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Anopheles stephensi: a guest to watch in urban Africa

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Abstract

Malaria vector control programs in Sub-Saharan Africa have invested many efforts and resources in the control of eight-sibling species of *Anopheles gambiae* complex and *An. funestus* group. The behaviour of sibling species of these vectors is well known and used for implementing the current intervention tools. The reports of *An. stephensi* in urban Africa with different habitats breeding behaviour is an alert on the success of malaria vector control efforts achieved so far. This communication intends to give an insight on what should be considered as a challenge for the management of *An. stephensi* in urban Africa to retain the achievement attained in malaria control.

Keywords: Malaria, Insecticide, Resistance, Habitat types, Breeding sites

Background

Malaria vectors have been managed well for the past two decades with significant progress in preventing malaria and related adverse outcomes [1]. From 2018 to 2019 the malaria mortalities have been stalled with an increase in 2020, the efforts done so far through the distribution of long-lasting insecticidal nets (LLINs), indoor residual spray (IRS) and urban larval source management have increased the coverage [1, 2]. The gradual changes in land use, interventions and climate changes have led to species shift and re-distribution [3–6].

For a decade now in different countries of Africa there are reports of *An. stephensi* invasion [7–9]. This vector has been for long a malaria vector in south-eastern Asia [10]. The countries reported having *An. stephensi* are Djibouti, Ethiopia, Sudan and Somalia [9]. These reports have been confirmed after the DNA molecular analysis [11]. *Anopheles stephensi* is quite different from *An. gambiae* s.l. (Table 1). This species invasion has prompted the author to make a commentary on *An. stephensi* in urban Africa and its control challenges.

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Main text

The introduction of *Anopheles stephensi* in African countries from Asia has alerted the national malaria control programmes in re-designing vector control strategies. The author indicates the main factors which are expected to be challenges in the efforts to control the species. These challenges are;

(i) *An. stephensi* is different from the current malaria vectors available in Africa with its breeding habitats mostly utilizing containers, holes in trees, water storage tanks and roof gutters used by *Aedes aegypti* species [13] (Table 1). Also, they were found to co-habit with culicine species in polluted habitats [13]. In Sri Lanka the *An. stephensi* has been found colonizing large water bodies breeding sites [14] which for larviciding are difficult to attend effectively. This vector possess a risk of occurrence in more countries Africa as a first case was reported in Djibouti in 2012 [15], Ethiopia in 2016 [16] and in Sudan 2019 [17]. The distribution rate of *An.*

Table 1 Differences between *An. gambiae* s.l. and *An. stephensi*

Factor	Differences	Comment
Oocyte prevalence	If both feed in the same infected blood meal source *An. stephensi* have higher oocyst development rate than *An. gambiae* s.s [12].	This means *An. stephensi* are more susceptible to parasites than An. gambiae s.l.
Breeding sites	*An. stephensi* breeds in containers and water cans indoors and outdoors while *An. gambiae* s.l. breeds in the natural habitats away from human dwellings	*An. stephensi* has advantage of transmissions of malaria based on breeding sites and man access point.
Feeding and Resting preferences	*An. stephensi* higher densities are found cattle sheds than human dwellings while for *An. gambiae* s.l. feeding and resting depend on species. *An. stephensi* rests both indoor and outdoor while An. gambiae s.l. depend on the species. Most of *An. stephensi* feed on cattle while *An. gambiae* s.l. depends on species	The feeding and resting behaviour of *An. stephensi* suggests having contribution to malaria transmission for been in contact with man either indoor or outdoor

stephensi is very high covering a long distance Djibouti to Sudan in 6 years.

(ii) nsecticide resistance has been reported as the main challenge for insectides used in IRS and in LLINs for other documented existing vector species [18]. In *An. stephensi,* the insecticides resistance has been reported in Sudan and Ethiopia [8, 19, 20]. Insecticides resistance confirmation is important for the vector control insectides based tools selection.

(iii) The *An. stephensi* in Asia do feeding on human and bovines, resting indoors and outdoors [12]. Due to variations on host availability in Africa it's not well known in which host apart from humans shall feed on. The *An. stephensi* resting and feeding behaviour in all reported areas has not been yet established in African countries.

(iv) Monitoring of anthropogenic factors. Due to high rural-urban migration areas in sub–Saharan Africa, the emerging of urban agriculture, unplanned settlements, and poorly organized drainage systems effective habitats have been created [21–24]. The new species of *An. stephensi* is well known to be urban and peri urban malaria vector.

The way forward

(i) To strengthen the entomological surveillance system with the ability to capture the presence of this invasive *An. stephensi* mosquitoes.

(ii) To coordinate capacity building for laboratory and field entomologists in identification of *An. stephensi.* This is of priority to ensure sustainacy of achieved malaria vector species control and cases in two decades, 2000 to 2020.

(iii) To establish the continuous monitoring of insecticide resistance profile of *An. stephensi* where the species will be reported to avoid impairing the existing tool efficacy.

(iv) To identify the potential breeding habitats for *An. stephensi* in urban and peri urban for appropriate control design.

(v) To establish the sentinel sites for continues data collection in all zones. These sentinels' sites should operate on proposed standard operating procedures for species sampling, identification and insecticides resistance status.

v) To emphases on the use of personal protection tools such as repellents for protection outdoors.

Conclusion

The NMCPs of sub-Saharan Africa have been awaken on insuring that, the attained malaria control efforts are not compromised by the new invasive species. The way forward plans should be considered for proper management and control of this new species vector.

Abbreviations

IRS: Indoor residual spray; LLINs: Long lasting insecticidal nets; NMCP: National malaria control program; WHO: World health Organisation

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References

1. WHO. World malaria report 2020: 20 years of global progress and challenges. In: World malaria report 2020: 20 years of global progress and challenges. Geneva: WHO; 2020. p. 299.
2. WHO. World malaria report 2021. In: World malaria report 2021. Geneva: WHO; 2021. p. 299.
3. Wanjala CL, Kweka EJ. Impact of Highland topography changes on exposure to malaria vectors and immunity in Western Kenya. Front Public Health. 2016;4:227. https://doi.org/10.3389/fpubh.2016.00227.
4. Himeidan Y, Kweka E. Malaria in east African highlands during the past 30 years: impact of environmental changes. Front Physiol. 2012;3:315. https://doi.org/10.3389/fphys.2012.00315.
5. Kweka EJ, Kimaro EE, Munga S. Effect of deforestation and land use changes on mosquito productivity and development in Western Kenya highlands: implication for malaria risk. Front Public Health. 2016;4:238. https://doi.org/10.3389/fpubh.2016.00238.
6. Mwangangi JM, Mbogo CM, Orindi BO, Muturi EJ, Midega JT, Nzovu J, et al. Shifts in malaria vector species composition and transmission dynamics along the Kenyan coast over the past 20 years. Malar J. 2013;12:1–9.
7. Sinka ME, Pironon S, Massey NC, Longbottom J, Hemingway J, Moyes CL, et al. A new malaria vector in Africa: predicting the expansion range of Anopheles stephensi and identifying the urban populations at risk. Proc Natl Acad Sci. 2020;117(40):24900–8. https://doi.org/10.1073/pnas.2003976117.
8. Ahmed A, Khogali R, Elnour M-AB, Nakao R, Salim B. Emergence of the invasive malaria vector Anopheles stephensi in Khartoum state, Central Sudan. Parasit Vectors. 2021;14(1):511. https://doi.org/10.1186/s13071-021-05026-4.
9. Balkew M, Mumba P, Dengela D, Yohannes G, Getachew D, Yared S, et al. Geographical distribution of Anopheles stephensi in eastern Ethiopia. Parasit Vectors. 2020;13(1):1–8. https://doi.org/10.1186/s13071-020-3904-y.
10. Sinka ME, Bangs MJ, Manguin S, Chareonviriyaphap T, Patil AP, Temperley WH, et al. The dominant Anopheles vectors of human malaria in the Asia-Pacific region: occurrence data, distribution maps and bionomic précis. Parasit Vectors. 2011;4(1):89. https://doi.org/10.1186/1756-3305-4-89.
11. Balkew M, Mumba P, Yohannes G, Abiy E, Getachew D, Yared S, et al. An update on the distribution, bionomics, and insecticide susceptibility of Anopheles stephensi in Ethiopia, 2018–2020. Malar J. 2021;20:263.
12. Thomas S, Ravishankaran S, Justin NJA, Asokan A, Mathai MT, Valecha N, et al. Resting and feeding preferences of Anopheles stephensi in an urban setting, perennial for malaria. Malar J. 2017;16(1):1–7. https://doi.org/10.1186/s12936-017-1764-5.
13. Sharma S, Hamzakoya K. Geographical spread of Anopheles stephensi vector of urban malaria, and *Aedes aegypti*, vector of dengue/DHF, in the Arabian Sea islands of Lakshadweep, India; 2001.
14. Gayan Dharmasiri AG, Perera AY, Harishchandra J, Herath H, Aravindan K, Jayasooriya HTR, et al. First record of Anopheles stephensi in Sri Lanka: a potential challenge for prevention of malaria reintroduction. Malar J. 2017; 16(1):326. https://doi.org/10.1186/s12936-017-1977-7.
15. Faulde MK, Rueda LM, Khaireh BA. First record of the Asian malaria vector Anopheles stephensi and its possible role in the resurgence of malaria in Djibouti, horn of Africa. Acta Trop. 2014;139:39–43. https://doi.org/10.1016/j.actatropica.2014.06.016.
16. Carter TE, Yared S, Gebresilassie A, Bonnell V, Damodaran L, Lopez K, et al. First detection of Anopheles stephensi Liston, 1901 (Diptera: culicidae) in Ethiopia using molecular and morphological approaches. Acta Trop. 2018; 188:180–6. https://doi.org/10.1016/j.actatropica.2018.09.001.
17. WHO. Vector alert: Anopheles stephensi invasion and spread: Horn of Africa, the Republic of the Sudan and surrounding geographical areas, and Sri Lanka: information note. Geneva: World Health Organization; 2019.
18. Orondo PW, Nyanjom SG, Atieli H, Githure J, Ondeto BM, Ochwedo KO, et al. Insecticide resistance status of Anopheles arabiensis in irrigated and non-irrigated areas in western Kenya. Parasit Vectors. 2021;14(1):335. https://doi.org/10.1186/s13071-021-04833-z.
19. Enayati A, Hanafi-Bojd AA, Sedaghat MM, Zaim M, Hemingway J. Evolution of insecticide resistance and its mechanisms in Anopheles stephensi in the WHO eastern Mediterranean region. Malar J. 2020;19(1):1–12. https://doi.org/10.1186/s12936-020-03335-0.
20. Yared S, Gebressielasie A, Damodaran L, Bonnell V, Lopez K, Janies D, et al. Insecticide resistance in Anopheles stephensi in Somali region, eastern Ethiopia. Malar J. 2020;19(1):1–7. https://doi.org/10.1186/s12936-020-03252-2.
21. Dongus S, Nyika D, Kannady K, Mtasiwa D, Mshinda H, Gosoniu L, et al. Urban agriculture and Anopheles habitats in Dar Es Salaam, Tanzania. Geospat Health. 2009;3(2):189–210. https://doi.org/10.4081/gh.2009.220.
22. Akono PN, Mbida JAM, Tonga C, Belong P, Ngo Hondt OE, Magne GT, et al. Impact of vegetable crop agriculture on anopheline agressivity and malaria transmission in urban and less urbanized settings of the south region of Cameroon. Parasit Vectors. 2015;8(1):293. https://doi.org/10.1186/s13071-015-0906-2.
23. Mathania MM, Munisi DZ, Silayo RS. Spatial and temporal distribution of Anopheles mosquito's larvae and its determinants in two urban sites in Tanzania with different malaria transmission levels. Parasit Epidemiol Control. 2020;11:e00179. https://doi.org/10.1016/j.parepi.2020.e00179.
24. Klinkenberg E, McCall PJ, Wilson MD, Amerasinghe FP, Donnelly MJ. Impact of urban agriculture on malaria vectors in Accra, Ghana. Malaria J. 2008;7(1):151. https://doi.org/10.1186/1475-2875-7-151.

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