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RESEARCH FOR SUSTAINABLE
DEVELOPMENT

Prevalence and Bionomics of Anopheles Species in a Gem Mining Area in Moneragala District of Sri Lanka

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1 INTRODUCTION

Sri Lanka has been well known for its gem stones for more than 2500 years and the main gem mining areas of the country are Eheliyagoda of Ratnapura District, Elahera of Matale District and Okkampitiya of Moneragala District. The gem fields when abandoned after use contribute to mosquito breeding and there are records of past malaria outbreaks in gem mining areas due to the potential of malaria vector breeding in the gem pits (Wickremasingha, 1981).

Malaria was a major public health problem in Sri Lanka in the past and it was endemic in the Dry zone and epidemic in the Intermediate and Wet zones. Since the interruption of indigenous malaria transmission in the country in October 2012 and being certified as malaria-free in 2016, the biggest threat to the malaria elimination efforts is the risk of resurgence due to imported malaria cases and the continuing receptivity in several parts of the country due to the persistence of malaria vectors (Premaratne *et al*., 2014). Previous studies in the Kaluganga gem mining area of Matale District show that changes in the environment due to gem mining have caused the emergence of *Anopheles subpicts* and *An. varuna* as significant vectors of malaria (Yapabandara and Curtis, 2004).

Moneragala District in the Intermediate zone of the country currently has a land area of 5636 km^2 with abandoned and active gem mining pits. It is also an area where indigenous malaria transmission has been reported even in 2012. Gem mining pits and the associated aquatic habitats in the Moneragala District may pose a significant threat to increase malaria vector breeding. Hence this study was designed to investigate the prevalence of *Anopheles sp* in Moneragala, their indoor resting habits, adult feeding habits and breeding habits.

2 METHODOLOGY

2.1 Study site and duration of data collection

Monthly entomological investigations were carried out over a two year period from April 2015 to March 2017 in three gem mining localities namely Minipuragam, Niyadella and Rathreewewa of Buttala MOH area.

2.2 Sampling methods of *Anopheles* mosquitoes

Adults vector mosquitoes were collected in monthly intervals by Cattle baited trap collections - CBTC (95 trap collections), indoor hand collections –IHC (1143 man hours), indoor and outdoor human landing catches partial and full night -HLC (631 man hours), using WHO recommended procedures.

Immature Anophelines were collected in monthly larval surveys (LS) carried out in all potential breeding sites present in the study area. All the collected *Anopheles* mosquitoes were identified to species with the use of standard mosquito taxonomic keys.

The study was approved by the ethics review committee of the Faculty of Medicine, University of Kelaniya.

3 RESULTS AND DISCUSSION

3.1 Abundance of *Anopheles* mosquitoes

A total of 41,919 *Anopheles* mosquitoes belonging to 16 species were caught from all sampling techniques. Table 1 shows the number and percentage of each vector species caught using different collection techniques. In addition to the main malaria vector, *An. culicifacies* 10 other potential vectors of malaria incriminated by ELISA method (Kondradsen *et al.*, 2000) were observed in this study. Further five species, namely *An. aitkeni, An. elegans, An. maculatus, An. jamesii* and *An. pseudojamesii* known as non-vectors of malaria were also observed (Table 1). Sixteen *Anopheles* species were encountered in larval surveys in the study area and a total of 7530 larvae collected. The most abundant species was *An. varuna* (35.7%) followed by *An. culicifacies* (17.8%) as shown in Table 1.

Table1: Number and percentage abundance of *Anopheles* species caught from different collection techniques

Species	Number of different *Anopheles* collected (%)			
	CBTC	IHC	HLC	LS
An. aconitus[b]	1633 (4.83)	0	0	54 (0.72)
An. annularis[b]	35 (0.10)	0	5 (0.8)	27 (0.36)
An. barbirostris[b]	629 (1.86)	0	1 (0.2)	940 (12.48)
An. culicifacies[a]	63 (0.18)	6 (13)	350 (62)	1340 (17.8)
An. nigerrimus[b]	4023 (11.91)	0	1 (0.2)	523 (6.95)
An. pallidus[b]	66 (0.19)	0	1 (0.2)	19 (0.25)
An. peditaeniatus[b]	7460 (22.08)	0	3 (0.5)	523 (6.95)
An. subpictus[b]	43(0.12)	39(84.8)	16 (2.7)	40(0.53)
An. tesellatus[b]	1355(4.01)	0	129 (21.9)	60(0.8)
An. vagus[b]	2763(8.18)	0	20(3.4)	156(2.07)
An. varuna[b]	3669(10.86)	1(2.2)	15(2.5)	2642(35.09)
Non vectors	12039 (35.64)	0	6(1.06)	1205(16.06)
Total	33778	46	566	7529

a -major malaria vector, b- potential vectors, CBTC-Cattle Baited Trap Collections, IHC-Indoor Hand Collections, HLC-Human Land Collections, LS-Larval Surveys

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3.2 Indoor resting behavior of *An. opheles* mosquitoes

Among the 16 species recorded in the study only *An. subpictus* (84.8%), *An. culcifacies* (13%) and *An. varuna* (2.2%) were found resting inside human dwellings in the study area.

3.3 Human Biting behavior of *Anopheles* mosquitoes

In the partial night and full night human landing catches carried out, all 11 vector species were encountered in the study area along with the three non-vector species *An. jamesii, An. maculatus* and *An. pseudojamesii* (Table 1). Five species among the 11 species showed both indoor and outdoor human biting behavior and they were the major malaria vector *An. culicifacies* and other potential vectors *An. subpictus, An. tessellatus, An. aconitus* and *An. peditaeniatus.* A significant feature is that highest proportion of human biting vectors was from *An. culicifacies* (62%). Moreover, *An. culicifacies* showed high outdoor biting rates compared to indoor biting rates.

The higher incidence of human biting among the *Anopheles* vector and potential vector species indicates the possibility of malaria transmission in the gem mining areas due to presence of many anthropophillic vectors and also their outdoor biting habit will be significant in gem mining industry since workers spend long hours outdoors in this industry.

3.4 Breeding site preference of *Anopheles* mosquitoes

There were 17 different larval breeding habitats in this gem mining area. Of these breeding sites, river bed pools and margin of the Kumbukkan Oya contributed to the highest *Anopheles* larval breeding while abandoned gem pits was in third place for larval breeding (Figure 1). Irrigation canals, paddy fields, domestic wells and rain water collections in rainy season contributed for the next highest breeding potential, respectively, throughout the study period.

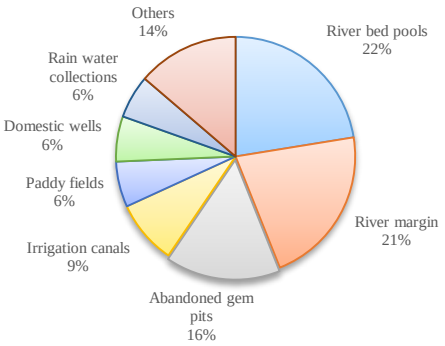

Figure 1: Breeding sites of *Anopheles* in Gem mining area of Moneragala District

In river bed pools *An. culicifacies* was the most abundant species while in the river margins it was *An. varuna* (Figure 2).

In abandoned gem pits the most abundant species was *An. jamesii* which is considered a non-vector species. This is comparatively a different finding from previous studies conducted in Kaluganga gem mining area of Matale district (Yapabandara and Curtis, 2004).).

In Kaluganga gem mining area, gem pits contributed to breeding of *An. culicifacies, An. varuna* and *An. subpictus* than the other species. In irrigation canals and rain water collections *An. varuna* was abundant and *An. peditaeniatus* was the most abundant in paddy fields. *An. varuna* was present in almost all major *Anopheles* breeding habitats while *An. culicifacies* also occupied a variety of breeding habitats in the present study.

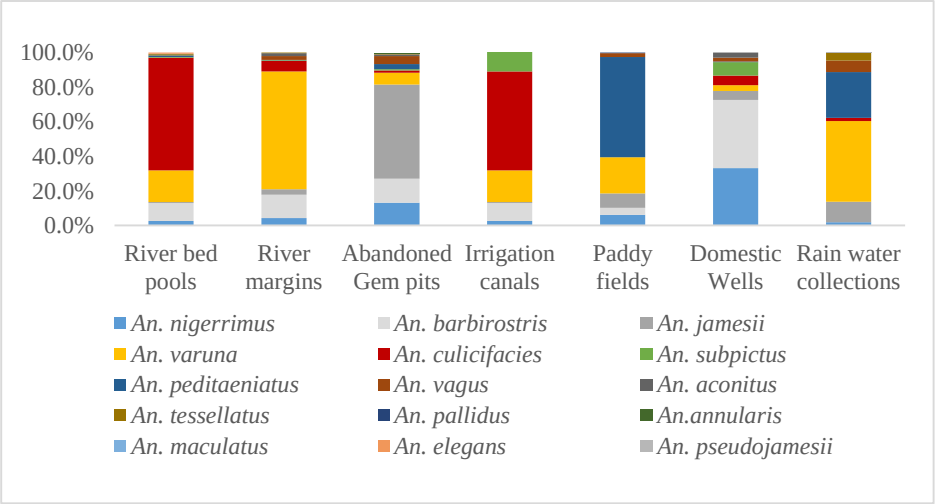

Figure 2: Breeding habitats of different *Anopheles* species found in gem mining area of Moneragala District

4 CONCLUSIONS

In the gem mining areas of Niyadella, Rathreeweva and Minipuragama of Buttala MOH Area of Moneragala District the malaria vector *An. culicifacies* is abundantly breeding in the river bed pools and in the margin of Kumbukkan oya which is flowing throughout this area. Abandoned gem pits are in the third place contributing to the *Anopheles* mosquito breeding and it contributed to breeding of *An. jamesii* than other species. Therefore, abandoned gem pits are not a significant malaria vector breeding site when compared to the previous study in Kaluganga gem mining area in Matale District. However, the high human biting rates of the major vector and anthropophillic behavior of other potential vectors in the study area have contributed to increased receptivity. Hence, the high receptivity in this gem mining area has to be considered as a malaria transmission risk factor even in the absence of malaria transmission to increase vigilance and evidence based vector control to keep the area malaria free.

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