THE IMPORTANCE OF NECTARINIIDAE AS A GROUP OF POLLINATING BIRDS IN THE AGROFORESTRY PLANTS AND EFFORTS TO PROTECT THEM

W.Widodo*
Research Center for Biota System, National Research and Innovation Agency (BRIN), Indonesia.
Email: pakw14359@gmail.com

E. Sulistyadi
Research Center for Biota System, National Research and Innovation Agency (BRIN), Indonesia.
Email: eko.bio33@yahoo.co.id

Abstract
The paper is to examine the importance of the nectariniidae family as a group of pollinating birds in agroforestry commodities among local communities. The method used is direct observation in the field for period 1998-2018 and through literature studies from various literatures, such as books, journals and from cyberspace. The results show that pollinator birds found in and of around agroforestry areas include: *Anthreptes malacensis*, *Anthreptes simplex, Anthreptes rhodolaema, Leptocoma sperata, Cinnyris jugularis*, *Aethopyga eximia*, *Aethopyga siparaja*, *Aethopyga mystacalis*, *Aethopyga temminckii, Chalcoparia singalensis, Hypogramma hypogrammicum, Leptocoma brasiliana*, *Arachnothera longirostra, Arachnothera robusta*, *Arachnothera flavigaster* and *Arachnothera affinis*. Pollinator birds for local communities in helping the process of pollinating flowers from agricultural or plantation crops commodities in real terms are not yet known economically. Policies to protect it need to be implemented because the treat from pesticides, burning of land for plantations and recent economic use for pets tends to increase. For this reason, further research needs to be carried out, in particular the diversities of each pollinator bird species with the flowers of the agricultural or plantation crops it pollinates.

Keywords
Agroforestry, bird, Nectariniidae, pollinator, protection.

Introduction

Agroforestry is a form of multiple cropping that has been widely developed, especially in up-land areas and around forest areas and also in lowland areas (Mokoginta 2016). In general, agroforestry is a farming pattern developed jointly in the fields of forestry and food crop agriculture (Lastiantoro 2017). Agricultural crop commodities that can be developed include rice, secondary crops and vegetables (potatoes, chilies, cabbage, carrots, tomatoes, shallots and garlic). Part of the land forest that has been converted to plantation land is used by farmers for the development of plantation crops. The main plantation crops are cloves, cocoa, cotton, rubber, cinnamon, coconut, oil palm, candlenut, coffee, pepper, nutmeg, tea and vanilla (Suwarto et al. 2014). Meanwhile there are agroforestry areas that are developed with hardwood commodity crops, such as acacia, rubber, pine, sengon, teak, rasamala, rosewood and ginger is planted between the staple crops. Locations for planting agricultural commodities, plantations or timber are very varied. Some are located in the middle of the forest and some are on the outskirts of an open forest. There are also various planting systems, including intercropping, path systems, and corridors (Indriyanto 2008).

The agroforestry system has developed over the years and has made the surrounding community well-sufficient. In fact, currently agroforestry with the main crop in the form of coffee has also developed under the shade of natural forest wood trees or protective plants such as sengon, lamtoro, and dadap. Agroforestry areas are also increasingly developing in rural areas. The lives of local people in rural areas who depend on agroforestry patterns do not realize that there is an important role behind all this, namely pollinating animals. The role of pollinating animals is as pollinators that pollinate the flowers of plants developed on agroforestry lands. This is due to the process of pollinating plants by pollinators such as bees, butterflies, birds, bats and the wind so that plants can bear fruit or produce seeds. Pollinator animals move from the tip of the stamens of one flower to another, which allows pollination to occur until fruit is formed. Pollen that falls to the ground surface, then fertilizes the soil. Without the presence of natural pollinating animals, we cannot enjoy coffee, chocolate, and other superior plantation crop products.

The purpose of this paper is to examine the important role of pollinator bird species in agroforestry areas by taking into account the various supporting plants. Considering the various types of pollinating animals such as insects (bees, beetles, butterflies etc.) and mammals (bats, weasels etc.). In this paper it is limited to the

group of birds (the Nectariniidae family). The expected result is to identify the types of pollinator birds and their role in supporting local communities in cultivating various types of agroforestry commodity crops.

Methods

The research uses a descriptive review approach from the results of fieldwork for the 2009-2018 period. The research locations were in the area of Gunung Pancar Pine agroforestry (2009-2010), Gunung Slamet Agathis agroforestry (2011-2012), Gunung Wilis and Petungkriyono Coffee and Pine agroforestry (2016-2017), Kulonprogo, Yogyakarta agroforestry (2018) mix of Coffee, Silk tree *Albizia chinensis* and Java palisander *Dalbergia latifolia*. Additional survey were conducted in the Tea plantation area ajacent to the Pine forest and natural forest on Gunung Mas Puncak, Bogor (2023). The method of direct observation with methods, namely IPA, TSC, Point Count and Bird encounter rate per unit time (Bibby et al. 1998; Bibby et al. 2000). Besides that, a literature study was conducted from several sources, both book literature, journals, and online from cyberspace. Binocular, notebooks and stationery as well as guidebooks for birds in Java are supporting facilities in the field.

Results And Discussion

Characteristics of Pollinator Birds

Based on the results of the study, it was shown that not all types of birds can be classified as pollinators that help pollinate the flowers of a plant. Birds that are categorized as pollinators have specific characteristics, namely the shape of a beak with a curved tip, the size of the beak is relatively long and the tongue is flat and there is a kind of "brush" on the side, and the tongue can be extended to absorb nectar or pollen (threads) even if pollen is inside of a flower. The tongue is flat and hollow inside. So that when there is nectar inside the flower, the tongue stretches out and touches the pollen or nectar granules, then the cavity of the flat protruding tongue opens automatically and the granules/pollen enter the cavity of the tongue and are absorbed into the bird's throat. Furthermore, the plant itself, with the help of pollination, physiologically carries out the fertilization process.

The color of the feathers of the pollinating birds, on average, is bright shiny, such as berlin blue, metallic black, red, yellow, green, purple with a color combination of black, slightly yellowish olive green. This is especially true for male birds. Meanwhile, the body hair color of female pollinator birds is not so bright. They also have distinctive and loud voices, such as Olive-backed Sunbird (*Cinnyris jugularis*), Brown-throated Sunbird (*Anthreptes malacensis*) and Little Spiderhunter (*Arachnothera longirostra*). In general, the Nectariniidae family is divided into two major groups, namely "honeybirds" whose main food is flower honey. One other group is the “spiderhunter" with the specifications of a long beak with a curved tip. This spiderhunter group eats not only flower nectar, but also insects.

The flowers pollinated by pollinating birds are also specific, namely: large flower size, brightly colored flowers, flowers without a distinctive smell, flowers produce large amounts of honey glands (nectar), trumpet-shaped flower crowns, for example vanilla flowers (FAO 2008). This large flower size is useful for holding the weight of the bird. Flowers pollinated by birds are usually shaped like tiger’s claw flowers (*Erythrina variegata*), and contain honey/nectar and water glands. In addition, flowers also contain elements of red, because birds are sensitive to this color.

Birds that can be categorized as pollinators and are generally spread across western Indonesia are the hummingbird group (Nectariniidae family). However, in eastern Indonesia, they are relatives of the Cikukua (the Meliphagidae family) and the Lorikeet (the Psittacidae family).

Distribution of Nectariniidae and Feed

All members of the Nectariniidae family that act as pollinators in Indonesia recorded 24 bird species (Beehler et al. 1986; MacKinnon 1990; Coates & Bishop 2000; MacKinnon et al. 2010; Strange 2011). The distribution of members of the pollinator bird species from the Nectariniidae family in Indonesia and their feed in detail is presented in Table 1.

Table 1. Groups of birds belonging to the Nectariniidae family and their types of food in Indonesia.

No.	Scientific Name	Local Name	Distribution	Habitat	Nectariniidae feed
1	*Anthreptes simplex*	Plain Sunbird	Sm, B	Open forest, bush	Unknown
2	*Anthreptes malacensis*	Brown-throated Sunbird	J, Sm, B, NT, C	Coconut plantation,beach, mangrove	*Loranthus* and *Hibiscus* flowers, banana, Coconut nectar, fruits smooth
3	*Anthreptes rhodolaema*	Red-throated Sunbird	Sm, B	Primary and secondary forest	Orchid flower

No.	Scientific Name	Local Name	Distribution	Habitat	Nectariniidae feed
4	*Anthreptes singalensis*	Ruby-cheeked Sunbird	J, Sm, B	Casuarina forest, Coconut plantation	Casuarina flower, pollen
5	*Hypogramma hypogrammicum*	Purple-naped Sunbird	Sm, B	Swamp forest	Low bush flowers
6	*Leptocoma sperata (Nectarnia sperata)*	Purple-throated Sunbird	J, Sm, B	Rubber plantation,Coconut plantation in the beach forest	Coconut nectars
7	*Leptocoma sericea (sinonim N. aspasia)*	Black Sunbird	C, M, P	Primary and secondary forest, mangrove	Ornament flowers
8	*Leptocoma calcostetha (Nectarinia calcostetha)*	Copper-throated Sunbird	J, Sm, B	Mangrove, beach,Coconut plantation, Casuarina	*Rhizophora*, Coconuts, Casuarinas flowers
9	*Cinnyris jugularis (Nectarnia jugularis)*	Olive-backed Sunbird	J, Sm, B, NT, C, M, P	Lowland and highland	*Loranthus*, Morinda, *Erythrina* flowers, papayas, guava,various ornamental plant flowers
10	*Cinnyris buettikoferi (Nectarinia buettikoferi)*	Apricot-breasted Sunbird	NT (E) (Sumba)	Lowland forest edge	Unknown
11	*Cinnyris solaris (Nectarinia solaris)*	Flame-breasted Sunbird	NT (E)	Secondary monsoon forest shrubs	Guava flowers
12	*Aethopyga duyvenbodei*	Elegant Sunbird	C(E) (Sangihe)	Mix plantation	Unknown
13	*Aethopyga eximia*	White-flanked Sunbird	J (E)	Mountain forest	Guava and Liana flowers
14	*Aethopyga siparaja*	Crimson Sunbird	J, Sm, B, C	Primary forest and forest edge	*Erythrina*, *Hibiscus rosa-sinensis* flowers, other ornamentals flowers
15	*Aethopyga temminckii*	Temminck's Sunbird	Sm, B	Open secondary forest	*Loranthus* flowers
16	*Aethopyga mystacalis*	Javan's Sunbird	J (E)	Top canopy of forest edge	Loranthus and *Hibiscus tiliaceus* flowers
17	*Arachnothera longirostra*	Little Spiderhunter	J, Sm, B	Lowland forest	*Helicornis*, ginger lily (Zingiberaceae), Liliaceae
18	*Arachnothera crassirostris*	Thick-billed Spiderhunter	Sm, B	Secondary forest	Banana flower, Zingiber
19	*Arachnothera robusta*	Long-billed Spiderhunter	J, Sm, B	Lowland forest	*Callyandra* flowers
20	*Arachnothera flavigaster*	Spectacled Spiderhunter	Sm, B	Secondary forest	Big flowers in top canopy
21	*Arachnothera chrysogenys*	Yellow-eared Spiderhunter	J, Sm, B	Secondary forest and garden	nectars, fruits seed, small insets, spider
22	*Arachnothera modesta*	Grey-breasted Spiderhunter	Sm, B	Unknown	Unknown
23	*Arachnothera affinis (sinonim A.everetti)*	Steaky-breasted Spiderhunter	J, B	Mountain forest	*Erythrina* flowers, wild bananas, small insects

No.	Scientific Name	Local Name	Distribution	Habitat	Nectariniidae feed
24	*Arachnothera juliae*	Whitehead's Spiderhunter	B(E)	Mountain moss forests	Orchid flower

Abbreviation: J=Java, Sm=Sumatera, B=Borneo, NT=Nusa Tenggara, C=Celebes, M=Moluccas, P=Papua; E=Endemic (Sukmantoro et al. 2007).

Based on Table 1, there are 6 categories of habitat types with certain types of pollinators, namely: 1). Mountain forests with the types *Arachnothera juliae* and *Arachnothera affinis* which specifically pollinate various clumps of orchids and tiger's claw flowers; 2). Primary forest with specific *Anthreptes rhodolaema* species on orchids; 3). Lowland forest with the types *Arachnothera longirostra* and *Cynniris jugularis* as specific pollinators for ornamental plant flowers and gingers; 4). Mangrove forest with specific *Leptocoma calcostetha* bird species as pollinator of Pidada and *Rhizophora* flowers; 5). Rubber or copra plantation forest with specific pollinator *Leptocoma sperata*; and 6). Coastal forest with the types of *Anthreptes malacensis* and *Anthreptes singalensis* as pollinators for coconut plants.

Pollinator Birds in Agroforestry Habitats

Until now, it can be said that local communities around forest areas are still not aware of and feel the important role of pollinator birds to the fullest in agroforestry plants, both ecologically and economically. Farmers who grow agricultural or plantation commodities (such as coffee, rubber, vanilla, pepper and the like) economically certainly enjoy benefits from the crops they cultivate. But on the other hand awareness of the presence and important role. Pollinator birds in agricultural areas are still lacking. This certainly affects the level of public (farmer) awareness of the sustainability of these pollinator bird species.

Pollinator birds with their unique long beaks and have flat tongues that can be extended into deep flower holes have an important role to suck the flower's honey glands. The pollen grains attached to the beak and carried to the next flower so that the stamens fall on the stigma and an ornitogamous pollination process occurs. It's all hard to imagine to be done by humans or farmers manually.

Each bird species belonging to the pollinator group typically has a role in obtaining nectar sources for different flowers. According to direct observations in the natural forest of Mount Slamet in the Bambangan area with damar (resin tree) agroforestry, it is known that *Aethopyga eximia* feeds on the flower nectar of the surrounding guava plant groups. The same thing was also revealed in *Arachnothera affinis* and *Cinnyris jugularis* which help pollinate dadap flowers as specific shade plants in coffee and pine agroforests in the Mount Pancar area. Meanwhile, *Aethopyga siparaja* helped pollinate flowers in an oil palm agroforestry in the Panajam area, East Kalimantan. *Anthreptes malacensis* is important as a pollinator for coconut flowers. Hummingbirds are a group of pollinators that help pollinate vanilla flowers (*Vanilla* sp) which grow in the tropics. The specific role of pollinator birds is of course very important for the preservation of plant/host plant species which are difficult to replace by manual pollination by humans.

Pollinator bird species that help pollinate flowers from various plantation crop commodities have not been studied and disclosed in detail. Likewise, how much the ecological and economic benefits of supporting farmers and local communities around agroforestry areas are still unknown. If the presence of more diverse pollinator birds in agroforestry areas is of course very beneficial in terms of their role as pollinators.

Agroforestry is one method of land management that is widely cultivated by the community because it is considered to have a function in supporting the economic needs of the community from its main crops and has an ecological function in preserving water resources, soil fertility, climate control and habitat for biodiversity, including bird fauna. Research conducted in Sumatra showed that around 300 species of birds were found in rubber and coffee agroforestry areas (Ayat 2011). This is a clear indication that agroforestry areas in Sumatra are able to provide a high carrying capacity after primary or secondary forests as bird habitats. This means that agroforestry areas have sufficient carrying capacity, such as food and shelter for various species of birds and for the surrounding community. Ayat (2011) states that the rubber agroforestry in the Muara Bungo area, Jambi is inhabited by 167 species of birds. Meanwhile, coffee agroforestry in Sumber Jaya, Lampung recorded 103 bird species (Joshi et al. 2002; O'Connor et al. 2005). Several species of pollinator birds occupy the Muara Bungo rubber agroforestry habitat, including: *Anthreptes malacensis*, *Anthreptes rhodolaema*, *Anthreptes singalensis*, *Hypogramma hypogrammicum*, *Cinnyris jugularis, Aethopyga siparaja*, *Arachnothera robusta* and *Arachnothera flavigaster*. Meanwhile, pollinator birds that occupy coffee agroforestry habitat include: *Anthreptes simplex*, *Anthreptes singalensis*, *Hypogramma hypogrammicum*, *Cinnyris jugularis*, *Aethopyga temminckii* and *Arachnothera longirostra*.

The diversity of birds in the agroforestry habitat of Sulawesi (Kabupaten Pohuwato) is slightly different from that in the region of Sumatra. Research by Boinau et al. (2020) shows that the diversity of bird species in the cocoa or cocoa agroforestry area is quite high, where 53 bird species are found on the edge of the forest and

a combination of white teak, 44 bird species in cocoa forests plus a mixture of rubber, lamtoro and coconut, and 23 bird species in unshaded cocoa forests, overgrown with shrubs or bushes. This shows that the diversity of birds in the cocoa monoculture habitat is only about 25% of the cocoa habitat combined with other plant species or using cover or shade plants. Pollinator birds found in cocoa agroforestry in Pahuwato District, North Sulawesi, namely: *Aethopyga siparaja*, *Anthreptes malacensis* and *Cinnyris jugularis*.

Several areas in Java that have coffee agroforestry areas with protective shade from the Petungkriyono natural forest (Pekalongan) and coffee agroforests on the outskirts of the Mount Wilis forest (Madiun), recorded two species of pollinator birds from the Nectariniidae family, namely *Cinnyris jugularis* and *Arachnothera longirostra* (Widodo 2021). In coffee agroforestry and community forestry in the Menoreh mountains (Yogyakarta), more pollinator bird species were recorded, including *Anthreptes malacensis*, *Cinnyris jugularis*, *Aethopyga mystacalis*, *Chalcoparia singalensis*, *Leptocoma brasiliana*, *Arachnothera longirostra*, *Arachnothera robusta* and *Arachnothera affinis* (Taufiqurrahman et al. 2019) .

Threat Factors and Conservation Efforts

The importance of role of pollinator birds in Indonesia has been recorded as pollinating the flowers of production plants, both agriculture and plantations or agroforestry. However, there is a threat to pollinators which forage or shelter in these agroforestry habitats. This is due to the system of managing agricultural land or plantations by burning, also in the treatment using chemicals/pesticides, weed herbicides, and the current global climate change.

On the other hand, the Government's policy through its latest law has removed pollinator birds, especially the Nectariniidae family, from protected list. That way, it is likely that there will be opportunities to utilize members of the Nectariniidae which are no longer protected for various purposes.

Thus, it is a challenge from various researchers in Indonesia who are competent in the field of bird conservation to face and anticipate threats from changes that occur, both natural and man-made.

In 1931, when the Dutch still controlled Indonesia, they tried to protect the birds in Indonesia. At that time, all relatives of the Nectariniidae family were protected by the Act for the Protection of Wild Animals Ordinance 1931. This has also been supported by the Government in the past and still fully protects all members of the Nectariniidae family. Wild animal laws and regulations in Indonesia are not only related to the richness of biological resources specifically for fauna, but also for their flora species. The government realizes that the conditions for natural changes in evolution cannot work as they should.

Awareness of the role of pollinator birds in various agroforestry commodities in Indonesia can be said to be lacking, particularly as pollinators for production crops, both agriculture and plantations. As a result, concern for the preservation of various species of pollinator birds is still lacking.

The government recognizes that the quantity and quality of natural resources and environmental conditions continue to decline. Nevertheless, environmental protection may remain ineffective when regulatory obligations are treated merely as formal requirements and are not supported by adequate monitoring and enforcement (Wibawa, 2026). This is influenced by the demand for animal commodities for trade and the degradation of forest areas for human interests tends to increase. Pressure on animal populations has an impact on increasing the level of endangerment of animal species which can lead to population decline.

Various laws and regulations have been and continue to be updated in an effort to manage animal populations and their ecosystems.

Some of the laws that have been drafted by the government, especially to protect bird species, are shown in Table 2.

Table 2. Government regulations on the protection of birds in Indonesia

No.	Government regulation/Decree
1	Wild Animal Protection Act 1931
2	Minister of Agriculture Decree No.421/Decree/General/8/1970 issued 26 August 1970
3	Minister of Agriculture Decree No.327/Decree/General/7/1972 issued 19 July 1972
4	Minister of Agriculture Decree No.66/Decree/General/2/1973 issued 14 February 1973
5	Minister of Agriculture Decree No.35/Decree/General/1/1975 issued 29 January 1975
6	Minister of Agriculture Decree No.190/Decree/General/2/1977 issued 21 February 1977
7	Minister of Agriculture Decree No.537/ Decree/General /12/1977 issued 7 December 1977
8	Minister of Agriculture Decree No.327 / Decree/General /5/1978 issued 29 May 1978
9	Minister of Agriculture Decree No.742/ Decree/General /12/1978 issued 2 December 1978
10	Minister of Agriculture Decree No.247/ Decree/General /4/1979 issued 5 April 1979
11	Minister of Agriculture Decree No.757/ Decree/General /12/1979 issued 5 December 1979
12	Minister of Agriculture Decree No.576/ Decree/General /8/1980 issued 6 August
13	Minister of Agriculture Decree No.716/ Decree/General /10/1980 issued 4 October 1980
14	Minister of Forestry Decree No.12/ Decree/General /II/1987 issued 12 January 1987

No.	Government regulation/Decree
15	Constitution No.5/1990 regarding the Law on the Conservation of Natural Resources and their Ecosystems
16	Minister of Forestry Decree No.301/Decree/General/8/1991 issued 10 June 1991
17	Minister of Forestry Letter No.1180/Minfor-VII/1997.
18	Government Regulation No.7/1999 regardingPreservation of Plant and Animal Species
19	Minister of Environment and Forestry Decree No P 20/MinEF/GenSec/Law 1/6/2018
20	Minister of Environment and Forestry Decree No P92/MinEF/GenSec/Law 1/8/2018

Sources: Fachrul (2007), Alikodra (2010).

Table 2 above shows the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.106/MenLHK/Setjen/Kum.1/12/2018 Concerning the Second Amendment to the Regulation of the Minister of Environment and Forestry Number P.20/MenLHK/Setjen/Kum. 1/6/2018 Concerning Protected Plant and Animal Species. Previously, all of the Nectariniidae family was protected by the Wild Animal Protection Act. However, in the end, the Government only protected 5 species of the Nectariniidae family, namely: *Aethopyga duyvenbodei* (Sangihe Honeybird), *Aethopyga mystacalis* (Javanese Honeybird), *Aethopyga siparaja* (Sepah-Raja Honeybird), *Anthreptes rhodolaemus* (Red-Necked Honeybird), and *Cinnyris buettikoferi* (Sumba Honeybird).

In fact, the basic considerations for the need to protect a species of flora and fauna have already been studied. There are at least 23 criteria or biological characteristics as presented in Table 3, that these biological species need to be protected by society and legislation (Noerdjito et al. 2005). These criteria are as follows:

Table 3. Criteria for flora and fauna to be protected

No.	Description of Biological Properties
1	Population is low or tends to decline
2	Animals have a narrow range
3	Mega-herbivore
4	Migrating animals
5	Animal makes local migrations
6	Anadromous animal
7	Live in a specific ecosystem
8	Energy supplier for life in caves
9	Live in a deep sea ecosystem
10	Intolerant of environmental changes
11	Have limited capabilities
12	Monogamous animal
13	Low fecundity
14	Limited sex ratio
15	Long larval stage
16	Reach thelevel of maturity in long period
17	Long gestation period
18	Ovovivipar
19	Ecosystem stabilizer
20	Pollinating animal
21	Seed dispersal animal
22	Potential as a pest or disease controller
23	Capture of species is chancy

Referring to Table 3 above, there are at least 11 criteria (bold) to determine the status of a bird species so that it can be protected by wild animal legislation as emphasized in the previous period. However, some species are protected for other reasons. The question is: has the minimum criteria been referred to in determining the protection of the 5 Nectariniidae species above?

Based on the role of the Nectariniidae group, its function as a pollinator is clearly stated. In fact, in other countries the role of pollinating birds is to pollinate the flowers of the purple-headed orchid (*Anacamptis morio*) and wine grape varieties (*Vitis vinifera*). The Bird of Paradise plant (*Strelitzia nicolai*) which grows in America is also pollinated by the "sunbird" as a member of the Nectariniidae family. In Indonesia, the role of Nectariniidae as a pollinator is widely known to pollinate the flowers of ginger plants (Zingiberaceae), tiger's claw (*Erythrina variegata*), mangrove flowers, orchids, guavas, cocoa, coffee, rubber, and bananas.

According to FAO (2008) pollinator animals such as bees, birds and bats can affect 35% of crop production in the world. It is further stated that on the continents of Latin America, Africa and Asia that 40% of the 'crop' area depends on pollinator animals. Crop plants or also called ground cover plants, namely plants specifically

planted to protect the soil from the threat of damage due to erosion, can improve the physical and chemical properties of the soil and increase the rate of infiltration (Ministry of Agriculture 2013). Among them is pintoi (*Arachis pintoi*) grown by pepper farmers to prevent the parasitoid *Spanthius piperis*. Also dadap plant (*Erythrina variegata*) as a shade for coffee plants. Members of the Nectariniidae family based on research as plant pollinators are Olive-backed Sunbird (*Cinnyris jugularis* formerly *Nectarinia jugularis*) and Little Spiderhunter (*Arachnothera longirostra*).

In fact, if an animal species (including birds) has met the criteria for protection, then every person: [1]. It is not permitted to catch, possess, kill, maintain, transport, and trade protected animals while they are alive; [2]. It is not permitted to store, possess, maintain, transport, and trade protected animals when they are dead; [3]. Not allowed to take protected animals from one place in Indonesia to another place inside or outside Indonesia; [4]. It is not permitted to trade, keep or possess the skin, body or other parts of protected animals or goods made from parts of said animals or take them out from another place inside or outside Indonesia; [5]. It is not permitted to take, destroy, trade, store or possess eggs and/or nests of protected animals. These five points are actually enough to help protect against the extinction of the Nectariniidae group in Indonesia. Management and utilization may be carried out with mature scientific studies and considerations. The importance of the role of Nectariniidae birds as pollinators/pollinators needs to be continuously studied and developed, both through the formulation of regulations and supporting research/development studies. More broadly, the management of pollinating birds also needs to be synchronized with other pollinating animals, such as insects (honey bees, butterflies, etc.); mammals (bats, weasels etc.) as well as other groups of pollinating animals.

Environmentally oriented sustainable development is therefore an essential strategy for governments, policymakers, communities, and other stakeholders involved in agroforestry land use. A gradual approach that combines institutional development, training, stakeholder participation, and protection of natural assets can increase the adoption of sustainable local economic practices (Savandha & Amelia, 2026). According to Napitulu (2013) that development activities are declared sustainable if these activities are economically, ecologically and socially sustainable. Economically sustainable means that a development activity must be able to generate economic growth, capital maintenance, and the efficient use of resources and investment. Ecologically, this means that these activities must be able to maintain the integrity of the ecosystem, maintain the carrying capacity of the environment and conserve natural resources, including biodiversity. Socially, it means that socializing a development activity should create an equal distribution of development results, social mobility, community participation, community empowerment, social identity, and institutional development. Operationally, it is further stated that sustainable development is in synergy with environmental management. Environmental management is an integrated effort to preserve environmental functions. The definition of environmental management has a broad scope because it does not only include efforts to preserve the environment, but also prevents the process of environmental degradation. The program of participation and empowerment of local communities around agroforestry areas is the key.

Conclusion

There are at least 16 species of birds belonging to the Nectariniidae family which act as pollinators in agroforestry habitats for rubber, cocoa, coffee with and without shade trees. Among others are *Anthreptes malacensis*, *Anthreptes simplex, Anthreptes rhodolaema, Leptocoma sperata, Cinnyris jugularis*, *Aethopyga eximia*, *Aethopyga siparaja*, *Aethopyga mystacalis*, *Aethopyga temminckii, Chalcoparia singalensis, Hypogramma hypogrammicum, Leptocoma brasiliana*, *Arachnothera longirostra, Arachnothera robusta*, *Arachnothera flavigaster* and *Arachnothera affinis*. Types of plants that have the potential as feed for the Nectariniidae family include nectar from orchids (*Anacamptis morio*), grapes (*Vitis vinifera*), tiger's claws (*Erythrina varigata*), bananas, ginger (Zingiberaceae), cocoa, coffee, rubber, pepper, pintoi (*Arachis pintoi*). Currently, the Nectariniidae family, which is protected by animal protection laws, is only five species, namely *Aethopyga duyvenbodei*, *Aethopyga mystacalis*, *Aethopgya siparaja*, *Anthreptes rhodolaema*, and *Cinnyris buettikoferi*.

References

1. Agriculture Departement. 2013. Plantation Weeds and Their Control Strategies. Plantation Plant Protection Agency, Pontianak. Accessed 11 November 2020.

2. Alikodra, HS. 2010. Wildlife Management Techniques to Maintain Indonesia's Biodiversity. IPB Press, Bogor.

3. Ayat, A. 2011. A Field Guide to Agroforestry Birds in Sumatra *In*: Mardiastuti, A. eds. Bogor, Indonesia. World Agroforestritry Centre-ICRAFT, SEA Regional Office. 112 Pages.

4. Beehler, BC., Pratt, TK. & Zimmerman, DA. 1986. Birds of New Guinea. Princeton University Press, New Jersey.
5. Bibby, CJ. Jones, M. & Marsden. 1998. Expedition Field Techniques: Birds Surveys. Royal Geographical Society, London.
6. Bibby, CJ, Burgess, ND., Hill, DA. & Mustoe, SH. 2000. Bird Census Techniques. The 2nd Academic Press, Tokyo.
7. Boinau, J., Sandalayuk, D.& Puspaningrum, D. 2020. Diversity of Bird Species in Various Types of Cocoa Plantation Habitat. *Journal of Forestry Research 3(1): 11-22.*
8. Coates, B.J. & Bishop, K.D. 2000. A Field Guide to Birds in the Wallacea Region: Sulawesi, Maluku and Nusa Tenggara. BirdLife International Indonesian Programme & Dove Publication Pty. Ltd, Indonesia.
9. Fachrul, MF. 2007. Biological Sampling Method. Bumi Aksara, Jakarta.
10. FAO. 2008. Rapid Assessment of Polinator' Status. Roma, Itali.
11. Indriyanto. 2008. Introduction to Forest Cultivation. Bumi Aksara, Jakarta.
12. Joshi, L., Gede, W., Vincent, G., Boutin, D., Akiefnawati, R., Manurung, G., van Noordwijk, M. 2002. Complex Rubber Agroforestry: Challenge for Development. Bogor: Booklet TFRI Extensions No.139.
13. Lastiantoro, CY. 2017. The Spark of Agroforestry Thinking on the Slopes of Mount Muria. Deepublish, Yogyakarta.
14. MacKinnon, J. 1990. Field Guideto the Birds of Java and Bali. Gadjah Mada University Press, Yogyakarta.
15. MacKinnon, J., Phillipps, K. & van Balen, B. 2010. Field Guideto the Birds of Sumatera, Java, Bali and Borneo. BirdLife International Indonesia Programme-Pusiltbang Biologi LIPI, Bogor.
16. Mokoginta, MM. 2016. Agroforestry Management. Deepublish, Yogyakarta.
17. Napitupulu, A. 2013. Sustainable Environmental Management Policy A Theoritical and Practical Policy. IPB Press, Bogor.
18. Noerdjito, M., Maryanto, I., Priyono, SN., Waluyo, EB., Ubaidillah, R., Mumpuni, Tjakrawidjaja, AH., Marwoto, RM., Heryanto, Noerdjito, WA. & Wiriadinata, H. 2005. Criteria for Biological Species that must be Protected by and for the People of Indonesia. LIPI & World Agroforestry Centre, Bogor.
19. O'Connor, T., Subekti, R., van Noordwijk, M. 2005. Birds in Agroforestry in Lampung. World Agroforestry Centre, Bogor.
20. Savandha, S. D., & Amelia, A. (2025). Green economy integration for sustainable BUMDES: A case study of Kintamani, Bali. Journal of Economic Development and Village Building, 3(2), 110–128. https://doi.org/10.59261/jedvb.v3i2.48
21. Strange, M. 2001. A Photographic Guide to the Birds of Indonesia. Periplus Eds. (HK) Ltd. Singapore.
22. Sukmantoro, W., Irham, M., Novarino, W., Hasudungan, F., Kemp, N. & Muchtar, M. 2007. List of Indonesian Birds No.2. IdOU and PILI, Bogor.
23. Suwarto, Octavianty, Y., Hermawati, S. 2014. Top 15 Plantation Crops. Penebar Swadaya, Jakarta.
24. Taufiqurrahman, I., Harjanto, S. & Suparno, K. 2019. Birds and Coffee: Community-led Conservation in Jatimulyo village, Yogyakarta, Java, Indonesia. *BirdingAsia (32): 108-111.*
25. Wibawa, R. (2026). Corporate environmental responsibility at every stage of mining business according to Undang-Undang Nomor 4 Tahun 2009 tentang Pertambangan Mineral dan Batubara. Journal of Law and Social Politics, 4(3), 292–306. https://doi.org/10.59261/jlsp.v4i3.114
26. Widodo, W. 2021. Comparison of Bird Communities in Coffee Plantations with Natural Tree Shade. *Bioedusains: Journal of Biology andScience Education 4(2):336-345.*