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CONSERVATION STATUS OF *ORNITHOPTERA CROESUS*, ENDEMIC BUTTERFLY OF BACAN ISLAND, NORTH MALUKU, INDONESIA

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Abstract

Ornithoptera croesus is a butterfly species that is native and endemic to Bacan Island. This study aimed to update the conservation status of O. croesus in Bacan Island based on the current information on the existence, characters, habitat carrying capacity, and conservation status of the species. In this descriptive exploratory study, data were collected through survey, specimen identification, and literature review on the butterfly conservation status. The results of the analyses show that based on the government regulation (PP) No.7/1999, the conservation status of O. croesus is protected, while according to IUCN Red List of Threatened Species, this animal is vulnerable, and according to CITES, the status is endangered (Appendix II). This is consistent to the forest conversion and habitat fragmentation phenomena that occur in Mt. Sibela nature reserve area, O. croesus natural habitat. Given this condition, the existence of the endemic butterfly has a low species density with adequate environmental capacity in terms of food availability. Both in situ and ex situ conservation efforts should be made to increase O. croesus viability

Keywords*: O. Croesus; Vulnerable; IUCN;Endangered; CITES; Appendix II; Endemic*

Introduction

Ornithoptera croesus is one of the endemic butterflies in the Bacan Island. This butterfly can be found in the nature reserve area of the Sibela mountain (CAGS). *O. croesus* is one member of the family Papilionidae. *O. croesus* discovered by Alfred Russel Wallace in 1859 in the *expedition Malay Archipelago*. This butterfly is named *Wallace's Golden Birdwing*. *O. croesus* including macrolepidoptera butterfly with the typical body color patterns. *O. croesus* front wing of black males have golden, orange or red front part and with black veins at the edge of the golden yellow wings. On the underside of the wing iridescent green, with grooved black edges. *O. croesus* females have larger wings with dark brown on both upper side and bottom with yellowish and gray spots, black head and chest, with yellow abdonemen [1]

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The existence of the butterfly *O. croesus* in Bacan Island has been known by the local community around [2]. But so far there has not yet been any conservation efforts done both by the community and regional government. Conservation of the endemic butterflies are highly valued compared to that of common butterflies [3]. Endemic species have limited geographical distribution, is very sensitive to the temperature and humidity changes of the forest caused by the forest disruption, thus the local extinction becomes inevitable [4-8]. Other factor that led to the species become endemic is the sensitivity of environmental changes, such as limited tolerance on temperature, humidity and light intensity [9-14]. Some research indicates that the endemic species butterflies have little preference toward human modified habitats [15-17]. In Northern Vietnam, noted that the endemic species of butterflies prefer the nearby forest habitat, while generalist species prefer open habitats [4, 12].

O. croesus like other animals also face the threat of scarcity and the extinction, mainly due to conversion of forest lands. There are two types of forest in mountain Sibela conservation namely forest production and limited production forest [18]. Both types of forest are located along the edges of forests in Sibela mountain conservation. Local people have converted the production forest into core estate and around the small holders [18]. The existence of these forests has been eradicated and converted into residential area and community plantation. Most species of butterflies, especially the endemic butterflies (*O. croesus*) rely heavily on one or two types of host plants, so the threat to the host plant jeopardises the existence of the butterflies as well. The decreases and changes in forest ecosystems that occur due to rapid exploitation is a threat to the existence of butterflies in the Bacan Island. For example, the forest area that has abundant of butterflies' life is destroyed and converted into plantations. Although some butterfly population manages to migrate to new habitats, but the availability of food resources for the larvae to grow have vanished, it may include the typical food for butterfly larvae. *O. croesus* requires a stable habitat components, such as the availability of vegetation components as food resources, if there is no or little food resources than their needs, there will be a migration of *O. croesus* to seek new territorial boasts abundance of feed and refuge from the predators.

The main threat of *O. croesus* is the destruction and changes of forest types as the habitat of *O. croesus*. So far, local communities who live along the mount Sibela natural conservation only utilize the potential of forests by exploiting the types of flora resources to meet daily needs, such as rattan, indigo sap, wood, and other forest products. Animals hunting is also carried out, for example, the hunt for black monkeys, several species of birds, and deers [18-22]. Exploitation activities done by local community is continuously carried out due to the absence of natural conservation efforts, it is feared to reduce the diversity of *O. croesus*, which will eventually lead to scarcity *O. croesus*. In the longer term can cause the extinction of *O. croesus*. The purpose of this research is to update the conservation status of *O. croesus* endemic butterflies in the Bacan Island based on the current information: the existence of the species, the characters and the habitat carrying capacity and conservation status.

Experimental

This research was conducted in June until August 2015 at Sibela mountain natural conservation of Bacan Island at four locations. The location 1 is settlement, the location 2 is plantations, the location 3 is forest production, and the location 4 is isolated forest conversion.

Materials

Tools and materials used are: GPS, camera, insect nets (sweep net), tweezers, altimeter, butterflies envelope paper.

Methods

Methods of data collection in the field by making four transects (line-transect method) at each study site with 3 plot observations. Sampling was purposive random sampling. Data analysis was performed with:

a. Analysis of the existence of the butterfly using density analysis of individual species of butterflies, simple method of estimating density [23].

$$D = ln\ n/n2 \times n/m\ (n \cdot r^2) \times 10.000,$$

where is: D = *density per hectare;* n = *total number of one individu;* n2 = *total individu of species outside the radius of 25m;* m = *total observed points;* r = *radius* (m).

b. Analysis of the characters and the carrying capacity of the habitat of butterflies by using a percentage (%) availability of food in each plot observation.

c. Analysis of butterfly conservation status is determined based on the standard of Regulation of the Minister of Environment and Forestry of the Republic of Indonesia [24] and the IUCN (*International Union for Conservation of Nature and Natural Resources*) the IUCN Red List on Wallace's Golden Birdwing Butterfly and *Ornithoptera croesus* in 2018 [25, 26] and the CITES (*Convention on International Trade in Endangered Species of Wild Fauna and Flora*) [27].

Results and discussion

The existence of O. croesus endemic butterflies in Bacan Island

O. croesus is an endemic butterfly in the Bacan Island of South Halmahera district that has aesthetic, economic, and high conservation values. The morphological descriptions *O. croesus* (Fig. 1).

Fig. 1. Species *O. croesus* males and females on Sibela mountain nature reserve area in Bacan Island

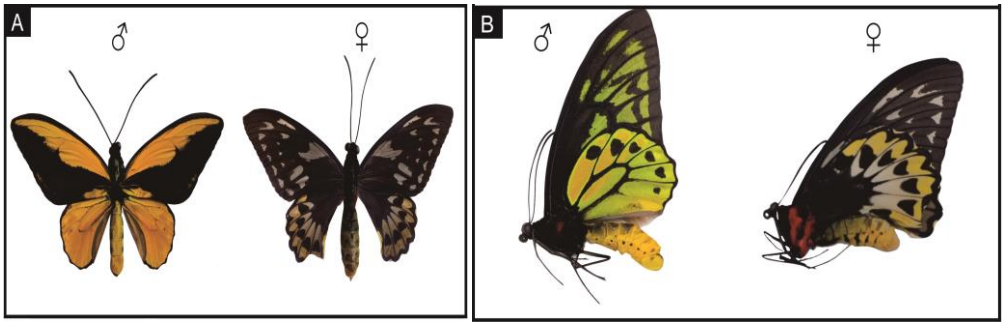

Fig. 2. Morphological structure of male and female *O. croesus* Endemic Butterfly of Bacan Island

To determine the existence of butterflies *O. croesus* on, in Sibela mountain natural conservation density data parameter butterfly species *O. croesus* were used on transect applied on the four observation sites with different heights (Table 1).

Table 1. Density of butterfly species at different elevations *O. croesus*

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No	*Location (m asl)*	*Density (individu/hectare)*
1	20	20
2	200	14
3	400	11
4	800	14

Density of *O. croesus* at different elevation in Sibela mountain natural conservation has low density and a few individuals *O. croesus* were found in small quantities.

Characters and Habitat Carrying Capacity

The Region of Sibela mountain natural reservation is one of the endemic regions for the distribution of species of flora and fauna. In this area the *O. croesus* species live at a particular location on one of its habitat, especially at the edges of rivers or swamp which plant as food are available. Location and contour maps of the stew butterfly *O. croesus* habitat at Sibela mountain natural conservation (Fig. 3).

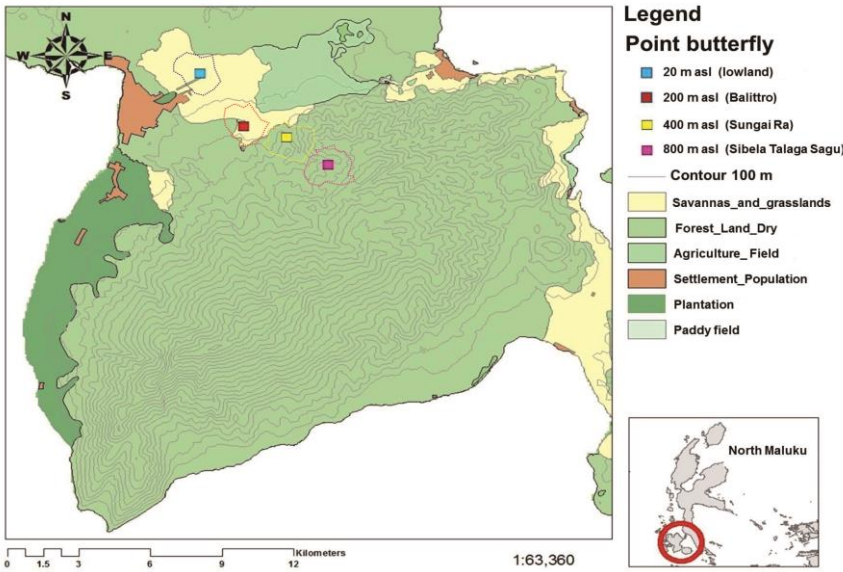

Fig. 3. Distribution of butterfly *O. croesus*on showed specific sidefor habitat/hotspot at Sibela mountain natural conservation of Bacan island.

The main hospot of *O. croesus* species on this region are located at a certain height of 20m above sea level (Lowland/settlement), 200m asl (Plantation Balittro), 400m (Forest production/River Ra), 800m asl (Forest finite conversion/Sibela talaga sago) or a buffer zone of Sibela mountain natural reservation, while at elevations above 800m asl butterfly *O. croesus* could not be found anymore. In general, a hotspot of *O. croesus* is marked by the availability of mussaenda and asoka plantation as the food resource of *Ornithoptera* spp. Data presenting the percentage of food resource in each location (Table 2).

Conservation Status O. croesus Endemic Butterflies in the Bacan Island

Bacan Island is one of the spots in Wallace expedition. According to [28] Wallacea area included in the 25 "hotspots" most important for conservation. This area has 529 species of endemic invertebrates (1.9% of the total number in the world). Species are experiencing serious

threat, because only 15% of the natural habitat that remains. Of the remaining natural habitat of these, 39.2% of which are in protected areas.

Table 2. Characteristics and habitat carrying *O. croesus* at the 4 locations

Location	*Position(Coordinat)*	*Food plant Dominant*	*Cover (%)*
Settlement (20m asl)	S = $00^0$37'21,8''	Musaenda	81
	E = $127^0$30' 33,0''	Asoka	83
Plantation (200m asl)	S = $00^0$39' 46,4''	Musaenda	78
	E = $127^0$31' 46,1''	Asoka	71
Production forest (400m asl)	S = $00^0$40'08,6''	Musaenda	68
	E = $127^0$32' 29,9''	Asoka	57
		Gusale	77
Conservation forest (800m asl)	S = $00^0$43'06,4''	Musaenda	53
	E = $127^0$33' 51,6''	Gusale	81

Conservation status *O. croesus* at Sibela mountain natural conservation based on Red list Data Book of the IUCN (*International Union for Conservation of Nature and Natural Resources*) and Appendix II (Table 3) of CITES (*Convention on International Trade in Endangered Species of Wild Fauna and Flora*) [25, 26, 27].

Table 3. Conservation status of the endemic butterflies *O. croesus* in Bacan Island

Spesies Name	*Goverment regulation (PP no 7 Th 1999) Conversion Status*	*IUCN Data Red Book Status*	*CITES Conversion Status*	*Endemic*
Ornithoptera croesus	Protected	*Vulnerable*	Threat of extinction	√

The conservation status of endemic butterflies *O. croesus* in Bacan Island is protected and endangered. *O. croesus* is a kind of large winged butterfly most sought after by collectors because of the beauty of the color of its wings and is now listed as endangered and entered in Appendix II of CITES, thus the need for efforts to restrict international trade in captive specimens is a necessity. According to the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia [24] it is known that *O. croesus* is a type of *O. croesus* butterfly that is protected because the population continues to decline. At this time, this butterfly became the object of hunting by collectors because of its wonderful shape and color patterns. In its natural habitat in the wild (out of conservation habitat) the survival of these butterflies are threatened by habitat loss as a place of life and reproduction, and as well as the shortage of feed due to conversion of forest lands.

Based on the analysis of the *O. croesus* conservation status above, it is necessary to build conservation of *O. croesus* butterflies to avoid extinction. Some conservation models that can be recommended for *O. croesus* are: *ex-situ* conservation models with captivity outside of their natural habitat. It is to accelerate the breeding of butterflies. These models consider the condition of the transfer functions of forests as *O. croesus* natural habitat is diminishing and positively correlated with the carrying capacity of the feed, so it can be assumed that with little amount of food available has caused the butterflies to migrate to obtain food. In addition, the *in-situ* conservation models also can be implemented by increasing the sustainability of the habitat through reforestation program at mount Sibela natural reservation and the reduction program over the function of forests into plantations and settlement.

The population of the endemic butterfly *O. croesus* in mount Sibela natural conservation has relatively low life span, it can be seen at each study site only a few individuals *O. croesus*

were found in relatively small quantities. In general, the diversity and abundance of butterfly populations in nature are influenced by the quality of the environment of its habitat. In areas with more natural diversity and abundance of butterflies higher than that of the areas that have been converted into agricultural land and plantations. The results of the study [29] showed that the diversity of the butterfly family Papilionidae at various altitudes on mount Sibela natural conservation of Bacan Island in all habitats (a height of 20 meters above sea level, 200 meters above sea level, 400 meters above sea level and 800 meters above sea level) were categorized as low as the value H ' in the range of 1.5 to 3.5. *M. Indrawan, et al*, [30] stated that generally the main threat to the population decline is due to the destruction of endemic species and habitat fragmentation, pollution, excessive utilization types, introduction of exotic species and the spread of disease. Furthermore [31-34] stated that the existence of butterflies in nature depend on the diversity of host plant, it is closely related to vegetation diversity in its habitat. Based on description above it can be said that the abundance/density of butterfly *O. croesus* is relatively low at mount Sibela natural conservation. This is likely to be influenced by the availability of forage plants other than environmental factors (temperature, humidity and light intensity), while the minimal availability of forage plants affected by conversion of forest lands.

The character and habitat capacity of the availability of forage plants for *O. croesus* at Sibela mountain natural reservation are categorized as quite abundant, so it can be said that Sibela mountain natural conservation of Bacan island owning sufficient food storage for the *O. croesus* butterfly. At each location forage plants: such as musaenda plant, asoka plant and gusale plant are found. *A. Shalihah, et al*, [35] stated that the existence of the butterfly depends upon the availability of food resource both at lowland and highland habitat. The habitat has hostplant components and foodplant. Hostplant are the food resource for the larvae and the regular plants feed the adult butterfly.

Furthermore, [36, 37] suggests that the swallowtail butterflies species (*O. croesus*) live in the lowlands located in swamps and wet places (rivers). Butterflies generally are encountered at various altitudes, ranging from lowlands to highlands 0-2000 m above sea level and is more common found on tropical areas [38-41]. In this study, the distribution of *O. croesus* butterflies at Sibela mountain natural reservation is limited to a height of 800 m above sea level, it is influenced by physiological adaptation factors and the availability of forage plants for survival.

Conservation status of a species made over the years is based on the category of IUCN and CITES. Special IUCN make a list of all types of flora that needs special attention because of the potential in its natural habitat began to decline. IUCN also made a list of fauna, including animals that are traded internationally as rare and endemic species, while CITES has made a list of the types that need to be protected based on the degree of scarcity. This list is very helpful in efforts to prevent illegal logging, illegal wildlife trade and black market.

CITES devides species into categories based on the type of status scarcity in nature ie Appendix I of species already threatened with extinction so that the circulation between countries is prohibited, except for a specific purpose and does not damage the natural habitat. Appendix II includes species which have not endangered yet, but if international trade is not controlled then there is the risk of extinction. Whereas Appendix III contains species need to be supervised by a country internationally, even though the country to where the species type are available, has not yet require a mechanism tool to control internationally [42].

In Indonesia to anticipate the threat of natural resources damage, government issued various regulations containing procedures for setting in the utilization of natural resources in a way that still maintain the ecological balance. Some of the rules include: Regulation of the Minister of Environment and Forestry of the Republic of Indonesia [24] about types of plants and animals protected; [43] about preserving plants and animals; [44] about the use of wild plants and animals; [45] about conservation of living natural resources and their ecosystems and

[46], about utilization of types of plants and wildlife. About 25 species of butterfly that are protected by law mostly categorised as rare flora. The law also includes a conservation program *in-situ* and *ex-situ* specified to the endangered and rare type.

Conclusions

The conservation status of *O. croesus* butterfly according to PP number 7 of 1999 is a protected animal, whereas according to IUCN the conservation status of *O. croesus* is vulnerable and according to CITES the conservation status of *O. croesus* is endangered. This is in accordance with the phenomenon in nature (natural habitat) of *O. croesus* butterflies in the Sibela mountain nature reserve with the condition of forest conversion causing habitat fragmentation which causes *O. croesus* butterflies as endemic butterfly species with low species density with sufficient environmental carrying capacity (availability of feed). The conservation efforts need to be made to the survival of *O. croesus* so that it is not extinct. Some conservation model recommendations for *O. croesus* are ex situ conservation by breeding around natural habitats and in situ conservation models through reforestation activities and reduction of forest conversion programs in the Sibela mountain reserve to increase environmental carrying capacity for the survival of *O. croesus* as endemic butterfly.

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