis of relationships between habitats, environmental factors and occurrence of anopheline mosquito larvae *Anopheles albimanus* and *A. pseudopunctipennis* in southern Chiapas, Mexico. J. Appl. Ecol. 28: 827-841.

Ribeiro, J. M. C., Seulu, F., Abose, T., Kidane, G. and Tekleheimanot, A. 1996. Temporal and spatial distribution of anopheline mosquitoes in Ethiopian village: implications for malaria control strategies. Bulletin of the World Health organization 74: 299-305.

Rihet, P., Abel, L., Traore, Y., Traore-Leroux, T., Aucan, C., and Furnoux F. 1998. Malaria in humans: Plasmodium falciparum blood infection levels are linked to chromosome 5q31-q33. Am J Hum Genet. 63: 498-505.

Robert, V., Gazin, P., Boudin, C., Molez, JF., Ouedraogo, V., and Carnevale, P. 1985. La transmission du paludisme en zone de savane arboree et en zone rizicole des environs de Bobo Dioulasso (Burkina Faso). Annales de la socieete de Medecine Tropicale 65 (Suppl.): 201-214.

Robert, V., Ouari, B., Ouedraogo, V., and Carnevale, P. 1988. Etude ecologique des culicidae adultes et larvaires dans une riziere en Vallee du Kou, Burkina Faso. Acta Trop 45: 351 - 359.

Robert, V., van de Broek, A., Stevens, P., Slootweg, R., Petrarca, V., Coluzzi, M., Le Goff, G., Di Deco, M.A., and Carnevale, P. 1992. Mosquitoes and malaria transmission in irrigated rice-fields in the Benoue Valley of northern Cameroon. Acta Trop 52: 201 - 204.

Roger, P. A., and Kurihara, Y. 1988. Flood water biology of tropical wetland rice fields. *Proceedings of the First International Symposium on Paddy Soil Fertility, 6 - 13 December, 1988.* University of Chiang Mai, Thailand: 275 - 300.

Rogers, D. J., and Williams, B.G. 1993. Monitoring trypanosomiasis in space and time. Parasitology 106: S77-92.

Schofield, C. J., and White, GB. 1984. House design and domestic vectors of disease. Trans. R. Soc. Trop. Med. Hyg. 78: 285-292.

Scott, J. A., Brodgon, WG., and Collins, FH. 1993. Identification of single specimens of *Anopheles gambiae* complex by Polymerase chain reaction. Am. J. Trop. Med. Hyg. 49: 520-529.

Service, M. 1993a. Mosquito Ecology: Field Sampling Methods. Second Edition. Elsevier Applied Science.

Service, M. W. 1980. *A guide to medical entomology.* Macmillan Press, London.: pp 24-52.

Service, M. W. 1986. *Lecture Notes on Medical Entomology.* Blackwell Scientific Publications, London.: p37-48.

Service, M. W. 1991. Agricultural development and arthropod borne diseases: a review. Rev. Saude Publica 25: 165-168.

Service, M. W. 1993b. In: Bruce Chwatts essential malariology. 3rd edition. (Gillies, HM. & Warrel, DA. eds.). Edward Arnold (A Division of Hodder and Stoughton) UK.: pp 12-33.

Settle, W. H., Ariawan, H., Astuti, E.T., Cahyana, W., Hakim, A.L., Hindayana, D., and Lestari, A.S. 1996. Managing tropical rice pests through conservation of generalist natural enemies and alternative prey. Ecology 77: 1975-1988.

Shililu, J., Ghebremeskel, T., Seulu, F., Mengistu, S., Fekadu, H., Zerom, M., Ghebregziabiher, A., Sintasath, D., Bretas, G., Mbogo, C., Githure, J., Brantly, E., Novak, R., and Beier, J.C. 2003. Larval habitat diversity and ecology of anopheline larvae in Eritrea. J. Med Entomol. 40: 921 - 929.

Shipitzina, K. N. 1930. On the role of organic colloids of water in the feeding of the larva of *Anopheles maculipennis.* Bull. Inst. Rech. Biol. Uniperm 7: 171-94.

Simpson, I., and Roger, P.A. 1991. Impact of agrochemicals on mosquito larvae populations in rice fields. International Rice Research Newsletter 16: 29 - 30.

Snow, R. W., Armstrong Schellenberg, J.R.M., Peshu, N., Forster, D., Newton, C.R.J.C., Winstanley, P.A., Mwangi, I., Waruiru, C., Warn, P.A., Newbold, C., Marsh, K. 1993. Periodicity and space-time clustering of severe childhood malaria on the coast of Kenya. Trans. R. Soc. Trop. Med. Hyg. 87: 386-390.

Snow, R. W., Gouws, E., Rapouda, B., Craig, M.H., Tanser, F.C., le Sueur, D., and Ouma, J. 1998. Models to predict the intensity of *Plasmodium falciparum* transmission: applications to the burden of disease in Kenya. Trans. Roy. Soc. Trop. Med. Hyg. 92: 601-606.

Snow, R. W., Mungala, VO., Forster, D., and Marsh, K. 1994. The role of the district hospital in child survial at the Kenyan coast. African Journal of Health Sciences 1: 71-75.

Sota, T. 1993. Performance of *Aedes albopictus* and *A. riversi* larvae (Diptera : Culicidae) in waters that contain tannin acid and decaying leaves. Is the tree hole species better adapted to tree hole water? Ann. Entomol. Soc. Am. 86: 450-457.

Strirnadel, H., Beck, HP., Alpers, MP., and Smith TA. 1999. Heretability and segregation analysis of immune reponses to specific malaria antigens in Papua New Guinea. Genetic Epidemiol. 17: 16-34.

Sunish, I. P., and Reuben, H. 2001. Factors influencing the abundance of Japanese encephalitis vectors in the rice fields in India. Medical and Veterinary Entomology 15: 381-392.

transmission in Dakar, Senegal and its implications for malaria control in Tropical Africa. Am. J. Trop. Med. Hyg. 48: 748-756.

Victor, T. J., and Reuben, R. 2000. Effects of organic and inorganic fertilisers on mosquito populations in rice fields of southern India. Med. Vet. Entomol. 14: 361 - 368.

Vulule, J. M., Beach, R.F., Atieli, F.K., Roberts, J.M., Mount, D.L., and Mwangi, R.W. 1994. Reduced susceptibility of *Anopheles gambiae* to permethrin associated with the use of permethrin-impregnated bednets and curtains in Kenya. Med. Vet. Entomol. 8: 71-75.

Watkins, M. W., and Mosobo, M. 1993. Treatment of *Plasmodium falciparum* with pyrimethamine-sulfadoxine: selective pressure for resistance is a function of long elimination half-life. Transactions of the Royal Society of Tropical Medicine and Hygiene 87: 75-78.

Wernsdorfer, W. H., and McGregor, I. 1986. *Malaria: Principles and practice of malariology*. Churchill Livingstone, Edinburgh, NY.

White, G. B. 1972. The *Anopheles gambiae* complex and the malaria transmission around Kisumu, Kenya. Trans. R. Soc. Trop. Med. Hyg. 66: 572-581.

White, G. B. 1974. *Anopheles gambiae* complex and disease transmission in Africa. Trans. R. Soc. Trop. Med. Hyg. 68: 278-301.

White, G. B. 1977. The place of the morphological studies in the investigation of *Anopheles* species complexes. Mosq. Sytematics 9: 1-24.

White, G. B. 1982. Malaria vector ecology and Genetics. British Medical Bulletin 38: 207-212.

WHO. 1975. Manual on practical entomology in Malaria. Part II. Methods and techniques. World Health Organization Offset Publication, Geneva No. 13.

WHO. 1995. Twelfth programme Report of the UNDP/World Bank/WHO special programme for Research and Training in Tropical Diseases (TDR). T.D.R., Progress 1975-94 Highlights 1993-94.

WHO. 1996. Operational manual on the application of insecticides for control of the mosquito vectors of malaria and other diseases. World Health Organization Geneva WHO/CTD/VBC96.1000Rev.1.

WHO. 1998. Malaria epidemiology. World Health Organization Geneva.

WHO. 2000. World Health Organization expert committee report on malaria .

Wigglesworth, V. B. 1976. *Insects and the life of man.* John Wiley and Sons Inc; New York.: p95-102.

Wotton, R. S., ed. 1990. *The biology of particles in aquatic systems.* Boca Raron, FL: CRC Press.

Yap, H. H. 1986. Effectiveness of soap formulations containing deet and permethrin as personal protection against outdoor mosquitoes in Malaysia. Journal of American Mosquito Control Association : 2: 63-67.

Zain, M., and Newsen. 1979. Larval development and oviposition behaviour of *Aedes triseriatus* (Diptera : Culicidae) as affected by varying concentrations of sodium chloride and calcium nitrate in the water. Environ. Entomol. 8: 326-329.