Description of a new mosquito species, *Topomyia* (*Suaymyia*) *puehensis*, (Diptera: Culicidae) from Sarawak, Malaysia

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**Abstract:** Here, a new species of mosquito, *Topomyia* (*Suaymyia*) *puehensis* Miyagi, Toma and Okazawa is described from Pueh, Sarawak, Malaysia. The adult male, adult female, pupa, and larva are described in detail. Illustrations of the male genitalia, female abdomen, pupa, and larva are also provided. This species is easily distinguished from all known species of the subgenus *Suaymyia* by the characteristic male genitalia. The larvae, which were collected individually from the leaf axils of taro aroid plants, are predacious, possessing well-developed maxillae apparently adapted for grasping prey.

Key words: *Topomyia puehensis*, new species, Culicidae, phytotelma mosquitoes, Sarawak, Malaysia

**INTRODUCTION**

Thurman (1959) proposed the division of the genus *Topomyia* Leicester, 1908 in Thailand into two subgenera: *Topomyia* and *Suaymyia* Thurman, 1959. In the subgenus *Topomyia*, Thurman placed 20 known species possessing claspettes with setaceous ventral lobes and rod-like dorsal lobes, elongated apical spines, and lobes of tergite IX that are in close proximity. In contrast, eight species of the subgenus *Suaymyia* possess claspettes with setaceous ventral lobes but without long rod-like dorsal lobes, and lobes of tergite IX that are widely separated. However, one species, *Topomyia argenteoventralis* Leicester, 1908, from Malaysia, was placed in *Suaymyia* because tergite IX in this species was typical of the subgenus despite it having a rod-like dorsal lobe on the claspette (Thurman, 1959; Miyagi et al., 2006). Currently, 34 species are recognized from Malaysia, including Sarawak and Sabah, of which 11 are in the subgenus *Suaymyia*, including *Topomyia roslihashimi* Miyagi and Toma, 2005, *Topomyia nepenthicola* Miyagi and Toma, 2007, *Topomyia lehcharlesi* Miyagi and Toma, 2008, and *Topomyia kelabitense* Miyagi and Toma, 2010b, having somewhat atypical genital structures similar to that of *To. argenteoventralis*. The genus *Topomyia* has not been comprehensively studied; therefore, many new species are still being described from Sarawak (Miyagi et al., 2021a, b). Recently, a new subgenus, *Miyagiella* Harbach, 2014, was proposed for a remarkable male mosquito, *Topomyia discors* Harbach, 2014 from Sabah, Malaysia (Harbach and Culverwell, 2014). The genus *Kimia* Harbach, 2007 was also established based on *Topomyia* (*Suaymyia*) *decorabilis* Leicester, 1908, with *Topomyia* (*Suaymyia*) *imitata* Baisas, 1946 from Mindanao, Philippines, *Topomyia* (*Suaymyia*) *suchariti* Miyagi and Toma, 1989 from Thailand, and *Topomyia* (*Suaymyia*) *miyagii* Toma and Mogi, 2003, from Flores, Indonesia (Harbach et al., 2007; Miyagi et al., 2007; Walter Reed Biosystematics Unit, 2020). As mentioned by Harbach and Culverwell (2014), the genus *Topomyia* is a diverse assemblage of taxa, the discovery and classification of which is far from complete.

In 2008, in association with a collaborative research project entitled “Study on taxonomy and bionomics of two winged flies, Diptera in Sarawak” from the Sarawak Museum in Kuching, three mosquito larvae were collected from three leaf axils of taro aroid plants along a stream at Kampung Pueh in Sarawak, Malaysia. After careful examination of these specimens and comparison with descriptions of other species from the genus *Topomyia* from Malaysia, Thailand, and China (Edwards, 1922; Thurman, 1959; Ramalingam, 1983; Miyagi and Toma, 1989, 2005, 2007, 2008, 2010a, b; Miyagi et al., 1989, 1990, 2006, 2012a, b, 2014, 2017;
Dong et al., 1990; Rattanarithikul et al., 2007), we concluded that the specimens were of a previously undescribed species of the subgenus Suaymyia with characteristic male genitalia. In the present report, we describe To. (Su.) puehensis Miyagi, Toma and Okazawa as a new species and include illustrations of the male genitalia, female abdomen, pupa, and larva.

**Materials and methods**

**Collection locations.** Mount Pueh (1°48’0”N, 109°40’59”E) is located near Sematan, approximately 67 km north-west of Kuching, Sarawak. Specimens were collected at the foot of the mountain.

**Specimen preservation and preparation.** Three fourth-instar larvae of Topomyia were collected from several leaf axils of taro aroid plants. They were reared individually in small containers with water from the breeding leaf axils. The specimens were isolated and then labeled with individual numbers (ID; indicated herein by bold font). As soon as possible after pupation and emergence, larval and pupal exuviae were preserved in 80% ethyl alcohol. Soon after emergence, the adult was transferred to a clean vial and provided with a moist cotton pad. After 24 h, adults were mounted on a micro-pin. Slide mounts were also made for male genitalia and given a genitalia number (G; indicated herein by bold font). Larval and pupal exuviae, and male genitalia preserved in ethyl alcohol, were mounted in euparal as a permanent mounting medium (Belkin, 1962).

**Terminology.** The terminology and abbreviations used for adults, pupae, larvae, larval maxilla and male

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**Table 1. Numbers of setal branches for pupae of Topomyia (Suaymyia) puehensis sp. nov.**

| Seta no. | Cephalothorax | I | II | III | IV | V | VI | VII | VIII |
|----------|---------------|---|----|-----|----|---|----|-----|------|
| 0        |               | - | -  | 1   | 1  | 1 | 1  | 1   | 1    |
| 1        | 2, 3          | 4-6*| 1-3| 2, 3| 1-4| 1-4| 1-4| 1, 2 |      |
| 2        | 1-4           | 1  | 1  | 1, 2| 1  | 1  | 1  |      |      |
| 3        | 3-6           | 1  | 1  | 1-4| 1-4| 1, 2| 1, 2|      |      |
| 4        | 2, 3          | 1  | 2-4| 1, 2| 1-3| 1-3| 1-3| 1, 2 | 1, 2 |
| 5        | 1-4           | 2-5| 1  | 1  | 1  | 1  | 1  | 1, 2 |      |
| 6        | 1-3           | 1, 2| 1  | 1, 2| 1-3| 1, 2| 1  |      |      |
| 7        | 1, 2          | 1-3| 2-4| 1-3| 2-4| 1-3| 1, 2|      |      |
| 8        | 1-3           | -  | -  | 1, 2| 1, 2| 1-4| 2-5| 3-5  |      |
| 9        | 1, 2          | 1  | 1  | 1  | 1  | 1  | 1  | 11-21*| 13-24**|
| 10       | 1-3           | -  | 1-3| 2  | 2, 3| 2, 3| 1-3| 1-3  |      |
| 11       | 1             | -  | 1, 2| 1, 2| 1-3| 1, 2| 1, 2| 1-3  |      |
| 12       | 2-4           | -  | -  | -  | -  | -  | -  |      |      |
| 13       | -             | -  | -  | -  | -  | 1  | 1  | 1    |      |

Specimens examined: 3 pupal exuviae from Pueh, Sematan, Sarawak. Numerals show variation of setal branches. *Dendritic with 4-6 main branches. **Aciculated. Obsolete and missing setae are shown with a hyphen (-).

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**Table 2. Numbers of setal branches for fourth-instar larva of Topomyia (Suaymyia) puehensis sp. nov.**

| Seta no. | Head | Thorax | Abdominal segments |
|----------|------|--------|--------------------|
|          |      | P      | M | T | I | II | III | IV | V | VI | VII | VIII |
| 0        | -    | 4, 6   |    |    |    |    | -   | -  | - |    | -   | -    |
| 1        | 1, 1 | 2      | 1, 1| 6, 6| 2, 2| 2, 2| 20* | 12, 17*| 15, 19*| 2, 2| 7   |
| 2        | 1, 1 | 2      | 1, 2| 2, 4| 2, 2| 2, 2| 2, 2| 2, 2| 4, 4| 4  | 2   | 1    |
| 3        | 1, 1 | 2      | 1, 1| 2, 3| 2, 4| 2, 2| 2, 2| 2, 2| 2, 4| 2, 2| 4, 4| 1    |
| 4        | 1, 1 | 3      | 1, 2| 2, 4| 2, 3| 2, 3| 2, 3| 2, 3| 4, 4| 4  | 1    |      |
| 5        | 1, 1 | 4      | 1, 2| 2, 4| 5, 8| 5, 8| 2, 4| 2, 2| 2, 4| 2, 4| 4, 4| 1    |
| 6        | 1, 1 | 5      | 1, 2| 2, 4| 5* | 5, 5*| 2, 4| 2, 4| 4, 4| 4  | 1    |      |
| 7        | 1, 1 | 6      | 1, 2| 13, 13*| 5, 6| 5, 5*| 1, 1| 1, 1| 1, 1| 5  | 2, 3| 1-X=3, 3*|
| 8        | 1, 1 | 7      | 1, 2| 7, 8*| -  | 1, 2| 1, 1| 1, 2| 1, 1| 2, 3|    |      |
| 9        | 2, 3 | 8      | 1, 2| 11, 9*| 7, 8| 5, 5*| 3, 3| 3, 3| 1, 4| 2, 2| 2-X=5, 5 |      |
| 10       | 1, 1 | 9      | 1, 2| 11, 1*| 2, 4| 5, 5*| 3, 3| 3, 3| 1, 2| 2, 3| 1, 1|      |
| 11       | 1, 1 | 10     | 1, 2| 11, 11*| 2, 5| 5, 5*| 3, 3| 3, 3| 1, 2| 2, 3| 1, 1|      |
| 12       | 1, 1 | 11     | 1, 2| 11, 11*| 2, 5| 5, 5*| 3, 3| 3, 3| 1, 2| 2, 3| 1, 1|      |
| 13       | 1, 1 | 12     | 1, 2| 11, 11*| 2, 5| 5, 5*| 3, 3| 3, 3| 1, 2| 2, 3| 1, 1|      |
| 14       | 1, 1 | 13     | 1, 2| 11, 11*| 2, 5| 5, 5*| 3, 3| 3, 3| 1, 2| 2, 3| 1, 1|      |
| 15       | 1    | 14     | -  | -  | -  | -  | -  | -  | -  | -  | -  |      |

Specimens examined: Holotype of fourth-instar larval exuviae from Pueh, Sematan, Sarawak, Malaysia. When one numeral is given, this shows that setal branch of one side was confirmed. Two numerals mean that setal branches of both sides were confirmed. *Aciculated. **Stellated. Obsolete or missing setae are shown with a hyphen (-).
genitalia mostly followed Harbach and Knight (1980, 1981) and Harbach and Peyton (1993), except for the dorsomesal lobe (DML) of the male genitalia (Miyagi et al., 2006; Miyagi and Toma, 2007, 2008, 2010a, b). The siphon index was considered the ratio of length to width at the midpoint of the siphon (Belkin, 1962). The trumpet and paddle indices were considered the ratio of length to width at the midpoint of the trumpet and at the widest point of the paddle, respectively. Numerals in Table 1 show the variation of setal branches of pupae. In Table 2, when one numeral is given, this shows that the setal branch of one side of a fourth-instar larva was confirmed; where two numerals are given, this shows that the setal branches...
of both sides were confirmed. The description of the larva is based only on the exuviae of the larval specimen (holotype), which was compressed on a glass microscope slide mount.

**Type specimens. Holotype.** 1♂ (20080903-8), individual number (385) mounted on pin, with L (fourth-instar larva) and P (pupa) exuviae and genitalia (G-98) mounted on two glass microscope slides, Pueh, Sarawak, Malaysia, September 3, 2008, by I. Miyagi. **Paratype.** 1♂ (20080903-3), individual number (441) mounted on pin, with P exuviae and genitalia (G-97) on two slides; 1♀ (20080903-1), individual number (481) mounted on pin with L and P on slide.

**Type deposition.** The holotype, individual number (385) and paratype (481) specimens have been deposited in the National Museum of Natural Science, Tsukuba, Japan and paratype (441) specimen has been deposited in the University Museum (Fujukan), University of the Ryukyus.

**Topomyia (Suaymyia) puehensis Miyagi, Toma and Okazawa sp. nov.**

The following descriptions were based on the holotype and paratype.

**Male.** Wing, 2.8 mm. Proboscis, 1.75 mm. Forefemur, 1.88 mm. **Head.** Occiput and side of head with broad, flat, velvety black, spatulate scales; dorsocentral part of anterior vertex with diamond-shaped silvery scale patch, posterior vertex with spatulate dark scales and without erect forked scales; postgena with indistinct silvery scale patch and a row of several strong postgenal setae. Interocular and ocular setae present. Clypeus quadrilateral in shape, integument brown without scales. Maxillary palpus brown, ca. 0.12 times as long as proboscis. Proboscis slender, elongate, and slightly swollen at tip, covered with dark brown scales dorsally, with a patch of yellow-white scales at base; narrow line of white scales extending forward to tip of proboscis on ventral aspect. The line apparently clear at basal half. Pedicel of antenna dark brown without scales, covered with gray dust; antenna as long as proboscis.

**Thorax.** Integument of scutum black, covered closely with dark piliform scales, except prescutellar area; median silver line composed of two overlapping rows of flat, round, silvery scales; line starting at anterior promontory and extending caudally to prescutellar, becoming slightly broader in posterior third; scutal-fossil, dorsocentral, prescutellar and supraalar setae well-developed. All three scutellar lobes dark brown with several black broad spatulate scales; four (two pairs) of black well-developed scutellar setae on mid lobe, and two or three black well-developed setae on each lateral lobe. Lateral aspect of thorax (pleuron), antepronotum, postpronotum, postspiracular area, mesokatepisternum and mesanepimeron covered with silver scales forming large patch. Paratergite bare. **Legs.**

All coxae with several setae and a patch of silver scales; trochanters covered with silver scales. Dorsal part of all legs covered with small dark brown scales, ventral part with a white scale line extending from base of femora to tips of tibiae; tarsomere II in foreleg longer than tarsomere III; apical tarsomeres straight; ungues of all legs small, simple and equal. **Wings.** Brown-scaled. Cell R<sub>1</sub>, ca. 2.4 times as long as length of its stem (R<sub>2+3</sub>). Alula with a row of fine hair-like scales; upper calypter bare. **Halter.** Capitellum and pedicel covered with dark brown scales, scabellum light brown without scales. **Abdomen.** Terga I–IX dark-scaled with indications of pale scales on lateral margins; conspicuous setae on only tergum I, dorsally and laterally; integuments of sterna II–VII apparently pale with sparse pale scales; sternum VIII entirely dark-scaled. **Genitalia** (Fig. 1A–E). Lobes of tergum IX (Fig. 1A, D) widely separated by narrow bridge, each lobe attenuated apically, with single stout blade-like seta; seta longer than the attenuated stem of the lobe, one seta closely spaced on inner basal margin of each lobe. Gonocoxite (Gc) long, slightly narrowed apically with conspicuous setae and scales, ca. 3.4 times breadth at middle; claspette (Fig. 1C) without rod-like stem; basal lobe of claspette (BLCI) [=DML of Miyagi et al. (2006) and Miyagi and Toma (2007, 2008, 2010a, b)]; ventral lobe of claspette (VL-CL) of Thurman (1959)], quadrangular-like with one strong curved seta (CL) on apical corner and a tuft of numerous strong setae on another corner. **Genostylus (Gs) long, expanded in basal half, with a row of about 10 fine setae dorsally positioned and narrowed with about five fine setae on dorsal margin; apical part with two lobes, basal (Bs-Gs) and apical (Ap-Gs): basal lobe with curved claw and about 15 fine setae, apical lobe with large, sharp, hook-like claw and about 10 fine setae (Fig. 1B). Phallosome (PH) and paramere (Par) shown in Fig. 1E.**

**Female.** Wing ca. 3.20 mm. Proboscis ca. 2.0 mm. Forefemur ca. 2.13 mm. Cell R<sub>2</sub> ca. 3.1 times the size of stem R<sub>2+3</sub>. Resembles male except for the following. Mid lobe of scutellum with a few white scales. Whitish scale line on ventral part of proboscis absent. Abdominal segment I with lateral patch of scales; segment II with an entire lateral patch of scales; segment III with a small lateral patch; segments IV–VI with a lateroapical patch extended dorsally; segment VII without lateral patch (Fig. 1F).

**Pupa** (Fig. 2A, B). Abdomen (I–VIII), ca. 3.32 mm. Trumpet length, ca. 0.35 mm. Paddle length, ca. 0.88 mm. Setal branches of cephalothorax and abdominal segments shown in Fig. 2 and Table 1. **Cephalothorax** (CT). Lightly pigmented in median dorsal keel (MK). Trumpet (T) brownish yellow with distinct sculpturing; index, ca. 2.80. Metathoracic wing (MtW) lightly pigmented. **Abdomen.** Lightly pigmented, segments I–VIII (magnification: 10×40) with indistinct microtrichia. Paddle tapering with
fine marginal setae, paddle index, ca. 2.18. Genital lobe (GL) lightly pigmented, narrower than width of paddle, extending to ca. 0.64 of the paddle length in the male, and short, extending to ca. 0.37 in female.

**Fourth-instar larva** (Fig. 3). Head length, 1.02 mm; width, 1.25 mm. Siphon length, 0.92 mm; width, 0.26 mm; index 3.48. Setal branches of head, thorax, and abdominal segments shown in Fig. 3 and Table 2. **Head** (Fig. 3B). Integument smooth, pale yellow in color. Lateral palatal brush (mouth brush) usually in head capsule. Mandible black with large apical tooth and three ventral teeth. Maxilla (Fig. 3D) large; maxillary bundle (MxBn) well-developed, shorter than length of maxillary body (MxBo); several short
lanceolate setae (LR: laciniarastrum) and a row of several spicules present; maxillary horn absent, apical teeth (AT) obsolete, small; seta 4 single, extending over tip of MxBo; seta 6 single, well-developed. Dorsomentum (Dm) (Fig. 3C) with a prominent middle tooth with nine regular teeth on either side.

Head seta 1-C small, single; 3-C minute; 4–8-C usually single; 9, 10-C single or double; 11-C single. **Antenna** (Fig. 3E). Integument smooth without spicules; length 0.28 mm, ca. 0.29 the length of the head. Seta 1-A single, placed at 0.76 from base of antenna. **Thorax** (Fig. 3A). Prothorax (P): seta 5-P long, 14- or
15-branched, aciculate; 6-P long, 4- or 5-branched, aciculate; 7-P long, 7-branched, aciculate; 9-P long, 4-branched, aciculate; 10-P long, single, aciculate; 12-P single. Mesothorax (M): setae 5-, 6-, 9-, and 10-M 4-branched, aciculate; 10-P long, single, aciculate; 13-T 17-branched, aciculate. Abdomen (Fig. 3A, F, I). Setae 1-III–V1 numerous; more developed than setae 1-1, -II, 6-, 12-P long, 5-branched, aciculate; 6-IV long, 3- or 4-branched; 6-V long, 4-branched. Seta 7-I long, 5- or 6-branched, aciculate; 7-II long, 5-branched; 7-VI long, 5-branched. Seta 13-V long, 3- or 4-branched. Setae 3-, 6-, and 10-VI numerously branched; more than 6-branched, aciculate; 6-IV, -V more than 6-branched, aciculate; siphon with 6 unpaired 1a-S. .......... lehcharlesi

Siphon (Fig. 3I). Pale yellow pigmentation, smooth integument, slender, widest at base, narrow to apex; pecten (Pt) small, scattered from base to apex (Fig. 3H). Seta 1-S long, double; subventral tufts (1a-S) 6 unpaired, basal 4 strong, simple, and finely aciculate (magnification:10×40), and apical 2 very small, double; subdorsal tufts (2a-S) usually 2 pairs, each single. Segment X (Fig. 3I). Seta 1-X very long, triple, aciculate; 2-X 5-branched; 3-X long, single; 4-X 9- or 12-branched.

Etymology. The species name, puehensis, refers to the district name Pueh in Sematan, Sarawak where the new species was collected.

Taxonomic discussion. The present new species, To. puehensis, is closely related to the Malaysian species To. argentoeventralis, To. lehcharlesi and To. nepenthicola in terms of the male genitalia and fourth-instar larva. The male genitalia have the characteristic lobes of tergum IX, which are widely separated by narrow bridges; each lobe is attenuated apically, terminating in single, stout and large blade-like, and possesses only one well-developed seta inner basal margin. Claspette is variable, with or without a rod-like long stem and with a characteristic appendage apically. The larvae have a large maxilla and stellate seta with aciculate branches in abdominal segments III–VII, as well as several strong, unpaired, spine-like setae in the siphon. Topomyia puehensis and its related species can be easily separated using the following key.

Male genitalia
1. Claspette (Cl) without rod-like stem having a long simple seta. .............................. 2
   — Cl with long stem having a characteristic caribou antler-like or flower-like apical appendage ............ 3
2. Gonostylus (Gs) of apical part (Ap-Gs) with a large apical simple gonostylar claw .......... nepenthicola
   — Gs with a large apical hooked claw .......... puehensis sp. nov.
3. Claspette (Cl) with a caribou antler-like apical appendage. .......................... lehcharlesi
   — Cl with a flower-like apical appendage. ............ argentoeventralis

Fourth-instar larva
1. Siphon with 12–14 unpaired, strong, aciculate, spin-like setae (1a-S); maxillary bundle (MxBn) strongly developed, longer than maxillary body (MxB) .................. nepenthicola
   — Siphon with 4–6 unpaired, strong, simple, spine-like 1a-S; MxBn shorter than MxB ................ 2
2. Abdominal setae 6-IV, 7-V more than 6-branched, aciculate; siphon with 6 unpaired 1a-S. ................ lehcharlesi
   — Setae 6-IV, 7-V less than 5-branched, aciculate; siphon with strong 4 or 5 unpaired 1a-S .......... 3
3. Setae 6-IV, 7-V single; siphon with 5 strong 1a-S; seta 1-X double, 2-X 8–10-branched .......... argentoeventralis
   — Setae 6-IV, 7-V 4-branched; siphon with 4 strong 1a-S; 1-X usually triple, 2-X usually 5-branched. ................ puehensis sp. nov.

Although To. puehensis seems to show similarities in terms of tergum IX of the male genitalia relative to that in the Yunnan and Thailand species Topomyia (Sua.) mengi Dong, Wang and Lu, 1990, as well as similarities in terms of the gonostylus with Topomyia (Sua.) leucotarsis Thurman, 1959 and Topomyia (Sua.) psuedoleucotarsis Thurman, 1959, it is not currently possible to make comparisons for the characteristics of Topomyia puehensis larvae because the larvae of other species are not yet known (Thurman, 1959; Dong et al., 1990; Rattanarithikul et al., 2007).

Bionomics. Topomyia puehensis is a plain mosquito species. The larvae were collected individually from three leaf axils of common taro aroid plants (Colocasia/Alocasia sp.) in the forest of Pueh village. Many larvae of Topomyia (Top.) gracilis Leicester, 1908 and Malaya genurostris Leicester, 1908 were collected from other leaf axils of taro aroid plants in the vicinity of the site; however, To. puehensis larvae were not found among these specimens. Other collections were made in 2011 and 2019 in the vicinity of the site to obtain additional specimens of this species; however, none were found due to environmental changes caused by the expansion of oil palm plantations in this area. The closely related larvae of To. argentoeventralis, To. lehcharlesi and To. nepenthicola have been collected exclusively from the leaf axils of various types of taro aroid plants, although To. nepenthicola has been collected only from the pitcher plant Nepenthes stenophylla Masters, 1890 (Clarke and Lee, 2004). These larvae are possibly predacious with more or less developed maxillary bundles.

Distribution. Malaysia (Sarawak).
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