FLOWER VISITORS OF 32 PLANT SPECIES IN WEST SUMATRA

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Abstract

We recorded flower visitors of 32 plant species belonging to 14 families: Annonaceae (1), Cruciferae (1), Leguminosae (1), Melastomataceae (1), Balsaminaceae (7), Verbenaceae (3), Gesneriaceae (3), Rubiaceae (2), Compositae (2), Musaceae (4), Zingiberaceae (4), Palmae (1), Pandanaceae (1) and Araceae (1) (number of species studied being in parenthesis) in West Sumatra.

Introduction

Reproductive biology of plant species in neotropical lowland rain forest has been investigated from various standpoints; sexual systems of trees (Bawa *et al.*, 1985a), pollination systems of trees (Bawa *et al.*, 1985b), bird-pollination syndrome (Feinsinger, 1976, Murray *et al.*, 1987), and pollination ecology of euglossine bees (Dressler, 1982), hummingbirds (Stiles, 1975) and bat (Heithaus *et al.*, 1974). In contrast, reproductive biology of plants in the lowland tropical rain forest in Southeast Asia has only recently been investigated, and pollination systems of many plants remain unknown excluding some members of Dipterocarpaceae (Appanah and Chan, 1981; Appanah, 1985), Sapindaceae (Appanah, 1982), Leguminosae (Atmowidjojo and Adisoemarto, 1986), Rafflesiaceae (Beaman *et al.*, 1988), Oxalidaceae (Lack and Kevan, 1987) and Bignoniaceae (Gould, 1978). To compare the evolutionary history of pollination systems in palaeotropics with that in neotropics, we need basic information on pollination systems of the tropical plants of Southeast Asia.

The floral characters of many plants are thought to have coevolved with the pollinators. For example, the length of tubular perianths and spurs of bumblebee-pollinated flowers in temperate zone and of hummingbird- or

euglossine bee-pollinated flowers in neotropics are good examples (Heinrich, 1975; Murray *et al.*, 1987; Dressler, 1982). In lowland rain forest of Southeast Asia where there are neither bumblebees, hummingbirds nor euglossine bees, we can find many plant species which have long tubular perianths or long spurs. What kinds of organisms with long tongue or long bills pollinate these flowers? Moreover there are various types of tropical flowers which are not distributed in temperate zone. Here we provide information on the flower visitors of 32 plant species belonging to 14 families, which have various floral characters.

Materials and Methods

We studied flower visitors of 32 plant species, of which 23 were indigenous species, 5 were naturalized and 4 were cultivated ones. In natural and disturbed vegetations ranging from lowland to montane zone in West Sumatra, we directly observed and sometimes collected flower visitors mainly in daytime on fine days between Nov. 27, 1987 and Jan. 30, 1988. Behavior of some flower visitors were recorded by video tape recorder (checked by (v) in the list of flower visitors). To analyze the relationship between floral characters and tongue characters of bees, we measured the lengths of proboscises and of forewings of bees collected on the flowers.

Results

We provide a list of flower visitors in phylogenetical order of plant family. For each plant species studied, locality, date of observation, habitat and floral characters are added. Flower visitors are classified into the following 7 categories of anthecological status according to Inouye (1980): pollinator searching for nectar [Pn], pollinator searching for pollen [Pp], primary nectar robber [Rnp], secondary nectar robber [Rsn], nectar thief [Tn], pollen thief [Tp] and ovule parasite [O].

1 ***Achasma macrocheilos*** **Griff.** (Zingiberaceae)
Ulu Gadut (350m), Padang, Jan. 21, 1988. Gigantic herb in young secondary forest. Floral characters are somewhat similar to *Carenophila* sp., but the tubular calyx is longer and the labellum is large and crimson. Length of the tubular calyx is about 80mm.

Hymenoptera
Anthophoridae
Amegilla elephas (Lieftinck) [Pn]

2 ***Amomum*** **sp.** (Zingiberaceae)
Tanjunlolo (250m), Sawahlunto Sijunjung, Jan. 27, 1988. Floral characters

are somewhat similar to *Costus* sp. excluding the smaller size and the pale color of perianths.

Hymenoptera
Halictidae
Nomia sp. 7 [Pn]
Nomia sp. 8 [Pn]

3 ***Cocos nucifera*** **L.** (Palmae)
Sungaidareh (125m), Sawalunto Sijunjung, Jan. 26-27,
1988. Monoecious tree cultivated in a orchard near primary rain forest. Flowers are small and composed of three separate petals and three separate sepals. Nectary is absent. Flower visitors were collected only on male inflorescences.

Hymenoptera
Apidae
Trigona (*Geniotrigona*) *thoracica* Smith [Tp]
T. (*Tetragonula*) *collina* Smith [Tp]
T. (*T.*) *geissleri* Cockerell [Tp]
T. (*T.*) *reepeni* Friese [Tp]
T. (*T.*) *drescheri* Schwarz [Tp]
T. (*T.*) *melina* Gribodo [Tp]

4 ***Cosmos sulphureus*** **Cav.** (Compositae)
Sungaidareh (125m), Sawahlunto Sijunjung, Jan. 26, 1988. Naturalized herb originating from North America and growing roadside. A capitulum is composed of hermaphrodite disk florets and asexual bilabiate florets, corolla of which is orenge yellow.

Diptera
Syrphidae
Baccha sp. 2 [Pn]
Hymenoptera
Halictidae
Nomia sp. 1 [Pn, Pp]
Megachilidae
Heriades sp. 1 [Pn, Pp]
Pithitis smaragdula (Fabricius) [Pn, Pp]
Anthophoridae
Ceratina (*Ceratinidia*) *nigrolateralis* (Cockerell) [Pn, Pp]
Apidae
Apis (*Megapis*) *dorsata* (Fabricius) [Pn, Pp]

5 ***Costus*** **sp.** (Zingiberaceae)
Tanjunlolo (250m), Sawahlunto Sijunjung, Jan. 27, 1988. Yellow hermaphrodite flowers are borne in a cyme just on the ground. The flower is enclosed by two whorls of perianth segments fused into a tubular calyx. Two large staminoids form the yellow labellum and the single stamen is

concealed under the posterior perianth.

Hymenoptera
Halictidae
Nomia sp. 1 [Pn]

6 *Cyrtandra* sp. (Gesneriaceae)
Ulu Gadut (350m), Padang, Jan. 21, 1988. Herb growing on a dark forest floor. White hermaphrodite flowers are borne on a cyme just on a ground. Five petals are fused into a long (38mm) tube. Nectar is secreted at the bottom of the corolla tube. Two of four stamens are vestigial.

Hymenoptera
Anthophoridae
Amegilla pendleburyi (Cockerell) [Pn]
Diptera
Tachinidae 2 unidentified species [Tp]
Anthomyiidae 1 unidentified species [Tp]

7 *Eupatrium odoratum* L. (Compositae)
Ulu Gadut (300-400m), Padang, Nov. 28, 1987-Jan. 22, 1988 and Bukit Sabarah (300m), Sawahlunto Sijunjung, Jan. 27-30, 1988. Naturalized herb (from tropical America) by roadside or wasteland near primary and secondary forest. A capitulum is composed of hermaphrodite disk florets, corolla of which is white. (v, at Alahanpanjang)

Hymenoptera
Halictidae
Lasioglossum (*Ctenonomia*) aff. *vagans* (Smith) [Pn]
Anthophoridae
Ceratina (*Ceratinidia*) *cognata* Smith [Pn]
Apidae
Trigona (*Lepidotrigona*) *terminata* Smith [Pn]
T. (*Tetragonula*) *laeviceps* Smith [Pn]
T. (*Heterotrigona*) *itama* Cockerell [Pn]
T. (*Lepidotrigona*) *ferminata* Smith [Pn]
Apis (*Megapis*) *dorsata* (Fabricius) [Pn]

8 *Globba* cf. *pendula* (Zingiberaceae)
Batang Barus (1300m), Alahanpanjang, Jan. 30, 1988. Herb beside streamlet in a montane forest. Hermaphrodite flowers are borne in a raceme. The flower is enclosed by two whorls of perianth segments fused into a tubular calyx. Two staminoids form the yellow labellum and the single stamen and the style protrude from the tubular calyx drawing an arc.

Hymenoptera
Anthophoridae
Elaphopoda impatiens (Lieftinck) [Pn]

9 *Homalomena pendula* (Bl.) Buckh. f. (Araceae)

Batang Barus (1300m), Alahanpanjang, Dec. 8, 1987. Monoecious herb beside a stream in a montane forest. The inflorescence consists of a large spathe enveloping a spadix of numerous small unisexual flowers. Female flowers are borne in the lower position of spadix than male flowers. Both flowers lack nectaries.

Coleoptera
Nitidulidae 1 unidentified species [Pp]

10 ***Impatiens albo-flava*** **Miq.** (Balsaminaceae)
Airsirah (1000m), Padang, Jan. 6-8, 1988 and
Batang Barus (1300m), Alahanpanjang, Jan. 14-15, 1988. Irregular hermaphrodite flower is borne on a raceme. One of three free sepals is petaloid and spurred. Length of the spur is about 22 mm. Five petals are yellow and lower lateral petals are markedly larger than upper ones.

Lepidoptera
Satyridae
Mycalesis oroatis [Tn]
Diptera
Syrphidae
Epistrophe aff. *balteata* de Geer [Tp]
Baccha sp. 1 [Tp]
Tachinidae 1 unidentified species [Tp]
Hymenoptera
Formicidae
Crematogaster sp. 2 [Tn]
Vespidae
Polybioides raphigastra (Saussure) [Rpn]
Halictidae
Lasioglossum (*Evylaeus*) sp. 1 [Tp, Rsn]
L. (*E.*) *vuloanicum* (Blüthgen) [Tp, Rsn]
Thrincostoma (*Diagonozus*) sp. 1 [Pn]
Anthophoridae
Amegilla andrewsi (Cockrell) [Rpn]
A. smatrana (Lieftinck) [Pn]
Protomelissa vulpecula (Lieftinck) [Rpn]

11 ***Impatiens eubotrya*** **Miq.** (Balsaminaceae)
Batang Barus (1300m), Alahanpanjang, Jan. 14-15, 1988. Herb growing beside streamlet in a montane forest. The peduncle is distorted and the yellow flower is inverted. The length of spurred sepal is 24 mm.

Coleoptera
Mordellidae
Glipa aff. *malaccana* Pic [Tp]
Diptera
Syrphidae
Epistrophe aff. *balteata* de Geer [Tp, Rsn]

Baccha sp. 1 [Tp, Rsn]

Hymenoptera

Formicidae

Paratrechina sp. 1 [Tn]

Halictidae

Lasioglossum (*Evylaeus*) sp. 1 [Tp, Rsn]

Anthophoridae

Amegilla andrewsi (Cockerell) [Rpn]

A. sumatrana (Lieftinck) [Pn]

Elaphopoda impatiens (Lieftinck) [Pn]

Protomelissa vulpecula (Lieftinck) [Rpn]

Braunsapis sp. 1 [Rsn]

12 ***Impatiens 'gadutensis'*** **M. Hotta,** nom. nud. (Balsaminaceae)

Gunung Gadut (1600m), Padang, Jan. 1-2, 1988. Herb growing on a floor of a montane moss forest. The floral characters are almost similar to *I. alboflava* excluding the shorter and thickness and hairiness of wall of the spur.

Hymenoptera

Apidae

Bombus (*Rufipedibombus*) *rufipes* Lepeletier [Pn]

Bombus (*Senexibombus*) *senex* Vollenhoven [Pn]

Several individuals of these two species flying around the *I. gadutensis* flowers were collected, but their visits on the flower were not directly observed. We found some scars on lower petals indicating pollinator visits. The fact that the two *Bombus* species were only bees observed at this site suggests that some *Bombus* individuals have visited the flower.

13 ***Impatiens junghuhnii*** **Miq.** (Balsaminaceae)

Mukomuko (800m), Maninjau, Dec. 21, 1987. Herb with fleshy stem growing beside streamlet in a hill forest. The floral characters resemble *I. pyrrhotricha*, but the lower sepal is saccate and the petals forming slightly campanulate collora.

Hymenoptera

Anthophoridae

Amegilla pendleburyi (Cockerell) [Pn]

14 ***Impatiens platypetala*** **Lindl.** (Balsaminaceae)

Airsirah (1000m), Padang, Jan. 6-8, 1988. Herb growing beside streamlet around a hill forest. A few irregular hermaphrodite flowers are borne in a raceme. One of three free sepals is petaloid and spurred. Length of the spur is about 32 mm. Five pink petals are nearly equal in size and shape. (v)

Lepidoptera

Sphingidae

Macroglossum corythus Rothschild et Jordan [Pn]

Diptera

Syrphidae

Epistrophe aff. *balteata* de Geer [Tp]

Hymenoptera

Formicidae

Crematogaster sp. 1 [Tn]

Halictidae

Lasioglossum sp. 2 [Tp, Rsn]

Anthophoridae

Amegilla andrewsi (Cockerell) [Rpn]

15 ***Impatiens pyrrhotricha*** **Miq.** (Balsaminaceae)

Batang Barus (1300m), Alahanpanjang, Jan. 30, 1988. The floral characters are similar to *I. albo-flava* excluding the larger size and the short (18 mm) curved spur.

Hymenoptera

Anthophoridae

Elaphopoda impatiens (Lieftinck) [Pn]

16 ***Impatiens 'talangensis'*** **M. Hotta,** nom. nud. (Balsaminaceae)

Batang Barus (1300m), Alahanpanjang, Jan. 30, 1988. Herb growing beside streamlet in a montane forest. The floral characters are similar to *I. pyrrhotricha* excluding the larger size and the long (23mm) broad spur.

Diptera

Calliphoridae

?*Protophormia* sp. [Tp]

Hymenoptera

Formicidae

Paratrechina (*Nylanderia*) sp. 1 [Tn]

Monomorium pharanonis (Linnè) [Tn]

Pheidole sp. 1 [Tn]

Halictidae

Lasioglossum (*Evylaeus*) *vuloanicum* (Blüthgen) [Tp, Rsn]

Anthophoridae

Amegilla sumatrana (Lieftinck) [Pn]

Elaphopoda impatiens (Lieftinck) [Pn]

Protomelissa vulpecula (lieftinck) [Rpn, Rsn]

17 ***Lantana aculeata*** **L.** (Verbenaceae)

Ulu gadut (400m), Nov. 27-Dec. 30, 1987. Small red hermaphrodite flowers are arranged in a cyme. The length of corolla tube is about 10 mm.

Lepidoptera

Papilionidae

Papilio memnon L. [Pn]

P. polytes L. [Pn]

Graphium sarpedon L. [Pn]
Amathusiidae
Hypolimnas bolina Linnaeus [Pn]
Danaidae
Danaus sp. [Pn]
Hymenoptera
Anthophoridae
Amegilla andrewsi (Cockrell) [Pn]

18 ***Mimosa pudica*** **L.** (Leguminosae)
Sungaidareh (125m), Sawahlunto Sijunjung, Jan. 25-27, 1988. Naturalized weed by roadside near primary rain forest. Regular hermaphrodite flowers are arranged in tight clusters. Five petals are small and equal. Numerous stamens are pink and showy.
Diptera
Sarcophagidae 1 unidentified species [Tp]
Tachinidae 1 unidentified species [Tp]
Anthomyiidae 1 unidentified species [Tp]
Hymenoptera
Halictidae
Nomia sp. 1 [Pn, Pp]
Lasioglossum (*Ctenonomia*) *xystonotum* (Vachal) [Pn, Pp}
Megachilidae
Heriades sp. 2 [Pn, Pp]
Anthophoridae
Ceratina (*Ceratinidia*) *cognata* Smith [Pn, Pp]
C. (*C.*) *nigrolateralis* (Cockerell) [Pn, Pp]

19 ***Monophyllaea hirtella*** **Miq.** (Gesneriaceae)
Ladang Padi (400m), Padang, Dec. 25, 1987. Herb growing on a calcareous rocky slope beside a stream in primary rain forest. Small white hermaphrodite flowers are borne on a raceme. Five white petals are fused into a shallow basal tube.
Hymenoptera
Halictidae
Nomia sp. 2 [Pn]

20 ***Monophyllaea hirtella*** **x** ***M. horsfieldii*** (Gesneriaceae)
Ladang Padi (400m), Padang, Dec. 25, 1987. Herb growing at the same habitat as the former species. Floral characters are almost similar to *M. hirtella* excluding the smaller size and the slightly pink color of the corolla.
Hymenoptera
Halictidae
Nomia sp. 2 [Pn]
Anthophoridae

Ceratina (*Lioceratina*) *flavopicta* Smith [Pn]

21 *Musa acuminata* Coll. (Pisan lidi) (Musaceae)
Ulu Gadut (370m), Padang, Dec. 14, 1987. Primitive cultivated banana. Floral characters are almost similar to *M. acuminata subsp. halabanensis* but bracts crimson in color.

Hymenoptera
Apidae
Trigona (*Tetrigona*) *apicalis* Smith [Rsn]
T. (*Tetragonula*) *laeviceps* Smith [Rsn]
Vespidae
Polybioides raphigastra (Saussure) [Rsn]
Chiroptera (Mammalia)
Pteropodidae
?*Macroglossus sobrinus* (Andersen) [Pn]

22 *Musa acuminata* Coll. subsp. *halabanensis* (Meijer) M. Hotta (Musaceae)
Ulu Gadut (350m), Padang, Dec. 11, 1987-Jan. 22, 1988. Gigantic monoecious herb growing in open area and secondary forest. Floral characters are roughly similar to *M. salaccensis* excluding the horizontal female and the pendent male part of inflorescence and the purplish-black bracts. Male flowers open in evening and fall by the morning of the next day whereas female flowers last for more than 1 day.

Lepidoptera
Hesperiidae
Ancistroides nigrita Latreille [Tn]
Diptera
Drosophilidae
Drosophila sp. [Rsn]
Hymenoptera
Formicidae
Crematogaster sp. [Rsn]
Apidae
Trigona (*Tetragonula*) *laeviceps* Smith [Rsn]
Rodentia (Mammalia)
Tupaiidae
Sundasciurus sp. [Pn?, Rpn?]
Chiroptera (Mammalia)
Pteropodidae
Macroglossus sobrinus (Andersen) [Pn]

23 *Musa balbisiana* Colla (Pisan batu) (Musaceae)
Sungaidareh (125m), Gigantic monoecious herb cultivated in orchard. (v, at Ulu Gadut)

Hymenoptera
Vespidae

Vespa sp. [Rsn]
Apidae
Trigona (*Tetragonula*) *atripes* Smith [Rsn]
T. (*T.*) *melina* Gribodo [Rsn]
T. (*T.*) *fuscobalteata* Cameron [Rsn]
T. (*T.*) *reepeni* Friese [Rsn]
T. (*T.*) *drescheri* Schwarz [Rsn]
T. (*T.*) *geissliri* Cockerell [Rsn]
T. (*Homotrigona*) *fimbriata* Smith [Rsn]
T. (*Tetratrigona*) *collina* Smith [Rsn]
T. (*Lepidotrigona*) *nitidiventris* Smith [Rsn]
Apis (*Apis*) *cerana javana* Enderlein [Rsn]
Chiroptera (Mammalia)
Pteropodidae
?*Macroglossus sobrinus* (Andersen) [Pn]

24 *Musa salaccensis* Zoll. (Musaceae)
Ulu Gadut (350m), Padang, Dec. 11, 1987-Jan. 22, 1988. Gigantic monoecious herb in open area and young secondary forest by a stream. Unisexual flowers are borne in a erect inflorescence; females in basal clusters and males terminal on the same inflorescence. Bract covering 2-6 flowers is showy purplish pink. A flower has two laticiferous perianths forming a stout tube and secrete plentiful nectar at the bottom of the tube. Male flowers open in early morning and fall by the end of the day, whereas female flowers last for about two days. (v, at Ulu Gadut)
Blattariae
Blattellidae 2 unidentified species [Tn]
Dermaptera
Pygidicranidae 1 unidentified species [O]
Lepidoptera
Hesperiidae
Ancistroides nigrita Latreille [Tn]
Erionata thrax L. [Tn]
Diptera
Bombyliidae 1 unidentified species [Rsn]
Hymenoptera
Formicidae
Crematogaster sp. [Rsn]
Vespidae
Polybioides raphigastra (Saussure) [Rsn]
Apidae
Trigona (*Tetragonula*) *drescheri* Schwarz [Rsn]
T. (*T.*) *minangkabau* Sakagami [Rsn]
T. (*T.*) *laeviceps* Smith [Rsn]
Passeriformes (Aves)
Nectariniidae

Arachnothera longirostra [Pn]
Aethopyga siparaja [Pn]
Rodentia (Mammalia)
Tupaiidae
Sundasciurus sp. [Pn?]

25 ***Ophiorrhiza* sp. 1** (Rubiaceae)
Airsirah (1000m), Padang, Jan. 16, 1988. Herb growing at margin of a hill forest. Small hermaphrodite flowers are borne in cymes. Five white petals are fused into a corolla tube.
Hymenoptera
Halictidae
Nomia sp. 2 [Pn]

26 ***Ophiorrhiza* sp. 2** (Rubiaceae)
Airsirah (1000m), Padang, Jan. 20, 1988. Herb growing at margin of a hill forest. Flower characters are similar to the former species.
Hymenoptera
Halictidae
Nomia sp.6 [Pn]

27 ***Pandanus* sp.** (Pandanaceae)
Gunung Gadut (1700m), Padang, Jan. 1, 1988. Dioecious tree in a montane moss forest. Unisexual flowers are arranged in a racemose spadix, and lack both calyx and corolla. In the male flower the numerous stamens are arranged in a raceme. Nectary is lacking.
Coleoptera
Nitidulidae
?*Carpophilus* sp. 1 [Pp]
Staphylinidae
?*Anthobium* sp. 1 [Pp]
Curculionidae
?*Apion* sp. 1 [O]
Hymenoptera
Braconidae 1 unidentified spices

28 Cf. ***Polyalthia* sp.** (Annonaceae)
Ulu Gadut(450m), Padang, Dec. 1-24, 1987. High tree growing in a primary rain forest. Hermaphrodite flowers are borne on trunks. The fleshy perianth is in three whorls of three, and is green at an early stage and then turns yellow. Stamens are numerous and spirally arranged. Nectary is absent.
Coleoptera
Scarabaeidae
?*Blitopertha* sp. [Pp]
?*B.* sp. [Pp]

Chrysomelidae 1 unidentified species [Tp?]
Curculionidae 2 unidentified species [O]
Hemiptera
Miridae 1 unidentified species [O]
Diptera
Ephydridae 1 unidentified species [Tp]

29 ***Raphanus sativus*** **L.** (Cruciferae)
Danau Talang (1500m), Alahanpanjang, Dec. 8, 1987. Herb cultivated in a field near primary montane forest. Hermaphrodite flowers are borne in a raceme, and have four sepals, four white petals, six stamens and nectaries in a shallow position. (v, at Danau Talang)
Hymenoptera
Apidae
Bombus (*Rufipedibombus*) *rufipes* Lepeletier [Pn, Pp]
Apis (*Apis*) *cerana javana* Enderlein [Pn, Pp]

30 ***Stachytarpheta indica*** **(L.) Vahl.** (Verbenaceae)
Sungaidareh (125m), Sawahlunto Sijunjung, Jan. 26, 1988. Floral characters are almost similar to *S. jamaicensis* excluding the white color of the corolla. (v, at Ulu Gadut)
Hymenoptera
Halictidae
Nomia sp. 1 [Pn]
Anthophoridae
Ceratina (*Ceratinidia*) *nigrolateralis* (Cockerell) [Pn]

31 ***Stachytarpheta jamaicensis*** **Vahl.** (Verbenaceae)
Ulu Gadut (350-400m), Padang, Nov. 27,
1987-Jan. 22, 1988 and Sungaidareh (125m), Sawahlunto Sijunjung, Jan. 26, 1988. Naturalized weed originating from Central America and growing by roadside. Several purple flowers are borne on a raceme. The corolla is small, tubular and five-lobed. The flower tube is rich in nectar. (v, at Ulu Gadut)
Diptera
Asilidae 1 unidentified species [Tn]
This species is mimic to *Trigona itama*.
Syrphidae
Epistrophe aff. *balteata* de Geer [Pn]
Lathyrophthalmus sp. [Pn]
Tachinidae 1 unidentified species [Pn]
Hymenoptera
Halictidae
Nomia sp. 1 [Pn]
Nomia sp. 3 [Pn]
Megachilidae

Coelioxys sp. 1 [Pn]

Anthophoridae

Amegilla andrewsi (Cockerell) [Pn]

A. sp. 1 [Pn]

Thyreus sp. 1 [Pn]

Xyrocopa (*Koptortoscyma*) aff. *confusa* (Pèrez) [Pn]

X. sp. 2 [Pn]

Ceratina (*Ceratinidia*) *nigrolateralis* (Cockerell) [Pn]

Apidae

Trigona (*Tetragonula*) *minangkabau* Sakagami [Pn]

Apis (*Megapis*) *dorsata* (Fabricius) [Pn]

32 ***Tibouchina semidecandra*** **Cogn.** (Melastomataceae)
Sungaidareh (125m), Sawahlunto Sijunjung, Jan. 25-27, 1988. Ornamental shrub (from Brazil) growing by roadside. Large hermaphrodite flowers have five blue petals, five yellow stamens and open nectaries.

Hymenoptera

Anthophoridae

Xylocopa (*Koptortoscyma*) aff. *confusa* (Pèrez) [Pn, Pp]

X. sp. 1 [Pn, Pp]

X. sp. 2 [Pn, Pp]

Apidae

Trigona (*Heterotrigona*) *itama* Cockerell [Tn, Tp]

T. (*Tetragonula*) *drescheri* Schwarz [Tn, Tp]

T. (*T.*) *laeviceps* Smith [Tn, Tp]

Length of proboscis of bees

The most common visitors of the plant species other than Annonaceae, Pandanaceae and Araceae were bees. Because bees imbibe nectar secreted from nectaries in flowers by proboscises, the length of proboscis and depth of nectary are key characters of the pollination syndrome. Fig. 1 shows the relationship between the length of proboscis and the length of forewing of 19 bee species belonging to Halictidae, Anthophoridae (Anthophorini, Melectini and Ceratinini) and Apidae (Bombini, Meliponini and Apini). The long proboscis were found in Halictidae, Anthophorini and Bombini. *Amegilla elephas* having the longest proboscis visited *Achasma macrocheilos* flowers which have long tubular perianths. The anthophorid bees with long proboscis visited flowers of Balsaminaceae, Gesneriaceae and Zingiberaceae to imbibe nectar left in deep flower tube legitimately, whereas those with short proboscis such as *Amegilla andrewsi* visited *Impatiens* flowers and robbed nectar by biting the spur.

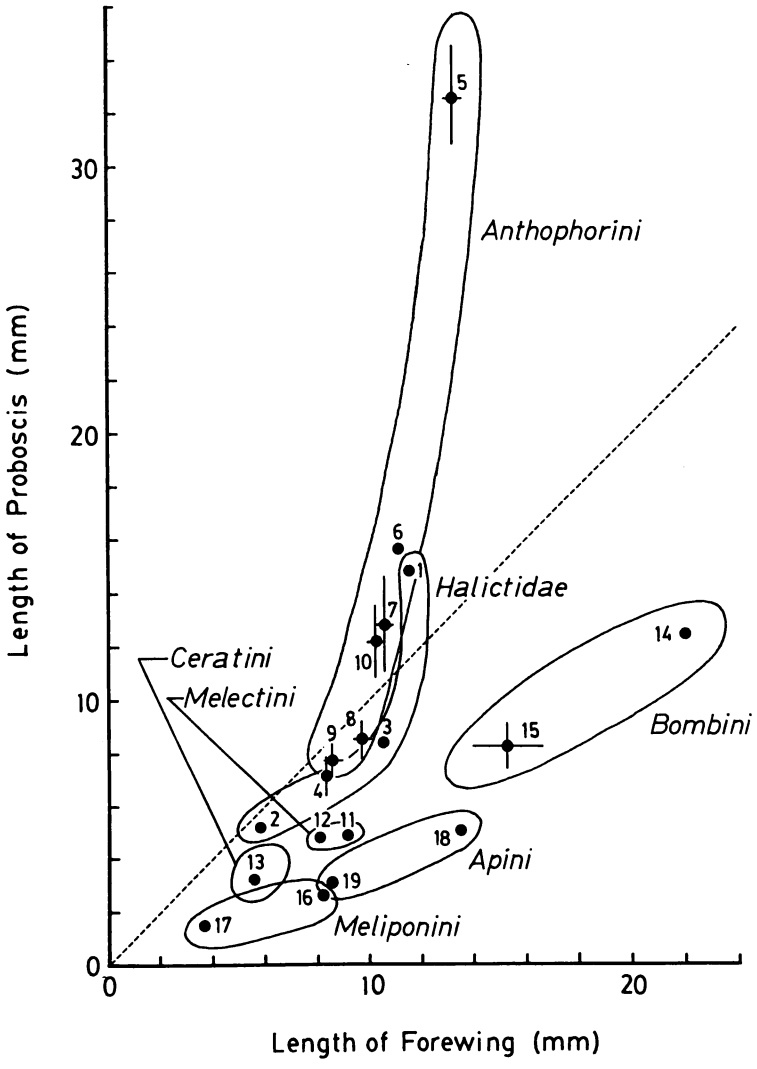

Fig. 1. The relationship between lengths of proboscis and forewing of bees. Bar denotes standard deviation.

1, *Thrincostoma* sp. 1. 2, *Lasioglossum* sp. 1. 3, *Nomia* sp. 1. 4. *Nomia* sp. 2. 5, *Amegilla elephas*. 6, *A. sendleburyi*. 7, *A. smatrana*. 8, *A. andrewsi*. 9, *A.* sp. 1. 10, *Elaphopoda impatiens*. 11, *Protomelissa* sp. 1. 12, *Thyreus* sp. 1. 13, *Ceratina nigrolateralis*. 14, *Bombus senex* (queen). 15, *B. rufipes* (worker). 16, *Trigona fimbriata*. 17, *T. minangkabau*. 18, *Apis dorsata*. 19, *A. cerana*.

Discussion

The plant species listed above can be classified as in Table 1 according to reward type, position of nectary and pollinators. The native plants whose rewards were only pollen were pollinated by pollen-feeding beetles whereas male inflorescences of cultivated palm (*Cocos nucifera*) were visited many stingless bees. Of the plants which secrete nectar in a shallow position in a flower, those growing in disturbed and/or open area such as *Raphanus sativus, Mimosa pudica, Tibouchina semidecandra, Stachytarpheta* spp., *Lantana aculeata, Cosmos sulphureus* and *Eupatrium odoratum* were visited and pollinated by various insects, especially bees. Those growing on a forest floor such as *Monophyllaea* spp. and *Ophiorrhiza* spp. were pollinated by solitary bees, especially Halictidae.

Of those plants with deep nectaries, the herbs growing on the floor of lowland rain forest such as *Impatiens* spp., *Cyrtandra* sp. and those of Zingiberaceae were pollinated by anthophorid and/or halictid bees. The deep nectaries of these rain forest herbs in Southeast Asia have coevolved neither with the hummingbirds nor with euglossine bees as in neotropics but with these long-tongued anthophorid and/or halictid bees (Fig. 1). In contrast with *Impatiens* species pollinated by long-tongued bees, *I. platypetala* having pink petals and long thin spur were pollinated by hawkmoth, and *I. gadutensis* growing in high altitudes (1600m) were by bumblebees.

Table 1. Reward type, positon of nectaries and main pollinators of plant species studied in West Sumatra

Reward type	Position of nectary[1]	Main pollinators	Plant family (number of species studied)
pollen	absent	beetles	Annonaceae(1), Pandanaceae(1), Araceae(1)
pollen	absent	-	Palmae(1)
nectar	shallow	various bees/ flies	Cruciferae(1**), Leguminosae(1*), Melastomataceae(1), Verbenaceae(2*), Compositae(1+1*)
nectar	shallow	halictid bees	Gesneriaceae(2), Rubiaceae(2)
nectar	deep	butterfly	Verbenaceae(1*)
nectar	deep	hawkmoth	Balsaminaceae(1)
nectar	deep	anthophorid/ halictid bees	Balsaminaceae(5), Gesneriaceae(1), Zingiberaceae(1)
nectar	deep	bumblebee ?	Balsaminaceae(1)
nectar	deep	birds	Musaceae(1)
nectar	deep	bats	Musaceae(1+2**)

[1] Distance from the flower entrance to nectary: shallow, < 5 mm; deep, > 5 mm.

* Naturalized species.

** Cultivated species.

The native gigantic herbs with stout long tubular perianths, *Musa salaccensis* and *M. halabanensis*, were pollinated by nectariniid birds and pteropodid bats, respectively. Flowers of *M. salaccensis* are borne in an erect inflorescence with pink showy bracts and provide nectar mainly in daytime, whereas flowers of *M. halabanensis* are in a pendent inflorescence with black bracts and provide nectar mainly in night. Thus floral characters and flowering habits of these *Musa* species are well adapted with their pollinators, i.e., diurnal birds and nocturnal bats, respectively.

Though flower visitors and their anthecological status were recorded, our data were very insufficient to clarify the reproductive biology of the plant species, because (1) pollinator visits on flowers were not quantitatively analyzed, (2) transportation of pollen by pollinators were not traced, and (3) observation time was very short and limited in three months in a year. Phenological studies in Southeast Asia (Medway, 1972; Appanah, 1985; Schaik, 1986; Ashton *et al.*, 1988) suggest that environment for successful pollination is not constant irrespectively of constant condition of temperature in tropical rain forest. Pollination syndromes in species-rich tropical rain forest in Southeast Asia must be studied on a long-term scale.

Aknowledgments

We thank Dr. S. Sakagami of Hokkaido University and Mr. Sk. Yamane of Kagoshima University for identifying bees and some of the ants, respectively.

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