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A New Species of *Graphium* Scopoli (Lepidoptera: Papilionidae) from the Bismarck Archipelago, Papua New Guinea

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ABSTRACT. *Graphium kosii* n.sp., a butterfly from high elevations in southern New Ireland, is described and figured. A key is presented for this and five closely related species: *Graphium weiskei* (Ribbe), *G. stresemanni* (Rothschild), *G. batjanensis* Okano, *G. macleayanum* (Leach) and *G. gelon* (Boisduval), all of which are confined to the Australasian region.

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This paper is the first of two treating new butterflies from little known montane forests of New Ireland. It describes a new species of *Graphium*. New Ireland is a long (c. 400 km) ancient island arc situated northeast of New Britain (2°–4°S 151°–153°E). The highest land reaches 2399 m in the southern "Lak" district and represents eroded, andesitic volcanoes, approximately 25 million years old (Pigram *et al.*, 1990). The biomes here are vertically diverse with lowland rainforest, mid and upper montane moss forest and a high montane heath vegetation, shown in Fig. 1 (McCallum & Sekhran, 1997). The International Conservation and Development Organisation (ICAD) attempted to procure the land proximal to the Weiten Rift Valley as World Heritage during 1992–1996 but terminated the project due to "land ownership difficulties" (P. Lavender, Pacific Heritage Foundation, pers. comm., 1998).

The "*weiskei*" group of butterflies within the genus *Graphium* comprises six closely related species: *G. macleayanum, G. weiskei, G. batjanensis, G. stresemanni, G. gelon* and the new species described here, *G. kosii* n.sp. All the species are restricted to the Australasian region, generally in and adjacent to mountainous areas. Saigusa *et al.*, (1977) showed more general phylogenetic relationships of this group with *G. empedovana* (Corbet), *G. codrus* (Cramer), *G. sarpedon* (Linnaeus), and *G. cloanthus* (Westwood).

Graphium macleayanum occurs as four subspecies in eastern mainland Australia, Tasmania, and Lord Howe Island (Common & Waterhouse, 1981) and in highland Papua New Guinea (Sands & Fenner, 1978). The various subspecies differ generally in the extent of the green in the basal area on the forewing above. Specimens from Mount Ginini (Australian Capital Territory) are distinct from most others from southeastern Australia in that they are small (forewing c. 29 mm) with broad wings, stunted tails and extensive greenish colouring. In this respect they more closely resemble specimens of *G. m. moggana* Couchman from Tasmania.

Graphium weiskei is a striking, well-known butterfly represented by the nominotypical subspecies and *G. w. goodenovii* (Rothschild), in upland mainland New Guinea and Goodenough Island, respectively (Parsons, 1998). Niculescu (1977) raised a monotypic genus, *Klinzigia*, for *G. weiskei* based primarily on its distinctive genitalia. However, he did not consider the other closely related species and, since then, this genus has been synonymised with *Graphium* (e.g., Hancock, 1983; Parsons, 1998). Haugum & Samson (1981) retained this as a subgenus for the whole "*weiskei*" group. Parsons (1998) recognised five main male colour forms from a study of many *G. weiskei* specimens from eastern Papua New Guinea.

Graphium batjanensis was described by Okano (1984) from an unknown locality in Batjan Island, Moluccas, but "it would be undoubtedly in the mountain area of 1,000 m high in Batjan Is." (Okano, 1984). This species is fairly common in the high mountains of southern Batjan (A. Lambartan, pers. comm.). Hancock (1985) treated this as a distinct species, although Parsons (1998) considered it conspecific with *G. weiskei*. The specific status of *G. batjanensis* is accepted in this work (see discussion). Parsons (1998) suggested that *G. weiskei* will eventually be discovered on Halmahera Island.

Graphium stresemanni was described by Rothschild (1915) from a series collected at Manusela, Central Seram (Ceram), above 1,000 m elevation, in 1912. Okano (1983) stated that the type locality was at "3250 ft". This species is distinct in bearing a full row of subterminal spots on the hindwing upperside, and by the shape of the male valva (see Fig. 3b).

Graphium gelon is superficially unrelated to the other species within the "*weiskei*" group, bearing a resemblance to other *Graphium* species—*G. sarpedon* and *G. monticolus* (Fruhstorfer). The genitalia of *G. gelon*, however, place it clearly within this group (Saigusa *et al*., 1977). Okano (1984) illustrated the female genitalia and male valva of *G. gelon* but did not include those of the other species within the group. *Graphium gelon* is restricted to New Caledonia and the nearby Loyalty Islands (Holloway & Peters, 1976).

The new species, *Graphium kosii*, is so far only recorded from the high mountains of southern New Ireland, although it probably occurs on the Lelet Plateau, central New Ireland, where there has been a fleeting glimpse of "*G. weiskei* or a closely related species" (Parsons, 1998).

Materials and methods. This study was based on material borrowed from the following institutions.

AM	Australian Museum, Sydney
ANIC	Australian National Insect Collection, CSIRO, Canberra
BMNH	British Museum (Natural History), London
CJMC	private collection of C.J. Müller, Sydney
DHC	private collection of D. Hall, Sydney
EPC	private collection of Edward Petrie, Sydney
KONE	Department of Primary Industries, Konedobu, Papua New Guinea
RGC	private collection of R. Gotts, Winmalee, Australia
RMC	private collection of Russell Mayo, Newcastle, Australia
RNHL	Rijksmuseum van Natuurlijke Historie, Leiden, Holland
SGC	private collection of S. Ginn, Sydney

Morphological terms and their abbreviations applied here conform with those used by Common & Waterhouse (1981).

Key to taxa within the "*weiskei*" species group of *Graphium*

1 Hindwing with tail at vein CuA1 vestigial/absent ..... *Graphium gelon* (Boisduval)

—— Hindwing with tail at vein CuA1 well developed 2

2 Forewing above with basal area beneath cell cream/light green 3

—— Forewing above with basal area beneath cell shade of blue, blue-green, turquoise, mauve, purple and/or pink 6

3 Forewing above with only anterior half of cell green ..... *G. macleayanum wilsoni* Couchman

—— Forewing above with cell entirely green 4

4 Beneath suffused yellowish ..... *G. macleayanum insulana* (Waterhouse)

—— Beneath not suffused yellowish 5

5 Forewing above with basal area green beyond cell towards dorsum ..... *G. macleayanum moggana* Couchman

—— Forewing above with basal area not green beyond cell . *G. macleayanum macleayanum* (Leach)

6 Hindwing vein M2 longer than forewing vein CuA2 7

—— Hindwing vein M2 shorter than forewing vein CuA2 8

7 Thoracic hairs ventrally light grey-brown ..... *G. batjanensis* Okano

—— Thoracic hairs ventrally pink ..... *G. kosii* n.sp.

8 Hindwing above with subterminal spots well developed ..... *G. stresemanni* (Rothschild)

—— Hindwing above with subterminal spots absent or vestigial 9

9 Hindwing subtornal spots either side of vein CuA1 with length similar to width ..... *G. weiskei weiskei* (Ribbe)

—— Hindwing subtornal spots either side of vein CuA1 with length much greater than width ..... *G. weiskei goodenovii* (Rothschild)

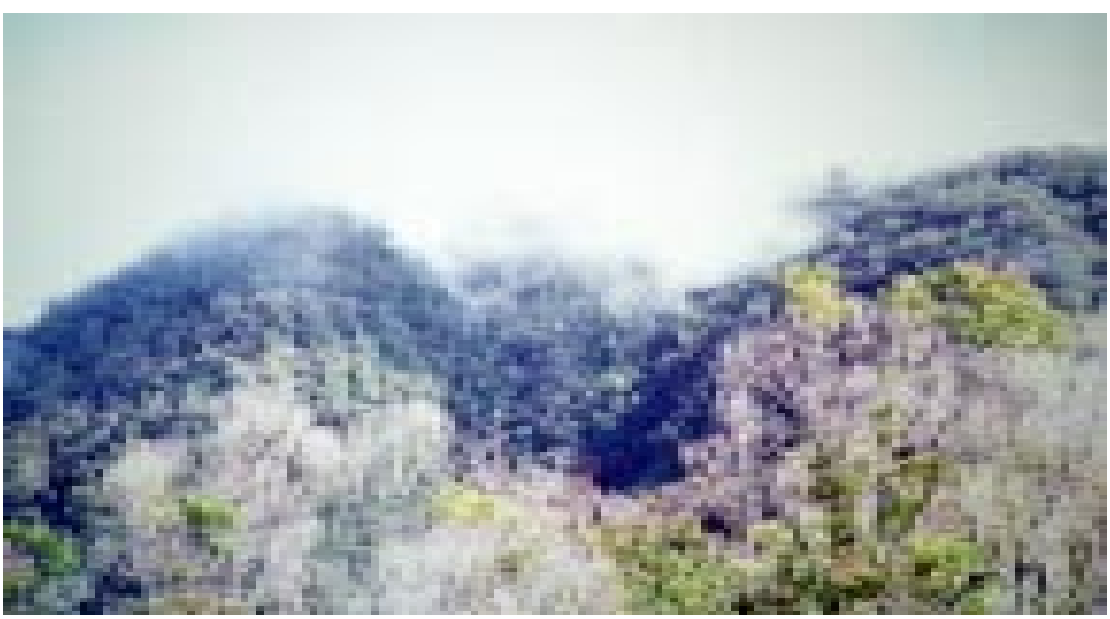


Figure 1. Hans Meyer Range southern New Ireland at 2300 m, c. 100 m below the summit—photograph of montane vegetation near the type locality.

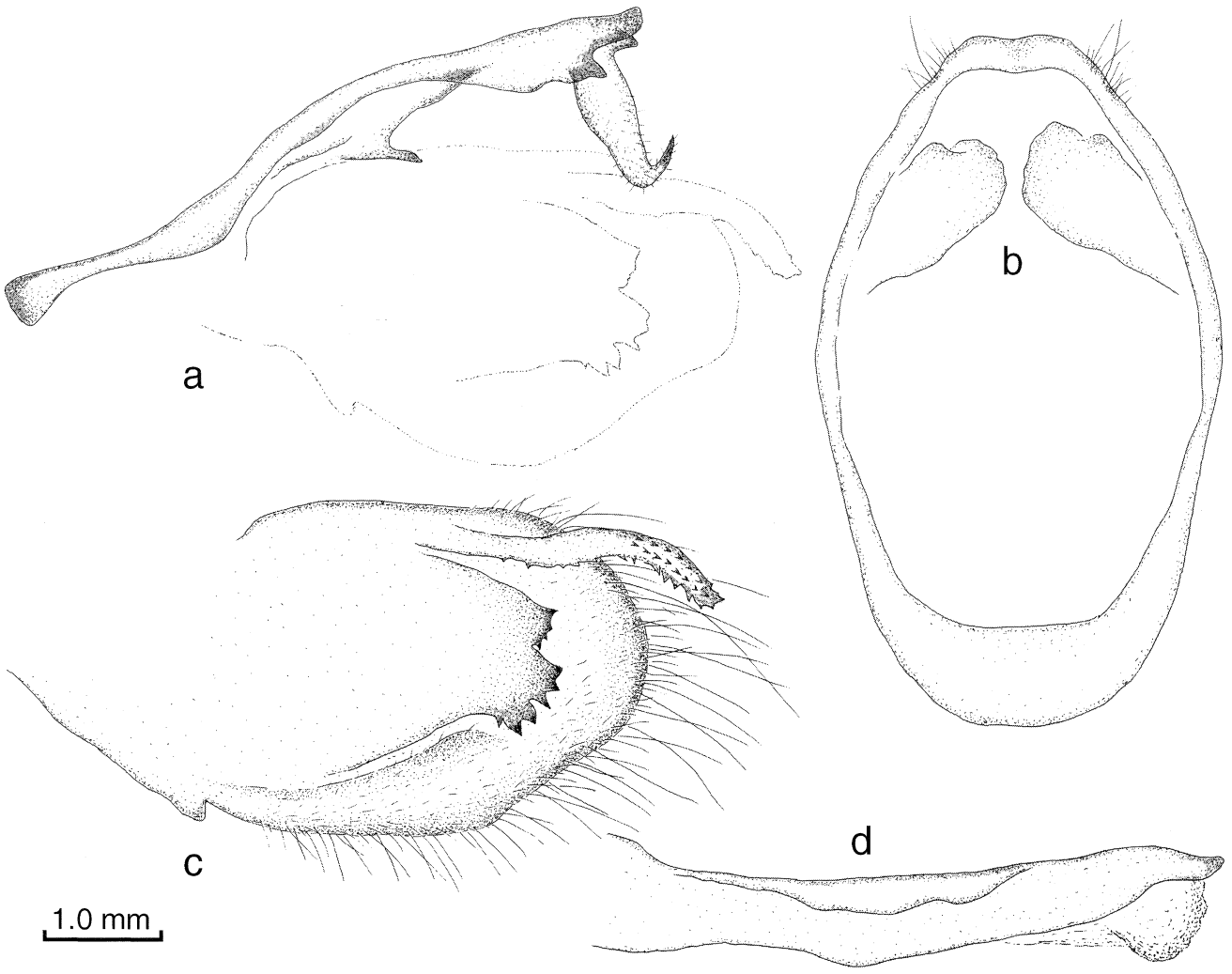


Figure 2. Male genitalia of *Graphium kosii* n.sp. (holotype ♂): a, lateral view; b, genitalic ring, dorsal view; c, left valva, lateral view; d, phallus, lateral view.

Graphium kosii n.sp.

Figs. 2a–d, 5–8

Type material. HOLOTYPE ♂, AM K111543, genitalia in vial attached to specimen in AM: "Lak district, Hans Meyer Range, 2400 m, S. New Ireland, 22 Aug. 1998, C.J. Müller". PARATYPES (44 ♂♂ and 5 ♀♀ all with same data as holotype unless otherwise indicated): 3 ♂♂ (one with genitalia dissected and attached to specimen) and 1 ♀ in ANIC; 3 ♂♂, 2 of which with genitalia dissected and attached to specimen and the third of which dated 20 August 1998, in BMNH; 3 ♂♂, 1 of which dated 20 August 1998 and 2 labelled "Lak district, Hans Meyer Ra., 1700 m, S. New Ireland, 18 Aug. 1998" in KONE; 3 ♂♂ (one with genitalia dissected and attached to specimen) in RNHL; 8 ♂♂ and 3 ♀♀, 4 of these 8 ♂♂ collected at an elevation at 1700 m and dated 18 August 1998 in CJMC; 15 ♂♂, 6 of which dated 20 August 1998, in DHC; 2 ♂♂ and 1 ♀ in SGC; 2 ♂♂ in RGC; 3 ♂♂, 1 of which dated 20 August 1998, in RMC; 2 ♂♂ in EPC.

Diagnosis. Forewing upperside basal and median markings brilliant turquoise, hindwings broad, ventral hairs on thorax and anterior segments of abdomen pink, genitalia with ring continuous, socii broad and simple, valva stepped.

Description. Male. (Figs. 5, 7). Head grey, covered with dense grey hairs above and pinkish-grey hairs beneath; antennae 19 mm long, brown, segmented deep brown-black, light brown ventrally, clubs broad and short, black dorsally and brown beneath; labial palpus, densely clothed with hairs, grey above, pinkish beneath. Thorax, densely haired, above grey-brown; beneath conspicuously greyish-pink; legs green. Abdomen, with thick hairs, deep grey-brown above and pinkish-brown beneath. Forewing 41.5 mm long, costa bowed strongly beyond postmedian area, termen straight between apex and vein M2, concave from vein M2 to CuA1, dorsum straight, above with ground colour black, a series of small, bluish-white submarginal spots from near costa to vein CuA2, congruent with termen except for proximal curve near apex; a large tear-shaped, dark green patch in postmedian area from, and normal to, costa to vein M2,

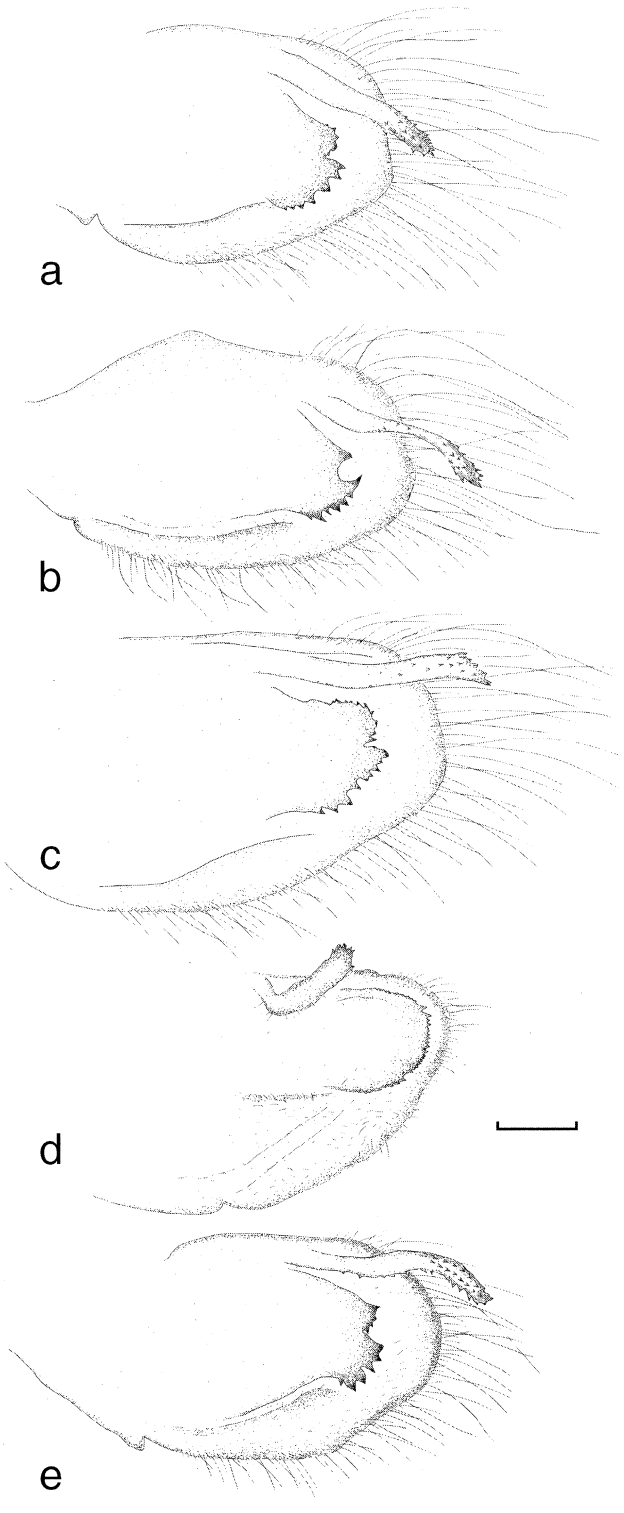


Figure 3. Lateral view of left valva. a, *G. weiskei* (Kerawagi, Papua New Guinea); b, *G. stresemanni* (Seram, Indonesia); c, *G. batjanensis* (Batjan, Indonesia); d, *G. macleayanum macleayanum* (Gosford, Australia); e, *G. kosii* n.sp. (New Ireland). Scale = 1.0 mm.

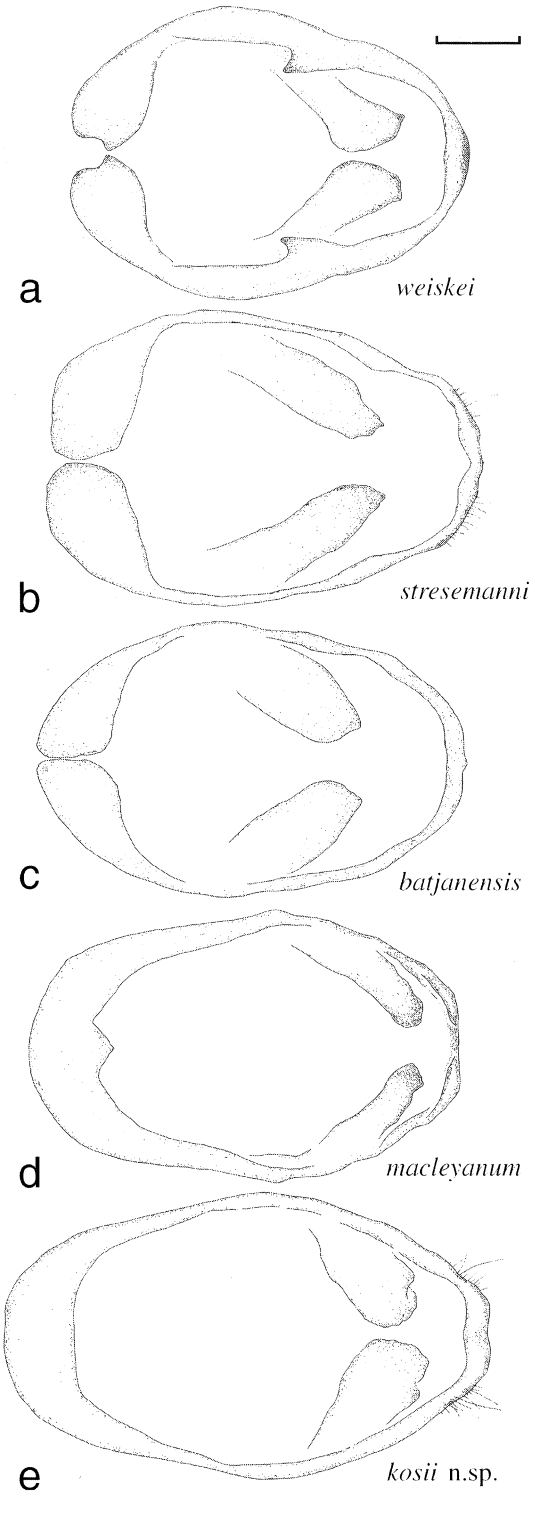
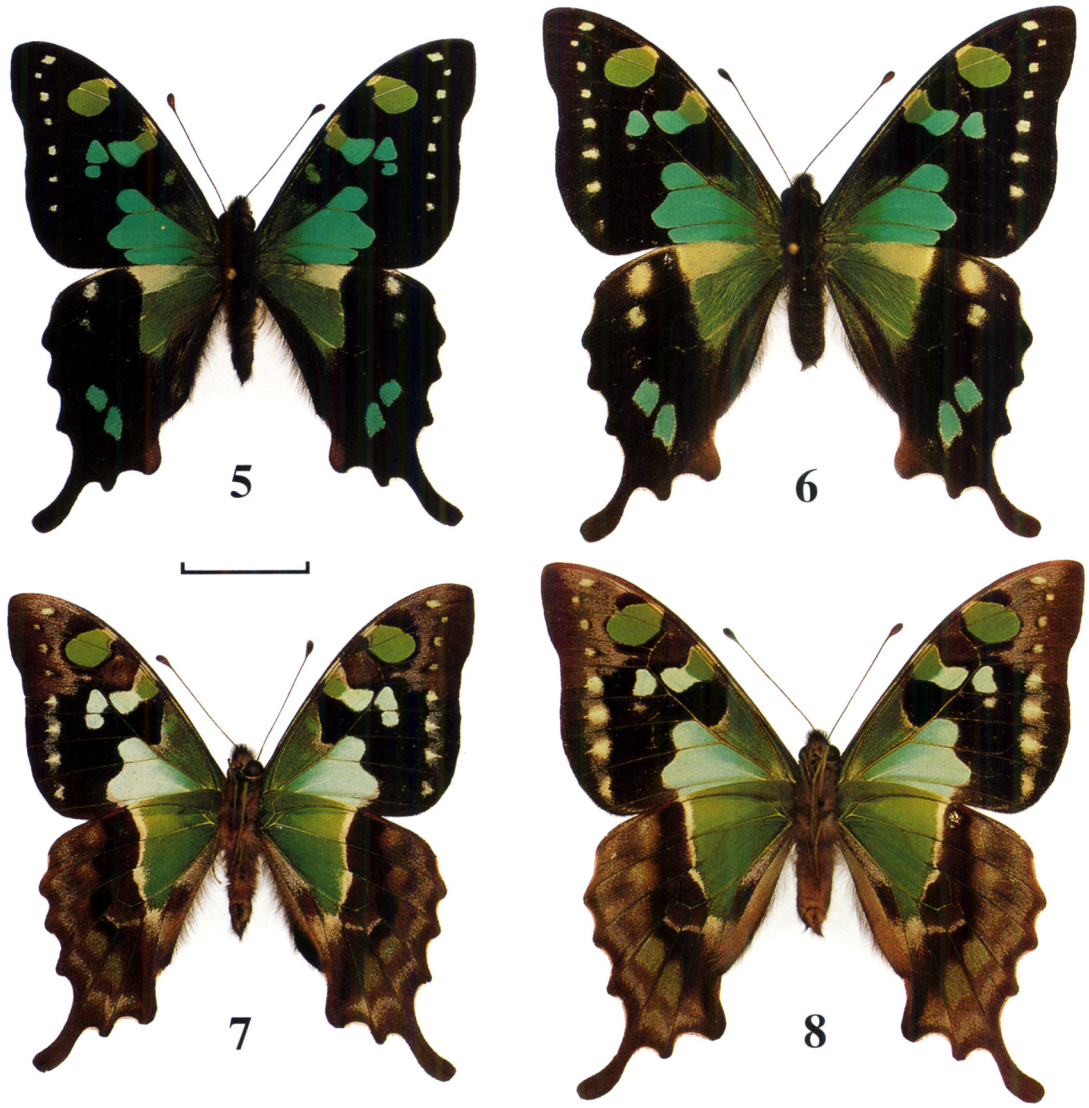


Figure 4. Dorsal view of male genitalic ring of *Graphium* species within the "*weiskei*" group, excluding *G. gelon*: a, *G. weiskei*; b, *G. stresemanni*; c, *G. batjanensis*; d, *G. macleayanum macleayanum*; e, *G. kosii* n.sp. Scale = 1.0 mm.



Figures 5–8. Adults of *Graphium kosii* n.sp. 3, holotype ♂ AM K111543, upperside; 4, paratype ♀ (CJMC), upperside; 5, holotype ♂, underside; 6, paratype ♀, underside. Scale = 20 mm.

intersecting veins white; a large "hour-glass" shaped marking in distal portion of cell approximately 1/5 distance from discocellulars to base, bright green in costal half and bright turquoise in remainder, two smaller turquoise spots in median area at end of cell to vein CuA1; a large basal turquoise area, below cell and vein CuA1, rounded distally between veins, basal portion of cell with obscure, deep green scales, often vestigial greenish-blue spot in middle of cell near costa, cilia narrowly black; beneath, ground colour brown in postmedian and apical area to vein M2, black in remainder, a series of small submarginal spots, greenish-white from apex to vein M2 and white and triangular in remainder, latter joined by scattered white scales; a postmedian patch near costa, shaped and coloured as above, median and basal pale markings shaped and positioned as in dorsal surface but bluish-white, costal half of "hour-glass" patch green; basal area with light blue scales below cell, large deep green area in cell, indented at lower half of cell in middle and tapered distally towards costa, white distal periphery, light brown scales in apical area tapering from costa to just beyond vein M3, cilia as above. Hindwing, narrow, with slightly spatulate tail at vein Cu A1, inner margin with fold supporting numerous dense grey sex hairs; lobed conspicuously at tornus, termen pronounced between veins; above ground colour black, deep green basal area from inner margin to junction of cell and veins Cu A2 and M2, concave at and white between vein Rs and costa, respectively; a small irregular white spot in apical area, vestigial blue spot beneath last spot; two turquoise tornal spots between veins M3 and Cu A2, well spaced, lower one larger and crescentic in shape, lobe chestnut brown, cilia pink or white; beneath, ground colour deep brown, darkening towards median area; a deep green basal area extending from bottom of cell and beyond, veins 1A+2A and Cu A2 and slightly bowed proximally to costa, narrowly crimson along costa at base and near apex; a white line of variable thickness separating basal area from brown distal 2/3 of hindwing; an acute, narrow white bar in median area

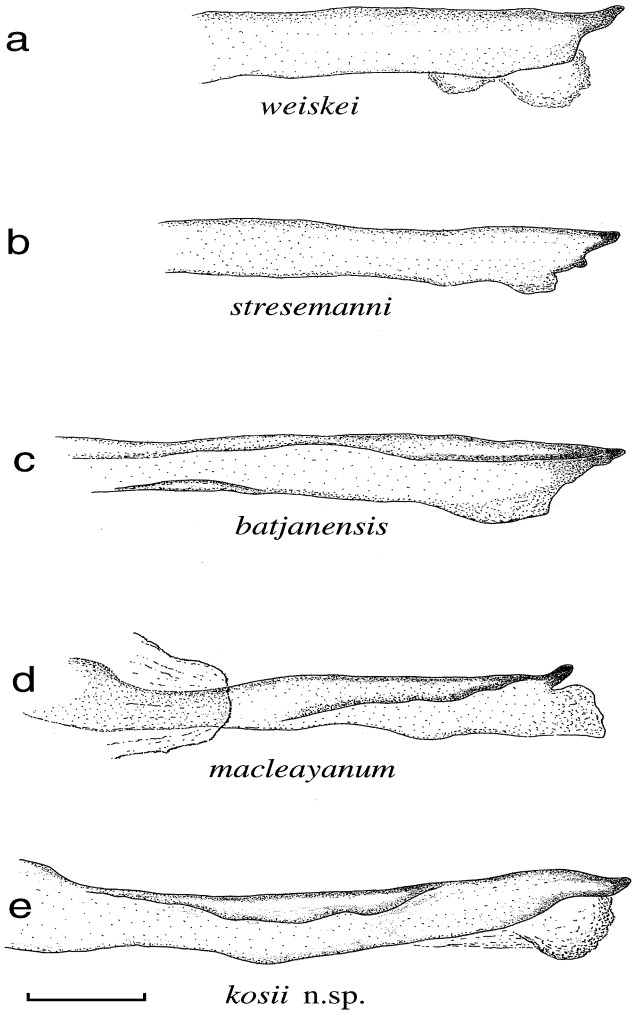


Figure 9. Lateral view of phallus of *Graphium* species within the "*weiskei*" group, excluding *G. gelon*: a, *G. weiskei*; b, *G. stresemanni*; c, *G. batjanensis*; d, *G. macleayanum macleayanum*; e, *G. kosii* n.sp. Scale = 1.0 mm.

between veins Cu A2 and M3, brownish-white scales between inner margin and cell, absent below junction of cell and vein 1A+2A, and also slightly bow-shaped brownish-white scales in submarginal area; vestigial bluish scales in tornal area identical in shape to tornal markings on upperside, cilia pink.

Female. (Figs. 6, 8). Similar to male but with both wings broader, submarginal spots in forewing much larger and whiter than in male, often extending to near dorsum; subapical white spots in hindwing upperside much larger and more obscure than in male, green and blue markings paler and slightly larger, postmedian spot below vein Cu A1 vestigial or absent; cell beneath with proximal green patch arcuate distally, submarginal markings beneath much paler than in male.

Male Genitalia. (Fig. 2). Genitalic ring long and continuous, oval-shaped, slightly concave anteriorly; socii broad; valva with ventrum straight, anteriorly toothed downward, aedeagus with anterior process.

Early stages. Unknown.

Measurements. Male forewing length 41.5 mm, antenna 19 mm; female forewing length 45 mm, antenna 21 mm.

Etymology. The new species name honours Tommy Kosi who, it is thought, collected the first specimens of this species.

Remarks. Only anecdotal information on Kosi's specimens can be found (L. Orsak, pers. comm., 1999). *Graphium kosii* n.sp. is the brightest species within the "*weiskei*" species group of *Graphium*. *Graphium kosii* may be readily separated from the other members of the species group by the colouration of the basal and median markings on the forewing above, which are deep turquoise, and by the broad hindwings which are only otherwise present in the Indonesian *G. batjanensis*. In addition, the hairs beneath the thorax and anterior segments of the abdomen are distinctly pink in *G. kosii*, a character developed elsewhere only in *G. macleayanum* and poorly in *G. weiskei*.

The genitalia of *G. kosii* provide useful diagnostic features in that the sociuncus ring is continuous and elongated posteriorly and the valva is distinctly stepped. Haugum & Samson (1981) recorded variability in the genitalia of *G. weiskei* but no such variability has been found among the five specimens of *G. kosii* examined, all of which fall outside the range of variation in the former species. The male genitalia of the other known species in the "*weiskei*" group are illustrated in Figs. 3–4.

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