The environment of Mokndoma and its *Delias* (Lepidoptera: Pieridae)

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Abstract: The results of collecting at Mokndoma and nearby areas are presented, focusing on the genus *Delias* and including description of the hitherto unknown female of *D. cyclosticha* and a form of *D. phippsi mulia*. Besides that, a general description is presented of the area of the Wano people with an impression of the entomologic fauna, completed with a few maps and some pictures of butterflies .

Rangkuman: Hasil penelitian di Mokndoma dan sekitarnya disajikan, yang terfokus pada genus *Delias*, termasuk deskripsi betina *D. cyclosticha* yang sampai sekarang belum diketahui, dan suatu bentuk *D. phippsi mulia*. Di samping itu gambaran umum wilayah orang Wano disajikan termasuk suatu kesan fauna serangga, dilengkapi dengan beberapa peta dan gambar-gambar kupu-kupu.

Key-words: Delias phippsi mulia, *Delias cyclosticha*, Indonesia, Papua.

Abbreviations

ANIC - Australian National Insect Collection, Camberra, Australia
IFTA - Insect Farming and Trading Agency Collection, Bulolo, PNG
KSP - Koleksi Serangga Papua (Papuan Insect Collection), Jayapura, Papua, Indonesia
RMNH - Naturalis Biodiversity Center (former Rijksmuseum van Natuurlijke Historie), Leiden, The Netherlands
WSP - West Sepik Province, PNG.

Introduction

In 2011 Henk van Mastrigt met the Wild Family (Mike & Libby, and the children Morgan, Hudson, Kian and Asher) at the KSP in Jayapura. The children were enthusiastic collectors of butterflies and some of their specimens and pictures

were identified by the first author. At that time the family was living at Kidudumo (E 137° 46.775'; S 3° 39.712') at 1600m in the Central Mountain range, close to the Lumo airstrip, slightly north between Sinak and Mulia. During that first meeting, some records caught the first author's attention: *Helcyra chionippe* C. Felder, 1860 (the first record for Papua seen by the author), some interesting Lycaenids including various *Hypochrysops* and *Candalides* species, an aberration or variety of *Hyantis hodeva* and two specimens of *Delias sinak*.
From 15 to 23 January 2013, the first author was a guest of the family at their new home in Mokndoma (E 137° 46.500'; S 3° 38,649') at 2180m, not far from Nggoduk river at Wigoduk (E 137° 6.963'; S 3° 38,242') at 1860m. During that week, collecting was carried out during the daytime and at night with the members of the family.
In this publication Mike Wild will describe the environment of Kidudumo, Mokndoma and Wigoduk, while Henk van Mastrigt, after some general comments, will focus on the *Delias* species of the area.

The environment of Kidudumo, Mokndoma and Wigoduk (by Mike Wild)

Introductory notes

The three areas of Kidudumo, Mokndoma, and Wigoduk all fall into the territory of the Wano tribe. The Wanos are a semi-nomadic people numbering less than 2000, but claiming a huge territory right in the heart of Papua.
The Wano people's territory is vast, and they live very spread out around its edges. The interior hinterlands are no longer inhabited. Their borders are well marked to the south, west and north by major rivers (the Yamo river [Rouffaer river] and the Yerei), which separate them from the Dem tribe to the South, the Moni tribe to the west, and the Edopi, Turu, Iao, and Duvle tribes to the north in the Lakes Plains region. The Wanos eastern border however is in a constant state of fluctuation, since the Wanos are in a constant land battle with the encroaching Western Dani. At the present, an approximate eastern most territorial boundary line can be drawn near the village of Mbinitmu to the north of Mulia. The line heads due north and intersects with Nggidueni, which is in the Kiage valley system east of Wanggiva. The borderline then cuts slightly to the northwest as it reaches past Acodi, ending at the sago swamps of the lakes planes region to the east of Dagai.
The three areas represented in this write up are at the southern most boundary of Wano land, with elevations ranging from 1600m up to nearly 2200m.

Kidudumo

At 1600m, Kidudumo has the lowest elevation of the three areas. The second author and his family lived at this location from 2007 until July 2012. It has the typical look and feel of a Papuan highland village. It is a Wano ancestral area, and

so there is a lot of pandanus, bread fruit, and betel nut trees off in the jungle, and around the houses. At Kidudumo there are three permanent Wano families living, and near their houses, the small trees and bushes are kept trimmed back. The soil is dark, and very fertile. Off into the jungle, around their houses in a circumference of approx. 60m, secondary growth is always encroaching on the hamlet site. Outwards to 250m beyond the secondary growth, the jungle is lush, but somewhat thinned out, since they clear out smaller trees, and underbrush for firewood and materials for building houses and gardens. Their gardens are out beyond that, and are roughly made and maintained. Beyond that, the jungle is pristine.

Collecting areas in this environment abound. There are three small rivers that come down in the proximity of Kidudumo. The largest named Padedai, which is 1.5m across, was a popular collecting site for Papilionidae and Pieridae. The wet ground covering, small pebbles and dirt on the main trail was a very popular site for collecting Lycaenids. Most Nymphalidae were collected around the dry brush and garden patches near our house.

In the Kidudumo area, *Delias* always tarry near a water source. In the near jungle on the Padedai, Dambera, and Amo' rivers, as mid morning light would filter through the canopy, the *Delias* would swirl down often in pairs, from the high foliage. Sometimes *Delias* could also be found on moist ground near a very small water source, just above our house site in the secondary growth jungle.

Mokndoma

At 2180m, Mokndoma is the highest location of the three areas. The second author and his family have lived at this location from July 2012 until present. This area is a high cloud forest, and vastly different from Kidudumo. In many places the ground is boggy with lots of moss and tannin stained streams and ponds. It is an almost mystical place featuring moss tunnels, bog grass, mountain rhododendrons, woody epiphytes, wild ginger and many shrubby small coniferous trees.

This is a newly developing area, and so the human population is low, and the wild life has yet to learn the fear of man. There is an airstrip project underway, and from mid morning to noon, Hesperiidae and Lycaenidae are plentiful on the airstrip site, along with many curious Odonata. Around the house site, (which sits on a knoll overlooking the airstrip) when the sun is out, Pieridae, particularly *Delias* are the most frequent visitors, along with an occasional *Ornithoptera priamus. Lycaenids,* especially the genera *Jamides, Udara,* and *Candalides* are also very common residents.

The *Delias* at Mokndoma usually show up in the very intense mid morning sunlight and stay until around noon. They often fly solitary, and are always in a hurry. Sometimes they can be seen grouped together and flying around certain smaller trees, but always out of reach of the net. Perhaps because of the high altitude, females are caught at this location in high numbers.

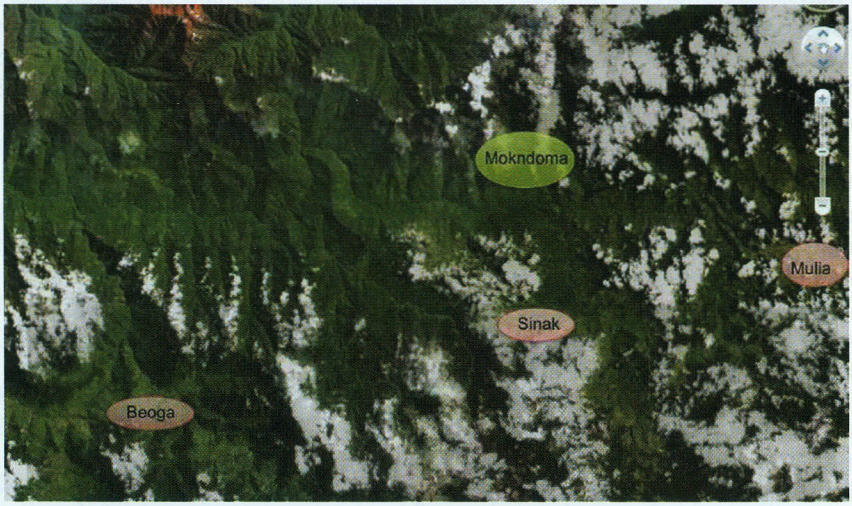
Wigoduk

Wigoduk is the name of a valley system to the North east of Mokndoma. It is about a 1 hour hike from our house site in Mokndoma. The collecting site at Wigoduk sits at 1860m right on the eastern bank of a wide bend in the Nggoduk river. The Nggoduk river is approximately 6-8m wide and most times only knee deep. In the Wigoduk valley, it meanders along, but upon exiting the valley, turns turbulent as it hurries down the mountain to the Yamo river at the bottom. The river banks are made of smooth rocks and pebbles, a superb site for collecting. Best collection results are observed between 9:00am and 1:00pm.

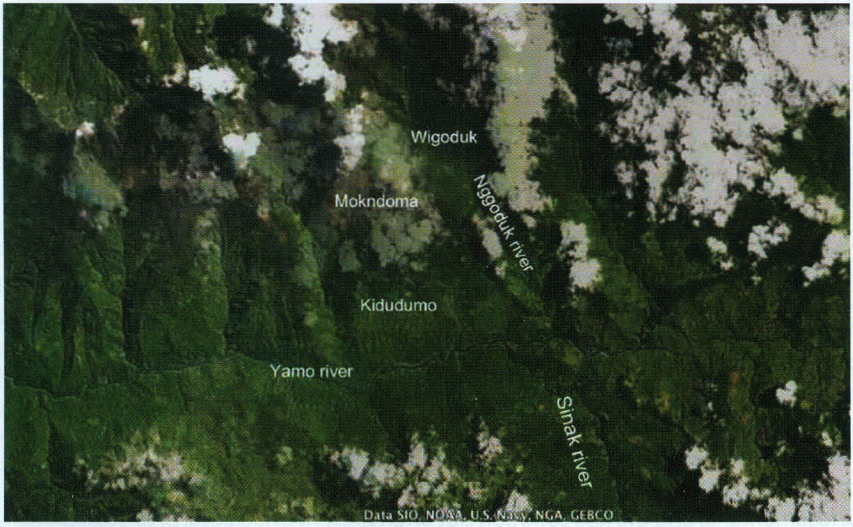
The sun beating down on baited rocks brings Lycaenids by the droves. This area is also very popular for *Graphium weiskei*, multiple species of *Delias*, and *Taenaris schoenbergi*, (including the albino form). We have also seen at times, majestic Phasmids traversing the river, and settling in the canopy beyond the reach of our nets!

Delias at Wigoduk are plentiful! They often are caught traveling up river, and are always flying low, close to the river. *D. sinak* are often captured right on the ground or while "kissing" the water. They seem to show up in later morning until around 1:00pm. Wigoduk is also the site in which we collected two females *D. cyclosticha*. They were each collected earlier in the day (approximately 9:30-10:00am).

Map 1. Papua with the Mokndoma area. (source: Google earth)



Map 2. Mokndoma area and its neighbour villages/towns. (source: Google earth)



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

Results (by Henk van Mastrigt)

Some general notes

Although the nocturnal collecting results at lights were not quantitatively extraordinary, a significant number of recorded species were new to the KSP, and some appear to be undescribed and new to science such as a *Macroglossum*, some Arctiinae (Erebidae) and an Agaristinae (Noctuidae). The record of male and female of *Spilosoma hampsoni* (Joicey & Talbot, 1916) is noteworthy.
Identification and description of new species among the moth fauna will take several years to complete.
Cicadas were also quite numerous. Our initial view is that four males collected represent different species, including a smaller one, and the two females collected are also distinct.
The diversity of Papilionoidea is quite reduced. Most of the species recorded at Kidudumo seem not to be present at Mokndoma and Wigoduk, probably due to the difference in altitude. The most exciting record is a white *Taenaris schoenbergi*-like Morphinae without a brown forewing band and without (or with only one) spots. Also interesting were records of some lycaenids, never seen before and not mentioned in Parsons (1999) or D'Abrera (1971, 1978, 1990). The presence of *Acraea meyeri* at nearly 2200m was surprising, as normally it is common only between 900 and 1400m.

Comments on *Delias*

During the week of 15-22 January 2013, thirteen species of *Delias* were recorded. On the 8th February 2013 two more species were caught, bringing the total to fifteen as follows:
D. sinak, D. microsticha, D. cyclosticha, D. hypomelas f. *clutus, D. aroae yabensis, D. pheres appoximata, D. antara, D. catisa, D. nais* f. *zebra, D. arabuana, D. virgo, D. isocharis, D. alepa, D. phippsi mulia,* and *D. neagra.*
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.
The Mokndoma-Wigoduk *Delias* fauna is notable for the absence of some elsewhere common species such as *Delias fascelis, D. toxopei, D. flavistriga, D. callista, D. leucias, D. rosamontana,* and the less common but often present *D. luctuosa, D. carstensziana,* and *D. klossi. Delias mulienses* and *D. rileyi* which are always encountered at Ilaga, were also not recorded.

Five species only (*sinak, microsticha, hypomelas, phippsi* and *aroae*) account for 75.04% of the total *Delias* population. This is not extraordinary however, among the five most common species in neighbouring localities are *niepelti* (± 20%), *flavistriga* (± 17%) and *pheres* (± 10%), two of which were not recorded at Wigoduk. In contrast, *sinak* (or *abrophora*) and *phippsi* are comparatively rare at other localities, never exceeding 10% of the total.

Delias sinak (figs 1-2)
D. sinak is a common species in the Sinak-Mulia area. The lack of records from Ilaga or other neighbouring districts, suggests that sinak is endemic in a restricted area between Sinak and Mulia.

Delias cyclosticha (figs 3-6)
This species was originally described by Roepke (1955) as *D. lecerfi cyclosticha* based on 12 males from the Rattan Camp (1200m) and one from the Sigi Camp (1350m) collected during the Archbold Expedition in 1938-1939 (which explored from the Mamberamo River to Mt Wilhelmina (now Gunung Trikora) in the central mountains). Parsons (1999) lifted *cyclosticha* to species level and mentioned three males from Telefomin (WSP), one collected by Straatman (RMNH), two by Parsons (IFTA), and a small series of males taken by W. Brandt (ANIC) at the nearby villages of Feramin and Eliptamin. In KSP *cyclosticha* is represented by a large number of males from various areas: Landikma and Sumbole (900m) 5 males, Pass Valley (900-1000m) 10 males, and 30 males from Okbibab in the Star Mountains, normally below 1600m.
Two males and two females from Wigoduk (1860m) and a male from Mokndoma (2180m) were surprising and notable records. Both locations are much higher than previous records of the species and Mokndoma at 137° 46.5' is a western extension of its known range. The previously unrecorded female is described below.

Delias aroae yabensis and ***D. pheres approximata***
D. aroae and *D. pheres* are sympatric in many mountainous areas of Papua. At lower altitudes (900-1600m) aroae is more common and pheres is rare; while at higher altitudes *pheres* predominates and *aroae* is rare. At Wigoduk (1860m) 9.24% of all *Delias* records were *aroae*, while only 5.04% were *pheres*, an unusual ratio at this altitude.

Delias antara
The species of the *eichhorni*-subgroup are never common but one or two species nearly always present in low numbers representing 1-5% of the total *Delias* population. The single record of *D. antara* and no records of *D. muliensis* from Mokndoma is poor in comparison with results from neighbouring areas.

Delias catisa
In general *Delias catisa* is a common species, abundant in the Baliem Valley and frequent in the Ilaga-Sinak-Mulia area. With only two specimens recorded from Wigaduk (0.84%). The frequency is much lower than nearby areas.

Delias arabuana (figs 7-8)
Delias arabuana occurs west of the Baliem Valley as far as the Kobowre Mountains. In this area its abundance is typically about 5-10% of the sampled *Delias* population and at Ilaga it is often over 10%. On the underside of hind wing the basal spot is anteriorly white and posteriorly red. In the KSP are several aberrant specimens with posteriorly orange and just one with posteriorly yellow basal spots, among the many specimens with red. These aberrant species were collected at Kanggime and in the Sinak-Mulia area.
Two specimens were recorded at Mokndoma, one with a posteriorly orange basal spot and one with a posteriorly yellow spot. The typical red-marked form has not yet been recorded from the locality.

Delias phippsi mulia (figs 9-12)
Delias phippsi mulia seems to be a common species in the Mulia-Sinak-Ilu area, although there are no records from Ilaga, and differs from *D. phippsi phippsi* and *D. phippsi wisseli* by its white basal strike on underside of hind wing which is posteriorly red, instead of without fill.
The population of Wigoduk and Mokndoma is quite variable on underside of hindwing. The disk is light yellowish to creamy (lighter than in the specimens from other localities), bordered by a black tornal patch which touches or slightly enters the discal cell, in this respect differing from specimens from other localities. A red fascia curved from the apex to above anal corner. However, in about $^1/_3$ of the specimens the red fascia is absent or vestigial in the black tornal area.

Descriptions

Delias cyclosticha female
(figs 3-5)

Material examined: 2 ♀♀: Puncak Jaya, Wigoduk, R. Nggoduk, E 137° 46.963' S 3 ° 38.242', 1860m, 16-23.I.2013, Mike Wild Fam., KSP.

Diagnosis:
The females differ from males by the larger black borders on the upperside of both wings and by the absence of the yellowish streak in the discal cell on the underside of the hind wing and the orange spots on the underside of hindwing.

Description:
Upperside forewing is dirty white, and clearly white along inner margin, caused by pattern on underside. Costa, subcostal vein and R_1 are black and connected with a black border, which inner edge is slightly curved from 4 mm outside discal cell until M_3, then fairly straight until CuA_2 were turning inwards to inner margin. One specimen bears three white subapical spots: the first one is vague, the second one less vague and the third one some larger and clear. The second specimen has no subapical spots. Upperside hindwing dirty white with black border getting broader from apex to M_1 than narrowing to tornus, which part in one species is quite undulate.
Underside of forewing brownish black with white area along inner margin getting slightly broader close to tornus and entering about 5 mm between inner part and border where diffused. Three yellow subapical spots followed by three submarginal spots, variable in size and shape, form an angle. Two other yellow spots outside discal cell along dc-bar, small and vague in first species, while larger and clear in second specimen. The yellow strike in discal cell (as present in all males) is lacking; only a few traces are visible in second specimen. Hindwing underside is dark brown (much darker than males) with a row of seven marginal spots from the middle of the costa to the tornus; the first one is elongate, all other more or less rounded; the first and second one are yellow, the others with reddish scales, looking orange. The yellow spot in the discal cell is very poorly developed; also the postmedian row with yellow spots is poorly developed and partly absent; only in CuA_1 an elongate yellow strike and in CuA_2 an elongate or shorter orange spot, only some yellow traces are left towards costa.
Length of forewing: 24-25 mm.

Discussion:
The underside of fore- and hindwing are not greyish brown as described by Roepke (1955) and as in all KSP-specimens, but dark brownish black. However this ground color is also present in the three males from the same locality and can therefore not be used as a character of the female. The absence of the yellow streak in the discal cell on the underside of forewing is also doubtful as characteristic feature for the females as this streak is shorter and much poorer developed at the three males from Wigoduk and Mokndoma, separating them from the males collected in other areas.
The orange marginal spots on the underside of hindwing is not restricted to the females of *cyclosticha*, some females of *D. microsticha* exhibit the same feature. Apart from the morphological differences, the altitude of this population (1820-2180m) distinguishes it from previously recorded populations of *cyclosticha* found between 900 and 1500m altitude. However, until more specimens from Wigoduk and Mokndoma and females from other localities are obtained, it is premature to treat this population as a new subspecies.

Delias phippsi mulia

(figs 9-12)

Material examined: 17 ♂♂: Puncak Jaya, Wigoduk, R. Nggoduk, E 137°46.963' S 3°38,242', 1860m, 16-23.I.2013, Mike Wild Fam., 9 ♂♂; idem, but 8.II.2013, 5 ♂♂; Puncak Jaya, Mokndoma, E 137°46.500'; S 3°38,649', 2180m, 15-23.I.2013, Wild Fam. + Henk v M, 1 ♂; idem, but 2-16.II.2013, Mike Wild Fam, 2 ♂♂, all in KSP.

Diagnosis:

The population of Wigoduk and Mokndoma differs from other localities on the underside of hindwing with a light yellowish to creamy discal area, bordered by a black tornal area, which touches or slightly enters the discal cell.

A red fascia, curved from the apex to above the anal corner, is present in all *phippsi*. However, in about 1/3 of the specimens from Wigoduk and Mokndoma this red fascia is absent or vestigial in the black tornal patch;

Description:

Upperside forewing white with narrow, black border, not entering discal cell. Black border along terman 9-11 mm; 4-6 mm at vein R_4, narrowing to termen and not reaching tornus, or just as a thin line. Upperside hindwing translucent white, pattern of underside clearly visible. A black border runs from M_1 to tornus, which is very irregular at inner edge, often quite undulate between veins M_2 and Cu_1b caused by a blackish diffusion. Underside of forewing with black border of same size as upperside, including two yellow subapical spots close to costal border. Underside hindwing with basal streak, anteriorly white and posteriorly crimson, surrounded by black. Lower half, from middle of anal margin, just touching discal cell to termen between vein M_1 and M_2. A crimson fascia turns from costa until above tornus, with at the outer side sometimes a very small white line. The apex is white; the disc mainly filled with light yellow or creamy, sometimes some darker, by a crimson streak separated from the anal area, filled with grayish blue, some black and golden yellow scales, same color as underside of thorax.

Varieties: Some (about 1/3) specimens completely lack the red fascia in the black patch. A significant number of intermediate forms were also recorded: some individuals have a very thin and partly absent red line others are further reduced to just a small red spot above the tornus.

Length of forewing: 24-28 (av. 26.7) mm.

Female: unknown

Discussion:

The population of *D. phippsi mulia* from Wigoduk and Mokndoma shows some gradual differences compared with specimens from the other localities. In general

the central part of underside hindwing is lighter however there are some exceptions. The form that lacks the red line in the black hindwing area is unique to this area and has not been found at other localities. However the presence of the transitional forms reduces the diagnostic value of this feature. In general females of *phippsi* are rare in collection and up untill now no females of *phippsi mulia* have been recorded.

General Discussion

The *Delias* species recorded at Wigoduk and Mokndoma include some interesting varieties when compared with the original type material and descriptions. The varieties found in a single area demonstrate the difficulties of delineating subspecies, and that NG montane *Delias* species should be perhaps be considered as varieties and populations rather than discreet subspecies.

The relative abundance of various species is curious. It is not clear why certain species which are common in surrounding localities, are very rare at Wigoduk and Mokndoma and equally why some species from this area are very rare or absent in other parts of the central mountain range.

More surveys are required to solve these interesting problems.

The population statistics will be more reliable if the Wild family continues to collect *Delias* for a year or more, as the frequency of some species may be seasonal or cyclical.

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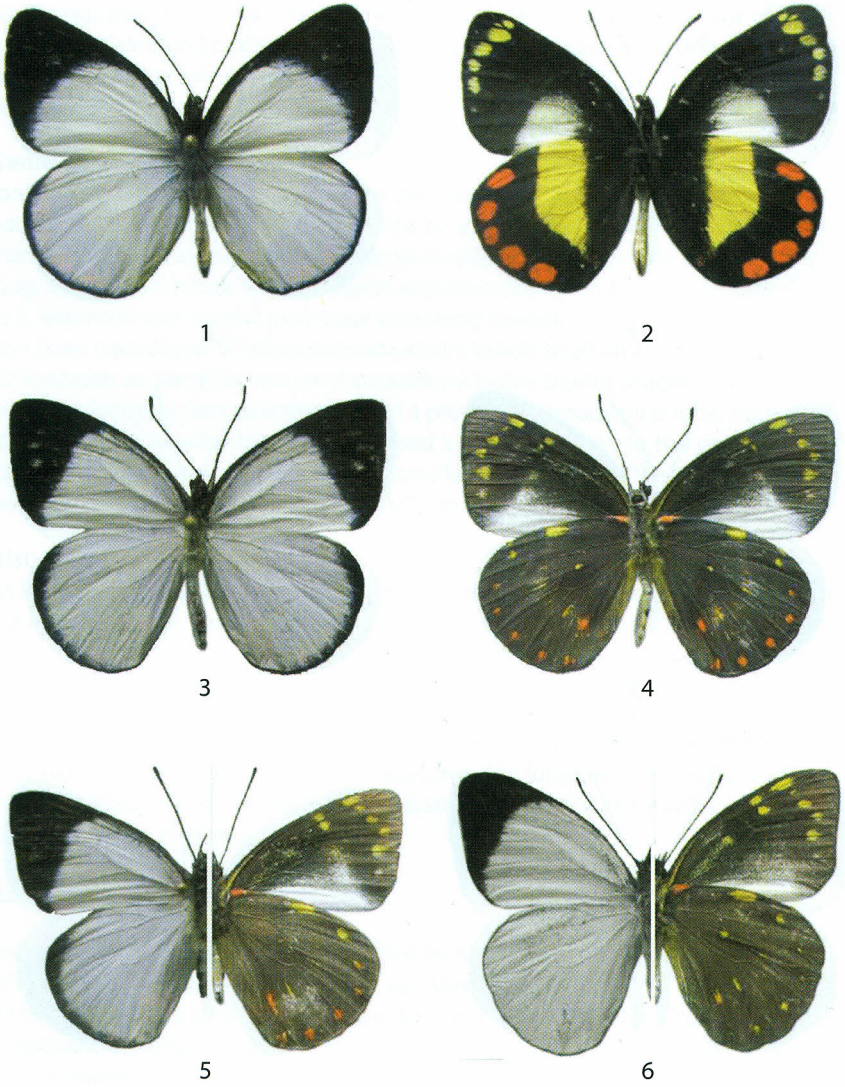
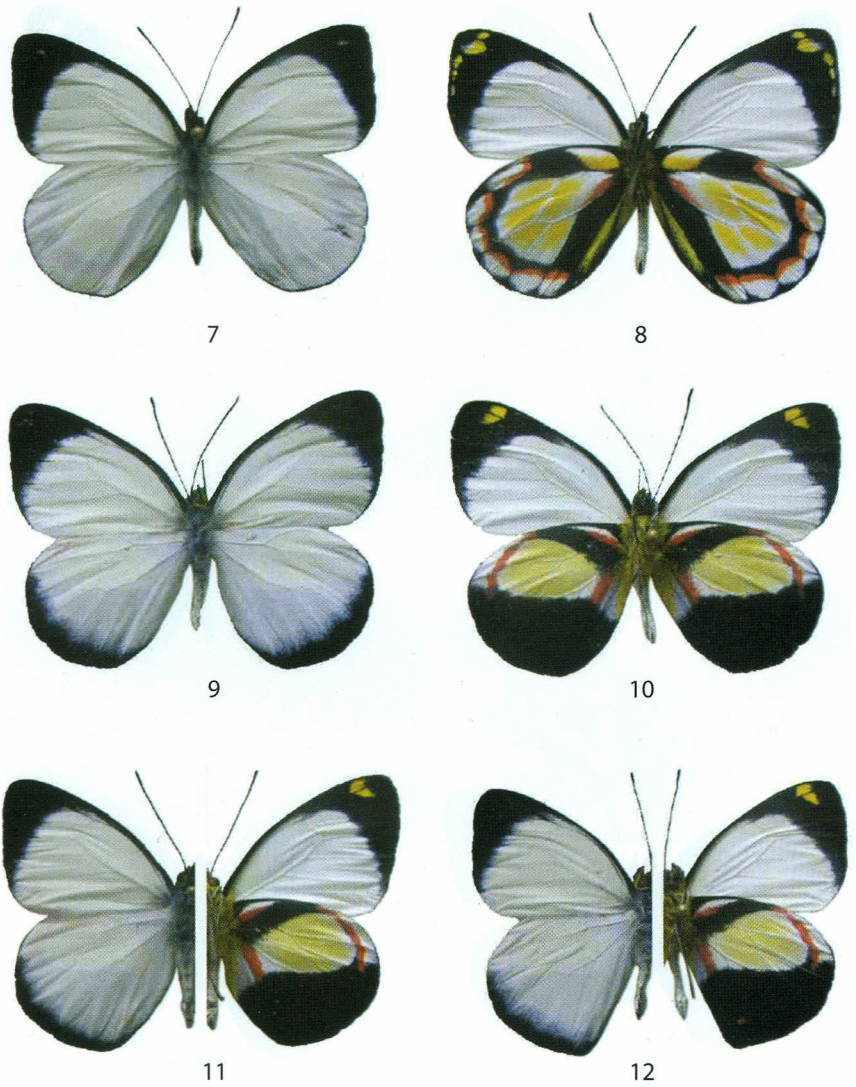


Figs 1-2. *Delias sinak* (KSP 65223): 1. upperside; 2. underside.
Figs 3-6. *Delias cyclosticha*:
3. upperside ♀; 4. underside ♀ (KSP 65197); 5. upperside/underside ♀ (KSP 65555);
6. upperside/underside ♂ (KSP 67358).



Figs 7-8. *Delias arabuana arabuana* form (KSP 65372).
Figs 9-12. *Delias phippsi mulia* form: 9. upperside; 10. underside (KSP 65206); 11. upperside/underside (KSP 65181); 12. upperside/underside (KSP 65208).

13 14

Figs 13-14. Upperside/underside *Delias phippsi mulia*:
13. (KSP 65367); 14. (KSP 65205).

Fig. 15. Collecting butterflies at Wigoduk river is not always an easy job.
(Photo: Mike Wild)