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# Anthophilic *Drosophila* of the *elegans* Species-subgroup from Indonesia, with Description of a New Species (Diptera: Drosophilidae)

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**Abstract.** A new species of the *Drosophila* (*Sophophora*) *elegans* species-subgroup is described based on specimens collected from morning glory (*Ipomoea*) and trumpet (*Brugmansia*) flowers at various localities in Java and Sumatra, Indonesia. Altitudinal distributions, host plants and tolerance abilities to heat and cold are provided for the new species and its relative, *D. elegans*.

**Key words**: *elegans* species-subgroup, Drosophilidae, new species, flower-visiting, Indonesia.

## Introduction

Most of drosophilid flies feed and breed on decayed or fermented vegetable materials such as fruits, flowers, leaves, mushrooms, or tree sap. It is, however, known that a number of species are specialized to utilize living flowers especially in tropical regions (Bruncic, 1983). Many of such anthophilic species prefer tubular flowers such as morning glory (*Ipomoea*), trumpet (*Brugmansia* previously cited as *Datura*), melon, and *Hibiscus* flowers (Carson, 1971; Bruncic, 1983). In the Oriental region including New Guinea, the *Drosophila* (*Sophophora*) *elegans* species-subgroup of the *melanogaster* species-group, which consists of four described species, is known to be anthophilous: two species, *D. elegans* Bock et Wheeler, 1972 and *D. sahyadrii* Prakash et Sreerama Reddy, 1979, were found in morning glory flowers (Prakash & Sreerama Reddy, 1979; Okada & Carson, 1982; Lemeunier *et al.*, 1986; Hirai & Kimura, 1997). Here, we describe a new species of this subgroup based on specimens collected from morning glory and trumpet flowers in mountain areas of Java and Sumatra and provide notes on altitudinal distributions, host plants and tolerance abilities to heat and cold of the new species and its relative, *D. elegans*.

## Materials and Methods

Drosophilid flies coming to flowers of *Ipomoea cairica* (Linneaus), *I. indica* (Burman), *Brugmansia candida* Persoon, and *B. suaviolens* (Humboldt et Bonpland) were collected at various localities ranging from about 10 m to 1,400 m above sea level in Sumatra, Java, and West Kalimantan, Indonesia. All the specimens were preserved in 70% ethanol. External morphological characters were observed under a stereoscopic microscope and metric characters were measured with an ocular micrometer. To observe the detailed structure of the head, the male fore leg, and the male and female terminalia, respective organs were detached from the body, cleared by warming in a 10% KOH solution around 100°C for several minutes, and observed in a droplet of glycerol under a compound light microscope. Drawings were made with the aid of camera lucida.

To understand adaptations of the new species described here and *D. elegans* to local temperature conditions, their tolerance abilities to heat and cold were compared. Experimental strains of both species originated from Sukarami (1,000–1,200 m a.s.l.) in western Sumatra and were maintained for a year in laboratory (15 h light : 9 h dark, 23°C) before experimentation. Experimental flies were reared from the egg stage under 15 h light : 9 h dark at 23°C. Eight-day old flies were transferred to new vials with food medium on the bottom and filter paper on the wall and directly exposed to cold (3–8°C) and heat (30–34°C) for 24 h. The food medium keeps moisture in the vials and the paper prevents flies from being caught by water drops on the wall. After heat or cold treatment, flies were placed at 23°C for 24 h and examined for survival. Usually, more than 30 individuals were used to examine survival at each temperature. Cornmeal-malt medium was used to rear flies.

## Description

***Drosophila (Sophophora) gunungcola*** **sp. nov.**
(Fig. 1)

*Diagnosis.* Male wing entirely hyaline, without black patch around apex. First 3 tarsomeres of ♂ fore leg each with transverse sex-combs on distal half: 1st tarsomere with 3 to 5 rows (consisting of 0–1, 0–3, 2–3, and 2–4 teeth, respectively); 2nd with 2 or 3 rows (0–3, 2–4, and 2–3); 3rd with 2 teeth arranged vertically (Fig. 1F). Aedeagal basal process apically strongly sclerotized and pointed, subapically with several large serrations (Fig. 1C). Oviscapt apically round, with about 19 peg-like ovisensilla arranged irregularly (Fig. 1D).

*Description of ♂ and ♀.* Head: Supracervical setae about 12–13 per side, tapered, thin, apically curved and sharp. Postocular setae about 15–18 per side. Ocellar triangle dark brown. Frontal vitta yellowish brown, anteriorly with a few interfrontal setulae. Fronto-orbital plate grayish brown, glossy. Face yellowish gray, darker below; carina high, broad below. Pedicel grayish brown; lst flagellomere grayish yellow. Gena yellowish brown, glossy. Clypeus dark brown. Palpus gray, with 1 prominent terminal and another shorter, thinner lateromedian setae. Cibarium thickened on anterior margin, distinctly protruded at anterolateral corners; dorsal wall pear-shaped in dorsal view, anteriorly slightly convex in lateral view; anterior cibarial sensilla 4, arranged in square, situated fairly posteriorly of anterior margin of hypopharynx; medial and posterior cibarial sensilla about 6–7 and 12–13 per side, respectively; hypopharyngeal apodeme expanded in anterior portion. Prementum slightly swelling at distal end.

Thorax entirely dark brown, glossy. Postpronotal lobe with 2 prominent, subequal setae. Acrostichal setulae in 8 rows; acrostichals in line with and anterior to dorsocentrals the same in size as others. Dorsalmost seta of a row of small setae ventral to and between 2 prominent katepisternals slightly longer than others. Prescutellar setae absent. Basal scutellar setae convergent; apicals crossed each other.

Wings hyaline, slightly fuscous. Veins grayish yellow; crossveins clear. Bm-cu crossvein absent. $R_{2+3}$ nearly straight but only slightly curved to costa at tip; $R_{4+5}$ and $M_1$ nearly parallel. $C_1$ setae 2, subequal. Halter pale gray.

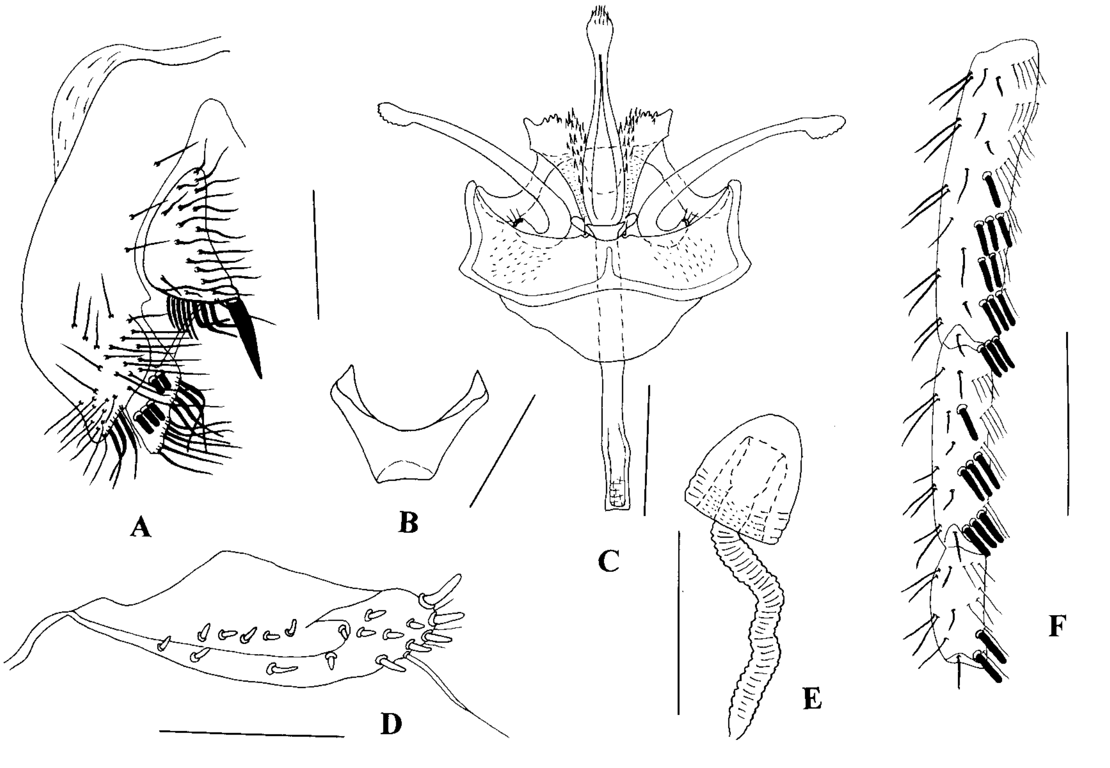


Fig. 1. *Drosophila* (*Sophophora*) *gunungcola* sp. nov. ♂ and ♀ (paratypes from Air Panas Canngar, Java, Indonesia) —— A, Epandrium, surstylus and cercus; B, 10th sternite; C, hypandrium, parameres, gonopods and aedeagus; D, oviscapt; E, spermatheca; F, first 3 tarsomeres of ♂ fore leg. (Scale-line = 0.1 mm).

Legs: Coxae, femora, and tibiae dark brown; tarsi grayish yellow. Preapical dorsal seta present on each tibia; apicals on each of fore and mid tibiae. Fore 1st tarsomere slightly shorter than 3 succeeding tarsomeres together; mid and hind 1st tarsomeres each slightly longer than 3 succeedings together. Mid and hind tarsi without any rows of cuneiform setulae.

Abdomen: ♂: Tergites nearly entirely grayish brown. Sternites grayish yellow to brown; anterior ones paler; VI dark brown, about thrice wider than long. ♀: Tergites I and II nearly entirely grayish brown; III to V each anteriorly grayish yellow and posteriorly with broad, grayish brown caudal band; VI entirely pale yellow. Sternites pale yellow.

Male terminalia: Tergite VII dark brown, much larger than cercus. Epandrium dark brown, entirely unpubescent, mid-dorsally strongly constricted, caudoventrally roundly expanded and covering base of surstylus, with about 3 bristles near upper to middle caudal margin, about 26 on ventral part, and about 3 especially stout ones on caudoventral margin just below expansion (Fig. 1A). Surstylus dorsally fused to epandrium, with 2 combs of apically rounded, black, peg-like prensisetae (upper one consisting of 2 teeth; lower one of 3 teeth) on medial mesal surface, about 4 curved, stout setae on mediocaudal margin, and about 6 setae along caudoventral margin (Fig. 1 A). Tenth sternite with trapezoid median lobe and 1 pair of dorsal, large arms (Fig. 1B). Cercus grayish brown, entirely unpubescent, separated from epandrium, slightly concave on caudal margin, distinctly thickened on ventral margin, with 1 very large, black, apically pointed spine at caudoventral apex, tuft of about 3–4 curved, stout setae at lateroventral corner, and about 18 setae distributed over (Fig. 1A). Hypandrium wider than long, laterally highly pubescent, with 1 pair of small paramedian setae on mediocaudal margin (Fig. 1C). Paramere articulating with base of aedeagus but free from hypandrium, recurved and very much elongated posteriod, with marginally finely serrated, round expansion at posterior end and about 3 sensilla at tip of anterior, shorter process (Fig. 1C). Gonopods connected with each other medially by small, thin plate (Fig. 1C). Aedeagus broad in basal half, narrow distally, but slightly dilated and hirsute apically, articulating with apodeme; basal process broad, apically fused to gonopod, with numerous finger-like processes basally to medially; apodeme rod-shaped, longer than aedeagus; aedeagal guide absent (Fig. 1C).

Female terminalia: Tergite VII dorsally separated into 2 lateral lobes, pubescent except for anterior and posterior margins. Sternite VII V-shaped, deeply notched caudomedially, unpubescent on caudal arms. Anteroventral bridge of oviscapt narrow, about half as long as lateral lobe. Cerci + epiproct and hypoproct entirely unpubescent. Spermathecal capsule brown, somewhat conical, slightly wrinkled in basal part; introvert about 3/4 as deep as height of capsule, basally wrinkled (Fig. 1E).

Measurements: BL (body length) = 2.15 mm in holotype (range in 9♂ and 10♀ paratypes: 1.88–2.38 in ♂, 2.08–2.67 in ♀); ThL (thorax length) = 0.96 mm (0.76–0.99 in ♂, 0.83–1.02 in ♀); WL (wing length) = 1.96 mm (1.58–1.98 in ♂, 1.78–2.05 in ♀); WW (wing width) = 0.89 mm (0.73–1.80 in ♂, 0.79–0.96 in ♀).

Indices: arb (dorsal branches of arista/ventral branches of arista) = 3/2 (3/2), FW/HW (frontal width/head width) = 0.44 (0.45–0.50), ch/o (maximum width of gena/maximum diameter of eye) = 0.16 (0.13–0.25), prorb (proclinate orbital/posterior reclinate orbital) = 1.00 (0.78–1.08), rcorb (anterior reclinate orbital/posterior reclinate orbital) = 0.50 (0.30–0.54), vb (subvibrissa/vibrissa) = 0.61 (0.44–0.78), dcl (anterior dorsocentral/posterior dorsocentral) = 0.67 (0.50–0.71), sctl (basal scutellar/apical scutellar) = 0.84 (0.64–1.08), sterno (anterior katepisternal/posterior katepisternal) = 0.60 (0.45–0.82), orbito (distance between proclinate and posterior reclinate orbitals/distance between inner vertical and posterior reclinate orbital) = 0.87 (0.62–0.93), dcp (distance between ipsilateral dorsocentrals/cross distance between anterior dorsocentrals) = 0.48 (0.38–0.49), sctlp (distance between ipsilateral scutellars/cross distance between apical scutellars) = 1.11 (1.00–1.44), C = 2.22 (1.83–2.50), 4c = 1.13 (1.03–1.50), 4v = 2.19 (2.12–3.08), 5x = 2.60 (1.70–2.73), ac = 3.00 (2.43–3.27), M = 0.81 (0.68–1.07), C3F = 0.50 (0.33–0.55).

Holotype ♂, Indonesia: Coban Rondo, Java, 29.X. 1994, ex *B. suaviolens* flower, 1,400 m a.s.l., M. T. Kimura leg. (MZB: Museum Zoologicum Bogoriense, Bogor, Indonesia).

Paratypes: Indonesia: 1♂, 4♀, same data as holotype; 30 ♂, 26 ♀, ex *B. suaviolens* flowers, 15 ♂, 35 ♀, ex *B. candida* flowers, Air Panas Canngar, Java, 29. X.1994, 1,400 m a.s.l.; 6♂, 5♀, Puncak, Java, 5.XI. 1994, ex *B. candida* flowers, 1,000 m a.s.l.; 4♂, 3♀, Cibodas, Java, 2.XI.1994, ex *B. candida* flowers, 1,200 m a.s.l.; 5♂, 2♀, Sukarami, Sumatra, 10.XI.1994, ex *I. indica* flowers, ca. 1,200 m a.s.l.; M. T. Kimura leg. (MZB, EHU: Entomological Institute, Hokkaido University, Sapporo, Japan).

*Distribution.* Indonesia (Java, Sumatra).

*Relationship.* This new species certainly belongs to the *D.* (*Sophophora*) *elegans* species-subgroup because of having the transverse sex-combs on the first 3 tarsomeres of ♂ fore leg and the posteriod recurved and much elongated paramere, but can be easily distinguished from the other members by the ♂ wing lacking the apical black patch. Among the other members of the *elegans* subgroup, *Drosophila* (*Sophophora*) *neoelegans* Gupta et Singh, 1977 is most closely related to the present new species in having the paramere with marginally finely serrated, round expansion at the posterior end, but different from it in the body color (generally yellowish in *neoelegans*), the numbers of rows and teeth of sex-combs (0–2, 2, and 3 teeth on the 1st tarsomere; 0–2, 2–3, and 2–4 on the 2nd; 1 and 1 on the 3rd), and the number of prensisetae (the upper comb consisting of 6 teeth and the lower of 2) in addition to other diagnostic features.

*Etymology.* Referring to its habitat mostly restricted to high mountains: "gunung" means mountain in Indonesian.

*Remarks.* The authors who described the members of the *elegans* species-subgroup referred to one pair of large lobes that are ornamented with numerous finger-like or conical processes or bristles (?) and situated laterodorsally to the aedeagus as the posterior parameres (Bock & Wheeler, 1972; Gupta & Singh, 1977), the posterior gonopophyses (Prakash & Sreerama Reddy, 1979), or the parameres (Okada, 1988). However, we defined this organ as the basal process of aedeagus. Homologous organs are seen not only in most species of the subgenus *Sophophora* Sturtevant but also in the genus *Lordiphosa* Basden and *Scaptodrosophila* Duda of the subfamily Drosophilinae and even in some taxa of the Steganinae: in the subgenus *Phortica* Schiner for instance, one pair of rod-like or plate-like processes extend posteriorly from the base of aedeagus and apically articulate with the gonopod (Toda & Peng, 1990, 1992).

## Altitudinal Distribution, Host Plants, and Tolerance to Heat and Cold

Table 1 shows all the collection records of drosophilid flies from morning glory and trumpet flowers in Indonesia. *Drosophila gunungcola* sp. nov. seemed to separate its habitat altitudinally from that of its relative, *D. elegans*: the former was almost restricted to high altitudes, more than 1,200 m a.s.l. in western Sumatra and 1,000 m a.s.l. in Java, while the latter was distributed from lowlands to highlands, although they were sympatric at Sukarami (1,200 m a.s.l.) in Sumatra and at Puncak (1,000 m a.s.l.) in Java.

Host plants of *D. elegans* were *Ipomoea cairica* at lowlands but *I. indica* or *Brugmansia candida* at highlands, although only one individual was collected from the last plant. It has been confirmed that this species uses at least *Ipomoea* flowers for breeding (Toda & Kimura, unpubl.). On the other hand, *D. gunungcola* sp. nov. was collected from *I. indica* together with *D. elegans* at Sukarami (1,200 m a.s.l.) in Sumatra, but exclusively from *Brugmansia* flowers in Java (breeding of this species has not been studied). The difference in host utilization between these two anthophilic *Drosophila* species partly reflects the difference in altitudinal distribution of host plants. In western Sumatra, *I. cairica* usually grows below 1,000 m a.s.l. Therefore, this plant is unavailable for *D. gunungcola* sp. nov. which occurs above 1,000 m in altitude. On the other hand, *I. indica, B. suaviolens,* and *B. candida* are available for *D. gunungcola* sp. nov. since they usually grow at high altitudes more than 1,000 m a.s.l. in Java and Sumatra. However, *B. suaviolens* and *B. candida* are not native to Southeast Asia but were introduced from South America. Therefore, *Ipomoea* flowers would be native host of these *Drosophila* species. Okada & Carson (1982) reported that *D. elegans* breeds on flowers of *I. carnea* Austin in New Guinea.

Table 1. Number of individuals of *Drosophila* species collected from flowers of *Ipomoea cairica* (*Ic*), *I. indica* (*Ii*), *Brugmansia candida* (*Bc*) and *B. suaviolens* (*Bs*) at various localities (PD: Padang, SK: Sukarami, BG: Bogor, PC: Puncak, CI: Cibodas, AP: Air Panas Canngar, CR: Coban Rondo, PN: Pontianak) in Indonesia (numerals in parentheses indicate approximate altitudes: m above sea level). Collection was made in December, 1996 at Pontianak and in October and November, 1994 at the other localities.

| Species | Western Sumatra | | | Western Java | | | Eastern Java | | | West Kalimantan |
|---|---|---|---|---|---|---|---|---|---|---|
| | PD (10) *Ic* | SK (1000) *Ic* | SK (1200) *Ii* | BG (200) *Ic* | PC (1000) *Bc* | CI (1200) *Bc* | AP (1400) *Bc* | AP (1400) *Bs* | CR (1400) *Bs* | PN (10) *Ic* |
| *Drosophila elegans* | 7 | 94 | 4 | 6 | 1 | — | — | — | — | 10 |
| *D. gunungcola* sp. nov. | — | — | 8 | — | 15 | 9 | 62 | 62 | 11 | — |
| *D. busckii* | — | — | — | — | — | 1 | — | — | — | — |

However, we could not find *D. elegans* on the flowers of this plant during our survey in Indonesia, although flowers of this plant were abundantly observed. Further study is needed on host utilization of these species.

Fig. 2 shows survival of these two species at heat and cold. *Drosophila gunungcola* was slightly more tolerant to cold than *D. elegans* (the difference in survival at 6°C was significant for both sexes; $\chi^2$ test, $P < 0.05$), but was apparently less tolerant to heat (the differences in survival at 32 and 33°C were significant for both sexes; $\chi^2$ test, $P < 0.01$). It has also been observed in some groups of *Drosophila* that species occurring at high altitudes are less tolerant to heat than those occurring at low altitudes (Kimura *et al.*, 1994; Beppu *et al.*, 1996; Goto & Kimura, 1998). Keeping high heat tolerance may be costly, and then drosophilid species may rapidly lose heat tolerance when it becomes unnecessary. On the other hand, highland species were not always more tolerant to cold than lowland species (Hori & Kimura, 1998).

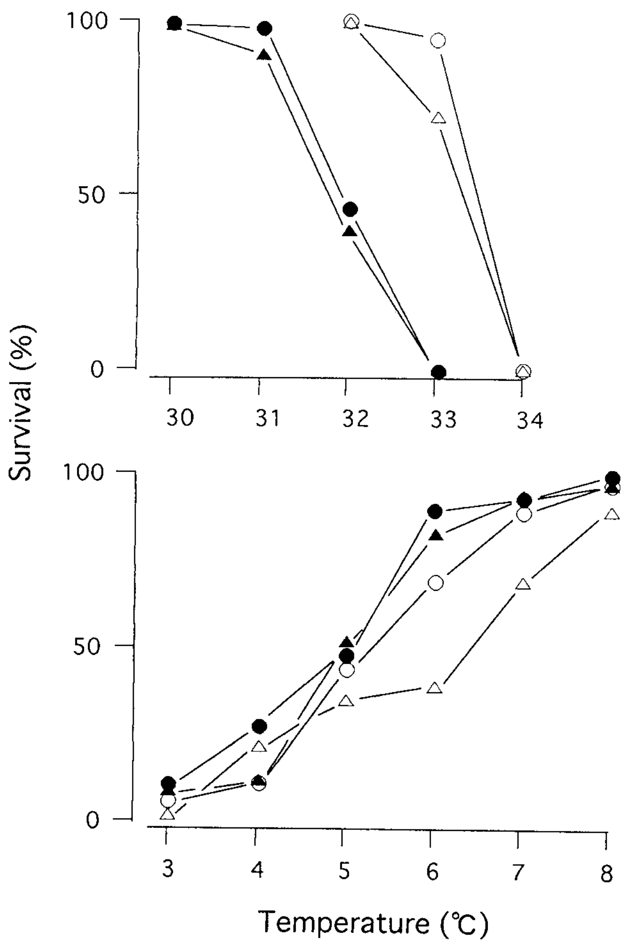


Fig. 2. Survival of *Drosophila gunungcola* sp. nov. (female: ●, male: ▲) and *D. elegans* (female: ○, male: △) at heat (upper panel) and cold (lower panel).

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