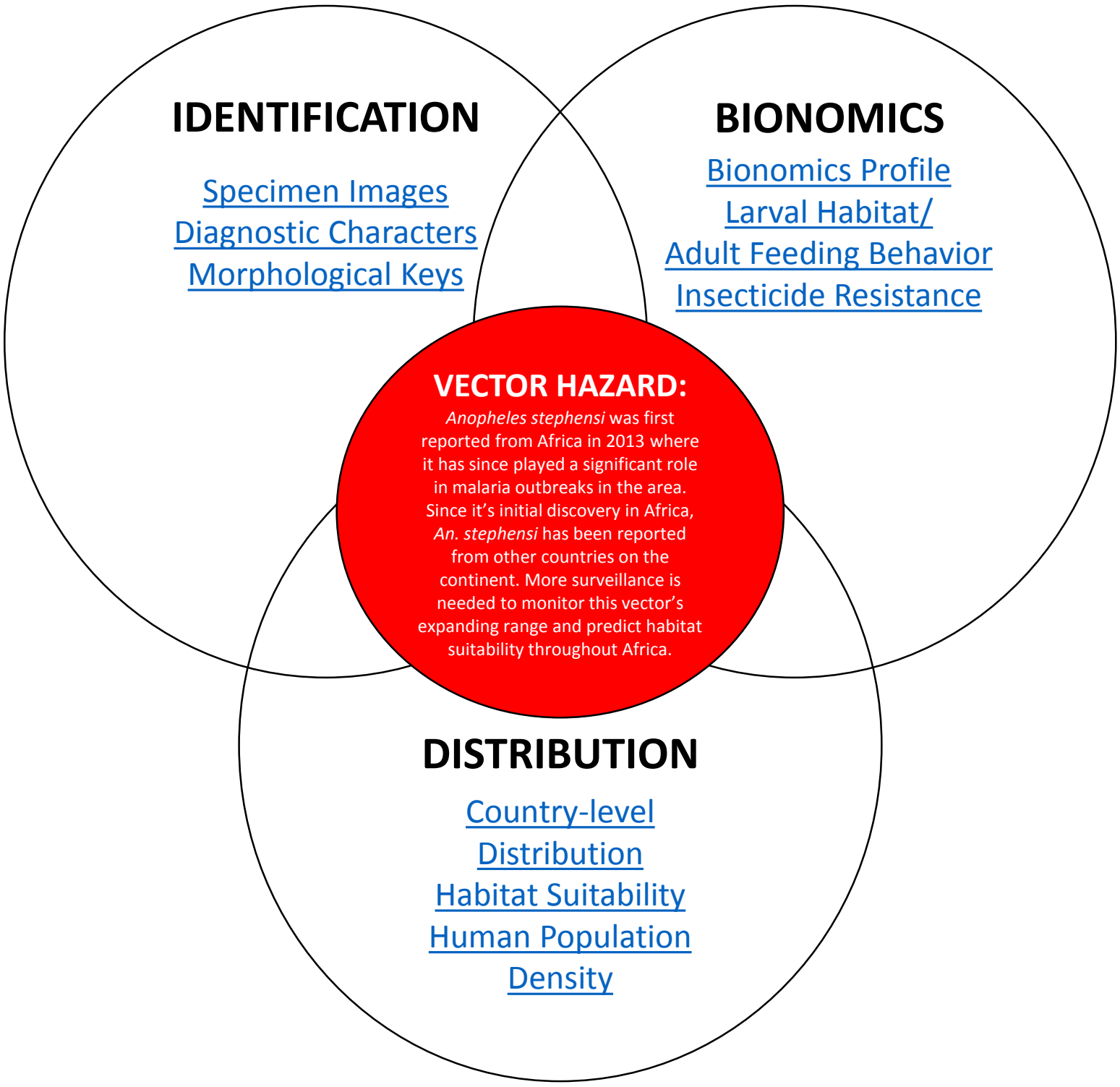
Vector Hazard Report

Range Expansion of Primary Malaria Vector *Anopheles* (*Cellia*) *stephensi* Liston, 1901 to Northern Africa and Beyond



WRAIR Walter Reed Army Institute of Research
Soldier Health • World Health

Compiled by David Pecor, April 2018

WRBU Walter Reed Biosystematics Unit
Know the vector, know the threat

IDENTIFICATION

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Specimen Images

Habitus: *An. stephensi* Female

Thorax Dorsal View: *An. stephensi* Female

Head Dorsal View: *An. stephensi* Female

Abdomen Lateral View: *An. stephensi* Female

Head Lateral View: *An.stephensi* Female

Abdomen Dorsal View: *An. stephensi* Female

IDENTIFICATION

Diagnostic Characters

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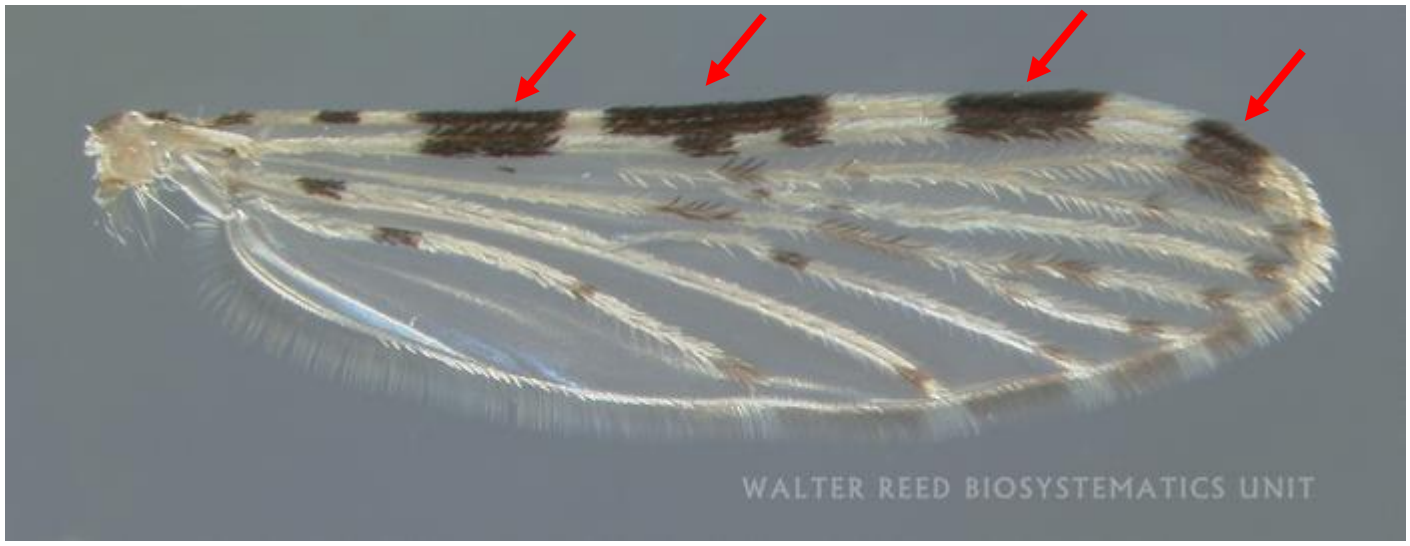
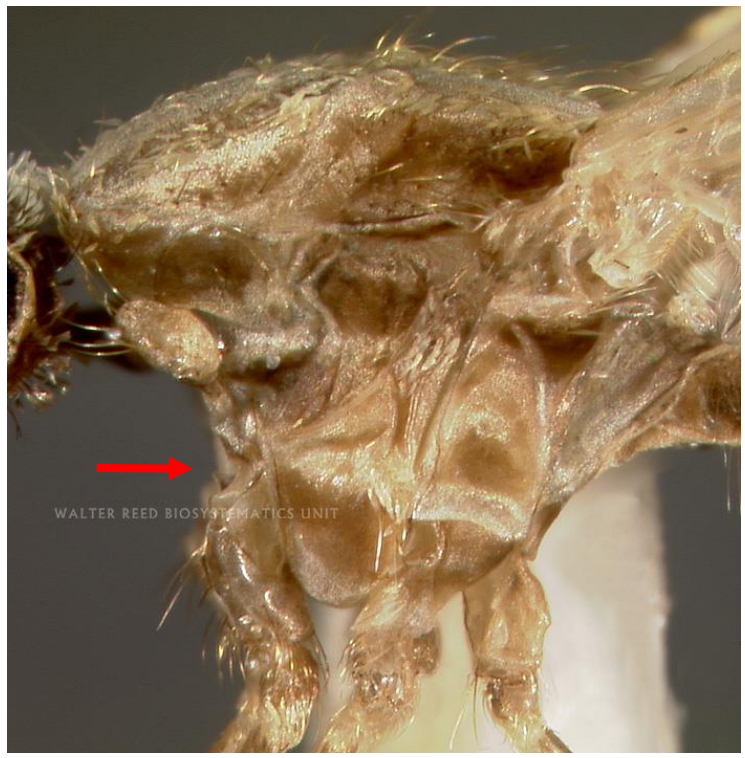


Wing Lateral View: *An. stephensi* Female
Character: Wing with four dark bands on both costa and sub costa, ASP spot present.

Hindleg: *An. stephensi* Female
Character: Hind femur, tibia and tarsomere 1 dark and speckled with pale scales

Hindtarsi: *An. stephensi* Female
Character: Hindtarsomere 3 & 4 not entirely white, 5 entirely dark.



Thorax Lateral View: *An. stephensi* Female
Character: Upper proepisternal seatae absent

IDENTIFICATION

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Morphological Keys

Morphological Keys to Confirm Identification of *An. stephensi*

Anopheles Mosquitoes, Africa:

ADULT KEY Author: Rueda, L. M. Adult identification key to the genus *Anopheles* in Africa, with emphasis on medically important mosquitoes.

LARVA KEY Author: Rueda, L. M. Larval identification key to the genus *Anopheles* in Africa, with emphasis on medically important mosquitoes.

- Rattanarithikul, Rampa; Harrison, Bruce, A.; Harbach, Ralph E.; Panthusiri, Prachong & Coleman, Russell, E. 2006. Illustrated Keys to the Mosquitoes of Thailand IV. *Anopheles*. The Southeast Asian Journal of Tropical Medicine and Public Health. 37(2).

Additional Resources:

- Faulde M.K., Rueda L.M., Khaireh, B.A. 2014. First record of the Asian malaria vector *Anopheles stephensi* and its possible role in the resurgence of malaria in Djibouti, Horn of Africa. Acta Tropica, 139:39-43.
- Health Map.org for news about ongoing vector-borne disease outbreaks
- WRBU Species Page
- VectorBase Species Page
- Malaria Atlas Project Species Page

BIONOMICS

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Vector Capacity:

Anopheles stephensi is considered a highly competent vector of both *Plasmodium falciparum* and *Plasmodium vivax* throughout it's historical range. This species has been found to play a major role in malaria outbreaks in Djibouti since 2013. Plasticity in vector competence and bionomic characteristics, particularly the shift to container breeding, may be indicative of cryptic taxa and needs investigation.

Biology:

Larval Habitat Conditions				
Light intensity	**Salinity**	**Turbidity**	**Movement**	**Vegetation**
Primarily Heliophilic but known to be Heliophobic as well	Mostly Freshwater but known to be Salt water tolerant	Primarily clear water but found in turbid water as well	Primarily still water but known from some flowing water sources	Found in water with emergent vegetation and no vegetation

Larval Habitat Types
Artificial containers
Lakes
Marshes
Slow moving rivers
Rice fields
Irrigation ditches

Adult Feeding and Resting Behavior				
Feeding habit	**Biting habitat**	**Biting time**	**Pre-feeding resting habitat**	**Post-feeding resting habitat**
Primarily anthropophilic but known to be zoophilic opportunistically	Primarily endophagic but exophagic in warm weather conditions	Dusk or at night	Primarily endophilic but exophilic in warm weather conditions	Primarily endophilic but exophilic in warm weather conditions

BIONOMICS

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Larval Habitat and Adult Behavior

Larval Habitat

In urban areas, larvae of *An. stephensi* can be found in artificial containers in and around homes and other developed sites as well as cisterns and gutters. In rural environments, *An. stephensi* can be found in fresh water pools, stream margins, irrigation ditches as well as domestic water storage. Although *An. stephensi* larvae have been found indoors, larvae are typically found outdoors. In urban areas, *An. stephensi* can be found all year long, however peak activity occurs during the summer months (June to August).

Adult Feeding Behavior

Adult *An. stephensi* are predominantly endophilic and endophagic, however are known to feed on animals and humans outside under warmer conditions. There is evidence implicating this species as primarily anthropophillic with opportunistic zoophilic behavior.

Additional Resources:

- VectorBase: *An. stephensi*
- Thomas, S. et al. 2017. Resting and feeding preferences of *Anopheles stephensi* in an urban setting, perennial for malaria. Malaria Journal. 16:111.
- Sinka, Marianne E. et al. 2011. The dominant Anopheles vectors of human malaria in the Asia-Pacific region: occurrence data, distribution maps and bionomic précis. Parasites & Vectors 4:89.
- Singh O.P. 2002. Bionomics of malaria vectors in India. Malaria Research Centre. 19-31.
- Reisen W.K. 1986. Population dynamics of some Pakistan mosquitoes: the impact of residual organophosphate insecticide spray on Anopheline relative abundance. Annals of Tropical Medecine and Parasitology. 80:69-75.
- Zaim, M. et al. 1986. The use of CDC light traps and other procedures for sampling malaria vectors in southern Iran. Journal of the American Mosquito Control Association. 2:511-515.

BIONOMICS

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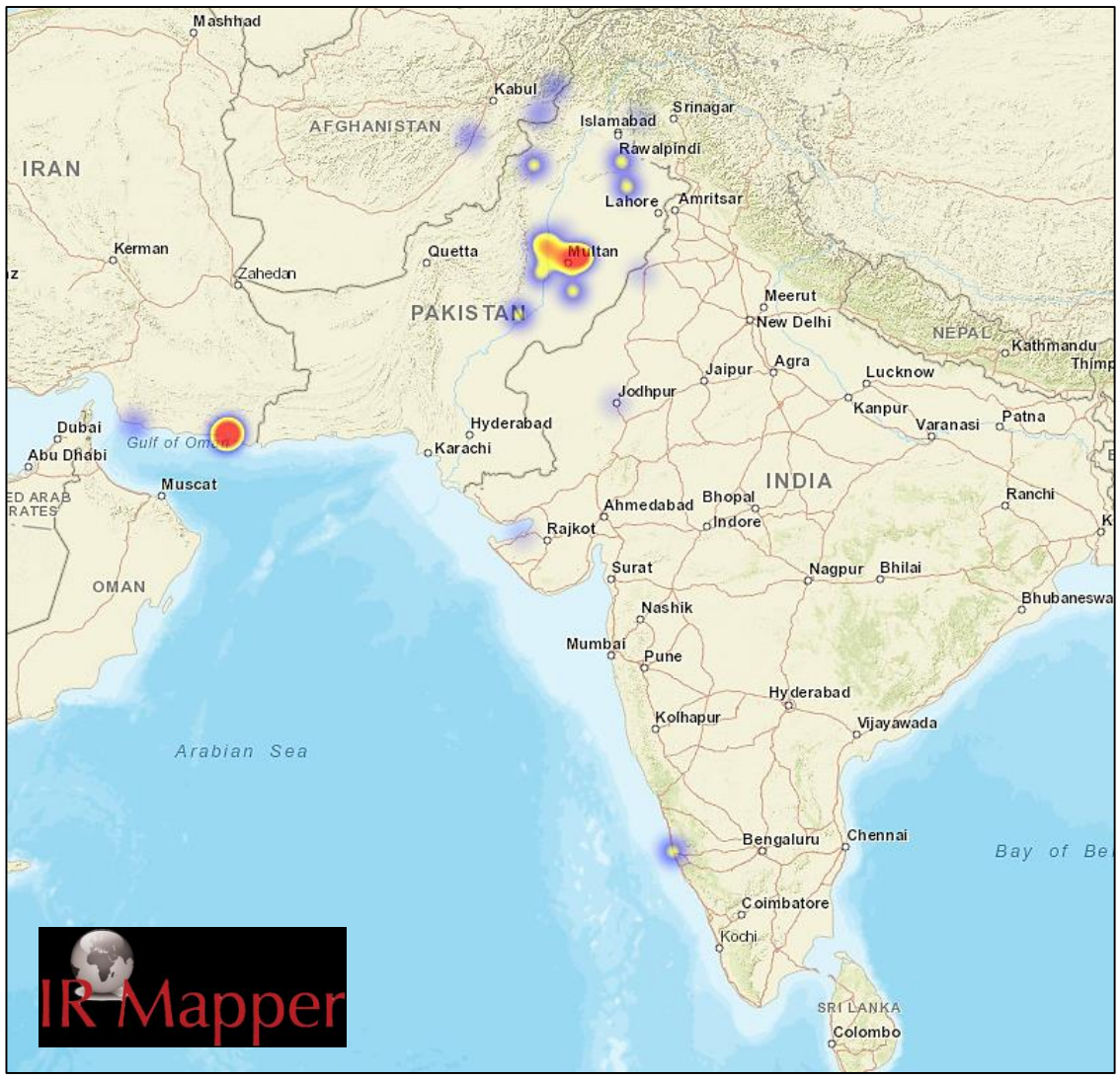
Insecticide Resistance

Resistance to pyrethroids, organochlorines (DDT) and organophosphates (Malathion) has been reported from *An. stephensi* populations in Iran, Afghanistan, India and Pakistan. Some resistance to Carbamates has been reported from Afghanistan and Iran.

Heat Map of Pyrethroid resistance reported from *An. stephensi* specimens. From IR Mapper: Anopheles Map.
Note: Heat maps are based on the frequency of resistance reports by mosquito collection site. These do not show the relative severity of resistance.



Additional Resources

- Rathor, H.R. et al. 2013. Pesticide susceptibility status of *Anopheles* mosquitoes in four flood-affected districts of South Punjab, Pakistan. Vector-borne and Zoonotic Diseases. 13(1).
- Vatandoost, H. & Hanafi-Bojd, A.A. 2012. Indication of pyrethroid resistance in the main malaria vector, *Anopheles stephensi* from Iran. Asian Pacific Journal of Tropical Medicine. 5(9): 722-726.
- Tikar, S.N. et al. 2011. Resistance status of the malaria vector mosquitoes, *Anopheles stephensi* and *Anopheles subpictus* towards adulticides and larvicides in arid and semi-arid areas of India. Journal of Insect Science. 11:85.
- Enayati A.A. et al. 2003. Molecular evidence for a kdr-like pyrethroid resistance mechanism in the malaria vector mosquito *Anopheles stephensi.* Medical Veterinary Entomology. 17(2): 138-144.

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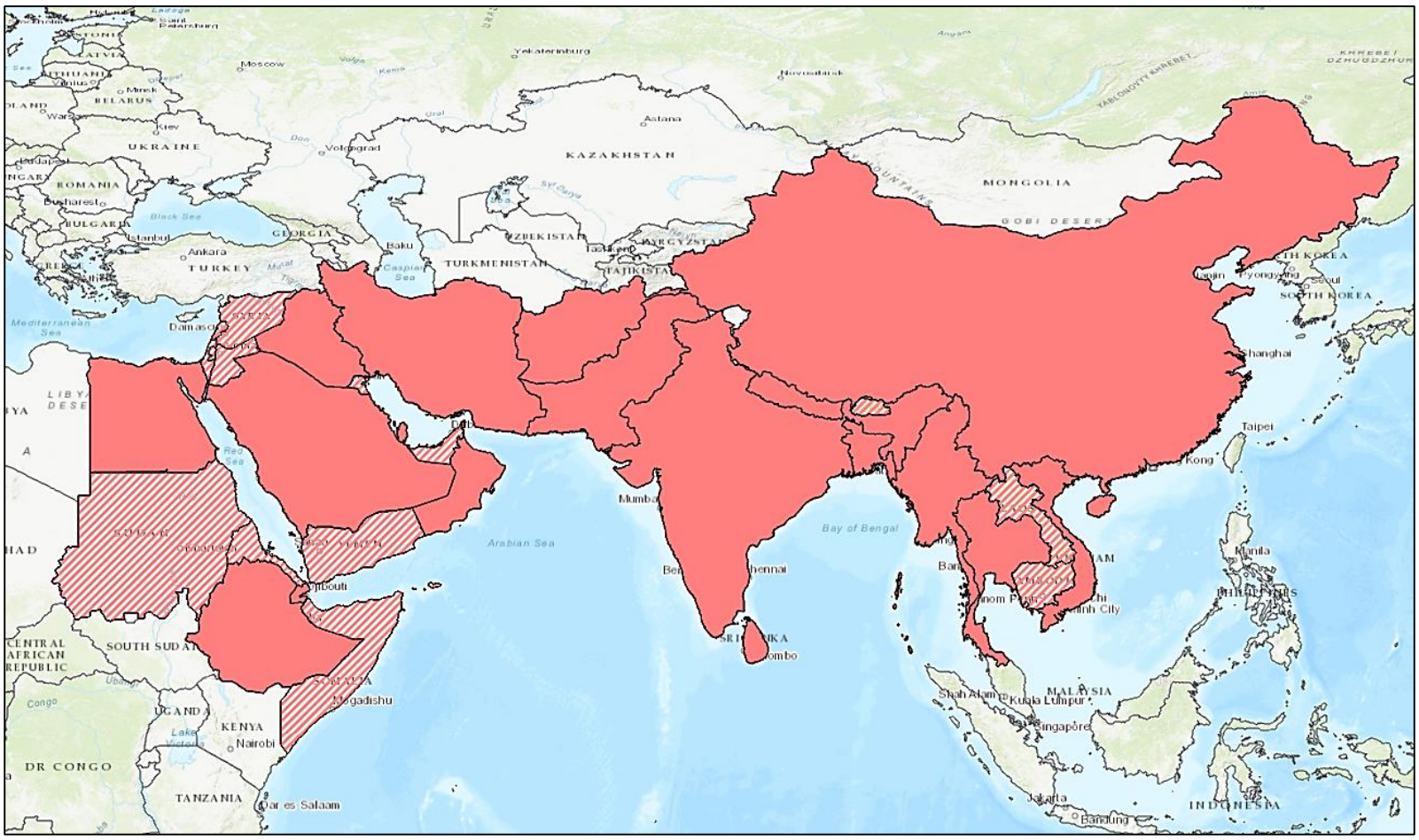
Country-level Distribution (WRBU Catalog of the Culicidae) for *Anopheles* (*Cel.*) *stephensi* Liston, 1901



Confirmed Distribution:	**Suspected Distribution:**
Afghanistan	Bhutan
Bahrain	Cambodia
Bangladesh	Eritrea
China	Israel
Djibouti	Jordan
Egypt	Laos
Ethiopia	Palestine
India	Somalia
Iran	Sudan
Iraq	Syria
Myanmar (Burma)	United Arab Emirates
Nepal	Yemen
Oman	
Pakistan	
Qatar	
Saudi Arabia	
Sri Lanka	
Thailand	
Vietnam	

Confirmed Distribution

Suspected Distribution

Histroical Range: *An. stephensi* have historically been found from the Middle East to the Indo-China region. Since it was initially discovered in Djibouti in 2013, *An. stephensi* has been found in Egypt and Ethiopia as well. There is potential for this species to continue expanding its range further into Africa.

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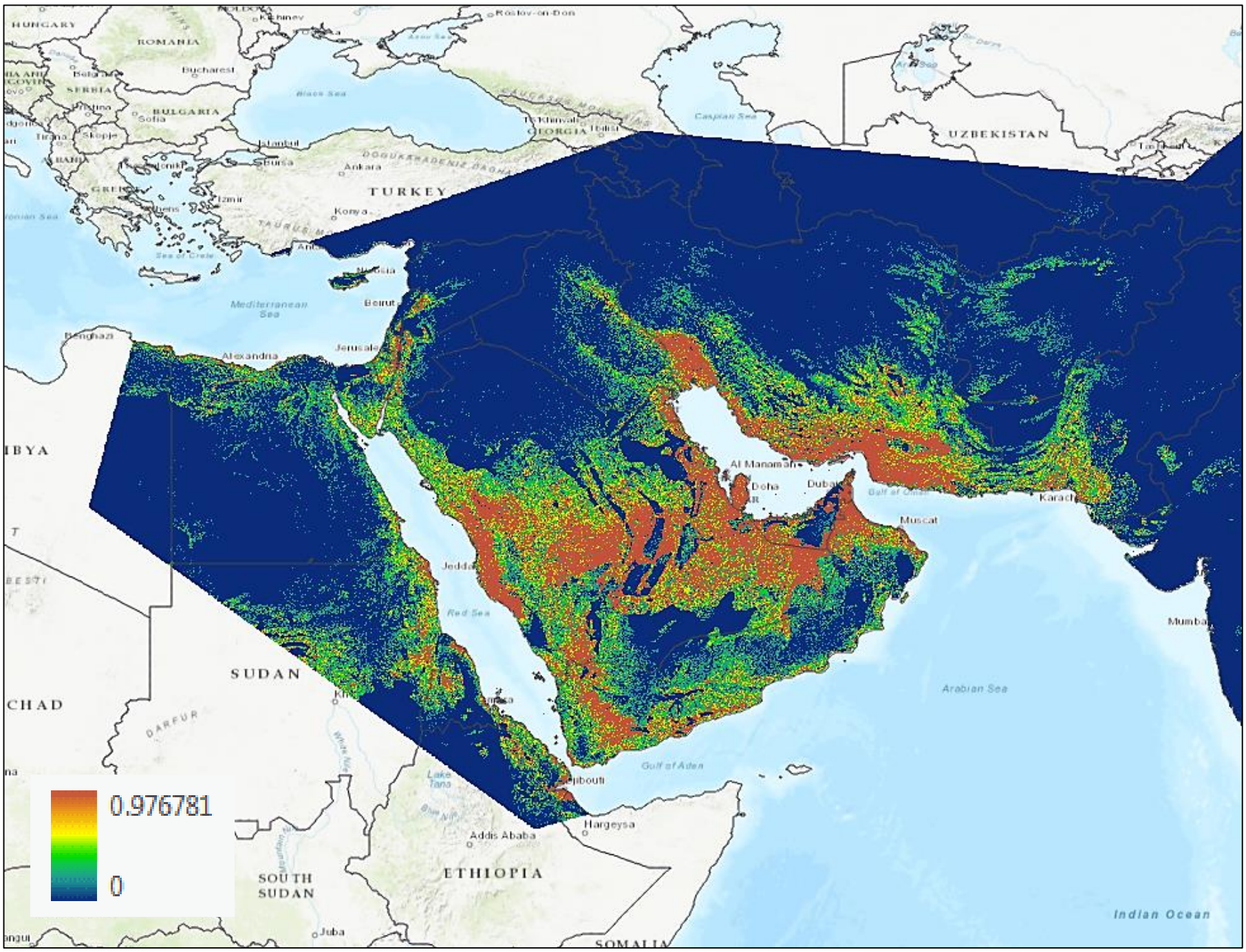
Habitat Suitability: *Anopheles* (*Cel*.) *stephensi* Liston, 1901

Currently, there is not sufficient data from the African continent to conduct habitat suitability modeling beyond the Northern Mediterranean and Red Sea coasts.



SpatialResolution: 0.0416667degrees
ExtentTop: 55.7821725593
ExtentLeft: 21.181813412
ExtentRight: 139.806908312
ExtentBottom: -0.176205540672
ModelDescription: Maximum entropy - Maxent 3.2.1 (Phillips 2006)
LayerClasses: Continuous
Threshold: minimum training presence
Value range: 109, 997 (Value of each pixel represents probability (x10) of species occurrence in that pixel)
NumberUniquePoints: 16 for training
EnvironmentalLayers: bio_1, bio_12, bio_13, bio_14, bio_15, bio_19, bio_4, bio_5, bio_6, bio_9, aspect, dem, flowacc, slope, topoind, soil_so

For Maxent Output Files Click Here.

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Human Population Density

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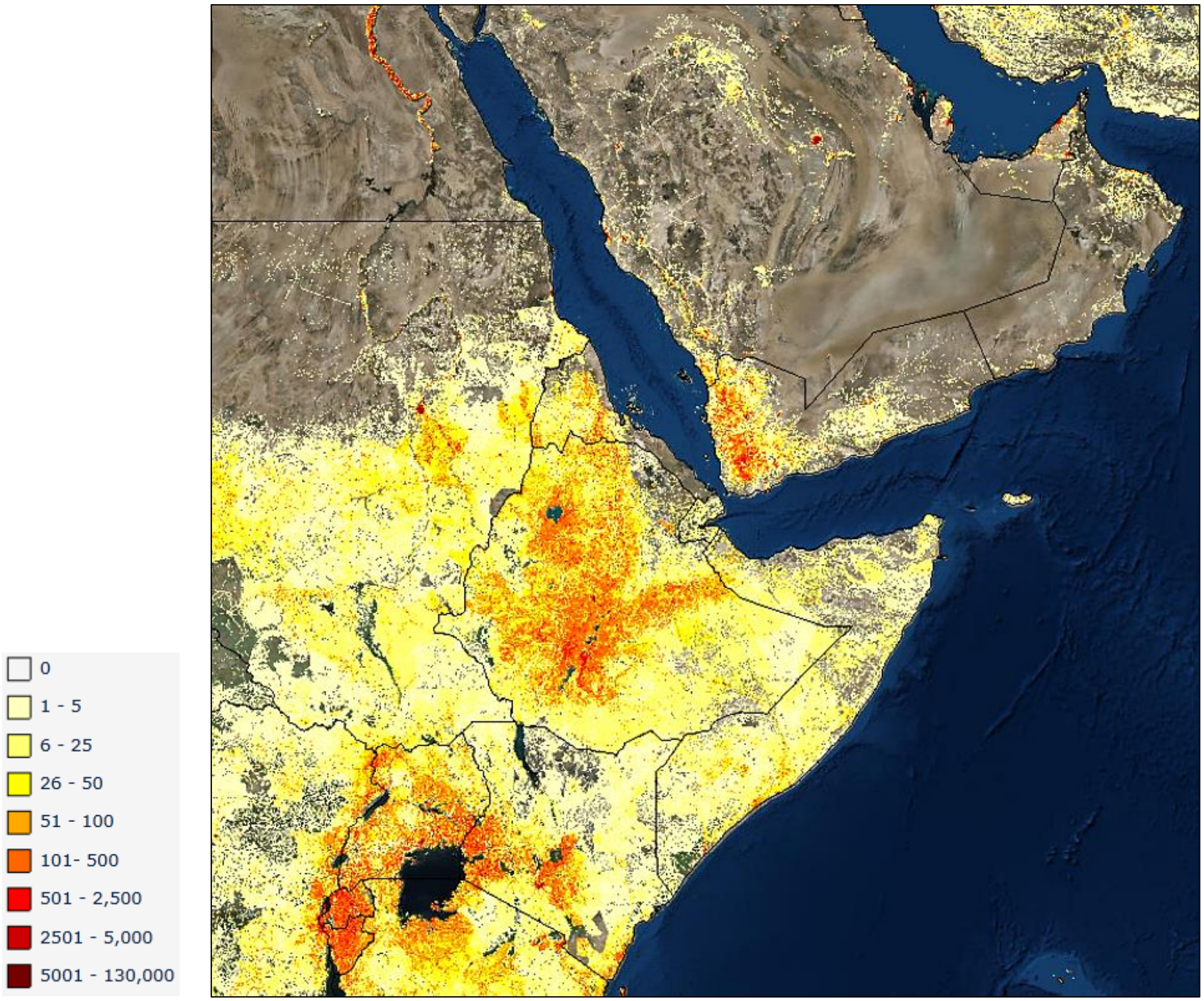
Of particular concern for *An. stephensi* are urban areas with high human population per sq/km. More surveillance data is needed from Eastern Africa, particularly from these areas to better characterize this species true distribution.



2011 LandScan

WE NEED YOUR DATA AND SPECIMENS!

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Are you collecting mosquitoes in Northern Africa? Consider contributing your collection data to WRBU's web repository, VectorMap. Your data will help characterize the true distribution of *Anopheles stephensi* and may be used to model habitat suitability in Africa. To learn about how to format your data for VectorMap and submit it for consideration click here.

You can also request a voucher specimen submission kit via WRBU. This kit will contain supplies for the preservation and shipment of voucher specimens associated with your study. For more information contact WRBU at NMNH-WRBU@si.edu.

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The Walter Reed Biosystematics Unit is part of the Walter Reed Army Institute of Research and is based at the Smithsonian Institution Museum Support Center. To access taxonomic keys, the Systematic Catalog of Culicidae or to learn more about WRBU visit wrbu.si.edu

VECTORMAP

VectorMap is only as good as the data you provide. If you have collection records, models or pathogen testing results please contact the VectorMap team to learn how to contribute data at mosquitomap@si.edu

Vector Photos Provided by Judith Stoffer, Walter Reed Biosystematics Unit