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Anopheline diversity in Undivided Aizawl district of Mizoram, India

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Abstract

Mizoram is designated as high malaria endemic area by the National Vector Borne Disease Control Programme (NVBDCP) in India. The status, diversity and the number of vectors and potential vectors within Mizoram are poorly studied. This study identified 16 *Anopheles* species, out of which 12 are potential vectors of malaria in undivided Aizawl district of Mizoram. There are 4 species identified form the sub-genus *Anopheles* and 12 species from the sub genus *Cellia*. The result also indicates that Champhai district have the lowest anopheline diversity and Mamit district the highest. The role of each vector and potential vectors of malaria has to be further investigated.

Key words: *Anopheles* diversity; malaria; Mizoram (Northeast India); vector.

Introduction

Malaria is a mosquito borne disease caused by *Plasmodium* sp. WHO estimated 216 million malaria cases worldwide in 2010, of which approximately 81%, or 174 million cases, were in the African Region and 0.12%, or 28 million in Southeast Asian countries, including India.[1] Northeast India lies within the Indo-Chinese hill zone of Macdonald's classification of stable malaria.[2] The seven northeastern states contribute to 10% of total malaria in India, 11% *Plasmodium falciparum* cases and 20% malaria deaths.[3] Malaria situation in the Northeast presents a convergence of following factors[4]: 1) highly exophilic and exophagic vectors; 2) mobile populations; 3) insurgency in a few areas; 4) borders with neighboring countries where multi-drug resistance is widespread; 5) possibility of important role of FBOs and NGOs, plantations and the military in some areas.

In India, 58 anopheline species are reported, of which 10 are known vectors of malaria.[5] *An. minimus*, *An. fluviatilis* and *An. dirus* are the main vectors of malaria in the Northeast.[3] The main objective of this study is to document the *Anopheles* diversity and to identify potential vec-

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tors of malaria within the study area.

Materials and Method

Study area

The study area covers an Undivided Aizawl District of Mizoram. Mizoram is one of the 28 states of India and the capital is Aizawl. It is located in Northeast India with two international boundaries, on the east to Myanmar (404 kms) and on the west to Bangladesh (318 kms). Mizoram have inter-state boundaries with Assam (123 kms),Tripura (66 kms) and Manipur (95km).[6] Mizoram is located between 21°58' N and 24° 35'N latitudes and 92°15' E and 93° 29' E longitudes. Elevation ranges from 40 m at Bairabi to 2157 m at Phawngpui above sea level.[7] Mizoram become the Union State in 1986 and was divided into three districts, namely Aizawl, Lunglei and Chhimtuipui districts. In 1998, the districts were re-organized and four new Districts namely Mamit, Kolasib, Champhai and Serchhip districts were created from Aizawl District. So, the current districts of Aizawl, Mamit, Kolasib, Champhai and Serchhip are sometimes called "Undivided Aizawl District" referring to pre-division before 1998. The study area accounts for 59.7 % of the geographical area of the state with 63.35% and 69.94 % of the total population.[6]

Sample collection and analyses

Mosquitoes were collected using light trap method –– CDC miniature light trap, local made light trap; hand collection with aspirators and collection vials using chloroform/formalin.[8] Collection was done in the districts of Aizawl, Kolasib, Champhai, Serchhip and Mamit. The majority of the collections were done in the periphery of all the districts capitals. Major investigated areas included the town of Zemabawk, Tuirial, Tuirial Airfield, Chawlhmun, Tanhril, Sihphir, within Aizawl district. Other major collection sites includes Kawlkulh, Champhai town area, Kolasib town area, Rengtekawn, Buhchang, Sawikhawthir, Sihthiang, Lengpui, Sairang, Dampa Wildlife Sanctuary, Mamit town area, Dapchhuah, Sairang town area, Serchhip town area and Thenzawl town area. Investigation was also carried out in animal huts, majority of which were cowsheds.

All collected specimens were identified through taxonomic keys of Nagpal and Sharma (1995),[5] Das *et al.* (1990)[9] and taxonomic software developed from the keys of Nagpal and Sharma (1995). The diversity was calculated using software called Bio-DAP, developed by Gordon Thomas for Parks Canada (PHQ) and Fundy National Park. Bio-DAP calculates diversity indices corresponding to those presented by Magurran (1988).[10]

Results

Morphological identification of adult *Anopheles* (n = 1640) yielded 16 species. Among these 12 species were from the sub-genus *Cellia* and 4 from the sub-genus *Anopheles*. Table 1 shows the district-wise distribution of anopheline species in the study area. Amongst the subgenus *Anopheles*, *An. barbirostris* group and *An. hyrcanus* group could not be further identified using morphological characteristics and simply tabulated as group or gp. The dominant species groups collected from all the study sites were *An. barbirostris* group followed by *An. maculatus* group – *An. maculatus* and *An. vagus*. The diversity indices calculation indicated that Champhai district had the lowest anopheline diversity and Mamit district had the highest. *Anopheleses* were also evenly distributed in the district of Serchhip. The diversity indices calculation table is shown in Table 2 & 3. The Simpson's Index of dominance (D) is highest in Champhai (D = 0.411) and lowest in Kolasib (D = 0.254). The Shannon diversity H' is highest in Mamit District (H' = 1.74) and lowest in Champhai District (H' = 1.03). The evenness calculation shows that Evenness (E) is highest in Aizawl (E =0.7) and lowest in Serchhip (E = 0.61).

Table 1. District-wise distribution of Anopheles species in undivided Aizawl District of Mizoram.

Sl no	Species	Sub-genus	Districts				
			Champhai	Serchhip	Kolasib	Aizawl	Mamit
1	*An. dirus*	*Cellia*	-	+	+	+	+
2	*An. minimus*	*Cellia*	+	+	+	+	+
3	*An. vagus*	*Cellia*	-	+	+	-	+
4	*An. jeyporiensis*	*Cellia*	+	+	-	-	+
5	*An. psudowilmori*	*Cellia*	-	-	-	-	+
6	*An. maculatus*	*Cellia*	+	+	+	+	+
7	*An. kochi*	*Cellia*	-	-	-	-	+
8	*An. annularis*	*Cellia*	+	+	+	+	+
9	*An. subpictus*	*Cellia*	-	+	+	+	-
10	*An. jamesi*	*Cellia*	-	+	-	-	+
11	*An. philippinensis*	*Cellia*	-	+	+	+	+
12	*An. aconitus*	*Cellia*	-	+	+	+	+
13	*An. barbirostris* gp	*Anopheles*	+	+	+	+	+
14	*An. gigas*	*Anopheles*	-	+	+	-	+
15	*An. aitkeni*	*Anopheles*	-	-	-	-	+
16	*An. nigerrimus/ An. hyrcanus* gp.	*Anopheles*	-	+	-	+	+

Table 2. Simpson's index of different study sites.

Index	Champhai	Serchhip	Kolasib	Aizawl	Mamit
Simpson's Index	0.411	0.299	0.254	0.255	0.257
1 / Simpson's Index	2.431	3.341	3.943	3.924	3.892

Table 3. Shannon diversity and evenness index of different study sites.

Species indices	Champhai	Serchhip	Kolasib	Aizawl	Mamit
H'	1.03	1.47	1.64	1.55	1.74
E	**0.64**	**0.61**	**0.68**	**0.7**	**0.64**
Var H'	0.00505	0.0016	0.0023	0.0023	0.0025

DISCUSSION

The diversity indices calculation indicates that Champhai district is with the lowest anopheline diversity and Mamit district, the highest anopheline diversity. *Anopheles* species are evenly distributed in the district of Serchhip.

The significance of this simple diversity study can be summarized with the role played by these species in malaria transmission at different countries, mainly India and other Southeast Asian countries.

1. *Anopheles dirus* (Peyton and Harrison, 1979): *An. dirus* is incriminated as a vector of malaria in southern Mizoram.[11] It is a complex species having seven species. The complex species reported from Mizoram is *An. baimaii* (species D) (Sallum and Peyton, 2005).[12]

2. *Anopheles minimus* (Theobald, 1901): *An. minimus* is also a complex vector of malaria found in NE India designated as species A to E.

It is also incriminated as a vector of malaria in southern Mizoram.[11]

3. *Anopheles vagus* (Doenitz, 1902): *An. vagus* is not considered a vector of malaria in India.[5] It is previously incriminated as a vector in Bangladesh.[13] It is also a suspected vector of malaria in the absence of other primary vectors, and may play a role as secondary vector of malaria in the Philippines.[14] Its role in malaria transmission has to be investigated especially in Mamit and Kolasib districts.

4. *Anopheles jeyporiensis* (James, 1902): *An. jeyporiensis* is a well known vector of malaria in central India.[5] It is well distributed within the study areas. The vector status of this species has to be established along with their resistance to insecticide.

5. *Anopheles philippinensis* (Ludlow, 1902): *An. philippinensis* considered secondary malaria vectors in the Northeast India.[3] It was found predominant in the state of Mizoram and Arunachal Pradesh.[15] The role of the species in malaria transmission has to be further investigated.

6. *Anopheles maculatus* gp. (Theobald, 1901): *An. maculatus* is vector of human malarial parasites in hilly areas of eastern India, southern Thailand, peninsular Malaysia and south-central Java.[16] The current status of the role played by this species and their resistance status of insecticides has to be investigated.

7. *Anopheles aconitus* (Doenitz, 1902): *An. aconitus* is known as primary vector of malaria and is regarded as a secondary vector in the coastal plains of Odissa.[5] The current status of the role played by this species in malaria transmission and its resistance to D.D.T. and other insecticides has to be investigated.

8. *Anopheles subpictus* (Grassi, 1899): *An. subpictus* have four sibling species, designated species A, B, C and D. It is also a vector of helminth (*Wuchereria bancrofti*) and arboviruses. *An. subpictus* s.l. is confirmed as a malaria vector in Malaysia and Indonesia.[16]

9. *Anopheles annularis* (van der Wulp, 1884): *An. annularis* is an important vector of malaria in India, Nepal and Sri Lanka.[5] It is distributed throughout India. This species is regarded as a secondary vector in the neighboring country of Myanmar. This species is responsible for epidemic outbreaks of malaria in the Rakhine coastal region of Myanmar where population densities increase dramatically after major cyclone activity.[19]

10. *Anopheles barbirostris* gp.: *An. barbirostris* group consists of three species,[9] namely *An. ahomi* (Chowdhury,1929), *An. barbirostris* (van der Wulp,1884), and *An. barbumbrosus* (Strickland & Chowdhury, 1927). It is found in the all the study sites and is the largest number of species collected in this study. It is highly zoophilic. It is a secondary vector of malaria and a recognized vector of human filaria in Indonesia. In India, it is found positive for filariasis (*Brugia malayi*) infection.[16]

11. *Anopheles hyrcanus* gp.: *An. hyrcanus* group is collected only from Mamit district. It consists of several species that are vectors of malaria found in the Oriental and Palearctic regions. It has about 30 species, including two newly described species, *An. belenrae* and *An. kleini*.[17]

12. *Anopheles nigerrimus* (Giles 1900): *An. nigerrimus* is also well-known vectors of malaria in Indonesia and Malaysia. Also transmits filariasis (*B. malayi*) in India, Malaysia, Thailand, and Sri Lanka.[16]

In conclusion, out of the 16 anopheline species collected from the study area 12 species have been incriminated as vectors of malaria in India and other Southeast Asian countries. Out of the 12 species only two species, i.e. *An. minimus* and *An. dirus* have been incriminated as vectors in southern parts of Mizoram.[11] The role played by known primary and secondary vectors in the transmission of malaria in Mizoram and their susceptibility to insecticides must be investigated to completely understand the problem of malaria in Mizoram.

REFERENCES

1. WHO (2011). *World Malaria Report: 2011*. World Health Organization, Geneva, Switzerland, WHO Library Cataloguing-in-Publication Data, ISBN 978 92 4 156440.
2. Macdonald G (1957). *The Epidemiology and Control of Ma-*

laria. Oxford University Press, London.

3. Dev V, Bhattacharyya PC & Talukdar R (2003). Transmission of malaria and its control in the north-eastern region of India. *J Assoc Physicians India*, **51**, 1073-1076.
4. Anonymous (2007). *Strategic Action Plan for Malaria in India 2007-2012*. Directorate of National Vector Borne Disease Control Programme (NVBDCP), 22, Sham Nath Marg, Delhi-110054, India.
5. Nagpal BN & Sharma VP (1995). *Indian Anopheles*. Oxford & IBH Publishing Co. Ltd, Janpath, New Delhi, India.
6. Anonymous (2011). *Census of India - 2011*. Provisional Population Totals Mizoram Series 16. Directorate of Census Operations, Mizoram, pp. 1-31.
7. Pachuau R (1994). *Geography of Mizoram*. R.T Enterprise, Aizawl, pp. 22-25.
8. WHO (2002). *Malaria Entomology and Vector Control - Learner's Guide*. World Health Organization, Geneva, Switzerland.
9. Das BP, Rajagopal & Akiyama J (1990). Pictorial key to the species of Indian anopheline mosquitoes. *Zoology*, **2**, 131-162.
10. Magurran AE (1988). *Ecological Diversity and Its Measurement*. Princeton University Press, Princeton, USA.
11. Das SC & Baruah I (1985). Incrimination of *Anopheles minimus* Theobald *and Anopheles balabacensis balabacensis* Baisas (*An.dirus*) as malaria vectors in Mizoram. *Indian J Malariol*, 22, 53-55.
12. Prakash A, Bhattacharyya DR, Mohapatra PK & Mahanta J (2005). Malaria transmission risk by the mosquito *Anopheles baimaii* (formerly known as *An. dirus* species D) at different hours of the night in North-east India. *Med Vet Entomol*, **19**, 423-427.
13. Alam MS, Khan MGM, Chaudhury N, Deloer S, Nazib F, Bangali AM & Haque R (2010). Prevalence of anopheline species and their *Plasmodium* infection status in epidemic-prone border areas of Bangladesh. *Malar J*, **9**, 15.
14. Rueda LM, Pecor JE & Harrison BA (2011). Updated distribution records for *Anopheles vagus* (Diptera: Culicidae) in the Republic of Philippines, and considerations regarding its secondary vector roles in Southeast Asia. *Trop Biomed*, **28**, 181-187.
15. Sarma NP, Prakash A, Bhattacharyya DR, Kalita MC, Mohapatra PK, Singh S, Sarma DK & Mahanta J (2012). Spatial distribution and molecular characterization of *Anopheles nivipes* and *Anopheles philippinensis* (Diptera: Culicidae) in north-east India. *Acta Trop*, **122**, 247-254.
16. Sinka ME, Bangs MJ, Manguin S, Chareonviriyaphap T, Patil AP, Temperley WH, Gething PW, Elyazar IRF, Kabaria CW, Harbach RE & Hay SI (2011). The dominant *Anopheles* vectors of human malaria in the Asia-Pacific region: occurrence data, distribution maps and bionomic précis. *Parasit Vectors*, **4**, 89.
17. Rueda LM, Kim HC, Klein TA, Pecor JE, Li C, Sithiprasasna R, Debboun M & Wilkerson RC (2006). Distribution and larval habitat characteristics of *Anopheles Hyrcanus* Group and related mosquito species (Diptera: Culicidae) in South Korea. *J Vector Ecol*, **31**, 198-205.