Diversity and blooming season of food sources plant of Apis cerana (Hymenoptera: Apidae) in polyculture plantation in West Sumatra, Indonesia

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Abstract. Jasmi. 2017. Diversity and blooming season of food sources plant of Apis cerana (Hymenoptera: Apidae) in polyculture plantation in West Sumatra, Indonesia. Biodiversitas 18: 34-40. The existence of honeybees in a habitat was highly affected by the presence of food source plant. Therefore, the research was conducted to examine the diversity and the blooming season of food source plant of Apis cerana Fabr. in polyculture plantation in West Sumatra from March 2011 to March 2012. Samples were collected with a plot method of 100 m x 100 m on altitudes of <100 m and >1,000 m asl. The results showed that 94 species (34 families) of food source plants for A. cerana were found. The most found species were Asteraceae (12 species) and Leguminosae family (10 species). On the plateau, food source plants were 21 species, while on lowland there were 18 species and on both altitudes, there were 55 species (similarity index 75.34%). The number of cultivated plants was 46 species and the number of wild plants was 48 species. The cultivated plants in lowland were 34 species and 33 species in the plateau (similarity index 59.70%). Plants that bloom all year round were 59 species, plants that bloom depending on growing season were 15 species and annual plants that bloom annually were 20 species. The largest number of flowering plants was found in August with 88 species out of 94 species found.

Keywords: Apis cerana, blooming season, diversity, food source plant, polyculture plantation

INTRODUCTION

Honeybees (Apis cerana Fabr.) are widespread in Indonesia. The existence of these bees has been reported in Sumatra, Java, Bali, Kalimantan, Sulawesi, and Irian Jaya (Radloff et al. 2010). In West Sumatra, the average colonies population density on polyculture lowland planting area reached 4.8 colonies per hectare and 4.2 colonies per hectare on the plateau (Jasmi et al. 2014a). The bees have been used as pollinators on coffee plantations (Vergara and Badano 2008; Saefudin et al. 2011), even reproduction of queen bee has been done with grafting techniques (Kuntadi 2013).

Polyculture cropping is a unique ecosystem with a high value of economic, biodiversity and conservation. On the plantation, there are various species of crops and wild plants. The extent of polyculture cultivation in West Sumatra is in the third rank (5.93%) of the total land area according to the type of land use. Various of plants found in the area are industrial plants, forestry, and fruit plants (BPS 2011). Plantation plays an important role as habitat for various species of bees in Sweden, Poland, United Kingdom, Germany and Francis (Westphal et al. 2008) and as the provider of nesting cavity sites for A. cerana in West Sumatra (Jasmi et al. 2014b) and other various species of bees lodged in a cavity in the Annapolis valley, Nova Scotia, Canada (Sheffield et al. 2008). Another important role of the plantation is food resources provider for A. cerana in Kepahiang Sub-district of Bengkulu (Saefudin et al. 2011), for A. mellifera in Veracruz, Mexico (Vergara and Badano 2008), in Zaria, Nigeria (Mbah and Amao 2010), in Ndokwa, Niger Delta, Nigeria (Emuh and Ofooku 2012) and for wild bees in Ottawa, Allegan and Van Buren, North America (Tuell et al. 2009).

From the aspect of mutuality, plantation plays an important role as a provider of food resources, while honey bees act as agents of pollinator. The plantation has a relatively high diversity of plant species which can be used as a source of pollen and nectar for honey bees. Each type of honey bees use different number of species of food source plants in different locations, such as A. mellifera honeybee which uses 18 species in Zaria, Nigeria (Mbah and Amao 2010), and 26 species in Iseyin and Ilesa of Southeast Nigeria (Ayansola and Davies 2012), while A. dorsata uses 194 species in Garhwal Himalaya India (Tiwari et al. 2010), and stingless bee Melipona Rufiventris Lepeletier uses 57 species in Ubatuba, São Paulo State, Brazil (Fidalgo and Kleinert 2010), but up to now, there are no reliable data and information about the species and the flowering period of plants in polyculture plantation which are used as food source for A. cerana honeybees. This study aims to determine the species and flowering period of food source plants for A. cerana in polyculture planting area in West Sumatra, Indonesia. The diversity of plant species in polyculture plantation is important for conservation and cultivation of A. cerana honey bees.
MATERIALS AND METHODS

Area of study
The study was conducted in lowland and highland polyculture planting areas in West Sumatra, Indonesia from March 2011 to March 2012. The lowland (altitude: <100 m above sea level) is located in Nagari Sungai Buluh, Sub-district of Batang Anai and Parik Malintang, Sub-district of Enam Lingkung, Padang Pariaman, West Sumatra, Indonesia. The location has an average daily temperature of 29.7°C, relative air humidity of 85.9%, and average annual rainfall of 368.4 mm with an average of rainy days as much as 19 days per month (BPS 2011). Polyculture plantation used as a research location (Figure 1 A-B) is dominated by coconut trees (Cocos nucifera), cocoa (Theobroma cacao) and fruit trees, such as durian (Durio zibethinus), kedondong (Spondias pinnata), and rambutan (Nephelium lappaceum).

The highland (altitude: > 1000 m above sea level) is located in Nagari Andaleh, Batipuh Subdistrict, Tanah Datar, West Sumatra. The location has an average daily temperature of about 26°C and monthly rainfall of 549.00 mm per month (BPS 2011). Polyculture plantation used as a research location (Figure 1c-d) is dominated by coffee (Coffea canephora), cinnamon (Cinnamomum burmanii) and dadap (Erythia variegata), while on the edges, various species of trees are planted. Wild plants commonly found in the planting area are laguek kanji (Bidens pilosa) and Tansi grass (Galinsoga parviflora).

Method
The research was conducted by survey method namely by observing the species of flowering plants visited by A. cerana worker bees in polyculture plantation area. Observations were carried out visually, and a binocular was used to observe the relatively high plants. Bees have taken pollen were identified by the visibility of collected pollen on its corbicula, at the time of taking nectar, bees stuck its proboscis on the basis of the flower. To determine the observation area, the model from Steffan-Dewenter and Kuhn (2003) is modified and used. The observation was carried out on a sample plot measuring 100 m x 100 m. The number of sample plots used at each height was five sample plots.

The blooming period was set when plants were flowering at the time of observation. Plant species found in flowering condition were recorded and the numbers of visiting of worker bees were counted. Observations were made only once a month from 7:00 to 10:00 am and at 02:00 to 05:00 pm at each point of observation. On the visited plants, some of its parts, such as branches, leaves, flowers and fruits, were collected and stored in a plastic bag and labeled. In order to make herbarium, the plant was pressed with suppressant board (45 cm x 30 cm) and newspaper paper measuring 44 cm x 28 cm (Womersley 1981). The identification of plant referred to Backer and Bakhuizen van den Brink (1964-1968) and Lawrence (1951) and was carried out at the Laboratory of Plant Taxonomy.

Figure 1. Research location in polyculture plantation in West Sumatra. A-B. Lowlands polyculture plantation. A. Polyculture plantation area of coconut, durian, and kedondong. B. Polyculture plantation area of areca nut, cocoa, and coconut. C-D. Highlands polyculture plantation. C. Coffee plantation area intercropped with various tree species. D. Coffee plantation area intercropped with cinnamon.
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Food source plant species are grouped on the basis of the blooming time, namely all year round flowering plants (BST, flowers appear all the time in a year), season flowering plants (TBM, flowers appear only at a certain time/season in a year), and annual plants (TMT, flowers appear only one time of planting). The flowering period is associated with the emerging time of flower until the end of its emerging on a certain plant species and is expressed in units of months. The visit frequency of A. cerana worker bee on any flowering plants during the observations are grouped into three categories (Ayansola and Davies 2012), namely: (1) frequent category (+++), i.e. if the worker bees are found to visit the same flower for more than nine times, (2) moderate category (++), i.e. if the worker bees are found to visit the same flower for 5-8 times, and (3) rare category (+), i.e. if the worker bees are found to visit the same flower for less than four times.

RESULTS AND DISCUSSION

Food source plants for A. cerana in polyculture plantation area in West Sumatra consist of 94 species and are included in 34 families. The family having the highest number of species are Asteraceae (12 species) and Leguminosae (10 species). The number of plants is 21 species found in the highlands, and 18 species in the lowlands, and 55 species in both heights (species total similarity index 75.34%).

Food source plants for bees include 48 species of cultivated plants and 46 species of wild plants. The number of cultivated plants is 12 species in the highland, about 13 species in the lowlands, and 23 species on both heights (similarity index 59.70%). The cultivated plants consist of 18 species of fruit plants, 11 species of vegetable plants, 9 species of plantation plants, 6 species of forestry plants and 2 species of food crops. Lowland crops are dominated by fruit plants (18 species) and industry plants (6 species) while highlands are dominated by forestry plants (5 species). The number of wild plants is 9 species in the highlands, only 5 species in the lowlands, and 32 species on both heights.

The visiting frequency of worker bees on plants is as follows, six species are on frequent category, 41 species are on moderate category, and 47 species are in the rare category. Cultivation plants belonging to frequent category consist of two species, namely Cocos nucifera and Areca catechu. While on wild plants, it consists of four species, namely Asystasia coromandeliana, Bidens pilosa, Galinsoga parviflora, and Mimosa pudica. On highlands, plants with the frequent category are two species, namely B. pilosa and G. parviflora. There is species of C. nucifera on lowlands, and, there are three species on both heights, namely A. catechu, A. coromandeliana, and M. pudica. Those six plant species can bloom all year round.

Food source plants blooming all year round are 64 species, and 14 species are the plants that bloom depending on the season, and 28 species of annual plants. Most plants blooms in August to December, namely 85-87 of 94 food sources species. Cultivated plants mostly bloom in October to December. There are 12 species of food resources cultivated plants in the highlands and they can bloom in December. 11 out of 13 cultivated plants species in lowland blooms in December, while on both altitude, 22 species blooms in October (Table 1).

The species of food resource plants that support the existence of A. cerana colonies in polyculture plantation area in West Sumatra is 94 species (34 families). The plant species and a number of visits depend on the diversity and flowering time of plants at a site. This can be seen from the data that 94 plant species were visited by A. cerana in polyculture plantation area in West Sumatra, 70 species were visited by Apis mellifera in Isfahan, Iran (Amiri and Sharif 2014) and 194 plant species were visited by A. dorsata in Garwhal Himalaya, India (Tiwari 2010), and from these locations, there are only 19 same species. This suggests that differences in location can cause different varieties of plants. This is made clear by Yonega and Gupta (2012) that, nowadays, it has been recorded that about 1,200 Angiospermae plant species have been visited by various types of Apis worker bees around the world.

The factor of the habit in choosing the crop type also affects the diversity of plant species in polyculture planting area. This study finds 48 species of cultivation plants, while the number of plant species which are intensively cultivated by society in various areas in West Sumatra are 51 species and belong to the group of food, vegetables, fruit and industry crops. The crops are grown in various location and altitude (BPS 2011). Various species of crops have been exploited by A. cerana honeybee as a source of nectar and pollen in Coorg Karnataka, India (Shubharani et al. 2012).

Eight out of 11 vegetable crops as the food source of A. cerana are found in the highlands. The vegetables are planted as intercrops on the edge and the middle of the garden. Locations having a direct border with the gardens are also commonly planted by various kinds of vegetables. Referring to Nicholls and Altieri (2012), in the field of agricultural intensification, the edges of fields, road edges, headlands, guardrail, and the gardens which are cultivated around the farms play an important role in the protection of pollinators insect. Maintenance and restoration of hedgerows and the main vegetation play an important role in the protection of pollinators.

The species of food sources plant of A. cerana are dominated by the family of Asteraceae (12 species) and Leguminosae (10 species) and are distributed on both altitudes. Referring to Lawrence (1951), the family of Asteraceae and Leguminosae has relatively high species and are distributed on the lowlands to the highlands. Plant habitus that belongs to the family of Asteraceae is terna, small shrubs, and is rarely in the form of woody trees. Habitus of Leguminosae is Terna, bushes, shrubs, and trees. Asteraceae has members of about 20,000 species (950 genera), while Leguminosae consists of 13,000 species (550 genera) which is distributed in various countries.
Table 1. Family and species, distribution and status, flowering time and the visit frequency of *A. cerana* worker bees on food resource plants in polyculture planting area of West Sumatra, Indonesia

| Family          | Species                                                                 | Distribution | Status | Flowering time | Visit frequency | Reference |
|-----------------|--------------------------------------------------------------------------|--------------|--------|----------------|----------------|-----------|
| *Acanthaceae*   | 1. Asystasia coronandeliana Bl.                                           | + + + - + BST | Jan-Dec | ++              | Es            |
| *Anacardiaceae* | 2. Mangifera indica L.                                                   | + + + + - TBM | Jun-Dec | ++              | Ti            |
|                 | 3. Mangifera sp.1                                                        | + + + + - TBM | Jun-Dec | ++              |               |
|                 | 4. Mangifera sp.2                                                        | + + + + - TBM | Jun-Dec | ++              |               |
|                 | 5. Mangifera sp.3                                                        | + + + + - TBM | Jun-Dec | ++              |               |
|                 | 6. Spondias pinnata Kurz.                                                | + + + + - TBM | Apr-May | +              | Ti            |
| *Arecaceae*     | 7. Areca catechu L.                                                       | + + + + - BST | Jan-Dec | +++             |               |
|                 | 8. Arenga pinnata Merr.                                                  | - + - + + BST | Jan-Dec | ++              |               |
|                 | 9. Caryota mitis Lour.                                                   | - + + + + BST | Jan-Dec | ++              |               |
|                 | 10. Cocos nucifera L.                                                    | + + + + - BST | Jan-Dec | +++             |               |
| *Asparagaceae*  | 11. Ageratum conyzoides L.                                                | + + + + - BST | Jan-Dec | +              | Ti            |
|                 | 12. Ageratum houstonianum Mill.                                          | + + + + - BST | Jan-Dec | +              |               |
|                 | 13. Bidens pilosa L.                                                     | - + - + + BST | Jan-Dec | +++             | Pe, Ti        |
|                 | 14. Clidium surinamens L.                                                | + + + + - BST | Jan-Dec | ++              |               |
|                 | 15. Eupatorium inulifolium L.                                            | + + + + - BST | Jan-Dec | ++              |               |
|                 | 16. Eupatorium odoratum L.                                               | + + + + - BST | Jan-Dec | ++              |               |
|                 | 17. Galinsoga parviflora Cav.                                            | - + + + + BST | Jan-Dec | +++             |               |
|                 | 18. Tithonia diversifolia Gray.                                          | - + + + + BST | Jan-Dec | ++              |               |
|                 | 19. Mikania micrantha Willd.                                             | + + + + + BST | Jan-Dec | ++              |               |
|                 | 20. Siplanthes iabadicensis A. H. Moore.                                 | + + + + + BST | Jan-Dec | ++              |               |
|                 | 21. Siplanthes paniculata Wall. Ex DC.                                   | + + + + + BST | Jan-Dec | ++              |               |
|                 | 22. Tridax procumbens L.                                                 | + + + + + BST | Jan-Dec | + Ti            |               |
| *Bombacaceae*   | 23. Durio zibethinus Mur.                                                | + + + + - TBM | Jun-Dec | ++              |               |
| *Brassicaceae*  | 24. Brassica rapa L.                                                     | - + + + - TMT | Jan-Dec | ++ Ti           |               |
|                 | 25. Brassica sp.                                                         | - + + + - TMT | Jan-Dec | ++              |               |
|                 | 26. Korippa indica (L) Hiern.                                            | + + + + + BST | Jan-Dec | ++              |               |
| *Caesalpiniaceae* | 27. Erithria variegata L.                                               | - + + + + TBM | Nov-Dec | +              |               |
| *Caricaceae*    | 28. Carica papaya L.                                                     | + + + + + TMT | Jan-Dec | ++              |               |
| *Capparidaceae* | 29. Cleome rutidosperma DC.                                              | + + + + + BST | Jan-Dec | +              |               |
|                 | 30. Cleome viscosa L.                                                    | + + + + + BST | Jan-Dec | +              |               |
| *Convolvulaceae*| 31. Calystegia sapium                                                    | + - + + + BST | Jan-Dec | +              |               |
|                 | 32. Ipomoea triloba L.                                                   | + - + + + BST | Jan-Dec | +              |               |
| *Cucurbitaceae* | 33. Citrulus vulgaris L.                                                 | + - + + + TMT | Jan-Dec | +              |               |
|                 | 34. Momordica charantia L.                                               | + + + + - TMT | Jan-Dec | ++ Ti           |               |
|                 | 35. Cucumis sativus L.                                                   | + - + + + TMT | Jan-Dec | ++ Ti           |               |
|                 | 36. Sechium edule (Jacq.) Swartz.                                        | - + + + + TMT | Jan-Dec | ++              |               |
| *Cyperaceae*    | 37. Cyperus brevifolios Hassk.                                           | + + + + + BST | Jan-Dec | +              |               |
|                 | 38. Cyperus kylina Endl.                                                 | + + + + + BST | Jan-Dec | ++              |               |
| *Euphorbiaceae* | 39. Aleurites moluccana (L.) Willd.                                      | + + + + + TMB | Sep-Oct | ++              |               |
|                 | 40. Hevea brasiliensis (Willd. ex A. Juss.)                             | + - + + + TMB | Jun-Dec | +              |               |
|                 | M. A.                                                                    |               |        |                |                |
|                 | 41. Omalanthus pulpanus (Geisl) Pax.                                     | - + + + + BST | Jan-Dec | ++              |               |
| *Gramineae*     | 42. Oryza sativa L.                                                      | + + + + - TMT | Jan-Dec | ++              |               |
|                 | 43. Zea mays L.                                                          | + + + + - TMT | Jan-Dec | ++ Te           |               |
|                 | 44. Leersea hexandra Swartz.                                             | + + + + + BST | Jan-Dec | +              |               |
|                 | 45. Cynodon dactylon (L.) Pers.                                          | - + + + + BST | Jan-Dec | +              |               |
|                 | 46. Echinochloa colanum L.                                               | + + + + + BST | Jan-Dec | +              |               |
| *Labiatae*      | 47. Hyptis brevipes Poit.                                                | + + + + + BST | Jan-Dec | +              |               |
48. *Hypitis capitata* Auct. non Jacq. + + - + BST Jan-Dec +
49. *Leucas lavandula* Smith. + - - + BST Jan-Dec +

**Lauraceae**
50. *Cinnamomum burmanii* Nees ex Bl. + + + - TBM Oct-Feb ++
51. *Persea Americana* Mill. + + + - TBM Oct-Feb ++

**Loranthaceae**
52. *Loranthus europaeus* Auct. non Jacq. + + - + BST Jan-Dec ++

**Leguminosae**
53. *Acacia auriculiformis* A. Cunn. Ex Bth + - + - BST Jan-Dec ++ Ti
54. *Crotalaria striata* DC. + + - + BST Jan-Dec +
55. *Lecanu glauca* Auct. non Bth. + + - + BST Jan-Dec ++
56. *Mimosa invisa* Mart. ex Colla. + + + BST Jan-Dec ++
57. *Mimosa pigra* L. + + - + BST Jan-Dec ++
58. *Mimosa pudica* L. + + + BST Jan-Dec +++
59. *Phaseolus sp.* 1 + + + - TMT Jan-Dec +
60. *Phaseolus sp.* 2 - + - + TMT Jan-Dec +
61. *Pithecellobium lobatum* Bth. + - + - TBM Nov-Jan ++ Le
62. *Perkia speciosa* Hassk. + - + - TBM Sep-Dec ++

**Lythraceae**
63. *Cupea sp.* + + + - BST Jan-Dec ++

**Malvaceae**
64. *Sida rhombifolia* L. + + - + BST Jan-Dec + Ti
65. *Urena lobate* L. + + - + BST Jan-Dec + Ti

**Melastomataceae**
66. *Melastoma polianthum* Bl. + + - + BST Jan-Dec +

**Meliaceae**
67. *Lansium domesticum* Corr. + - + - TBM Dec-Feb +
68. *Melia azederach* L. - + + - TBM Dec-Feb ++ Ti
69. *Toona sureni* (Bl.) Merr. - + + - TBM Oct-Jan ++ Ti

**Musaceae**
70. *Musa paradisiaca* L. + + + - TMT Jan-Dec + Ti

**Myrtaceae**
71. *Syzygium aqueum* (Burm. f.) Alst. + + + - TBM Jun-Dec +
72. *Syzygium jambos* (L.) Alst. + - + - TBM Jun-Nov +
73. *Psidium guajava* L. + + + - TMT Jan-Dec ++ Ti

**Passifloraceae**
74. *Passiflora foetida* L. + + - + BST Jan-Dec +

**Rubiaceae**
75. *Coffeea canephora* Pierre ex Froehner - + + - TBM Jul-Dec +
76. *Coffeea Arabica* L. - + + - TBM Jun-Dec +
77. *Borreria leavis* (Lamk) Griseb. + + - + BST Jan-Dec +

**Rutaceae**
78. *Citrus aurantifolia* (Christm. & Panz.) + + + - TBM Jun-Oct + Ti
79. *Citrus maxima* (Burm. f.) + - + - TBM Sep-Dec +
80. *Citrus sinensis* (L.) Osbeck. + + + - TBM Oct-Dec + Ti

**Sapindaceae**
81. *Nephetium lappaceum* L. + + + - TBM Jul-Oct +

**Solanaceae**
82. *Physalis angulata* L. + + - + BST Jan-Dec +
83. *Solanum turvum* Swartz. + + - + BST Jan-Dec + Rj
84. *Solanum melongena* L. - + + - TMT Jan-Dec +
85. *Capsicum annuum* L. - + + - TMT Jan-Dec + Ti

**Sterculiaceae**
86. *Petersiana blumeana* Hochr. - + + + - TBM Aug-Dec +
87. *Theobroma cacao* L. + + + - BST Jan-Dec +

**Tiliaceae**
88. *Muntingia calabura* L. + - + - BST Jan-Dec +

**Umbelliferae**
89. *Eryngium foetidum* L. - + + - BST Jan-Dec +

**Urticaceae**
90. *Toxicodendron radicans* (L.) Kuntze - + - + BST Jan-Dec +

**Verbenaceae**
91. *Stachytarpheta indica* (L.) Vahl. + + - + BST Jan-Dec +
92. *Stachytarpheta jamaicensis* (L.) Vahl. + + - + BST Jan-Dec +
93. *Tectona grandis* L. I. + - + - TBM Jun-Sep ++ Ti
94. *Peronema canescens* Jack. + + + - TBM Sep-Jan +

**Total** 76 70 48 46
Crop blooming all year round and frequently visited by A. cerana consists of two species, namely C. nucifera and A. catechu. Coconut (C. nucifera) and Areca nut (A. catechu) belong to a group of industrial plants and are cultivated on a large scale and is one of the high commodities for local people. The planting area of these two commodities continues to increase from time to time, accompanied by an increase in average production per year. Areca nut is an exported commodity for Padang Pariaman District. And, coconut plantation in this district is the largest plantation in West Sumatra with 33,940.46 hectares. The location spreads from city areas to village areas (BPS 2011). Coconut plant is also considered as a pollen source for A. cerana in the district of Coorg, Karnataka, India (Shubharani et al. 2012).

The main feed source crops for A. cerana on highland polyculture plantation consist of two species, namely Coffee arabica and Coffee canephora. Both species of coffee plants produce relatively high amounts of flowers in one flowering period. The flowers are white. Saepudin et al. (2011) reported that the nectar production of these coffee plants is about 0.64 mL per 25 buds per day, equivalent to 18.14 mL/tree/day. The nectar production on these coffee plants fluctuates and the highest average of nectar production occurred in July.

Wild plants as a source of feed for A. cerana in polyculture planting area in West Sumatra are 46 species. The relatively same wild plant species are also visited by other pollinating insects, for example, 43 species of 22 families of wild plants in an area of Malang and Pasuruan (East Java) are visited by various pollinating insects (Erniwati and Kahono 2009). Pollinating insects are attracted by the flowers of wild plants, mainly due to the substances excreted by these flowers in the form of pollen and nectar. Some families of plants are very important as a source of pollen for honeybees. The availability of these plants as a source of pollen varies from time to time (Fidalgo and Kleinert 2010). Annual and perennial plants that exist in and around the farm location became a source of nectar and pollen containing important components as food for many insects (Ratnadass et al. 2012).

All year round blooming wild plants spreading on both altitude and as the food source for A. cerana with the high category are four species, namely A. coromandeliana, B. pilosa, G. parviflora, and M. pudica. Of the four species of these plants, A. coromandeliana has been reported as dominant weeds in oil palm plantations in South Assin, Ghana (Essandoh et al. 2011). M. pudica grows wild in the mangrove areas and is used as a food source for A. cerana in Qingland, Hainan Island, China (Yao et al. 2006) and in the North Queensland (Hyatt 2012). G. parviflora is widespread in Asia, Africa and in other parts of the world at lowland to the area with an altitude of over 1000 m. This plant is the weeds on various crops (Petrova et al. 2013). B. pilosa, including perennial herb, is widely distributed in tropical and temperate location (Petrova et al. 2013) and is the food source for A. dorsata in Garhwal, Himalaya, India (Tiwari et al. 2010), but to be a food source for A. cerana has never been reported.

Six plant species (2 species of cultivated plants and 4 species of wild plants) are frequently visited by bees, that it is categorized as frequent (+++) (Table 1). The visit frequency of honeybees is more in the crops with many flowers (Rollin et al. 2013). The foraging activity of bees has so many relations to the natural plant communities and the climate. Some factors affecting the nectar concentration collected by bees are the distance of flowers to the nest, the availability and the morphology of flower (Fidalgo and Kleinert 2010).

Species of food sources plant for A. cerana in polyculture planting area has a various flowering season. The difference in the flowering season plays an important role in maintaining the continuous availability of food resources for bees. Planting area with a high diversity of plant species provides abundant sources of pollen and nectar throughout the year. Referring to Winfree et al. (2008), a high number of visiting species is due to the abundant amount of flowers, the variety of flower colors, and the attractiveness of plants. The density and diversity of flowers are the most important and determining factor for the diversity of pollinating insects, especially when the flowers are available throughout the year. Taha and Bayoumi (2009) reported that the frequency of bee visits in plants is positively related to the flowering time of plants. Bees will more intensively visit the plant in peak flowering time.

Total similarity index of food resources plants for A. cerana in lowland (<100 m asl) and highland (> 1,000 m asl) polyculture planting area is 75.34% or 80 plant species. The similarity percentage of food source species in the two altitudes relates to spreading regions of plant species. Various plant species are widespread and can thrive in a variety of ecosystems. Man-modified habitat is ecologically the homogeneity that is rich with biodiversity (Petrova et al. 2013). Human has a powerful influence in modifying the landscape through fragmentation, degradation, and destruction of natural habitats and in the creation of new anthropogenic habitats (Winfree et al. 2009).

Polyculture cultivation in West Sumatra can provide food source plants for A. cerana honey bees throughout the year. Polyculture cultivation is supported by 94 species (34
families) consisting of 48 species of crop and 46 species of wild plants. The details are more than 68% of plant species blooming all year round, 21.87% of plants blooming depending on the flowering season, and 29.78% of annuals plants. The average number of species to flower monthly is 73.75% (70 species) with peak flowering season in August-December with more than 91% of species producing flowers. From these findings, it can be recommended that the cropping polyculture in West Sumatra can be used as a location for honeybee cultivation or other wild bee conservation.

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