Malaria Control & Elimination

Oluwasogo et al., Malaria Contr Elimination 2016, 5:2
DOI: 10.4172/2470-6965/1000146

Research Article | Open Access

Diversity and Abundance of *Anopheles* (Diptera: Culicidae) Species Complex in some Selected Settlements in Ogbomoso Local Government Area of Oyo-State, Nigeria

Oluwasogo AO[1,2*], Adeyemi MA[3], Gabriel S[1], Kabir OO[4], Owolabi AA[3] and Henry OS[1,3]

[1]*School of Allied Health and Environmental Sciences, College of Pure and Applied Sciences, Kwara State University, Nigeria*

[2]*Centre for Ecological and Environmental Research Management Studies, Kwara State University, Nigeria*

[3]*Department of Bio-Sciences and Biotechnology, Kwara State University, Nigeria*

[4]*Department of Statistics and Mathematical Sciences, Kwara State University, Nigeria*

[*]**Corresponding author:** Oluwasogo AO, Centre for Ecological and Environmental Research Management Studies, Kwara State University, Nigeria, Tel: 234-703603-9078; E-mail: olalubisogo@gmail.com

Received date: Apr 04, 2016; **Accepted date:** June 27, 2016; **Published date:** June 30, 2016

Abstract

Background: It is part of efforts of every passionate government in Africa to reduce, if not eliminate morbidity and mortality due to malaria being transmitted by female *anopheles* mosquito. Part of this struggle is the malaria indicator survey annually conducted by the Federal Bureau of Statistics (FBS) in Nigeria. It therefore important to communicate community based investigation and communication of entomological data vital for malaria control using appropriate statistical tools. This study generally aims to investigate seasonal abundance of *Anopheles* mosquito species and their compositions in some selected human settlements. The specific objective is to determine which particular specie of such *Anopheles* mosquitoes are most abundant and which of the human settlements requires most intervention due to high prevalence of such *Anopheles*.

Methods: Mosquito collection was made once per week indoor between 5:30hr to 7:00hr and 20:00hr to 22:00hr in rooms for twelve months using insecticide spray technique. Adult Mosquitoes from the knock down effect were collected and identified to species and species complex level using keys described by Gillett, Gillies and Coetzee. Two sample test of proportion was adopted to test for significant difference between species occurrence. The Friedman rank sum test was utilized to determine whether or not there exists a statistically detectable difference in abundance of the four species of *anopheles* mosquitoes in the seven study wards and whether the seven study ward significantly differ in their composition of the four species of *anopheles* complex.

Results: At 5% significance level (α=0.05), the test revealed with p-values 0.0001 and 0.0005 that there is statistically detectable difference among median abundance of the four *Anopheles* species. *An. gambiae s.l.* had the highest median (3006) abundance, followed by *An. arabiensis* (834.5), *An. rufipes* (608) and *An. funestus* (471), respectively. However, Akata ward had the largest median composition (812) of the mosquito species followed by Lagbedu ward (786). Alapata ward rank third in terms of median abundance (739.5). Ibapon and Ilogbo wards had approximately the same median *Anopheles* composition of 714 out of the total of 35,974. Arowomole ward had the least median composition (698). However, most mosquito species (6822) was collected in October and the least (252) in February.

Conclusion: Identifying human activities and practices that promote mosquito breeding by communities themselves, identifying and selecting culturally appropriate mosquito control techniques, and the initiation of actions aimed at controlling mosquito abundance are among community directed and self-reliant coping strategies envisaged. Among such includes Long-Lasting Insecticide Treated Bednets, (LLITNs) alongside with Indoor residual spray and most importantly the practice of Larval Source Management (LSM) (Larviciding) in the study areas.

Keywords: Mosquito; *Anopheles* complex; Incidence; Coping strategies

Introduction

In most parts of the tropics, Malaria is life-threatening disease transmitted through the bite of a female *Anopheles* mosquito. Although recent estimates suggest that malaria mortality rates decreased by an impressive 47% between 2000 and 2013 globally, and by 54% in the World Health Organization's (WHO) African Region, malaria remains a major public health problem in a number of countries [1]. Majority of the world's population live in areas at risk of vector borne diseases, most of which are spread through mosquitoes [2-5].

Mosquitoes are important vectors of most deadly diseases such as malaria, lymphatic filariasis, dengue and yellow fever and many others in Nigeria [6,7]. The continued transmission of the mosquito borne-diseases is perhaps due to seasonal alternation of cold and warm climates and the vast larval habitats available that ensure prolific and continuous breeding of the vectors [8,9]. Agricultural occupational

Citation: Oluwasogo AO, Adeyemi MA, Gabriel S, Kabir OO, Owolabi AA, et al. (2016) Diversity and Abundance of *Anopheles* (Diptera: Culicidae) Species Complex in some Selected Settlements in Ogbomoso Local Government Area of Oyo-State, Nigeria. Malaria Contr Elimination 5: 146. doi:10.4172/2470-6965/1000146

practices such as the use of irrigation, the use of ponds for fish, rice farming and the storage of water in tanks for domestic and livestock provide suitable breeding grounds for anthropophylic mosquitoes [10-12].

The most common anthropophylic mosquito in Nigeria which causes much of the morbidity and mortality associated with malaria is the *Anopheles* mosquito [12-15]. However, not much is known about species composition, distribution and abundance of *Anopheles* species in Ogbomoso, Oyo-state, Nigeria. This study presents the impact of *Anopheles* mosquito species on seven human settlements in Ogbomoso South, Local Government Area Council.

Materials and Methods

Study area

The study was conducted in seven wards (Lagbedu, Arowomole, Ibapon, Alapata, Ilogbo, Akata and Oke-Ola) in Ogbomoso South Local Government Area Council, Oyo, South-western Nigeria. The town is situated on Longitude 4.25°E and Latitude 8.13°N. Ogbomoso has a typical tropical climate with a mean annual temperature of 26.1°C, relative humidity of 78% and an average rainfall of 1217 mm. It has population density of about 150,000 with area covers of 10,500 square meters surrounded with streams and rivers. The study area is known for human activities such as farming, hunting, fishing and damming, dyeing, trading and construction works (Figure 1).

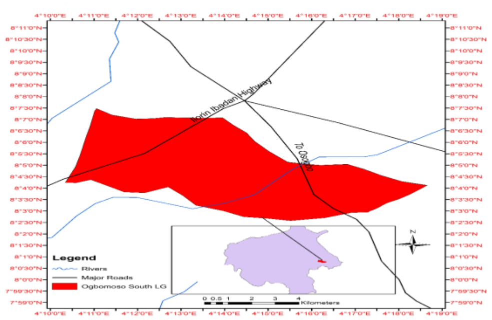

Figure 1: Ogbomoso South Local Government (Inset) Oyo State, Nigeria.

Collection of adult indoor resting mosquitoes

Mosquitoes' captures were carried out from randomly selected households from seven villages at the study area. The collection was made once per week indoor between 5:30 hr and 7:00 hr and at night between 20:00 hr and 22:00 hr in rooms in each of the selected houses at the study locations, using insecticide spray technique. White sheets were spread on the floor and all the windows and doors were closed. Mosquitoes from the knock down effect were collected and transferred into small plastic containers with cover containing silica gel and labelled. The date, place and time of collection were also recorded. The collection was carried out for twelve months between August 2014 and July 2015. Captured adult mosquitoes were identified to species and species complex level using keys described by Gillett, Gillies and Coetzee [16,17].

Ethical considerations

All aspects of the study were approved by Kwara State University Research Committee and Ethical Review Board. Verbal and written Informed consent was obtained from the individuals that partook in mosquito collection. They were assured of voluntary participation, confidentiality of their roles and the opportunity to withdraw at any time without prejudice.

Statistical Data Analysis

Due to the nature and structure of the data sets obtained from the field and the aim of the study to determine whether, on average, there exists a statistically detectable difference in abundance of the four species of *anopheles* mosquitoes in the seven study wards and whether the seven study ward significantly differ in their composition of the four species of *anopheles* complex, the non-parametric equivalent of the two-way analysis of variance (ANOVA) called the Friedman test [18] was conducted. Our choice of this statistical procedure is based on the fact that the data comprises unreplicated complete block designs structure with exactly one observation for each experimental factor level (i.e. *anopheles* species) for each combination of group variable levels (i.e. study wards) and that because observations are counts, the normality assumption may be violated. The Friedman test is known to give reliable results whether or not normality assumption holds.

The analysis was done using the stats library of the R software for statistical computing and graphics [19] version 3.3.2. via the R studio (RStudio, Inc.) integrated development environment (IDE) (Table 1).

Ward/Month	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Total	%
Lagbedu	685	856	1027	799	458	57	42	145	159	173	479	572	5452	15.2
Arowomole	697	744	948	755	357	50	32	133	147	156	348	502	4869	13.5
Ibapon	701	885	991	759	230	44	29	140	135	167	355	546	4982	13.8
Alapata	732	946	1002	680	447	51	38	100	145	133	360	511	5145	14.3
Ilogbo	854	760	884	669	410	46	34	128	134	142	368	522	4951	13.8
Akata	905	892	1012	792	457	55	41	143	157	171	465	574	5664	15.7
Oke-ola	657	900	958	768	354	49	36	132	134	122	345	456	4911	13.7
Total %	5231	598317	682219	522215	27137.5	3520.9	2520.7	9212.6	10112.8	10642.9	27207.5	368310	3.6E+07	100

Citation: Oluwasogo AO, Adeyemi MA, Gabriel S, Kabir OO, Owolabi AA, et al. (2016) Diversity and Abundance of *Anopheles* (Diptera: Culicidae) Species Complex in some Selected Settlements in Ogbomoso Local Government Area of Oyo-State, Nigeria. Malaria Contr Elimination 5: 146. doi:10.4172/2470-6965/1000146

	14.5 5231 14.5 523115													
Source: Field Survey, 2015														

Table 1: Adult mosquito species collected indoors at the study area.

Data description and results summary

In Table 1, abundance and seasonal distribution of adult mosquito species collected from the households are summarized. Most mosquito species 6822 (18.96%) was collected in October and the least 252 (0.7%) in February. Figure 2 furthers summarizes these results.

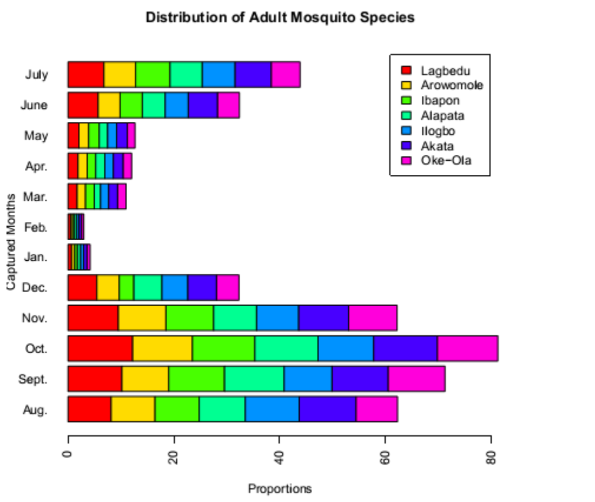

Figure 2: Stacked Bar Chart showing Seasonal Abundance of Indoor resting adult mosquito species across study areas.

The result of the study revealed that, of the 35,974 mosquito species sample obtained during the study, *Anopheles* (*An. gambiae s.l.*, *An. funestus*, and *An. Arabiensis* and *An. rufipes*) constituted the predominant species 35542 (98.79%) and other species the least 432 (1.21%) (Table 2).

Mosquito Species	No of Adults Collected	% Occurrence
***Anopheles* mosquito complex**	35542	98.79
Others	432	1.21
Total	35974	100
Source: Field Survey, 2015		

Table 2: Mosquito Species Occurrence at the Study Area.

We investigated whether or not proportion of *anopheles* complex occurrence is significantly greater than that of other species in the study wards using the two-sample test of proportion summarized in Table 3.

Data	X-square	Degree of freedom	P-value	95 percent confidence interval	
				Lower Bound	Upper Bound
Specie Occurrence	68529.6	1	2.20E-16	0.9746	1

Table 3: 2-Sample Test for Equality of Proportions with Continuity Correction.

The small p-value 2.2e-16 rejects the null hypothesis of less or equal proportions of mosquito species occurrence in the study wards. This implies that *anopheles* complex species are truly statistically more than other species at 95% (α=0.05) significance level. This inference is also evident in Figure 3.

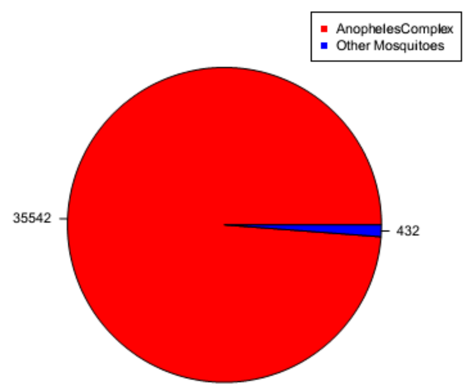

Figure 3: Mosquito specie occurrence at the study area.

In Table 4, the most predominant according to frequency counts (21,787) of the *Anopheles* species encountered during the study was *Anopheles gambiae* (61.3%). *Anopheles arabiensis,Anopheles rufipes*and *Anopheles funestus*constituted 16.7%, 12.4% and 9.6%, respectively.

Anopheles mosquito spp	No of adult collected	% Occurrence
An. gambiae s.l.	21787	61.3
An. funestus	3412	9.6
An. rufipes	4407	12.4
An. arabiensis	5936	16.7
Total	35542	100

Citation: Oluwasogo AO, Adeyemi MA, Gabriel S, Kabir OO, Owolabi AA, et al. (2016) Diversity and Abundance of *Anopheles* (Diptera: Culicidae) Species Complex in some Selected Settlements in Ogbomoso Local Government Area of Oyo-State, Nigeria. Malaria Contr Elimination 5: 146. doi:10.4172/2470-6965/1000146

Source: Field Survey, 2015

Table 4: Adult *anopheles* species collected at the study area.

Table 5, presents the incidence of *Anopheles* mosquito species within seven human settlements including Lagbedu, Arowomole, Ibapon, Alapata, Ilogbo, Akata, and Oke-Ola wards at Ogbomoso. Of a total of 35542 species encountered, Akata had most (5581) prevalent mosquito species at the study area. Lagbedu ward ranks with 5403 (15.2%) *anopheles* species, 5083 (14.3%) were recorded from Alapata ward while the least 4798 (13.5%) were recorded from Arowomole ward, respectively. Ibapon and Ilogo wards have equal (4904) distribution of *anopheles* species.

Study wards	*An. gambiae. s.l*	*An. funestus*	*An. rufipes*	*An. arabiensis*	**Total**	**%**
Lagbedu	3312	519	670	902	5403	15.2
Arowomole	2941	461	595	801	4798	13.5
Ibapon	3006	470	608	820	4904	13.8
Alapata	3116	488	630	849	5083	14.3
Ilogbo	3006	471	608	819	4904	13.8
Akata	3421	536	692	932	5581	15.7
Oke-Ola	2985	467	604	813	4869	13.7
Aggregate	21787	3412	4407	5936	35542	100
Source: Field Survey, 2015						

Table 5: *Anopheles* mosquito species distribution per settlement.

Friedman rank sum test of significance for *anopheles* specie abundance

In order to determine whether there exist a statistically detectable difference in abundance of the four species of *Anopheles* mosquitoes in the study area and to investigate whether on average, the seven study wards differ significantly in terms of their composition of the four *Anopheles* species, we conducted the Friedman rank sum test on results presented (Tables 6 and 7).

Source	**Friedman X-squared**	**DF**	**P-value**	**Decision**
Anopheles Species	21	3	0.0001	Reject null of no statistical difference
DF: Degree of Freedom				

Table 6: Test of significance for difference in *anopheles* species abundance.

Since the p-value 0.0001 for the four mosquito species is smaller than 0.05, we reject the null hypothesis that: on average, all the four species of *Anopheles* mosquito have equal abundance across the seven study areas. This means that there is statistically detectable difference between abundance of the four species. This inference is further revealed by the box and whisker plot in Figure 4 where *An. gambiae s.l.* (3006) had the highest median abundance. Next in median abundance across the seven study wards is *An. arabiensis* (834.5), followed by *An. rufipes* (608) and *An. funestus* (471) in the order summarized in what follows: *An.gambiae s.l.>An.arabiensis>An.rufipes>An.funestus.*

Source	**Friedman X-squared**	**DF**	**P-value**
Anopheles Species	23.784	6	0.0005
DF: Degree of Freedom			

Table 7: Test of Significance for difference in study word composition of *anopheles* species.

Also, p-value 0.0005 rejects the null hypothesis that on average, the study wards are the same in terms of mosquito composition. This implies that all the seven human settlements differ in terms of composition of *Anopheles* mosquitoes.

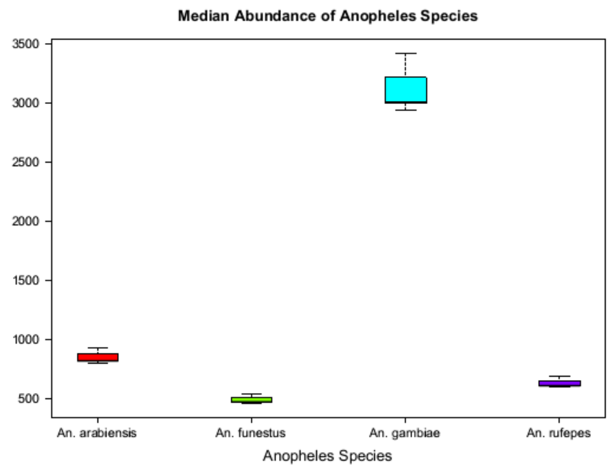

Figure 4: Median Abundance of *Anopheles* Mosquito Species.

Evidence in Figure 5 further reveals the inference from (Table 7). Although all the seven study wards have appreciable spread of composition of the four An. species, it is still crystal clear that Akata had the largest median composition of the mosquito species followed by Lagbedu ward. All other wards have approximately the same median composition of the species.

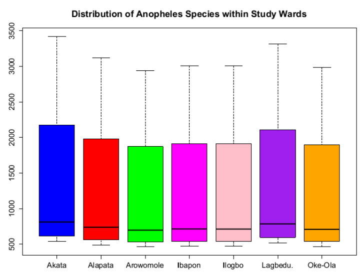

Figure 5: Study Ward Composition of *Anopheles* Species.

Discussion of Results

From the foregoing, data evidences revealed that based on seasonal abundance, most mosquito species (6822) were collected in October and the least (252) in February. Of the 35,974 mosquito species sample obtained during the study, *An. gambiae s.l* constituted the predominant species (3006 out of 35542) and the least predominant species (471 out of 35542) in the study area is *An. funestus*. This inference is further evident in the rejection of the null hypothesis that: on average, all the four species of *Anopheles* mosquito have equal abundance across the seven study areas with p-value 0.0001 reported by the Friedman Rank Sum Test (FRST).

Similar results in Gimba and Idris reported that *An. gambiae s.l* constituted 942 (82.70%), *An. arabiensis* with 91 (7.99%), followed by *An. rufipes* 62 (5.62%), and *An. funestus* the least population 42(3.69%) a total of 2,929 collected. Our study follows similar trend with more sample (35,974). In the two studies, *An. gambiae* has the highest abundance. This data are expected to assist integrated vector control programmer to devote more control efforts to elimination of *An.*

With p-value 2.2e-16 of the two-sample test of proportion revealed that there is enough data evidence to reject the null hypothesis of "less or equal proportions of mosquito species occurrence" in the study wards. This implies that *anopheles* complex species are truly statistically more than other species at 5%significance level. However, of a total of 35542 species encountered, Akata ward had most (5581) prevalent mosquito species at the study area while the least (4798) were recorded from Arowomole ward, respectively. This inference is based on the fact that at 5% significance level, p-value 0.0005 reported by the FRST for testing the null hypothesis that "on average, the study wards are the same in terms of mosquito composition" revealed that all the seven human settlements differ in terms of composition of *Anopheles* mosquitoes.

Conclusion

Following results presented in this study, we can infer that abundance of the four species is not the same in the study areas. Specifically, identifying human activities and practices that promote mosquito breeding by communities themselves, identifying and selecting culturally appropriate mosquito control techniques and adoption of ownership of such interventions and the initiation of actions aimed at controlling mosquito abundance are among community directed and self-reliant coping strategies such as Long-Lasting Insecticide Treated Bednets, (LLITNs) alongside with Indoor residual spray and most importantly the practice of Larval Source Management (LSM) (Larviciding) in the study areas.

Recommendations

This data should assist malaria programmers to plan and implement interventions to reduce risk of malaria infections in the rural endemic communities. Multiple interventions are recommended for tackling the challenges identified in this study. The use of community organization and development is one of the interventions that hold great promise. It should entail enhancing the capacity of community-directed interventions aimed at controlling *Anopheles* in rural communities in Ogbomoso. The critical steps or approaches may include the following: identifying and alleviating human activities and practices that promote mosquito breeding by communities themselves; identifying and selecting culturally appropriate mosquito control techniques; and the initiation of actions aimed at controlling mosquito abundance in the spirit of self-reliance and self-determination. The rationale usage and practice of larvicides to eliminate larva stage of the mosquito in identified fixed habitat should be highly encouraged.

Acknowledgement

We are most grateful to the inhabitants of the study communities for granting us undeniable access to their dwelling places.

Funding Information

Secondary project: Supported by Centre for Sponsored Project, Conditional Education Trust Fund Research Grant, Kwara State University, Malete, Nigeria (Grant No. ASU/CSP/062215/VOL3/TETF/0030).

References

1. Abdoulaye AD, Amelia WM, Dinkorma O, Bakary F, Issaka S, et al. (2016) Gametocyte clearance dynamics following oral artesunate treatment of uncomplicated falciparum malaria in Malian children. Parasite 23:3.
2. Townson H, Nathan MB, Zaim M, Guillet P, Manga L, et al. (2005) Exploiting the potential of vector control for disease prevention. Bull W Health Organ 83: 942-947.
3. Aina SA, Banjo AD, Lawal OA, Jonathan K (2009) Efficacy of some plant extracts on Anopheles gambiae mosquito larvae. Acad J Entomol 2: 31-35.
4. Ilahi I, Suleman M (2013) Species composition and relative abundance of mosquitoes in Swat, Pakistan. Int J Innov App Stud 2: 454-463.
5. Guruprasad NM, Jalali SK, Puttaraju HP (2014) Wolbachia-a foe for mosquitoes. Asian Pac J Trop Dis 4: 78-81.
6. Mbanugo JI, Okpalononuju CN (2003) Surveillance of Mosquito Vectors in some habitats of Awka Metropolis, Anambra, Nigeria. Nigeria J Parasitol 24: 185-190.
7. Ajao AM, Adeleke MA (2014) Species composition and seasonal abundance of mosquito vectors in rice growing community in Kwara State, North Central, Nigeria. Mun Ent Zool 9: 838-841.
8. Amusan AAS, Mafiana CF, Idowu AB, Oke OA (2003) A survey of adult mosquitoes in the hostels of the University of Agriculture, Abeokuta, Ogun State Nigeria. Nigeria J Parasitol 24: 167-172.
9. Anthony K, Andrew M, Pia M, Soma E, Sachs J, et al. (2005) A global index representing the stability of malaria transmission. Am J Trop Med 70: 486-498.
10. Okogun GRA, Anosike JC, Okere AN, Nwoke BED (2005) Ecology of mosquitoes of Midwestern Nigeria. J Vector Borne Dis 42: 1-8.
11. Oduola AO, Awe OO (2006) Behavioural biting preference of Culex quinquefasciatus in human host in Lagos metropolis, Nigeria. J Vector Borne Dis 43: 16-20.
12. Adeleke MA, Adebimpe WO, Hassan AO, Oladejo SO, Olaoye I, et al. (2013) Larval habitats of mosquito fauna in Osogbo metropolis Southwestern Nigeria. Asian Pac J Trop 3: 673-677.
13. Oladimeji O, Grace OT, Frederick OO, Musibau AT (2010) Malaria knowledge and agricultural practices that promote mosquito breeding in two rural farming communities in Oyo State, Nigeria. Malaria J 9: 91.
14. Rubio A, Bellocq MI, Vezzani D (2012) Community structure of artificial container-breeding flies (Insecta: Diptera) in relation to the urbanization level. Landscape Urban Plan 105: 288-295.
15. Abiodun O, Adedayo O, Kehinde P, Adeyemi A (2014) Community knowledge and practices as regards malaria in Ilorin City: implications for the elimination plan of the National Malaria Elimination Program. Asian Pac J Trop Dis 4: S583-S589.

16. Gilles MT, Coetzee M (1987) A supplement to the Anophelinae of Africa south of the Sahara (Afro Tropical Region). Publ South Afr Inst Med Res 55: 1-143.
17. Gillet JD (1972) Common African Mosquitoes and their medical importance (with colour illustrations). William Heinemann Medical Books Ltd London pp 236.
18. Myles H, Douglas AW (1973) Nonparametric Statistical Methods. New York John Wiley & Sons 139-146.
19. R Core Team (2015) A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.