Revisiting diversity of coccinellid beetle in Mount Gede-Pangrango National Park: a preliminary observation

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Abstract. Declines in insect population and diversity particularly in the tropical forest region have stimulated wide interest among researchers worldwide. Loss of insect diversity and abundance is expected to provoke cascading effect on the ecosystem, but few data and documentation are available. So far, the coccinellid beetle study in Mount Gede-Pangrango National Park, Indonesia was conducted more than 40 years ago with last well-documented exploration by 2004. We aimed to update and deliver the newest data on the diversity of coccinellids of Mount Gede-Pangrango National Park. We tracked along the interpretation path and beetles were collected using hand method during observation between July 2018 to October 2019. A total of 17 species coccinellids were identified. Seven species belong to the phytophagous group of Diekeana, Epilachna, and Henosepilachna. Two mycophagous species from Psylloborini and Sticholotidini tribe, while others species (8 species) are a member of the predatory group, including Coccinellini and Chilocorini tribe. In this study, plenty of them are common species and widely distributed in the open area of the buffer zone. Our temporary findings indicate the possibility of species loss compared to past surveys that discover rare taxa, such as Ryszardia, and other specialist Epilachna group infesting wild host-plants.

Keywords: Coccinellidae, Indonesia, mycophagous, phytophagous, predator

1. Introduction

The earth’s biological wealth largely concentrated in tropical rainforest ecosystems. This ecosystem is predicted to become the main region of the actual mass extinction scenario that has occurred today [1, 2]. Alroy [3] through his study describe a rapid loss of biodiversity, even in a world where disturbed forests remain widespread. This loss may unrecognized because many rare species found in terrestrial communities are at high risk of extinction. Failure to stem widespread degradation and loss of habitat can sharply decline biodiversity [4]. Unfortunately, the negative consequences of habitat change and cumulative wildlife exploitation still seem to be underestimated globally [5, 6].

One of the many ecosystem regions that are biotically threatened is in the Southeast Asia, including Indonesia and its unique biogeographic complexity [7]. With high endemicity and biodiversity, Indonesia forces to develop policy, research, and sustainable use of resources [8]. However, much is remains unknown about biodiversity and the possibility of surviving in an area. Many species are under pressure, even before they are discovered and explored scientifically. Thus, biodiversity conservation research and its relevance to the role in ecosystems become irreplaceable. Although there are growing numbers of such studies, most are focused on vertebrates and plants. There are few
researches that studies invertebrates as the main focus. Though insect species may suffer more due to habitat loss [9]. Apparently, the direct contribution of insects to the nutrient cycle has been dwarfed due to its size and cumulative biomass. The loss of insects adversely affects to ecosystem function, because insects play a central role in food chain and ecosystem services [10, 11].

One of the most familiar beetle is the coccinellids that best known as biological control agent. The beetle ranges from leaf-feeding specialist to fungus feeding [12, 13]. Its important economic role as predators of aphids and scales for agriculture as well as minor pests for a variety of plantation crops [14, 15] encourages studies in various fields both taxonomy, ecology, evolution, and its application. However, not many coccinellid beetle studies were conducted in Indonesia.

Currently, diversity references of coccinellid beetle in Indonesia are very limited, such as Amir [16] for predatory and mycophagous ladybird beetle and literature from Indonesian Institute of Sciences (LIPI) in collaboration with Japanese researchers for phytophagous ladybird beetle [17-19]. Historically, taxonomic study of coccinellid beetle in Indonesia have been reported, previously by numerous classical works [20-25]. Until now, only a few reliable taxonomic studies were available [26-29,17-19,30]. In Indonesia, report of predatory coccinellid beetle are limited. Java and Sumatra islands have more contributed in phytophagous ladybird beetle publications.

Mount Gede-Pangrango National Park (GPNP) was one of the most explored areas for biodiversity research with forests as one of the last pristine areas in Java [31]. The latest visit by Riyanto [32] in 2004 report on phytophagous coccinellid beetle and its vertical distribution in Mount Gede-Pangrango and Mount Halimun-Salak National Park. His study managed to report some rare coccinellid species that had a narrow distribution in the highlands. After more than 15 years, there has never been a review of the diversity of coccinellid beetle in the oldest national park in Indonesia (GPNP). In this paper, we reported diversity of coccinellid beetle in part of GPNP, such as in the northern and southern side of the Mount Gede-Pangrango, including Cibodas Botanical Garden. This area were chosen because it is home for the various type locality of rare coccinellid species, such as Diekeana alternans, Epilachna gedeensis, and Epilachna orthofasciata [33].

2. Materials and methods

2.1. Study area

In this observation, we explored northern side of GPNP along the interpretation route of Cibodas to Cibereum Waterfall (figure 1). Exploration were also conducted in five locations around the park (guest house, Rawagede waterfall, Mandalawangi camping ground, Landbouw Cipanas, and Cibodas Botanical Garden (1300 – 1500 m asl). The survey were conducted for three days (July 30 - August 1, 2018) from morning to evening (07.00 am – 05.30 pm). We also explored southern side of GPNP along the interpretation route of Selabintana to Cibereum waterfall and Situ Gunung to Sawer Waterfall while eastern part explored along Gunung Putri route to Alun-Alun Suryakencana between August and October 2019.

2.2. Beetle collection and preservation

Beetle collections are carried out using road sampling. Three investigators randomly walked and looked for beetles in the canopy of plants, under the leaves, and in the fungus. Captured beetles were handled gently, and no additional tools were used during capture. Collected beetle were stored in the sample bottle or rearing box and killed with ethyl acetate. The number of species and individual beetles found were recorded and photographed and some were released back into their habitat. A total of 45 individual beetles were preserved and deposited in the laboratory of Animal Biosystematics and Ecology, IPB University. Specimens were pinned dry or kept in 95% ethanol. Photos were taken using OptiLab camera embedded to the Olympus SZ61 stereoscopic microscope. Measurements of beetle body length were undertaken under a binocular dissecting microscope equipped with measurement software Image Raster Miconos 4.0.5. Final plates were prepared using Adobe Photoshop CC 2019.
2.3. Beetles identification and terminology
Identification of beetle was carried out using various determination key and descriptions, both for predatory [34,35,16,14] and phytophagous ladybird beetles [17-19,36]. Terminology principally followed Ślipiński [37] and Ślipiński and Tomaszewska [38]. Some terms followed Dieke [25]. Based on morphology [37] and initial molecular analyses [12,38,39], taxonomic rank of the subfamily Epilachninae was reduced to a tribal level within broadly defined Coccinellinae.

2.4. Measurement of environmental parameters
Each of the sampling sites was geo-located using Global Positioning System (GPS) (Garmin 72H and Garmin GPSMAP 62s). Digital Elevation Model from Shuttle Radar Topographical Mission (SRTM) from the USGS website were used to generate elevation and slope map. Air temperature, humidity, light intensity, and velocity were measured using 4-in-1 environmental measurer immediately after collecting beetles.

3. Results
Totally, we collected 17 species of beetle from sub-montane zone (1330-1450 m asl) belong to subfamily Coccinellinae (figure 2). Twelve species were found in rural area (Henosepilachna diekei, Henosepilachna vigintioctopunctata, Coccinella transversalis, Cheilomenes sexmaculata, Verania lineata, Coelophora inaequalis, Coelophora reniplagiata, Coelophora novemmaculata, Chilocorus melanophthalimus, Chilocorus politus, C. sp 1, and C. sp 2), 4 species from semi-natural area (Henosepilachna diekei, Henosepilachna enneasticta, Henosepilachna vigintioctopunctata, and Sticholotis crux) and 4 species from natural area (Henosepilachna bifasciata, Henosepilachna enneasticta, Epilachna gedensis, Epilachna incauta, and Illeis cincta). The high number of species were found in lowland, rural, and open habitat. The beetles collected represented a variety of food plants (from specialist to generalist). The Henosepilachna group is largely depends on Solanaceous plant. Our observations showed at least four Solanaceae plants, including Lycianthes, Brugmansia, Solanum nigrum, and Solanum torvum as host of H. bifasciata, H. enneasticta, and H. vigintioctopunctata. In addition, other plants, such as Asteraceae also as a host for phytophagous ladybird beetle. Pattern of interaction between phytophagous ladybird beetle with its hosts is shown in figure 3. Feeding preferences of most predatory ladybird beetle (aphidophagous, coccidophagous, acarophagous, etc.) cannot be determined, due to the motility of beetles and limited observation time.
Figure 2. Coccinellid beetles collected from Mt. Gede-Pangrango. (A-E) Epilachnini tribe, (A) Henosepilachna vigintioctopunctata, (B) Henosepilachna enneasticta, (C) Henosepilachna diekei, (D) Diekeana alternans, (E) Henosepilachna bifasciata, (F) Epilachna gedeensi, (G) Epilachna incauta; (H-J, O-Q) Coccinellini tribe, (H) Coccinella transversalis, (I) Verania lineata, (J) Cheilomenes sexmaculata, (O) Coelophora novemmaculata, (P) Coelophora reniplagiata, (Q) Coelophora inaequalis; (K-L) Chilocorini tribe, (K) Chilocorus politus, (L) Chilocorus melanophthalmus; (M) Psylloborini tribe, Illeis cincta; (N) Sticholotidini tribe, Sticholotis crux. bar=5mm.
4. Discussion

4.1. Diversity of coccinellid beetles
Most of our findings are similar to previous reports [17,32]. Compared to Riyanto report [32], Epilachna orthofasciata, Epilachna pytho, Epilachna sp. F (later known as Diekeana sundaeensis [19]), Epilachna sp. 5 (later known as Henosepilachna nakanoi [18]), and Epilachna sp. G (later known as Ryszardia clematophilis [40]) are absence in our survey. These species commonly found at an altitude of 1300-1500 m asl with narrow geographical range. The phytophagous ladybird beetles distributed in lower plains such as Henosepilachna septima, Henosepilachna pusillanima, and Epilachna. sp. V is also not found, given the limited area of research (see materials and methods). Our encounter with Epilachna decipiens (later known as Ryszardia decipiens [40]) is also not expected given that this beetle is among those distributed on very high plains and strict host range.

Interestingly, we found beetle with a unique elytral pattern (figure 2G), we suspect to E. incauta based on the similarity of the elytral spot pattern. These beetles was found in Brugmansia (commonly, E. incauta) attacks Urticaceae [17]. The elytral pattern is very different compared to Henosepilachna commonly found in Brugmansia, namely H. vigintioctopunctata and H. enneasticta. It is probably as a new variation of the existing species. Our study also found the new variation in elytral pattern of H. bifasciata. Previously, this beetle indicated by having two transverse fascia on the elytra [17], but we also find beetle with only basal fascia. The spot 5 on medial fascia separated from fused spot 4 and 3 (figure 2E).

4.2. Reasons and possible interpretation on current conditions
There are several scenarios that might explain the absence of particular species, including: (1) loss of species, (2) decrease in abundance, (3) and elevation shift. Our research seems too premature to state species loss, but further research and monitoring with more systematic methods will contribute valuable information. We recognize that the possibility of species is not encountered due to lack of effort or lack of skilled investigators. It seems that this research is the initial alarm to study the minor species from silent extinction.

If true, the loss of species or a decrease in abundance is a signal to protect the population of phytophagous ladybird beetle or insects in general [41]. This decline of coccinellids population may be affected by landscape changes or transformations that occurred in recent years. It should be noted that the absence of species that become a type locality is the most disturbing thing. For example, D. alternans that widespread in Java and has interesting geographic variations. The simplest elytral pattern is found in West Java and inhabit a variety of Cucurbitaceae plants. So, it's quite disappointing not to get along the tracks where the geographical range is quite extensive [32,19]. With greater effort of observations, we found D. alternans at the Cibodas Botanical Garden and Sawer Waterfall between August-September 2019 (figure 2D). Another hypothesis is elevation shift. Several years ago, E. gedeensis commonly found at relatively low altitude because the host plant they inhabit (Elatostema) was distributed along a pass of Mount Gede [17]. We only found this beetle near Cibereum waterfall Selabintana with extremely low number of individual but not in Cibodas route. It is possible to imagine large contribution of increasing human activity at Cibodas route suppress this population to a narrower habitat besides patterns change of altitudinal distribution caused by climate change [42].

4.3. Phytophagous ladybird beetle network with its host-plant
The insect-plant network that we constructed has no different with previous reports. Interestingly, we found inhabited in plants of H. vigintioctopunctata similar with S. tuberosum. The host-plant of H. vigintioctopunctata at Landbouw Cipanas is not S. tuberosum (Solanaceae), it is possible closely related to S. tuberosum. Future observations should compare the host plant with leaves of cultivated potato around the location. Indeed, there would be many Solanaceous plant species attacked by H. vigintioctopunctata but were not described as hosts. The important and interesting points are, how often,
Figure 3. Interaction between phytophagous ladybird beetle and hosts plant. Note: this network not compiled based on phylogeny and the size of the band does not correlate with the frequency of preference. Green band indicate beetle found infested this plant at the time of observation; Grey band indicate only feeding scars were found; Pattern band indicate the identification status of this beetle together with the hosts association remains unresolved by us. Left to right, Lycianthes sp.; Brugmansia sp.; Solanum tuberosum?; Solanum nigrum; Solanum torvum; Solanum giganteum; Solanum erianthum; Physalis sp.; Zehneria maysorensis; Mikania sp.; Elatostema acuminata.

where, and as subsidiary host or main host (contribution to larval growth and population sustenance) this host was. In the future it is necessary to monitor biodiversity in GPNP. In the case of ladybird beetles, in fact, although many of them are minor pests, not a few species live in undisturbed habitats in tropical forests. The difficulty of finding this beetle is caused by low mortality or immature mortality as well as longevity relative to the immature period [17]. So that further research related to this beetle group will further complement fragmented information at this time.

5. Conclusion
Seventeen species of coccinelids beetle were recorded from this study. Our temporary findings indicate the possibility of species loss compared to the past surveys that found the rare taxa, such as Ryszardia, Diekeana, and others specialist Epilachna group infesting wild host-plants.

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