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RESEARCH ARTICLE

A MORPHOLOGICAL STUDY OF *Leptoconops spinosifrons* (DIPTERA: CERATOPOGONIDAE) AT BAGAN LALANG BEACH, SELANGOR

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ABSTRACT

Leptoconops are tiny blood-feeding insects commonly found in sandy beaches of tropical and sub-tropical regions and is known for its irritating bites. Their bites can cause allergic reactions and scarring. *Leptoconops spinosifrons* were collected from Bagan Lalang beach in Selangor with human landing catch (HLC) and modified emergence traps techniques. The specimens collected were mounted on microscope slides in Canada Balsam for morphological identification. The basic morphological features of *L. spinosifrons* were based on taxonomy key. In addition, the morphological features of male and female *L. spinosifrons* were differentiated in this study. This study aimed to describe the morphological characteristics of *L. spinosifrons*. The morphological characteristics of the poorly-known *L. spinosifrons* in this study are the first reported in Malaysia. It provides crucial surveillance data for this medically important, yet neglected insect that is associated with outdoor and tourism activities.

KEYWORDS

Biting midges, *Ceratopogonidae, Leptoconops spinosifrons, Culicoides*

1. INTRODUCTION

Ceratopogonidae is a large family with 112 genera and approximately over 6206 species excluding Antarctica (Borkent et al., 2022). Ceratopogonidae are divided into four subfamilies which are Leptoconopinae, Forcipomyiinae, Dasyheleinae, and Ceratopogoninae (Carrieri et al., 2007; El-Hawagry et al., 2020; Mullen and Murphree, 2018). The genus *Leptoconops* consist of 80 species primarily in the subtropical and tropical regions (Borkent et al., 2022).

Leptoconops, an insect belonging to family Ceratopogonidae and known as biting midges, is widely distributed in tropical and subtropical regions around the world. They are most commonly found on beaches with pure sand or sandy soils, but can also be found in inland areas with silt-clay soils to a lesser extent (Borkent, 2001; Kettle, 1977; Raspi et al., 2007). Tourist destinations with pristine sandy beaches are often susceptible to the constant presence of *Leptoconops*, likely due to the year-round emergence of sand-breeding species (Aussel, 1993; Kettle, 1977). *Leptoconops* are known worldwide and play important role as nuisance insects. Their bite throughout the day can disrupt outdoor activities and cause serious problems, particularly in tourism related with beaches (Linley and Davies, 1971).

In the Caribbean, which comprises of island nations such as Haiti, Jamaica, and The Bahamas, *Leptoconops becquaerti* is considered a major hindrance to the local economy. It reported biting infestations of *Leptoconops nimponensis oshimaensis* affected the daily activities of residents in Katoku and Isu village, Japan (Takaoka and Hayashi, 1977). This species is known to inhabit beaches popular with tourists and persistently attacks humans, causing significant inconvenience (Kettle and Linley, 1967). Meanwhile, in Malaysia, only *L. spinosifrons* has been reported on beaches such as Bagan Lalang Beach in Selangor, Pulau Aur and Pulau Besar in Johor, Pulau Tenggol A and Pulau Tenggol B in Terengganu (Nur Amalina et al., 2023; Rohani et al., 2006; Khadri et al., 2002).

None of these species act as vectors of pathogens for humans and other mammals. However, female *Leptoconops* feed on the blood of various vertebrates, including humans, during the day (Borkent, 2001; Kettle, 1977). *Leptoconops* bites are irritating and often cause dermatitis, resulting in extreme itching, swelling, and lesions with serous exudate, followed by secondary infections, oedema and lymphadenopathy in severe cases (Fontaine, et al., 1957; Rees and Smith 1950; Perich et al., 1995). Symptoms may last for weeks before the bites finally heal, sometimes leaving permanent scars (Freeborn and Zimmerman 1934; Lane and Crosskey 1993; Steffen 1981).

Despite the recognized nuisance and economic impact of *Leptoconops* species, there is limited detailed morphological information available, particularly on *L. spinosifrons* in Malaysia. Most studies have focused on distribution and biting behavior, while comprehensive morphological characterization is still lacking. A thorough understanding of the morphology of *L. spinosifrons* is essential for accurate identification, species differentiation, and the development of effective monitoring and control strategies. Therefore, this study aims to provide a detailed morphological description of *L. spinosifrons* collected from Bagan Lalang Beach, Selangor, to enhance the existing knowledge of this species and support future taxonomic and ecological studies.

2. MATERIALS AND METHODS

The study was conducted at Bagan Lalang beach, Selangor. Specimens were collected using HLC and emergence traps for 24 hours period as described in (Nur Amalina, 2023). The collected insects were preserved in 70% alcohol before being pinned and mounted. The genus of biting midges was identified based on the wing characters (Carter, 1921). Samples from

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the emergence traps were separated by sex.

The specimens were pinned and examined under a dissecting microscope (Leica EZ4W), as shown in Figure 1. The specimens were dissected on a glass slide, with the abdomen, wings, legs, and head separated using a fine needle. The body parts were then mounted in Canada Balsam for identification, following the method described by (Phillips, 2022; Carter, 1921). All morphological characteristics were examined using a light microscope (Leica ICC50 HD) and scanning electron microscope (SEM). Species descriptions were used for morphological identification of *Leptoconops* by (Carter, 1921).

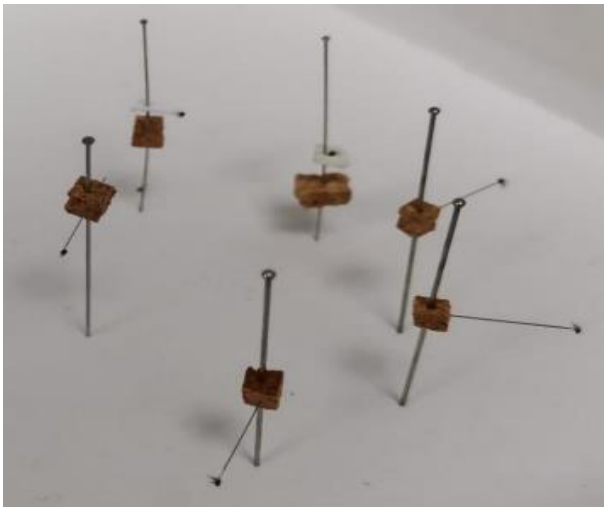

Figure 1: The specimens were pinned for identification

3. Results

A total of 1085 *Leptoconops* were collected through HLC and 20 individuals were trapped using emergence traps as previously described by (Nur Amalina, 2023). The genus of *Leptoconops* was determined based on wing characteristics. In this study, the body length of *Leptoconops* ranged from 1.70 mm to 2.20 mm. The species is easily recognized by its distinctive white colour and the presence of minute upright setae covering the entire wing surface (Figure 2 and 3). Wing length ranged from 1.10 mm to 1.34 mm (Figure 4).

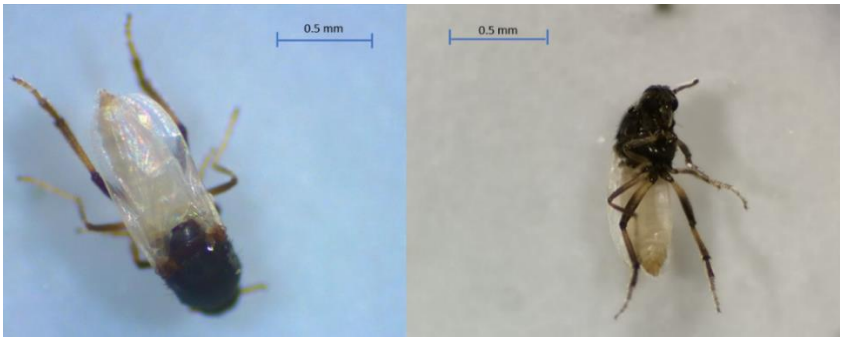

Figure 2: *L. spinosifrons*

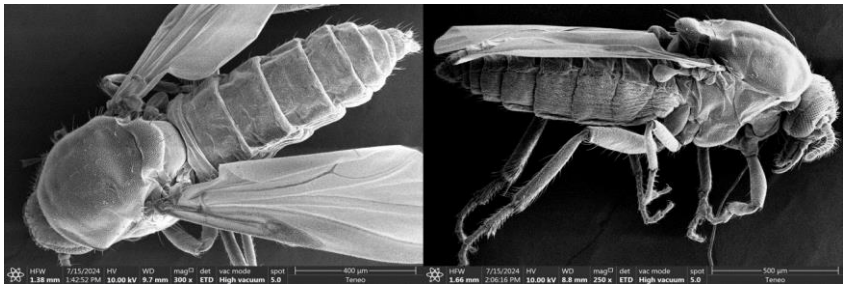

Figure 3: *L. spinosifrons* under SEM

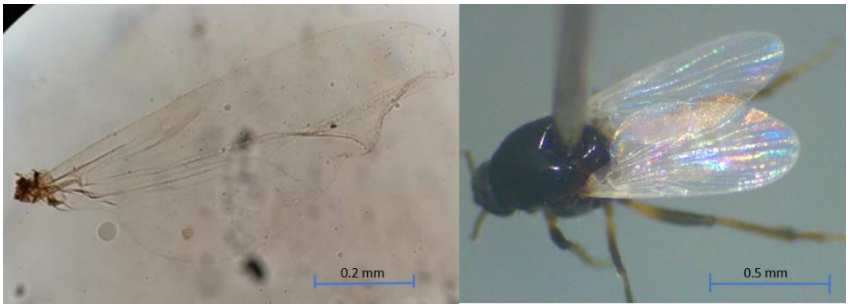

Figure 4: Wing of *L. spinosifrons*

The large number of spines on the front of the head led to the identification of the species as *L. spinosifrons* (Figure 5). This characteristic is similar with the description by (Carter, 1921). In this study, *L. spinosifrons* was found to have widely spaced eyes and a black head measuring between 0.31 mm and 0.34 mm in width. This species also exhibited a shiny black thorax covered short brown hairs.

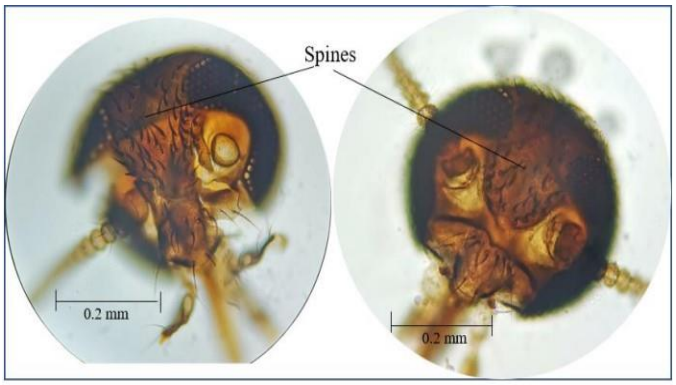

Figure 5: Frons with spines of female *L. spinosifrons*

In addition, the antennae of female *L. spinosifrons* in this study measured between 0.24 mm and 0.26 mm in length and they have dark brown in colour. Each antenna consisted of 12 segments with hairs (Figure 7). The female has non-plumose (smooth) antennae (Figure 6B). The first segment was cup-like and connected to the eyes. The second to eleventh segments were oval to subspherical in shape, while the terminal segment was elongated-oval and considerably longer than the others. In contrast, male has long, fine and plumose (feathery) appearance (Figure 6A). The antenna is composed of 14 segments. (Figure 8). The *L. spinosifrons* collected in this study also have a dark brown proboscis (Figure 9a) and a pair of dark brown palpi (Figure 9b). The palpi of this species consisted of three segments with dark hairs, and the apical segment is yellowish brown.

Figure 6: Antenna of male *L. spinosifrons* (A); antenna of female *L. spinosifrons* (B)

Figure 7: Antenna of female *L. spinosifrons*

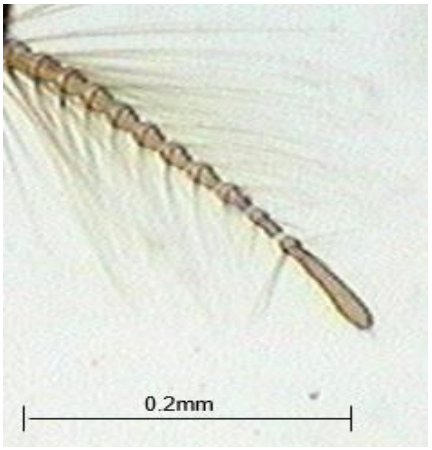

Figure 8: Antenna of male *L. spinosifrons*

Figure 9: Head of female *L. spinosifrons* (a: proboscis; b: palpi)

Scanning electron microscopy (SEM) revealed that the spiracles of *L. spinosifrons* are small, circular openings and covered by fine hairs or scales. There were six abdominal spiracles located on each side of the body. The spiracles were located laterally, one per body segment in the abdomen as shown in Figure 10. The diameter of spiracle ranging between 2.35 µm to 3.63 µm.

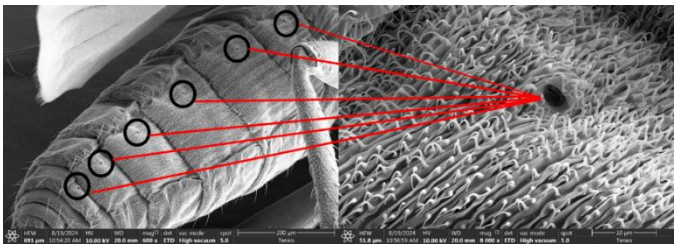

Figure 10: Spiracles of *L. spinosifrons* under SEM

Furthermore, the abdomen of *L. spinosifrons* can be used to differentiate between females and males. In this study, the abdomen consisted of nine segments with a creamy white colour and pale hairs. The female abdomen consists of creamy white lamellae with pale hairs and two spermathecae (Figure 11). In contrast, the male abdomen was more slender than female and has black-coloured genital part, with the terminal segment also appearing black (Figure 12).

Figure 11: Two spermathecae in female *L. spinosifrons*

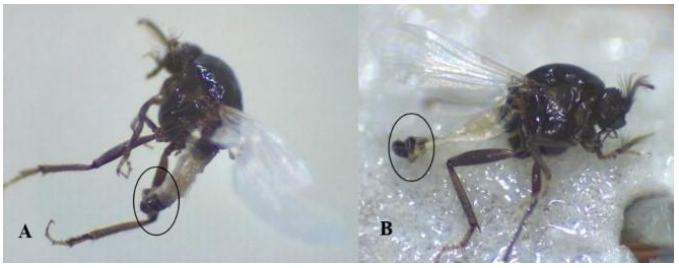

Figure 12: Male *L. spinosifrons* with male genital part black colour at terminal abdomen

4. Discussion

In Malaysia, information on the species composition and abundance of *Leptoconops* is very limited this biting midge is relatively unknown in Malaysia. In this study, Bagan Lalang beach was examined for the presence of biting midges and to describe the characteristics of the *L. spinosifrons*. Accurate species identification is a fundamental method in the study of *Leptoconops* species. The combination of morphological and molecular methods facilitates species identification and supports future research by individuals who are not taxonomic experts (Polidori et al., 2023). However, morphological identification remains widely used, as it is still practical and applicable method for identifying biting midge species.

There have been no published reports on the taxonomy of *L. spinosifrons* in Malaysia. This study is the first to identify and describe the

characteristics of *L. spinosifrons* in Malaysia. A morphological study on *Leptoconops* specimens collected in this study was conducted, focusing on key structures such as wing colour, spine on the head, antennae, proboscis, palpi and abdomen, providing detail than previous studies.

The size of *Leptoconops* and *Culidoides* are very small ranging from 1.5 mm to 5.0 mm and they are known as no-see-ums due to their minute size and ability to go unnoticed (Service, 1980). However, reported that *Leptoconops* can be distinguished from *Culicoides* by their wing characteristics. *Culicoides* species have contrasting dark and white spots or patches on their wings, whereas *Leptoconops* have a milky white color (Service, 1980; Boorman, 1993). It described *Culicoides* species have light greyish colour with pale spots (Belkharchouche et al., 2020). Additionally, described *Leptoconops* as having glassy wings and milky white colour (Carter, 1921; Yu, 1997).

The abdomen of *Culicoides* is described as dull grey, yellowish brown, or blackish in colour as reported by (Service, 1980). This contrasts with the creamy white colour abdomen of *Leptoconops*, as described in previous studies (Carter 1921; Khadri et al., 2002). However, engorged or partially fed *L. spinosifrons* appear to be dark brown colour abdomen. It also described that female *L. spinosifrons* consists of creamy white lamellae with two spermathecae (Carter, 1921). These characteristics are similar with the specimens collected in the present study. Therefore, both wing and abdominal characteristics can be used to differentiate between these two genera of biting midges.

In addition, the spinulation on the front of the head has been used to differentiate *L. spinosifrons* from other species, as mentioned by (Carter, 1921; Khadri et al., 2002). The name of *L. spinosifrons* was given because this species has numerous spines or bristles covering the entire frons and the eyes are widely separated both above and below the interocular space as mentioned by (Carter, 1921). In this study, more than 25 spines or bristles were observed on the head of the specimens, supporting their identification as *L. spinosifrons.* Additionally, *L. spinosifrons* collected in this study exhibited dark brown antennae and palpi. All of these characteristics are similar with the description provided by (Carter, 1921). As in mosquitoes, males *Leptoconops* also do not take blood-meals and have feathery or plumose antennae, whereas the blood-sucking females have non-plumose antennae (Service, 1980).

The structural features of the abdominal spiracles in *Leptoconops* observed in this study are consistent with adaptations for life in sandy, coastal and dusty habitats which are known breeding grounds for this genus. The circular shape and the presence of dense hairs or scales surrounding the opening likely provide mechanical protection against particle intrusion and minimize water loss, a critical function for small Dipterans inhabiting dry or exposed microhabitats (Chapman, 2013).

5. Conclusion

The morphological measurements made in this study was based on the previous taxonomic study. Since *L. spinosifrons* impacts outdoor activities and tourism, this study provides new information on the characteristics of *L. spinosifrons* present in Bagan Lalang beach, Selangor. For the first time, this study reveals differences in certain characteristic between *L. spinosifrons* and *Culicoides*.

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Conflicts of Interest

The authors declare no conflict of interest

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