

RECORD ON SOME CATERPILLARS OF BUTTERFLIES (LEPIDOPTERA: PAPILIONOIDEA) IN EAST JAVA, INDONESIA

Abdul Mutholib Shahroni*¹, Fariq Izzudien Ash Shidiq², Soenarko²,
Lutfi Irwansyah², and Djunijanti Peggie³

¹Department of Biology, Faculty of Natural and Science, Brawijaya University,
Malang 65145, East Java, Indonesia

²Kupunesia, Malang, East Java, Indonesia

³Museum Zoologicum Bogoriense, Research Center for Biosystematics and Evolution, National Research
and Innovation Agency (BRIN), Jl. Raya Jakarta-Bogor Km. 46, Cibinong, Bogor 16911, Indonesia

*corresponding author: amshahroni@student.ub.ac.id

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ABSTRACT

Indonesia has a high diversity of butterflies with more than 2,000 species, yet knowledge of their pre-adult stages is very limited. A thorough understanding of the larval stage is necessary to complement the data on butterfly diversity and distribution. This survey, which lasted from 2012 to 2022, aimed to document the butterfly larvae in their last instars that were encountered in East Java. Leaves of the host plants were visually inspected during the day to collect butterfly eggs or larvae. The eggs and larvae were then reared to adulthood and resulted in 136 verified species in total. Of 136 species, the caterpillars of 107 species (78.68%) had previously been documented, and those of 29 species (21.32%) are newly reported here, including the caterpillars of *Eurema beatrix* and *Ixias venilia*, which are rare and endemic to Java. This information will serve as a substantial part of developing a field guide to the butterflies of Java, which will include pre-adult stages.

Key words: caterpillar, diversity, documentation, last instar, photographic

INTRODUCTION

Butterflies belong to the superfamily of Papilionoidea of the insect order of Lepidoptera (van Nieukerken et al., 2011; Kawahara & Breinholt, 2014), and have a variety of different species (Majumder et al., 2013). According to current estimates, there are up to 17,280 species of butterflies in the world (Shields, 1989). More than 2,000 species of butterflies occur in Indonesia, with an estimated 640 species discovered on Java Island when surveys were performed in unspoiled areas (Peggie, 2014). In addition, Java is home to 46 species of butterflies that are endemic to the island (Whitten et al., 1996). It is essential to preserve the rare butterflies from human interference with their native environment, as the dangers of them going extinct are imminent (Lewis et al., 1998).

As crucial pollinators, herbivores, and prey for predators, butterflies contribute to the integrity of the ecosystem's structure (Bonebrake et al., 2010). Butterflies perform the role of herbivores during the caterpillar stage to gather nutrition before the pupal stage (Kunte, 2000). At times it is quite difficult to detect butterflies at the caterpillar stage in nature. The caterpillars may employ several unique strategies when avoiding predatory threats. They may use



mimetic adaptation, which adjusts their appearance to the surroundings. Each group of butterflies evolves its means of adaptation, such as taking on characteristics of the plant that serves as their larval host or imitating a snake head or bird droppings (Lev-Yadun, 2016; Futahashi & Fujiwara, 2008). Additionally, numerous species of the Lycaenidae family form associations with Myrmecophile ants for self-defense and strategic purposes. This symbiotic interaction happens through trophallactic feeding, i.e., transfer of food from caterpillar excretory organs to be consumed by the ants, whereas the caterpillars receive protection against predators due to the presence of the ants (Fiedler, 2021).

It can be challenging to research a species without knowing what its larval phase looks like. Knowledge and publications on the early stages of butterflies, especially for Indonesian butterflies, are very limited (e.g., Piepers & Snellen, 1909, 1910, 1913, 1918; Igarashi & Fukuda, 1997, 2000) and not readily available. Therefore, it is highly desirable to have efforts dedicated to improving the condition. In this paper, we aim to present a record of some butterfly caterpillars in East Java, especially those distributed in Malang and Pandaan. The enthusiasm of butterfly observers, especially in Malang and Pandaan, has made this possible. Butterfly larvae obtained in the wild must be properly documented to be identified. As a result, it can aid observers and researchers in understanding the phases of a butterfly's life cycle. This will serve as complementary information, no less important than information of the adult form when developing a butterfly field guide for Java.

MATERIALS AND METHODS

From 2012 to 2022, information was gathered in several locations in East Java, particularly in Malang and Pandaan. Samples of eggs and caterpillars were gathered by visually inspecting the foliage of host plants during the day. Then, the samples were stored and raised in ventilated plastic containers. For optimal larval development, each container was lined with damp paper towels to maintain a high level of humidity. The leaves of the appropriate host plant were fed to the caterpillars until they were pupated (Schauff, 1986). Every two to three days, the old leaves were replaced with fresh ones. The caterpillar was set up at an ideal angle while it was in the last larval stage. Then, a digital camera was used to document it. Pupae were placed in comparable plastic enclosures until adult emergence.

The identification of emerging butterflies resulting from caterpillar rearing was confirmed with butterfly field guidebooks (Baskoro et al., 2018; Iqbal et al., 2021). Primary references for SE Asian butterflies (Morishita, 1981; Yata, 1981; Aoki et al, 1982; Tsukada & Nishiyama, 1982; Tsukada, 1985, 1991) were also consulted.

RESULTS

The results of 10-year observation and rearing efforts have accumulated in 136 distinct species of caterpillars, which are members of six different families. These include Papilionidae (14 species), Pieridae (20 species), Nymphalidae (68 species), Lycaenidae (17 species), Riodinidae (1 species), dan Hesperiidae (16 species). Members of the Nymphalidae family made up about

50.00% of all groups. At the subfamily level, Limenitidinae had the highest discovery record with 12.50%, while Pyrginae, Lycaeninae, Apaturinae, and Riodininae had the lowest records with a mere 0.74% each (Fig. 1). Photographs of the caterpillar of each species are presented (Figs. 2–7).

Caterpillars of as many as 107 species (78.68% of 136 spp.) had been covered in previous records, while the other 29 species (21.32% of 136 spp.) are newly reported here (Table 1), i.e., *Graphium empedovana*, *Graphium macareus*, *Eurema beatrix*, *Appias indra*, *Appias nero*, *Cepora iudith*, *Cepora temena*, *Delias periboea*, *Ixias venilia*, *Rohana nakula*, *Ariadne specularia*, *Cyrestis lutea*, *Cyrestis nivea*, *Idea stolli*, *Tirumala hamata*, *Argyreus hyperbius*, *Euthalia adonia*, *Tanaecia palguna*, *Tanaecia trigerta*, *Hypolimnas misippus*, *Junonia villida*, *Symbrenthia lilaea*, *Discophora necho*, *Lethe minerva*, *Jamides aratus*, *Arhopala eumolphus*, *Arhopala silhetensis*, *Rapala iarbus*, and *Suastus gremius*.

Table 1. List of identified caterpillars from the field

Taxa			Previous records – the number indicates the publication
No.	Subfamily	Species	
Family: Papilionidae			1. Piepers & Snellen (1909); 2. Piepers & Snellen (1910); 3. Piepers & Snellen (1913); 4. Piepers & Snellen (1918); 5. Igarashi & Fukuda (1997); 6. Igarashi & Fukuda (2000); 7. Tan (2009a); 8. Tan (2009b); 9. Tan (2011a); 10. Tan (2011b); 11. Wafa & Sari (2017); 12. Karmakar et al. (2018); 13. Corbet & Pendlebury (2020)
1	Papilioninae	<i>Graphium agamemnon</i>	6 (in Malaya)
2	Papilioninae	<i>Graphium antiphates</i>	6 (in China), 13 (in Malaya)
3	Papilioninae	<i>Graphium doson</i>	9 (in Singapore)
4	Papilioninae	<i>Graphium empedovana</i>	-
5	Papilioninae	<i>Graphium macareus</i>	-
6	Papilioninae	<i>Graphium sarpedon</i>	7 (in Singapore)
7	Papilioninae	<i>Pachliopta adamas</i>	5 (in Taiwan)
8	Papilioninae	<i>Papilio demoleus</i>	6 (in Taiwan)
9	Papilioninae	<i>Papilio demolion</i>	5 (in Malaya)
10	Papilioninae	<i>Papilio helenus</i>	6 (in Taiwan)
11	Papilioninae	<i>Papilio memnon</i>	8 (in Singapore), 12 (in India)
12	Papilioninae	<i>Papilio peranthus</i>	6 (in Bali)
13	Papilioninae	<i>Papilio polytes</i>	10 (in Singapore), 12 (in India)
14	Papilioninae	<i>Troides helena</i>	5 (in Malaya), 12 (in Malaya)
Family: Pieridae			
15	Coliadinae	<i>Catopsilia pomona</i>	1 (in Java), 5 (in Malaya)
16	Coliadinae	<i>Catopsilia pyranthe</i>	5 (in India)
17	Coliadinae	<i>Catopsilia scylla</i>	5 (in Thailand)
18	Coliadinae	<i>Eurema beatrix</i>	-
19	Coliadinae	<i>Eurema blanda</i>	6 (in Taiwan), 13 (in Malaya)
20	Coliadinae	<i>Eurema hecabe</i>	1 (in Java), 6 (in Bali & Laos)

Taxa			Previous records – the number indicates the publication
No.	Subfamily	Species	
			1. Piepers & Snellen (1909); 2. Piepers & Snellen (1910); 3. Piepers & Snellen (1913); 4. Piepers & Snellen (1918); 5. Igarashi & Fukuda (1997); 6. Igarashi & Fukuda (2000); 7. Tan (2009a); 8. Tan (2009b); 9. Tan (2011a); 10. Tan (2011b); 11. Wafa & Sari (2017); 12. Karmakar et al. (2018); 13. Corbet & Pendlebury (2020)
21	Pierinae	<i>Appias indra</i>	-
22	Pierinae	<i>Appias lycinda</i>	1 (in Java), 5 (in India)
23	Pierinae	<i>Appias nero</i>	-
24	Pierinae	<i>Appias olferna</i>	5 (in Malaya)
25	Pierinae	<i>Cepora iudith</i>	-
26	Pierinae	<i>Cepora nerissa</i>	1 (in Java), 5 (in India)
27	Pierinae	<i>Cepora temena</i>	-
28	Pierinae	<i>Delias hyparete</i>	1 (in Java), 5 (in Taiwan)
29	Pierinae	<i>Delias pasithoe</i>	1 (in Java), 5 (in Hong Kong)
30	Pierinae	<i>Delias periboea</i>	-
31	Pierinae	<i>Hebomoia glaucippe</i>	1 (in Java), 5 (in Taiwan)
32	Pierinae	<i>Ixias venilia</i>	-
33	Pierinae	<i>Leptosia nina</i>	6 (in Taiwan)
34	Pierinae	<i>Pareronia valeria</i>	6 (in Philippines)
Family: Nymphalidae			
35	Apaturinae	<i>Rohana nakula</i>	-
36	Biblidinae	<i>Ariadne ariadne</i>	5 (in Malaya), 13 (in Sri Lanka)
37	Biblidinae	<i>Ariadne specularia</i>	-
38	Charaxinae	<i>Charaxes (Polyura) athamas</i>	5 (in Malaya)
39	Charaxinae	<i>Charaxes (Polyura) hebe</i>	5 (in Malaya)
40	Charaxinae	<i>Charaxes (Polyura) schreiber</i>	5 (in Malaya), 13 (in Malaya)
41	Cyrestinae	<i>Chersonesia rahria</i>	5 (in Malaya)
42	Cyrestinae	<i>Cyrestis lutea</i>	-
43	Cyrestinae	<i>Cyrestis nivea</i>	-
44	Cyrestinae	<i>Cyrestis themire</i>	11 (in Java)
45	Danainae	<i>Danaus chrysippus</i>	3 (in Java), 5 (in Malaya)
46	Danainae	<i>Danaus genutia</i>	3 (in Java), 6 (in Laos)
47	Danainae	<i>Euploea corinna</i>	6 (in Bali)
48	Danainae	<i>Euploea eleusina</i>	6 (in Sulawesi)
49	Danainae	<i>Euploea eunice</i>	5 (in Philippines)
50	Danainae	<i>Euploea mulciber</i>	3 (in Java), 5 (in Malaya)
51	Danainae	<i>Euploea phaenareta</i>	5 (in Palawan)
52	Danainae	<i>Idea stolli</i>	-
53	Danainae	<i>Ideopsis juventa</i>	3 (in Java), 6 (in Malaya)
54	Danainae	<i>Parantica aspasia</i>	3 (in Java), 5 (in Malaya)
55	Danainae	<i>Tirumala hamata</i>	-

Taxa			Previous records – the number indicates the publication
No.	Subfamily	Species	
			1. Piepers & Snellen (1909); 2. Piepers & Snellen (1910); 3. Piepers & Snellen (1913); 4. Piepers & Snellen (1918); 5. Igarashi & Fukuda (1997); 6. Igarashi & Fukuda (2000); 7. Tan (2009a); 8. Tan (2009b); 9. Tan (2011a); 10. Tan (2011b); 11. Wafa & Sari (2017); 12. Karmakar et al. (2018); 13. Corbet & Pendlebury (2020)
56	Heliconiinae	<i>Acraea issoria</i>	6 (in Taiwan)
57	Heliconiinae	<i>Acraea terpsicore</i>	6 (in Thailand)
58	Heliconiinae	<i>Argyreus hyperbius</i>	-
59	Heliconiinae	<i>Cethosia penthesilea</i>	6 (in Bali)
60	Heliconiinae	<i>Cupha erymanthis</i>	5 (in Malaya)
61	Heliconiinae	<i>Phalanta phalantha</i>	5 (in India)
62	Heliconiinae	<i>Vindula dejone</i>	5 (in Philippines)
63	Limenitidinae	<i>Athyma nefte</i>	6 (in Malaya)
64	Limenitidinae	<i>Athyma perius</i>	6 (in Malaya)
65	Limenitidinae	<i>Athyma selenophora</i>	6 (in Taiwan)
66	Limenitidinae	<i>Dophla evelina</i>	5 (in Malaya)
67	Limenitidinae	<i>Euthalia aconthea</i>	5 (in Malaya)
68	Limenitidinae	<i>Euthalia adonia</i>	-
69	Limenitidinae	<i>Euthalia anosia</i>	12 (in India)
70	Limenitidinae	<i>Euthalia monina</i>	5 (in Malaya)
71	Limenitidinae	<i>Lebadea martha</i>	6 (in Thailand)
72	Limenitidinae	<i>Moduza procris</i>	6 (in Malaya)
73	Limenitidinae	<i>Neptis clinia</i>	5 (in Hong Kong)
74	Limenitidinae	<i>Neptis hylas</i>	5 (in Japan)
75	Limenitidinae	<i>Pantoporia hordonia</i>	5 (in Malaya)
76	Limenitidinae	<i>Parthenos sylvia</i>	6 (in Malaya)
77	Limenitidinae	<i>Phaedyra columella</i>	5 (in Philippines)
78	Limenitidinae	<i>Tanaecia palguna</i>	-
79	Limenitidinae	<i>Tanaecia trigerta</i>	-
80	Nymphalinae	<i>Doleschallia bisaltide</i>	5 (in Malaya), 12 (in Malaya)
81	Nymphalinae	<i>Hypolimnas bolina</i>	5 (in Philippines)
82	Nymphalinae	<i>Hypolimnas misippus</i>	-
83	Nymphalinae	<i>Junonia almana</i>	5 (in Malaya)
84	Nymphalinae	<i>Junonia atlites</i>	5 (in Philippines)
85	Nymphalinae	<i>Junonia hedonia</i>	5 (in Philippines)
86	Nymphalinae	<i>Junonia iphita</i>	5 (in Malaya)
87	Nymphalinae	<i>Junonia orithya</i>	5 (in Malaya)
88	Nymphalinae	<i>Junonia villida</i>	-
89	Nymphalinae	<i>Symbrenthia lilaea</i>	-
90	Nymphalinae	<i>Yoma sabina</i>	6 (in Maluku)
91	Satyrinae	<i>Amathusia phidippus</i>	5 (in Java)

Taxa			Previous records – the number indicates the publication
No.	Subfamily	Species	
			1. Piepers & Snellen (1909); 2. Piepers & Snellen (1910); 3. Piepers & Snellen (1913); 4. Piepers & Snellen (1918); 5. Igarashi & Fukuda (1997); 6. Igarashi & Fukuda (2000); 7. Tan (2009a); 8. Tan (2009b); 9. Tan (2011a); 10. Tan (2011b); 11. Wafa & Sari (2017); 12. Karmakar et al. (2018); 13. Corbet & Pendlebury (2020)
92	Satyrinae	<i>Discophora necho</i>	-
93	Satyrinae	<i>Discophora sondaica</i>	6 (in Malaya)
94	Satyrinae	<i>Elymnias hypermnestra</i>	3 (in Java), 5 (in India)
95	Satyrinae	<i>Elymnias nesaea</i>	3 (in Java), 5 (in Malaya)
96	Satyrinae	<i>Elymnias panthera</i>	6 (in Malaya), 12 (in Malaya)
97	Satyrinae	<i>Lethe europa</i>	5 (in Philippines)
98	Satyrinae	<i>Lethe minerva</i>	-
99	Satyrinae	<i>Melanitis leda</i>	12 (in India)
100	Satyrinae	<i>Melanitis phedima</i>	3 (in Java)
101	Satyrinae	<i>Melanitis zitenius</i>	6 (in Malaya)
102	Satyrinae	<i>Mycalesis perseus</i>	5 (in Philippines)
Family: Lycaenidae			
103	Lycaeninae	<i>Heliophorus epicles</i>	12 (in India)
104	Polyommatainae	<i>Anthene emolus</i>	5 (in Malaya)
105	Polyommatainae	<i>Castalius rosimon</i>	4 (in Java), 6 (in Laos)
106	Polyommatainae	<i>Jamides aratus</i>	-
107	Polyommatainae	<i>Lampides boeticus</i>	4 (in Java)
108	Theclinae	<i>Amblypodia narada</i>	4 (in Java)
109	Theclinae	<i>Arhopala centaurus</i>	4 (in Java)
110	Theclinae	<i>Arhopala eumolphus</i>	-
111	Theclinae	<i>Arhopala silhetensis</i>	-
112	Theclinae	<i>Drupadia ravindra</i>	4 (in Java), 5 (in Malaya)
113	Theclinae	<i>Flos diardi</i>	6 (in Laos)
114	Theclinae	<i>Hypolycaena erylus</i>	6 (in Laos)
115	Theclinae	<i>Loxura atymnus</i>	5 (in Malaya)
116	Theclinae	<i>Rapala iarbus</i>	-
117	Theclinae	<i>Rapala manea</i>	5 (in Philippines)
118	Theclinae	<i>Remelana jangala</i>	6 (in Sulawesi)
119	Theclinae	<i>Tajuria cippus</i>	5 (in Hong Kong)
Family: Riodinidae			
120	Riodininae	<i>Zemeros flegyas</i>	6 (in Hong Kong)
Family: Hesperidae			
121	Coeliadinae	<i>Badamia exclamationis</i>	2 (in Java), 5 (in Taiwan)
122	Coeliadinae	<i>Bibasis sena</i>	2 (in Java)
123	Coeliadinae	<i>Burara gomata</i>	2 (in Java), 6 (in Hong Kong & Philippines)
124	Coeliadinae	<i>Burara harisa</i>	2 (in Java)

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125	Coeliadinae	<i>Burara oedipodea</i>	2 (in Java)
126	Coeliadinae	<i>Choaspes subcaudata</i>	2 (in Java), 5 (in Borneo)
127	Coeliadinae	<i>Hasora badra</i>	2 (in Java)
128	Coeliadinae	<i>Hasora chromus</i>	2 (in Java)
129	Coeliadinae	<i>Hasora myra</i>	2 (in Java)
130	Hesperiinae	<i>Erionota thrax</i>	2 (in Java)
131	Hesperiinae	<i>Matapa aria</i>	2 (in Java)
132	Hesperiinae	<i>Pirdana distanti</i>	2 (in Java), 5 (in Malaya)
133	Hesperiinae	<i>Suada swerga</i>	2 (in Java)
134	Hesperiinae	<i>Suastus gremius</i>	-
135	Hesperiinae	<i>Udaspes folus</i>	2 (in Java)
136	Pyrginae	<i>Tagiades japetus</i>	2 (in Java), 5 (in Malaya)
Total:		136 spp.	107 spp.

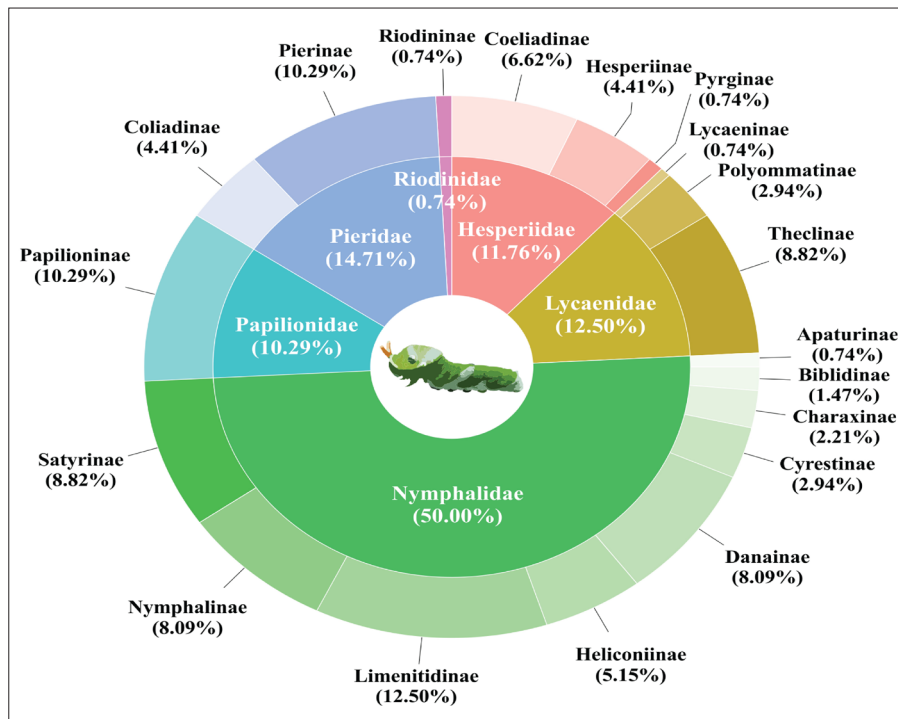


Figure 1. Percentage of documented caterpillars of different taxa of butterflies, based on the 10-year observation and rearing efforts in Malang and Pandaan, East Java.

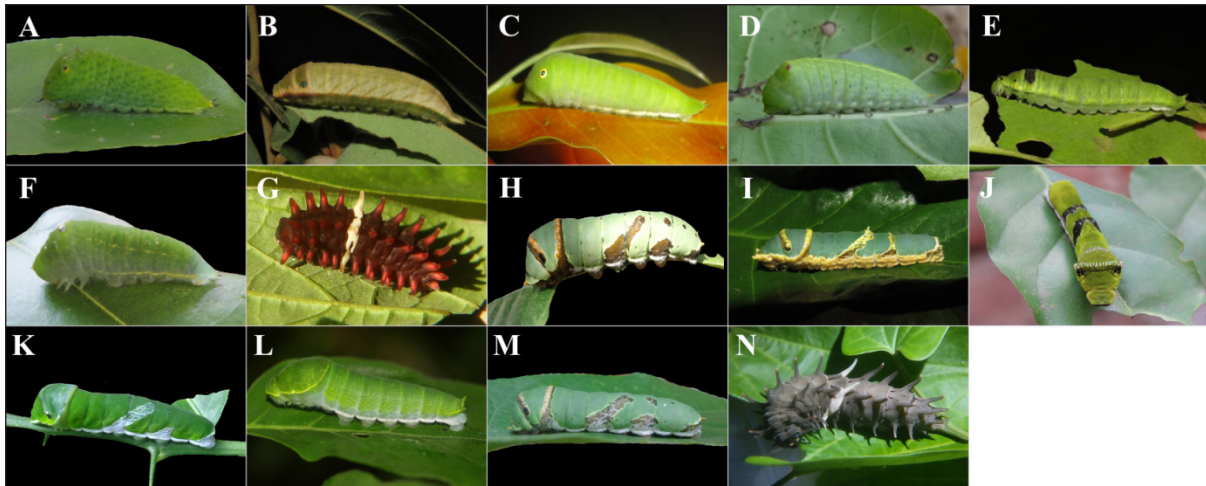


Figure 2. List of Papilionidae caterpillars. A) *G. agamemnon*, B) *G. antiphates*, C) *G. doson*, D) *G. empedovana*, E) *G. macareus*, F) *G. sarpedon*, G) *Pc. adamas*, H) *P. demoleus*, I) *P. demolion*, J) *P. helenus*, K) *P. memnon*, L) *P. peranthus*, M) *P. polytes*, N) *T. helena*. (Photographs by Imti Yazil Wafa, Soenarko, and Lutfi Irwansyah).

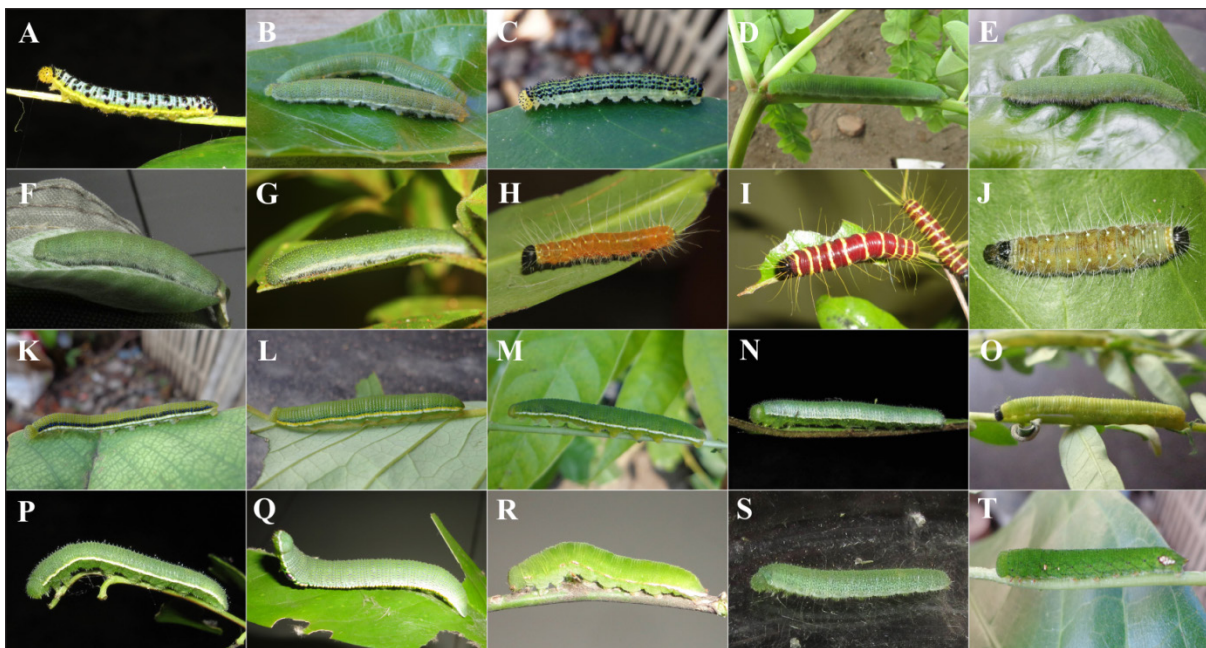


Figure 3. List of Pieridae caterpillars. A) *A. indra*, B) *A. lyncida*, C) *A. nero*, D) *A. olferna*, E) *C. iudith*, F) *C. nerissa*, G) *C. temena*, H) *D. hyparete*, I) *D. pasithoe*, J) *D. periboea*, K) *C. pomona*, L) *C. pyranthe*, M) *C. scylla*, N) *E. beatrix*, O) *E. blanda*, P) *E. hecabe*, Q) *H. glaucippe*, R) *I. venilia*, S) *L. nina*, T) *P. valeria*. (Photographs by Imti Yazil Wafa, Soenarko, and Lutfi Irwansyah).

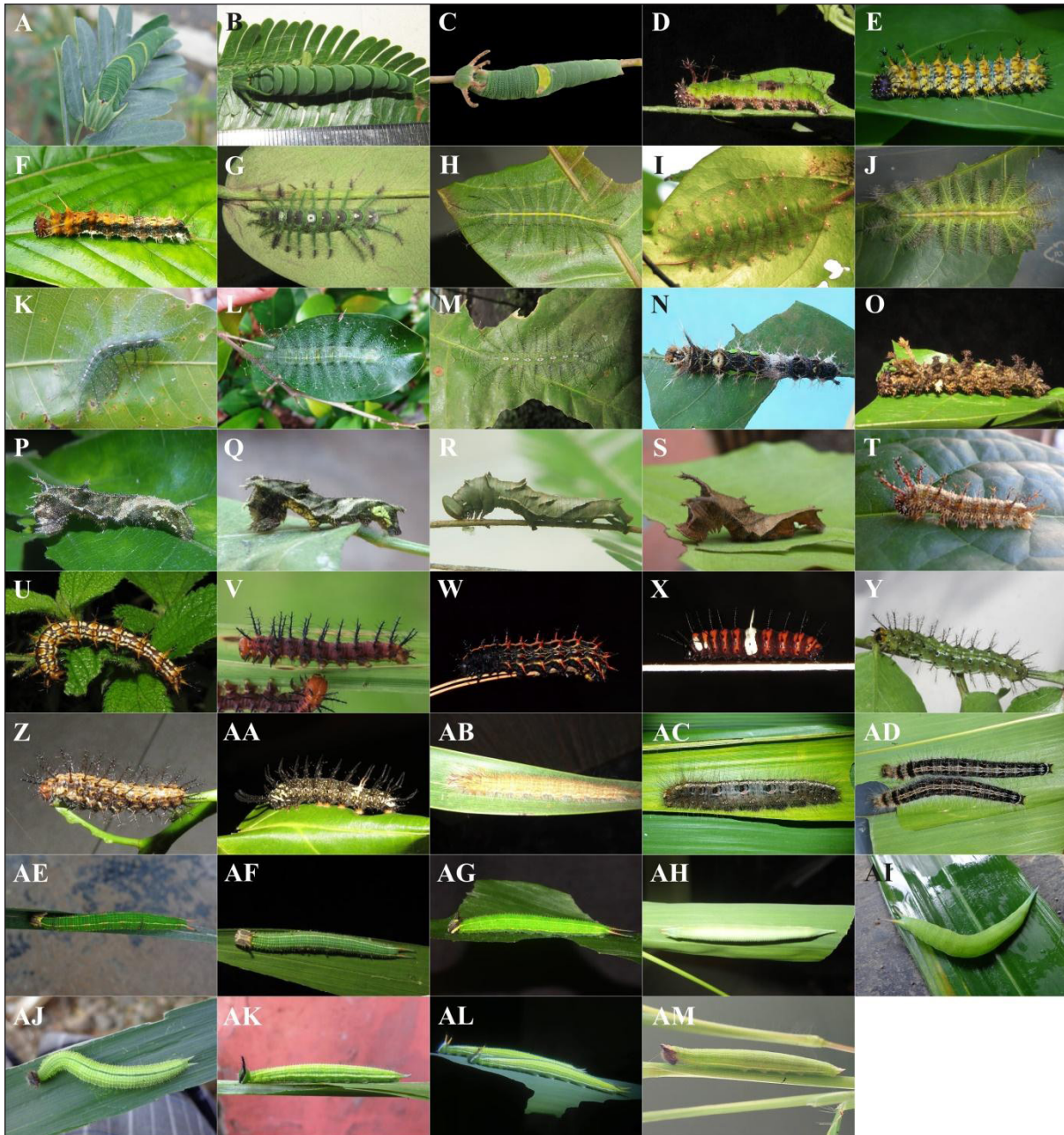


Figure 4. List of Nymphalidae (I) caterpillars. A) *P. athamas*, B) *P. hebe*, C) *P. schreiber*, D) *A. nefte*, E) *A. perius*, F) *A. selenophora*, G) *D. evelina*, H) *E. aconthea*, I) *E. adonia*, J) *E. anosia*, K) *E. monina*, L) *T. palguna*, M) *T. trigerta*, N) *L. martha*, O) *M. procris*, P) *N. clinia*, Q) *N. hylas*, R) *P. hordonia*, S) *P. columella*, T) *P. sylvia*, U) *A. issoria*, V) *A. terpsicore*, W) *A. hyperbius*, X) *C. penthesilea*, Y) *C. erymanthis*, Z) *P. phalantha* AA) *V. dejone*, AB) *A. phidippus*, AC) *D. necho*, AD) *D. sondaica*, AE) *E. hypermnestra*, AF) *E. nesaea*, AG) *E. panthera*, AH) *L. europa*, AI) *L. minerva*, AJ) *M. leda*, AK) *M. phedima*, AL) *M. zitenius*, AM) *M. perseus*. (Photographs by Imti Yazil Wafa, Soenarko, and Lutfi Irwansyah).

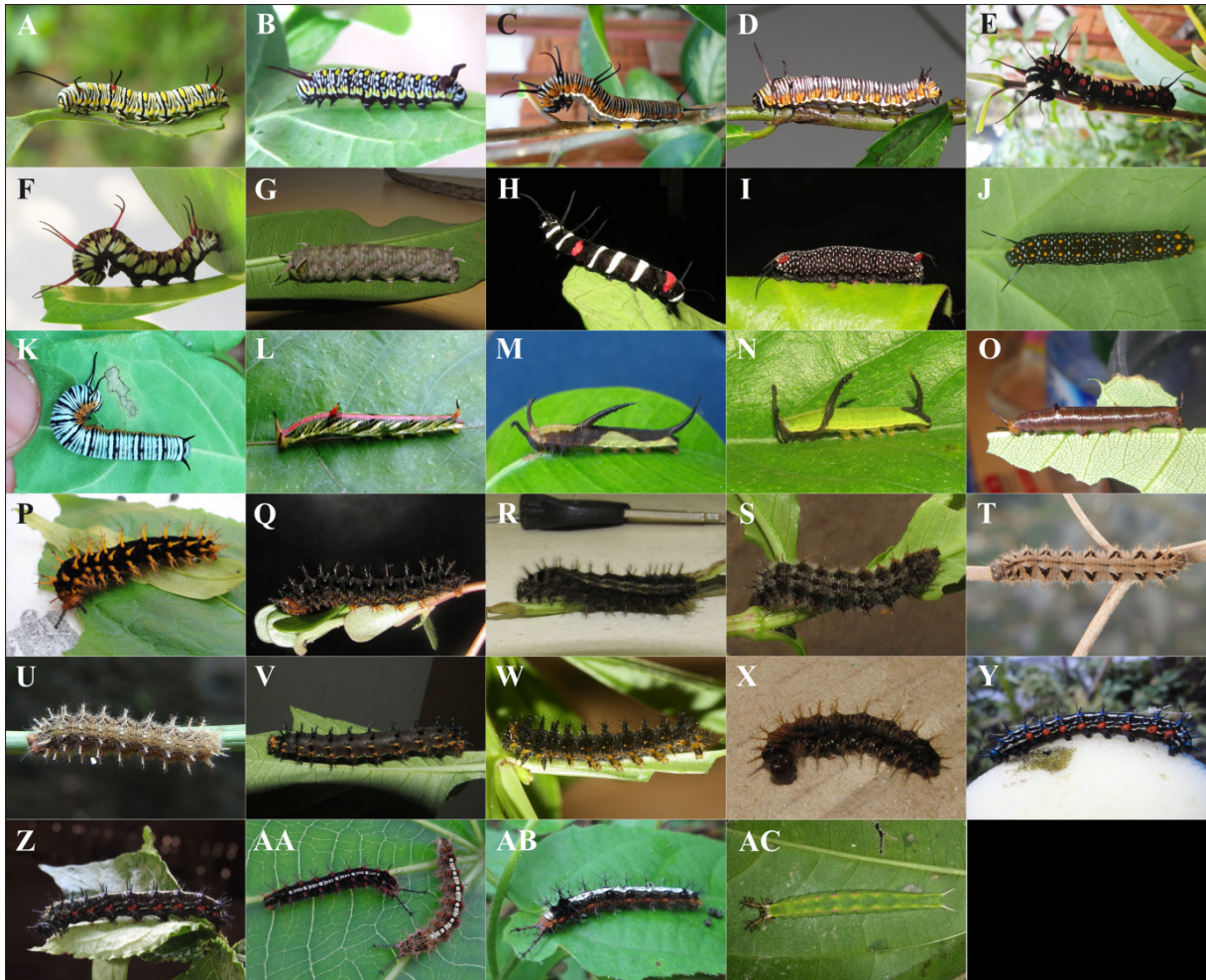


Figure 5. List of Nymphalidae (II) caterpillars. A) *D. chrysippus*, B) *D. genutia*, C) *E. corinna*, D) *E. eleusina*, E) *E. eunice*, F) *E. mulciber*, G) *E. phaenareta*, H) *I. stollii*, I) *I. juvena*, J) *P. aspasia*, K) *T. hamata*, L) *C. rahria*, M) *C. lutea*, N) *C. nivea*, O) *C. themire*, P) *H. bolina*, Q) *H. misippus*, R) *J. almana*, S) *J. atlites*, T) *J. hedonia*, U) *J. iphita*, V) *J. orithya*, W) *J. villida*, X) *S. lilaea*, Y) *D. bisaltide*, Z) *Y. sabina*, AA) *A. ariadne*, AB) *A. specularia*, AC) *R. nakula*. (Photographs by Imti Yazil Wafa, Soenarko, and Lutfi Irwansyah).

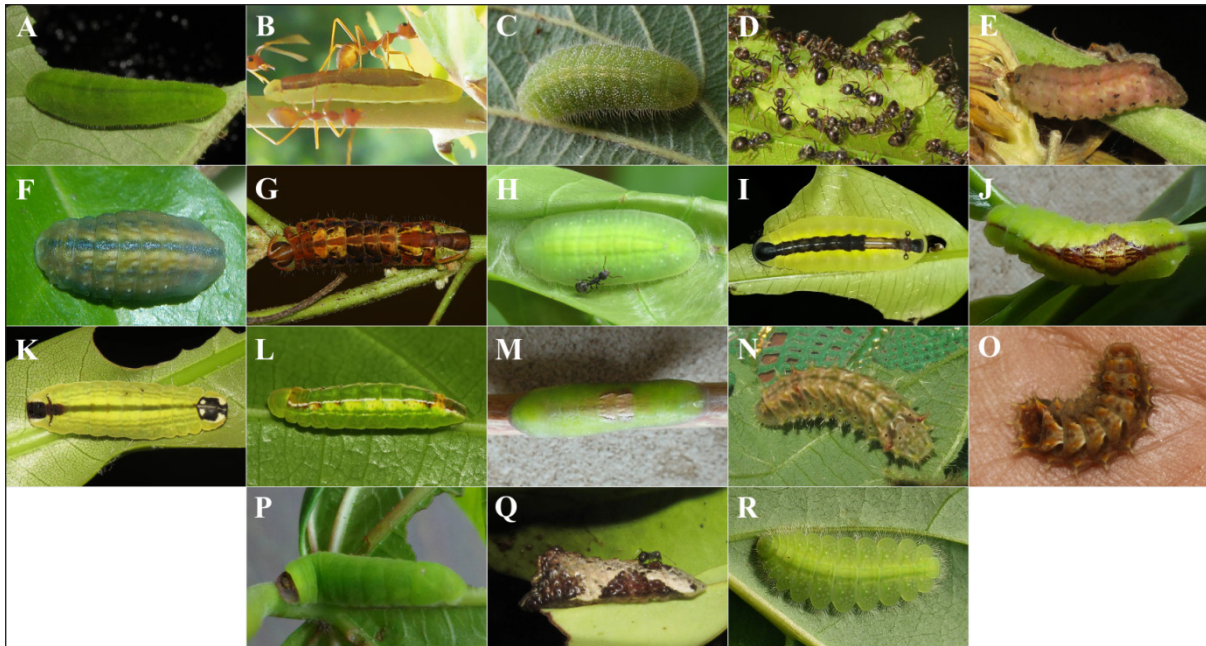


Figure 6. List of Lycaenidae and Riodinidae caterpillars, A) *H. epicles*, B) *A. emolus*, C) *C. rosimon*, D) *J. aratus*, E) *L. boeticus*, F) *A. narada*, G) *A. centaurus*, H) *A. eumolphus*, I) *A. silhetensis*, J) *D. ravindra*, K) *F. diardi*, L) *H. erylus*, M) *L. atymnus*, N) *R. iarbus*, O) *R. manea*, P) *R. jangala*, Q) *T. cippus*, R) *Z. flegyas*. (Photographs by Imti Yazil Wafa, Soenarko, and Lutfi Irwansyah).

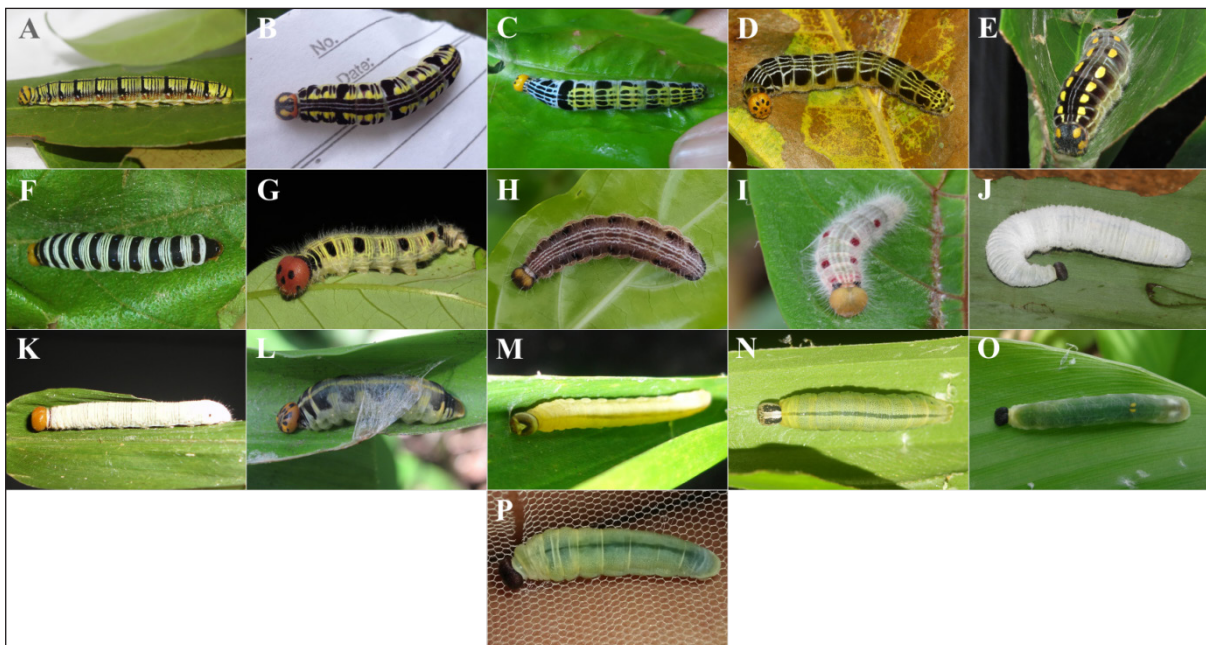


Figure 7. List of Hesperiiidae caterpillars, A) *B. exclamationis*, B) *B. sena*, C) *B. gomata*, D) *B. harisa*, E) *B. oedipodia*, F) *C. subcaudata*, G) *H. badra*, H) *H. chromus*, I) *H. myra*, J) *E. thrax*, K) *M. aria*, L) *P. distanti*, M) *S. swerga*, N) *S. gremius*, O) *U. folus*, P) *T. japetus*. (Photographs by Imti Yazil Wafa, Soenarko, and Lutfi Irwansyah).

DISCUSSION

The findings of this study, which include an investigation of the factors contributing to the variety of butterfly caterpillars, have not yet been completed. During sampling, caterpillars were collected and subsequently reared, resulting in 136 different species. During field observations, members of the Nymphalidae family were the most frequently seen. This is due to the fact that the Nymphalidae have the highest species diversity in comparison to other butterfly families (Tiple, 2012; Koneri et al., 2019; Dar et al., 2022). The early stages of 107 butterfly species or 78.68% of 136 spp. covered in this study have been previously documented (Piepers & Snellen, 1909, 1911, 1913, 1918; Igarashi & Fukuda, 1997, 2000; Tan, 2009a, 2009b, 2011a, 2011b; Wafa & Sari, 2017; Karmakar et al., 2018; Corbet & Pendlebury, 2020) on various localities as presented in Table 1. Other studies on the pre-adult stages of a few butterfly species in Java included those on *P. peranthus* (Peggie, 2019); *T. helena*, and *Pc. adamas* (Peggie et al., 2021); and on *P. memnon* (Danus, 2015; Komala et al., 2018).

A significant result of this long-term survey is the discovery and documentation of caterpillars of 29 species that had never been reported before. This was made possible due to the active participation of butterfly enthusiasts. We would encourage that more thorough observations can be made when an imago butterfly lays eggs on the larval host plant. These observations would allow observers to note the plant species' preferences for egg laying and to investigate the caterpillars after the eggs have hatched. However, the challenge is that the eggs are relatively small and it is quite tricky to identify due to their deceptive appearance as an effort on the part of butterflies to avoid the risk of predation, parasitism, and interference (Mochioka et al., 2021). Furthermore, the caterpillar's solitary characteristic, its mysterious appearance, and its protracted immobilization also add to the challenge (Ravenscroft, 2021).

The government of Indonesia has designated 25 species of birdwing butterflies (members of *Ornithoptera*, *Troides*, and *Trogonoptera*) as being protected (Ministry of Environment and Forestry, 2018), of which 6 were recently added to the earlier list of 19 species (Ministry of Agriculture, 1980; Simbolon & Iswari, 1990; Noerdjito, 2001; Peggie, 2011). In our study, one species of the protected butterfly species, *T. helena* was discovered. According to the IUCN assessment, the population of *T. helena* was severely decreasing worldwide (Böhm et al., 2018). Additionally, the availability of host plants for the larvae, *Aristolochia* spp. is currently fairly uncommon. The unintentional threat of the extinction of these plants in nature posed by the conversion of forest functions into plantations, settlements, or logging, might lead to declining populations of the butterfly species.

Two species, *Eurema beatrix* (Toxopeus, 1939) and *Ixias venilia* (Godart, 1819), reported here based on the caterpillar findings, are endemic to Java. *Cyrestis lutea* and *Tanaecia trigerta* are endemic to Java and Bali, while *Cepora temena* and *Delias periboea* are only found in Java and Lesser Sunda. To further understand the ecology of the species, there is a desperate need for research on butterfly species endemic to Java, as well as those endemic to other islands of Indonesia. Further research may inform the attempts to prevent the extinction of endemic species. This photographic concept of recording serves as a guide for researchers and casual observers to conduct further research. The research might include the egg-laying behavior of

butterflies, the selection of host plants, the observation of the life cycle of each species up to the imago stage, and other aspects crucial to the understanding of butterflies.

This long-term effort involving citizen science participation has contributed greatly to the knowledge about butterflies, in this case the caterpillar phases. We hope that butterfly enthusiasts, including our fellows at Kuponesia and other communities, will continue to watch for butterflies and care for butterfly conservation.

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