Ecosystem Services From Honey Beees Apis cerana Fabr. In Taman Hutan Raya (Tahura) Ir. H. Djuanda Dago Expert Bandung Ecology and Economically

by Arief Anshory Yusuf

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Syayidah Nuriyah [1], *Arief* Anshory Yusuf [1,3], *Wawan* Hermawan[1,2], *Teguh* Husodo[1,2]

[1] Postgraduate Program on Environmental Science, Padjadjaran University, Indonesia
[2] Department of Biology, Faculty of Mathematics and Natural Sciences, Padjadjaran University, Indonesia.
[3] Faculty of Economics, Padjadjaran University, Indonesia

Abstract. Pollination is one of the key components of global biodiversity and is very important for ecosystems in ensuring the maintenance of ecological processes, which are largely responsible for the successful reproduction of native plants. *Apis cerana* Fabr. including insect pollinators that are widely cultivated in the conservation forest Tahura Ir H Djuanda. Through survey and observation methods, it is known that some plants in Tahura are visited by honey bees, which have great potential for the effectiveness of plant pollination in Tahura. The types of plants visited by honey bees can be classified into agricultural and non-agricultural crops in a radius of 500 meters from Tahura. Based on the data, it is known that honey bees visited non-agricultural plants as many as 39 families and 83 species, while agricultural crops were 6 families and 17 species. So it can be concluded that bees prefer visiting non-agricultural crops rather than agricultural crops in Tahura, therefore the potential for pollination effectiveness by honey bees will be greater in non-agricultural crops such as plants in Tahura to maintain conservation forest biodiversity.

1 Preliminary

Humans benefit from the many resources and processes that natural ecosystems provide. Collectively, these benefits are known as ecosystem services. Ecosystem services are understood as conditions and processes that exist in natural ecosystems and species that enable them to sustain themselves and fulfill human life [4]; in other words, ecosystem services are a set of ecosystem functions that are useful for humans [8].

In another sense, ecosystem services are goods or services provided by ecosystems for human life [3,10]. For example, the amount of wood extracted from an ecosystem that depends at the request of the local community and the costs incurred in order to firewood can be obtained. The supply of ecosystem services will varying time, actual and potential supply in the future should be included in the valuation of ecosystem services [6].

According to [11], ecosystem services are divided into four categories, namely:

1. supply Services (*provisioning*): includes the results obtained from ecosystems, such as food (fruits, vegetables, grains), wood and fiber.
2. settings Services (*regulating*): eg climate arrangement, pollination (*pollination*), and control of the disease. settings Services including pest control and removal of carcasses
3. Cultural services (*cultural*) provide recreational services, inspiration for art and music, and spiritual value.
4. Support services (*supporting*), such as pollination, seed dispersal, purification of water and nutrient cycles, providing an important process for ecological communities and agricultural ecosystems

Tahura Djuanda is a conservation forest area with a high wealth of vegetation and various ecosystem services [1,12]. Among the forest ecosystem services provided by honey bees such as pollination services and honey production value.

Honey bees are pollinating insects that are widely cultivated by the people of Tahura Djuanda, namely the *Apis cerana* Fabr species. *Apis cerana* is a type of wild bee native to Asia. Current research on bees as honey producers or as pollinators on agricultural land [7,9,13] has not assessed the value of bees in maintaining conservation forest ecosystems such as in Tahura. So a research was carried out with the aim of knowing the value of the ecosystem services of *A. cerana* honeybees from the bee forage plants and the value of honey production in Tahura Ir. H. Djuanda .

2 Research methods

The research method used is the method of roaming in the area within Tahura and around Tahura with a

radius of 500 meters, structured interviews, and observing bee pollen being brought to the hive.

3 Time and place

The research was conducted for 3 months from January to March 2019 at Forest Park Raya (TAHURA) Ir H Djuanda Dago Pakar, Bandung.

4 Tools and Materials

Tool:

1. *Insect net*
2. Tweezers
3. Rapia
4. Camera
5. Test tube
6. Stirring Rod
7. *object glass*
8. *Cover Glass*
9. Binocular Microscope CX22

materials

1. Alcohol 70%
2. CH3COOH (vinegar)

5 Data analysis

Data analysis using SPSS and literature study from various literature.

6 Results and Discussion

6.1 Location overview

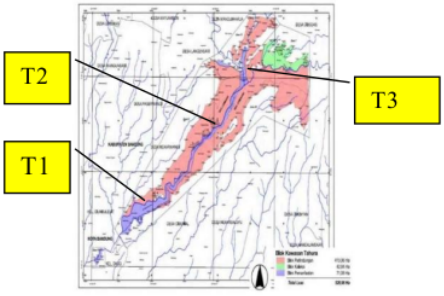

Fig.1. Maps of study at Tahura

Forest Park (TAHURA) Ir. H. Djuanda Dago Pakar was founded on January 14, 1985, geographically located 107°30'00 "East Longitude and 6°52'00" South Latitude approximately 7 kilometers from the city center of Bandung (**Fig.1**).

Tahura Djuanda is an integrated conservation area between secondary nature and plantations with the type of Pinus (*Pinus merkusii* Jungh. & Vriese), which is located in the Cikapundung River Basin and the Citarum Watershed which stretches from Curug Dago, Dago Pakar to Curug Maribaya which is part of the Gunung Pulosari forest group. The administration is in the territory of the District Ciburial Cimenyan Bandung District and parts of the village entrance Mekarwangi, Cibodas Village, Village Langensari and Wangunharja village, Lembang, West Bandung regency and village Dago [5]. In **Fig.** 2 , the research location shows three main points of honey bee maintenance, namely Batu Garok (T1), deer breeding (T2), and Maribaya (T3). The three of them are the center for *A. cerana* honey bee cultivation in Tahura, with the number of stups reaching more than 100 per location. The large number of hives indicates that the potential of Tahura as a provider of bee food is quite large, with a fairly high diversity of vegetation. It can be seen from IVI some vegetation in Tahura in **Table 1**, which also is a bee plant

Table 1. Importance Value Index (INP) based on the level of growth

No	Habitus	Growth	Types of Plants	INP (%)
1	**Tree**	**Tree**	**Pinus *(Pinus merkusii* L)**	**85.16**
		Pole	Pulus Binong *(Laportea peltata*)	29.34
		Stake	Cinnamon (*Cinnamomum burmannii* BL)	8.54
		Seedling	Ki Harendong (Astronia *spectabilis* Bl)	32.64
2	**Shrubs**		**Kaliandra Merah (*Calliandra calothyrsus* Meisn.)**	**62.78**
3	Herbs		Lempuyang Grass (*Panicum repens* L)	35.24
4	Liana		Rattan (*Calamus Sp.*)	45.67
5	Epiphyte		Fur fern, monkey fern (*Cibotium barometz* (L.) J.Sm).	40.48

Based on **Table 1**. The vegetation that has the highest IVI value based on the growth rate and habitus in Tahura Djuanda can be seen that those with the highest IVI are the dominant species, namely Pinus with an IVI value of 85.16% and calliandra with an IVI value of 62.78%. *Calliandra* is the main food crop for honey bees.

In **Table 2,** it can be seen that at the research location a total of 83 types of forage plants were found in Tahura. Consists of 39 families were dominated by the family Fabaceae 10 species, Myrtaceae 8 species, Moraceae 5 species, Euphorbiaceae 4 species, Lauraceae 4 species, Anacardiaceae 3 species, Arecaceae 3 species, Malvaceae 3 species, Rutaceae 3 species, Zingiberaceae 3 species, Theaceae 1 species, Sapindaceae 2 species, Rosaceae 2 species, Pittosporaceae 2 species, Passifloraceae 2 species, Papilionaceae 2 species, and the rest only consists of 1 species, namely the family Annonaceae, Araliaceae, Bignoniaceae, Caesalpineaceae, Callophylaceae, Caricaceae, Dipterocarpaceae, Ebenaceae, Fagaceae, Gnetaceae, Lamiaceae, Lytheraceae, Magnoliaceae, Musaceae, Pineaceae, Rubiaceae, Salicaceae, Solanaceae, Sterculiaceae and Verbenaceae.

Table 2. List of *A.cerana* honey bee forage plants in Tahura

No.	Species name	Family	Region name	Pollen/ nectar
1	*Acacia mangium* Wild	Fabaceae	Acacia	P / N
2	*Adenanthera pavonina (Tellzw. & Binn.) IC Nielsen*	Fabaceae	Red Saga	P
3	*Albizia chinensis* (Osb.) Merr.	Leguminosae	Sengon	P
4	*Aleurites moluccana* (L.) Willd.	Euphorbiaceae	Candlenut	P
5	*Amomum cardamomum* Willd.	Zingiberaceae	cardamom	N
6	*Antidesma bunius* (L.) Spreng.	Euphorbiaceae	Buni / Huni	N
7	*Archidendron jiringa* (Jack) ICNielsen	Fabaceae	Jengkol	P
8	*Arenga pinnata* (Wurmb) Merr.	Arecaceae	Aren	P / N
9	*Artocarpus heterophyllus* Lam.	Moraceae	Jackfruit	P
10	*Bauhinia purpurea* DC.ex Walp Blume	Fabaceae	butterfly leaves	N
11	*Bouea macrophylla Griff.*	Anacardiaceae	Gandaria	P
12	*Brugmansia candida* Pers.	Solanaceae	Amethyst	P / N
13	*Calliandra calothyrsus* Meissn.	Fabaceae	Red Calliandra	P / N
14	*Calliandra tetragona* Meissn.	Fabaceae	White Calliandra	P
15	*Calophyllum soulattri Burm.F.*	Calophyllaceae	bintangur / sulatri	N
16	*Camellia sinensis* (L.) Kuntze	Theaceae	Tea	P / N
17	*Cananga odorata* (Lam.) Hook. f. & Thomson	Annonaceae	Ylang	N
18	*Carica papaya* L.	Caricaceae	Papaya	P
19	*Castanopsis argentea (Blume) A.DC.*	Fagaceae	Saninten	P
20	*Cedrela mexicana Roem.*	Meliaceae	Cedar Honduras	P / N
21	*Cinnamomum burmannii* (Nees & Th. Nees)	Lauraceae	Cinnamon	P / N
22	*Cinnamomum parthenoxylon* (Jack) Meisn.	Lauraceae	lemongrass	P / N
23	*Cinnamomum porrectum* (Roxb.) Kosterm.	Lauraceae	Ki teja / selasihan	P / N
24	*Citrus maxima* (Burm. F.) Merr.	Rutaceae	Pomelo	P / N
25	*Citrus sinensis* (L.) Osbeck	Rutaceae	Local orange	P / N
26	*Clidemia hirta* (L.) D. Don	Melastomataceae	Harendong Bulu	P
27	*Coffea canephora* Pierre ex Froehner	Rubiaceae	Robusta coffee	N
28	*Delonix regia* (Bojer ex Hook.)	Fabaceae	Flamboyant	N
29	*Diospyros discolor Willd.*	Ebenaceae	Bisbul	P
30	*Durio zibethinus* Murray	Malvaceae	Durian	P / N
31	*Dysoxylum excelsum* Blume	Meliaceae	Monkey banana	N
32	*Elaeis guineensis* Jacq.	Arecaceae	Palm oil	N
33	*Enterolobium cyclocarpum* (Jacq.) Griseb.	Fabaceae	Sengon Buto	P / N
34	*Eryobotrya japonica (Thunb.)* Lindl.	Rosaceae	Loquat	N
35	*Erythrina fiscens*	Papilionaceae	dadap	N
36	*Erythrina subumbrans* (Hassk.) Merr.	Papilionaceae	Dadap spare	N
37	*Eucalyptus citriodora* Hook.	Myrtaceae	Lemon eucalyptus	N
38	*Eucalyptus deglupta* Blume	Myrtaceae	leda / eucalyptus	N
39	*Eugenia cumini (L.)* Druce	Myrtaceae	Jamblang	P / N
40	*Eugenia densiflora* (Bl.) Miq.	Myrtaceae	Jambu-jambuan / Ki sireum	N
41	*Euphorbia longan* Lour.	Euphorbiaceae	Longan	P / N
42	*Fagraea fragrans* Roxb.ex Carey & Wall.	Rosaceae	strawberry	P / N
43	*Ficus altissima* Blume	Moraceae	ficus tree	P
44	*Ficus glomerata* Blanco	Moraceae	Loa tree	P
45	*Ficus septica* Burm.	Moraceae	Ki Ciat	P
46	*Ficus variegata* Blume	Moraceae	Ara Kondang	P
47	*Filicium decipiens* (Weight & Arn.)	Sapindaceae	Kiara Payung	N
48	*Flacourtia rukam* Zoll. & Moritzi	Salicaceae	rukem / lobbies	P / N
49	*Globba pendula* Roxb.	Zingiberaceae	Spicy mouse deer	P / N
50	*Gmelina arborea* Roxb.	Lamiaceae	White Teak	P
51	*Gnetum gnemon* L.	Gnetaceae	melinjo	P / N
52	*Hibiscus similis Blume*	Malvaceae	Waru doyong	N
53	*Kigelia aethiopica* (Aubrev. ex Sillans)	Bignoniaceae	Sausage tree	P / N
54	*Lagerstroemia speciosa* (L.) Pers.	Lythraceae	bungur	P
55	*Leucaena leucocephala* (Lam.) De Wit.	Leguminosae	White leadtree	P
56	*Mangifera foetida* Lour.	Anacardiaceae	Mango chopped / Limus	P / N
57	*Mangifera × odorata* Griffith.	Anacardiaceae	Mango pakel	P / N
58	*Melastoma malabathricum* L.	Melastomataceae	Harendong	P
59	*Michelia champaca* L.	Magnoliaceae	Manglid / campaka	N
60	*Murraya paniculata* (M). Jack	Rutaceae	Kamuning	N
61	*Musa paradisiaca* L.	Musaceae	Banana	N
62	*Nephelium lappaceum* L.	Sapindaceae	Rambutan	P / N
63	*Passiflora edulis* Sims	Passifloraceae	Purple passion fruit	P / N
64	*Passiflora ligularis* Juss.	Passifloraceae	Yellow passion fruit	P / N
65	*Persea americana* Mill.	Lauraceae	Avocado	P / N
66	*Pinus merkusii* Jungh. & Vriese	Pinaceae	Pine	P
67	*Pittosporum ferrugineum* Dryand. ex W.T.Aiton	Pittosporaceae	Ki Honje	P
68	*Pittosporum moluccanum* (Lam.) Miq.	Pittosporaceae	Ki Honje	P
69	*Psidium guajava* L.	Myrtaceae	Guava / klutuk	P
70	*Ricinus communis* L.	Euphorbiaceae	Kaliki / jarak	N
71	*Salacca edulis* Reinw.	Arecaceae	Salak	N
72	*Schefflera scandens* (Blume) R.Vig.	Araliaceae	Ramogiling	P
73	*Schima wallichii* (DC.) Korth.	Theaceae	Puspa	P
74	*Senna siamea* (Lam.) HS Irwin & Barneby	Fabaceae	Venus	P / N
75	*Shorea laprasula* Miq.	Dipterocarpaceae	Copper Meranti	P
76	*Sterculia urceolata* Sm.	Sterculiaceae	Hantap / Faloak	P
77	*Syzygium aqueum* (Burm.f.) Alston	Myrtaceae	Water apple	P
78	*Syzygium malaccense* (L.) Merr. & LMPerry	Myrtaceae	Guava bol	P
79	*Syzygium polyanthum* (Wight) Walp.	Myrtaceae	Regards	P / N
80	*Tamarindus indica* L.	Caesalpiniaceae	Tamarind	P / N
81	*Urena lobata* L.	Malvaceae	Pungpurutan	P
82	*Vitex pubescens* Vahl.	Verbenaceae	Laban wood	P
83	*Zingiber inflexum* Blume.	Zingiberaceae	ginger ale	N

Fabaceae is the dominant bee food family in Tahura, such as acacia and butterfly flower plants which are a source of nectar and honey bee pollen. Acacia and butterfly flower plants belong to tree habitus, which is found in mixed forest habitats. Butterfly flower plants (*Bauchinia purpurea*) are widely planted in utilization blocks and areas near Japanese caves or Dutch caves along pedestrian tracks, this is because these plants have beautiful purple flowers that have aesthetic value for Tahura visitors.

Tabel 3. Forage crops of A. cerana honey bees on agricultural land

No.	Latin name	Family	Region name	Pollen / nectar
1	*Arachis hypogaea* L.	Fabaceae	Peanuts	P / N
2	*Brassica juncea* (L.) Czern.	Brassicaceae	Mustard greens	P / N
3	*Brassica oleracea* L. var. *italica*	Brassicaceae	Broccoli	P
4	*Brassica oleracea* L. var. *capitata*	Brassicaceae	Cabbage	P
5	*Capsicum annuum* L.	Solanaceae	Great chili	P / N
6	*Capsicum frutescens* L.	Solanaceae	Cayenne pepper	N
7	*Cucumis sativus* L.	Cucurbitaceae	Cucumber	P / N
8	*Fragaria × ananassa* (Weston) Duchesne	Rosaceae	Strawberry	P / N
9	*Glycine max* (L.) Merril	Fabaceae	Soy	P / N
10	*Oryza sativa* L.	Poaceae	rice	P
11	*Phaseolus vulgaris* L.	Fabaceae	Bean	P / N
12	*Sechium edule* (Jacq.) Sw.	Cucurbitaceae	Chayote	N
13	*Solanum lycopersicum* L.	Solanaceae	Tomato	P
14	*Solanum melongena* L.	Solanaceae	Purple eggplant	P / N
15	*Solanum tuberosum* L.	Solanaceae	Potato	P / N
16	*Zea mays* L.	Poaceae	corn	P
17	*Vigna unguiculata* (L.) Walp.	Fabaceae	long beans	P / N

Based on the observations in Table 3, 6 families and 17 species of bee food plants were obtained, consisting of Fabaceae, Brassicaceae, Solanaceae, Cucurbitaceae, Rosaceae, and Poaceae.

Various studies have shown that pollination services by insects are higher on agricultural land bordering forests and other semi-natural lands compared to land bordering other agricultural lands. [2] found that there was a negative relationship between the diversity and abundance of pollinating insects and the distance from the forest boundary, the farther from the forest the diversity and abundance of pollinating insects was getting smaller.

6.2 Observation of Pollen loads carried by honey bees to the hive

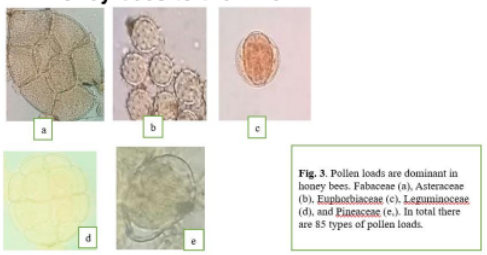

Fig. 2. Shows some images of the dominant *pollen loads* of *A. cerana* honey bees in Tahura. Total *pollen lo ads* of honeybees brought k e nests based observations laborato rium there are 45 species of plants. Then do the grouping po l len loads dominant, the pollen of a rare species, and pollen from tana man with high IVI Tahura. Dominant *pollen loads* carried by bees: Asteraceae 4513 eggs per head. Pollen loads: Rare plant species based on IUCN: Dipterocarpaceae, namely *Shorea leprosula* (copper meranti) . Pollen loads with high INP: Fabaceae and Pineaceae

6.3 The economic value of honey bees

Table 3. Annual productivity of honey bee cultivation in Tahura

No	Location	The number of filled stacks in Tahura	Honey produced (kg)	The nominal earned by farmer groups per year (Rp)	Production value for the manufacture and maintenance of bee stew per year
1	Cave Belanda 1	20	40	10.000.000	500.000
2	Cave Belanda 2	16	34	8.500.000	400.000
3	Pos 2	11	20	5.000.000	275.000
4	Maribaya	50	150	37.500.000	1.250.000
5	PLN 1	10	25	6.250.000	250.000
6	PLN 2	15	45	11.250.000	375.000
7	PLN 3	7	21	5.250.000	175.000
8	PLN 4	10	22	5.500.000	250.000
9	PLN 5	12	27	6.750.000	300.000
10	Deer Breeding tracks 1	16	38	9.500.000	400.000
11	Deer Breeding tracks 2	12	28	7.000.000	300.000
12	Deer Breeding tracks 3	11	22	5.500.000	275.000
13	Deer Breeding 1	14	30	7.500.000	350.000
14	Deer Breeding 2	18	40	10.000.000	450.000
15	Deer Breeding 3	27	56	14.000.000	675.000
16	Deer Breeding 4	16	33	8.250.000	400.000
17	Deer Breeding 5	18	37	9.250.000	450.000
18	Deer Breeding 6	17	36	9.000.000	425.000
19	Panguyangan Valley	20	42	10.500.000	500.000
20	Garok Stone	48	120	30.000.000	1.200.000
	Total	368	866	216.500.000	9.200.000
	Average/years			18.041.666	766.666

The honey bee productivity value in producing honey in Tahura which is the gross benefit value obtained is Rp.216.500.000 / year, with an average of Rp. 18.041.666 / farmer / year.

Then the production value of the bee hive is Rp. 9.200.000/year, with an average of Rp. 766,666 / farmer/year.

The average age of beekeeping per hive is 2 years. The price of 1 bee stup is around Rp. 100.000 Then the cost per farmer/year is Rp. 50,000. In total there are about 368 hives in Tahura, then the value of the outlay for maintaining the hive is:

- 368x IDR 50,000 = 18.400.000

Then the total net production value of honey or the direct benefit value (DUV) of honey bees in Tahura:

DUV = Rp. 216.500.000 - Rp. 9.200.000 - Rp. 18.400.000 = Rp. 188.900.000 / year

Then the value of the direct benefits of honey bees in Tahura is Rp. 188.900.000/year .

7 Conclusion

- Honey bees *A.cerana* provide various types of ecosystem services in Tahura, including pollination services and honey production. The ecological services that honey bees provide include pollination. The existence of honey bees has the potential for conservation of Tahura vegetation through pollination of dominant plants and rare plants seen from bee pollen collection. Bees are known to take plant pollen of 39 families and 83 species from vegetation in Tahura, and 6 families 17 species from agricultural crops 500 m radius from Tahura.
  - In addition, the honey bee *A.cerana* provide economic services through the production of honey valued at 216.500.000 / year from 20 beekeepers. And the value of direct benefits (DUV) of Rp. 188.900.000/year
  - So it can be concluded that bees provide ecosystem services ecologically and economically to the sustainability of the Tahura Ir. H. Djuanda ecosystems.

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