

A new subspecies of *Delias clathrata* Rothschild, 1904 and records of other *Delias* species occurring on Mount Hagen, Papua New Guinea (Lepidoptera: Pieridae, Pierinae)

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Abstract: A new subspecies of *Delias clathrata* Rothschild & Jordan, 1904 from the Mt Hagen area of central Papua New Guinea is described and illustrated, comparison is made with allied forms. The female of *Delias hagenensis* Morinaka, Van Mastrigt & Sibatani, 1993 is illustrated for the first time. The identity, occurrence and behavior of other *Delias* species found on Mt Hagen are discussed.

Rangkuman: Subspesies baru dari *Delias clathrata* Rothschild & Jordan, 1904 yang berasal dari Gunung Hagen, Papua New Guinea bagian tengah dideskripsikan dan diilustrasikan, perbandingan dibuat dengan bentuk bentuk yang bersekutu. Betina *Delias hagenensis* Morinaka, Van Mastrigt & Sibatani, 1993 diilustrasikan untuk pertama kali. Identitas, kehadiran dan tingkah laku spesies *Delias* lainnya yang ditemukan di Gunung Hagen juga didiskusikan.

Keywords: new subspecies, Pieridae, *Delias*, Mt Hagen, Papua New Guinea

Introduction

Some 132 species of the Pierine genus *Delias* Hübner, 1819, are currently recognized as occurring on the main island of New Guinea, the majority being found at mid montane levels between 1,000 and 3,000 meters altitude where, in suitable forested biotopes, ten or more species are often found in sympatry. To date, 20 species of the genus have been recorded from the Mt Hagen area (Appendix 1).

The Mt Hagen range, rising to a summit of 3,680 meters located 20 kilometers west of the town of the same name, is isolated to the east and north by the Wahgi and Baiyer River valleys and to the northwest by the Lai River valley, now densely populated and largely deforested.

Between 2014 and 2018, a series of visits to the Murmur Pass area on the southern slopes of Mt Hagen have confirmed the presence of previously recorded species and provided additional material of a distinctive new subspecies of *Delias clathrata*, described below, the previously unrecorded female of *Delias hagenensis*, and examples of *Delias hapalina*, a new species record for the area.

Abbreviations

ANIC	Australian National Insect Collection, Canberra, Australia
BT	collection of Bernard Turlin, Paris, France
CD	collection of Chris Davenport, Inverness, UK
IFTA	Insect Farming & Trading Agency, Papua New Guinea
NHMUK	Natural History Museum, London, UK
NG	collection of Nicolas Grimaldi, Kuala Lumpur, Malaysia
NMSUK	National Museum of Scotland, Edinburgh, UK
PS	collection of Philip Sawyer, Australia
KSP	Koleksi Serangga Papua, Waena, Indonesia
PNG	Papua New Guinea

Delias clathrata Rothschild, 1904

Delias clathrata Rothschild, 1904 was described from a series of both sexes collected by A.S. Meek in May 1903 at Owgarrá on the upper Aroa River in the Owen Stanley Mts, southeast Papua. A further subspecies, *Delias clathrata limata*, was described by Jordan, 1930 from 1 male and 6 females collected by A. F. Eichhorn at Edie Creek on the west side of the Herzog Mts (near the present-day town of Wau). It is distinguished from the nominate race on the hindwing underside by broader white lines along the veins and consequently smaller sized black submedian spots. Lectotypes and paralectotypes of both taxa were designated by Van Mastrigt (2000).

Following establishment of the PNG government sponsored Insect Farming and Trading Agency in 1978, examples of *D. clathrata* from other parts of Morobe and Simbu provinces in central PNG became widely available. The majority of these specimens originate from Kundiawa, Kerowagi and Gembogl, on the south slopes of Mt Wilhelm in Simbu province, and are identified as subspecies *limata* by Yagishita (2003) and Parsons (1998), however Van Mastrigt (2000) considered *clathrata* from Simbu to be the nominate race, so implying a discontinuous range surrounding that of *limata*. Post 2000, the IFTA began to receive specimens from local collectors around Gumine village in the southern part of Simbu Province. Males from this area are notable for having variable degrees of brown suffusion on the pale areas of the hindwing underside, a characteristic that is also present in occasional specimens from north Simbu and the Wau area.

West of the Wahgi Valley, *Delias clathrata* has been recorded from the Mt Hagen area and Wabag, Enga Province (Parsons, 1998) and Mt Tari (Lachlan, 2000) but not in the Star Mountains that straddle the PNG- Indonesia border. Further west in the Papua province of Indonesia, the closely-related species *Delias neeltje* Gerrits & Van Mastrigt, 1993 is restricted to a small area of the central mountain range near the settlements of Ilu, Mulia and Sinak.

Parsons (1998) notes that “the *clathrata* from Welya, Hagen Range (WHP) likely represents an unnamed race of the species ... and may yet be found to represent a distinct species closely related to *clathrata*.” The male specimen illustrated by Parsons, collected by Don Jeffers at Welya, Hagen Range, 2,450m on the 17th June 1969, is held in the Department of Primary Industry (DPI) collection at Konedobu, Port Moresby. Parsons also mentions the presence of a further specimen in the NHMUK, “collected by Philip Sawyer at Wabag, Enga Province, 2,450m altitude in July 1978”. No specimen with this data is currently held in the NHMUK collection

however a male labeled “*D. clathrata* ? V: Papua New Guinea, Pap Ck., Hagen Ra., 2800m., 12.XI.1973” remains in the private collection of Philip Sawyer, Queensland, Australia and may be the specimen referred to by Parsons.

***Delias clathrata parsonsi* subsp. nov.** (Figs 1-4)

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Holotype: ♂ NMSUK, Papua New Guinea, Enga Province, Mt Hagen, Maropi Creek, 2550m, 22.12.2016, N. Grimaldi.

Paratypes: (7 ♂♂, 3 ♀♀) 1♂ NG, Mt Hagen, Maropi Creek, 2550m, 24.12.2016; 1♂ CD, Mt Hagen Maropi Creek, 2550m, 24.12.2016; 1♂ OP, Mt Hagen, Maropi Creek, 2550m, 24.12.2016; 1♂ NG, Mt Hagen, Pap Creek, 2650m, 24.12.2016; 1♂ NG, Mt Hagen, Kumul Lodge, 2850m, 26.12.2016; 1♂ NG, Mt Hagen, Maropi Creek, 2550m, 07.09.2017; 1♂ PS, Pap Ck, Hagen Ra. 2800m, 12.xi.1973; 1♀ NG, Mt Hagen, Maropi Creek, 2550m, 24.12.2016; 2♀♀ NG, Mt Hagen, Maropi Creek, 2550m, 08.09.2017.

Diagnosis: The subspecies is distinguished from previously described races of *clathrata* by the grey brown coloration of the pale areas, the narrow vein markings and smaller yellow basal spot on the hindwing underside.

Description: Male (Figs 1-2) Wingspan 55mm, forewing length 30mm. Upperside: forewing ground color white, black costal border partly absorbing black discocellular bar, black border along termen widening toward apex, indented on inner edge at cubital veins, 3 creamy-white subapical spots. Upperside of hindwing is white with a thin black terminal border.

Underside: forewing white with black costal and terminal borders narrower than in the nominate subspecies, discal cell incompletely filled with black, connected to termen on vein R3. Three orange-yellow subapical spots and two smaller terminal spots. Underside of hindwing: pale grey-brown with a triangular black sub-basal area from costa toward top of inner margin, crossing discal cell at sub-basal level and including a yellow basal spot that is anteriorly white and divided from the costal margin by a pale streak. Median area dark grey to sepia, divided by narrow, pale grey vein markings. The size and shade of the median patch is variable and more diffuse in flight-worn individuals. Black postmedian spot in space M2-M3 that interrupts the pale marking of vein M2 in approximately 50% of individuals. Terminal area pale grey, variable in width, shading to white at tornus in some specimens. Anal area with yellow and black scaling. Female (Fig 4) Wingspan 50mm, forewing length 28mm. Upperside: forewing ground color white, black costal border partly absorbing broad black dc bar. Black border along termen narrower and less serrated than in the nominate subspecies, widening toward apex, inner edge dusted with grey, three creamy-white subapical spots. Hindwing white with narrower black terminal border than the nominate.

Underside: forewing white with black costal and terminal borders, discal cell incompletely filled with black extending to the termen on vein R3. Three orange-yellow subapical spots and 2 smaller terminal spots. Underside of hindwing is pale coffee-brown with triangular black subbasal area and yellow basal spot as in the male. Median area dark sepia brown, wider and

more diffused than in other races and divided by narrower vein markings. Black median spot in space M2-M3. Anal area with more pronounced yellow scaling than male.

Distribution: Mt Hagen, Western Highland Province, Papua New Guinea. Records of the species from the Wabag, Enga Province and Tari, Southern Highlands Province require confirmation.

Etymology: The subspecies is named after Michael Parsons who first mentioned and illustrated the new taxon in his seminal work 'The Butterflies of Papua New Guinea. Their Systematics and Biology' (Parsons, 1998).

Discussion: The population of *D. clathrata* on Mt Wilhelm exhibits a variety of phenotypes that intergrade between the nominate subspecies and ssp *limata* from Wau. These suggest that *limata* should be considered a synonym of the nominate subspecies.

The population from Gumine in south Simbu province also has a variable phenotype, the hindwing base colour ranging from white to coffee brown. The darkest of these resemble ssp. nov. *parsonsi* but are distinguished on the hindwing underside by the grey colour and elongated shape of the hindwing basal streak, more sharply defined median patch and broader white vein markings. The female has not been recorded and the identity of the population remains uncertain. Though less than 40km from Mt Wilhelm, Gumine is situated at the eastern extreme of the Kubor Range that extends westward to the Mt Hagen massif, and may therefore be a hybrid zone.

***Delias* species on Mt Hagen**

The Murrumbidgee Pass on the southwest slope of Mt Hagen has been visited periodically by the authors between 2014 and 2017, generally during the local wet season from November to January and once during a drier period in August 2017.

Surveys were carried out at four locations:

1. forest edge beside the access road to Kumul Lodge guest house, at 2850m altitude
2. forest edge with flowering tree beside an agricultural clearing, 2830m altitude
3. Maropi Creek, Kui Pangji, a narrow stream bed at 2550m - 2650m altitude that crosses the Highlands Highway road 2 kilometers uphill from the well-known Pap Creek collecting location.
4. Aiyamp Creek near Angi village, a stream bed at 2,200m altitude.

Locations 1 and 2 are near the highest point of the Murrumbidgee Pass, approximately 2km south of the main summit of Mt Hagen. In this zone, *Delias* are numerically the most abundant of the diurnal Lepidoptera and approximately 50% of the individuals observed were females, in contrast with the predominance of males recorded at lower altitude, water-side locations.

At location 2, both sexes of *D. hallstromi*, *D. hagenensis* and *D. gilliardi* habitually congregated on a 15 meter high flowering tree of the genus *Acacia* with inconspicuous yellow tufted flower heads. Females were also attracted to a white-flowered orchid *Dendrobium bracteosum*, a red orchid *Dendrobium cuthbertsonii* and to the orange-flowered ornamental shrub, *Datura sp.*, commonly planted near human settlements. Males were less attracted to flowers and generally rested on high branches where they display territorial behavior, flying off to challenge intruding males in spiraling aerial fights.

Despite aposematic coloration and assumed toxicity, predation of *Delias* adults by Papuan Swiftlets, *Aerodramus papuensis*, was frequently observed around the flowering tree.

During the wet season, from November to January, adults were active only during intermittent periods of sunshine, usually between 8am and 1pm when clouds accumulated over the area. On occasional days of continuous sunshine in August, significantly more adults were observed.

At the lower-altitude creek-side locations 3 & 4, male specimens were predominant. During intermittent periods of sunlight, the majority of individuals were seen to follow well-defined flight corridors between the tall trees flanking the stream, pausing frequently on gravel banks to imbibe fluids. Movement in both directions, both uphill and downhill, was observed.

Records of note include:

***Delias hagenensis* Morinaka, Van Mastrigt & Sibatani, 1993** (Figs 17-18)

Delias hagenensis was described from material collected at Pap Creek, Walya, 3000m in August 1973 and has since been recorded from Mt Hagen, Laiagam and Porgera (Parsons, 1998) and Tari (Lachlan, 2000). On Mt Hagen it is a common species however until now the female has not been recorded or illustrated in a publication.

Description of female: Broadly similar to male but distinguished on the upperside forewing by the suffusion of grey scales in the basal area and beyond the discocellular vein, (uniformly black in the male), and more prominent white subapical spots. The basal area of the hindwing has a slightly blue tinge in fresh specimens and contains yellow streaks at the costal and anal border. On the underside, the forewing discocellular bar is broader than in males and the white subapical spots are larger, particularly in space $M_1 - M_2$.

***Delias hallstromi* Sanford & Bennett, 1955** (Figs 19-22)

Delias hallstromi is a common species in central PNG however the female is rarely encountered. Parsons (1998) illustrates a specimen in the ANIC from Marifunga in the Eastern Highlands. On Mt Hagen, females were frequently seen at locations 1 and 2 feeding on flowering plants. Individual variation is seen in the width of the discocellular bar on the forewing underside and the extent of white markings on the forewing upperside.

***Delias gilliardi* Sanford & Bennett, 1955** (Figs 23-24)

This species is commonly found in sympatry with *D. hallstromi* at elevations between 2,500 – 3,000 meters in central PNG. The female has rarely been collected and is not illustrated by Parsons (1998) or Yagishita (1993). It is distinguished from the male by a paler yellow ground colour and more diffused black margins on the upperside wings, and by orange coloration on the underside of the abdomen.

***Delias mira roepkei* Sanford & Bennett, 1955 stat. rev.** (Figs 25-28)

The type locality of *Delias mira roepkei* Sanford & Bennett, 1955 is Mt Hagen. The taxon was raised to species level by Van Mastrigt (2000) who mentioned the presence of two forms in the Hagen population; one with broad black borders on the upperside, the other with narrower borders and paler yellow hindwing patch on the underside that he speculated might represent a separate species. Males collected at the Murmur Pass locations exhibit a continuum of

individual variations in the upperside border depth and underside hindwing markings and are not readily dividable into two separate groups.

Specimens from Mt Wilhelm (Simbu Province) and the Eastern Highlands are also variable and, on average, have a more peach-colored anal patch on the hindwing underside.

Van Mastrigt's decision to elevate *roepkei* to species level was based by the supposed sympatry of both *roepkei* and *mira* in parts of the Owen Stanley Mountains. Pending genetic analysis, the original taxonomy is adopted in this paper.

Among a number of typically white coloured females, two individuals with yellow-colored uppersides have been recorded. (Figs 28-29). Similar yellow female forms have been recorded in a number of species of the *D. iltis*, *D. aroae* and *D. eichorni* groups.

***Delias hapalina* Jordan, 1930** (Figs 29-30)

A new record for the Mt Hagen area. The species is widespread though less common in PNG than in Indonesian Papua and has previously been recorded from Mt Wilhelm and Tari (ssp. *kerowagiensis* Yagishita, 1993), the Owen Stanley Mts (ssp. *owenstanleyi* Schröder & Treadaway, 1994) the west Bismark Mts and Porgera in Enga province (CD).

Male specimens from Mt Hagen are distinguishable from topotypical *kerowagiensis* by the narrower black median bands on the hindwing underside and from the Bismark and Porgera populations which lack red median bands on the hindwing. The identity and distribution of potential subspecies of *D. hapalina* in PNG will be reviewed after comparative study of these populations.

***Delias leucias leucias* Jordan, 1912** (Figs 9-16)

The subspecific identity of *D. leucias* from the central mountains of Papua New Guinea has a confusing history, having been assigned to the nominate race (type locality: Mt Goliath) by D'Abbrera (1978), and subsequently to subspecies *huonensis* by later authors such as Parsons (1998), Yagishita et al. (1993) and Van Mastrigt (2003). Lachlan (2000) reports collection of *Delias leucias leucias* at Ok Tedi, Western Province and *D. leucias huonensis* at Tari, Southern Highlands. Gotts & Ginn (2004) described a new subspecies, *D. leucias torini*, from the Snow Mts, west of the nominate range, and discussed variation in *D. leucias* across New Guinea, mentioning the differences between the Kerowagi (Mt Wilhelm) population and the nominate subspecies from the Star Mountains. They considered the taxon *D. weiskei sayuriae* Okano, 1989, recorded only from Mt Wilhelm, to be a variation of *leucias* rather than a subspecies of *D. weiskei* Ribbe, 1900.

D. leucias huonensis Talbot, 1928 was described from a single male collected by Keysser in the isolated Rawlinson Mountains on the Huon peninsula in north east New Guinea. The race remains rare in collections and apparently in nature; William Brandt did not record the species during his expedition to the Rawlinson Mts in 1968.

Specimens from Mt Hagen are similar to those from Mt Wilhelm & the Eastern Highlands, both can be distinguished *in the majority of individuals* from the nominate subspecies - by the complete separation of the pale hindwing patch from the white costal border by the red and black subapical bands, and a more orange coloration of the forewing underside - and from ssp

huonensis by the narrower black margins on the both surfaces and the more elongated hind wing patch. Although these characters are consistent in the majority of specimens from central PNG, populations of the nominate race from various locations within Indonesian Papua show clinal development of the same features on a west - east axis. *Delias leucias* from central PNG is considered to represent a recognizable geographic form of the nominate subspecies.

***Delias callista* Jordan, 1930** (Figs 31-32)

The type locality of *D. callista porquaiensis* Yagishita, 2003 is stated to be 'Porquia, PNG' however no such place name is gazetted in PNG and it is assumed that it is a misspelling of Porgera, the site of a large gold mine in western Enga Province, approximately 80km west of Mt Hagen. Male specimens from Porgera and the Ok Tedi area agree with the original description of *porquaiensis* and are characterized by rich yellow coloration, broad black submarginal bands and triangular shaped black terminal vein markings on the hindwing underside.

Males of *D. callista* from Mt Hagen consistently differ from this phenotype by having a paler shade of yellow on the hindwing underside, narrow subterminal bands and terminal vein markings. A similar form has been recorded from Gumine (IFTA). Females from Mt Hagen have a series of 5 white apical spots on the forewing upperside and 4 – 5 white subterminal spots on the hindwing that are absent or poorly developed in more western areas. The taxonomic status of *D. callista* populations in PNG and western Papua is uncertain and will be reviewed in a further publication.

***Delias carstenziana inexpecta* Morinaka & Nakazawa, 1999**

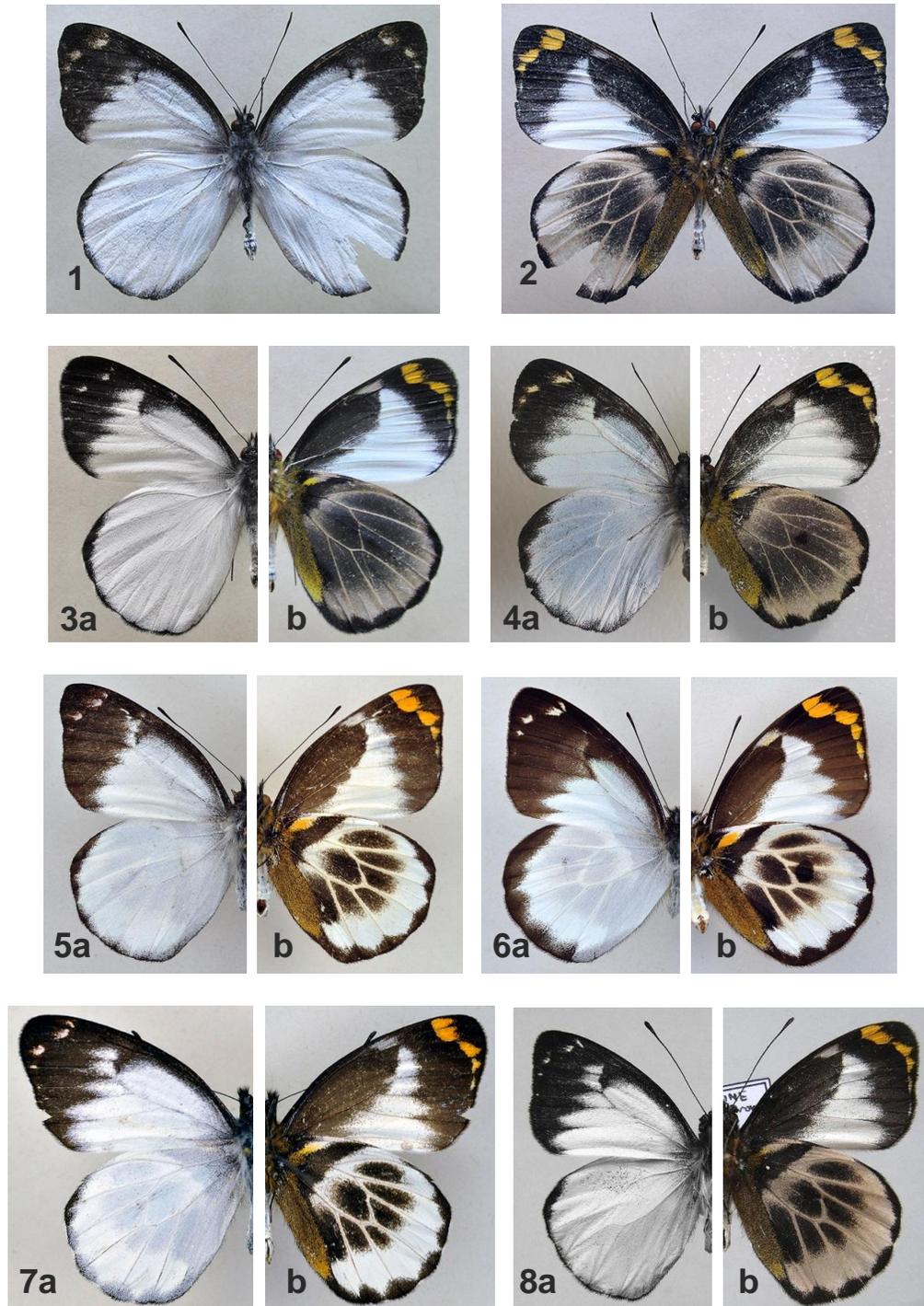
The presence of this species in close proximity to, but at lower altitude than, its sister species *D. gilliardi*, is of interest. A single male was recorded by a local collector at Aiyamp creek, on the lower western slopes of the Mt Hagen massif. The holotype and other specimens were collected by Phil Saywer in July 1975 at 'Poketamanda' = Mt Nose, near Wabag, Enga Province, approximately 30km west of Mt Hagen.

Acknowledgements

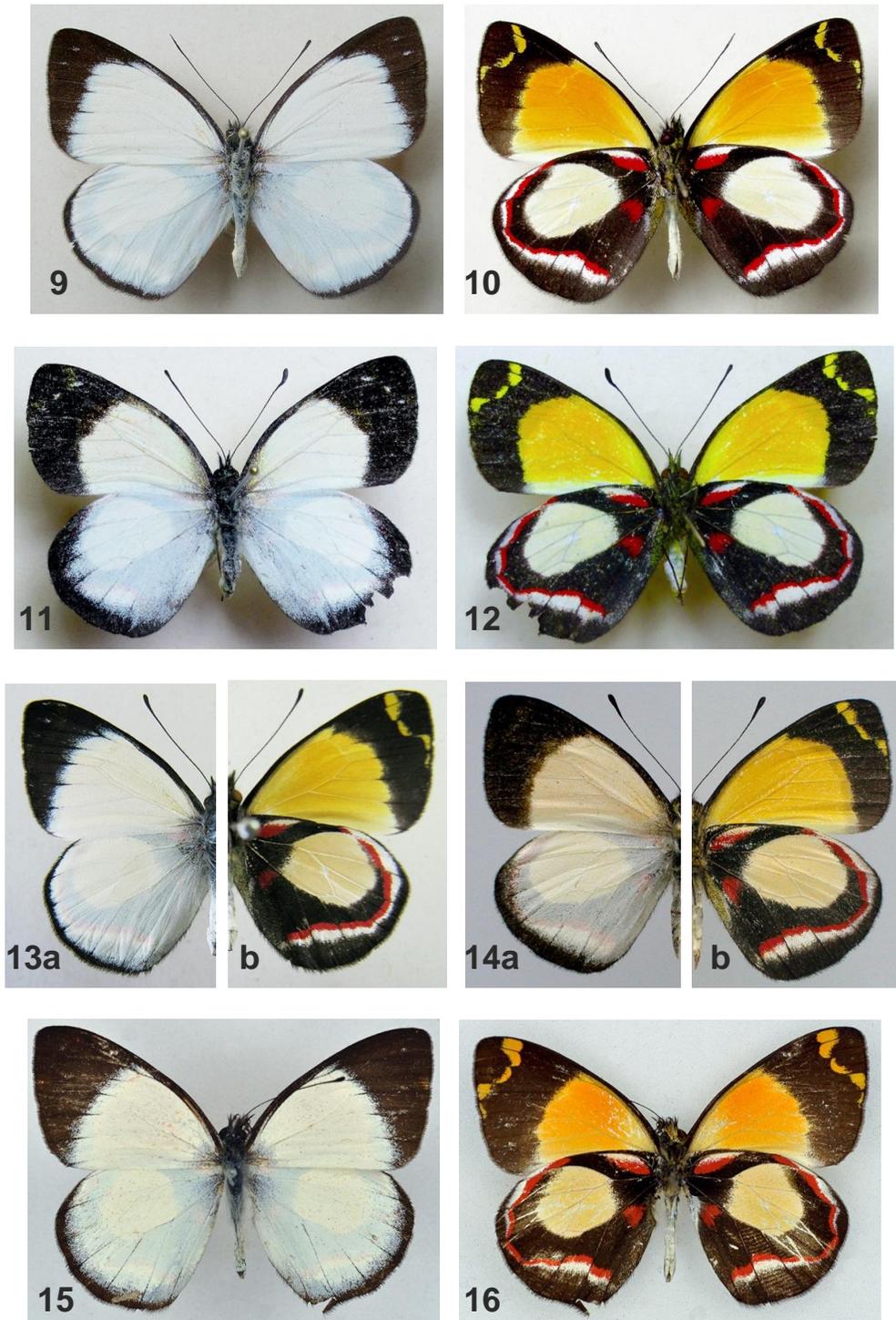
The authors are grateful to the owners and staff at Kumul Lodge, Mt Hagen and to local land-owners, particularly Max Mall, for guidance and assistance with field work. We acknowledge and thank Blanca Huertas at the NHMUK for assistance in locating specimens, Olivier Pequin for critical comment and photographs, Steve Woodhouse for plant identification and Bernard Turlin for permission to reproduce photographs of material in his collection. All NHMUK specimen photographs are copyright of the Trustees of the Natural History Museum London and are reproduced with permission. We thank Mrs. Daawia Suhartawan for the Indonesian translation of the "Rangkuman".

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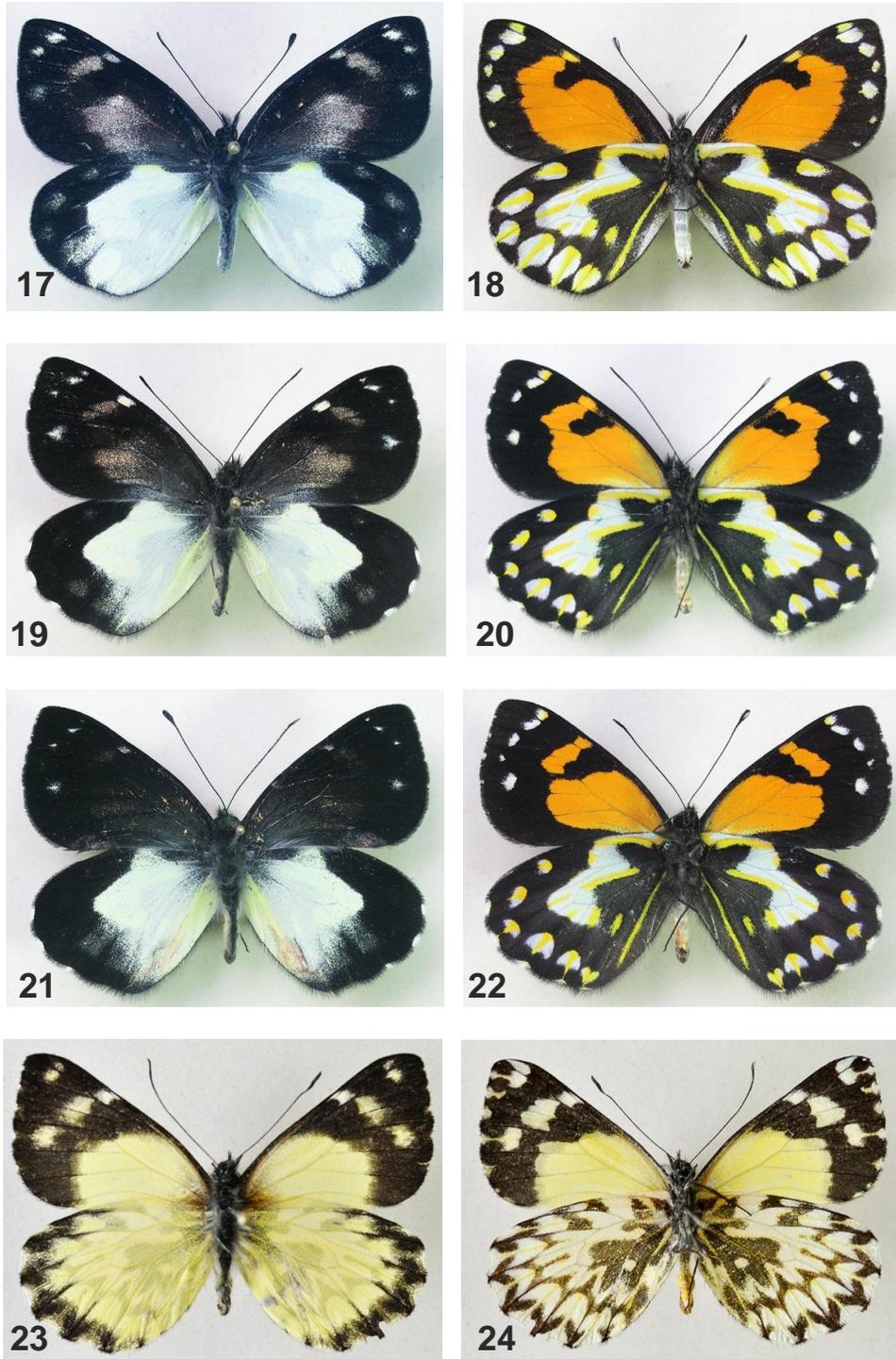


Figs 1-4. *Delias clathrata parsonsi* subsp. nov. 1. ♂ holotype, PNG, Mt Hagen, Murrumbidgee Pass, 2850m (NHMUK), dorso; 2. Idem, verso; 3. ♂ paratype, PNG, Mt Hagen (CD), a. dorso, b. verso; 4. ♀ paratype, PNG, Mt Hagen (NG), dorso, b. verso.
Figs 5-8. *Delias clathrata clathrata* Rothschild, 1904. 5. ♂, PNG, Owingarra (NHMUK), a. dorso, b. verso; 6. ♀, PNG, Owingarra (NHMUK), a. dorso, b. verso; 7. ♂ lectotype *limata* Jordan, 1930, PNG, Herzog Mts (NHMUK), a. dorso, b. verso; 8. ♂, PNG, Gumine, Simbu Province (BT), a. dorso, b. verso.



Figs 9-14. *Delias leucias leucias* Jordan, 1912. **9.** ♂, PNG, Mt Hagen, Pap Creek, 2500m (CD), dorso; **10.** Idem, verso; **11.** ♀, PNG, Mt Hagen, Murrur Pass, 2850m (CD), dorso; **12.** Idem, verso; **13.** ♂, Indonesia, Papua, Star Mts, Ok Tedi (CD), **a.** dorso, **b.** verso; **14.** ♀, Indonesia, Papua, Ilu (KSP), **a.** dorso, **b.** verso.

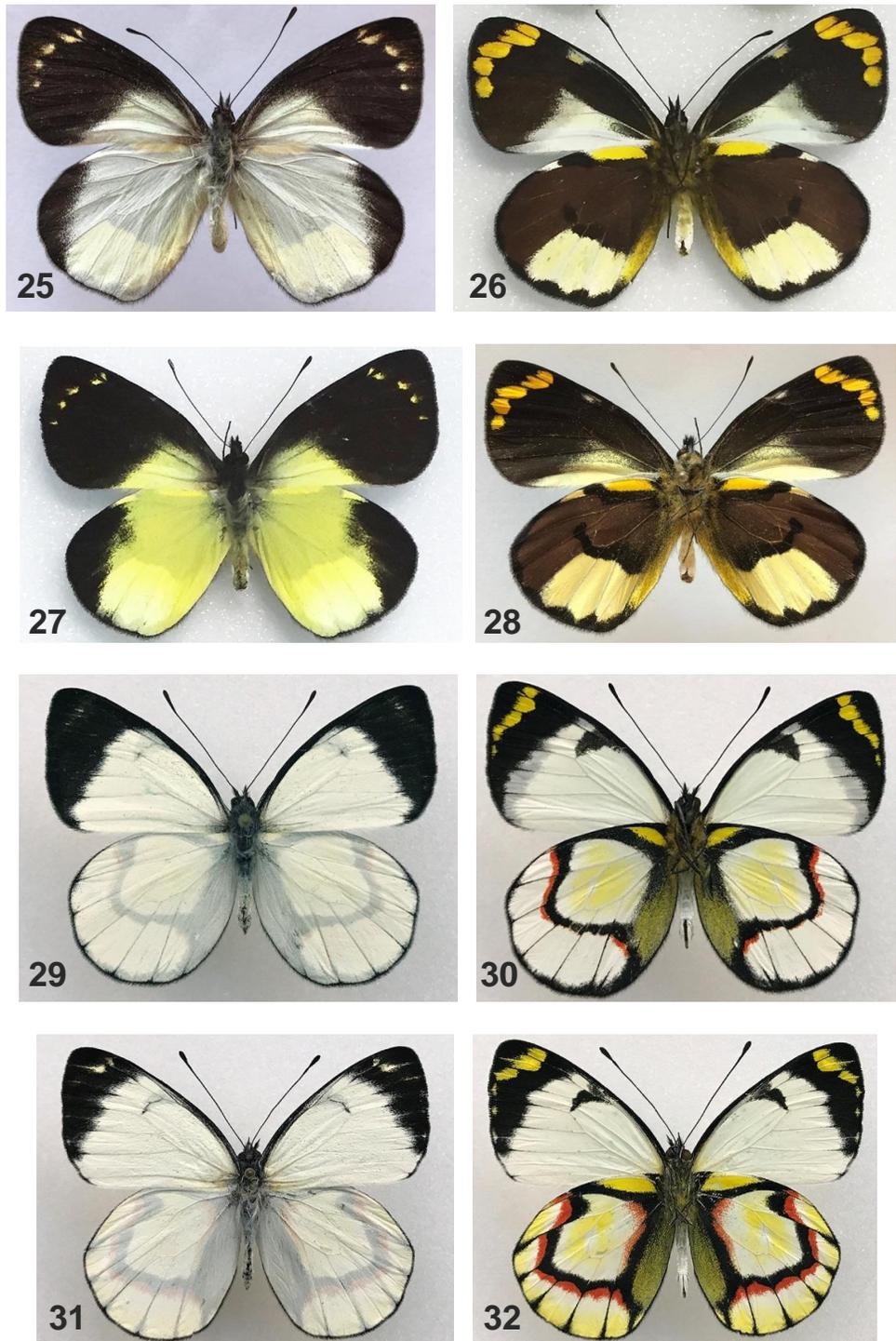
Figs 15-16. *Delias leucias huonensis* Talbot, 1928. **15.** ♂ holotype, PNG, Rawlinson Mts (NHMUK), dorso; **16.** Idem, verso.



Figs 17-18. *Delias hagenensis* Morinaka, Van Mastrigt & Sibatani, 1993. 17. ♀, PNG, Mt Hagen, 2850m (CD), dorso; 18. Idem, verso.

Figs 19-22. *Delias hallstromi* Sanford & Bennett, 1955. 19. ♀, PNG, Mt Hagen, 2850m (CD), dorso; 20. Idem, verso; 21. ♀ dark form, PNG, Mt Hagen (CD), dorso; 22. Idem, verso.

Figs 23-24. *Delias gilliardi* Sanford & Bennett, 1955. 23. ♀, PNG, Mt Hagen, 2850m (CD), dorso; 24. Idem, verso.



Figs 25-28. *Delias mira roepkei* Sanford & Bennett, 1955. **25.** ♀ typical form, PNG, Mt Hagen, Murmur Pass (NG), dorso; **26.** Idem, verso; **27.** ♀ yellow form, PNG, Mt Hagen, Murmur Pass (NG), dorso; **28.** Idem, verso.

Figs 29-30. *Delias hapalina* ssp. **29.** ♂, PNG, Mt Hagen, Murmur Pass (NG), dorso; **30.** Idem, verso.

Figs 31-32. *Delias callista* ssp. **31.** ♂, PNG, Mt Hagen, Murmur Pass (NG), dorso; **32.** Idem, verso.



Fig. 33. Mt Hagen summit from Murmur Pass (photo: Chris Davenport)



Fig. 34. *Delias hallstromi* female feeding on *Datura* (photo: Nicolas Grimaldi)



Fig. 35. *Delias hagenensis* female resting on vehicle (photo: Nicolas Grimaldi)



Fig. 36. Flowering tree, *Acacia* spec. (photo: N. Grimaldi)

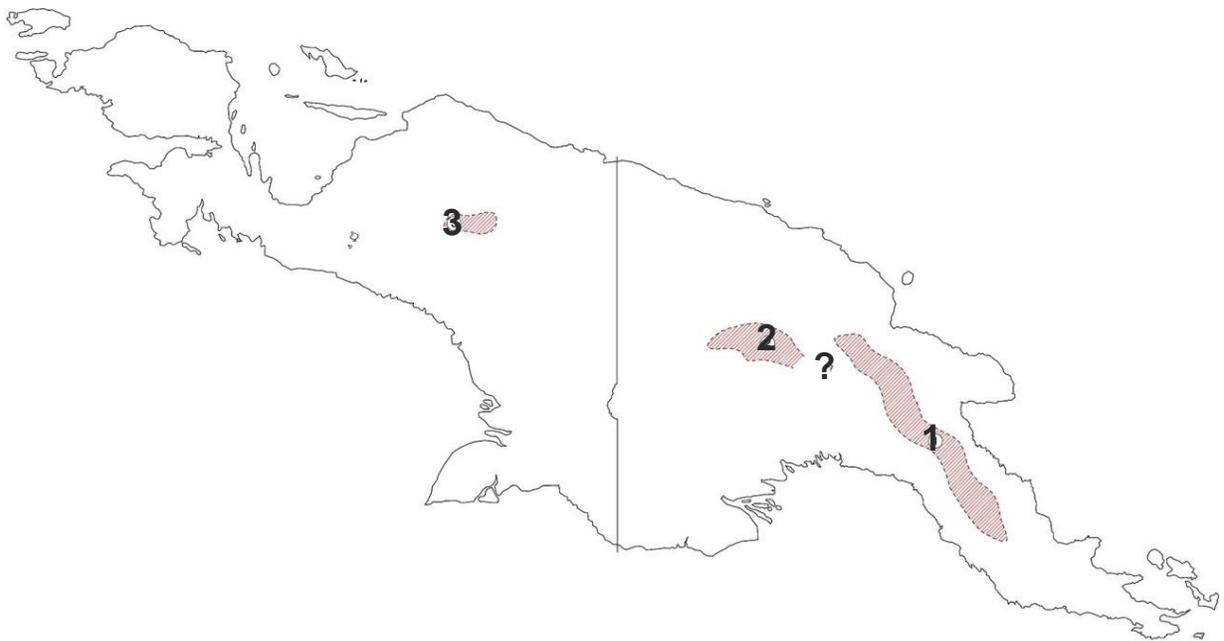


Fig. 37. Range map of *Delias clathrata*. 1. *Delias clathrata clathrata*, 2. *D. clathrata parsonsi*, 3. *D. neeltje*.

Appendix 1***Delias* species recorded on Mt Hagen.**

December 2014 – April 2018

Location	1. (2850m)	2. (2830m)	3. (2550m)	4. (2200m)
<i>isocharis isocharis</i>		X	X	X
<i>microsticha microsticha</i>		X	X	
<i>hypomelas hypomelas</i>		X	X	
<i>aroe</i>		X	X	
<i>flavissima</i>		X		
<i>gilliardi</i>	X	X	X	
<i>hallstromi</i>	X	X	X	
<i>hagenensis</i>	X	X	X	
<i>meeki neagra</i>	X	X	X	X
<i>nais keysseri</i>		X	X	
<i>luctuosa mizukamii</i>	X	X	X	
<i>callista ssp.</i>		X	X	
<i>iltis leucotera</i>	X	X	X	X
<i>hapalina ssp.</i>			X	X
<i>mira roepkei</i>	X	X	X	
<i>leucias leucias</i>		X	X	
<i>clathrata parsonsi</i>	X	X	X	
<i>carstenziana inexpecta</i>				X
<i>ladas ladas</i>				X
<i>campbelli dentatus</i>	Tsak valley, southwest of Mt Hagen, c. 2,200m			