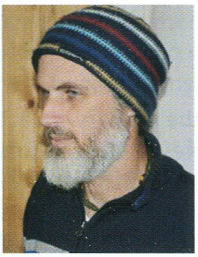
Inventory of *Delias* Hübner (Lepidoptera: Pieridae) from Mokndoma, Papua, Indonesia



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Abstract: The results of continuous collecting of *Delias* during 2013 at Mokndoma and Wigoduk are presented along with records from brief collecting trips lower down and higher up the mountain. The diversity and frequency of recorded *Delias* species is analyzed and the previously unknown female of *D. phippsi mulia* is described

Rangkuman: Hasil menangkap *Delias* secara terus-menerus selama 2013 di Mokndoma dan Wigoduk disajikan, disertai dengan hasil dua perjalanan pendek, satu ke wilayah yang lebih rendah, yang kedua ke tempat pegunungan yang tinggi. Keragaman dan frekuensi spesies yang diperoleh dianalisa. Akhirnya betina *D. phippsi mulia* yang sebelumnya tidak dikenal, dideskripsi.

Keywords: Delias, diversity, frequency, New Guinea, new female.

Abbreviations

KSP - Koleksi Serangga Papua (Papuan Insect Collection), Jayapura, Papua, Indonesia

Introduction

From the 15th to 23rd January 2013, Papuan *Delias* specialist Henk van Mastrigt visited the author at his home in Mokndoma (E 137°146.500'; S 3°138,649') at 2,180m, not far from the River Nggoduk at Wigoduk valley (E 137°146.963';S 3°138,242') at 1,860m. During that week, collecting was carried out with a focus

on the genus *Delias*, and Henk encouraged the author to consistently collect *Delias* at both the Mokndoma and Wigoduk locations for a duration of a year or longer. The author and sons then collected systematically for one or more days each month at the Wigoduk river location and also at the home site of Mokndoma for a period of one year from January 2013 to January 2014.

Collecting sites

Mokndoma is the author's home village and one of the primary collecting sites. At 2,180m elevation, the location is upper montane forest with moss jungle areas, pockets of bog grass, marsh and scrub brush. Wigoduk, the other primary collection site is at 1,860m in mid montane forest, located in a narrow flat valley alongside the Nggoduk river. Kidudumo is lower further down the mountain at 1,600m. This area is lush with many small streams flowing down through it. The final collecting area is Dugudok, near the peak of the highest mountain, inside the tribal borders of the Wano people. At 3,352m, this is an upper montane forest habitat, with shunted trees, scrub brush and yellow moss carpets.

Results of one year survey

In January 2013, during the first collecting trip at Mokndoma and Wigoduk, only 15 species of *Delias* were recorded. Since then, after collecting consistently each month for one year, the total number of species collected has climbed to 21. When including species collected from the nearby sites of Kidudumo and Dugudok the total count comes to 24.

Species diversity (see Tables 1,2)

The 24 species collected from all four locations (represented by 1,123 specimens) were; *lara, sinak, aroae yabensis, pheres approximata, cyclosticha, microsticha, antara, callista callipareia, catisa, isocharis, kummeri, alepa, phippsi mulia, luctuosa archboldi, arabuana, hapalina, niepelti, ladas, nais* f. *zebra, hypomelas* f. *clutus, virgo, neeltje, sigit* and *muliensis.*

The greatest numbers of *Delias* were recorded at the riverside location of Wigoduk. Reaching this site requires a one hour hike from Mokndoma through the jungle down to the river. The collecting site here is alongside the Nggoduk river at a bend in the river where there is enough space to run back and forth in pursuit of butterflies. Large numbers of *Delias* converge at this site, usually flying down river towards the south. The author and family would arrive each day around 9.00am and collect until 12.00-1.00pm. In 14 days of collecting 930 specimens were

collected. The vast majority of these were males (922 specimens 99.13%). Only 8 females were collected (0.87%) including the newly discovered female of *D. cyclosticha*.

Wigoduk shares in common with Mokndoma the following fifteen species; *sinak, aroae yabensis, pheres approximata, cyclosticha, microsticha, antara, callista callipareia, isocharis, alepa, phippsi mulia, arabuana, hapalina, niepelti, nais* f. zebra, and *hypomelas* f. *clutus*. These two locations share 62.5% of the overall total of collected species.

Mokndoma is located near the peak of the mountain separated by the north to southward flowing Nggoduk river to the east and the Mayuk river to the west. There are no rivers close by this collecting area, and the *Delias* are always alone and flying by in a hurry. In fourteen days of collecting here, the author and family collected 153 specimens. Out of these, 125 specimens (81.67%) were male, and 28 specimens (18.33%) were female, including the newly discovered females of *D. neeltje* and *D. phippsi mulia*.

The author lived in the village of Kidudumo for five years but at that time was not concentrating on *Delias*. Later, after moving up to Mokndoma, he returned to this site for two days and collected 38 specimens. All 38 (100%) were males. At this location, *D. lara* and *D. kummeri* were added to the species count for the overall area.

Kidudumo shares twelve species in common with Wigoduk; *sinak, aroae yabensis, pheres approximata, microsticha , isocharis, alepa, phippsi mulia, hapalina, niepelti, ladas, nais* f. *zebra*, and *hypomelas* f. *clutus*. This represents 50% of the overall collected species. More collecting days at this location will probably add a couple more species to the list.

Kidudumo shares eleven species in common with Mokndoma which are; *sinak, aroae yabensis, pheres approximata, microsticha , isocharis, alepa, phippsi mulia, hapalina, niepelti, nais* f. *zebra*, and *hypomelas* f. *clutus*. These represents 45.8% of the overall collected species.

On an expedition to the nearby peak of mount Dugudok (3,352m), collecting was limited by weather conditions.. The collecting site was on a razorback ridge among high scrub brush and thick moss. where there was little room to move and chase butterflies. In one day, two *Delias* species: *luctuosa archboldi* and *catisa*, both female (100%) were collected. A few other *Delias* that flew within range (and missed with the net!) had the signature sulfur yellow dusting on the white uppersides along with the thick black borders of females. More days collecting in this location would surely reveal a few more species.

Species frequency

Due to the inadequate number of collecting days and data from Kidudumo and Dugudok, the author will only compare data from Wigoduk and Mokndoma.

At Wigoduk , 50.95% of specimens collected are represented by only three species; *microsticha* 21.61%, *hypomelas* f. *clutus* 17.41%, and *sinak* 11.93%. At Mokndoma a fourth species must be added to reach 53.57%. These are *microsticha* 23.52%, *hypomelas* f. *clutus* 11.76%, *hapalina* 9.80% and *alepa* 8.49%.

By far, the most frequent/dominant *Delias* species at both locations is *microsticha*, 21.05% with *hypomelas* f. *clutus* 16.62% second.

Noteworthy forms and varieties

Some noteworthy forms and varieties from the Mokndoma area are found within *D. arabuana*, *D. hypomelas* f. *clutus* and *phippsi mulia*

D. arabuana
The typical *D. arabuana* form has a red posterior strike in the basal spot but this form has not yet been recorded from the Mokndoma locality. *D. arabuana* from the Mokndoma area have either a posterior orange strike or a posterior yellow strike in the basal spot. Out of a total of 23 *D. arabuana* collected (1.40% of total *Delias*), 15 (65.2%) were orange form and 8 (34.8%)were yellow form. In nearby areas the red spotted form is the most common one and at some other locations the orange and red forms are rarely present. Future genetic analysis could lead to a review of the status of *arabuana* witin the mesoblema-complex.

D. hypomelas f. *clutus*
There are two varieties found at Mokndoma, the most common having red tips at the upperside forewing and another rarer form with yellow tips. Out of 188 total *hypomelas* f. *clutus* (16.18% of all collected *Delias*) 180 (95.75%), were red tipped and only 8 (4.25%) had yellow tips.

D. phippsi mulia
A 'black' form of this species lacks the curved red fascia between the apex and anal corner in the black tornal area of the underside hindwing. It was first mentioned and pictured by Yagashita (1993) from the Ilu/Mulia area in 1991-92, who treated it as an aberration. However, after one year of consistent collecting, this form (including some transitional forms, showing a very thin or partially absent red line

or just a small red spot above the tornus) is found to make up 28.51% of the *D. phippsi mulia* population at Mokndoma, showing that it is a consistent form or variety in some areas.

Comparison with species known from nearby collecting sites of Ilu (2,500m), Mulia (1,645m) Sinak (1,866m), and Ilaga (2,180m)

In comparison with geographical records held by the KSP, the number of species (24) from the Mokndoma area is similar to those known from the nearby towns of Ilu (24), Mulia (29), Sinak (22), and Ilaga (23) which each have similar elevations and environments. Mokndoma shares twelve common species with all of these; *arabuana, sinak, muliensis, antara, alepa, phippsi mulia, luctuosa archboldi, hapalina, niepelti, sigit, ladas* and *hypomelas*.

Mokndoma shares eleven species with Mulia which are; *sinak, microsticha, muliensis, isocharis, alepa, phippsi mulia, callista callipareia, arabuana, virgo, hapalina,* and *sigit. D. kummeri* was collected at the lower elevation site of Mulia and also collected at Kidudumo which is lower down the mountain from Mokndoma. The high altitude species *D. luctuosa archboldi* was also apparently collected from Mulia. The author collected a female *D. luctuosa archboldi* from Dugudok which is in the general Mokndoma area, but at a much higher elevation This is consistent with other records confirming *luctuosa archboldi* to be a relatively high altitude *Delias*. KSP records include *D. luctuosa* collected from Mulia, but it is likely that these were not collected directly in Mulia but somewhere higher up on the southern slope of the mountain outside Mulia.

The Mokndoma area and Sinak share fourteen species in common : *sinak, muliensis, alepa, arabuana, virgo, hapalina, ladas, sigit, isocharis, phippsi mulia, luctuosa archboldi, calista callipareia, niepelti*, and *hypomelas clutus* both red and yellow forms. Again, *D. luctuosa archboldi* has been recorded from Sinak, but was probably collected higher up to the south, beyond the Sinak valley. Finally, Mokndoma shares ten species in common with Ilaga which are; *arabuana, michrosticha, muliensis, alepa, luctuosa archboldi, callista callipareia, virgo, niepelti, sigit,* and *hypomelas*.

Notes on female to male ratio (see Table 1)

Out of a total of 1,123 *Delias*-specimens from all four localities, 1,085 were male (96.66%) and 38 were female (3.33%). At the lowest elevation location of Kidudumo no females were collected. This collection site was secondary forest with small streams nearby. The next highest elevation site at Wigoduk is located alongside a riverbank. Here, 99.13% of specimens collected were male and only 0.87% were female.

Females of five species, from the total of 16, were collected at this location. At the next highest site of Mokndoma, 81.69% of collected specimens were male, and 18.31% were females. Here, out of 20 total recorded species, females of 12 of the species were collected. This site is scrubby and boggy with no nearby streams or running water.

The final collecting site of Dugudok is at the peak of a mountain, again with no nearby watercourses. 100% of collected specimens here (only two) were female.

The great discrepancy between numbers of males collected compared to females has also been recorded from the Baliem valley. Henk van Mastrigt recorded that out of 11,338 specimens of *Delias* collected in the Baliem valley area, at altitudes between 1,650m to over 2,800m, only 159 or 1.40% were female. Mokndoma, with 3.33% females, is only slightly higher. This data shows that in the Mokndoma area, male *Delias* are much more common below 2,180m and inhabit the riversides. Females on the other hand are more common higher up, 2,180m + and prefer non-riverside locations.

The 13 species of female *Delias* collected from the general Mokndoma area are; *pheres approximata, cyclosticha, microsticha , callista callipareia, catisa, alepa, phippsi mulia, arabuana, hapalina, nais* f. *zebra, hypomelas* f. *clutus, virgo,* and *neeltje*.

Female Delias phippsi mulia

(figs 1-2)

Material examined: 1 ♀: Puncak Jaya, Mokndoma, E 137°146.500'; S 3°138.649', 2,180m, 8.viii.2013, Mike Wild Fam, 1 ♀: in KSP.

Diagnosis:

D. phippsi mulia is in the kummeri group and shares very similar markings with *D. phippsi phippsi* and *D. phippsi wisseli*. In both males and females, the only striking difference is in the basal streak on the underside hindwing. In *phippsi mulia*, the basal streak is anteriorly white and posteriorly red, surrounded by black, whereas in *phippsi phippsi* and *phippsi wisseli*, the streak is only white. The three subspecies females all share the typical thicker black upperside borders, and yellow tinge on upper and lower side white areas.

Description:

Upperside forewing light yellow with thicker patch of yellow scales submedially; thick black costal border, entering into the discal cell; series/band of four yellow subapical spots between veins R4, R5, M1, and M2; thick black border along termen thicker towards apex and tapering towards tornus. Upperside hindwing is dusted with

yellow scales, but translucent, with pattern of underside clearly visible; thick terminal border starts from vein Rs near the apex, and runs along the termen to vein 3a past the tornus; inner edge is irregular and not quite reaching to the discal cell area. Underside of forewing has black border of the same size as upperside, including the band of four yellow subapical spots, only spots are slightly more embellished than on the upperside. Underside hindwing has basal streak, anteriorly white and posteriorly deep red, surrounded by black. Lower half, from middle of anal margin, nearly touching discal cell to termen between vein M1 and M2. A deep red fascia turns from costa till above tornus, with at the outer side having a very small white line. The apex is white; the discal area is creamy yellow with white borders; a deep red streak separates from disk from the anal area, which is filled with deep gray and golden yellow scales, the same color as underside of thorax.

Length of forewing: 24.5 mm.

Discussion

During the initial visit by Henk Van Mastrigt to Mokndoma in January 2013, 13 species of *Delias* were recorded. In a publication subsequent to that trip, Henk wrote, "As far as diversity is concerned the species number is poor in comparison with other localities in the central mountain range of Papua at more or less the same altitude, where 16-25 species are normally found in locations such as Ilaga, around the Baliem Valley and at various spots in the Star Mountains." After one year of consistent collecting, the total number of *Delias* species recorded has risen to a comparable level (24 species). It is noteworthy and curious that a number of species such as *Delias leucias torini, nais takanami*, and *klossi gome* which are known from Ilaga to the south west, Sinak to the south, and Mulia and Ilu to the east, have not yet been encountered at Mokndoma. Perhaps further collecting will discover the presence these species in the area. The relatively high number of rare females collected at Mokndoma, including 4 specimens of *catisa* and the recently discovered females of *cyclosticha, neeltje*, and *phippsi mulia*, is noteworthy, indicating a preference by this sex for non-riverside habitats

Acknowledgments

I would like to thank my four sons who were diligent collectors and helpers. Without their help this study would not have been near as complete. And I would like to thank Ira Nggire who collected the ♀ *D. phippsi mulia*. I would also like to thank Henk van Mastrigt for his comments and editing. Also, many thanks to Chris Davenport for proof reading.

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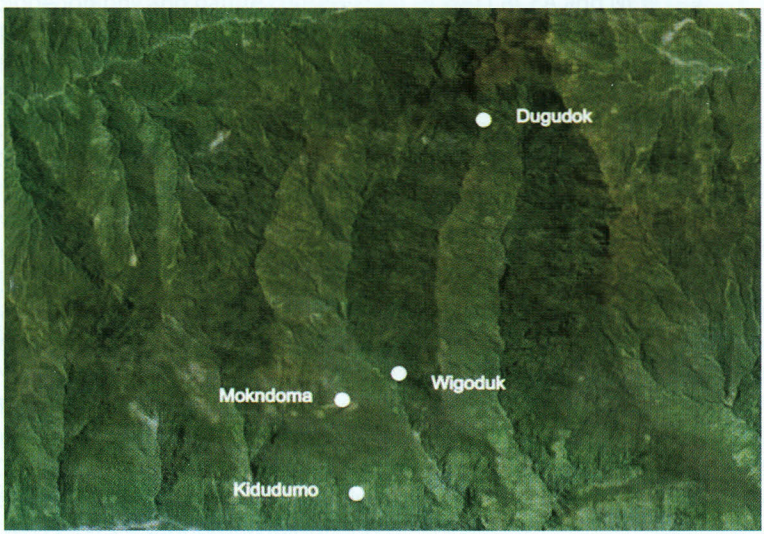
Figs 1-2. *Delias phippsi mulia* ♀ (KSP 68946): 1.upperside; 2.underside.

Map 1. Papua with the Mokndoma area

Map 2. Mokndoma and nearby towns/collecting sites.



Map 3. Map of Mokndoma and its close sites. (source: Google earth.)

Table 1. Results of *Delias* from the four collecting areas in the general Mokndoma area, with highlighted female.

No.	location/elevation/days	Kidudumo, 1600m, 2 d.				Widoguk, 1850m, 14 d.				Mokndoma, 2180m, 14 d.				Dugudok, 3362m, 1 d.				Total all localities, 31 days			
	name of *Delias*	M	F	M+F	%	M	F	M+F	%	M	F	M+F	%	M	F	M+F	%	M	F	M+F	%
1	*lara*	2	-	2	5.26	-	-	-	-	-		-	-	-	-	-	-	2	-	2	0.18
2	*sinak*	3	-	3	7.89	111	-	111	11.94	6	-	6	3.92	-	-	-	-	120	-	120	10.69
3	*aroae yabensis*	5	-	5	13.16	105	-	105	11.29	3	-	3	1.96	-	-	-	-	113	-	113	10.06
4	*pheres approximata*	2	-	2	5.26	73	1	74	7.96	3	1	4	2.61	-	-	-	-	78	2	80	7.12
5	*cyclosticha*	-	-	-	-	24	2	26	2.80	1	-	1	0.65	-	-	-	-	25	2	27	2.40
6	*microsticha*	7	-	7	18.42	201	1	202	21.72	27	9	36	23.53	-	-	-	-	235	10	245	21.82
7	*antara*	-	-	-	-	1	-	1	0.11	2	-	2	1.31	-	-	-	-	3	-	3	0.27
8	*callista callipareia*	-	-	-	-	2	-	2	0.22	4	1	5	3.27	-	-	-	-	6	1	7	0.62
9	*catisa*	-	-	-	-	-	-	-	-	-	3	3	1.96	-	1	1	50.00	-	4	4	0.36
10	*isocharis*	3	-	3	7.89	27	-	27	2.90	2	-	2	1.31	-	-	-	-	32	-	32	2.85
11	*kummeri*	2	-	2	5.26	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	0.18
12	*alepa*	3	-	3	7.89	54	1	55	5.91	11	2	13	8.50	-	-	-	-	68	3	71	6.32
13	*phippsi mulia*	2	-	2	5.26	78	-	78	8.39	3	1	4	2.61	-	-	-	-	83	1	84	7.48
	phippsi mulia f. black	1	-	1	2.63	20	-	20	2.15	3	-	3	1.96	-	-	-	-	24	-	24	2.14
14	*luctuosa archboldi*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	50.00	-	1	1	0.09
15	*arabuana f. orange*	-	-	-	-	4	-	4	0.43	10	1	11	7.19	-	-	-	-	14	1	15	1.34
	arabuana f. yellow	-	-	-	-	4	-	4	0.43	4	-	4	2.61	-	-	-	-	8	-	8	0.71
16	*hapalina*	1	-	1	2.63	24	-	24	2.58	13	2	15	9.80	-	-	-	-	38	2	40	3.56
17	*niepelti*	1	-	1	2.63	5	-	5	0.54	9	-	9	5.88	-	-	-	-	15	-	15	1.34
18	*ladas*	2	-	2	5.26	6	-	6	0.65	-	-	-	-	-	-	-	-	8	-	8	0.71
19	*nais f. zebra*	1	-	1	2.63	16	3	19	2.04	3	1	4	2.61	-	-	-	-	20	4	24	2.14
20	*hypomelas f. clutus*	3	-	3	7.89	162	-	162	17.42	16	2	18	11.76	-	-	-	-	181	2	183	16.30
	hypomelas f. clutus (yellow tips)	-	-	-	-	5	-	5	0.54	2	1	3	1.96	-	-	-	-	7	1	8	0.71
21	*virgo*	-	-	-	-	-	-	-	-	-	2	2	1.31	-	-	-	-	-	2	2	0.18
22	*neeltje*	-	-	-	-	-	-	-	-	-	2	2	1.31	-	-	-	-	-	2	2	0.18
23	*sigit*	-	-	-	-	-	-	-	-	1	-	1	0.65	-	-	-	-	1	-	1	0.09
24	*muliensis*	-	-	-	-	-	-	-	-	2	-	2	1.31	-	-	-	-	2	-	2	0.18
	Number of specimens	38	-	38	100%	922	8	930	100%	125	28	153	100%	-	2	2	100%	1,085	38	1,123	100%
	Number of species	15	-	15	-	16	5	16	-	17	12	20		-	2	2		22	14	24	-
	percentage of females	0.0%				0.9%				18.3%				100.0%				3.4%			
	percentage of species with females	0.0%				31.3%				60.0%				100.0%				58.3%			

Table 2. Results of *Delias* from the two primary collecting sites of Wigoduk and Mokndoma, with Michael Parsons' DACOR scale.

No.	location/elevation/days	Widoguk, 1850m, 14 d.				av. 10 d.	Mokndoma, 2180m, 14 d.				av. 10 d.	Total all localities, 31 days				av. 10 d.
	name of *Delias*	M	F	M+F	%		M	F	M+F	%		M	F	M+F	%	
1	*lara*	-	-	-	-	-	-		-	-	-	-	-	-	-	-
2	*sinak*	111	-	111	11.94	79.29	6	-	6	3.57	4.29	117	-	117	10.66	41.79
3	*aroae yabensis*	105	-	105	11.29	75.00	3	-	3	1.79	2.14	108	-	108	9.84	38.57
4	*pheres approximata*	73	1	74	7.96	52.86	3	1	4	2.38	2.86	76	2	78	7.10	27.86
5	*cyclosticha*	24	2	26	2.80	18.57	1	-	1	0.60	0.71	25	2	27	2.46	9.64
6	*microsticha*	201	1	202	21.72	144.29	27	9	36	21.43	25.71	228	10	238	21.68	85.00
7	*antara*	1	-	1	0.11	0.71	2	-	2	1.19	1.43	3	-	3	0.27	1.07
8	*callista callipareia*	2	-	2	0.22	1.43	4	1	5	2.98	3.57	6	1	7	0.64	2.50
9	*catisa*	-	-	-	-	-	-	3	3	1.79	2.14	-	3	3	0.27	1.07
10	*isocharis*	27	-	27	2.90	19.29	2	-	2	1.19	1.43	29	-	29	2.64	10.36
11	*kummeri*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	*alepa*	54	1	55	5.91	39.29	11	2	13	7.74	9.29	65	3	68	6.19	24.29
13	*phippsi mulia*	98	-	98	10.54	70.00	6	1	7	4.17	5.00	104	1	105	9.56	37.50
14	*luctuosa archboldi*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	*arabuana f. orange*	8	-	8	0.86	5.71	14	1	15	8.93	10.71	22	1	23	2.09	8.21
16	*hapalina*	24	-	24	2.58	17.14	13	2	15	8.93	10.71	37	2	39	3.55	13.93
17	*niepelti*	5	-	5	0.54	3.57	9	-	9	5.36	6.43	14	-	14	1.28	5.00
18	*ladas*	6	-	6	0.65	4.29	-	-	-	-	-	6	-	6	0.55	2.14
19	*nais f. zebra*	16	3	19	2.04	13.57	19	3	22	13.10	15.71	35	6	41	3.73	14.64
20	*hypomelas f. clutus*	167	-	167	17.96	119.29	16	2	18	10.71	12.86	183	2	185	16.85	66.07
21	*virgo*	-	-	-	-	-	-	2	2	1.19	1.43	-	2	2	0.18	0.71
22	*neeltje*	-	-	-	-	-	-	2	2	1.19	1.43	-	2	2	0.18	0.71
23	*sigit*	-	-	-	-	-	1	-	1	0.60	0.71	1	-	1	0.09	0.36
24	*muliensis*	-	-	-	-	-	2	-	2	1.19	1.43	2	-	2	0.18	0.71
	Number of specimens	922	8	930	100%	664.29	139	29	168	100%	120.00	1,061	37	1,098	100%	392.14
	Number of species	16	5	16			17	12	20			22	14	24		

Dominant	21-40+
Abundant	11-20
Common	6-10
Occasional	2-5
Rare	0-1