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The New Zealand Genus *Metacrias* Meyrick (Lepidoptera:
Arctiidae) Systematics and Distribution

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Abstract

THREE species of the New Zealand arctiid genus *Metacrias* are described in detail, including their immature stages. Two closely related species over which some confusion has existed, *M. huttoni* and *M. erichrysa*, are regarded as distinct and recent glaciation is suggested as a possible explanation of their separation. The differing habitats and distribution patterns of the three species are discussed. It is concluded that rainfall is a major factor governing distribution. The female is semiapterous.

INTRODUCTION

THE endemic New Zealand genus *Metacrias* Meyrick comprises three species of strikingly coloured, diurnal "Tiger Moths" which are the sole representatives of the cosmopolitan sub-family Arctiinae in this country. A remarkable feature of the genus, which is shared with only two other genera of Arctiids, is that the female is semiapterous, remaining within her cocoon for mating and oviposition. Apart from this, the species are typical "Tiger Moths" with very hairy larvae feeding on a variety of low herbs, large but rather frail cocoons, and moderate-sized, stout-bodied male imagoes with yellow and black wings. The subfamily Arctiinae attains its greatest development in the tropics.

A. G. Butler described the first species of *Metacrias* in 1879 as *Phaos Huttonii* from material collected by F. W. Hutton at Queenstown, Otago. Hutton also observed the apterous female. In 1886 E. Meyrick discovered *M. erichrysa* on Mt Arthur, Nelson, and in the same year proposed the genus *Metacrias* for this and *M. huttoni*. G. V. Hudson added the third species in 1889, when he described *M. strategica* from a single specimen taken by W. W. Smith from near the summit of the Richardson Range, South Canterbury.

Some confusion has existed between *M. huttoni* and *M. erichrysa*, two very similar species inhabiting mountainous areas. Meyrick (1886, 1890) distinguished *M. huttoni* from *M. erichrysa* by the presence of a red subcostal streak on the forewings. When Howes (1943) collected numerous specimens from the Homer Valley, Southland, he concluded that the colour variations are so great that previous distinctions cannot be relied upon for separating the two species. He

proposed that the Homer form was a local race of *M. huttoni* and referred to it as *M. huttoni* subsp. *erichrysa*. Hudson (1951), discussed the same Homer specimens, referring to them as *M. erichrysa* and thus maintaining the two distinct species. In the course of this study a total of 57 male specimens of *M. huttoni* and 86 of *M. erichrysa* were examined from most of the habitats recorded, and the descriptions drawn up from these. Thirty-eight males of *M. strategica*, a quite distinct species, were examined. An extensive study of the ecology, distribution and life histories of these species has supported the original division into three distinct species.

GENUS METACRIAS Meyrick, 1886

Head with proboscis reduced, galeae fleshy and separate; maxillary palps minute; labial palps short, three-segmented, hairy. Antennae in male moderately binate to apex, filiform in female. Legs with one pair of short tibial spurs distally on both meso- and metatibiae. Head, thorax, abdomen and femora densely hairy. Forewings with R1 free, R2 and R3 stalked, R4 and R5 stalked, with R3 sometimes anastomosing with R4 for a short distance to form an areole; M1 from a point with or out of R4+5; M2, M3 and Cula very close and equally spaced at the base; Cu1b from $\frac{2}{3}$. Hindwings with Sc+R from $\frac{1}{3}$; RS and M1 from a point. Genitalia in male with very simple club-like valvae. Female semi-apterous and inactive.

There is no general agreement on the affinities of this genus. Hudson (1928) considers it nearest to *Ocnogyna* Led., a European genus with a semiapterous female imago. As far as can be determined, these two genera, and one species of *Phragmatobia* Steph. from the Pyrenees are the only Arctiids to have flightless females. This, however, is not a sign of affinity since other species of *Phragmatobia* possess fully developed females. Hampson (1901) places *Metacrias* close to the Palaearctic genus *Arctia* Schrk., and Hudson (1889) originally described one of the species under that genus. Affinities with Australian genera are considered by Meyrick (1886) who states that *Metacrias* is "apparently most allied to some Australian forms of *Spilosoma* Steph. but quite distinct"; and Tillyard (1926) who suggests affinities with *Estigmene*, especially *E. interfixa*, which occurs in the Southern Alps of Australia and in Tasmania.

KEY TO THE SPECIES OF *Metacrias*. (Males only.)

- | | |
|---|----------------------|
| 1 (4) Hindwings with a large black reniform patch at the distal end of the cell. | |
| 2 (3) Forewing markings creamy-white on black, crimson subcostal streak invariably present, wingspan rarely exceeds 32 mm | <i>M. huttoni</i> |
| 3 (2) Forewing markings orange on black, red subcostal streak often pale or orange as other markings, wingspan rarely less than 34 mm | <i>M. erichrysa</i> |
| 4 (1) Hindwings without large black reniform patch, forewing markings creamy white without any costal or subcostal streaks | <i>M. strategica</i> |

Metacrias huttoni (Butler). (Fig. 1.)

1879. *Phaos Huttonii* Butler, p. 487.

1886. *Metacrias huttonii* (Butl.). Meyrick, p. 750.

1890. *Metacrias huttonii* (Butl.). Meyrick, p. 216.

1892. *Metacrias huttonii* (Butl.). Kirby, p. 263.

1898. *Metacrias huttonii* (Butl.). Hudson, p. 5, Pl. IV, fig. 6.

1901. *Metacrias huttoni* (Butl.). Hampson, p. 468, fig. 204.

1928. *Metacrias huttoni* (Butl.). Hudson, p. 43, Pl. VI, fig. 1.

MALE

Wingspan approximately 29 mm.

Head. Densely clothed in long greyish hair concealing the palps and galeae. Antennae 7 mm, black, $\frac{1}{2}$ or slightly more of the forewing, moderately bipectinated to apex.

Thorax. Lightly clothed above with black hair, with longer greyish hair around margins of tegulae and patagia, forming loose crests; ventrally the hairs long, greyish, dense.

Legs. Coxal hairs almost white; profemur with red and orange closely adhering scales dorsally; tibiae and tarsi of all legs with orange-yellow scales.

Wings. Forewings elongate triangular, costa straight, termen strongly rounded; R2+3 distinct from R4+5 in 9 of the 10 specimens examined (i.e., no areole) (Fig. 7); RS extremely short. Upper surface black with cream markings between the veins; a cream costal streak tapers distally to about $\frac{1}{4}$; a narrow crimson subcostal streak is invariably present, terminating at $\frac{1}{3}$; a short wedge-shaped streak occurs towards the distal end of cell and posterior to it between Cu1b and 1A is a long streak from the base to the termen with a constriction at $\frac{2}{3}$; a black reniform patch covers the medial cross-vein, distal to which is a series of five oval cream patches between veins R5 to Cu1b, the second from costa being the largest; a subterminal series of six narrow streaks between the veins, and a very narrow cream posterior margin to the wing complete the markings. Hindwings rounded, orange-yellow above, costal area often light red; an area of scattered black scales mixed with long whitish hairs occurs towards the base between the cubital vein and the inner margin, the black scales being most prominent along the cubital and second anal veins; a large black reniform patch is in the centre of the hindwing and a broad black terminal band, scalloped along its inner margin between the veins is connected to a large circular tornal spot on the second anal vein. Undersurface of both wings orange-yellow; forewings with a prominent but rather diffuse crimson subcostal streak, a black reniform patch on the medial cross-vein and a broad black terminal band containing the same small subterminal cream streaks as on the upper surface; hindwings almost identical to upper surface. The cilia are mainly yellowish.

Abdomen. Black, sparsely clothed with black and greyish hairs except on pleural regions where dense, long, orange hairs and scales occur, also forming transverse bands across the posterior margin of each sternite; three tufts of long, black or greyish hairs conceal the genitalia.

Genitalia. Uncus triangular in dorsal view with the apex bluntly pointed; gnathos absent; aedeagus approximately 2 mm, vesica unevenly covered with numerous small to minute chitinous spines; valva with an elongate club-like posterior process, $\frac{1}{2}$ of the aedeagus, expanded slightly at its extremity where it bears some short, stiff setae.

FEMALE

Total length approximately 9 mm. All parts, except the antennae and tibiae and tarsi of the legs, are invested with dense whitish hair, lying close to the integument and not more or less erect as in the male. Antennae 4.2 mm, filiform, with sparse covering of whitish scales.

Thorax. Dense covering of hair above and below. Legs short and stout, with closely adhering scales similar to those of the male but white. Dorsum of thorax membranous except for anterior margin and a narrow sclerified mid-line.

Wings. Extremely reduced, thick and fleshy, forewing as long as antenna; hair covering white but may show some indefinite blackish markings; almost immovable and not linked together; usually held out laterally.

Abdomen. Large and membranous, almost spherical, segmental divisions indicated by the hair covering; anal papillae conspicuous at the posterior extremity.

Genitalia. Ductus bursae curved, sclerotised above, membranous beneath, the sclerotised part expanding to surround the dorsal and lateral margins of the aperture as the lamina postvaginalis which is free from sternite 8; corpus bursae a two-lobed sac, one rather thick-walled opening directly from the ductus, the other a thin-walled sac directly above; no signa; a pair of branched scent glands open dorsally, posterior to tergite 8.

IMMATURE STAGES

Ovum. Creamy-white, becoming darker immediately prior to hatching; almost spherical, 0.92 mm diameter, slightly flattened opposite the micropyle; dorsal surface of shell minutely stippled in a reticulate pattern, smooth and glabrous beneath.

First Instar Larva. Length 4 mm; white, with head, legs and setal sclerites brown; abdominal setae few, black, moderately long, with small barbs; spiracles circular, ringed with brown.

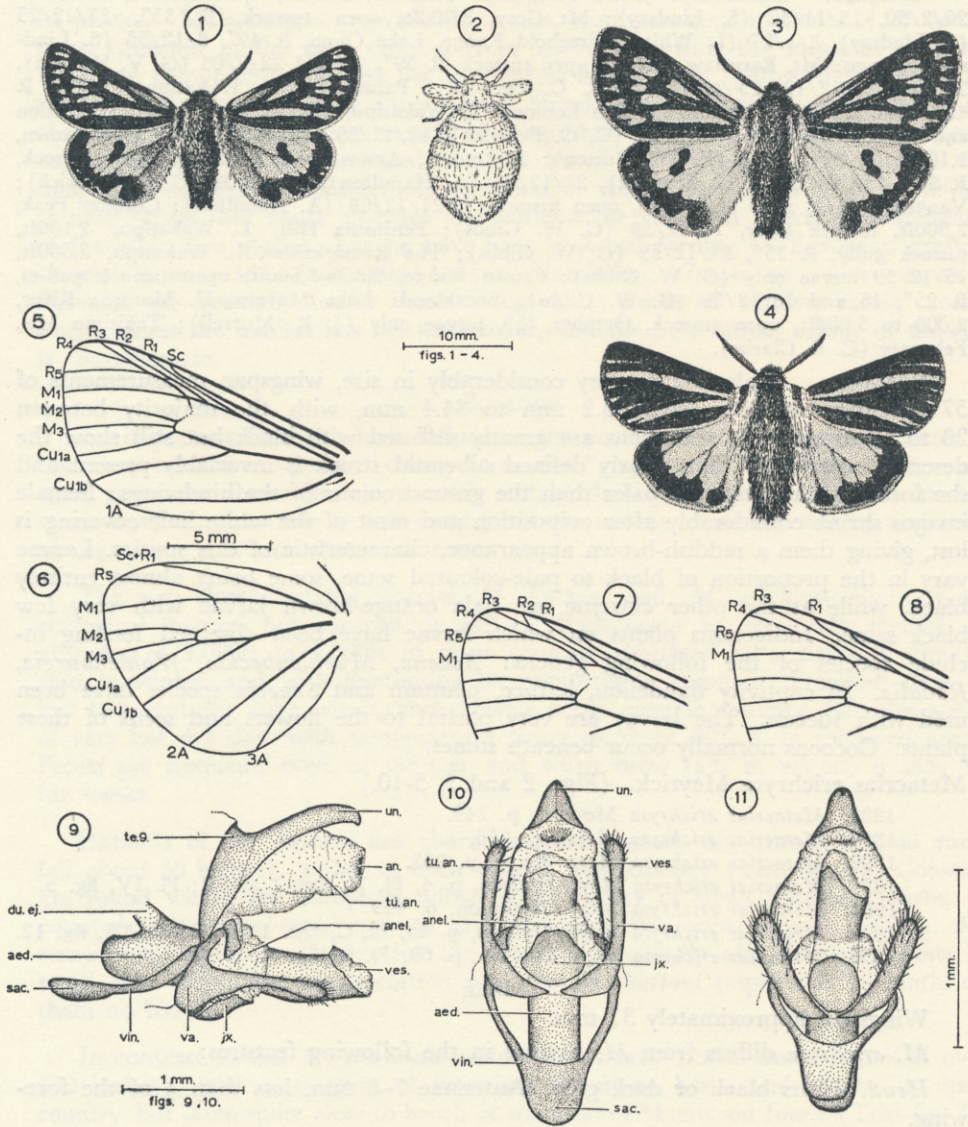
Second Instar Larva. Length 7 mm; grey with a prominent white mid-dorsal stripe; sclerites dark brown, those bearing setae convex verrucae; black setae numerous and very long; several short white setae on each dorsal verruca and about 10 extremely long whitish setae projecting posteriorly from the dorsum of the last four segments; spiracles circular, ringed with dark brown.

In the succeeding instars the larvae increase in size and "hairiness", the integument becoming darker. The long white posterior setae remain in all instars after the first but the proportion of short white and yellow setae increases.

Ultimate Instar Larva. Length 28 mm; black with a faint mid-dorsal stripe; head capsule and leg sclerites glossy black; verrucae appear as a series of iridescent blue warts in sunlight; trunk with dense long black setae, those of the posterior segments being the longest; short pale-coloured setae, situated around the margins of verrucae, form intersegmental bands on all segments except prothoracic, mesothoracic and anal; yellowish or white on dorsal and subdorsal verrucae, yellowish-brown on lateral. Spiracles oval with black margins.

Pupa. Length of male 13 mm, blunt anteriorly, roughly parallel-sided, tapering posteriorly; female 15 mm, thorax small but abdomen very stout, tapering abruptly. Dark brown with intersegmental regions of abdomen slightly paler. Antennae in male meet in mid-ventral line, but terminate at $\frac{2}{3}$ of wing in female. Conspicuous patches of short, stiff setae on abdomen in same positions as the larval verrucae; cremaster with 7-10 radiating rods, each with an expanded roughened head. Pupa enclosed in a thin double cocoon of white silk intermixed with larval setae.

TYPES. Holotype and two paratype males from Queenstown, Otago, 1879, F. W. Hutton. (Holotype and 1 paratype, British Museum; 1 paratype, Canterbury Museum.)



TEXT-FIG. 1.—Fig. 1—*Metacrias huttoni* (Butler), paratype male from Queenstown. Fig. 2—*Metacrias erichrysa* Meyrick, female from Homer. Fig. 3—*Metacrias erichrysa* Meyr., syn-type male from Mt Arthur. Fig. 4—*Metacrias strategica* (Hudson), male from Owaka. Figs. 5–10—*M. erichrysa*. Fig. 5—Forewing with areole. Fig. 6—Hindwing. Fig. 7—Forewing without areole. Fig. 8—Forewing with R2 lacking. Fig. 9—Male genitalia, lateral view. Fig. 10—Male genitalia, ventral view. Fig. 11—*M. strategica*, male genitalia, ventral view. Abbreviations: aed., aedaeagus; an., anus; anel., anellus; du. ej., ductus ejaculatorius; jx., juxta; sac., saccus; te., tergite; tu. an., tuba analis; un., uncus; va., valva; ves., vesica; vin., vinculum.

RECORDS. Canterbury: Jack's Pass, near Hanmer, 2,800ft, open tussock, R 45",* 20/2/30, 15/11/32 (S. Lindsay); Mt Grey, 3,000ft, open tussock, R 35", 27/12/25 (S. Lindsay), 8/1/27 (L. White); Freehold Range, Lake Ohau, R 49", 3/12/35 (S. Lindsay). Otago: Mt Earnslaw, 5,300ft, open tussock, R 59", 20 and 22/2/03 (G. V. Hudson), 26 and 27/12/19, 25-29/12/22 (C. C. Fenwick); Paradise, Lake Wakatipu, 1,200ft, R 45", Dec. '22 (C. C. Fenwick); Ben Lomond, L. Wakatipu, 4,000ft, open mixed vegetation and tussock, 22/12/12, 10/1/21 (C. C. Fenwick), 12/12/59 (G. W. Gibbs); Queenstown, 1,100ft, R 32", 1879 (F. W. Hutton); Macetown, Arrow River, 1,800ft, open tussock, R 30", 15/12/08 (C. C. Fenwick), 21/12/08 (A. Hamilton), 26/12/09 (C. C. Fenwick); Vanguard Peak, near Macetown, open tussock, 19-21/12/08 (A. Hamilton); Coronet Peak, 2,500ft, tussock gully, 13/12/59 (G. W. Gibbs); Peninsula Hill, L. Wakatipu, 2,100ft, tussock gully, R 35", 23/12/59 (G. W. Gibbs); The Remarkables, L. Wakatipu, 2,500ft, 15/12/59 larvae only (G. W. Gibbs); Crown Range, 2,800-3,600ft, open tussock gullies, R 25", 16 and 18/12/59 (G. W. Gibbs). Southland: Lake Mavora, U. Mararoa River, 2,000 to 3,000ft, open tussock, October, '59, larvae only (J. R. Murrell); Takitimo Mts, February (C. E. Clarke).

REMARKS. Male imagos vary considerably in size, wingspan measurements of 57 specimens ranging from 25.2 mm to 34.4 mm, with the majority between 28 to 32 mm. Some specimens are greatly suffused with black but still show the described markings. The clearly defined subcostal streak is invariably present and the forewing markings are paler than the ground colour of the hindwings. Female imagos shrink considerably after oviposition and most of the white hair covering is lost, giving them a reddish-brown appearance, characteristic of this species. Larvae vary in the proportion of black to pale-coloured setae, some being almost entirely black, while at the other extreme are pale orange-brown larvae with very few black setae. Indigenous plants on which larvae have been observed feeding include species of the following genera: *Acaena*, *Muehlenbeckia*, *Wahlenburgia*, *Raoulia*. In captivity dandelion, lettuce, plantain and *Senecio* species have been used with success. The larvae are very partial to the flowers and seeds of these plants. Cocoons normally occur beneath stones.

Metacrias erichrysa Meyrick. (Figs. 2 and 3, 5-10.)

1886. *Metacrias erichrysa* Meyrick, p. 749.

1890. *Metacrias erichrysa* Meyr., p. 216.

1892. *Metacrias erichrysa* Meyr. Kirby, p. 263.

1898. *Metacrias erichrysa* Meyr. Hudson, p. 4, Pl. II, figs. 1 and 2; Pl. IV, fig. 5.

1901. *Metacrias erichrysa* Meyr. Hampson, p. 469.

1928. *Metacrias erichrysa* Meyr. Hudson, p. 43, Pl. C, figs. 1 and 2; Pl. VI, fig. 12.

1950. *Metacrias erichrysa* Meyr. Hudson, p. 69, Pl. V, fig. 3.

MALE

Wingspan approximately 37 mm.

M. erichrysa differs from *M. huttoni* in the following features:

Head. Hairs black or dark grey. Antennae 7-8 mm, less than $\frac{1}{2}$ of the forewing.

Thorax. Hair black, very few grey hairs except on margins of tegulae; hair dark grey below, those of coxae grey, rarely whitish.

Wings. Areole present in 8 of the 12 specimens examined, formed by R3 anastomosing with R4 for about $\frac{1}{2}$ its length (Fig. 5); radial sector (RS) longer than in *M. huttoni*. Costal and subcostal streaks coalesce at the base; colour of combined streak varies from pale orange to dull red. Hindwing with reniform patch often quite narrow and crescent-shaped; very few black scales towards base of wing.

Genitalia. Genitalia (Figs. 9 and 10) almost identical to *M. huttoni* but larger; aedeagus approximately 2.9 mm.

* R, mean annual rainfall in inches.

FEMALE

Total length reaches 16 mm, abdomen 9 mm diameter; hair white, integument pale yellow, never reddish.

IMMATURE STAGES

Ovum. 1.13 mm diameter, otherwise as in *M. huttoni*.

Larva. First instar larva 5 mm, identical to *M. huttoni*; growth is more rapid but colour very similar to *M. huttoni* from second to fifth instars; short setae covering intersegmental regions golden yellow, not whitish. Ultimate instar larva reaches a length of 35–40 mm, females larger than males; velvety-black, head and leg sclerites glossy black, verrucae dark iridescent blue in strong light; short, deep yellow setae form intersegmental bands on all segments except prothoracic, mesothoracic and anal, never as pale or as numerous as in *M. huttoni*.

Pupa. Length of male 16 mm; female 20 mm; patches of setae inconspicuous with extremely short setae; other features of pupa and cocoon as in *M. huttoni*.

TYPES. Three male and one female syntypes from Mt Arthur, Nelson, January 15, 1886, E. Meyrick. (Four syntypes, British Museum; one paratype, Canterbury Museum.)

RECORDS. North Island: Head of Waipawa River, Ruahine Range, 4,000ft to 5,000ft, R 70", reared, 1932–33 (E. S. West); head of Wangawa River, Tararua Range, 3,600ft, subalpine scrub and tussock bog, R 200", 26/11/58, larvae and imago (G. W. Gibbs), 7/3/59, larvae only (G. W. Gibbs). South Island, Nelson: Mt Arthur, 4,000ft, open tussock, R 100", 15/1/86 (E. Meyrick), 23/1/89, 8/1/91 (G. V. Hudson); Mt Peel, 7/1/96 (G. V. Hudson), 28/12/12 (A. Hamilton); Gordon's Pyramid, Arthur Range, 25/1/24 (S. Lindsay); Nuggets Knob, Upper Wangapeka River, 4,500ft, tussock mountain tops, 26/12/61 (G. W. Gibbs). Canterbury: Lewis Pass, 3,000ft, tussock clearing in beech forest, R 100", Dec. '58, larvae only (J. T. Salmon); Goat Pass, Head of Mingha River, 4,000ft, open *Dracophyllum* scrub and tussock, R 160", February '37 (A. G. Macfarlane); Upper Waimakariri River, December, '35 (R. C. Cooke); Upper Rakaia River, R 60", 2/12/33, 9/12/33 (L. White). Otago: Mt Earnslaw, 5,000ft to 6,000ft, open tussock, R. 59", 22/12/22 (C. C. Fenwick), 1/1/41 (R. Parlin); Ben Lomond, Lake Wakatipu, 4,000ft, 10/1/21 (C. C. Fenwick). Westland: Upper Hokitika River, December, '56, larvae only (N.Z. Forest Service survey). Southland: Lake Marian, Hollyford Valley, 2,400ft, grassy slopes of lake shore, 27/12/59, larvae only (G. W. Gibbs); Marion, Hollyford Valley, December, '42 (G. Howes); Upper Hollyford Valley, 3,000ft, open river flats, 26/12/59 (G. W. Gibbs); Homer Valley, 3,300ft, rocky slope with mixed vegetation, R 280", January, '42 (G. Howes), 17/12/43, 21/12/44 (J. T. Salmon), 24–29/12/59 (G. W. Gibbs); Cleddau Valley, 3,000ft, 17/12/44 (J. T. Salmon); Pompalona Hut, Milford Track, 1,800ft, subalpine river flats, R 180", 7/12/32 (L. White); McKinnon Pass, Milford Track, 3,400ft, open tussock, R 200", 27 and 28/12/19 (Campbell) (C. E. Clarke); Southland: Mt Kemp and Kepler Range, Lake Te Anau, December and January (C. E. Clarke).

REMARKS. Variation in male imago is similar to that in *M. huttoni*. Wingspan measurements of 86 specimens ranged from 31–41 mm, with the majority between 36 and 38 mm. Colour variations involve the extent of the black markings and the depth of colour in the coalesced costal and subcostal streaks. This latter, however, is never as bright as in *M. huttoni*. The pale colour of both wings is almost invariably of the same tone. Female imago may be distinguished by their large size and creamy yellow colour after oviposition, never reddish. Very little variation occurs in the larva, this being distinguished from *M. huttoni* by the darker golden intersegmental bands. Food plants are the same as for *M. huttoni*. Cocoons are normally found beneath stones.

***Metacrias strategica* (Hudson). (Figs. 4 and 11.)**

1899. *Arctia* (*Metacrias*) *strategica* Hudson, p. 53.

1890. *Metacrias strategica* (Huds.). Meyrick, p. 216.

1892. *Metacrias strategica* (Huds.). Kirby, p. 263.

1898. *Metacrias strategica* (Huds.). Hudson, p. 4, Pl. IV, fig. 4.

1901. *Metacrias strategica* (Huds.). Hampson, p. 468.

1928. *Metacrias strategica* (Huds.). Hudson, p. 44, Pl. I, fig. 20; Pl. VI, figs. 9 and 10.

MALE

Wingspan approximately 31 mm.

Head. Densely clothed with long erect hair, yellow on frontal region, black elsewhere, concealing the palps. Antennae blackish-brown, 6 mm, moderately bipectinated to apex.

Thorax. Densely hairy; a semi-circular crest on the prothoracic patagia, dark-grey in the midline, yellow laterally; dorsum of meso- and metathorax jet-black; very conspicuous crests on tegulae, black with long yellow hairs around margins; very long hair beneath, blackish with some yellow on procoxa.

Legs. Femur of each leg with closely adhering pale crimson scales above, yellow and black scales below; tibiae and tarsi yellowish above, dark-coloured beneath.

Wings. Forewings elongate triangular, costa straight, termen strongly rounded, anal margin curved basally; R3 anastomoses with R4+5 to form a short areole in 7 of the 10 specimens examined. Upper surface black with creamy-white streaks; an anterior broad cream streak, narrowed at either end, from the base through cell to the termen between veins M1 and M2; a long broad posterior streak from base to termen between the cubital and anal veins, often finely forked at extremity; four narrow streaks along the termen, one anterior between R5 and M1, the others between the two long streaks; a narrow cream line along the anal margin. Hindwings rounded, orange-yellow with long yellow hairs towards anal margin and base; a moderate to broad black terminal band, scalloped along its inner margin between the veins; an isolated circular black ternal spot; a narrow band of red along the terminal margin from M1 to the ternal spot on 2A; the veins are indicated by fine black lines. Undersurface of both wings yellowish, margined with black, narrow along costa, broad around termen, a diffuse red subcostal streak and an extremely small black discal spot on both wings; hindwing with ternal spot and red terminal margin as on upper surface. Cilia creamy-white and grey.

Abdomen. Clothed dorsally with dense, long, brownish-yellow or black hair; tufts of long yellow hair on pleural region; closely adhering scales on the sternites forming black and yellow transverse bands.

Genitalia. (Fig. 11.) Uncus triangular in dorsal view, apex hooked ventrally; gnathos absent; aedeagus approximately 1.5 mm; valva with short broad posterior process, $\frac{1}{3}$ of the aedeagus, and bearing some short, stiff setae on its rounded extremity.

FEMALE

Total length approximately 12 mm. Entirely covered except antennae, with long, pale-brown, grey or yellowish-brown hair and scales. Antennae 4 mm, filiform, with sparse covering of whitish scales.

Thorax. Densely covered with hair above and below, including all leg joints in fresh specimens. Dorsum fully sclerotised. Legs fully developed, but each joint shorter than in the male.

Wings. Reduced to approximately the length of the antennae; thick and fleshy; densely hairy, often with some dark-coloured markings; almost immovable and held back against the abdomen.



TEXT-FIG. 2.—Habitat of *Metacrias huttoni* (Butl.) on Coronet Peak. Young larvae and cocoons were found under the flat schistose stones on the left-hand side of the gully. Altitude 2,500ft.



TEXT-FIG. 3.—Habitat of *Metacrias erichrysa* Meyr. in the Tararua Range, North Island. A subalpine bog near the bushline at 3,600ft, where larvae were abundant on a small *Juncus* sp. which forms the ground cover.

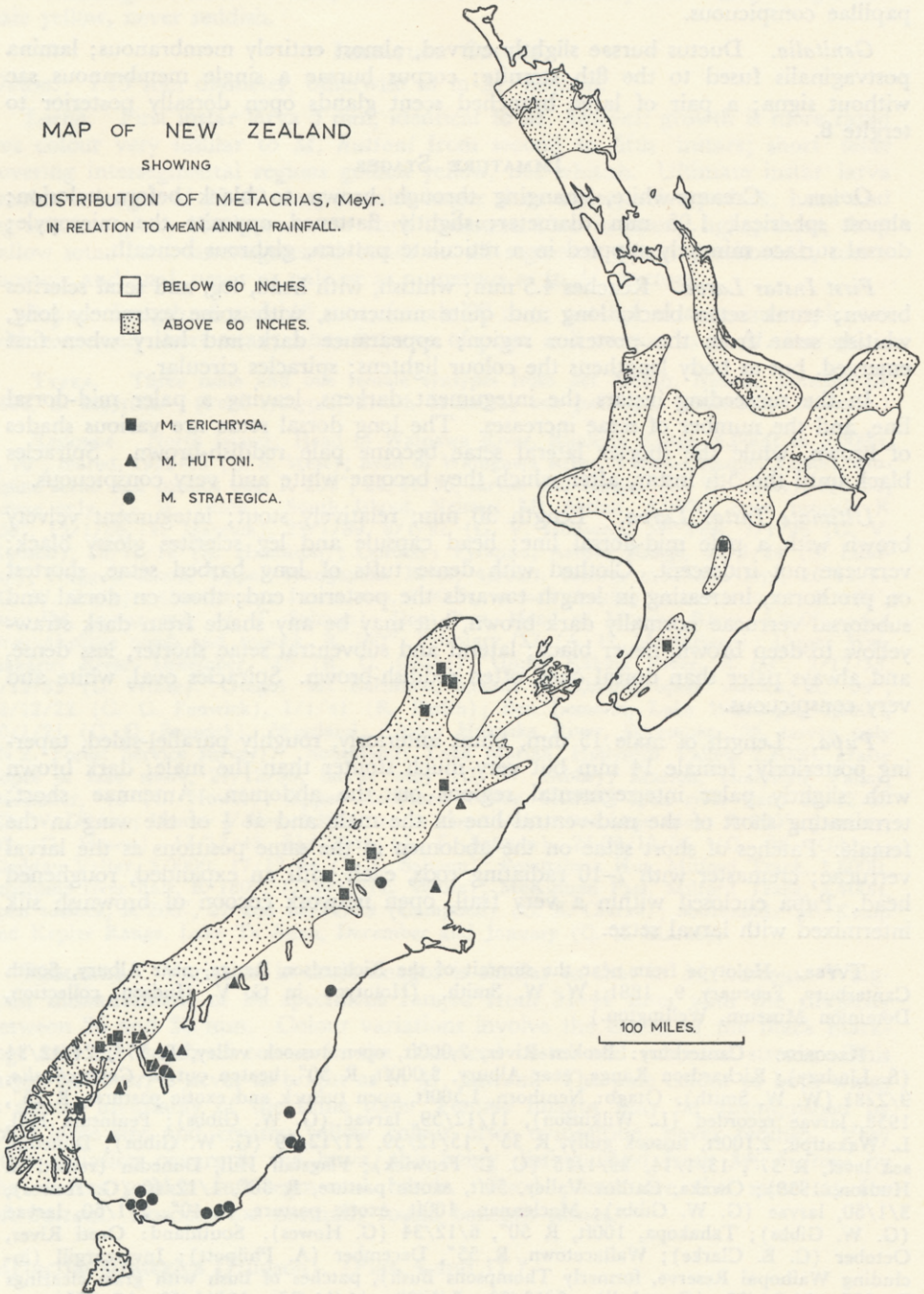
MAP OF NEW ZEALAND

SHOWING

DISTRIBUTION OF METACRIAS, Meyr.
IN RELATION TO MEAN ANNUAL RAINFALL.

- BELOW 60 INCHES.
- ▒ ABOVE 60 INCHES.

- M. ERICHRYSA.
- ▲ M. HUTTONI.
- M. STRATEGICA.



Abdomen. Large and spherical; 1st and 2nd tergites sclerotised, remainder membranous; segmental divisions clearly indicated by the hair covering; anal papillae conspicuous.

Genitalia. Ductus bursæ slightly curved, almost entirely membranous; lamina postvaginalis fused to the 8th sternite; corpus bursae a single membranous sac without signa; a pair of large branched scent glands open dorsally posterior to tergite 8.

IMMATURE STAGES

Ovum. Creamy-white, changing through brown to black before eclosion; almost spherical, 1.05 mm diameter; slightly flattened opposite the micropyle; dorsal surface minutely stippled in a reticulate pattern, glabrous beneath.

First Instar Larva. Reaches 4.5 mm; whitish, with head, leg, and setal sclerites brown; trunk setae black, long and quite numerous, with some extremely long, whitish setae from the posterior region; appearance dark and hairy when first emerged, but as body lengthens the colour lightens; spiracles circular.

In the succeeding instars the integument darkens, leaving a paler mid-dorsal line, and the number of setae increases. The long dorsal setae are various shades of brown, while the shorter lateral setae become pale reddish-brown. Spiracles black until the 5th instar, after which they become white and very conspicuous.

Ultimate Instar Larva. Length 30 mm, relatively stout; integument velvety brown with a pale mid-dorsal line; head capsule and leg sclerites glossy black; verrucae not iridescent. Clothed with dense tufts of long barbed setae, shortest on prothorax, increasing in length towards the posterior end; those on dorsal and subdorsal verrucae normally dark brown, but may be any shade from dark straw-yellow to deep brown, never black; lateral and subventral setae shorter, less dense, and always paler than dorsal ones, often reddish-brown. Spiracles oval, white and very conspicuous.

Pupa. Length of male 13 mm, blunt anteriorly, roughly parallel-sided, tapering posteriorly; female 14 mm but very much stouter than the male; dark brown with slightly paler intersegmental regions on the abdomen. Antennae short; terminating short of the mid-ventral line in the male and at $\frac{1}{2}$ of the wing in the female. Patches of short setae on the abdomen in the same positions as the larval verrucae; cremaster with 7–10 radiating rods, each with an expanded, roughened head. Pupa enclosed within a very frail, open network cocoon of brownish silk intermixed with larval setae.

TYPES. Holotype from near the summit of the Richardson Range, near Albury, South Canterbury, February 9, 1881, W. W. Smith. (Holotype in G. V. Hudson collection, Dominion Museum, Wellington.)

RECORDS. Canterbury: Broken River, 2,000ft, open tussock valley, R 37", 24/12/34 (S. Lindsay); Richardson Range, near Albury, 3,000ft, R 30", beaten out of *Carmichaelia*, 9/2/81 (W. W. Smith). Otago: Nenthorn, 1,500ft, open tussock and exotic pastures, R 25", 1958, larvae recorded (L. Wilkinson), 11/12/59, larvae (G. W. Gibbs); Peninsula Hill, L. Wakatipu, 2,100ft, tussock gully, R 35", 15/12/59, 21/12/59 (G. W. Gibbs); Dunedin, sea level, R 37", 13/1/14, 29/1/15 (C. C. Fenwick); Flagstaff Hill, Dunedin (record in Hudson, 1939); Owaka, Catlins Valley, 50ft, exotic pasture, R 36", 1/12/40 (G. Howes), 3/1/60, larvae (G. W. Gibbs); MacLennan, 100ft, exotic pasture, R 40", 2/1/60, larvae (G. W. Gibbs); Tahakopa, 100ft, R 50", 6/12/34 (G. Howes). Southland: Oreti River, October (C. E. Clarke); Wallacetown, R 55", December (A. Philpott); Invercargill (including Waihopai Reserve, formerly Thompsons Bush), patches of bush with grass clearings R 55", 24/11/99 (Campbell), 6/12/99, 7/1/00, 11/11/00, 16/11/00 (G. Howes), 27/11/08 (A. Hamilton), 1/12/13 (Campbell), 1/1/60 (G. W. Gibbs); Morton Mains, 1901, larvae (A. Philpott); Otatara, 1901, larvae (A. Philpott and G. Howes); West Plains, 1901, larvae (A. Philpott and G. Howes).

REMARKS. *Metacrias strategica* is distinct from the other two species in all its phases. Male imagos are variable in size, wingspan measurements of 31 specimens collected in the field ranging from 26–36 mm with the mean at 31 mm. However, colour variations are not as great as in the other species, the majority of specimens having the four short cream streaks on the forewings indistinct or absent. Female imagos are readily distinguished by their brownish or greyish colour and the brown sclerotised notal plates of the thorax. In contrast to the imagos, larvae exhibit considerable variation in colour, ranging from straw-yellow to deep brown, but never jet-black and without the yellowish intersegmental bands of the other two species. Larvae have been observed feeding on European grasses, clover, *Acaena* sp., *Bulbinella hookeri*, dandelion, *Crepis* sp., and plantain. Cocoons are normally found beneath logs and pieces of timber, rarely under stones unless the habitat has no other cover, and the pale brown colour of the silk is characteristic.

ECOLOGY

An important feature which influences the ecology of the *Metacrias* species is that they exhibit a type of "colony formation", appearing abundantly over very small areas, yet absent from apparently suitable habitats. The colonies presumably result from the immobile female imago, but are usually also restricted by a change of vegetation or a lack of suitable cover.

The two closely related species, *M. huttoni* and *M. erichrysa* share some ecological features but contrast in others. Both occur in mountain regions at altitudes of 3,000ft to 4,000ft in open country, subjected to a rigorous climate, cold in winter, and with fluctuating temperatures in summer. Frequent days of low temperatures, high winds, and showers occur even in summer, but also spells of very hot dry days with temperatures rising to about 80° F. in sheltered areas. Frosts are frequent, even in summer and when snow falls in winter, it may lie for weeks.

Habitats of *M. huttoni* are characteristically small, dry (mean annual rainfall about 35 inches), gullies in open tussock high country (Text-fig. 2). Colonies are found where the dampness allows some variety of small subalpine herbs, in particular *Muehlenbeckia* spp. to grow amongst the snow tussock. Some flat stones are necessary as cover for the cocoons, frequently also sheltering nests of small ants which live in association with the *M. huttoni* pupae but evidently do them no harm.

In contrast to this *M. erichrysa* prefers a wet area (mean annual rainfall over 100 inches), with a mixture of luxuriant subalpine herbs and shrubs in open country, but often quite close to beech or mountain ribbonwood forest (Text-fig. 3). Characteristic plants include: *Raoulia* spp., *Muehlenbeckia* spp., and *Senecio* spp., as well as snow tussock. Areas with these features are usually old shingle scree, river flats or subalpine bogs.

Habitats of *M. strategica* are more variable; those in the northern part of its range being open tussock similar to those of *M. huttoni*. However, it occurs predominantly in pasture land near the coast where the rainfall is moderate (mean annual rainfall about 40 inches), but the climate rigorous with much misty, windy weather, and light snow falls in winter. Typical habitats are grassy areas near patches of bush, although the species may now occur in exotic pasture grassland. Cocoons, which are almost invariably found under logs, are often in association with those of another arctiid, *Nyctemera annulata*. Colony formation in this species has been noted by Howes (1901) in the Invercargill district, but from my

own observations is not as conspicuous as in the mountain species, presumably due to the more continuous nature of the habitats.

Howes and Philpott speak of *M. strategica* as being abundant in the Invercargill district about 1901. I could find no traces of larvae or cocoons in this area, and it is possible that many of the natural haunts of this species have now been cultivated and although it is surviving in exotic pasture, it may not be as plentiful as previously. Generally speaking it does not seem as successful as the two mountain species, neither in abundance nor in range of distribution.

DISTRIBUTION

Ecological conditions suiting *M. huttoni* or *M. erichrysa* occur in almost all New Zealand mountain regions yet the distribution of these two species is not continuous, but apparently confined to certain small areas. Climate seems to be the major factor responsible for separating these species, above all the rainfall and its related effects. *M. huttoni*, which is confined to the South Island, has occurred invariably on the drier eastern side of the Southern Alps where large areas of open tussock country predominate (see map). On the other hand *M. erichrysa*, which has the greatest range of the three species extending into the North Island, is normally close to the main dividing ranges or on their wetter western sides. *M. strategica* has not been recorded further north than 43° 10' S in the South Island and extends south to Invercargill. Its northern localities are in open country, but it seems most suited to the south-west coastal region of Otago and Southland.

It is of interest that in the Lake Wakatipu region all three species occur without any evidence of hybridisation. On Mt Earnslaw, where C. C. Fenwick captured specimens of both *M. huttoni* and *M. erichrysa* on December 27, 1922, these two closely related species remain very distinct. Both of these species have also occurred together on Ben Lomond, while on Peninsula Hill, *M. huttoni* and *M. strategica* are breeding in the same small gully, the former being much more plentiful than the latter.

Colour variations, although considerable even among specimens from a single colony, may be partly geographical. Thus specimens of *M. erichrysa* from the Ruahine Ranges may be recognised by a very fine red subcostal streak and the almost complete obliteration of the basal cream streak in the cell of the forewing; specimens from the western Nelson district (type locality), Waimakariri and Rakaia Valleys have the subcostal streak the same tone as the other forewing markings; while those from the Lake Wakatipu and Te Anau districts may have the subcostal streak either dull red or orange-yellow. No records of *M. erichrysa* exist for about 150 miles between the upper Rakaia Valley and Mt Earnslaw. Geographical colour variations are hardly apparent with *M. huttoni*, although specimens from Mt Earnslaw tend to be rather suffused with black. Specimens from the northern habitats of *M. strategica*, Broken River, Albury and Nenthorn, have the four short cream streaks very strongly marked, while in those from Queenstown and the Southland coast, these streaks are almost or completely absent.

The climatic differences between the habitats of the two mountain species have possibly had a direct effect on the size of each species, those from the high rainfall areas being considerably larger. This is in accordance with the observations of Salmon (1954) on other insects from the Homer Valley, which in many cases were larger and darker than their lowland forms. In the one species, *M. huttoni*, specimens from higher rainfall areas—e.g., Mt Grey and Jack's Pass,

North Canterbury, are larger than those in dry Central Otago. Also, in *M. erichrysa* those from the driest habitat recorded for this species, Rakaia, are smaller and paler than specimens from high rainfall areas of fiordland. Specimens from the type locality of the Arthur Range fall about mid-way between these two extremes.

DISCUSSION

It is evident that the two mountain species are very closely related. Morphologically they differ only in size, but biologically they differ in their types of habitat and rates of larval growth. These features, and their very similar colour pattern, at first suggests that they are two ecological forms of the same species, however the following evidence establishes them as two distinct species. First, both species have occurred together on Mt Earnslaw on the same day (27/12/22, Fenwick) and on Ben Lomond, also on the same day (10/1/21, Fenwick). There are no intermediate forms from either of these localities. Secondly, I succeeded in cross-fertilising Homer Valley *M. erichrysa* and Crown Range *M. huttoni* imagos four times in captivity, once with a male *M. huttoni* and three times with males of *M. erichrysa*. The attractive scent of the female is similar in both species and copulation was successful, but of approximately 1,000 ova produced by the four matings, only five hatched. All were from one female which had laid 570 ova, and none reached maturity. Thirdly, the larval growth rates remained different for each species even when reared under identical conditions. It appears then, on the evidence available, that the two species are fully isolated in the Otago district where their distributions are adjacent or overlapping.

The methods of dispersal available to these species are limited to the larvae only. It is noteworthy that the larvae of all lepidoptera with flightless female imagos can feed on a great variety of plants, which enables them to wander from their normal habitat without the need to rely on a supply of a single plant species. In spite of being capable of migration, the larvae normally remain in small colonies. Male imagos are strong fliers and no doubt can cover extensive distances, probably from colony to colony, thus allowing an occasional exchange of genes and preventing each colony from diverging and becoming distinct forms.

On the basis of the close relationship between *M. huttoni* and *M. erichrysa*, it seems reasonable to assume that these have diverged relatively recently, while *M. strategica* has been distinct for a very much greater period of time. It is interesting to speculate on the geological and climatic factors which could be responsible for recent speciation in this genus by considering the present distribution of *M. huttoni* and *M. erichrysa*, one on the dry eastern side of the South Island ranges, the other largely in the high rainfall areas of the western ranges of both islands. The sequence of events was possibly as follows. In the Miocene a more or less continuous chain of low mountains occurred from the Ruahines southward to Southland, and a species of *Metacrias* was distributed along its whole length. Isolation of the Ruahines as an island was the first geological event to break up this extensive distribution, occurring about the U. Miocene or L. Pliocene (Fleming, 1949). The Tararuas remained connected to the South Island until the U. Pliocene, when Cook Strait was breached. A series of glacial advances followed in the Pleistocene, and although these are not known in detail, it is evident that in the last Alpine glaciation, permanent snow tipped the Tararuas and the N.W. Nelson mountains and descended to about 3,000ft at Stewart Island, lowering the life zones of the Alps some 3,000ft. In these conditions the South Island population could have been split into two groups, one on either side of the ranges. In their isolation the two groups diverged slightly, becoming adapted to the differing ecological conditions in the two

areas and are now spreading back towards each other as the ice retreats (i.e., over the past 20,000 years). In the Lake Wakatipu district, the only known area where they have overlapped, reproductive isolation is complete, and in this region of overlap they show more divergence than elsewhere, particularly with respect to size. Evidence from male specimens tends to support the geological evidence for the breaking up of the original species. First, the Ruahine specimens form a very distinctive group, suggesting long isolation, and secondly, together with the Tararua specimens, they exhibit somewhat intermediate characters between the two "newer" South Island species, and could thus be remnants of the original mountain population.

One interesting feature arising from the geological evidence is that the North Island forms could possibly be reproductively isolated from both of the South Island mountain species, yet not show much morphological differentiation. This has not been confirmed, so they are at present included in *M. erichrysa* to which they show the greatest resemblance.

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