

ORIGINAL ARTICLE

Review of the *Drosophila* (*Drosophila*) *quadrisetata* species group (Diptera: Drosophilidae), with descriptions of three new species from the Oriental RegionAwit SUWITO¹, Hideaki WATABE² and Masanori J. TODA^{3,4}¹Zoology Division (Museum Zoologicum Bogoriense), Research Center for Biology-LIPI, Cibinong, Bogor, Indonesia;²Biological Laboratory, Sapporo College, Hokkaido University of Education, Sapporo, Japan, ³Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan and ⁴The Hokkaido University Museum, Sapporo, Japan**Abstract**

A review of the *Drosophila* (*Drosophila*) *quadrisetata* species group is provided on the basis of samples collected from tropical to warm-temperate areas of the Oriental Region and the collection records so far accumulated for all known species. Three new species, *D. (D.) aotsukai* Suwito & Watabe sp. nov., *D. (D.) rinjaniensis* Suwito & Watabe sp. nov. and *D. (D.) sundaensis* Suwito & Watabe sp. nov., are described, and new distribution records and supplementary, revised descriptions are given for known species. A multiple-entry key, based on a character database, to all species of this species group is constructed and uploaded to the Internet.

Key words: geographic distribution, multiple-entry key, revised description, streamsides, subtropics, tropics.

INTRODUCTION

The *Drosophila* (*Drosophila*) *quadrisetata* species group was established by Toda and Peng (1989) for three species, *D. quadrisetata* Takada, Beppu & Toda, 1979, *D. beppui* Toda & Peng, 1989 and *D. potamophila* Toda & Peng, 1989, having four pairs of dorsocentral setae and two pairs of prominent acrostichal setae between dorsocentral lines. Since then, nine more species have been assigned to this species group (Okada 1988; Watabe *et al.* 1990, 1993; Watabe & Peng 1991; Zhang & Liang 1994). They are distributed from the tropics to the cool-temperate region in Asia. In this distribution range, they constitute particular drosophilid communities in riparian habitats, living in very near vicinities (within approximately 0.5 m) from water, along with other species groups. These are the *virilis* (in

temperate regions), *robusta* (in temperate to tropical regions), *polychaeta* and *angor* (in subtropical to tropical regions) groups, of the *Drosophila virilis* section (Beppu 1980; Beppu *et al.* 1989; Ichijo & Beppu 1990; Watabe & Peng 1991; Watabe & Takahashi 2007). Some species of these riparian drosophilids are known to breed on decayed phloem of branches and logs dipped in the water (Ichijo & Beppu 1990; Watabe & Ohtani 2006). The highest species diversity of this species group has been recorded from the subtropics of mainland China, but only one species has been reported from the tropics (*D. hyperpolychaeta* Okada, 1988 from Sri Lanka) and two from cool-temperate regions (*D. quadrisetata* from northern Japan and *D. fulva* Watabe & Li in Watabe *et al.* 1993 from northwestern China). However, our recent collections have revealed rich riparian drosophilid faunas in the tropics of Southeast Asia, showing a number of new species (Suwito & Watabe 2010).

In this paper, examining all samples collected from riparian habitats in Japan, Taiwan, China, Vietnam, Sunda Islands and Lesser Sunda Islands, we review the *quadrisetata* species group. Three new species are described, and revised descriptions and new records are given for known species.

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MATERIALS AND METHODS

Most specimens were collected by bait traps with fermenting bananas set along streams, and several flies from resting sites among rocks and in bamboo stumps, both just beside (within 0.5 m of) water, by insect nets. All samples were preserved in 70% ethanol. External morphology was observed under a stereoscopic microscope, and metric characters were measured with an ocular micrometer. Male and female terminalia were detached from the body, treated with 10% KOH solution at 80°C for several minutes, and observed in a droplet of glycerin on a well slide under a compound microscope. The genitalia and other parts were microphotographed using a DinoLite Camera (AnMo Electronics Corporation, Hsinchu, Taiwan), and drawn based on the pictures using a Wacom pen tablet, Driver v 6.05 on Adobe Illustrator CS4. We followed McAlpine (1981) for the morphological terminology and Zhang and Toda (1992) for the definitions of measurements and indices (otherwise the definitions given).

The specimens are deposited in the following institutions: Museum Zoologicum Bogoriense, Research

Center for Biology, Indonesian Institute of Science, Cibinong, Indonesia (MZB); Systematic Entomology, Hokkaido University Museum, Hokkaido University, Sapporo, Japan (SEHU); and Taiwan Forestry Research Institute, Taiwan (TFRI).

***Drosophila (Drosophila) quadrisetata* species group**

Drosophila quadrisetata species group, Toda and Peng (1989, p. 158).

Diagnosis [modified from Toda & Peng (1989)]. Dull brown species with 4 pairs of dorsocentral setae and 2 pairs of prominent acrostichal setae between dorsocentral lines.

Distribution. All collection localities, including those of new records and species to be described here, of the *quadrisetata* group are shown in Figure 1. This species group is distributed in the range north to Hokkaido (northern Japan) and Xinjiang (northwestern China), south to Lombok Island (Indonesia), east to Hokkaido and west to Sri Lanka.

In the following description, supplementary and/or revised descriptions for known species are first given and

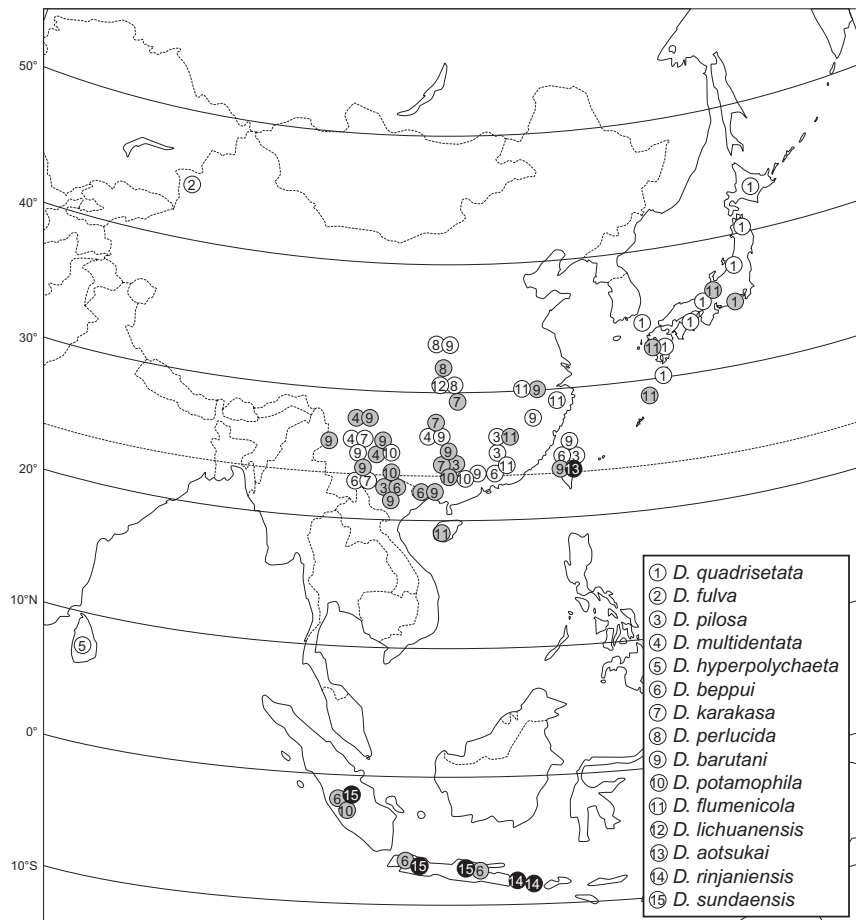


Figure 1 Distribution of the *Drosophila (Drosophila) quadrisetata* species group. White circle, known record; gray circle, new record; black circle, new species.

then new species are described, in the order of species taking their relatedness or morphological similarity into account.

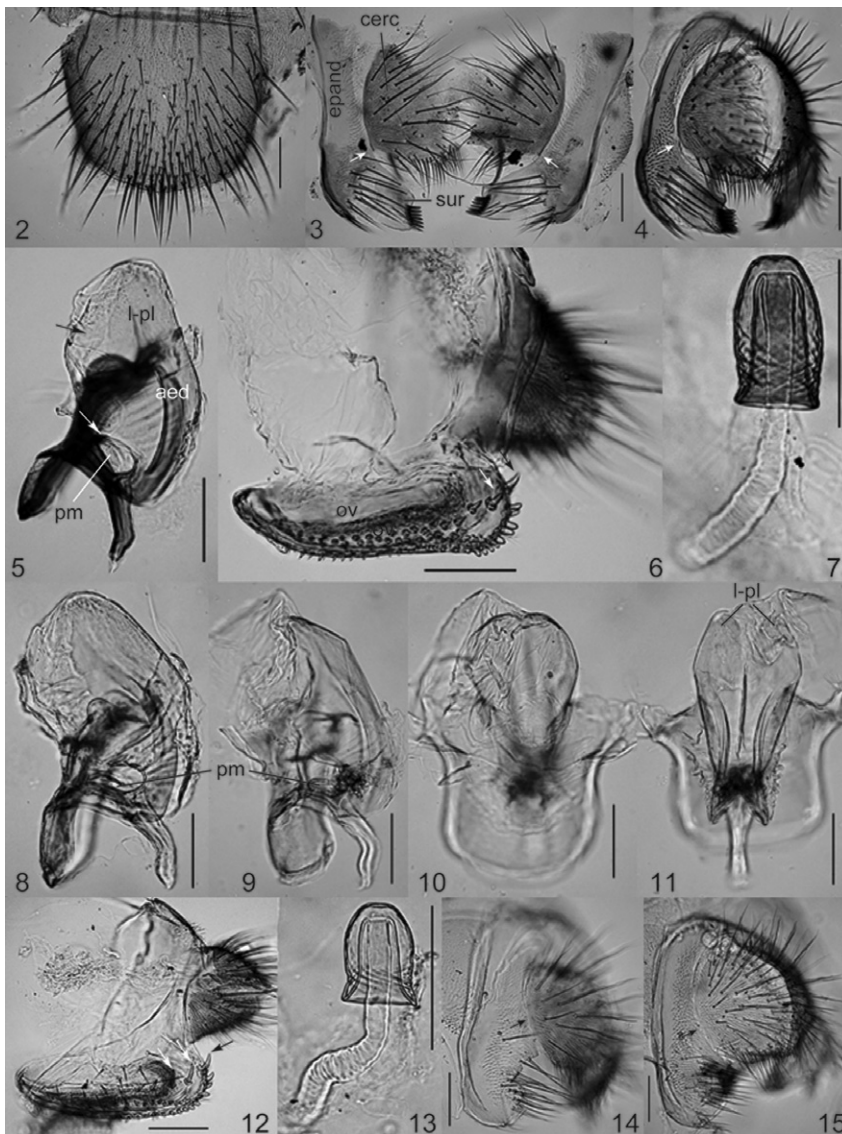
***Drosophila (Drosophila) quadrisetata* Takada, Beppu & Toda, 1979** (Figs 2–7)

Drosophila (Drosophila) quadrisetata Takada *et al.* (1979, p. 124); Watabe and Takahashi (2007, p. 16).

Diagnosis. Palpus with 2 prominent setae. Cercus with dense, long setae along ventral margin (Figs 3,4). Paramere oval, partly pubescent, largely transparent, but with dark patch (Fig. 5). Oviscapt with 1 or 2 lateral ovisensilla as stout as apicodorsal, marginal one; distalmost, lateral ovisensillum as long as apicodorsal, marginal one (Fig. 6). Spermathecal capsule apically slightly

concaved, basally obliquely wrinkled, with sparse, fine spinules on medial portion (Fig. 7).

Supplementary and revised description. Fronto-orbital plate anteriorly narrower than frontal vitta; dorsal branches/ventral branches of arista (arb) = 2–4/1–2; dorsal branches shorter than upper seta on pedicel. Acrostichal setulae in 6–8 irregular rows. Foreleg 1st and 2nd tarsomeres in combination shorter than its tibia. Posterior margin of male sternite V convexed, medially with dense, short setae (Fig. 2). Epandrium narrowly fused to cercus, with transparent plate in caudoventral portion (Figs 3,4). Surstylus with 5–7 prenisetae longer than three times of width (Fig. 3). Hypandrium not pubescent on medial portion of lateral lobes. Paramere located at proximal to submedial



Figures 2–15 *Drosophila (Drosophila) quadrisetata* Takada, Beppu & Toda, 1979 (2–7) and *Drosophila (Drosophila) fulva* Watabe & Li in Watabe *et al.*, 1993 (8–15). 2 Male sternite V (male from Nayoro, Hokkaido, Japan); 3,4 peripheral organs, arrows indicating narrow fusion of epandrium (epand) to cercus (cerc); sur, surstylus (3 holotype, 4 male from Nayoro, Hokkaido, Japan); 5 phallic organs in lateral view, black arrow indicates transparent plate of aedeagus (aed), and white arrow indicates dark patch of paramere (pm); l-pl, lateral plate of aedeagus (male from Nayoro, Hokkaido, Japan); 6 female terminalia in lateral view, black arrow indicates apicodorsal, marginal ovisensillum, and white arrow indicates distalmost, lateral one; ov, oviscapt (female from Nayoro, Hokkaido, Japan); 7 spermatheca (female from Nayoro, Hokkaido, Japan); 8–11 phallic organs (8 male paratype in lateral view, 9–11 holotype in lateral, ventral and dorsal views, respectively); 12 female terminalia in lateral view, black arrow indicates apicodorsal, marginal ovisensillum, and white arrows indicating two distalmost, lateral ones (female paratype); 13 spermatheca (female paratype); 14,15 peripheral organs, arrows indicates narrow fusion of epandrium to cercus (14 holotype, 15 male paratype). Scale = 0.1 mm.

portion of aedeagal guide (Fig. 5). Aedeagus proximally somewhat expanded ventrad (Fig. 5). Oviscapt with anteroventral bridge shorter than half of oviscapt length.

Specimens examined. **Japan:** holotype, male (first deposited in the Biological Laboratory, Sapporo University, Sapporo, Japan, but later relocated to SEHU), “Sor-anuma, near Sapporo, Hokkaido, June 26, 1976 (K. Beppu)”; 83 males, 74 females, Nayoro, Hokkaido, 18.vii.2005, H.Watabe leg.; 11 males, 8 females, Namesawa-keikoku, Yugashima, Izu, Shizuoka Prefecture, 428 m a.s.l., 29.x.2007, H.Watabe leg.; 12 females, Siiba, Miyazaki Prefecture, Kyushu, 19–20.vii.1997, H.Watabe leg.; 12 males, 1 female, Jusso, Oguchi, Kagoshima Prefecture, Kyushu, 120 m a.s.l., 29–30.ix.1996, H.Watabe leg.

Distribution. Japan (Hokkaido, Tohoku, Chubu, Kinki, Shikoku, Kyushu, Tsushima Is., Yakushima Is.) (Fig. 1).

Remarks. In the original (Takada *et al.* 1979) and the later supplementary/revised (Watabe & Takahashi 2007) descriptions, the epandrium was described as being separated from the cercus. This time, however, we carefully re-examined the holotype and other specimens, and confirmed that the epandrium is narrowly fused to the cercus (Figs 3,4). The shallow concavity at the apex of spermathecal capsule has never been declared in the previous descriptions, but the illustration (fig. 7) in the original description clearly shows this structure. The anteroventrad swelling of medial portion of the aedeagus, illustrated and described (as fig. 1d) by Watabe and Takahashi (2007), is due to an expansion of the transparent plate: the sclerotized, lateral plate of the aedeagus less expanded in the proximal portion (Fig. 5).

***Drosophila (Drosophila) fulva* Watabe & Li in Watabe *et al.*, 1993** (Figs 8–15)

Drosophila (Drosophila) fulva Watabe & Li in Watabe *et al.* (1993, p. 532).

Diagnosis. Cercus with dense, long setae along ventral margin (Figs 14,15). Paramere narrowly oval, slightly pubescent, nearly entirely transparent (Figs 8,9). Oviscapt with 2 distalmost, lateral ovisensilla longer than apicodorsal, marginal one (Fig. 12). Spermathecal capsule apically slightly concaved, basally obliquely wrinkled, with sparse, fine spinules on medial portion (Fig. 13).

Supplementary and revised description. Fronto-orbital plate anteriorly narrower than frontal vitta. Longest dorsal branch of arista shorter than upper seta on pedicel. Palpus club-shaped, with 1 or 2 prominent setae. Acrostichal setulae in 6–8 irregular rows. Foreleg 1st and 2nd tarsomeres in combination shorter than its tibia. Posterior margin of male sternite V convexed,

medially with dense, short setae. Epandrium fused to cercus, with transparent plate in caudoventral portion (Figs 14,15). Premsisetae on surstylus longer than three times of width. Hypandrium not pubescent on medial portion of lateral lobes. Paramere located at proximal to submedial portion of aedeagal guide (Figs 8,9). Aedeagus curved ventrad, proximally somewhat expanded ventrad, apically not pointed (Fig. 8). Anteroventral bridge of oviscapt shorter than half of oviscapt length.

Specimens examined. **China:** holotype, male (the Biological Laboratory, Hokkaido University of Education, Sapporo, Japan), “7.viii.1990, Gozegou, Ili, Xinjiang, China”; 1 male, 2 female paratypes, Charbacotor, Ili, Xinjiang, 8–9.viii.1990, Entomack & H.Watabe leg. (Biological Laboratory, Hokkaido University of Education, Sapporo, Japan).

Distribution. China (Xinjiang) (Fig. 1).

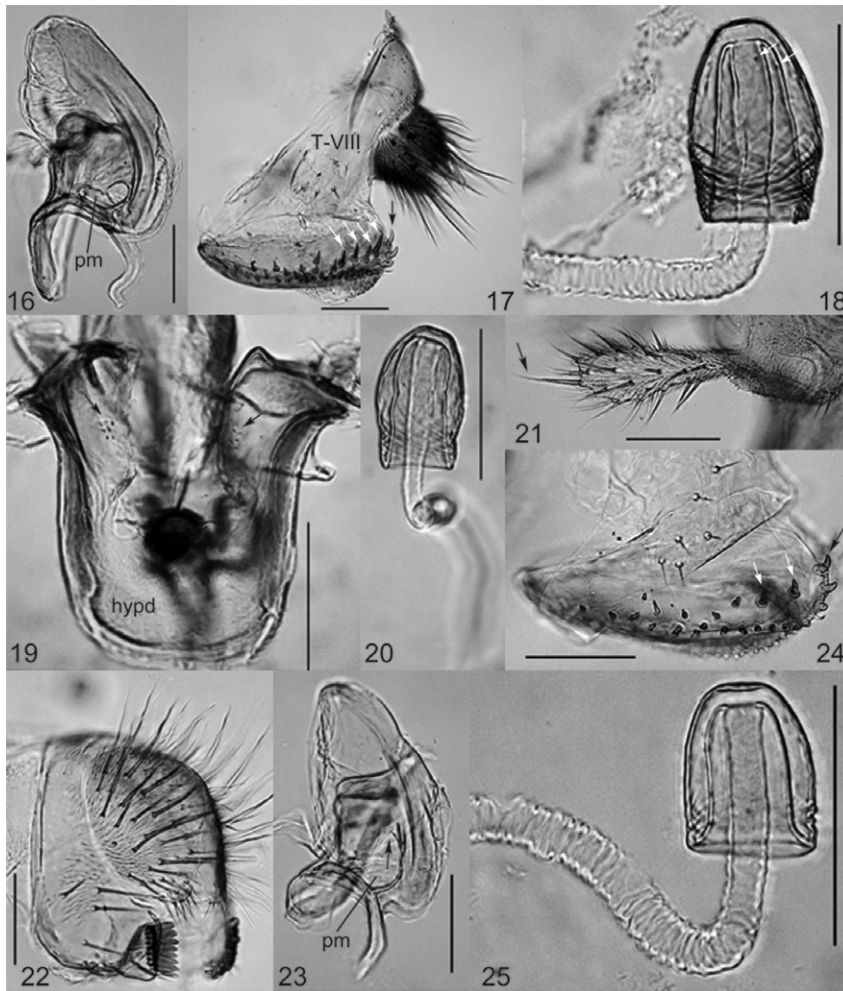
Remarks. The illustrations of the male terminalia (Figs 11,13,14), based on the holotype, in the original description (Watabe *et al.* 1993) show that the epandrium is separated from the cercus, and that the aedeagus is apically pointed and less curved ventrad. However, re-examination of the holotype has revealed that these characters are as redescribed above: in particular, the illustrations of the aedeagus, where the apex appears to be pointed, should have been drawn from the exact, lateral view of the organ, of which lateral plates are unusually opened ventrally in the holotype (Figs 9–11). This species closely resembles *D. quadrisetata* in the relatively large body size, most characters of the external morphology and the male and female terminalia, except for the paramere nearly entirely transparent and the distalmost, lateral ovisensillum longer than the apicodorsal, marginal one (in *D. quadrisetata*, those with dark patch and as long as the apicodorsal, marginal one, respectively). And, among species of the *quadrisetata* group, only these two are distributed up to the cool-temperate region.

***Drosophila (Drosophila) pilosa* Watabe & Peng, 1991** (Figs 16–18)

Drosophila (Drosophila) pilosa Watabe and Peng (1991, p. 152); Chen and Watabe (1993, p. 315).

Diagnosis. Cercus with dense, long setae along ventral margin. Hypandrium not pubescent on medial portion of lateral lobes. Paramere oval, not pubescent, largely transparent, but with dark patch (Fig. 16). Oviscapt with 3 or 4 lateral ovisensilla as stout as apicodorsal, marginal one (Fig. 17). Spermathecal capsule basally obliquely wrinkled, with sparse spinules distributed on medial portion (Fig. 18).

Supplementary and revised description. Fronto-orbital plate anteriorly narrower than frontal vitta; arb = 3–4/



Figures 16–25 *Drosophila* (*Drosophila*) *pilosa* Watabe & Peng, 1991 (16–18), *Drosophila* (*Drosophila*) *multidentata* Watabe & Zhang in Watabe *et al.*, 1990 (19, 20) and *Drosophila* (*Drosophila*) *perlucida* Zhang & Liang, 1994 (21–25). 16 Phallic organs in lateral view (male from Fushan, Taiwan); 17 female terminalia in lateral view, black arrow indicates apicodorsal, marginal ovisensillum, and white arrows indicating four lateral ovisensilla as stout as the apicodorsal, marginal one; T-VIII, tergite VIII (female from Mt. Fanshipan, Sapa, Laochai Province, Vietnam); 18 spermatheca, arrows indicating spinules on capsule (female from Mt. Fanshipan, Sapa, Laochai Province, Vietnam); 19 hypandrium (hypd) in ventral view, arrows indicate small patches of pubescence on lateral lobes (male paratype); 20 spermatheca (female paratype); 21 palpus, arrow indicates apical, prominent seta (male from Mt. Emei, China); 22 peripheral phallic organs in caudolateral view (male from Mt. Emei, China); 23 phallic organs in lateral view, arrow indicates deep constriction of ventroproximal expansion (male from Mt. Emei, China); 24 oviscapt, black arrow indicates apicodorsal, marginal ovisensillum, and white arrows indicate two lateral ovisensilla as stout as apicodorsal, marginal one (female from Mt. Emei, China); 25 spermatheca (female from Mt. Emei, China). Scale = 0.1 mm.

1–2; longest dorsal branch shorter than upper seta on pedicel. Foreleg 1st and 2nd tarsomeres in combination shorter than its tibia. Posterior margin of male sternite V convexed, medially with dense, short setae. Epandrium with transparent plate in caudoventral portion. Prensensetae on surstylus longer than three times of width. Paramere located at proximal to submedial portion of aedeagal guide (Fig. 16). Aedeagus proximally somewhat expanded ventrad (Fig. 16). Female tergite VIII gray brown, ventrally with 4 or 5 setae per side (Fig. 17). Oviscapt (Fig. 17) broad, with approximately 40 peg-like and trichoid ovisensilla in addition to subterminal, trichoid one; 4 distal, marginal and 3 or 4 distal, lateral ones black, stout; approximately 32 proximal, marginal ones in irregular rows; anteroventral bridge shorter than half of oviscapt length. Spermathecal capsule longer than wide, apically slightly concaved; introvert approximately 0.9 as deep as height of capsule (Fig. 18).

Specimens examined. Taiwan: 9 males, 3 females, Fushan, 26.iv.2006, M.Takahashi and H.Watabe leg. *China:* 17 males, 6 females, Huajiang, Guangxi, 19–20.iii.2009, M.J.Toda leg. *Vietnam:* 3 males, 4 females, Mt. Fanshipan, Sapa, Laochai Province, 22°21'18.6"N, 103°46'27.5E, 1866 m a.s.l., 12.ix.2010, H.Watabe and H.Takamori leg.

Distribution (* new record). Taiwan, China (Jiangxi, Guangdong, Guangxi*), Vietnam* (Fig. 1).

Remarks. The description and illustrations of the female terminalia by Chen and Watabe (1993) were based on 2 females from Jinggangshan (misspelled as “Gingangshan”), Jiangxi, China. However, we have confirmed their misidentification by re-examining one of the specimens, which has been preserved in the Biological Laboratory, Hokkaido University of Education; i.e., the specimens are of *D. flumenicola* Watabe & Peng, 1991. This species resembles *D. quadrisetata* in most characters of the external morphology and the male and

female terminalia, but can be distinguished from it by the medium-sized body, only 1 apical, prominent seta on the palpus, and the unpubescent paramere.

***Drosophila (Drosophila) multidentata* Watabe & Zhang in Watabe *et al.*, 1990** (Figs 19,20)

Drosophila (Drosophila) multidentata Watabe & Zhang in Watabe *et al.* (1990, p. 464).

Diagnosis. Palpus with only 1 apical, prominent seta. Cercus with dense, long setae along ventral margin. Hypandrium slightly pubescent on medial portion of lateral lobes (Fig. 19). Oviscapt with 3 or 4 lateral ovisensilla as stout as apicodorsal, marginal one. Spermathecal capsule basally obliquely wrinkled, without spinules (Fig. 20).

Supplementary and revised description. Fronto-orbital plate anteriorly narrower than frontal vitta. Longest dorsal branch of arista shorter than upper seta on pedicel. Foreleg 1st and 2nd tarsomeres in combination shorter than its tibia. Posterior margin of male sternite V convexed, medially with dense, short setae. Epandrium with transparent plate in caudoventral portion. Prensensetae on surstylus longer than three times of width. Paramere oval, largely transparent but with dark patch, not pubescent, located at proximal to submedial portion of aedeagal guide. Aedeagus proximally somewhat expanded ventrad. Oviscapt with 34–45 ovisensilla, including peg-like and trichoid ones; distalmost, lateral one as long as apicodorsal, marginal one; anteroventral bridge shorter than half of oviscapt length. Spermathecal capsule apically slightly concaved (Fig. 20).

Specimens examined. China: 1 male, 1 female paratypes, Dabochin, Dali, Yunnan, 21.ix.1988, X.Liang leg. (Biological Laboratory, Hokkaido University of Education, Sapporo, Japan); 13 males, 13 females, Lugufu, Lijiang District, Yunnan, 24–27.vii.2001, H.Watabe and J.Gao leg.; 1 male, Ailao-shan, Yunnan, about 2450 m a.s.l., 22.vi–1.vii.2001, H.Watabe and J.Gao leg.; 2 males, 1 female, Wuliangshan, Yunnan, 22.vi–1.vii.2001, H.Watabe and J.Gao leg.; 11 males, 13 females, Leigongshan, Guizhou, 26–30.ix.2001, L.He, leg.

Distribution. China (Guizhou, Yunnan) (Fig. 1).

Remarks. This species most closely resembles *D. pilosa*, but can be distinguished from it by slightly pubescent lateral lobes of the hypandrium and the smooth spermathecal capsule.

***Drosophila (Drosophila) hyperpolychaeta* Okada, 1988**

Drosophila (Drosophila) hyperpolychaeta Okada (1988, p. 142).

Diagnosis. Epandrium separated from cercus. Hypandrium anteriorly somewhat triangular. Aedeagus apically round and nearly straight on distal, dorsal margin in lateral view.

Distribution. Sri Lanka (Fig. 1).

Remarks. Okada (1988) established this species based on several specimens of both sexes, but did not describe the morphology of the female terminalia. The above diagnosis is based on the original, rather simple description and illustrations from the reference. The type specimens should be re-examined to confirm the status of this species.

***Drosophila (Drosophila) beppui* Toda & Peng, 1989**

Drosophila (Drosophila) beppui Toda and Peng (1989, p. 158).

Diagnosis. [modified from Toda and Peng (1989)]. Palpus with numerous, long setae in both sexes; male palpus apically much broadened and with flat undersurface [fig. 9 in Toda and Peng (1989)]. Anteroventral bridge of oviscapt half as long as oviscapt [fig. 13 in Toda and Peng (1989)].

Supplementary and revised description. Fronto-orbital plate anteriorly narrower than frontal vitta. Longest dorsal branch of arista shorter than upper seta on pedicel. Acrostichal setulae in 4–6 irregular rows. Foreleg 1st and 2nd tarsomeres in combination shorter than its tibia. Posterior margin of male sternite V nearly straight, medially without dense, short setae. Epandrium without transparent patch/plate in caudoventral portion. Prensensetae on surstylus 9 or 10, three times as long as wide. Cercus with tuft of short setae around caudoventral corner. Paramere narrowly oval, nearly transparent, located at laterodistal portion of aedeagal guide. Aedeagus proximally not expanded ventrad. Oviscapt with 22–28 peg-like ovisensilla but no trichoid ones except for subterminal one.

Specimens examined. Taiwan: 3 males, 6 females, Fushan, about 1180 m a.s.l., 18–20.iv.1997, H.Watabe, leg.; 1 male, 2 females, Fushan, 25–26.iv.2006, M.Takahashi and H.Watabe leg. **China:** 1 male, 1 female, Fulong, Shiwandashan, Guangxi, 4–6.ix.2001, H.Watabe leg.; 11 males, 8 females, Manxi, Simao, Yunnan, 8–10.xi.2001, H.Watabe and L.He leg. **Vietnam:** 13 males, 12 females, Mt. Fanshipan, Sapa, Laochai Province, 22°24'50.2"N, 103°53'54.7"E, 749 m a.s.l., 10–12.ix.2010, H.Watabe and H.Takamori leg. **Indonesia:** 4 males, 4 females, Mt. Tujuh, Kerinci Seblat, West Sumatra, 1°25'30.5"S, 101°12'54.0"E, 1735 m a.s.l., 4–5.xii.2004, H.Watabe and A.Suwito leg.; 25 males, 23 females, Sakokiri River, Kerinci Seblat, Jambi, West Sumatra, 2°02'05.2"S,

101°09'57.6"E, 1038 m a.s.l., 6–7.xii.2006, H.Watabe and A.Suwito leg.; 1 male, Cikaniki, Mt. Halimun, West Java, 4–5.xi.2009, by a light trap, M.J.Toda leg.; 1 female, Citarik River, Sukabumi, West Java, 6°45'53.8"S, 107°21'49.4"E, 1006 m a.s.l., 24.vii.2007, A.Suwito and E.Cholik leg.; 1 male, Curug Sabuk, Mt. Ciremai, West Java, 6°56'08.1"S, 108°26'17.0"E, 1143 m a.s.l., 27.x.2008, A.Suwito leg.; 22 males, 16 females, Coban Kembar, East Java, 7°26'24.7"S, 112°18'54.0"E, 1625 m a.s.l., 27.xi.2005, H.Watabe and A.Suwito leg.

Distribution (* new record). Taiwan, China (Guangdong, Guangxi*, Yunnan), Vietnam*, Indonesia* (West Sumatra, West Java, East Java) (Fig. 1).

Remarks. This species is unique and easily distinguishable from the others of the *quadrisetata* group by the diagnostic characters.

***Drosophila (Drosophila) karakasa* Watabe & Liang in Watabe *et al.*, 1990**

Drosophila (Drosophila) karakasa Watabe & Liang in Watabe *et al.* (1990, p. 461).

Diagnosis. [modified from Watabe *et al.* (1990)]. Palpus short, with numerous, short setae but no prominent ones [fig. 7 in Watabe *et al.* (1990)]. Spermathecal capsule cone-shaped [fig. 14 in Watabe *et al.* (1990)].

Supplementary and revised description. Fronto-orbital plate anteriorly narrower than frontal vitta. Longest dorsal branch of arista shorter than upper seta on pedicel. Foreleg 1st and 2nd tarsomeres in combination shorter than its tibia. Oviscapt with 16–22 ovisensilla, including peg-like and trichoid ones; anteroventral bridge shorter than half of oviscapt length. Spermathecal capsule with sparse spinules distributed on medial portion.

Specimen examined. **China:** 1 female paratype, Dabochin, Dali, Yunnan, 21.ix.1988, X.Liang leg. (Biological Laboratory, Hokkaido University of Education, Sapporo, Japan); 1 male, 2 females, Manxi, Simao, Yunnan, 8–10.xi.2001, H.Watabe and L.He leg.; 2 females, Leigongshan, Guizhou, 26.ix.2001, L.He, leg.; 1 male, 2 females, Tianpingshan, Badagongshan Nature Reserve, Hunan, 30.viii–5.ix.2000, H.Takamori leg.; 1 male, Huajiang, Guangxi, 19.iii.2009, M.J.Toda leg.

Distribution. China (Hunan*, Guizhou*, Guangxi*, Yunnan, Fig. 1).

Remarks. This species is unique in having the palpus lacking prominent setae among species of the *quadrisetata* group.

***Drosophila (Drosophila) perlucida* Zhang & Liang, 1994** (Figs 21–25)

Drosophila (Drosophila) perlucida Zhang and Liang (1994, p. 215).

Diagnosis. Palpus with only 1 apical, prominent seta as short as palpal width (Fig. 21). Cercus separated from epandrium, with tuft of setulae around caudoventral corner (Fig. 22). Aedeagal, ventroproximal expansion deeply constricted at base (Fig. 23). Oviscapt apically broad, roundish, with 1 or 2 lateral ovisensilla as stout and long as apicodorsal, marginal one (Fig. 24).

Supplementary and revised description. Fronto-orbital plate anteriorly narrower than frontal vitta. Dorsal branches of arista shorter than upper seta on pedicel; arb = 3–4/1–2. Acrostichal setulae in 6 irregular rows. Foreleg 1st and 2nd tarsomeres in combination shorter than its tibia. Posterior margin of male sternite V nearly straight, medially without dense, short setae. Epandrium pubescent, except anterior margin and lower portion of ventral portion; ventral portion with approximately 4 setae on lateral surface and approximately 3 at caudoventral corner but no transparent patch/plate in caudoventral portion (Fig. 22). Prensistetae on surstylus 8 or 9, longer than three times of width (Fig. 22). Cercus pubescent except for ventral margin, with approximately 36 long setae (Fig. 22). Paramere oval, located at proximal to submedial portion of aedeagal guide, slightly pubescent, largely transparent, but with dark patch (Fig. 23). Anteroventral bridge of oviscapt shorter than half of oviscapt length. Spermathecal capsule apically slightly concaved, with spinules; basal wrinkles somewhat oblique (Fig. 25).

Specimens examined. **China:** 2 males, 4 females, Shennongjia, Hubei, 22–28.vii.1992, H.Watabe, leg.

Distribution. China (Shaanxi, Hubei) (Fig. 1).

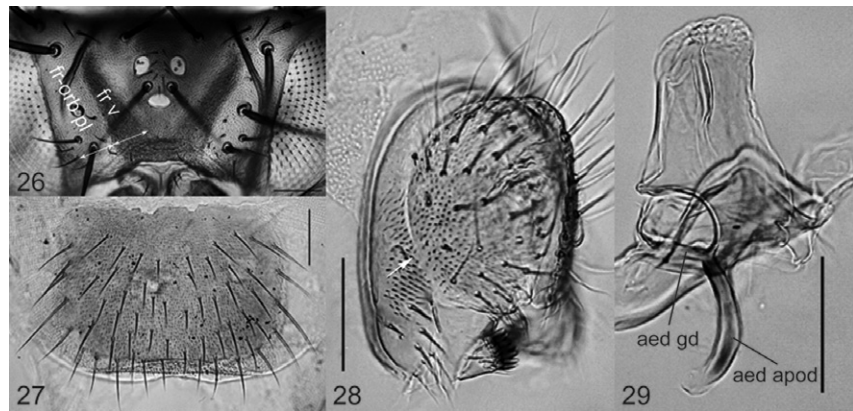
Remarks. This species somewhat resembles *D. beppui* in the cercus separated from the epandrium and bearing a tuft of setulae around caudoventral corner, but can be distinguished from it by the morphology of the palpus.

***Drosophila (Drosophila) barutani* Watabe & Liang in Watabe *et al.*, 1990** (Figs 26–29)

Drosophila (Drosophila) barutani Watabe & Liang, in Watabe *et al.* (1990, p. 463).

Diagnosis. [modified from Watabe *et al.* (1990)]. Fronto-orbital plate anteriorly as wide as frontal vitta (Fig. 26). Dorsal branches of arista shorter than upper seta on pedicel. Foreleg 1st and 2nd tarsomeres in combination as long as its tibia. Cercus narrowly fused to epandrium, with tuft of setulae around caudoventral corner (Fig. 28). Aedeagus proximally triangularly expanded ventrad, slight concaved on distal, outer margin, apically unsclerotized; sclerotized portion truncate apically in lateral view (Fig. 29). Spermathecal capsule hemispherical, as long as wide, without spinules [fig. 14 in Watabe *et al.* (1990)].

Figures 26–29 *Drosophila* (*Drosophila*) *barutani* Watabe & Liang in Watabe *et al.*, 1990 (specimens from Fushan, Taiwan). 26 Frons, arrows indicating nearly equal widths of anterior portions of fronto-orbital plate (fr-orb pl) and frontal vitta (fr v); 27 male sternite V; 28 periphallalic organs in caudolateral view, arrow indicates narrow fusion of epandrium to cercus; 29 phallic organs in lateral view; aed ad, aedeagal apodeme; aed gd, aedeagal guide. Scale = 0.1 mm.



Supplementary and revised description. Palpus horizontally flattened, with two prominent setae. Posterior margin of male sternite V nearly straight, medially without dense, short setae (Fig. 27). Epandrial ventral lobe with approximately 15 setae; lowermost, sclerotized portion seen somewhat triangular due to narrow. Transparent patch in caudoventral portion (Fig. 28). Surstylus quadrate, slightly pubescent on medial, outer surface, with 6 or 7 prenisetae three times as long as wide in straight row on distal margin and 5–9 trichoid setae near ventral margin (Fig. 28). Cercus somewhat constricted subventrally, pubescent except for ventral margin (Fig. 28). Hypandrium longer than wide, anteriorly semicircular. Paramere large, oval, transparent, located along whole length of aedeagal guide. Aedeagus curved ventrad; apodeme approximately 1/3 as long as aedeagus; aedeagal guide slightly shorter than apodeme, horizontally flat, plate-like (Fig. 29). Oviscapt apically narrowing, with approximately 17 trichoid (one stout apical, approximately 12 min marginal and approximately 4 small lateral) ovisensilla and anteroventral bridge shorter than half of oviscapt length.

Specimens examined. **Taiwan:** 2 males, Fushan, 19.iv.1997, H.Watabe leg.; 6 males, 9 females, Fushan, 25–26.iv.2006, M. Takahashi and H.Watabe leg.; 2 males, Chitou, about 1300 m a.s.l., 20–22.iv.1997, H.Watabe leg. **China:** holotype, males (the Kunming Institute of Zoology, Academia Sinica, Kunming, China), “Dabochin, Dali district, Yunnan Province, 21.ix.1988, X.C.Liang leg.”; 2 females, Huangshan, Anhui, 30.viii.1991, H.Watabe leg.; 2 males, 4 females, Yipingli, Tongmu, Fujian, 16–19.viii.2001, H.Watabe leg.; 48 males, 38 females, Leigongshan, Guizhou, 26.ix–1.x.2001, L.He, leg.; 1 male, 3 females, Maershan, Guangxi, 18–19.iii.2009, M.J.Toda leg.; 11 males, 6 females, Huajiang, Guangxi, 19–20.iii.2009, M.J.Toda leg.; 6 males, 7 females, Fulong, Shiwandashan, Guangxi, 4–6.ix.2001, H.Watabe leg.; 1 male,

Pianma, Gaoligongshan, Yunnan, about 2300 m a.s.l., 15.viii.2000, H.Watabe, leg.; 3 males, 3 females, Ailaoshan, Yunnan, about 2450 m a.s.l., 22.vi–1.vii.2001, H.Watabe and J.Gao leg.; 4 males, 7 females, Wuliangshan, Yunnan, 22.vi–vii.2001, H.Watabe and J.Gao leg.; 1 male, 4 females, Lugufu, Lijiang District, Yunnan, 24–27.vii.2001, H.Watabe and J.Gao leg.; 2 females, Manxi, Simao, Yunnan, 8–10.xi.2001, H.Watabe and L.He leg. **Vietnam:** 1 female, Mt. Fanshipan, Sapa, Laochai Province, Vietnam, 22°21'18.6"N, 103°46'27.5E, 1866 m a.s.l., 12.ix.2010, H.Watabe and H.Takamori leg.

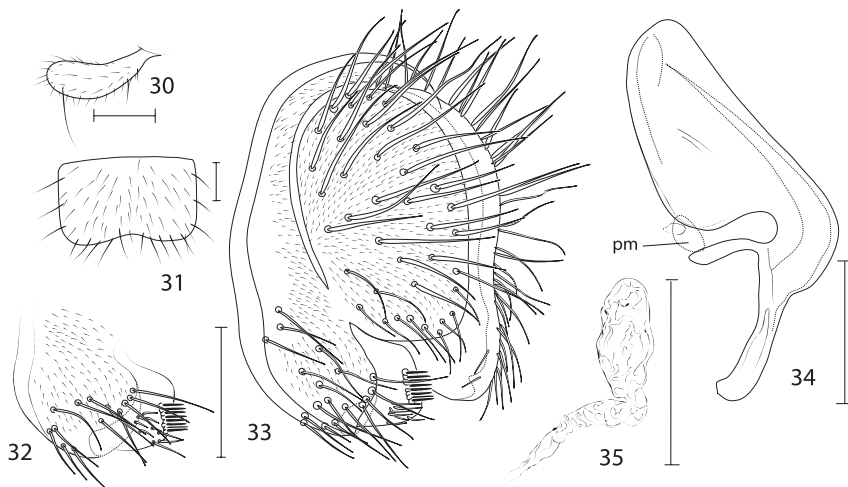
Distribution (* new record). Taiwan, China (Anhui*, Shaanxi, Fujian*, Jiangxi, Guizhou, Guangdong, Guangxi*, Yunnan), Vietnam* (Fig. 1).

Remarks. We re-examined the holotype of *D. barutani* and found that the detailed structure of the male terminalia, especially tips of the epandrium and aedeagus, had been incorrectly drawn in the original description. Thus, they are shown in Figures 28 and 29, respectively. This species can be easily distinguished from the foregoing species by the fronto-orbital plate anteriorly as wide as the frontal vitta and the foreleg 1st and 2nd tarsomeres in combination as long as its tibia.

Drosophila (*Drosophila*) *potamophila* Toda & Peng, 1989 (Figs 30–35)

Drosophila (*Drosophila*) *potamophila* Toda and Peng (1989, p. 159).

Diagnosis. Longest dorsal branch of arista longer than upper seta on pedicel. Palpus distally dilated and roundish, subapically with 1 prominent seta shorter than 2/3 of palpal length, and sometimes 1 or 2 shorter lateral ones (Fig. 30). C3F = 0.82–0.95. Surstylus with 7–9 prenisetae longer than three times of width (Figs 32,33). Aedeagus proximally largely expanded ventrad with basal, inner margin convergent to aedeagal guide in lateral view, nearly straight on distal, outer



Figures 30–35 *Drosophila* (*Drosophila*) *potamophila* Toda & Peng, 1989 (specimens from Mt. Tujuh, Kerinci Seblat, West Sumatra, Indonesia). 30 Palpus; 31 male sternite V; 32 lower part of epandrium and surstylus in ventrolateral view; 33 periphallallic organs in caudolateral view; 34 paramere and aedeagus in lateral view; 35 spermatheca. Scales = 0.1 mm.

margin, without small warts on lateral surfaces (Fig. 34). Oviscapt apically narrowing; all ovisensilla trichoid.

Supplementary and revised description. Fronto-orbital plate anteriorly narrower than frontal vitta. Acrostichal setulae in 4–6 irregular rows. Foreleg 1st and 2nd tarsomeres in combination shorter than its tibia. Male sternite V concaved on posterior margin, with approximately 3 long setae on lateral margin but no dense, short setae medially on posterior margin (Fig. 31). Epandrium fused to cercus narrowly at middle; caudoventral margin of sclerotized portion seen sigmoidal due to existence of transparent patch there (Figs 32,33). Cercus without tuft of setae/setulae around caudoventral corner or on ventral margin (Fig. 28). Hypandrium longer than wide, anteriorly rectangular. Paramere nearly transparent, small, located at distal portion of aedeagal guide (Fig. 34). Spermathecal capsule membranous, irregular in shape; duct not introverted into capsule (Fig. 35).

Specimens examined. **China:** 1 male, 1 female paratypes, Dinghushan, Guangdong, 21.viii.1987, K.Beppu leg. (SEHU); 6 males, 13 females, Huajiang, Guangxi, 19,20.iii.2009, M.J.Toda leg.; 20 males, 35 females, Manxi, Simao, Yunnan, 8–10.xi.2001, H.Watabe and L.He leg. **Vietnam:** 2 males, 1 female, Mt. Fanshipan, Sapa, Laochai Province, 22°22'20.9"N, 103°52'15.4"E, 1214 m a.s.l., 10–12.ix.2010, H.Watabe and H.Takamori leg. **Indonesia:** 8 males, 12 females, Mt. Tujuh, Kerinci Seblat, West Sumatra, 4–5.xii.2004, H.Watabe and A.Suwito leg.

Distribution (* new record). China (Guangdong, Guangxi*, Yunnan), Vietnam*, Indonesia* (West Sumatra) (Fig. 1).

Remarks. Re-examining carefully the two paratype specimens, we revised and supplemented the original

description and illustrations by Toda and Peng (1989), which overlooked a narrow fusion of the epandrium to the cercus, a transparent patch in the caudoventral portion of the epandrium, and nearly transparent parameres.

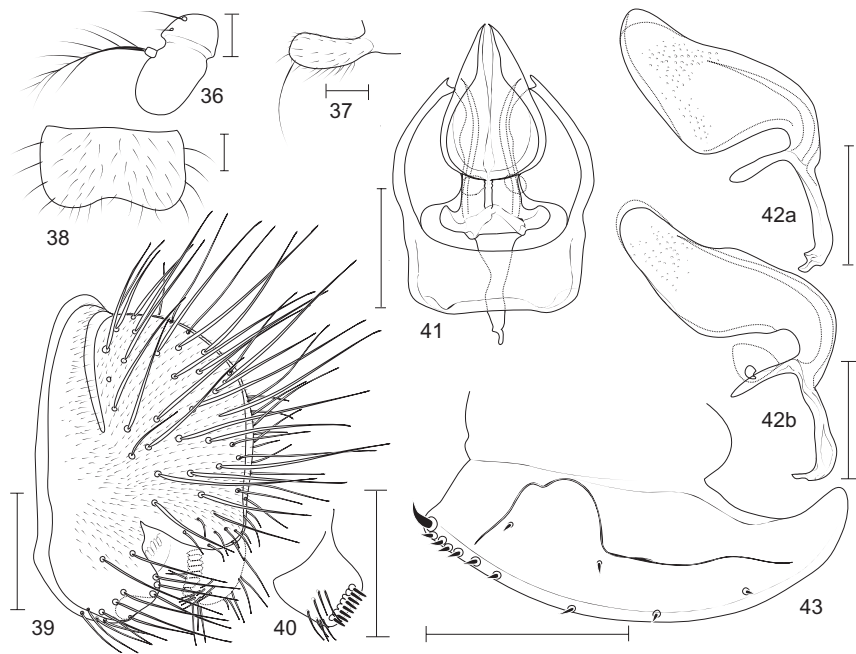
Drosophila (*Drosophila*) *flumenicola* Watabe & Peng, 1991 (Figs 36–43)

Drosophila (*Drosophila*) *flumenicola* Watabe and Peng (1991, p. 152).

Drosophila (*Drosophila*) *potamophila*: Toda and Peng (1989, p. 159) (part, misidentified).

Diagnosis. Longest dorsal branch of arista longer than upper seta on pedicel (Fig. 36). Palpus distally dilated and roundish, subapically with 1 prominent seta longer than 2/3 of palpal length, and sometimes shorter lateral one (Fig. 37). C3F > 0.8. Surstylus with 8 or 9 prensisetae shorter than three times of width (Fig. 40). Aedeagus proximally largely expanded ventrad but with basal, inner margin parallel (Fig. 42a) or divergent (Fig. 42b) to aedeagal guide in lateral view, slightly concaved on distal, outer margin, with small warts on distal, medial portion of lateral surfaces (Fig. 42). Oviscapt apically narrowing, with 12–14 (1 stout apical, 10–12 marginal and 1 lateral) trichoid ovisensilla (Fig. 43).

Supplementary and revised description. Fronto-orbital plate anteriorly narrower than frontal vitta. Acrostichal setulae sparse, in 4–6 irregular rows. Foreleg 1st and 2nd tarsomeres in combination shorter than its tibia. Male sternite V concaved on posterior margin, with approximately 3 long setae on lateral margin but no dense, short setae medially on posterior margin (Fig. 38). Epandrium fused to cercus at middle; caudoventral margin of sclerotized portion seen sigmoidal due to existence of transparent patch there (Fig. 39). Cercus without tuft of setae/setulae around caudoventral corner or on ventral margin



Figures 36–43 *Drosophila* (*Drosophila*) *flumenicola* Watabe & Peng, 1991 (specimens from Amami Island, Japan, except for male from Jusso, Oguchi, Kagoshima Prefecture, Japan for 42a). 36 Antenna; 37 palpus; 38 male sternite V; 39 epandrium and cercus in lateral view; 40 surstylus; 41 phallic organs in ventral view; 42a,b aedeagus and paramere in left, lateral view; 43 oviscapt. Scales = 0.1 mm.

(Fig. 39). Hypandrium longer than wide, anteriorly rectangular (Fig. 41). Paramere small, located at distal portion of aedeagal guide (Fig. 42b). Anteroventral bridge of oviscapt shorter than half of oviscapt length. Spermathecal capsule small, membranous, irregular in shape; duct not introverted into capsule.

Measurements and indices (for 1 male and 5 females from Amami Island, Japan): BL = male: 2.96 mm, female: 2.80–3.20 mm, ThL = male: 1.32 mm, female: 1.12–1.36 mm, WL = male: 3.40 mm, female: 3.00–3.48 mm, WW = male: 1.16 mm, female: 1.16–1.36 mm, arb = male: 5/2, female: 4–5/2, FW/HW = male: 0.51, female: 0.46–0.53, ch/o = male: 0.16, female: 0.15–0.23, prorb = male: 0.69, female: 0.50–0.73, rcorb = male: 0.44, female: 0.40–0.45, orbito = male: 0.44, female: 0.50–0.63, vb = male: 0.42, female: 0.33–0.63, pprnl (lower postpronotal seta/upper postpronotal seta in length) = male: 0.80, female: 0.63–0.94, dc₁l (1st dorsocentral seta/4th dorsocentral seta in length) = male: 0.68, female: 0.54–0.63, dc₂l (2nd dorsocentral seta/4th dorsocentral seta in length) = male: 0.66, female: 0.53–0.65, dc₃l (3rd dorsocentral seta/4th dorsocentral seta in length) = male: 0.84, female: 0.63–0.78, ac₁l (presutural acrostichal seta/4th dorsocentral seta in length) = male: 0.45, female: 0.41–0.50, ac₂l (postsutural acrostichal seta/4th dorsocentral seta in length) = male: 0.58, female: 0.53–0.63, dc₁p (length distance between ipsilateral 1st and 2nd dorsocentral setae/cross distance between 3rd dorsocentral setae) = male: 0.54, female: 0.54–0.71, dc₂p (length dis-

tance between ipsilateral 2nd and 3rd dorsocentral setae/cross distance between 3rd dorsocentral setae) = male: 0.46, female: 0.44–0.60, dc₃p (length distance between ipsilateral 3rd and 4th dorsocentral setae/cross distance between 3rd dorsocentral setae) = male: 0.58, female: 0.44–0.63, sterno = male: 0.54, female: 0.54–0.78, sterno2 = male: 0.25, female: 0.17–0.26, sctl = male: 0.98, female: 0.85–1.00, sctlp = male: 0.43, female: 0.44–0.50, C = male: 2.72, female: 2.46–2.85, 4c = male: 0.92, female: 0.79–0.93, 4v = male: 1.92, female: 1.62–1.83, 5x = male: 1.13, female: 1.00–1.36, ac = male: 2.40, female: 2.20–2.58, M = male: 0.44, female: 0.38–0.48, C3F = male: 0.92, female: 0.76–0.86.

Specimens examined. Japan: 6 males, 11 females, Ashu, Kyoto Prefecture, Kinki, 10.viii.2005, H.Watabe leg.; 12 males, 21 females, Jusso, Oguchi, Kagoshima Prefecture, Kyushu, 120 m a.s.l., 29–31.ix.1996, H.Watabe leg.; 1 male, 9 females, Kamiyakukatsu, Amami Island, Kagoshima Prefecture, 75 m a.s.l., 11.iii.2004, M.Takahashi and H.Watabe leg. *China:* 1 male, 3 females (paratypes of *D. potamophila*: SEHU), Nankunshan, Guangdong, 28.viii.1987, ex traps, K.Beppu leg.; 1 female, Huangshan, Anhui, 30.viii.1991, H.Watabe leg.; 1 female, Qinggangshan, Jiangxi, 10.x.1992, H.Chen leg.; 1 male, Jianfengling, Ledong, Hainan, 800 m a.s.l., 24,25.ix.1993, M.J.Toda leg.

Distribution (new record).* Japan* (Kinki, Kyushu, Amami Is.), China (Zhejiang, Anhui, Jiangxi*, Guangdong, Hainan*) (Fig. 1).

Remarks. This species was originally described based on only male specimens (the holotype and 1 paratype) from Guangdong Province, China by Watabe and Peng (1991). Later, the description and illustrations of the female terminalia were supplemented by Chen and Watabe (1993) based on the female specimens from Anhui Province, China. This time, however, we re-examined two (from Huangshan) of the female specimens used by Chen and Watabe (1993), which have been preserved in the Biological Laboratory, Hokkaido University of Education, and confirmed their misidentification; i.e., the specimens are of *D. barutani*.

***Drosophila (Drosophila) lichuanensis* Zhang & Liang, 1994**

Drosophila (Drosophila) lichuanensis Zhang and Liang (1994, p. 214).

Distribution. China (Hubei) (Fig. 1).

Remarks. This species was described based on only the male holotype specimen collected from Xingdou Mountain, Lichuan, Hubei Province, China by Zhang and Liang (1994). In the light of the present study thoroughly reviewing the *quadrisetata* group, however, some characters described and illustrated, though brief and simple, respectively, in the original description suggest that this species is conspecific to *D. flumenicola*. Especially, the lateral aspect of the aedeagus [fig. 7 in Zhang and Liang (1994)] concaved on the distal, outer margin and with small warts (“spines”) on the distal, medial

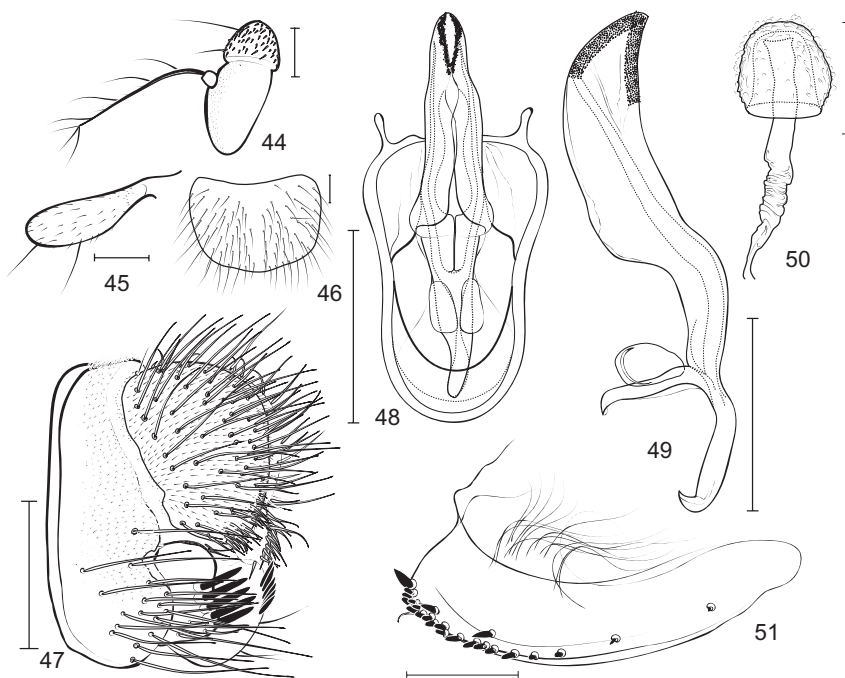
portion of lateral surfaces is very similar to that of *D. flumenicola* (Fig. 42). Although Zhang and Liang (1994) recognized a fusion of the cercus to the epandrium in *D. lichuanensis* as a difference from *D. flumenicola*, which was originally described as having the cercus separated from the epandrium (Watabe & Peng 1991), the present study has confirmed a fusion of the cercus to the epandrium in the latter species as well (Fig. 39). On the other hand, the fewer (“about 6”) and seemingly longer prensisetae (“primary teeth”) on the surstylus [fig. 5 in Zhang and Liang (1994)] suggest the similarity to *D. potamophila* (Figs 32,33). Therefore, we refrain from synonymizing *D. lichuanensis* Zhang & Liang, 1994 with *D. flumenicola* Watabe & Peng, 1991 until re-examination of the holotype of the former species.

***Drosophila (Drosophila) aotsukai* Suwito & Watabe, sp. nov.** (Figs 44–51)

Drosophila sp.T (tentative name for *Drosophila aotsukai* sp. nov.), Wang *et al.* (2006, p. 486).

Diagnosis. Aedeagus distally curved dorsad, apically somewhat pointed in lateral view (Fig. 49). Spermathecal capsule bell shaped, as long as wide, not wrinkled basally, with spinules over outer surface; introvert deep (Fig. 50).

Description. (male and female). Head: Eyes dark red, with dense interfacetal setulae. Frons dark brown, mat darker on frontal vittae and orbital plate, with 2 or 3



Figures 44–51 *Drosophila (Drosophila) aotsukai* Suwito & Watabe, sp. nov. (44–49 holotype; 50,51 female paratype from Fushan, Taiwan). 44 Antenna; 45 palpus; 46 male sternite V; 47 periphallalic organs in caudolateral view; 48 phallic organs in ventral view; 49 aedeagus and paramere in lateral view; 50 spermatheca; 51 oviscapt. Scales = 0.1 mm.

interfrontal setulae; fronto-orbital plate anteriorly as wide as frontal vitta. Anterior reclinate orbital seta situated slightly behind proclinate orbital seta. Face yellowish to gray brown; distance between antennal sockets much narrower than 1/4 socket width; carina high, as broad as 1st flagellomere. Antennal pedicel dark brown, with 2 thick setae; 1st flagellomere gray brown; arisal branches shorter than upper seta on pedicel (Fig. 44). Clypeus gray brown. Palpus distally dilated, roundish, with 2 prominent setae subapically and laterally (Fig. 45).

Thorax: Postpronotal lobe brown, ventrally paler. Scutum dark brown, with 2 pairs of obscure, longitudinal stripes inside and outside dorsocentral lines. Second dorsocentral setae situated behind transverse suture; pre- and postsutural acrostichal setae slightly behind 1st and 2nd dorsocentral setae, respectively. Acrostichal setulae in 4 irregular rows. Anepisternum dark brown; katepisternum brown. Scutellum dark brown, paler along lateral to posterior margin; anatergite brown, medially paler. Anterior scutellar setae parallel to slightly convergent. Halter whitish; stalk gray.

Wing faintly brownish fuscous; veins brown; cross-veins clear.

Legs dark yellowish gray, except for paler joints. Foreleg 1st and 2nd tarsomeres in combination as long as its tibia. All 1st tarsomeres longer than 4 succeeding in combination. Preapical dorsal setae present on all tibiae; apicals on fore- and midleg tibiae.

Abdomen: Tergites nearly entirely dark brown, except for anteromedial pale gray portion on II. Sternites yellowish brown; male V rectangular, medially convexed but without dense, short setae on posterior margin (Fig. 46).

Male terminalia: Epandrium pubescent, except anterior margin and lower ventral portion, narrowing from submedial to dorsal portions, dark at insertion of surstylus; ventral portion approximately twice as broad as dorsal portion, more or less angled at anteroventral and posteroventral corners, with approximately 21 long seta but no transparent patch/plate in caudoventral portion (Fig. 47); dorsal portion lacking setae. Surstylus quadrate, with 5 or 6 prensisetae longer than three times of width on lower, distal margin, approximately 3 trichoid setae at caudoventral corner and fine spinules or sculpture on upper portion of outer surface (Fig. 47). Cercus separated from epandrium, somewhat constricted subventrally, pubescent except for ventral margin, with approximately 48 long setae on nearly allover surface and dense setulae around caudoventral corner (Fig. 47). Hypandrium longer than wide, anteriorly semicircular, yellowish brown, bare (Fig. 48). Paramere oval, nearly transparent

(Figs 48,49). Aedeagus with 1 pair of sclerotized, dorsal ridges; aedeagal guide slightly shorter than aedeagal apodeme, horizontally flat, plate-like; apodeme approximately 0.25 as long as aedeagus (Fig. 49).

Female terminalia: Tergite VIII gray brown, pubescent only on dorsocaudal portion, ventrally with approximately 4 setae per side. Oviscapt with 2 lateral, trichoid ovisensilla, and approximately 11 marginal, peg-like ones; apicalmost one largest (Fig. 51); anteroventral bridge shorter than half of oviscapt length.

Measurement: BL = 4.24 mm in holotype (range in 4 male paratypes: 3.28–4.24 mm, range in 6 female paratypes: 3.60–4.28 mm), ThL = 2.04 mm (male: 1.68–2.04 mm, female: 1.68–2.08 mm), WL = 4.80 mm (male: 4.08–4.80 mm, female: 4.00–4.76 mm), WW = 1.84 mm (male: 1.36–1.84 mm, female: 1.44–1.76 mm).

Indices: arb = 4/1 (male: 4/1, female: 4–5/1–2), FW/HW = 0.52 (male: 0.49–0.56, female: 0.49–0.52), ch/o = 0.21 (male: 0.20–0.26, female: 0.18–0.24), pror = 0.21 (male: 0.21–0.46, female: 0.36–0.52), rcorb = 0.31 (male: 0.27–0.32, female: 0.21–0.31), orbito = 0.55 (male: 0.50–0.63, female: 0.56–0.82), vb = 0.28 (male: 0.28–0.40, female: 0.32–0.53), pprnl = 0.53 (male: 0.49–0.78, female: 0.50–0.72), dc₁l = 0.57 (male: 0.57–0.64, female: 0.51–0.67), dc₂l = 0.54 (male: 0.54–0.69, female: 0.57–0.67), dc₃l = 0.76 (male: 0.76–0.81, female: 0.71–0.90), ac₁l = 0.52 (male: 0.51–0.55, female: 0.49–0.55), ac₂l = 0.57 (male: 0.55–0.57, female: 0.54–0.57), dc₁p = 0.59 (male: 0.54–0.64, female: 0.48–0.70), dc₂p = 0.62 (male: 0.50–0.77, female: 0.52–0.63), dc₃p = 0.55 (male: 0.50–0.68, female: 0.52–0.67), sterno = 0.89 (male: 0.59–0.89, female: 0.61–0.77), sterno2 = 0.25 (male: 0.14–0.25, female: 0.13–0.29), sctl = 0.90 (male: 0.79–0.96, female: 0.82–1.00), sctlp = 0.50 (male: 0.46–0.77, female: 0.51–0.58), C = 4.11 (male: 3.67–4.11, female: 3.49–4.47), 4c = 0.56 (male: 0.56–0.69, female: 0.53–0.73), 4v = 1.43 (male: 1.43–1.77, female: 1.47–1.80), 5x = 0.96 (male: 0.95–1.05, female: 0.67–0.85), ac = 1.67 (male: 1.63–1.74, female: 1.52–1.94), M = 0.35 (male: 0.35–0.43, female: 0.38–0.48), C3F = 0.80 (male: 0.79–0.88, female: 0.79–0.91).

Holotype. Male (TFRI), “Chitou, Taiwan, China, 10.iii.1992, H.Watabe leg.”

Paratypes. **Taiwan**: 1 male, same data as holotype; 3 males, 6 females, Fushan, Taiwan, 18.iv.1999, H.Watabe leg.; 1 male, 1 female, Fushan, Taiwan, 25–26.iv.2006, M. Takahashi and H.Watabe leg.

Distribution. Taiwan (Fig. 1).

Habitat. This species inhabits streamsides in forests at high altitudes (>1000 m a.s.l.) with relatively cool

climates. They were resting in bamboo stumps beside the river when raining.

Remarks. This species resembles *D. barutani* in having the fronto-orbital plate anteriorly as wide as the frontal vitta, the foreleg 1st and 2nd tarsomeres in combination as long as its tibia, and the spermathecal capsule as long as wide. However, the male is very special among the species of the *quadrisetata* group in having the aedeagus distally curved dorsad and apically somewhat pointed in lateral view, and the female can be distinguished from that of *D. barutani* by the spermathecal capsule bearing spinules over outer surface (smooth in *D. barutani*).

Etymology. This species is named in honor of Dr. Tadashi Aotsuka (Department of Biology, Tokyo Metropolitan University, Japan), who has been leading projects on Oriental drosophilids for many years.

***Drosophila (Drosophila) rinjaniensis* Suwito & Watabe, sp. nov.** (Figs 52–59)

Diagnosis. Aristal branches shorter than upper seta on pedicel (Fig. 52). Male sternite V medially somewhat constricted but without dense, short setae on posterior margin (Fig. 54). Cercus with tuft of setulae around caudoventral corner (Fig. 55). Spermathecal capsule small (approximately 0.06 mm in diameter), less sclerotized, roundish but irregular; duct not introverted into capsule (Fig. 58).

Description. (male and female). Some characters commonly seen in the foregoing species, *D. aotsukai* Suwito

& Watabe, sp. nov., are not referred to in the following description.

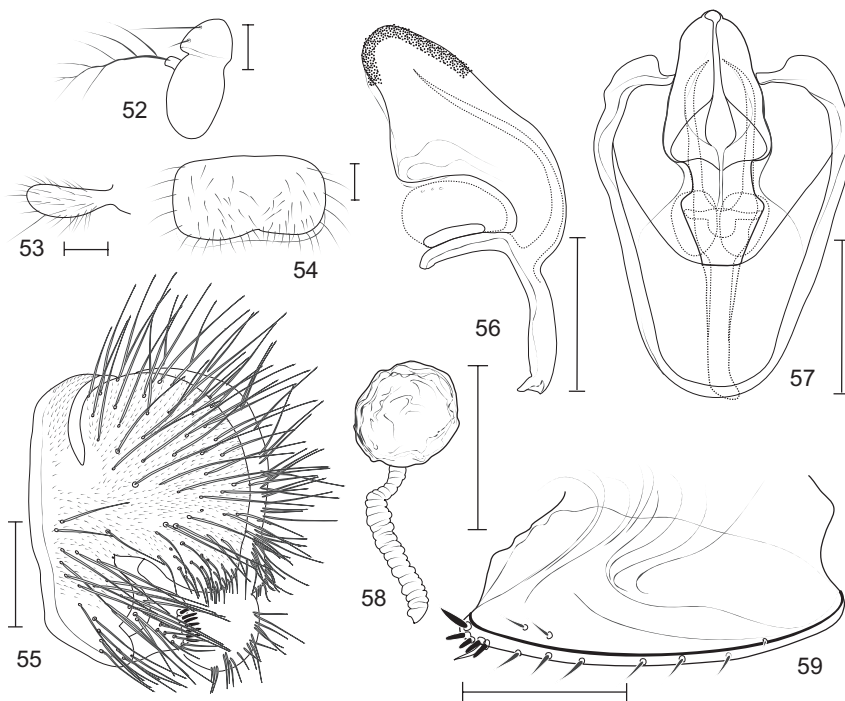
Head: Fronto-orbital plate anteriorly narrower than frontal vitta. Facial carina narrower than 1st flagellomere. Antennal pedicel yellowish dark brown. Clypeus yellowish dark brown. Palpus slender, with 1 or 2 longer setae laterally (Fig. 53).

Thorax: Postpronotal lobe pale brown. Anepisternum and katepisternum gray brown. Scutellum dark brown; anatergite brown. Halter and stalk gray brown.

Legs yellowish brown, except for paler joints. Foreleg 1st and 2nd tarsomeres in combination shorter than its tibia. Foreleg 1st tarsomere as long as 4 succeeding in combination.

Abdomen: Tergites nearly entirely dark brown; II–V each with dark line on posterior margin. Sternites gray yellow.

Male terminalia: Epanthrium with approximately 21 long seta; caudoventral margin of sclerotized portion seen sigmoidal due to existence of transparent patch there (Fig. 55). Surstylus with 7 or 8 prenisetae three times as long as wide in straight row on distal margin and approximately 9 trichoid setae on caudoventral portion (Fig. 55). Cercus widely (in approximately half length of cercus) fused to medial portion of epanthrium, pubescent except for ventral margin, with approximately 43 setae on nearly allover surface (Fig. 55). Paramere nearly transparent except for narrow, brown portion adjoining to aedeagal guide,



Figures 52–59 *Drosophila (Drosophila) rinjaniensis* Suwito & Watabe, sp. nov. (52–57 holotype; 58,59 female paratype from Lombok, Indonesia). 52 Antenna; 53 palpus; 54 male sternite V; 55 periphallallic organs in lateral view; 56 aedeagus and paramere in lateral view; 57 phallic organs in ventral view; 58 spermatheca; 59 oviscapt. Scales = 0.1 mm.

large, oval in lateral view, with small patch of pubescence (Fig. 56). Aedeagus curved ventrad, proximally largely expanded ventrad, apically not pointed; apodeme approximately half as long as aedeagus (Fig. 56).

Female terminalia: Tergite VIII ventrally with approximately 2 setae per side. Oviscapt apically narrowing, with 2 lateral and approximately 7 proximal, marginal, trichoid ovisensilla, and approximately 5 distal, marginal, peg-like ones (Fig. 59).

Measurement: BL = 2.68 mm in holotype (range in 9 male paratypes: 2.60–3.08 mm, range in 10 female paratypes: 2.64–3.20 mm), ThL = 1.12 mm (male: 1.12–1.28 mm, female: 1.12–1.36 mm), WL = 2.92 mm (male: 2.84–2.92 mm, female: 2.8–3.08 mm), WW = 1.04 mm (male: 1.00–1.12 mm, female: 0.96–1.28 mm).

Indices: arb = 5/1–2 (male: 4–5/1, female: 4–5/1–2), FW/HW = 0.44 (male: 0.44–0.49, female: 0.43–0.49), ch/o = 0.18 (male: 0.12–0.18, female: 0.13–0.19), pror = 0.25 (male: 0.25–0.65, female: 0.42–0.58), rcorb = 0.32 (male: 0.27–0.53, female: 0.32–0.45), orbito = 0.75 (male: 0.60–0.75, female: 0.50–0.88), vb = 0.33 (male: 0.18–0.42, female: 0.33–0.50), pprnl = 0.83 (male: 0.57–0.83, female: 0.54–1.00), dc₁l = 0.52 (male: 0.48–0.65, female: 0.56–0.76), dc₂l = 0.59 (male: 0.45–0.69, female: 0.60–0.72), dc₃l = 0.69 (male: 0.61–0.78, female: 0.72–0.85), ac₁l = 0.41 (male: 0.32–0.50, female: 0.43–0.52), ac₂l = 0.48 (male: 0.35–0.59, female: 0.45–0.63), dc₁p = 0.65 (male: 0.43–0.65, female: 0.48–0.59), dc₂p = 0.59 (male: 0.43–0.64, female: 0.43–0.64), dc₃p = 0.53 (male: 0.45–0.64, female: 0.48–0.59), sterno = 0.76 (male: 0.65–0.89, female: 0.52–0.89), sterno2 = 0.16 (male: 0.13–0.30, female: 0.16–0.33), sctl = 0.91 (male: 0.81–1.00, female: 0.84–1.00), sctlp = 0.46 (male: 0.46–0.57, female: 0.41–0.56), C = 2.66 (male: 2.32–2.79, female: 2.29–2.84), 4c = 0.97 (male: 0.88–1.15, female: 0.94–1.19), 4v = 1.87 (male: 1.87–2.29, female: 1.82–2.38), 5x = 1.64 (male: 1.64–2.00, female: 1.55–2.45), ac = 2.23 (male: 2.07–2.80, female: 2.14–2.46), M = 0.60 (male: 0.56–0.86, female: 0.57–0.93), C3F = 0.86 (male: 0.81–0.90, female: 0.81–0.94).

Holotype. Male (MZB), “Sendan Gila Waterfall, Senaru Village, Bayan, Lombok, 8°18' 19.98" S, 116°24'24.73" E, 459 m a.s.l., 29.xi.2005, H.Watabe, M.Takahashi and A.Suwito leg.”

Paratypes. **Indonesia:** 43 males, 27 females, same data as holotype, except 29–30.xi.2005; 2 males, Tukad Campuhan, Penebel, Baturiti, Taban, Bali, 8°13'19.1"S, 115°05'45.6"E, 611 m a.s.l., 3.xii.2005, H.Watabe, M.Takahashi and A.Suwito leg.

Distribution. Indonesia (Bali Island, Lombok Island) (Fig. 1).

Habitat. This species inhabits streamsides at lowlands (<650 m a.s.l.) in Bali and Lombok Islands. In Bali, this species was collected, along with *Drosophila baliensis* Suwito & Watabe, 2010 of the *robusta* species group, just beside a river running through paddy fields of villages (Suwito & Watabe 2010).

Remarks. This species resembles *D. potamophila* and *D. flumenicola* in having the male sternite V medially concaved on the posterior margin and the less sclerotized, irregularly shaped spermathecal capsule without introvert of duct, but differs from them in the arisal branches shorter than upper seta on the pedicel.

Etymology. Referring to the Mt. Rinjani of the type locality in Lombok Island.

Drosophila (Drosophila) sundaensis Suwito & Watabe, sp. nov. (Figs 60–69)

Diagnosis. Proximal, arisal branches longer than upper seta on pedicel (Fig. 60). Foreleg 1st and 2nd tarsomeres in combination as long as its tibia. Hypandrium as long as wide, anteriorly somewhat triangular (Fig. 66). Oviscapt apically narrowing, with 1–2 lateral and approximately 12 marginal, trichoid ovisensilla, and approximately 3 apical, peg-like ones; apicalmost one largest (Fig. 69).

Description (male and female). Some characters commonly seen in *D. aotsukai* Suwito & Watabe, sp. nov. are not referred to in the following description.

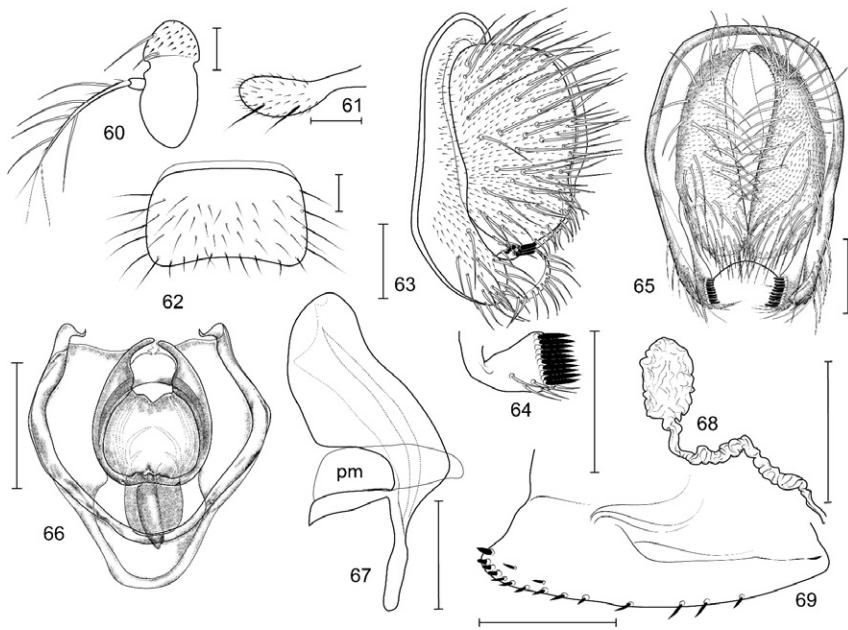
Head: Frons anteriorly lighter. Fronto-orbital plate anteriorly narrower than frontal vitta. Anterior reclinate orbital seta situated just outside proclinate orbital seta. Facial carina narrower than 1st flagellomere. Clypeus gray brown, medially darker. Palpus distally dilated and somewhat thickened, with 2 prominent setae laterally (Fig. 61).

Thorax: Postpronotal lobe pale brown. Anepisternum gray brown; katapisternum pale brown. Scutellum dark brown, darker along lateral to posterior margins; anatergite yellowish brown. Halter whitish gray; stalk pale brown.

Legs dark yellowish gray, except for paler femora and joints.

Abdomen: Tergites nearly entirely dark brown, often with very small, pale patch medially on anterior margin of each of III to V in male. Sternites pale yellow, quadrate; male V nearly straight but medially without dense, short setae on posterior margin, with 4–5 long setae on lateral margin (Fig. 62).

Male terminalia: Epandrium with approximately 22 setae; caudoventral margin roundish (Fig. 63). Surstylus with 9 or 10 pensisetae longer than three times of width



Figures 60–69 *Drosophila* (*Drosophila*) *sundaensis* Suwito & Watabe, sp. nov. (paratype specimens from Mt. Halimun, West Java, Indonesia). 60 Antenna; 61 palpus; 62 male sternite V; 63 epandrium and cercus in lateral view; 64 surstylus; 65 periphallallic organs in caudal view; 66 phallic organs in ventral view; 67 aedeagus and paramere in lateral view; 68 spermatheca; 69 oviscapt. Scales = 0.1 mm.

in straight row on distal margin, approximately 5 trichoid setae around caudoventral corner (Fig. 64). Cercus narrowly fused to epandrium, pubescent except ventral portion, with approximately 45 long setae on nearly allover surface (Figs 63,65). Hyandrial, posterolateral lobes hemispheric in lateral view. Paramere transparent, large, roundish ventrally, but tapering and extending dorsally to lateral side of aedeagal, basal portion (Fig. 67). Aedeagus curved ventrad, proximally largely expanded ventrad, apically not pointed, concaved on distal, outer margin in lateral view, without warts on lateral surfaces; apodeme approximately 0.45 as long as aedeagus (Fig. 67).

Female terminalia: Tergite VIII ventrally with approximately 2 setae per side. Spermathecal capsule small, membranous, irregular in shape; duct not introverted into capsule (Fig. 68).

Measurements: BL = 3.00 mm in holotype (range in 9 male paratypes: 2.60–3.36 mm, range in 10 female paratypes: 2.76–3.32 mm), ThL = 1.36 mm (male: 1.08–1.48 mm, female: 1.32–1.48 mm), WL = 3.00 mm (male: 2.84–3.64 mm, female: 3.20–3.72 mm), WW = 1.28 mm (male: 1.00–1.48 mm, female: 1.08–1.40 mm).

Indices: arb = 4/2 (male: 3–4/1–2, female: 3–4/1–2), FW/HW = 0.45 (male: 0.44–0.51, female: 0.45–0.51), ch/o = 0.16 (male: 0.13–0.20, female: 0.13–0.18), prorb = 0.48 (male: 0.35–0.69, female: 0.44–0.67), rcorb = 0.29 (male: 0.25–0.56, female: 0.32–0.50), orbito = 0.56 (male: 0.44–0.78, female: 0.44–0.75), vb = 0.33 (male: 0.20–0.41, female: 0.28–0.50),

pprnl = 0.56 (male: 0.58–0.85, female: 0.52–0.90), dc₁l = 0.68 (male: 0.50–0.69, female: 0.45–0.76), dc₂l = 0.71 (male: 0.61–0.69, female: 0.58–0.76), dc₃l = 0.87 (male: 0.80–0.87, female: 0.76–0.93), ac₁l = 0.45 (male: 0.47–0.59, female: 0.45–0.64), ac₂l = 0.55 (male: 0.46–0.59, female: 0.49–0.71), dc₁p = 0.65 (male: 0.60–0.75, female: 0.59–0.80), dc₂p = 0.55 (male: 0.46–0.65, female: 0.55–0.70), dc₃p = 0.60 (male: 0.45–0.65, female: 0.45–0.72), sterno = 0.82 (male: 0.59–0.84, female: 0.57–0.96), sterno2 = 0.18 (male: 0.11–0.29, female: 0.13–0.32), sctl = 0.95 (male: 0.86–1.11, female: 0.75–1.03), sctlp = 0.47 (male: 0.42–0.67, female: 0.35–0.55), C = 3.00 (male: 3.00–3.62, female: 3.00–3.62), 4c = 0.82 (male: 0.71–0.77, female: 0.68–0.78), 4v = 1.74 (male: 1.58–1.76, female: 1.50–1.85), 5x = 1.31 (male: 1.00–1.43, female: 1.07–1.33), ac = 2.29 (male: 1.87–2.29, female: 1.76–2.36), M = 0.44 (male: 0.37–0.50, female: 0.38–0.73), C3F = 0.94 (male: 0.89–1.00, female: 0.85–1.00).

Holotype. Male (MZB), “Cibodas, Mt. Gede-Pangrango, West Java, Indonesia, 6°26′35.3″S, 107°00′10.8″E, 1350 m a.s.l., 13.xii.2004, H.Watabe and E.Cholik leg.”.

Paratypes. **Indonesia**: 15 males, 10 females, same data as holotype, except 12–13.xii.2004; 12 males, 4 females, Cikaniki, Mt. Halimun, West Java, 6°26′17.6″S, 106°18′53.2″E, 1160 m a.s.l., 14–15.xii.2004, H.Watabe and E.Cholik leg.; 46 males, 39 females, Cikaniki, Mt. Halimun, West Java, 5–10.xi.2009, A.Suwito leg.; 1 male, 1 female Curug Sabuk, Mt.

Ciremai, West Java, 27.x.2008, A.Suwito leg.; 1 female, Cilengkrang, Mt. Ciremai, West Java, 6°56'08.9"S 108°26'03.6"E, 1143 m a.s.l., 27.x.2008, A.Suwito leg.; 1 male, Coban Kembar, East Java, 27.xi.2005, H.Watabe and A.Suwito leg.; 4 males, 2 females, Mt. Tujuh, Kerinci Seblat, West Sumatra, 4–5.xii.2004, H.Watabe and A.Suwito leg.; 2 males, 2 females, Air Sirah, Kabupaten, Solok, West Sumatra, 9.xii.2004, H.Watabe and A.Suwito leg.; 14 males, 7 females, Sakokiri River, Kerinci Seblat, Jambi, West Sumatra, 6.xii.2004, H.Watabe and A.Suwito leg.

Distribution. Indonesia (West Sumatra, West Java, East Java) (Fig. 1).

Habitat. This species coexists with *D. potamophila* and *D. beppui* of the same group and *D. sungaicola*, *D. barobusta* and *D. hitam* of the *robusta* group reported by Suwito and Watabe (2010), inhabiting streambanks at highlands (>1038 m a.s.l.) with relatively cool climates from West Sumatra to East Java.

Remarks. This species resembles *D. potamophila* and *D. flumenicola* in having the C3F index almost 1.0 and the small, membranous, irregularly shaped spermathecal capsule without introvert of duct. However, the new species can be distinguished from these species by the longer foreleg 1st and 2nd tarsomeres, the shorter, anteriorly somewhat triangular hypandrium and the presence of peg-like oviscapta on the oviscapta.

Etymology. Referring to the Sunda Islands, including Sumatra and Java Islands, of the type locality.

Key to species of the *Drosophila quadrisetata* species group

The multiple-entry key “*Drosophila quadrisetata* species group” to all species of this group has been constructed based on a database of morphological characters, and is available from the website “Biological Classification and Identification System (BioCIS: <http://biokey.museum.hokudai.ac.jp/Classification/index.jsp>)”.

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