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THE BUTTERFLIES OF THE TONGA ISLANDS AND NIUE, COOK ISLANDS, WITH THE DESCRIPTIONS OF TWO NEW SUBSPECIES

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ABSTRACT. The butterfly fauna of the Tonga Islands and Niue, Cook Islands, and their taxonomic relationships are reviewed in light of recent collections with five new records. Two new subspecies, *Jamides carissima thomasi* and *Catochrysops taitensis hopkinsi,* are described and the status of *Catochrysops lithargyrea pepe* Hopkins is revised. Based on the current biogeographic evidence, the interrelationships of the Tongan and Niue butterfly fauna with other insular and continental faunas are explored.

INTRODUCTION

Tonga is an independent country comprised of a north-south series of island groups that are situated along the International Date Line in the eastern Pacific (Figure 1). Quite isolated from the major Pacific insular groups, these islands lie geographically northeast of New Zealand and slightly southeast of Fiji. The Tonga Islands are approximately 699 km² and are situated just west of the Tonga Trench, which is more than 10,000 m deep and about 1,000 km long and is a very active site of sea-floor spreading (Windley 1984: 263).

Geologically, this typical volcanic island arc probably dates from early Tertiary, and there apparently was some structural continuity between Fiji, the Samoas, the Kermadecs and the Tongas until the mid-Tertiary (Holloway 1984; Vane-Wright 1990) with the opening of the South Fiji basin and displacement of the Lau-Tonga ridge eastwards. These islands naturally cluster into four distinct groups from north to south: the northern Vava'u group, the central Ha'apai, Nomuka, and the southern Togatabu, most frequently called 'Tongatapu' group (Hopkins 1927:1). Each of these island groups represent a localized topographic summit along the Tonga Ridge and each is separated by major WNW and ESE faults.

Niue, in the Cook Islands, is a young (Pliocene) island lying on the opposite (east) side of the Tonga Trench and remote from the young volcanic islands of Rarotonga, Tahiti, Hawaii, *etc.* (Paulay and Spencer, in press). Its physical proximity to the Tongas makes a comparison of the two faunas interesting. Niue is a protectorate of New Zealand which lies to the east of the Tonga Trench. The Cook Islands which lie further to the east are volcanics, Tertiary in age (Shields, 1976; Wood & Hay 1970; Paulay, pers. comm.).

This suggests a similar time frame of isolation to that shown for the West Indies, and the faunal diversity of the Tongas and their neighbors is comparable to that shown in the West Indies (L. and J. Miller 1989). The endemicity of the Tongas is also roughly the same as that shown in some of the West Indian islands, but only at the subspecific

level; there are no endemic species, though there are a few New Caledonian and Fijian endemics.

The lepidopteran fauna of the Tonga group of islands is very poorly known. Perhaps because they are so remote, the islands are not even discussed in the recent works of D'Abrera (1971, 1978). However, where appropriate, other authors have considered the Tongas in discussions of other island faunas (Ackery and Vane-Wright 1984; Holloway 1979, 1984; Hopkins 1927). The Tongan Lepidoptera fauna, in fact, is most closely allied to that of Fiji and the Samoas, and, to a lesser degree, New Caledonia (Holloway 1979: 212). Holloway commented further that the Tongan fauna is obviously more recent with more than three-fourths of the species comprised of "widespread elements."

The history of observations and collecting of Lepidoptera on islands of the Tonga group is summarized in Table 1. Sir Joseph Banks and Daniel Solander accompanied Captain Cook on his voyage around the world, stopped briefly at Togatabu in 1770, and collected the specimens that serve as the types of *Junonia villida* (Fabricius 1787). Nearly a century passed before J. D. E. Schmeltz (1876) wrote his treatise on butterflies of Polynesia. Another 50 years went by until G. H. E. Hopkins (1927) recorded what was then known about the butterflies of the Tongas, though the main theme of his paper involved the Samoa Islands further to the north. Hopkins collected on the three major islands, Togatabu (usually spelled "Tongatapu"; for a discussion of the confusion of the name see Hopkins 1927: 1), Ha'apai and Vava'u, but regrettably most of his material from the Tongas was destroyed at sea. We have studied what surviving Hopkins material remains preserved in the Hope Entomological Collections (HEC), University

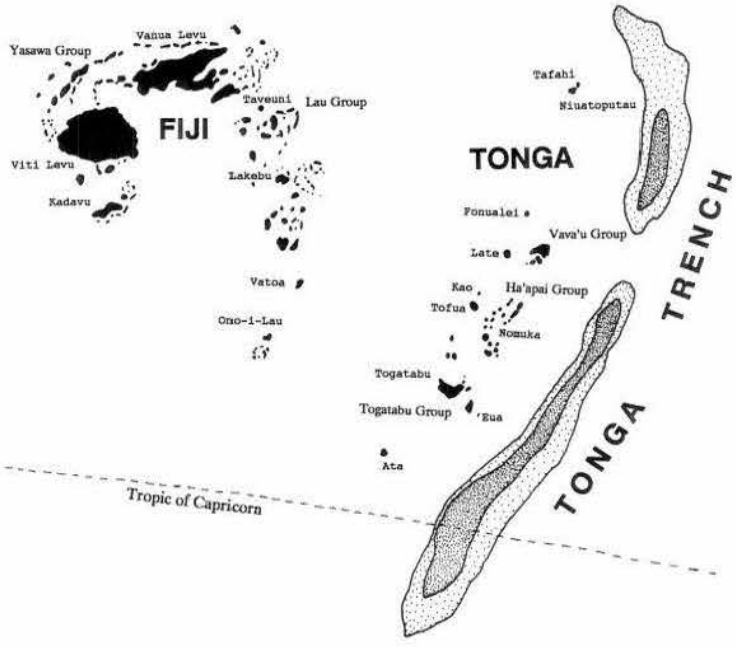


Fig. 1: The Tonga Group of islands in relationship to others in the Pacific.

Museum, Oxford, England, as well as his types in The Natural History Museum (BMNH), in London.

It was indeed a great and unexpected pleasure when we received a small lot of butterflies and moths collected by Mr. Don Thomas of Dunedin, Florida, an accomplished butterfly collector and intrepid traveller to out-of-the-way places. He did not, of course, visit and collect on all of the islands but concentrated his work on the major northern island of Vava'u with specimens captured during 20-31 August of 1986. He also collected briefly near Nuku-alofa, Togatabu in the southern end of the Tongas on 3, 5, and 8 September 1986. The Thomas collection was augmented substantially by specimens forwarded to us Bishop Museum (BPBM), Honolulu, Hawaii. The BPBM material was collected chiefly on Vava'u, Togatabu, Nuku'alofa, Vitilevu, 'Eua and Niue Islands and obtained over a 50 year period. Although G. Paulay contributed the most recent specimens collected on Niue, N. H. L. Krauss has perhaps done more field work in the area, especially in the Tongas and associated islands.

Naturally, we have made extensive reference to Butler (1883) and Hopkins (1927) works in the preparation of this manuscript. In view of our field experience in the West Indies and given the geologic history of Tonga Islands, it was surprising that new taxa for the islands have been recorded, but also that other species originally

Table 1. Collectors in Tonga Islands and Niue, Cook Islands

Name	**Islands Visited**	**Collection Date**
J. Banks	Togatabu	1770
J. D. E. Schmeltz	Fiji	viii.1874
A. G. Butler	Togatabu	vii. 1874
T. D. A. Cockerell	Togatabu	vii.1924
	Ha'apai	
	Vava'u	
G. H. E. Hopkins	Togatabu	1924-25
	Ha'apai	primarily ii-iii.1925
	Vava'u	
G. P. Wilder	Togatabu	1925
	Ha'apai	
Cotrell-Dormer	Vaikeli	1940-1943
H. S. Ladd	Vitilevu	iv.vii.1929
N. L. H. Kraus		1969-1980
	'Eua	iii.1969
		i.1979
	Vava'u	i.1979
		i.1980
	Nuku'alofa	i.1970
	Niue	i.1978
		xii.1979
D. Thomas	Togatabu	ix.1986
	Vava'u	viii.1986
G. Paulay	Niue	ix.1991

recorded as common by Butler and Hopkins are not present at all in the Thomas collection nor among recent BPBM material. Butler (1883) records 11 species, three of which were later synonymized under the same taxon (*H. bolina pallescens*) for the Tonga Islands, all collected on 'Tongatabu' in July, 1874. Hopkins (1927: 6) lists 20 species of butterflies from the Tongas, 15 of which were recorded from Vava'u, based on his collection on that island during the first two weeks of March, 1926. Mr. Thomas' activity was during August and September, and perhaps, as with other insular faunas, there are seasonal differences in emergence periods of butterflies to account for the contrast between these two large collections.

Table 2. Butterflies of the Tonga Islands and Niue, Cook Islands

Taxon	Togatabu	Vava'u	Vakeli	Other	Niue
Satyridae					
Melanitis leda solandra (Fabricius)	x	x			
Danaidae					
Tirumala hamata angustata (Moore)	x				
Danaus p. plexippus (Linnaeus)	x	x	x	'Eua	
Euploea lewinii mathewi Poulton	x	x	x	Ha'apai	
Euploea lewinii perryi Butler					x
**Euploea tulliolus forsteri* C. & R. Felder		x		'Eua	
Nymphalidae					
Vagrans egista bowdeni (Butler)	x	x			
Junonia v. villida (Fabricius)	x	x			
Doleschallia bisaltide tongana Hopkins	x	x			
Hypolimnas antilope lutescens (Butler)		x			
Hypolimnas bolina pallescens (Butler)	x	x	x		
Lycaenidae					
**Spalgis?* sp.		x			
Deudorix epijarbas armstrongi Hopkins		x			
Nacaduba dyopa (Herrich-Schäffer)			x		
Jamides carissima thomasi, ssp. nov.	x	x		'Eua	
**Jamides bochus argentina* Prittwitz					x
**Lampides boeticus* (Linnaeus)	x	x			
Euchrysops cnejus samoa (Herrich-Schäffer)		x			
Catochrysops taitensis hopkinsi, ssp. nov.		x			
Famegana alsulus lulu (Mathew)	x	x		Ha'apai	x
Zizina otis, nr. *mangoensis* (Butler)	x	x			
Pieridae					
Belenois java schmeltzi		x		'Eua	x
Appias leis mania (Hopkins)		x			
Eurema hecabe sulphurata (Butler)	x	x	x		x
**Eurema brigitta* (Stoll)		x			
Hesperiidae					
Badamia exclamationis (Fabricius)		?			

* New record

Mr. Thomas' collecting activities yielded 20 species of butterflies from the island of Vava'u alone, a number equal to Hopkins' total for the Tongas. Most of these are represented in the material by short to moderate series, with only five species recorded by single specimens. There are three new records for the Tongas, including *Lampides boeticus* (Linnaeus 1767), a species that occurs almost universally throughout the Paleotropics, and one additional species, *Euploea tulliolus* (Fabricius 1793), was not even considered a likely Tongan insect by Ackery and Vane-Wright (1984). Thomas' collection on Togatabu, taken near Nuku'alofa, resulted in another nine species being recorded, one of which he did not encounter at all on Vava'u. There are now 26 butterfly taxa known from the Tongas (Table 2). Comparatively, there are only five species, three of which are shared with the Tonga Islands, currently recorded from Niue. However, due to the paucity of studies on these islands, we expect that these faunal lists are far from complete.

Thomas' collecting localities on Vava'u are not further documented on envelope data that we received. He did state (Thomas, pers. commun.) that the *Euploea* were taken mostly on the flanks of Mt. Talau, whereas most of the "blues" (Lycaenidae: Polyommatinae) were collected along the beach at Tu'anekivale. This is a small island, and it is doubtful that further localization is necessary. A listing of the Thomas captures and additional material in the BPBM supplemented by the observations of Hopkins follows. Names of species previously recorded from Vava'u and Togatabu, but not represented in the Thomas nor BPBM collections, are indicated in square brackets.

SATYRIDAE

Melanitis leda solandra (Fabricius 1775)

This characteristically dark brown species with the angulate wing margins, two postmedian forewing white markings, and ventral mottled brown coloration is widely distributed in the Pacific basin. Thomas collected four ♂ and six ♀ specimens on Vava'u (20-29.viii.1986), and another ♂ and six ♀ at Nuku'alofa, Togatabu (3 and 5.ix.1986). The BPBM material consists of a ♂ and two ♀ also from Nuku'alofa, Togatabu, 1.1980. Butler (1883: 409) listed this species as *Melanitis taitensis* from 'Tongatabu', July 1874. Hopkins (1927: 21) discussed this species' crepuscular habits and mentions specimens from Vava'u collected by the Eclipse Expedition in April 1911, though he apparently did not take it there; the Thomas specimens thus may be considered as confirmation of the older records; his specimens from Nuku'alofa and those from BPBM further confirm the records of Butler (1883: 409) and Hopkins (1927: 21) from Togatabu.

DANAIDAE

[*Tirumala hamata angustata* (Moore 1883)]

Butler (1883: 405) lists 18 examples of this endemic black danaid species with the translucent pale green markings, both ♂ and ♀, from 'Tongatabu', collected in July, 1874. He remarked further that with the exception of one specimen in which there was an irregular spot near the end of the forewing cell, all of the specimens were similar in the darker melanistic coloration and maculations patterns to the Australian populations.

Alternatively, a single Tongan species of this genus was recorded from near Nuku'alofa, Togatabu (Hopkins 1927: 10-11). Thomas never encountered it, but there are four ♂ and two ♀ in BPBM from 'Eua: two ♂, Magu, 100-200 m, iii.1969; one

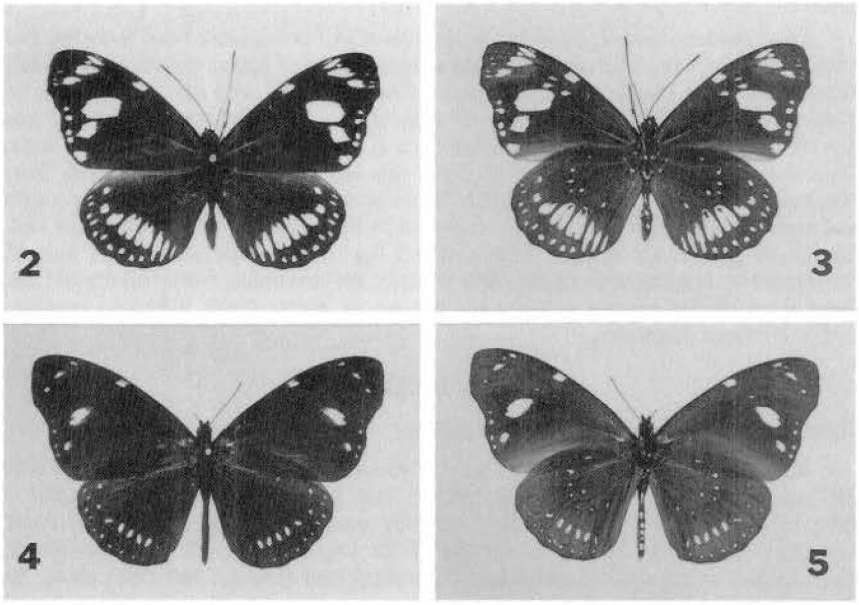
♂ and two ♀, Pangai, 0-100 m, i.1979 (all N. L. H. Krauss) and a single ♂ from Tafuna, xii.1956. These are the first published records from these localities. Hopkins (1927: 8- 9) records the early stages of the Samoan *T. h. melittula* (Herrich-Schäffer 1869); the larval hostplant is *Tylophora samoensis* A. Gr. (Asclepiadaceae).

Danaus plexippus plexippus (Linnaeus 1758)

Butler (1883:408) simply mentioned the record of this world wide species from 'Tongatabu' (July, 1874) and Hopkins (1927: 7) records this butterfly as "by no means common." This assessment appears to be equally true today as Thomas collected a single ♀ on Vava'u on 21.viii.1986. Among BPBM specimens, there is a single ♂ from Fagatua, Vaikeli, collected on 6.ix.1943 by Cottrell-Dormer. Thomas also collected a single ♀ at Tutuila, Samoa on 17.viii.1986. Hopkins (1927) did not mention this species from Vava'u.

Euploea lewinii mathewi Poulton 1924 Figs. 2-3

Recorded by Butler (1883:408) as *"Nipara eleutho"* from 'Tongatabu', this butterfly is apparently an abundant one on Vava'u, a conclusion confirmed by Hopkins (1927: 13-14). *E. l. mathewi* is represented from Vava'u in the Thomas material by 28 ♂ and 11 ♀ with dates ranging the entire length of his stay. He also collected six ♀ at Nuku'alofa, Togatabu on 3 and 5.ix.1986. The BPBM has four ♂ from Neiafu, Vava'u, 1.1980 (Krauss), a ♂ from Nuku'alofa, 1.viii.1925 (G. F. Wilder), a ♂ from Fagatua, Vaikeli, 4.ix.1940 (Cottrell-Dormer) and another ♂ from "Haipai" (Ha'apai), 31.vii.1925



Figs. 2-3: *Euploea lewinii mathewi* Poulton; ♂, dorsal (**2**) and ventral (**3**) surfaces; TONGA: Vava'u; 27.viii.1986 (D. Thomas; AME).

Figs. 4-5: *Euploea lewinii perryi* Butler; ♂, dorsal (**4**) and ventral (**5**) surfaces; Niue, 21.x.1933; (H.W. Simmonds; AME)

(Wilder). According to Thomas' notes, *mathewi* was chiefly found on the flanks of Mt. Talau. He also collected a single ♂ of *E. l. bourkei* Poulton 1924 from Tutuila, Samoa on 17.viii.1986. *E. l. mathewi* is the only *Euploea* previously recorded from the Tongas (Ackery and Vane-Wright 1984). The larva feeds on *Ficus tinctoria* Forst. (Moraceae), according to Hopkins (1927: 14).

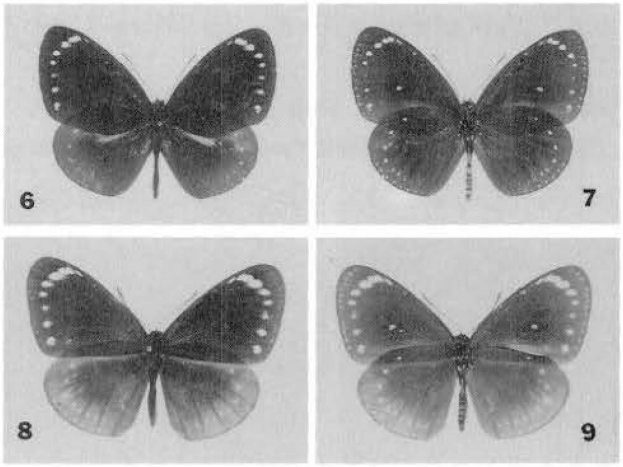
Euploea lewinii perryi Butler 1874 Figs. 4-5

This subspecies is much more obscurely marked than the above species in the size of the white markings, especially those at the forewing apex along the lateral margins of both wings, and the reduced hindwing submarginal band. Paulay collected a series on Niue: three ♂ 'nr. Togo & airport' (1.ix.1991) and a single ♂ near Hakupu (5.ix.1991) (all BPBM). As indicated above and elsewhere in the literature (Ackery & Vanewright 1984: 155), the distribution of *E. lewinii* and its subpecies in the central Pacific is quite complex with the subspecies *E. l. perryi* previously recorded from Niue and the Cook Islands.

Euploea tulliolus forsteri C. and R. Felder 1865 Figs. 6-9

This species is newly recorded from Vava'u on the basis of eight ♂ and two ♀ collected by Thomas (24-31.viii.1986) and two ♂ in BPBM from Hafu, 'Eua, 100-200 m (Krauss). These records are all the more surprising in light of Ackery and Vane-Wright's (1984: 155) prediction that future discoveries of another *Euploea* in the Tongas most likely would be a subspecies of *E. algea* (Godart [1819]), a species that remains unrecorded from the islands. The specimens are inseparable from those of the *E. tulliolus* subspecies from Fiji, and the name of the Fijian subspecies, *forsteri,* is here employed tentatively for Tongan material. Single Vava'u specimens of this taxon are being transferred by AME to BMNH and HEC, where arguably the finest assemblages of *Euploea* reside.

Ackery and Vane-Wright (1984: 224) list several Asclepiadacaceae and Moraceae as larval foodplants.



Figs. 6-9: *Euploea tulliolus forsteri* C. & R. Felder; **6-7** ♂, dorsal (**6**) and ventral (**7**) surfaces; TONGA: Vava'u: 31 August 1986; no further data (D. Thomas); **8-9** ♀, dorsal (**8**) and ventral (**9**) surfaces; TONGA: Vava'u: 29 August 1986; no further data (D. Thomas; AME).

NYMPHALIDAE

Vagrans egista bowdenia (Butler 1873) Figs. 10-11

Recorded originally from 'Tongatabu' by Butler (1883: 411), this butterfly is shared with the Samoan islands. *V. e. bowdenia* is well documented by Hopkins (1927: 38-39), who reared it on *Xylosoma* (Flacourtiaceae). Thomas collected nine ♂ and a single ♀ on Vava'u (22-27.viii.1986), and there are a ♂ from Neiafu, Vava'u, 1.1980, a ♂ from Nuku'alofa, Togatabu, 0- 50 m, i.1979 (both Krauss), and a ♀ from Nuku'alofa, 2.viii.1925 (Wilder) in BPBM.

Hopkins (1927: 38-39) and Comstock (1966: 8) record the early stages in some detail, and both authors comment upon the adults taking nectar especially at *Morinda* and *Lantana.*

Junonia villida villida (Fabricius 1787)

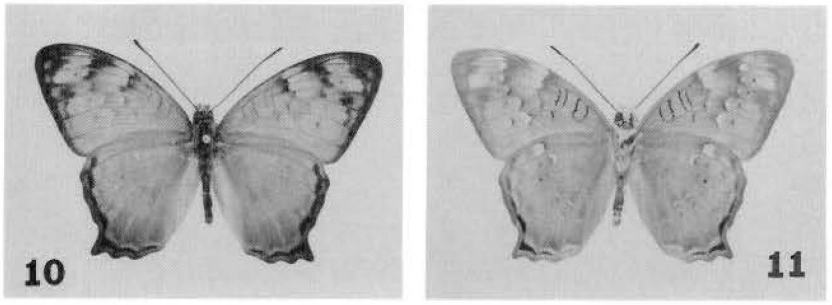
The first butterfly to have been described from "Amsterdam Island" (Togatabu) (Hopkins 1927: 35), the types are preserved in the Banks collection (BMNH). Specimens from these islands are brown overscaled with orange, and the dorsal submarginal ocelli outlined prominently in orange and are inseparable from material collected on the Ellice Islands and the eastern Samoas. Butler (1883: 415) recorded *J. villida* from 'Tongatabu' (July, 1874) and Fiji (2 August, 1874). The Thomas material included seven ♂ and a single ♀ taken on Vava'u 22-27.viii.1986) and four ♂ from Nuku'alofa, Togatabu (3.ix.1986). BPBM contains four ♂ and four ♀ from Neiafu, Vava'u, 1.1980 (Krauss) with two ♂ and two ♀ taken on Fulahi, Niue, 17.ix.1991 (Paulay).

Doleschallia bisaltide tongana Hopkins 1927

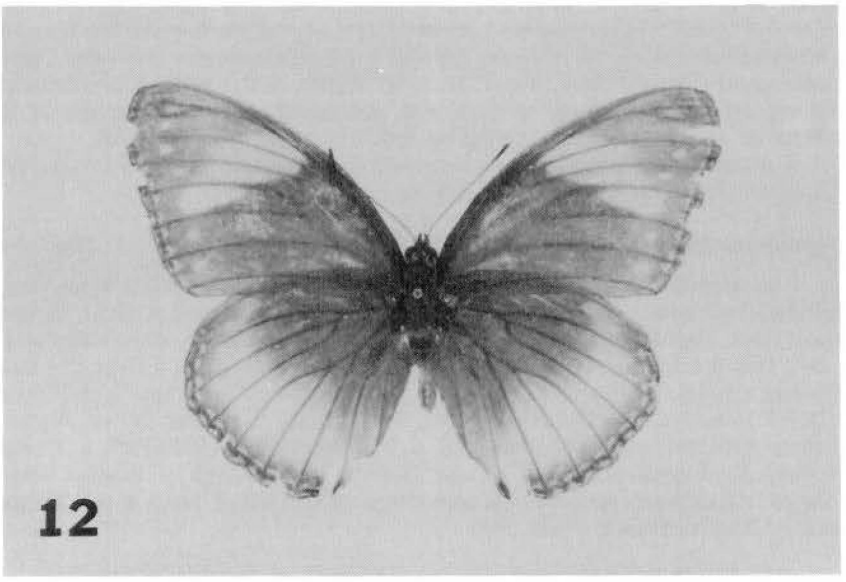
This endemic subspecies is distinguished by the enlarged diagonal golden brown subapical forewing bands which extend almost to the lateral margin and the more prominent hindwing ocelli. It was described on the basis of specimens collected in the Tongas, including some from Vava'u. An uncommon butterfly from this area in museum holdings, Thomas collected a ♂ and a very tattered ♀ from Nuku'alofa, Togatabu, 3.ix.1986.

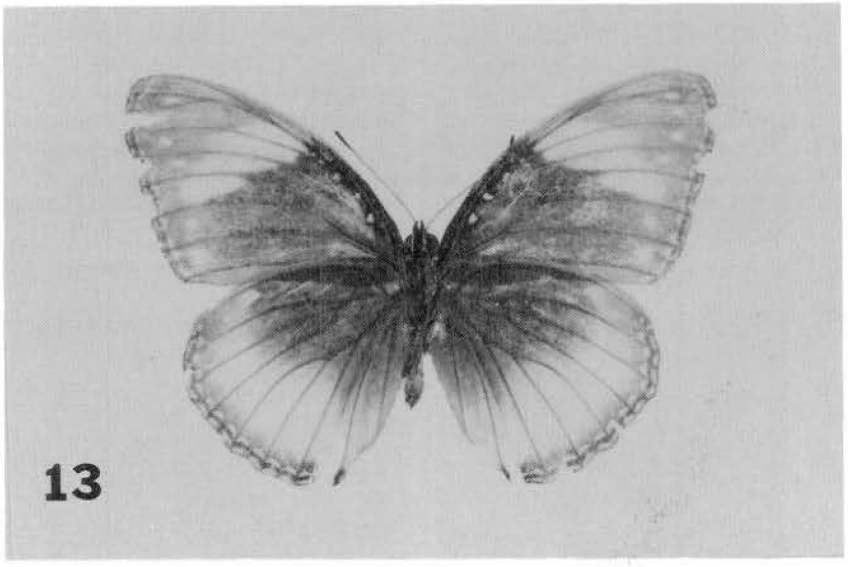
Hypolimnas antilope lutescens (Butler 1874) Figs. 12-13

Hopkins (1927: 25) records this butterfly as reasonably common near Neiafu,



Figs. 10-11: *Vagrans egista bowdenia* Poulton, ♂ dorsal (**10**) and ventral (**11**); COOK ISLANDS: Ragatonga: 12 June 1920 (H. H. Simmonds; AME)





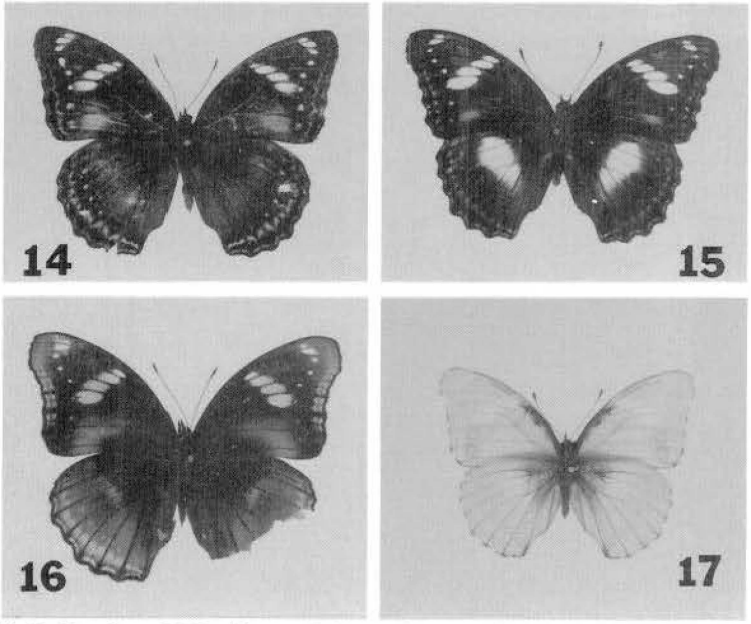
Figs. 12-13: *Hypolimnas antilope lutescens* (Butler), ♀ dorsal (**12**) and ventral (**13**) surfaces; TONGA: Vava'u: 27 August 1986; no further data (D. Thomas; AME).

Vava'u in early 1925, but Thomas took a single aberrant ♂ on 29.viii.1986 that is illustrated here. This specimen has a broad white subapical patch on the forewing and a whitish shade outside the hindwing cell that is not shown in most specimens. Paulay took a single ♂ near Fulahi, Niue (17.ix. 1991; BPBM). Butler (1883) did not mention this species. Two additional ♂ with wing coloration more characteristic of the subspecies were collected by Thomas on Tutuila, Samoa, on 17.viii.1986.

The larval foodplant is *Pipturus incanus* Wedd. (Urticaceae), and Hopkins (1927: 25) reported that the larvae are gregarious.

Hypolimnas bolina pallescens (Butler 1883) Figs. 14-17

This common species is represented by a series of 24 ♂ and 26 ♀ from Vava'u collected by Thomas between 20 and 31.viii.1986 and 13 ♂ and a single ♀ from Nuku'alofa, Togatabu on 3.ix.1986. The BPBM series includes a ♀ from Nuku'alofa, i.1970, two ♀ from Neiafu, Vava'u, i.1980, a ♀ from Alofi, Niue, 0-50 m, i.1978 (all Krauss); also on Niue: one ♂ near Vaiea (1.x.1991), one ♂ and one ♀ at Hakupu (5.ix.1991), and one ♂ at Fulahi (17.ix.1991) (Paulay); one ♂ and one ♀ from Fagatua, Vaikeli, 4.viii.1940 (collector unknown), a ♀ from Ha'apai, 31.vii.1925, a ♀ from Nuku'alofa, Togatabu, 1.viii.1925 (both Wilder), and a single ♀ labelled simply "Tonga". All of the above specimens were compared with five ♂ and a ♀ that Thomas took at Tutuila, Samoa, 17.viii.1986.



Figs. 14-17: Females of *Hypolimnas bolina pallescens* (Butler) showing the remarkable polymorphism in the Tonga population; all specimens from TONGA: Vava'u, August 1986; no further data (D. Thomas; AME). The female in **14** fuscous with white forewing apical spots and only a minor orange-brown patch at inner forewing margin; that in **15** fuscous with prominent white patches on fore- and hindwings, almost no brown; that in **16** fuscous strongly overlaid with cinnamon, obscuring the white cell-end forewing patch; that in **17** uniform tan with fuscous fringes and basal dusting.

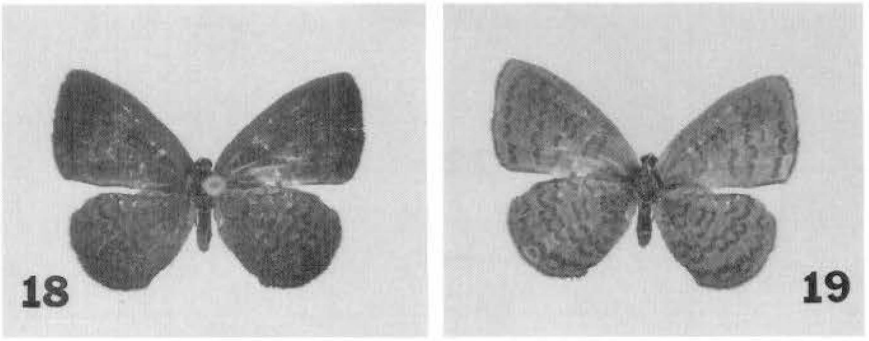
Males are generally monomorphic, but Tongan ♀ are highly variable. Butler (1883) notes ♂ and ♀ referable to this species, collected near Kandavu, Fiji, most likely in August, 1874. He remarks further on their condition, indicating that the specimens were tattered and had probably been on the wing for a long time. In addition, Butler noted a wide range of variability of size, wing maculation and coloration within *Hypolimnas* in the Tongan and Fijan Islands and described three separate taxa from Tongatabu: *H. thomsoni* (type series included one ♀ specimen from Kandava, Fiji), *H. moseleyi,* and *H. naresi,* all currently synonymized to *H. bolina pallescens.* Likewise, the Thomas specimens display a bewildering range of forms from the Tonga Islands. The wing pattern of one ♀ is rather male-like with bold blue-violet patches on both wings (Fig. 15), four others resemble ♀ of the subspecies *nerina* (Fabricius) from the Moluccas and Australia, and two are similar to ♀ of *montrouzieri* (Butler) from Woodlark and the Trobriands. Another specimen is similar to a *nerina* ♀, but with extensive fulvous shading (Fig. 14) on the upper surface outlining the white hindwing spot; still another specimen is reminiscent of the example figured by d'Abrera (1977: 222) as a *"pallescens variant"* (Fig. 16). The remaining 17 ♀ are similar to, or even paler than, the one figured by d'Abrera (1977: 222) as typical of *pallescens* (Fig. 17).

Hopkins (1927: 34) records larvae feeding on *Sida* (Malvaceae), but he also mentions that *Pipturus propinquus* Wedd. (Urticaceae) is used where *Sida* is not available.

LYCAENIDAE

[*Spalgis* species, near ***epeus*** (Westwood [1851])] Figs. 18-22

An unusual, single ♀ referable to this genus was collected at Alofi, Niue, by Krauss at 0-100 m elevation in xii.1979 (BPBM). The wing coloration is dark grey-brown above with darker brown scales along the cubitus and near end cell. On the ventral surface, this specimen is a lighter grey-brown with darker brown markings reminiscent of *Spalgis epeus* (Westwood), and particularly, *S. e. nubilus* Moore but bolder and more pronounced. The nearest colony of *S. epeus* (Westwood), or any *Spalgis,* recorded thus far is from Irian Jaya, and there are no other Miletinae recorded from east of New Guinea (D'Abrera 1977: 379-380; Seki and Takanami 1991: 18). The present specimen differs from most *epeus* ♀ in the unmarked brown upper surface but is otherwise rather similar to that species.

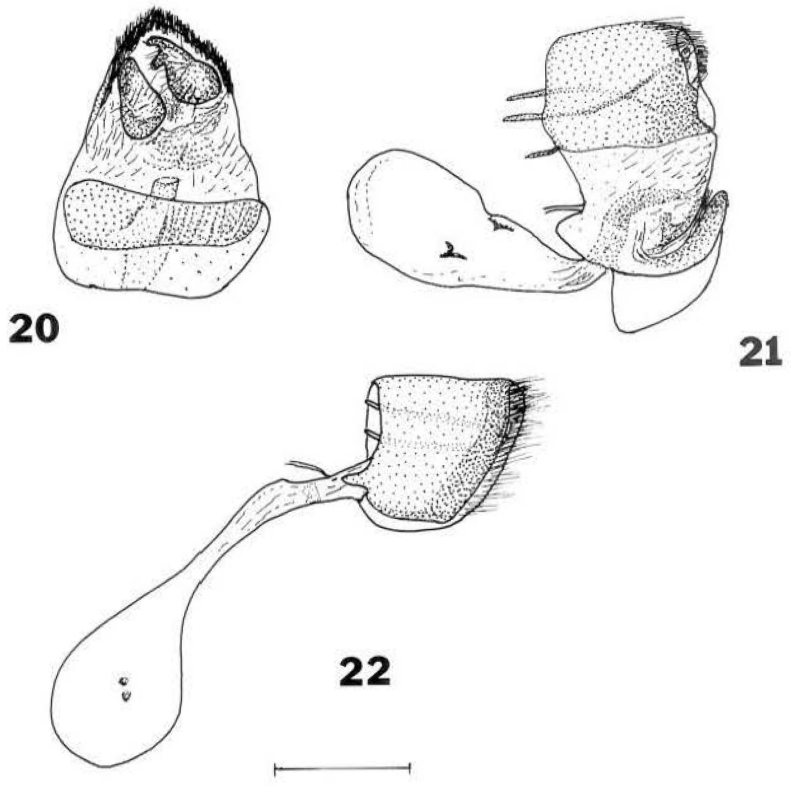


Figs. 18-19: *Spalgis species,* ♀ dorsal (**18**) and ventral (**19**) surfaces; Alofi, Niue, [TONGA]; xii.1979 (N. L. H. Krauss; BPBM)

The ♀ genitalia (Fig. 20, M-7249) are aberrant with the papillae anales moderately sclerotized but with the distal margin modified into a single acute point on the left and a bifid margin on the right and with few setae. The lamella antevaginalis is lightly sclerotized with the lamella postvaginalis a moderately sclerotized bar along the width of the sternite. The ostium bursae and antrum are moderately sclerotized shading to lightly sclerotized along the length of the curved, rather rigid ductus bursae. The bursa copulatrix is membranous and lightly folded with two spinous signae.

In contrast, the ♀ genitalia of *S. epeus nubilus* (Figs. 21-22) is rather simple with the sterigma quite membranous and the lamella postvaginalis restricted to a small sclerotized plate. The ostium bursae, antrum, and ductus bursae are membranous with a small, sclerotized, square-shaped plate about mid-length in the ductus bursae. The bursa copulatrix is membranous with signae spicuose.

We are reticent to describe a subspecies on the basis of a single specimen, and



Figs. 20-22: Female genitalia of *Spalgis* species, (preparation M-7249, J. Y. Miller); data as **Figs. 18-19** (BPBM); **20** ventral view, **21** lateral view. *Spalgis epeus nubilis,* **22,** lateral view (preparation M-7250, J. Y. Miller); WEST MALAYSIA: Langkawi Islands; iii.1973. (Scale = 0.5 mm)

we illustrate this ♀ and its genitalia to alert others that there is apparently an interesting new discovery to be made on at least Niue.

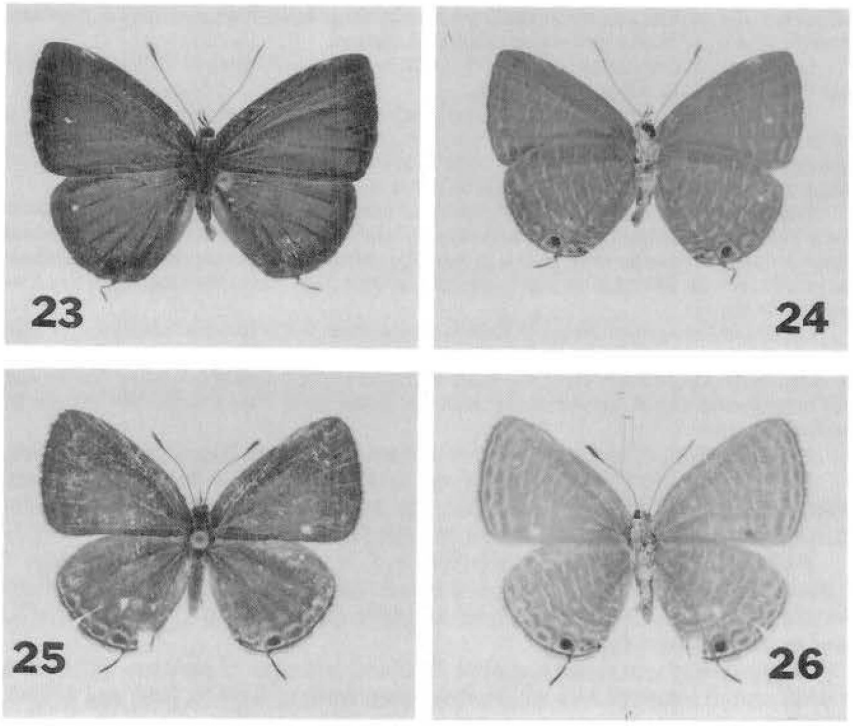
Larvae of *Spalgis* are carnivorous, feeding on aphids (Homoptera).

Deudorix epijarbas armstrongi Hopkins 1927

This subspecies was described on the basis of three ♀ from Vava'u (Hopkins 1927: 51). The author stated that he had collected both sexes during his stay, but the specimens were destroyed during his return trip. Thomas collected a single dull grey-brown ♀ with broad darker brown forewing margins on Vava'u, 24.viii.1986; the ♂ of this subspecies remains unknown, and there were no comparative specimens in BPBM. The ♂ is probably similar to that of other *epijarbas* subspecies, with a fiery red on the upper surface and broad black wing margins. The Thomas specimen agrees in all particulars with Hopkins' (1927: pl. 1, fig. 8) illustration of his type.

Nacaduba dyopa (Herrich-Schäffer 1869)

We accept with some reservation the assignment of Tongan representatives to this species (Tite 1963: 86-87). The latter author had specimens before him of *dyopa* from Fiji, Samoa, Tonga and the New Hebrides. This seems to be a very broad distribution



Figs. 23-26: *Jamides carissima thomasi,* new subspecies. **23-24:** holotype ♂, dorsal (**23**) and ventral (**24**) surfaces: TONGA: Vava'u; 31.viii.1986; no further data (D. Thomas; AME). **25-26:** paratype ♀, dorsal (**25**) and ventral (**26**) surfaces: data as for holotype ♂.

for such a homogeneous taxon since most *Nacaduba* are more affected by geographic variation. An infrequently observed species in museum collections, *N. dyopa* is rather nondescript above with the hindwing anal markings indicated by diffused black spots; below, this species is grey-brown peppered with numerous white bands and the hindwing ocelli are prominently outlined in iridescent blue-green. We have seen, however, no other comparative specimens other than the seven ♂ and a single ♀ that Thomas collected on Vava'u, 24.viii.1986. Hopkins (1927: 56-57) discusses this taxon under the name *N. vitiensis samoensis* (H. Druce), whereas Comstock (1966: pl. 1, figs. 10-11) confuses this insect with *Jamides bochus argentina* (Prittwitz) (See below).

The larva feeds on *Desmodium umbellatum* D. C. (Fabaceae), according to Hopkins (1927: 56).

Jamides carissima thomasi, new subspecies Figs. 23-29

Hopkins (1927: 53) anticipated the description of this taxon and detailed some of its characteristics. The present subspecies differs from the nominate race from the New Hebrides and the recently described *J. c. susana* d'Abrera (1977: 348) from Lifu in the Loyalty Islands in the following particulars:

Male. (Figs. 23-24): Upper surface coloration not so intensely blue as in either previously described subspecies; upper surface with broader fuscous borders, particularly on the hindwing; ground color of under surface grey-brown, darker than in *c. carissima,* but without the reddish component of *c. susana*; pale linear under surface markings more prominent than in nominate *carissima* and equal to the contrast to those of *c. susana.*

Length of the forewing of Holotype ♂ is 14.2 mm; those of the eight ♂ Paratypes range from 11.0 to 13.6 mm, averaging 12.7 mm.

The ♂ genitalia (Figs. 27-28; M-7369) are compact with moderately sclerotized labides and distinct spines on the interior margin. The falces are prominent and quite tapered with the valvae moderately sclerotized and lobate along costa. The penis is lightly sclerotized with the dorsal ductus and a moderately sclerotized plate in the vesica.

Female. (Figs. 25-26): The upper surface blue coloration is not a shining blue, but rather of a powdery blue shade; upper surface fuscous borders wider than in the ♀ of the nominate subspecies and as broad as those in ♀ *J. c. susana*; subterminal hindwing markings prominent and whitish, not pale blue as in the other subspecies; under surface differs from the other subspecies similarly as the ♂.

Lengths of forewings of the ten ♀ Paratypes range from 12.6 to 14.4 mm, averaging 13.1 mm.

The ♀ genitalia (Fig. 29, M-7370) do not differ from those of nominate *carissima* with the ductus seminalis attached along one-third the length of the membranous ductus bursae, and with membranous bursae copulatrix and with two prominently spined signae just anterior of the ductus bursae.

Described from 19 specimens, nine ♂ and ten ♀, from the Tonga group of islands.

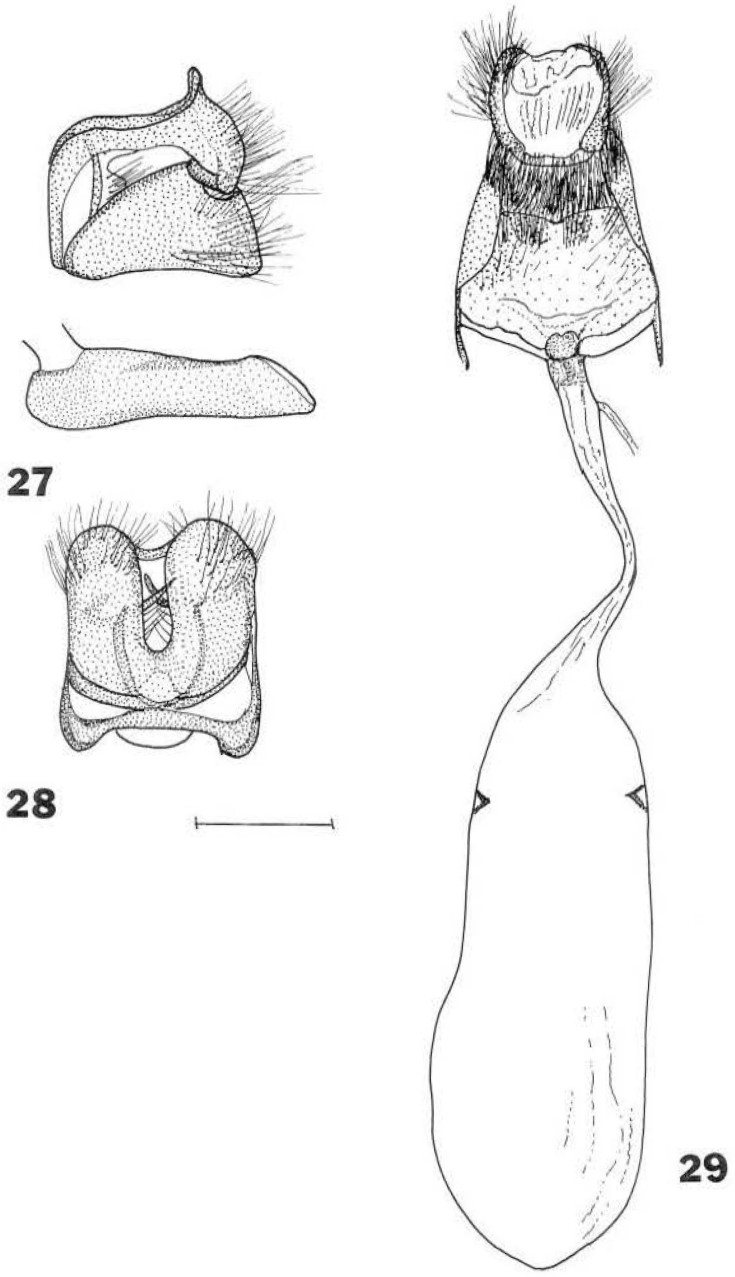
HOLOTYPE ♂: TONGA: Vava'u: no further locality (but stated to have been collected along the beach at Tu'anekivale (D. Thomas, pers. commun.), 31.viii.1986 (D. Thomas); ♂ genitalia preparation M-7369 (J. Y. Miller).

PARATYPES: same data as holotype: 5 ♂, 3 ♀; same locality as holotype: 1 ♀ 20.viii.1986; 1 ♂, 1 ♀ 22.viii.1986; 1 ♀ 25.viii.1986; 1 ♂, 1 ♀ 26.viii.1986; TONGA: TONGATABU [*sic.*]: Nuku'alofa, 0-50 m, i.1979 (Krauss), 1 ♀ ; TONGA: 'EUA: Pangai, ii.1972 (Krauss), 1 ♀.

Disposition of type series: Holotype ♂, five ♂ and eight ♀ paratypes will remain in AME; one ♂ paratype each will be ceded from AME to BMNH, HEC and BPBM. BPBM also contains the paratype ♀ from Togatabu and 'Eua.

Etymology: This insect is named for Mr. Don Thomas who collected most of the type series.

Discussion: Butler (1883: 417) records *J. carissima* from 'Tongatabu' without



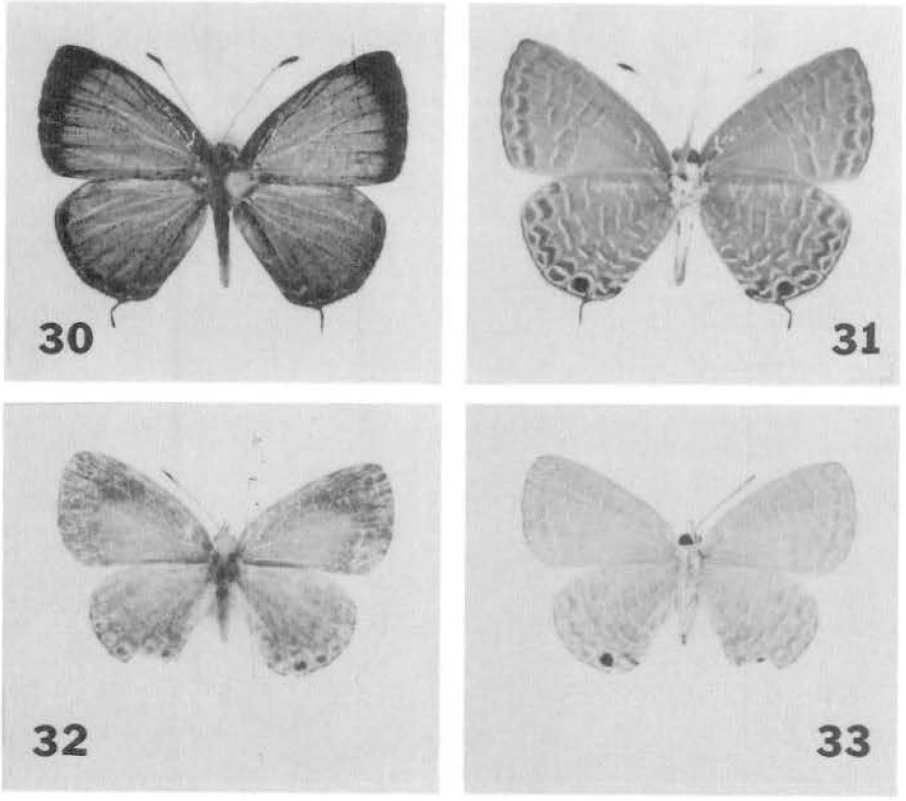
Figs. 27-29: Genitalia of *Jamides carissima thomasi,* new subspecies. ♂ genitalia of holotype; **27,** lateral view; **28,** ventral view; (preparation M-7369 J. Y. Miller). ♀ genitalia of paratype; **29,** ventral view (preparation M-7370, J. Y. Miller). Same data as **Figs. 23-26.** (Scale = 0.5 mm)

further comment. Whether or not it was the series of specimens collected during the 1874 to which Hopkins referred, we could not discern. We could not locate the Hopkins' short series of specimens but suggest these specimens will most likely be referable to *thomasi*. His descriptive notes appear to refer to the present taxon, rather than to nominate New Hebridean material or the race from the Loyalties.

Jamides bochus argentina Prittwitz 1867 Figs. 30-33

Although somewhat similar in appearance to the preceding species, *Jamides carissima thomasi,* this species differs significantly in its much brighter blue dorsal coloration and by the even broader dark wing margins above. *J. bochus walkeri* H. H. Druce occurs in the Cook Islands and is distinctly paler below with faint indication of the linear markings below. Females of *J. b. argentina* are somewhat paler on the ventral surface, but the off-white markings, especially of forewing submarginal band are more prominent than in the male.

Paulay collected six ♂ and 2 ♀ on a coastal terrace near Vaiea, Niue, 15-35 m on 1.ix.1991 (BPBM). In addition, there is a single ♂ from Tutuila, Samoa, 17.viii.1986 in the Thomas material.



Figures 30-33: *Jamides bochus argentina* Prittwitz. ♂, dorsal (**30**) and ventral (**31**); ♀, dorsal (**32**) and ventral (**33**); both Niue, Fulahi, 17.ix.1991 (G. Paulay; BPBM).

Lampides boeticus (Linnaeus 1767)

Surprisingly, this widespread "blue" has not previously been recorded from Tonga Islands. Usually associated with disturbed habitats, Thomas collected two ♂ and seven ♀ on Vava'u (23- 31.viii.1986). Another two ♂ and six ♀ were taken at Nuku'alofa, Togatabu on 3 and 5.ix.1986.

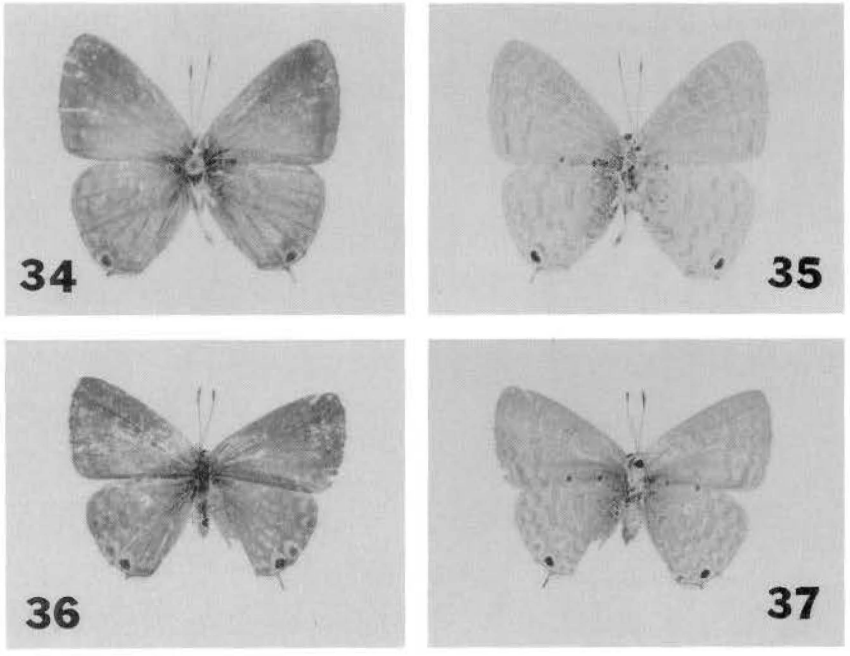
Euchrysops cnejus samoa (Herrich-Schäffer 1869)

This butterfly was recorded for Tonga by Schmeltz (1876), but it was not encountered by Hopkins (1927: 54), who listed only Samoan specimens. Thomas collected two ♂ on Vava'u (25- 26.viii.1986), and they are comparable in all respects to Samoan specimens. Contrary to D'Abrera (1971:361), our study series of *E. cnejus* is quite variable with the continental species much more heavily marked ventrally, especially basad but with the characteristic submarginal markings capped anteriorly in orange. *E. cnejus samoa* is considerably paler below than *E. c. cnidus* from Australia and New Guinea.

Hopkins (1927: 52) describes the early stages from Samoan material; larvae are associated with *Vigna lutea* A. Gr. (Fabaceae).

Catochrysops taitensis hopkinsi, new subspecies Figs. 34-41

Male. (Figs. 34-35): Upper surface much as in the nominate subspecies from the New Hebrides and Hopkins' subspecies, *C. t. pepe* from Samoa, but the ground color is slightly bluer

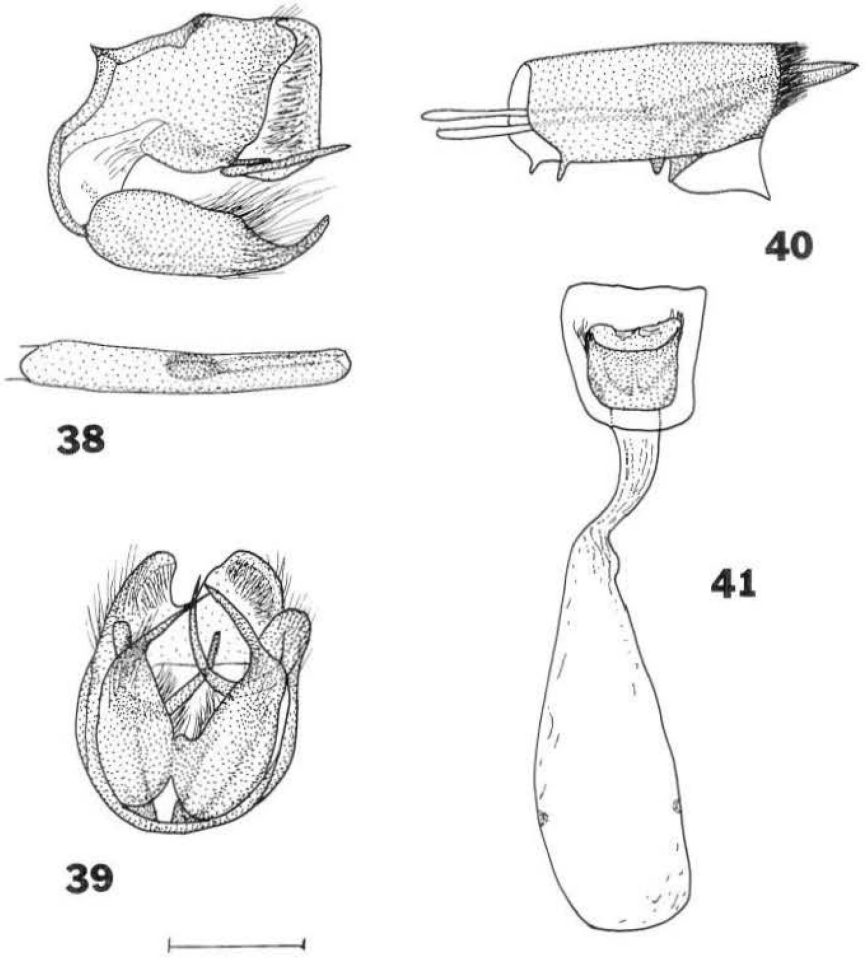


Figures 34-37: *Catochrysops taitensis hopkinsi,* new subspecies. **34-37:** holotype ♂, dorsal (**34**) and ventral (**35**) surfaces; TONGA: Vava'u: 26.viii.1986; no further data (D. Thomas; AME). **36-37:** paratype ♀, dorsal (**36**) and ventral (**37**) surfaces; data as holotype.

than in either; the present insect has a marginal dot in hindwing space Cu_1-Cu_2, and the costal and marginal fuscous shade on the forewing is more strongly developed. The under surface is whitish with light brown bands somewhat reminiscent of those on *pepe,* and the marginal spot in hindwing space Cu_1-Cu_2 is capped proximad with light, dull orange.

Length of the forewing of the Holotype ♂ is 12.3 mm, those of the 11 ♂ paratypes range from 11.4 to 12.8 mm, averaging 12.0 mm.

The ♂ genitalia (Figs. 38-39; M-7371) do not differ from those of Samoan examples. The genitalia are quite compact with the labides prominently spined on the interior margin and the falces are quite distinct and large; valva moderately sclerotized, lobate and terminates into an



Figures 38-41: Genitalia of *Catochrysops taitensis hopkinsi,* new subspecies. **38-39:** genitalia of holotype ♂, lateral view (**38**) and ventral view (**39**) (preparation M-7371, J. Y. Miller); data as **Figures 34-35. 40-41:** genitalia of paratype ♀, lateral (**40**) and ventral (**41**) views (preparation M-7376, J. Y. Miller); data as **Figures 36-37.** (Scale = 0.5 mm)

acute process. The penis is somewhat flattened with the ductus anterior.

Female. (Figs. 40-41): Very similar to the ♂ of *C. t. pepe,* but with almost no blue scaling on the upper surface and much broader fuscous margins; the hindwing submarginal lunules are better developed than are those of *pepe* and weakly tinged with orange, most prominent in Cu_1-Cu_2. The under surface is again as in *pepe,* but the dark markings are better developed in the present insect, and the black marginal spot in hindwing Cu_1-Cu_2 is capped by a narrow orange chevron.

Lengths of the forewings of the four ♀ paratypes range from 11.5 to 12.8 mm, averaging 12.0 mm.

The ♀ genitalia (Figs. 40-41; M-7376) are similar to the nominate taxon, but *C. taitensis hopkinsi* has the rather distinct acute papillae anales, a sclerotized sterigma with the antrum and ductus bursae lightly sclerotized. The bursae copulatrix is membranous with two spinose signae.

Described from 16 specimens, 12 ♂ and four ♀, from Vava'u, Tonga.

HOLOTYPE ♂: TONGA: VAVA'U: no further locality (but stated to be near Tu'anekivale (Thomas, pers. commun.), 26.viii.1986 (D. Thomas); (♂ genitalia preparation M-7371, J. Y. Miller).

PARATYPES: same data as holotype: 1 ♂, 2 ♀; same locality and collector as holotype: 1 ♂ 20.viii.1986; 2 ♂ 22.viii.1986; 2 ♂ 24.viii.1986; ♂, 1 ♀ 27.viii.1986; 1 ♂ 29.viii.1986; 2 ♂, 1 ♀ 31.viii.1986.

Disposition of type series: Holotype ♂, seven ♂ and four ♀ paratypes are in AME; one ♂ paratype ceded by AME to BPBM, BMNH, and HEC.

Etymology: This subspecies is named in honor of G. H. E. Hopkins who first indicated the distinctness of it; we also wish to honor him for his comprehensive study of Tongan butterflies in conjunction with his Samoan work.

Discussion: Tite (1959: 211) grouped material of this species from the New Hebrides and Fiji (as well as Tonga and the Samoas) under the long-forgotten Boisduval name *taitensis.* Examination of paratypes of *Catochrysops lithargyrea pepe* Hopkins (1927: 55-56) and New Hebridean material shows slight, but constant differences between those two populations such as the poor development of the large black spot on near the anal angle of the dorsal hindwing and the absence of the orange lunule found in *C. caledonica* on the ventral surface. Similarly, there are also discrete differences between either of the above and the Tongan subspecies described here. We here choose to reverse Tite's action, and now remove *pepe* from the synonymy of *taitensis* [**STAT. REV.**]. This stated here, comparisons of the material demonstrate that Hopkins (1927: 55) correctly predicted the subspecific status of the Tongan population. Butler (1883: 417) also noted a small grey-brown *Catochrysops* species, perhaps closely associated with *C. caledonica,* from 'Tongatabu', July 1874. However, the specimen was in very poor condition and is not referable to the above taxon nor to other species obtained in the Thomas collection.

Hopkins (1927: 56) records the larval foodplant of *C. t. pepe* as *Desmodium* (Fabaceae).

[***Famegana alsulus lulu*** (Mathew 1889)]

Mathew originally described this butterfly from Togatabu, and Hopkins (1927: 58-59) records it from other Tongan islands, including Vava'u. *F. alsulus lulu* is not among specimens more recently collected and deposited in the BPBM. This species' small size and rather undistinguished coloration may have contributed to the paucity of specimens represented in museum collections.

Hopkins (1927: 59) described the immature stages of this species in association with *Indigofera anil* L. (Fabaceae).

Zizina otis mangoensis (Butler 1884)

The Tonga and Niue populations of this species agree favorably with the description of *mangoensis*. Our chief concern is that the subspecies are at best poorly defined in *Z. otis*. The present series are variable in size (18-24 mm) and the intensity of markings and coloration since they are easily worn following flight. *Z. o. mangoensis* is easily distinguished from *Famenaga alsulus lulu* by the faint grayish postmedian ventral and the hindwing anal spot is absent. Thomas' series includes 19 ♂ and three ♀ collected on Vava'u (20-31.viii.1986) and nine ♂ and a single ♀ taken at Nuku'alofa, Togatabu on 3.ix.1986. There is also a ♂ from Nuku'alofa, Togatabu, i.1978 (Krauss) and 14 ♂ taken near the airport at Falahi, Niue (all 17.ix.1991; Paulay) in BPBM. This is an easily overlooked insect, which perhaps accounts for the paucity of other records of its occurrence.

The larvae feed on a variety of Fabaceae (Hopkins 1927: 60).

PIERIDAE

Belenois java schmeltzi (Hopkins 1927)

Described from Vava'u, *B. j. schmeltzi* is closely allied to the *B. j. micronesia* (Fruhstorfer 1902), a taxon known from Fiji and Samoa. Hopkins (1927: 46-49) characterized this species on the basis of the overall darker coloration of the wing veins, additional submarginal black spotbands on both wings, and expanded yellow markings, especially on the under surface hindwing. Thomas collected seven ♂ on Vava'u on 24, 26, 28 and 31.viii.1986; there are three ♂ and two ♀ in BPBM, a ♂ from 'Eua, 11.v.1928 (H. S. Ladd), two ♂ from Alofi, Niue, xii.1979 (Krauss), and two ♀ from near Togo, Niue, 1.ix.1991 (Paulay).

The larvae are associated with the hostplants *Capparis* (Capparidaceae) (Comstock 1966: 9) and *Apophyllum* (Yata, 1985: 432).

Appias leis manaia (Hopkins 1927)

This subspecies, described from Samoa, more recently recorded from Lalomanu Upoli, Friendly Island, is also found in the Tongas, including Vava'u (Hopkins 1927: 44-46). Thomas collected a single ♀ on Vava'u, 24.viii.1986. Although the ♀ exhibit polymorphism as in other southeast Asian *Appias* (Yata 1985: 379), Hopkins (1927: 49) further comments on the marked seasonality of appearance of this insect; perhaps it was this restricted flight period that prevented Thomas from taking additional specimens.

Eurema hecabe sulphurata (Butler, 1875)

Originally described by Butler (1883: 420) from 'Tongatabu' as *"Terias aprica"*, he noted the almost immaculate under surface, the total absence of the sigmoidal streak on the forewing, and the larger size of this species from the Tonga Islands as compared with the *E. h. sulphurata* present on Aru. Butler (1883: 421) also recorded *Eurema hecabe* from Aru. These observed differences are well within the range of variation in dry versus wet season forms in this most widely dispersed species known from the Old World tropics.

Thomas collected five ♂ and three ♀ on Vava'u (20- 29.viii.1986). In BPBM, there are six ♂ collected on Niue near Vaiea (1.ix.1991) and Fukahi (17.ix.1991) and two ♂ from Fagatua, Vaikeli, 23.viii.1940 (collector unknown) that apparently constitute a new record from the latter island. The Thomas captures confirm the Vava'u records

gathered by members of the 1911 Eclipse Expedition. Hopkins (1927: 49) did not encounter *sulphurata* there, though he did obtain a long series near Nuku'alofa, Togatabu.

The larvae are associated with approximately 40 species of Leguminosae and several species of Rhamnaceae and Euphorbiaceae (Yata, 1985: 225).

Eurema brigitta (Stoll, 1780)

The broader black margins, particularly along the forewing apex, distinguish this species from *E. hecabe sulfurata.* Thomas collected four specimens (2 ♂, 2 ♀) on Vava'u of this species that has not previously been recorded from the Tongas (24-28.viii.1986). The BPBM series contains three ♂ and another ♀ from Neiafu, Vava'u, i.1980 (Krauss). Previously, the most easterly records of *E. brigitta* were from Papua New Guinea (*papuana* [Butler, 1898]) and Australia (*zoraide* [Felder & Felder 1865]). The series is rather short, and the subspecific differences are not so distinct in this species, and thus this series cannot be assigned to one subspecies with ease, though there are definite affinities to *E. b. zoraide* from Australia and New Guinea. It is possible that *brigitta* was an accidental introduction from further west, or perhaps it simply had been overlooked by previous collectors.

The larval hostplants include herbaceous species of *Cassia* (Leguminosae) (Yata, 1985: 220).

HESPERIIDAE

[*Badamia exclamationis* (Fabricius 1775)]

Hopkins (1927: 3; 62) described the early stages of this species from Samoa but did not record it from the Tonga Islands. Thomas nor recent collections in BPBM did not take this species. However, Evans (1949: 72) lists two ♂ and a ♀ from "Tonga Is." Such records are not surprising inasmuch as *B. exclamationis* is an opportunistic species that is widely distributed throughout the Pacific.

DISCUSSION

As stated previously, some of the islands of the Tonga group are not recently emerged islands; based on current geologic information, an age of middle to late Eocene is indicated for the basement of the Tonga Islands (Ewart 1988: 18). Fosberg (1984: 37) classes the Tongas as "Polynesian High Islands" with a flora and fauna certainly related to the Fijian-Melanesian assemblage. The ancient nature of these islands, and knowledge that the Tongas have been displaced eastward (Ewart 1988: 19; Shields 1987: 111) makes these islands fertile fields for further biogeographic study.

While not contradicting the basic assumption of the mobility of the Tongas, Holloway (1984: 131-135) detailed the separation of the Outer and Inner Arcs roughly across New Guinea. The Outer Arc includes the northern Moluccas, Bismarcks and Solomons, eastward to Fiji and the Tongas. Holloway further speculated that islands of the Outer Arc might have been an archipelago until nearly ten million years ago. Between 50 and 30 million years ago, the Outer Arc crust slowly subducted, and a shear zone resulted in the isolation of the eastern islands of the Arc through seafloor spreading. Ewart (1988) discussed the presence of some early Tertiary (middle Eocene) volcanic basement on 'Eua, which predates the opening of the South Fiji basin and would have formed part of the single Lau-Tonga Ridge. This latter area may have been associated or located near the Norfolk-New Caledonian ridge. There is sufficient evidence to indicate that during much of the Miocene, an active volcanic arc existed

west of the Tonga ridge (probably near the current location of the Lau ridge), and much of the Tonga ridge was submerged during this period. During the late Miocene, volcanic activity subsided with continuing tectonic instability and with faulting and differential uplift and subsidence throughout the Holocene.

Much of the current butterfly fauna on the Tonga Islands (Table 2) is closely related to that of Fiji and Samoa, and to a lesser degree, New Caledonia. These small islands are subject to the vicissitudes of climate and tectonic activity and are, therefore, more likely to have faunal turnovers than on larger, more stable islands. The majority of species that have colonized the Tongas are for the most part excellent dispersalists with the Danaidae (17%), Pieridae (17%), and the Nymphalidae (22%) comprising more than half of the butterfly fauna. Species of *Elymnias, Hypolimnas,* many lycaenids, *etc.,* have managed to colonize very remote islands, presumably under their own power. The representation of a single hesperiid, *Badamia exclamationis,* as contrasted with the remarkable diversity and evolution of this group throughout the tropics is of interest. The Papilionidae are curiously absent, although *Papilio schmeltzi* Herrich-Schäffer is endemic to Fiji and may occasionally stray into the Tonga Islands chain. In comparison to the other butterfly groups, the Lycaenidae comprise 39% of the modern Tongan butterfly fauna, similar to the insular faunas of the West Indies in which the Lycaenidae represent 5-34% of the butterflies in the Bahama and Virgin Islands (Miller & Miller, in prep.). Of the butterflies recorded, the current distribution of only one taxon, *Spalgis* near *epeus,* might be considered an accidental introduction or a vicariant event. Geographically the nearest record of *S. epeus* or any *Spalgis* is known from Irian Jaya with no further records east of New Guinea. The present Tonga specimen most closely resembles the northern Moluccan subspecies. Given the geologic history that Tonga represented part of subaerially exposed volcanic chain which also comprised part of the single Lau-Tonga ridge and also located near to or attached to the Norfolk-New Caledonia ridge, it is possible that *Spalgis* travelled to its present location on this mobile block through the Cretaceous and the Tertiary. However, with the continuous tectonic activity and the submergence of most of the Tonga Islands during the early to mid-Miocene, it is highly unlikely that most of the ancestral butterfly fauna survived.

Tempting as the vicariance scenario might be, one further thing must be taken into account. Small islands, particularly islands such as the Tongas that are clustered together, are subject to faunal turnovers and population fluctuations than are larger ones (McArthur and Wilson, 1967). Extinction of butterfly populations caused by natural intervention, storms, *etc.,* is much less likely to occur on larger landmasses with a variety of available habitats than on small ones. Obviously, this has not always developed as is demonstrated by the anomalous libytheid, *Libythea collenettei* Poulton and Riley from Marquesas Islands (Shields 1987). Theoretically, the only species that could have survived throughout geologic time should be the more adaptable generalized taxa, and *L. collenettei* is a prime example. In all likelihood, the Tongas were continuously populated by butterflies, but it is doubtful if many component species of an early fauna persisted until the present.

Although a composite vicariance-dispersal model for insular butterfly faunas has been employed elsewhere (Thornton 1983; L. Miller & J. Miller, 1989), the major portion of the present-day Tonga Islands and Niue, Cook Islands butterflies have been derived via a dispersal or accidental introduction with the possible exception of the *Spalgis* sp. While vicariance might have occurred initially, it is very unlikely that many of the original faunal components would have survived. Of these, the greatest percentage are represented in the Lycaenidae, a far more dispersalist family than once believed (Thornton 1983). There are presently 26 butterfly taxa recorded from the Tonga Islands

and Niue, Cook Islands. However, due to the paucity of researchers to these islands, we expect that the faunal list is far from complete and look forward to further studies on the Lepidoptera and other insect fauna.

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The map was prepared by Mrs. C. Kienzle, now of the Dept. of Biology, University of Virginia, Charlottesville.

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