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RESEARCH ARTICLE

Sexual mosaicism in the black fly *Simulium* (*Gomphostilbia*) *hongthaii* (Diptera: Simuliidae) in Vietnam

Nguyen, D.V.[1], Takaoka, H.[2*]

[1]Department of Entomology, National Institute of Malariology, Parasitology and Entomology, Hanoi, 12000, Vietnam
[2]Higher Institution Centre of Excellence (HICoE), Tropical Infectious Diseases Research and Education Centre (TIDREC), Universiti Malaya, 50603, Kuala Lumpur, Malaysia
*Corresponding author: takaoka@oita-u.ac.jp

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ABSTRACT

Sexual mosaicism was found in an adult black fly reared from a pupa in Vietnam. It is considered an antero-posterior type of gynandromorph, showing female phenotype for the head, thorax and wing; male phenotype for the abdomen including the genitalia; and mixed phenotype for the legs. The fly is identified as *Simulium* (*Gomphostilbia*) *hongthaii* in the *S. asakoae* species-group by having the sensory vesicle medium-long (0.28–0.30 times as long as the third palpal segment), mandible without teeth on its outer margin, and ventral plate transverse, with its lateral margins emarginated basally when viewed ventrally, and trapezoidal, with its ventral margin nearly straight when viewed posteriorly. This specimen represents the first record of a black fly with sexual mosaicism in Vietnam.

Keywords: phenotype; mosaic; biting insects.

INTRODUCTION

The black fly fauna in Vietnam is represented by 74 species of the genus *Simulium* s. l., of which 25 are classified in the subgenus *Gomphostilbia*, one is in the subgenus *Montisimulium*, eight are in the subgenus *Nevermannia*, and 40 are in the subgenus *Simulium* s. str. (Adler, 2024). Biting habits of these species are not known in Vietnam, although *S.* (*G.*) *asakoae* Takaoka & Davies, *S.* (*S.*) *nigrogilvum* Summers, and *S.* (*S.*) *nodosum* Puri bite humans and are natural vectors of unnamed filarial species in Thailand (Fukuda *et al*., 2003; Takaoka *et al*., 2003; Ishii *et al*., 2008).

We found sexual mosaicism in an adult black fly reared from a pupa in Vietnam. A brief description of the sexually mosaic phenotype and species identification of this specimen are presented.

MATERIAL AND METHODS

An adult black fly was reared from a pupa collected from a stream (width 0.5–0.8 m, depth 5–10 cm, bottom sandy, elevation 1,431 m; 22°48’65.709”N/102°48’88.993”E), 29-XI-2023 at Pa Ve Su, Muong Te District, Lai Chau Province, Vietnam, by Nguyen, D.V. and kept in a vial with 70% ethanol. The head and abdomen were treated overnight with potassium hydroxide (KOH) solution. Morphological characteristics were observed and photographed under dissecting and biological microscopes. Terminology of morphological features follows those of Takaoka (2003).

The specimen is deposited in the Department of Entomology, National Institute of Malariology, Parasitology and Entomology, Hanoi, Vietnam.

RESULTS

Description of a sexually mosaic adult black fly

The body (Figure 1A) is about 2.9 mm long. The head is of a female phenotype, evidenced by the dichoptic head (eyes with small facets widely separated in the middle by the frons) (Figure 1B), and toothed maxillary lacinia (Figure 1C) and mandible (Figure 1D). The abnormalities are in the frons, of which the left margin is much longer than the right margin (Figure 1B), and the fronto-ocular area on the left side, which is malformed (Figure 1B). The thorax and wings are of a female phenotype, having three dark longitudinal vittae on the scutum and a haired subcosta. The legs are of a male phenotype, characterized by darker tibiae and enlarged hind basitarsi (Figure 1F) except for the claws (Figure 1G) of the right foreleg, left midleg and both hindlegs, which are of a female phenotype. The abdomen, including the genitalia (Figure 1I), is of a male phenotype. None of the features shows the intermediate structure of normal males and females.

Identification of a sexually mosaic adult black fly

According to the keys for black fly species in Vietnam (Takaoka *et al*., 2017), the sexual mosaic is identified as *S.* (*G.*) *hongthaii* Takaoka, Sofian-Azirun & Ya’cob, originally described from Vietnam (Takaoka *et al*., 2014, 2017). The assignment to the subgenus *Gomphostilbia* is based on the haired katepisternum, and inclusion in the *S. asakoae* species-group is based on the enlarged male hind basitarsus (Figure 1G) and ventral plate with its lateral margins emarginated basally when viewed ventrally (Figure 1I). The species identification is verified by the female

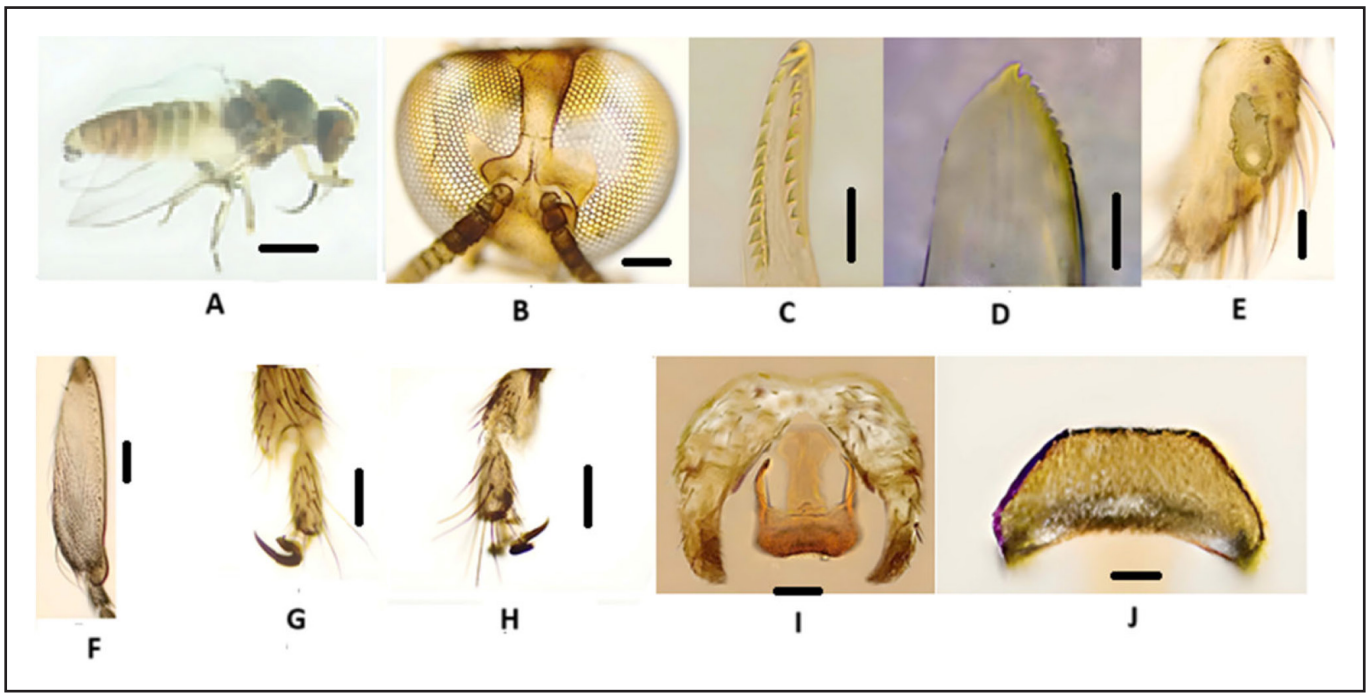

Figure 1. Morphological characteristics of an adult black fly with a sexual mosaic phenotype. A, Whole body. B, Head showing dichoptic eyes, frons and fronto-ocular areas (front view; female phenotype). C, Maxillary lacinia (female phenotype). D, Mandible (female phenotype). E, Third palpal segment with sensory vesicle (female phenotype). F, Hind basitarsus (lateral view; male phenotype). G, Claw of right foreleg (female phenotype). H, Claw of right midleg (male phenotype). I, Male genitalia (ventral view). J, Ventral plate (end view). Scale bars. 0.5 mm for A; 0.1 mm for B and F; 0.05 mm for G, H and I; 0.02 mm for C, D, E and J.

mandible without teeth on the outer margin (Figure 1D), female sensory vesicle medium-long (0.28–0.30 times as long as the third palpal segment) (Figure 1E), and male ventral plate trapezoidal, with its ventral margin nearly straight (Figure 1J) when viewed posteriorly.

DISCUSSION

Sexual mosaicism, either as gynandromorphs or intersexes, rarely occurs in the family Simuliidae (Crosskey, 1990). In Asia, adult black flies with sexual mosaicism have been reported in several species, including *S*. (*S*.) *arakawae* Matsumura, *S*. (*S*.) *bidentatum* (Shiraki), *S*. (*S*.) *iwatense* (Shiraki), *S*. (*S*.) *oitanum* (Shiraki), and *S*. (*Wilhelmia*) *takahasii* (Rubtsov) from Japan (Saito & Kanayama, 1986; Hadi & Takaoka, 1993; Hadi *et al*., 1994); *S*. (*S*.) *palmatum* Puri from India (Puri, 1933); *S*. (*G*.) *asakoae* from Thailand (Fukuda *et al*., 2004); and *S*. (*G*.) *trangense* Jitklang *et al*. from Peninsular Malaysia (Ya'cob *et al*., 2021). Sexual mosaicism in the form of gynandromorphs is usually expressed bilaterally or antero-posteriorly (Crosskey, 1990).

We add *S*. (*G*.) *hongthaii* as an example of sexual mosaicism, and consider it an antero-posterior type of gynandromorph having a female phenotype for the head, thorax and wings; male phenotype for the abdomen including the genitalia; and mixed phenotype for the legs.

Mermithid parasites are a common cause of intersexuality in insects (Wülker, 1975). Ya'cob *et al*. (2021) reported the occurrence of sexual mosaics of *S*. (*G*.) *trangense* that were infected with mermithid nematodes. However, our adult black fly did not harbor any nematode parasite, although there is a possibility that it was infected in an earlier life stage with mermithid parasite(s), which might have escaped before the fly emerged.

Our discovery represents the first record of a black fly species with sexual mosaicism in Vietnam.

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Declaration of Competing Interest

We declare that this is our original work. It has not been published elsewhere and we have no conflicts of interest concerning the work reported in this paper. All authors have contributed to this study throughout the study design, field work, data collection, data analyses and data interpretation. The authors have read and approved the manuscript

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