

Description of a new species of *Topomyia* (*Topomyia*) *aliyusopi* (Diptera: Culicidae) from Kelabit highlands, Sarawak, Malaysia

Ichiro Miyagi^{1,2*}, Takako Toma^{1,2}, Takao Okazawa³, Siew Fui Wong⁴,
Moi Ung Leh⁴ and Hoi Sen Yong⁵

¹The University Museum (Fujukan), University of the Ryukyus, Senbaru 1,
Nishihara, Okinawa, 903-0213, Japan

²Laboratory of Mosquito Systematics of Southeast Asia and Pacific,
c/o Ocean Health Corporation, 4-21-11, Iso, Urasoe, Okinawa, 901-2132 Japan

³Faculty of Medicine, Kanazawa University, Kakuma, Kanazawa, Ishikawa,
920-1192 Japan

⁴Sarawak Museum Department, 93566, Kuching, Sarawak, Malaysia

⁵Institute of Biological Sciences, University of Malaya, 50603 Kuala Lumpur, Malaysia
(*E-mail: topmiyagii@ybb.ne.jp)

Received 15-04-2014; accepted 28-04-2014

Abstract A new species, *Topomyia* (*Topomyia*) *aliyusopi* is described from Sarawak, Malaysia. The adult male, female, pupa and larva are described in detail and illustrations of the male genitalia, pupa and larva are provided. This species occurs in secondary rain forests in the Kelabit highlands, Bario and Ba'Kelalan at elevation from 1,000 to 1,700 m. It breeds mainly in the leaf axils of a wild banana (*Musaceae*), sometimes in those of taro (*Alocasia* sp.) and Screw pine (*Pandanus* sp.). The new species described in the present paper is attributed to Miyagi and Toma.

Keywords genus *Topomyia* – new species – phytotelmata – Kelabit highlands – Sarawak

INTRODUCTION

Topomyia is the Oriental genus, with most of the species occurring in Southeast Asia [1]. After the pioneer works by Leicester [2] and Edwards [3], extensive surveys for *Topomyia* mosquitoes throughout Peninsular Malaysia, Sarawak and Sabah were carried out by Ramalingam [4–6], Ramalingam *et al.* [7] and Miyagi *et al.* [8–21], and to our knowledge, 27 species of the genus have been described in these regions. The species of this genus generally show a high degree of endemism. Adult females of the genus are non-blood feeding mosquitoes and their immature stages are found exclusively in phytotelmata, cryptic mosquito habitats [22]. Therefore, taxonomic work of the genus still remains to be done.

Since 2005, in connection with the project “Study on taxonomy and bionomics of two winged flies, Diptera in Sarawak”, with the coordination and cooperation of the Sarawak Museum in Kuching, extensive mosquito larval collections have been made in the secondary forest. Many collections of the genus *Topomyia* were

made from the Kelabit highlands, Bario in 2006 and Ba'Kelalan in 2007, 2008 and 2013. They included a series of adult males and females, larvae and pupae and associated exuviae.

In the course of investigating the collection, we have found some specimens with interesting male genitalia. As the result of close examination, it was found to be an undescribed species belonging to the subgenus *Topomyia* Leicester [23]. In the present paper, we describe the new species.

The terminology follows mostly Harbach and Knight [24], and Harbach and Peyton [25]. Holotype and some paratypes are deposited in the Smithsonian Institution, Washington D.C., USA, and some paratypes are in the Sarawak Museum, Kuching, Sarawak, Malaysia.

DESCRIPTION AND DISCUSSION

Topomyia (Topomyia) aliyusopi Miyagi and Toma new species (Figs.1–3)

Description

Male (Fig.1) — Wing, 3.13 mm. Proboscis, 2.0 mm. Forefemur, 2.25 mm. Abdomen about 2.2 mm, long. Small dark brown with silver markings on head and thorax. Head. Vertex, occiput and side of head covered with broad, flat, dark brown decumbent scales with blue lustre. A large patch of flat silvery scales present on vertex, similar patch on side of head below eye. Erect scales absent. One interocular and 4 or 5 ocular setae present. Clypeus elongate; dark brown integument, bare of scales. Maxillary palpus entirely covered with brown scales; about 0.15 of proboscis. Proboscis elongate, narrow at base and slightly enlarged towards distal end; ventral side of the proboscis has a pale line of scales on basal 1/3. Pedicel of antenna dark with few narrow scales on inner side. Flagellum pillose, approximately 1.8 mm, long. Thorax. Scutum covered with small, narrow, curved, brown scales, with a median line composed of two rows of flat, round, silvery scales; silver line extending all the way to the scutellum and getting slightly broader in the posterior third. Dorsocentral, humeral, supra-alar and prescutellar setae present. Central lobe of the scutellum covered with a patch of silver scales, side lobes with only brown scales dorsally and a row of setae on anterior side. Postpronotum covered with brown scales on upper 2/3 and with silvery scales on lower half; single seta present on posterior border. Four prespiracular setae present. Postspiracular setae absent. Paratergite bare. A large patch of round silvery scales covering the post- and subspiracular areas, mesokatepimeron and the mesanepimeron. Several setae present in patches on prealar and upper mesepimeron. Leg. Coxae of all three legs with patches of silver scales. All legs covered dorsally with brown scales. A pale

line of scales present on the ventral side of the all legs; this line extending all the way down the femur to tarsi V. Foretarsomere Ta-L₂ slightly shorter than Ta-L₃, apical tarsomeres usually not elbowed. Ungues of all legs small, simple and

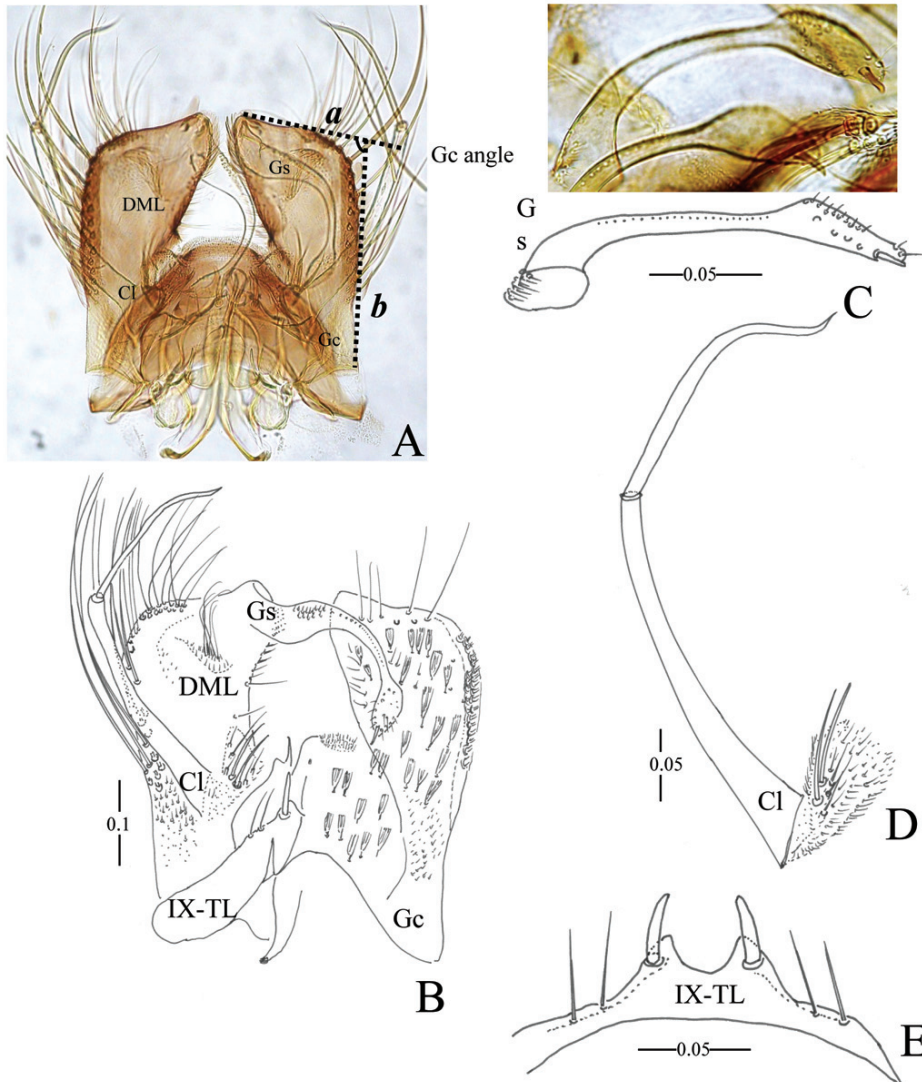


Figure 1. *Topomyia (Topomyia) aliyusopi*, n. sp. Male (A–E). A, genitalia in dorsal view (paratype: 20080823-2, G-13); B, genitalia (prerotaion sense), in dorsal (left) and ventral (right) views (holotype: 20130611-1, G-43); C, gonostylus (Gs) in lateral view (paratypes: 20060915-1, G-24; 20090902-4, G-66); D, Claspette (Cl) in dorsal view (holotype: G-43); E, Tergum IX (IX-TL). Gc, gonocoxite; DML, dorsomesal lobe; Gc angle, an angle of the point intersect lines *a* (horizontal line) with *b* (vertical line) of gonocoxite. Scales in mm.

equal in size. Wing. Brown scaled. Squame scales densely covering wing veins; plume scales narrow. Cell R_2 about 4.0 times the length of its stem. Anal vein ending beyond fork of Cu. Alula with several hair-like scales. Upper calypter bare. Haltere. Pedicel with light brown scales, capitellum scales darker. Abdomen. Terga I–VIII densely covered with dark brown scales, with the lateral aspect of each tergum having a strip of yellow-gold scales. Tergum I with several well developed setae dorsally. Sterna II–VIII entirely covered with flat, pale golden scales.

Male genitalia (Fig. 1A–D). As figured. Tergum IX broad, with the two lobes close to each other; each lobe bearing 2 minute lateral setae smaller than a flat, broad and pointed spinulate seta medially inserted. Sternite IX broadly conical and covered with scales and scattered setae; apical area with very fine setae. Gonocoxite narrow at base and broadest at distal end; length about 1.5 (1.4–2.0) its breadth at distal end (Fig. 1A, B); ventral aspect covered with many scales and fine setae uniformly; dorsal aspect with a row of about 20 long curved setae on outer lateral side and with a patch of several curved setae present on the distal end and some very fine setae present on the inner apical side of the gonocoxite (Fig. 1B). Dorsomesal lobe (DML) undeveloped with a row of 3–5 filamentous pale setae and with many fine setae laterally (Fig. 1A, B). Claspette (CL) is composed of a long slightly curved stem and with a narrow, elongate, curved spine with pointed filament; the stem is longer than the spine; ventral lobe bears a patch of setiforms, with 2–3 being more prominent than the others (Fig. 1A, B). Gonostylus (Gs) (Fig. 1C) slightly expanded from base to middle, with minute setae in cluster at base dorsally and with a row of several minute setae on middle dorsally. Apical part of gonostylus swollen remarkably like an oval, with a dark sharp gonostylar claw and several scattered minute setae. Paraproct elongate with pointed apex. Phallosome long and slender.

Female—Wing, 2.90–3.25 mm. Proboscis, 1.72–2.0 mm. Forefemur, 1.8–2.1 mm. Abdomen about 1.9 mm, long. Proboscis without pale ventral line. Leg. A pale ventral line present but not so clear as in the male. Foretarsomere $Ta-I_2$ slightly shorter than TaI_3 , apical tarsomeres usually not elbowed.

Pupa (Fig. 2, Table 1) — Abdomen (I–VIII), mean 2.75 mm. Trumpet, mean 0.32 mm. Paddle, mean 0.53 mm. Integument of cephalothorax and abdomen pale yellow, with yellow brown stripes on dorsal aspect of abdominal segments I–VII. Chaetotaxy as figured. Seta 1-CT long bifid curved on the inside. Seta 1-I fanlike with aciculate dendritic branches. Setae 3-I–III, 5-IV–VI, 4-VIII long and single. *Cephalothorax* (Fig. 2B): Trumpet (T), dark yellow, with distinct sculpturing; index, mean 3.25. *Abdomen* (Fig. 2A, C), microtrichia present on all

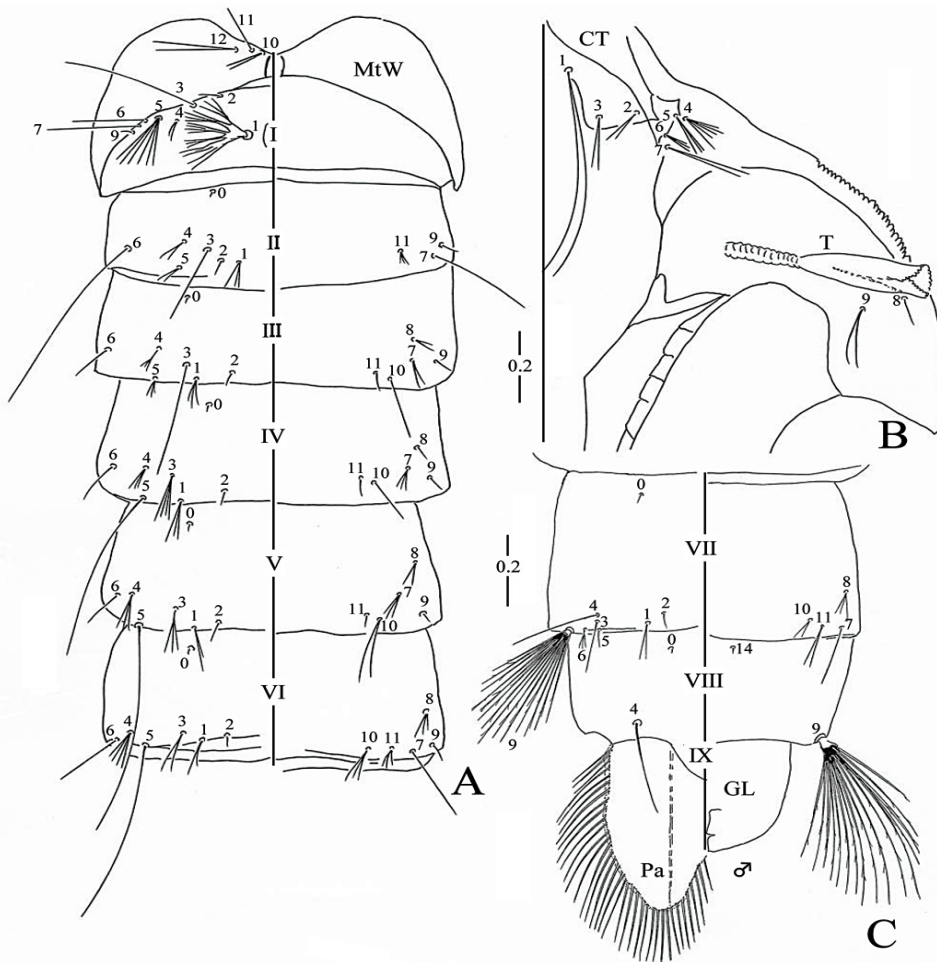


Figure 2. Pupal exuviae (A–C) of paratypes of *Topomyia (Topomyia) aliyusopi*, n. sp. A, metathoracic wing (MtW) and abdominal segments I–VI; B, cephalothorax (CT); C, abdominal segments VII–IX with male genital lobe (GL) and paddle (Pa); T, Trumpet. Scales in mm.

abdominal segments; setae 9-VII, VIII long many aciculated branched. Paddle with midrib from base to apex and with marginal long fringe of filamentous spicules. Male genital lobe large, extending to 0.64 of paddle, 0.38 in female lobe.

Fourth-instar larva (Fig. 3 A–E) — Head, length slightly shorter than width, 0.64–0.82 (mean, 0.76) of width. Siphon, 0.62–0.76 mm (0.67). Chaetotaxy of head, thorax and abdominal segments as Fig. 3. Setae lightly pigmented. Thorax seta 8-M conspicuous, 7–17 branched with forked-tip. Abdominal seta 8-II well developed, single. *Head*: Integument smooth, pale yellow in color. Maxillar

Table 1. Numbers of branches for pupae of *Topomyia (Topomyia) aliyusopi* n. sp.

Seta no	Cephalo-thorax	Abdominal segments							
		I	II	III	IV	V	VI	VII	VIII
0	-	-	1	1	1	1	1	1	1
1	2	M	2-5	3-7	2-7	1-6	1-5	1-3	-
2	2, 3	1, 2	1 (1, 2)	1	1	1	1	1	-
3	2, 3	1	1	1	3-5	1-3	1-3	1	-
4	1-5	1-3	2-4	1-4	2, 3	2-7	2-4	1, 2	1
5	2-6	3-7	2, 3	1-3	1	1	1	1	-
6	2-4	1	1	1 (1, 2)	1-3	1, 2	1	1-7	-
7	1-4	1	1 (1, 2)	2-5	1-5	3-5	1	1	-
8	1, 2	-	-	1-4	1-3	1-3	2-4	3-8	-
9	2	1, 2	1	1	1	1	1	22-35*	17-34*
10	1, 2	-	-	1-3	1-3	1, 2	1-4	1-3	-
11	1, 2	-	1-3	1, 2	1, 2	1-3	2-4	1, 2	-
12	1-4	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	1

M: dendritic with many branches. *Aciculated.

Obsolete and missing setae are shown with a hyphen (-).

Specimens examined: 5 pupal exuviae from Bakelalan, Mt, Murud, Sarawak, East Malaysia.

(Fig. 3, Mx); maxillary horn absent; apical tooth (AT) developed indistinctly. Dorsomentum (Dm) with a prominent middle tooth with 9 to 10 small regular teeth on either side. Seta 1-C single, prominent, about 0.17 mm, thick and slightly curved inwardly, with blunt end; setae 4-7 prominent, single; 14-C prominent, as long as or longer than 11-C, with 3-6 branches. *Antenna*: Long, 0.30-0.41 (0.34) mm; integument smooth, without spicules; seta 1-A single, placed at 0.73 from base. *Abdomen*: Abdominal setae 4-III-V long, usually single. Segment VIII: Comb scales 22-28 (24.3), in irregular row or patch; scale variable in size, pointed, without marginal fringe (Fig. 3, CS). Segment X (Fig. 3E): Saddle incomplete, several spicules present on caudolateral border; anal papilla tapering, longer than setae 4-X. Seta 1-X long, aciculated with 2 branches; 2-X single and simple; 3-X 9-15 branched, longer than seta 4-X which with 8-14 branched. Siphon (Fig. 3E): Pale yellow pigmentation, smooth integument. Seta 1-S paired with 5-8 branches; ventral setae (1a-S) 10-13 in numbers, each 2-7 branched on irregular line; ventral setae (2a-S) 11-17 in number (7 or 8 pairs, often 5, 6 pairs) each with 3-7 branches. Pecten teeth (Fig. 3, PT) variable in number, usually 10-25 extending from base to apical 0.23 but in some paratypes, 48-80 scattered from base to apex of the siphon; siphonal index variable, 4.47-6.63 (5.30).

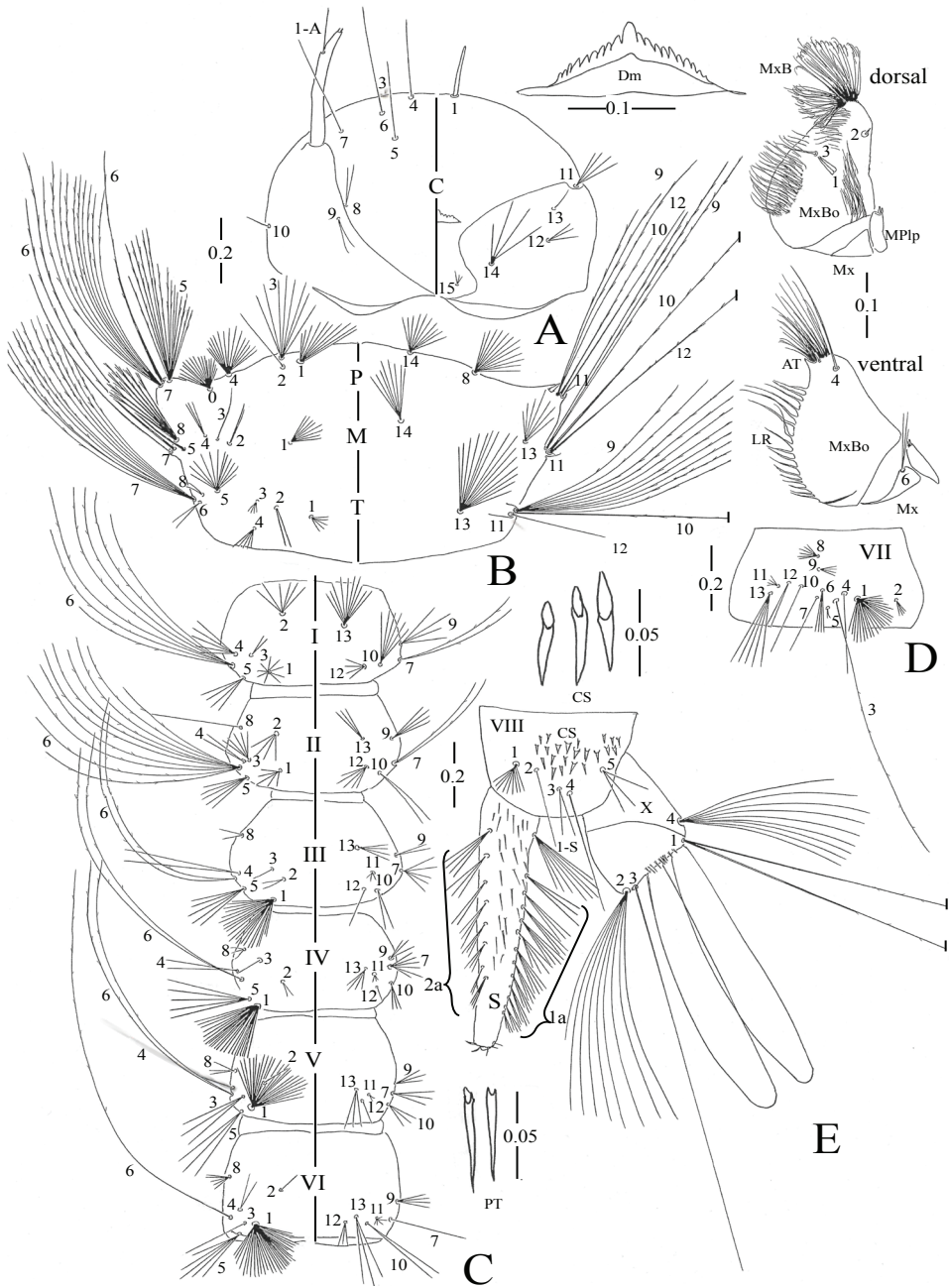


Figure 3. Paratypes of *Topomyia (Topomyia) aliyusopi*, n. sp. 4th-instar larva (A–E); A, head; B, thorax; C, abdominal segments I–VI; D, abdominal segment VII; E, abdominal segments VIII, X with siphon (S). 1-A, antennal seta 1; Dm, dorsomentum; Mx, maxilla; MPlp, maxillary palpus; MxB, maxillary brush; MxBo, maxillary body; AT, apical teeth; LR, laciniarstrum; CS, comb scale; PT, pecten; 1-S, 1a, ventral (posterior) setae of siphon; 2a, dorsal (anterior) setae of siphon. Scales in mm.

Table 2. Numbers of branches for fourth-instar larvae of *Topomyia (Topomyia) aliyusopi* n. sp.

Seta no	Thorax			Abdominal segments								
	P	M	T	I	II	III	IV	V	VI	VII	VIII	
0	-	-	-	-	-	-	-	-	-	-	-	-
1	10-18	7-13	3-8	3-9	2-8	21-25†	20-28†	23-36†	26-34†	23-34†	11-17	-
2	-	1,2	1,2	6-14	3-9	1-4	1,2	2,3	1-3	1-10	1	-
3	1	6-9	1	3-8	2,3	5-9	1	1,2	2-4	1,2	1*	2,3
4	1	13-32	1-4	5-11	5-11	1,2	1,2	1-3	1	2-4	1	1
5	1,2	15-18*	1*	11-27	4-7	5-8	3-6	5-7	2-5	3-7	2,3	3-5
6	1	1*	1-4	7-10*	9-11*	2*	2*	2*	1*	1*	4-7	-
7	1	10-15*	1	11-18*	2,3*	2,3*	5-9	4-9	3-6	1	1,2	1-X=2*
8	1-3	6-13	7-17**	1-5	-	1	2-4	2-4	3-5	6-13	6-10	-
9	3-7	2-4*	2-4*	9-17*	4-9	5-7	3-5	3-7	2-7	3-9	3-7	2-X=9-15
10	1,2	1*	1*	6-15	1,2	1-3	1-3	1-4	2-5	2	1,2	-
11	3-5	1,2	1,2	-	-	3-5	2-4	2-4	2-4	5-8	4-7	3-X=1
12	2-5	1*	1	2-6	5-10	1	1	1	1,2	3-6	2-4	-
13	1,2	-	7-11	15-25	8-18	4-6	3-6	2-5	3-5	2-4	5,6	4-X=8-14
14	3-6	6-12	8-16	-	-	-	-	-	-	-	-	-
15	2-4	-	-	-	-	-	-	-	-	-	-	-

*Aciculated. **Forked-tipped. †Stellate.

Obsolete and missing setae are shown with a hyphen (-).

Specimens examined: 5 fourth-stage larvae from Bakelalan, Mt. Murud, Sarawak, Malaysia.

Type specimens

Holotype

♂ (20130611-1) on pin with L (larva) and P (pupa) exuviae mounted on slide 138 and G-43 with following collection data: *Mt. Murud, Sarawak, Malaysia on 11 June, 2013 by I. Miyagi and T. Okazawa.*

Paratypes

The following specimens collected in wild banana leaf axils, Ba'kelalan to Mt. Murud (01°49' 684"N, 109°41' 720"E; Elevation, 1,000–1,500m above sea level), Sarawak, Malaysia on 10–14 June, 2013 by I. Miyagi and T. Okazawa: 8 ♂♂ (20130610-1) with pupal (P) or/and larval (L) exuviae and genitalia (G) mounted on a slide (75), and genitalia (G-31), (82, G-32), (93, G-28), (135, G-41), (137, G-42), (G-1), (1, G-2) and (188); 4 ♂♂ (20130611-1) with (123, G-39), (78, G-29), (84, G-26), (138, G-43) and (90, G-33); 3 ♂♂ (20130811-1) with P, L on slides 109, 184, 191; 1 ♂ (20130614-7) with P, L (18, G-8); 11 ♀♀ (20130611-1) with P, L on 98, 103, 117, 121, 133, 172, 178, 182, 192, 195, 199. 7 whole larvae (20130610-1, 11-1).

Collected in wild banana leaf axils, Ba'kelala (1,000 m), on 23–26 August, 2008 by I. Miyagi and T. Toma: 4 ♂♂ (2080826-6) with P, L and G on slide (470, G-47), (466, G-45), (269, G-63) and (467, G-44); 1 ♂ (20080824-20) with (30, G-28); 1 ♂ (20080824-2) with (51, G-52); 1 ♂ (20080824-20) with (30, G-28); 1 ♂ (20080824-25) with (20, G-16); 2 ♂♂ (20080824-30) with P, L and G on slide (377, G-111), and (G-107); 1 ♂ (20080824-32) with (19, G-18); 5 ♂♂ (20080823-2) with P, L and G on slide (337, G-114), (15, G-13), (289, G-70), (315, G-101), (58); 2 ♂♂ (20080825-4) with (23, G-12), (395, G-108); 2 ♂♂ (20080826-4) with (31, G-29), (93, G-35).

Collected in wild banana leaf axils, Bario (3°44' 27" N, 115°27' 59" E; Elevation 1,066m), on August–September, 2007. I. Miyagi and T. Toma: 1 ♂ (20070909-16) with P, G (349, G-137), (463, G-146); 1 ♂ (20070909-2) with P, L and G (330, G-158); 1 ♂ (20070904-29) with P, L, G (162, G-173); 5 ♂♂ (20070904-2) with (395, G-140), (329, G-154), (345, G-165), (394, G-143), (133, G-167); 1 ♂ (20090902-4) with (174, G-66); 1 ♂ (20060915-1) with (301, G-24).

Etymology

The species name *aliyusopi* is in honour of Haji Ali Bin Yusop, Director of Forest Department of Sarawak for his kind support and granting permission for sampling of two-winged flies in the Pulong Tau National Park.

Taxonomic discussion

In general appearance, the adult and immature stages of *Topomyia aliyusopi* are very similar and may be confused with *Topomyia sabahensis* Ramalingam and Ramakrisna, 1988 [7] from Sabah and *Topomyia tenuis* Edwards, 1922 [3] from

Peninsular Malaysia but easily differentiated by the details of male genitalia: 1. Gonocoxite with a patch of several (8–13) curved setae on outer distal corner; 2. Gonostylus is swollen remarkably like oval at apical part; and 3. Dorsomesal lobe of gonocoxite is indistinctly developed with 3 to 5 weak, filamentous pale setae and many fine setae. In order to compare general appearance of male genitalia in dorsal (prerotation sense) aspect, an angle of outer apical corner of gonocoxite (Gc) is employed here as Gc angle. The angle is measured on a point intersect lines **a** (vertical line of outer lateral Gc) with **b** (horizontal line of apical Gc) as shown in Fig. 1A. The angle is right, 80–100° in *To. aliyusopi*, but 60–70° in description of *To. sabahensis* [7].

The larva of *To. aliyusopi* is very similar to *To. sabahensis*, the only reliable distinction is found in thoracic, abdominal and siphonal setae. In *To. aliyusopi*, the seta 8-M is specialized, 7–17 forked-tipped branched, abdominal seta 4-V very long and single, and 12 (6 pairs) of 1a-S, while in *To. sabahensis*, 8-M is 3–5 simple branched, seta 4-V short 2–6 branched and 1a-S with 8 or 10 (4 or 5 pairs). The larva of *To. aliyusopi* shows variation in the index and number of seta tufts (1a- and 2a-S) and pecten of the siphon. These morphological variations, we suspect, may be owing to some environmental variations in the larval habitat. In the individual larval rearing, the genital characters of the species are uniform in the specimens examined.

Clear distinctions of females and setal branches in the pupal stages could not be found between *To. aliyusopi* and *To. sabahensis*. Female, pupa and larva of *To. tenuis* are not known.

Biological notes

Topomyia aliyusopi is a high mountain species. The immature stages were collected from mountain forest at an elevation of 1,000–1,700 m of Ba'Kelalan and Bario in the leaf axils of wild banana (Musaceae), sometimes in taro and screw pine (*Pandanus* sp.). This species was found to breed in association with *Topomyia* (*Suaymyia*) *auriceps*, *Topomyia* (*Topomyia*) sp. near *Topomyia malaysiensis* and *Malaya genurostris*.

Distribution

Sarawak, Malaysia. So far known only from Bario and Ba'Kelalan, Kelabit highlands.

Acknowledgements — We wish to express our gratitude to the Forest Department of Sarawak for granting permission for sampling of the two-winged flies (Diptera) and for providing facilities in Lepo Bunga, the Pulong Tau National Park.

REFERENCES

1. Walter Reed Biosystematics Unit (2011) *Systematic Catalog of Culicidae*. Water Reed Biosystematics Unit [accessed July 1, 2011]. <http://www.mosquito-catalog.org/>
2. Leicester G.F. (1908) The Culicidae of Malaya. *Studies of Medical Research Federated Malay States* 3: 18–261.
3. Edwards F.W. (1922) A synopsis of adult Oriental Culicidae (including Megarhinine and Sabethine) mosquitoes. Part II. *Indian Journal Medical Research* 10: 430–475.
4. Ramalingam S. (1975) A new species of *Topomyia* from Peninsular Malaysia (Diptera: Culicidae). *Mosquito Systematics* 7: 185–192.
5. Ramalingam S. (1983) *Topomyia haughtoni* Feng, a new record in Malaysia and a redescription of the adult and immature stages. *Mosquito Systematics* 15: 33–40.
6. Ramalingam S. and Banu Q. (1987) Studies on the genus *Topomyia*: 2. Description of a new species from Sabah, Malaysia (Diptera: Culicidae). *Tropical Biomedicine* 4: 119–124.
7. Ramalingam S. and Ramakrishna K. (1988) Studies of the genus *Topomyia* 1. A new species from Sabah, Malaysia. *Mosquito Systematics* 20: 33–40.
8. Miyagi I., Toma T., Ramakrishna K. and Ramalingam S. (1989) Studies on the genus *Topomyia*: 3. Redescription of *spathulirostris* and transfer to the subgenus *Suaymyia*. *Mosquito Systematic* 21: 40–49.
9. Miyagi I., Toma T. and Ramalingam S. (1989) *Topomyia (Topomyia) hardini*, a new species from Sarawak Malaysia (Diptera: Culicidae). *Tropical Biomedicine* 6: 91–98.
10. Miyagi I., Toma T. and Ramalingam S. (1990) *Topomyia (Topomyia) yongi*, a new species of mosquito from Peninsular Malaysia (Diptera: Culicidae). *Mosquito Systematics* 22: 185–191.
11. Miyagi I. and Toma T. (2005) *Topomyia roslihashimi*, a new species of the subgenus *Suaymyia* (Diptera: Culicidae) from Gombak, Peninsular Malaysia. *Medical Entomology and Zoology* 56: 275–282.
12. Miyagi I., Toma T. and Okazawa T. (2006) Redescription of *Topomyia argenteoventralis* Leicester, 1908 (Diptera, Culicidae) from Malaysia. *Medical Entomology and Zoology* 57: 347–354.
13. Miyagi I. and Toma T. (2007) A redescription of *Topomyia decorabilis* Leicester, 1908 (Diptera, Culicidae) from Malaysia and Indonesia. *Medical Entomology and Zoology* 58: 251–259.
14. Miyagi I. and Toma T. (2007) A new mosquito of the genus *Topomyia* (Diptera: Culicidae) from *Nepenthes* pitcher plants in a Bario highland of Sarawak, Malaysia. *Medical Entomology and Zoology* 58: 164–174.
15. Miyagi I. and Toma T. (2008) Description of a new species *Topomyia (Suaymyia) lehcharlesi* (Diptera: Culicidae) from Sarawak, Malaysia. *Medical Entomology and Zoology* 59: 163–170.
16. Miyagi I., Okazawa T., Toma T., Higa Y. and Leh M.U. (2009) Culicidae and Corethrellidae (Diptera) collected in Sarawak, Malaysia from 2005 to 2008. *Sarawak Museum Journal* 66: 313–331.
17. Miyagi I. and Toma T. (2010) Descriptions of *Topomyia auriceps* Brug and

- Topomyia pseudoauriceps*, n. sp. from Sarawak, Malaysia (Diptera: Culicidae). *Medical Entomology and Zoology* **61**: 27–38.
18. Miyagi I. and Toma T. (2010) *Topomyia (Suaymyia) kelabitensis* (Diptera: Culicidae), a new species from Sarawak, Malaysia. *Medical Entomology and Zoology* **61**: 353–361.
 19. Miyagi I., Toma T., Okazawa T. and Leh M.U. (2011) Description of pupa and larva of the Malaysian mosquito *Topomyia (Topomyia) rubithoracis* Leicester (Diptera, Culicidae). *Medical Entomology and Zoology* **62**: 93–99.
 20. Miyagi I., Toma T., Okazawa T., Wong S. F., Leh M. U. and Yong H. S. (2012). Three new phytotelma mosquitoes of the genus *Topomyia* (Diptera: Culicidae) from Katibas, Lanjak-Entimau, Sarawak, Malaysia. *Journal of Science and Technology in the Tropics* **8**: 97–117.
 21. Miyagi I., Okazawa T. Toma T. Higa Y., Wong S. F., Leh M. U. and Yong H. S. (2013) A redescription of *Topomyia trifida* Edwards (Diptera: Culicidae) from Sarawak, Malaysia. *Journal of Science and Technology in the Tropics* **9**: 103–111.
 22. Mogi M. (2000) Phytotelmata: cryptic mosquito habitats. In F.S.P. Ng and H.S. Yong (eds) *Mosquitoes and mosquito-borne diseases* pp. 255–272. Academy of Sciences Malaysia, Kuala Lumpur.
 23. Thurman E.B. (1959) *A Contribution to a Revision of the Culicidae of Northern Thailand*. Bull. A-100, 182 pp. University of Maryland Agriculture Experiment Station, Maryland.
 24. Harbach R.E. and Knight K.L. (1980) *Taxonomists' glossary of mosquito anatomy*. Plexus Publishing Inc., Marlton.
 25. Harbach R.E. and Peyton E.L. (1993) Morphology and evolution of the larval maxilla and its importance in the classification of the Sabethini (Diptera: Culicidae). *Mosquito Systematics* **25**: 1–16.
-