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The Type of Honeybees Forages in District of Pakem Sleman and Nglipar Gunungkidul Yogyakarta

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ABSTRACT

This research aimed to investigate the type of plants for honeybees forages in Pakem Sleman and Nglipar Gunungkidul. This research was conducted from 16 March to 12 May 2016. The method used was direct observation in the plantations, fields, and forests. The type of plants observed were dominant plants, so can be developed beekeeping, honey. To determine the type of plants that produce nectar and pollen, one or two samples of flower in each plant were taken, then the availability of nectar and pollen was checked. The data of honeybees forage types were analyzed descriptively. The results showed that the type of honeybees forages in Pakem Sleman consisted of coconut, coffee, banana, calliandra, avocado, rice, albizia, chili, tomato, long beans, mustard green, maize, cucumber, melinjo, mahogany, cassava, and cherry. Honeybees forages in Nglipar Gunungkidul consisted of coconut, albizia, acacia, banana, peanuts, tamarind, eucalyptus, rambutan, sorghum, cacao, soybeans, cassava, maize, rice, rose wood, mahogany, and cherry. Thus, Pakem Sleman and Nglipar Gunungkidul have great potential for development of beekeeping honey.

Keywords : Honeybees, Forages, Nectar and Pollen

Introduction

Honeybees are a group of insects that act as plant pollinator agent, so they increase the crop productivity (Corlett, 2011). Very few flowers are dependent on a single insect species, although no other pollinators are as effective as are honeybees. Approximately 80% of flowering plants worldwide are pollinated by insects, and about 85% of these are pollinated by honeybees. As many as 90% of fruit tree flowers are dependent on honeybees. The list of flowering plants pollinated by honeybees includes about 170,000 species (Tautz, 2008). Honeybees obtain feeds of nectar and pollen from flowers of plants. The nectar and pollen will be collected by worker bees regularly and continuously. Nectar is a sweet liquid secreted by plant nectaris glands that can grow in the flower (floral nectar), leaves and stems (extrafloral nectar). Bee-pollen is a product produced by worker bees from the pollen or plant male genitals as raw material. The pollen contains proteins, vitamins, and minerals that are needed by honeybees to make a healthy colony (Sihombing, 2005; Abrol, 2011). Honeybees collect pollen and nectar from flowers as a source of carbohydrates, protein, fat, vitamins, which are essential for growth and development, repairing of worn out tissue and stimulating the development of hypopharyngeal glands (Abrol, 2011).

Generally, almost all flowering plants can be a source of bees forages, but there are several types of flowers contain toxic compounds, therefore honeybees and insects could not obtain pollen from it generally (Pacini and Nicolson, 2007). Dissolved substances in nectar have several functions such as, water, ions, carbohydrates, amino acids, and proteins with low molecular weight are beneficial for pollinators, nectar also contain scented compounds to attract pollinators (Raguso, 2004), enzymes and antioxidants to maintain nectar composition homeostasis (Carter and Thornburg, 2004). The information of solutes other than sugars and amino acids, generally much more available for the floral nectars than extrafloral nectars (Pacini and Nicolson, 2007).

One source of variation in foraging cues between genotype is that the nectar may provide a variety of stimuli. It has been found to be a very significant parameter that decisively shapes the behavior and physiology of pollinators in relation to their energy demands (Abrol, 1990; 1995; 2007a,b; 2009; 2010; 2011), so impact on different production of nectar from plants (Roubik, 1991; Chalcoff *et al*., 2006) and volume of nectar can be collected by worker bees. Nectar is a raw material used by worker bees to produce honey (Sihombing, 2005; Abrol, 2011; 2015). Generally, nectar produced by plants contains water, glucose, and sucrose as the source of

energy, while protein as the source of amino acids, lipids for honeybees in the hive. In addition, nectar contains ions K^+, antioxidants such as ascorbic acid, phenols, and alkaloids (Pacini and Nicolson, 2007).

Information of plants species which can produce of nectar and pollen as feeds for honeybees are limited, especially in Pakem Sleman and Nglipar Gunungkidul, Yogyakarta. Thus, the limited of information of plants for honeybees feed in the regions are very serious problems for the development of beekeeping honey, so it decreases the production of honey and beekeepers income. One strategy was done by collecting plant types data that can produce nectar and pollen. Thus, the information of plants species has become guidelines and prototype for the development of beekeeping in the long term. In addition, as the first step for the development of honeybees forages in the future to support the sustainable beekeeping by the cultivation of bees forages in the empty land and not fully utilized.

Materials and Methods

This research has been conducted from 6 April to 12 June 2016 in District of Pakem Sleman and Nglipar Gunungkidul Regency, Yogyakarta. The study obtained data such as the types of honeybee forages produced nectar, pollen or both and ambient temperature. The data of bee forage types in the research were collected using direct survey method to the plantations and fields to observe the plants producing nectar, pollen and both. Flower samples were taken to determine the plant types which can produce nectar, pollen, and both; then availability of nectar and pollen was checked. The method for checking the flower plants as a source of nectar was performed by opening the petals of flowers, then checking the liquid content was indicated as the nectar in the base. For checking the flower plants that produce pollen was performed with checking at another of flower, then checking pollen floured colored and powder. In addition, the ambient temperature in District of Pakem and Nglipar were measured using thermo-hygrometers. The data of land area for food crops and horticulture were collected from Central Agency on Statistics (BPS) District of Pakem Sleman and Nglipar Gunungkidul (as secondary data). The result data of research were analyzed using descriptive analysis (Steel and Torrie, 1993).

Results and Discussion

Ambient temperature

The results showed that the ambient temperature in District of Pakem Sleman was about 20 to 27ºC, while District of Nglipar Gunungkidul was about 24 to 32ºC. The ambient temperature in the Pakem and Nglipar were normal temperature for honeybees. Thus, the regions were great potential as an area for development of beekeeping honey in Yogyakarta. The honeybees can be integrated with the agricultural crops, plantations, and forest through roles as pollinator agent to improve and increase the crops production. Thus, impact on increasing of income for beekeepers and farmers (Partap, 2011).

The result of the research reported that *Apis florea* commenced foraging where a combination of 19.5ºC and 87% relative humidity (RH) (Abrol, 2011). In addition, in *Apis dorsata* and *Apis florea*, the onset of flight occurred at 15ºC under subtropical conditions of Hisar during winter. In flowers of *Brassica juncea*, nectar secretion occurred between 12 and 15ºC thereby indicating that 12 to 15ºC is a minimum threshold temperature for activation of the enzymatic machinery to secretion nectar (Abrol, 1986). Futhermore, Tautz (2008) explained that honeybees keep the temperature of the brood combs containing the pupae at about 35ºC. For rearing larvae and pupae requires brood temperatures within the narrow about 32 to 36ºC with a mean of 34.5ºC (Becher *et al*., 2010); about 33 to 36ºC (Sihombing, 2005); about 32ºC (Kovac *et al*., 2010). *Apis dorsata* was generally most active when temperature about 24.5 to 34.5ºC (Abrol, 1991). When collecting nectar and pollen the honeybees must set thermoregulation during foraging. The honeybees must maintain their body temperature below the lethal upper limit of about 45ºC, and while flying must keep their thoracic temperature above 27ºC, the lower limit for steady flight (Abrol, 2011).

The relation between body temperature and ambient temperature shows impressively the thermoregulatory ability of the water foraging honeybees. The thorax temperature was regulated independently of sunshine and shade in a broad range of 23 to 30.8ºC (Kovac *et al*., 2010). The result of the research was reported mean thoracic temperatures of 36.0 to 38.8ºC for *Apis mellifera* (Schmaranzer, 2000). Bees foraging from other natural resources like flowers regulate their thoracic temperature at a somewhat lower level (Kovac *et al*., 2010). In shade Heinrich (1979) reported means of about 30 to 35.8ºC and was reported the average thoracic temperature about 35.7°C in spring and about 29.3ºC in summer (Kovac and Schmaranzer, 1996). The mean temperature of the head was 30.9ºC in spring and 26.8ºC in summer, that of the abdomen 25.2ºC and 23.1ºC. In addition, the ambient temperature in summer was reported about 20 to 26ºC (Abrol, 2011). The stingless bees *Trigona* sp. can activities at ambient temperature 26 to 35ºC with humidity about 46 to 60% (Agussalim, 2015). For collecting resin in by *Trigona* sp. workers was started about 06.00 to 06.15 am with temperature 23 to 24ºC, humidity 68% and entrance to hives was about 18.00 to 18.15 pm with temperature about 29 to 30ºC, humidity about 54% (Agussalim *et al*., 2015).

Type of honeybees feeds

Nectar. In general, almost all of flowering plants can become feed for honeybees consists of nectar and pollen. Nectar is a sweet liquid secreted by nectaris glands of plants that develop in the flowers, stems, and leaves of plants that were absorbed by ants, birds and insects including honeybees (Pacini and Nicolson, 2007). Honeybees can be integrated with agriculture crops and have a relation which beneficial, honeybees very productive that act as pollinators agent and improve or increase the productivity of crops. Thus, the integration can improve food security and increase the income of beekeepers and farmers (Partap, 2011).

Nectar produced by the flowers of the plant contains water, glucose, and sucrose as a source of energy in the hives, while the protein as a source of amino acids for honeybees. In addition, nectar contains ions K^+, antioxidants such as ascorbic acid, lipids, phenols and alkaloids (Pacini and Nicolson, 2007). Nectar was collected by worker bees was used as a raw material to produce honey (Sihombing, 2005; Abrol, 2011; 2015). One source of variation in foraging cues between genotype is that the nectar may provide a variety stimuli. It has been found to be a very significant parameter that decisively shapes the behavior and physiology of pollinators in relation to their energy demands (Abrol, 1990, 1995, 2007ab, 2009, 2010, 2011), so impact on differences production of nectar from plants (Roubik, 1991; Chalcoff *et al*., 2006) and volume of nectar can be collected by worker bees. Nectar as honeybees forage was obtained from the flowering plants (floral nectar) and other parts of plants that can develop on stems and leaves (extrafloral nectar). The several plants can produce extrafloral nectar there are sugar cane, sugar palm, and coconut. In addition, the plants of *Acacia spp*. was potential to produce nectar in dry areas. Adgaba *et al*. (2016) explained nectar secretion amount of the species was positively correlated with the ambient temperature, indicating the adaptation of the species to hot climatic conditions. Plant of *Acacia* spp. was one of the great potential feed for honeybees in Saudi Arabia.

Pollen. Bee-pollen is a honeybees product produced by worker bees with raw materials such as pollen from the male flowers of plants and stored in the hive. Pollen contains proteins, vitamins, and minerals required by the bees to build and create a healthy colony, so can develop properly. Pollen is also a raw material to produce royal jelly as food for queen bee (Sihombing, 2005; Abrol, 2011). Pollen obtained from the flowers of plants and produced in the microsporangium in the anther (Pacini, 2000; Sihombing, 2005; Abrol, 2011). Worker bees have a special way used to collect pollen from the plant flowers by using the mouth, tongue and almost all parts of the outside of the body to harvest pollen grains of very small size (from 0.01 to 0.10 mm). In addition, the way that is generally was done by bees usually with clasped her repeatedly to the plant's flowers, so all of the pollen attaches to the worker bees body. Pollen attached it will be collected using brush pollen found in the legs and placed in corbicula or pollen baskets in the rear legs (Sihombing, 2005).

The result of research was reported that pollen has a chemical composition based on the dry weight (%) ie. dry matter 83%, fat 11%, protein 23%, total carbohydrate were calculated as invert sugar 36%, glucose 14%, fructose 19%, ash 2.4%, fat was calculated as lecithin fitosterin 1.7% and 1.6%. In addition, pollen also was contained amino acids (Linskens and Jorde, 1997). Based on the complete chemical composition, so pollen can be used as functional food and much more was used in the medicine for human health.

Type of honeybees forage

District of Pakem Sleman Regency. The results showed that honeybees forage plants species in District of Pakem Sleman were varied depending on the lands type and availability of water in the regions. Generally, species of plants as honeybees forage in Pakem were grouped as a source of nectars, pollens and both (Table 1).

Variations of the type of plants as honeybees forage was expected become sources of honeybees feed that potential in the Pakem. The type of forage plants can producing nectar and pollen in Pakem consisted of coconut, long beans, banana, albizia, cucumber, melinjo, mustard green, and cherry. The plants have flowering bloom all year round, so was expected can fulfill the dietary requirements for honeybees. In addition, the forage plants could be the alternative feed for honeybees when crisis and shortage feed especially in the rain season. Partap (2011) states that increase production of honey will impact on the increase of income for beekeepers.

The type of honeybees forage plants producing nectar consisted of coffee, calliandra, chili, and cassava. Nectar from all of the honeybees forage is raw material to produce honey by worker bees. The result of research Bravo-Monroy *et al*. (2015) was found that pollination services provided by stingless bees, honeybees, and other insects accounted for a 10.5±2.0% increase in final coffee fruit set and that the various pollinators are affected differently by the differing factors. Thus, the coffee was one of the potential feed for honeybees in the District of Pakem Sleman. Production of nectar in the flowers plants are varied (Abrol, 1990, 1995, 2007ab, 2009, 2010; Chalcoff *et al*., 2006; Roubik, 1991) dependent on the season flowerings, type of plants, the size of flowers and the most important is the development of nectar gland from plants flowers.

The results research Raj *et al*. (1993) was found that honeybees of *Apis mellifera* and *Apis cerana* foraging on rapeseed, *Brassica ampestris* exhibited pollen consistency: 66.78% of the pollen loads collected by *Apis mellifera* and 65.45% by *Apis cerana* was found to be from a mustard crop. Calliandra was much more available and was found in plantations in District of Pakem because leaves were used by farmers for goat feed. In

addition, calliandra have a flowering all year. Thus, potential the plant of calliandra was expected can provide continuous nectar for honeybees. The daily production and volume of nectar each flower some kinds of calliandra were reported (MacQueen and Hernandez´, 1997) ie. *Calliandra grandiflora* volume nectar was 6.3 mg/flower and 10.7 mg/flower for *Calliandra palmeri* (Cruden *et al*., 1983), 1.5 mg/flower (Arizmendi, 2001), 6 to 32 mg/flower/day (Hernández-Conrique *et al*., 2007). The information of nectar production indicating that nectar from calliandra was a source of potential feed for honeybees, thus can increasing production of honey. The types of forage as the source of nectar for stingless bees *Trigona* sp. was found in Papak, Genggelang Village, Lombok consists of *Cocos nucifera, Musa paradisiaca, Muntingia calabura, Syzygium aqueum, Mangifera indica, Carica papaya, Moringa oleifera* and *Ceiba pentandra* (Agussalim, 2015).

Type of plants source of pollen in District of Pakem consisted of rice, corn or maize and tomatoes. The supporting of the source of pollen from these plants was expected to provide a source of protein for the development of honeybees colonies especially the queen bee. Pollen collected by worker bees is one source of protein and raw materials for production royal jelly for food the queen bee and candidate of queen bee in the colony (Sihombing, 2005; Abrol, 2011). Maize was a potential source of pollen for honeybees in the late summer (Danner *et al*., 2014). Honeybees forage in Pakem supported by harvest area crops for avocado was 93.96 ha; maize 343.3 ha; rice 2530 ha; peanuts 417 ha; mustard 24.76 ha; long beans 34.80 ha; chili 219.04 ha (in the village of Purwobinangun, Candibinangun, Harjobinangun, Pakembinangun, Hargobinangun) (BPS Sleman, 2015). The results of research for honeybees forage was indicated District of Pakem Sleman has great potential for beekeeping honey.

District of Nglipar Gunungkidul Regency. The research results showed that the type honeybees forage in the District of Nglipar were varied that presented in Table 2. The type of honeybees forage was obtained for producing nectar, pollen and both consisted of coconut, albizia, acacia, banana, peanuts, eucalyptus, tamarind, rambutan, sorghum, cacao, soybeans, cassava, corn, rosewood, mahogany, and cherry. Generally, Nglipar is a dry region, it has great potential for development plants *Acacia* spp. as the source of nectar and pollen for honeybees.

Research results showed that the type of honeybees forage producing nectar and pollen in Nglipar consisted of coconut, albizia, acacia, banana, peanuts, and cherry. The plant has flowering patterns and different nectar production (Roubik, 1991; Chalcoff *et al*., 2006), it can influence the production of honey and pollen by worker bees. Coconut and acacia were the plants can produce nectar throughout all of the years, so was expected as a source of potential nectar to increase honey production for sustainable. Nectar was produced by flowers and stalk for coconut and by leaves for acacia that including nectar of extrafloral. In addition, the coconut have potential production of pollen for honeybees feed. The result of research Devkota and Thapa (2005) was found that the pollen loads of *Apis cerana* bees in March and June were mostly from coconut (90%), while in *Apis mellifera* pollen loads were from coconut (67%) thereby indicating floral constancy in the collection of pollen.

Nectar from *Acacia* was one of the potential nectar for feed honeybees in Saudi Arabia (Adgaba *et al*., 2016). Differences acacia species that have been reported to have an important role as a potential feed honey bees in areas with hot and semi-arid tropical regions in particular (Stone *et al*., 1996; 1998; Adgaba *et al*., 2016). The result research was measured production of nectar some genus *Acacia*, a maximum of 2.60 kg nectar TSS/tree was recorded for *Acacia gerrardii*, whereas a minimum of 0.15 kg nectar TSS/tree was recorded for *Acacia etbaica*. Production of nectar eight species of acacia for honeybees feed and was estimated in the production of *Acacia* every hectare areas. Honey production of several species of the acacia plants were *Acacia asak* 110 kg/ha; *Acacia ehrenbergiana* 443 kg/ha; *Acacia etbaica* 51 kg/ha; *Acacia gerrardii* 511 kg/ha; *Acacia johnwoodii* 625 kg/ha; *Acacia aoefota* 120 kg/ha; *Acacia origena* 325 kg/ha and *Acacia tortilis* 223 kg/ha (Adgaba *et al*., 2016). Production of nectar extrafloral from *Acacia crassicarpa* (0.035 ml/day; 25.69 ml/tree; 42.774 kg/ha for the age of *Acacia* 12 months) and (0.035 ml/day; 44.31 ml/day; 73.766 kg/ha) (Pribadi and Purnomo, 2013).

Based on the information production of honey from the nectar of Acacia indicating that the Acacia nectar was a source of high potential for honey bees. In addition, the Acacia plants were much more widely grown in Nglipar areas, so the District of Nglipar had great potential as a center for development beekeeping of honeybees. The source of pollen for stingless bees *Trigona* sp. in Nglipar village were found from pollen in hives consists of *Carica papaya, Nephelium longan, Acacia auriculiformis, Eucalyptus nandiniana, Amaranthus spinnosus, Cosmos caudatus, Clitoria ternatea, Zea mays, Averrhoa carambola, Talinum paniculatum, Capsicum annuum, Coleus scutellarioides and Impatiens balsamina*. The types of pollen source were obtained around the stingless bee *Trigona* sp. beekeeping in Gunungkidul consisted of *Carica papaya, Nephelium longan, dan Cosmos caudatus* (Nugroho and Soesilohadi, 2014). Based on survey and explore in the

Table 1. Type of honeybees forage located in District of Pakem Sleman, Yogyakarta

Type of bees forage	Indonesian name	Latin name	Source of nectar/pollen
Coconut	*Kelapa*	*Cocos nucifera*	Nectar/Pollen
Coffee	*Kopi*	*Coffea sp*.	Nectar
Calliandra	*Kalliandra bunga merah*	*Calliandra calothyrsus*	Nectar
Avocado	*Alpukat*	*Persea americana*	Nectar
Rice	*Padi*	*Oryza sativa*	Pollen
Albizia	*Sengon*	*Albizzia falcataria*	Pollen
Chili	*Cabe*	*Capsicum annum*	Nectar/Pollen
Tomato	*Tomat*	*Solanum melongena*	Pollen
Long beans	*Kacang panjang*	*Vigna unguiculata s.*	Nectar/Pollen
Banana	*Pisang*	*Musa paradisiaca*	Nectar/Pollen
Mustard green	*Sawi hijau*	*Brassica Juncea*	Nectar/Pollen
Corn	*Jagung*	*Zea mays*	Pollen
Cucumber	*Ketimun*	*Cucumis sativus* Linn	Nectar/Pollen
Melinjo	*Melinjo*	*Gnetum gnemon*	Nectar/Pollen
Mahogany	*Mahoni*	*Swietenia mahagoni*	Nectar
Cassava	*Ubi kayu*	*Manihot uttilisima*	Nectar
Cherry	*Kersen*	*Muntingia calabura*	Nectar/Pollen

Table 2. Type of honeybees forage located in District of Nglipar Gunungkidul, Yogyakarta

Type of bees forage	Indonesian name	Latin Name	Source of nectar/pollen
Coconut	*Kelapa*	*Cocos nucifera*	Nectar/Pollen
Albizia	*Sengon*	*Albizzia falcata*	Nectar/Pollen
Acacia	*Akasia*	*Acacia* spp.	Nectar/Pollen
Banana	*Pisang*	*Musa paradisiaca*	Nectar/Pollen
Peanuts	*Kacang tanah*	*Arachis hypogaea*	Nectar/Pollen
Tamarind	*Asam*	*Tamarindus indica*	Nectar
Eucalyptus	*Kayu putih*	*Melaleuca leucadendra*	Nectar
Rambutan	*Rambutan*	*Niphelium lapaceum*	Nectar
Sorghum	*Sorgum*	*Sorghum* spp.	Pollen
Cacao	*Cokelat*	*Theobroma cacao*	Nectar
Soybeans	*Kedelai*	*Glycine soya*	Nectar
Cassava	*Ubi kayu*	*Manihot uttilisima*	Nectar
Corn	*Jagung*	*Zea mays*	Pollen
Rice	*Padi*	*Oryza sativa*	Pollen
Rosewood	*Sonokeling*	*Dalbergia latifolia*	Nectar
Mahogany	*Mahoni*	*Swietenia mahagoni*	Nectar
Cherry	*Kersen*	*Muntingia calabura*	Nectar/Pollen

field showed the types of honeybees forage around KTH Madusari beekeeping in Subvillage Ngrandu, Katongan Village District of Nglipar was found coconut, rambutan, banana, mango and *Averrhoa carambola* L. and some *Calliandra calothyrsus.* The type of honeybees forage can produce nectar in Nglipar consisted of eucalyptus, rambutan, cacao, soybeans, cassava, rosewood, and mahogany. The variation of nectar source from the forage expected can fulfill the requirement for honeybees feed, so can produce sustainable honey. Cassava could be the potential source of nectar in Nglipar with the total land area was 3221 ha; soybeans was 1614 ha. The type of honeybees forage producing of pollen consisted of sorghum, rice with total land area in the District of Nglipar was 2300 ha; corn was 3276 ha (village of Kedungkeris, Nglipar, Pengkol, Kedungpoh, Katongan, Pilangrejo, Natah) (BPS Gunungkidul, 2015), it indicating rice and maize were a sources of pollen very potential for honeybees forage. Thus, it expected to provide and fulfill the requirement of honeybees as the source of protein, so can increase productivity queen bee to produce eggs as the candidate of workers and drones. Maize was a potential source of pollen for honeybees in the late summer (Danner *et al.*, 2014). The chemical composition of corn pollen (based on dry matter) comprising the protein content about 22.69 to 24.84% dm, glucose 44.66 to 103.34 mg/g dm, fructose 103.48 to 193.30 mg/g dm and sucrose 0.53 to 50.26 mg/g dm. The chemical composition of the maize pollen was obtained from the various type of maize (Žilic´ *et al*., 2014).

Conclusion

The types of honeybee forage located in District of Pakem Sleman generally as source of nectar and pollen consists of coconut, coffee, banana, calliandra, avocado, rice, albizia, chili, tomato, long beans, mustard green, maize, cucumber, melinjo, mahogany, cassava, and cherry. The types of honeybees forage located in District of Nglipar Gunungkidul consists of coconut, albizia, acacia, banana, peanuts, tamarind, rambutan, sorghum, cacao, soybeans, cassava, maize, rice, eucalyptus, mahogany, and cherry. Thus, District of Pakem and Nglipar has great potential for development of honeybees.

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