MORPHOLOGICAL CHARACTERISTIC DIFFERENCE BETWEEN MOSQUITOES VECTOR FOR MALARIA AND DENGUE FEVER

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Abstract

Malaria and Dengue Hemorrhagic Fever (DHF) are two major tropical diseases in East Java. The pathogens of these diseases are transmitted to human hosts via haematophagy by vector mosquitoes. Anopheles spp. specifically transmits Plasmodium parasites which cause Malaria, while Aedes spp. transmits Dengue viruses that cause DHF. Bangsring, Banyuwangi is one of the endemic areas of Malaria, while Jember is one of endemic areas of DHF. Two species of Malaria vectors i.e Anopheles vagus and Anopheles sundaicus have been found from several samplings which were conducted in Bangsring region. This mosquitoes have been previously identified as a major vector for malaria. Aedes aegypti and Aedes albopictus, which were major vectors for DHF, have been easily found in Jember during our sampling for any season of the year. This research wanted to differentiate the morphological characteristic of those vectors for malaria and Dengue. Adult mosquitoes can be distinguished from one another by characterizing their morphological features. Palpi, wings, and legs characteristics are commonly used as determination keys in Anopheles sp., while thoraxes and legs characteristics are used as identification keys in Aedes sp. Morphological identification is considered as the basic necessity in understanding and determining bionomic of mosquito vector. This is very important in developing effective and efficient mosquito vector control strategies, which is also an important step to prevent the death risks associated with Malaria and DHF cases.

Keywords: *Aedes aegypti, Aedes albopictus, Anopheles vagus, Anopheles sundaicus, morphology*

1. INTRODUCTION

Malaria and Dengue Hemorrhagic Fever (DHF) still occur in East Java, although the number of cases decreased from 2016 to 2017 (Dinas Kesehatan, 2017). Malaria is caused by pathogenic protozoa (*Plasmodium* sp.) infection, transmitted by *Anopheles* sp. mosquitoes, while DHF caused by dengue virus infection (DENV), transmitted by *Aedes* sp. mosquitoes (Elyazar *et al*., 2013; Soni *et al*., 2017). Pathogen transmission can occur when female mosquitoes (vectors) blood feed a host (Bowman et al., 2014). The breeding of these two mosquito species is endemic. The high number of mosquito populations in an area results in an increased cases of malaria and DHF (Sukesi, 2012).

Bangsring village in Banyuwangi district is one of the malaria endemic areas because there was an an outbreak in 2011 (Arifianto et al., 2018). Jember is one of the dengue endemic areas in East Java with the second highest number of cases after Sumenep (Kurniawati et al., 2015; Shafarini, 2018). Both of these endemic areas pose environmental factors which trigger mosquito breeding with vector-borne diseases (Kurniawati et al., 2015; Wahyuni et al., 2018).

An. sundaicus, *An. vagus*, *An. subpictus*, *An. barbirostris* and *An. indefinitus* were found in Bangsring, Banyuwangi (Arifianto et al., 2018). Previous studies by Arifianto et al., (2018) and Wahyuni et al., (2018) show that *An. sundaicus* and *An. vagus* are dominant species in this area. *An. sundaicus* and *An. vagus* are species which have been confirmed as a malaria vector in Indonesia (Zarowiecki et al., 2011), while *Ae. aegypti* is the primary vector whereas *Ae. albopictus* as a secondary vector in the spread of dengue virus found in Jember (Wan et al., 2013; Shafarini, 2018; Wathon et al. 2020).

Morphological identification can be done to characterize malaria vector and DHF species. Morphological differences in the

thorax and legs can be used as a reference for the identification of the *Aedes* sp. (Rueda et al., 2017). In addition, the color of palpus tip, the bracelet color on the proboscis, wing ornamentation and spots on the feet can be used as a reference in identifying *Anopheles* sp. (Gunathilaka, 2017).

Accurate identification of mosquitoes can be used as an initial measure to determine the ecological behavior of each mosquito. The ecological behavior includes feeding location (indoors or outdoors), biting behavior (predominant in humans, animals or both), geographical distribution and vectorial capacity (vector or non-vector) (Weeraratne et al., 2017). Morphological characters and ecological behavior are important information in carrying out vector control to determine effective and specific methods (Tahir et al., 2015).

2. MATERIALS AND METHODS

Research Site and Setting

The study was conducted from September 2019 to March 2020. Landing collection *Anopheles* sp. was conducted in Paras Putih urban village, Bangsring village, Wongsorejo sub-district, Banyuwangi district, while *Aedes* sp. was collected around the Botanical Gardens and the Biology-Department, Mathematics and Natural Sciences Faculty, University of Jember. Morphological identification of mosquitoes was carried out at the Zoology and Biotechnology Laboratory, University of Jember.

Landing Collection of *Anopheles* sp.

Anopheles sp. was collected during blood feeding hours, from 20.00 to 02.00 (UTC+7) around the coastal settlement area of Bangsring. The mosquitoes were kept using aspirator and put in a paper cup, with labels indicating location, type of mosquito and collection time.

Landing Collection of *Aedes* sp.

Aedes sp. was also collected during blood feeding hours, from 08.00 to 09.00 (UTC+7) in the Botanical Gardens and the Biology-Department Building. The mosquitoes were also kept using an aspirator and put in labeled paper cups.

The Morphological Identification

Morphological identification of mosquitoes was carried out using a stereo microscope (Nicon SMZ745, Japan) by referring to a book by Borror et al. (1995) entitled *Pengenalan Pembelajaran Serangga (Introduction to Insect Study)*, Reid's book (2008) entitled *Anopheline Mosquitoes of Malaya and Borneo*, and B2P2VRP book (2015) entitled *Pedoman Pengumpulan Data Vektor (Nyamuk) di Lapangan* (Guidelines for Data Collection of Mosquitoes). Morphological characteristics of *Ae. aegypti* and *Ae. albopictus* were identified by referring to Rueda's (2004) description of DHF vectors' morphology.

3. RESULTS AND DISCUSSION

The morphological identification successfully characterized various mosquitoes within *Anopheles* genus. These included 65 *An. vagus*, 20 *An. sundaicus*,15 *Ae. aegypti*, and 15 *Ae. albopictus.*

The Morphological Identification of Malaria Vector

The landing collection showed that *An. vagus* was more dominant than *An. sundaicus*. The morphological identification of *An. vagus* informed several features of this species, including the palpus which was characterized by subapical dark bracelet on 1/3 of the apical pale bracelet. The proboscis had pale patches. The prehumeral wing possessed black scales, whereas the wing venation had white tufts between venates 5.2 and 6. The legs did not have any pale patches (Figure 1) (Reid, 1968).

An. vagus landing collection demonstrated zoophilic behavior (the tendency to do blood feeding in farm animals). According to Sinka et al., (2011), *An. vagus* is known for its biting behavior which may turn into anthropophilic (blood feeding in humans). This is in congruence with the presence of host types. In addition, Laurent et al., (2017) report that *An. vagus* shows exophagic behavior (more active outdoors) and exophilic behavior (tends to be far from human habitat). Based on the results of the landing collection, *An. vagus*

exhibits exophagic behavior, but the location of mosquitoes is still close to settlements, which are also close to cattle pens. This circumstance triggers anthropophilic behavior because the likelihood of contact with humans is greater.

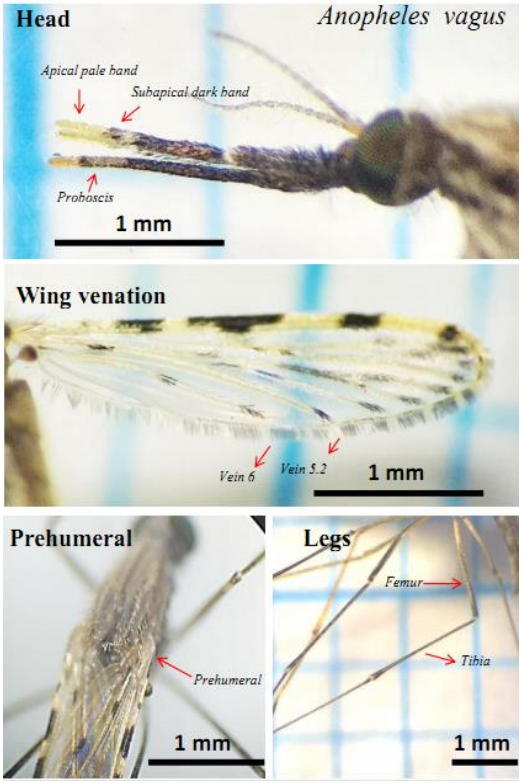

Figure 1. Morphology *An. vagus*. Nikon SMZ745 stereo microscope with 50x magnification (Image: Personal Documentation).

An. sundaicus from the landing collection has a characteristic on the palpus that is the length of the subapical dark bracelet 1/2 of the pale apical. The proboscis section does not have a pale ring, the wing venation between venation 5.2 and 6 has no white tufts. The legs have pale patches on the femur and tibia (Figure 2).

An. sundaicus from landing collection generally shows exophagic and anthropophilic behavior (tends to do blood feeding in humans). According to Elyazar et al., (2013), *An. sundaicus* exhibits both exophagic and endophagic behavior, and anthropophilic behavior. Based on its characteristics and behaviors, *An. sundaicus* has become the primary malaria vector in several regions. Landing collection *An. sundaicus* and *An. vagus* was performed by referring to the study of Kenea et al., (2016), stating that the *Anopheles* sp. have active hours of blood feeding from night to early morning

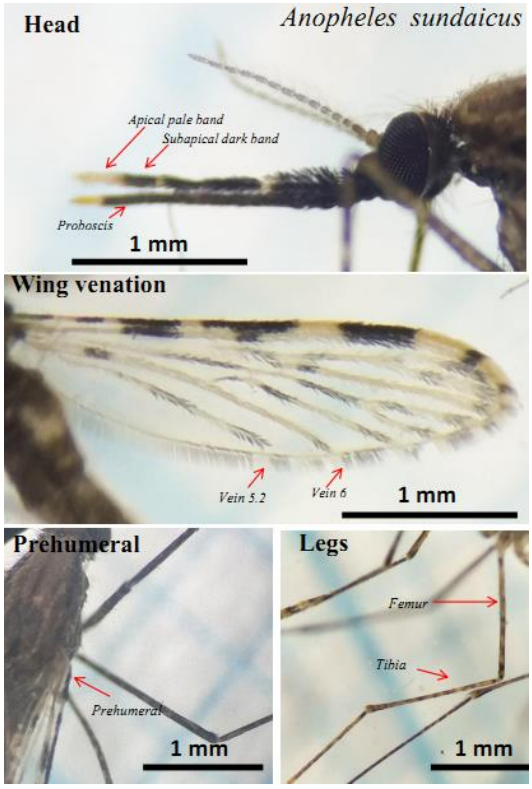

Figure 2. Morphology *An. sundaicus*. Nikon SMZ745 stereo microscope with 50x magnification (Image: Personal Identification).

The Morphological Identification of Dengue Vector

The body part was used as a key for differentiating *Aedes* sp. from *Anopheles* sp. Some of the important body parts in the genus *Aedes* are the scutum plate in the dorsal thorax, mesepimeron in the lateral thorax, and the middle leg femur. The landing collection results show *Ae. aegypti*'s color is brighter, compared to *Ae. albopictus* which is dominantly black. *Ae aegypti* has a pair of submedian-longitudinal white lines and a pair of curved white lines on the scutum plate (dorsal thorax) which are called

lyre-shaped markings (Figure 3A). *Ae aegypti* has patterned white scales in mesepimeron separated into 2 parts (Figure 3B). In addition, there are white scales that form a single longitudinal white line pattern along the femur of the lower middle leg (Figure 3C).

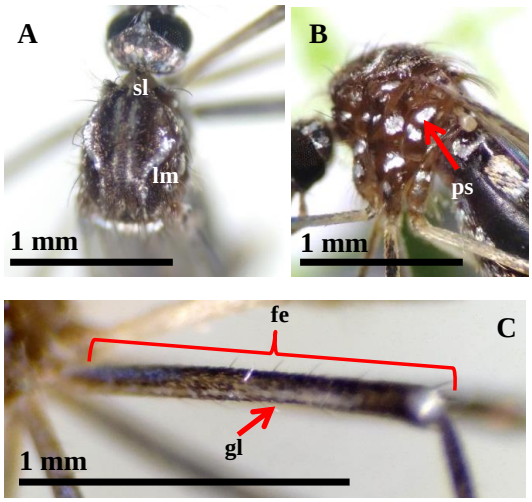

Figure 3. Morphological characteristics of *Ae. aegypti*. Submedian-longitudinal (sl) lines; lyre-shaped markings (lm); mesepimeron scales (ps); femur (fe); longitudinal line (gl) (Image: Personal Identification).

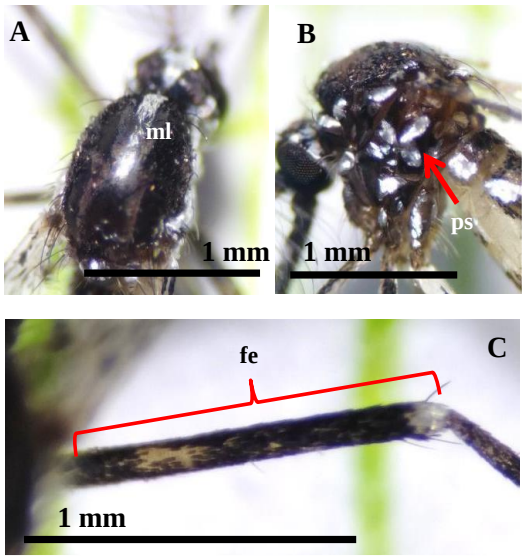

Figure 4. Morphological characteristics of *Ae albopictus*. Median-longitudinal line (ml); mesepimeron scales (ps); femur (fe). (Image: Personal Identification).

Ae aegypti with *Ae. albopictus* have one median-longitudinal thick line on the scutum (Figure 4A). The pattern of white scales on mesepimeron is connected, (Figure 4B). Besides that, *Ae. albopictus* has a plain black mid-leg femur without a longitudinal white line along the middle of the femur (Figure 4C).

The landing collection results show that *Ae. aegypti* and *Ae. albopictus* tends to exhibit anthropophilic behavior because it lives in an urban environment with high rate of contacts with humans. Bowman et al., (2014) state that although both species show anthropophilic behavior, in line consistent with the results of the landing collection which shows that Ae. aegypti is mostly found indoors while *Ae. Albopictus* is outdoors (garden).

The larval development of *Ae. aegypti* is mostly intense near clean water stored in building, but that of *Ae. albopictus* is naturally formed puddles (Boesri, 2011). The characteristics of both species from the landing collection acknowledge the research results by Syahribulan and Al (2012), namely active blood feeding in the morning and evening. That characteristic results from the temperature and humidity at that specific time, which supports the blood feeding of *Ae. aegypti* and *Ae. albopictus*.

4. CONCLUSION

Identification of mosquitoes across specieses can be conducted based on its morphological characteristics. These encompass specific features on legs, wings, thorax, proboscis and palpus. In addition to morphological characteristics, ecological behavior confers an important feature to understand bionomic of mosquito vectors. These behaviors include feeding location, biting behavior, and vectorial capacity. This information is very important to determine mosquito vector composition which is a key factor of controlling malaria and DHF vectors.

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