

A new large *Oreophryne* species from the mountains of Papua Province, Indonesian New Guinea (Amphibia, Anura, Microhylidae)

Rainer Günther¹, Djoko T. Iskandar², Stephen J. Richards³

¹ Museum für Naturkunde, Herpetologie, Invalidenstr. 43, 10115 Berlin, Germany

² School of Life Sciences and Technology, Institut Teknologi Bandung, 10 Jalan Ganesha, Bandung 40132, Indonesia, and Basic Sciences Commission, Indonesian Academy of Sciences. 11, Jl. Medan Merdeka Selatan Jakarta 10110

³ South Australian Museum, North Terrace, Adelaide, South Australia 5000, Australia

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Corresponding author: Rainer Günther (rainer.guenther@mfn.berlin)

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Abstract

The microhylid genus *Oreophryne* reaches its greatest diversity in the New Guinea region, where more than 60 species have been documented to date. Most *Oreophryne* are small (<30 mm SVL) and only three species, *O. anthonyi*, *O. idenburgensis* and *O. inornata*, exceed 40 mm SVL adult body size. Here we describe a fourth large species of *Oreophryne* that was collected in 1998 from the mountains of Papua Province in western New Guinea. In having a cartilaginous connection between the procoracoid and scapula it is most similar to *O. idenburgensis*, a species known only from the mountains of central-western New Guinea but differs from that species in a suite of morphological characters including a broader head, a hidden (vs. visible) tympanum and a more pointed snout.

Key Words

Central cordillera, frog, Indonesia, morphology, new species, taxonomy

Introduction

Oreophryne Boettger, 1895 is the most diverse genus of microhylid frogs in the New Guinea region with 64 species recognised from mainland New Guinea and adjacent islands to date (Richards and Günther 2019, Frost 2022). Rates of discovery and description have increased dramatically in the past two decades with more than two thirds of *Oreophryne* species (45/64) from the New Guinea region described since 2000 (Kraus 2013, 2016, 2017a,b, Günther et al. 2018, Richards and Günther 2019) and numerous additional species in collections awaiting description. The majority of these are small species, with adult body

lengths rarely exceeding 35 mm (Menzies 2006, Kraus 2016). Just three species, *O. anthonyi* (Boulenger, 1897), *O. idenburgensis* Zweifel, 1956 and *O. inornata* Zweifel, 1956 reach body sizes in excess of 40 mm. Two of these, *O. anthonyi* and *O. inornata*, occur in southeastern New Guinea (Zweifel 1956, Menzies 2006), while *O. idenburgensis* is currently known from a single location on the northern slopes of the central cordillera in Papua Province, western New Guinea (Zweifel 1956, IUCN 2020).

Exploration of New Guinea's mountainous interior has revealed an exceptionally rich microhylid frog fauna. In

western New Guinea, important contributions to knowledge about the region's Microhylidae were made during a series of expeditions organised by Conservation International's Rapid Assessment Program (RAP) in collaboration with the Indonesian Institute of Science (LIPI) (Mack and Alonson 2000, Richards and Suryadi 2002). These surveys documented numerous undescribed microhylid species, several of which have subsequently been described including members of the genera *Choerophryne* van Kampen, 1914 (Günther et al. 2018), *Oreophryne* (Günther et al. 2001, 2018) and *Xenorhina* Peters, 1863 (Günther and Richards 2005). Among the species discovered during these RAP surveys is a large (>40 mm SVL) species of *Oreophryne* that resembles *O. idenburgensis* but differs from that species by a suite of morphological characters. Here we provide a description of the new species.

Material and methods

The male holotype was located at night by its advertisement calls. It was euthanized in an aqueous chlorobutanol solution (Gamble 2014), fixed in 5 % formalin and transferred to 70 % ethanol within two days of fixation. The following measurements were taken with a digital calliper (> 10 mm) or with a binocular dissecting microscope fitted with an ocular micrometer (< 10 mm) to the nearest 0.1 mm from the preserved specimen: **SUL** – snout-urostyle length from tip of snout to posterior tip of urostyle bone. **SUL** is generally slightly shorter than snout-vent length (**SVL**); as the measurement error is higher in the latter, we prefer to use the former. Both measurements are sufficiently similar (unpublished data) that, where relevant, we compared our **SUL** measurements with **SVLs** presented by other authors; **TL** – tibia length: external distance between knee and tibio-tarsal articulation; **TaL** – length of tarsus: external distance between tibio-tarsal and tarsal-metatarsal joints held at right angles; **FtL** – length of 4th toe, from tip of fourth toe to proximal end of inner metatarsal tubercle; **T4D** – transverse diameter of disc of 4th toe; **T1D** – transverse diameter of disc of first toe; **HdL** – length of 3rd finger, from tip of third finger to proximal edge of palm; **F3D** – transverse diameter of disc of 3rd finger; **F1D** – transverse diameter of disc of first finger; **Head length** and **Tympanum diameter** could not be measured because external tympana are absent; **HW** – maximum head width; **SL** – snout length, from an imaginary line connecting the centres of the eyes to tip of the snout; **EST** – distance from anterior corner of orbital opening to tip of snout; **END** – distance from anterior corner of orbital opening to centre of naris; **IND** – internarial distance between centres of nares; **ED** – eye diameter, from anterior to posterior corner of orbital opening.

Structure of the procoracoids was determined by superficially dissecting the chest region and staining cartilaginous elements with Alcian Blue. Colour of the holotype in life is described from digital photographs, and of preserved specimen from direct observations. Most

colours were determined according to a colour matching system created and administrated by the German RAL GmbH (https://en.wikipedia.org/wiki/RAL_colour_standard). When it was not possible to find an exact match between observed colours and RAL colour numbers, the most similar RAL number was chosen.

Comparative material was examined at the American Museum of Natural History, New York (AMNH), Natural History Museum, London (BMNH), Naturalis, Leiden (RMNH), Museum of Comparative Zoology, Harvard (MCZ), South Australian Museum, Australia (SAMA), Museum für Naturkunde Berlin (ZMB), and Museum Zoologicum Bogoriense, Cibinong, Indonesia (MZB). Additional information for comparisons was taken from Zweifel (1956). SJR and JCUNQ refer to original field collection numbers of S.J. Richards. The holotype is deposited in the collection of the Museum Zoologicum Bogoriense (MZB). We examined the following comparative material of large *Oreophryne* species: *Oreophryne anthonyi*, BMNH 1947.2.12.34–40 (cotypes, Papua New Guinea, Mount Victoria); *Oreophryne idenburgensis*, RMNH 10473, AMNH A49665–6, 49668 (paratypes, Indonesia, Papua Province, 18 km SW Bernhard Camp); *Oreophryne inornata*, BMNH 1956.1.1.21, AMNH A56731, 56903–4, 56984, 57259 (paratypes, Papua New Guinea, Goodenough Island). Additional material of *Oreophryne* species examined is listed in Richards and Iskandar (2000), Günther et al. (2001), Günther (2003a,b), Zweifel et al. (2005), Günther et al. (2009) and Günther (2015).

Taxonomy

Oreophryne chlorops sp. nov.

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Figs 1 and 4

Holotype. MZB.Amph.32875, adult male, unnamed mountain range, Derewo River Basin, Papua Province, Indonesia, (3.4416°S, 136.4738°E; ~2090 m a.s.l.), collected by Stephen Richards and Djoko Iskandar, 7th April 1998.

Diagnosis. A species of *Oreophryne* based on the presence of eleutherognathine maxillae and clavicles that do not extend to the scapulae. Size large (>40 mm SUL); bony clavicle strongly curved; cartilaginous procoracoid reaching scapula; fifth toe slightly longer than third; tympanum not visible externally; iris blue-green in life; W-shaped scapular folds and eye spot in lumbar region present.

Description of the holotype. Adult male (Fig. 1a–f) with a snout-urostyle length of 41.6 mm. Additional measurements and body ratios are listed in Table 1.



Figure 1. Adult male holotype of *Oreophryne chlorops* sp. nov.: **a** dorsolateral view of body; **b** lateral view of head, in life; **c**, **d** dorsal and ventral views of body; **e**, **f** palmar and plantar views, in preservative.

Snout subelliptical in dorsal view, rounded, scarcely protruding in profile; nostrils near tip of snout, directed laterally, not visible from above or below, distance between nares greater than distance between eye and naris (END/IND 0.90); canthus rostralis rounded; loreal region slightly skewed and slightly concave; tongue long, broad, free laterally and posteriorly without posterior indenta-

tion; posterior palatal ridge with 12 distinctly pronounced teeth; long vocal slits on both sides of mouth floor; tympanum not visible externally; prominent supratympanic fold present. Forelegs and hind legs moderately long; fingers unwebbed with large truncate, grooved terminal discs (disc of third finger 2.5 times wider than penultimate phalanx), their relative lengths $3 > 4 > 2 > 1$ (Fig.

Table 1. Body measurements and body ratios of the male holotype (MZB.Amph.32875) of *Oreophryne chlorops* **sp. nov.** All measurements in mm; for explanation of abbreviations see “Material and methods”.

SUL	41.6	TL/SUL	0.44
TL	18.5	TaL/SUL	0.32
TaL	13.3	FtL/SUL	0.48
FtL	19.9	T4D/SUL	0.053
T4D	2.2	T1D/SUL	0.053
T1D	2.2	HdL/SUL	0.36
HdL	15.1	F3D/SUL	0.079
F3D	3.3	F1D/SUL	0.063
F1D	2.6	T4D/F3D	0.67
HW	13.9	T1D/F1D	0.85
END	3.6	HW/SUL	0.33
IND	4.0	END/SUL	0.087
SL	6.1	IND/SUL	0.096
EST	5.3	END/IND	0.90
ED	4.8	ED/SUL	0.115
		SL/SUL	0.147
		EST/SUL	0.127

1e); all toes with wide, grooved terminal discs, those of fourth toe 1.8 times wider than penultimate phalanx; basal webbing present, most pronounced between toes 3 and 4 and least developed between toes 1 and 2; metatarsal and subarticular tubercles only faintly indicated as low protuberances; relative lengths of toes $4 > 5 > 3 > 2 > 1$ (Fig. 1f). A few tubercles on all dorsal and lateral surfaces, more conspicuous in life than in preservative; W-shaped mark in scapular region consists of short ridges and tubercles; lower surfaces of extremities smooth; abdomen, chest and throat slightly granular.

Colour in preservative: Dorsal surfaces of body and limbs (Fig. 1c) broom yellow (RAL 1032) with a few light ivory (RAL 1015) markings on extremities, in lumbar region (eye spots) and snout and a few brown beige (RAL 1011) markings on forelimbs and laterally of the W-shaped dorsal mark. Ventral surfaces (Fig. 1d) largely pearl white (RAL 1013), but forearms, lower legs and tarsi with ochre yellow (RAL 1024) patterns (as a result of Alcian Blue colouring parts of lateral surfaces, anterior surfaces of abdomen, and throat are now blue).

Colour in life: Dorsal and lateral surfaces of body and limbs beige (RAL 1001) or brown beige (RAL 1011) with beige-grey (RAL 7006) markings (Fig. 1a). A conspicuous semilunar lumbar spot is ivory (RAL 1014) surrounded by brown beige flecks; and an irregular spot in the tympanal region is brown beige; ventral surfaces pale, unspotted. Iris largely pastel turquoise (RAL 6034) with black veining, except golden near pupil and blackish-brown patch anterior and posterior of central part of pupil (Fig. 1b).

Distribution and ecological notes. *Oreophryne chlorops* **sp. nov.** is known only from the type locality in the mountains of Papua Province, Indonesia (Fig. 2).

The habitat is very mossy, wet mid-montane rainforest on steep, rugged terrain at about 2000 m a.s.l (Fig. 3). The holotype was calling from a *Pandanus* frond at a height of approximately 4 m, but the call was not recorded. Nine species of frog were collected at the type locality, including three other species of *Oreophryne*, all of which are of uncertain taxonomic identity (Richards et. al. 2000).

Suggested IUCN status. *Oreophryne chlorops* **sp. nov.** is currently only known from a single locality. However, large areas of suitable habitat at similar elevations remain

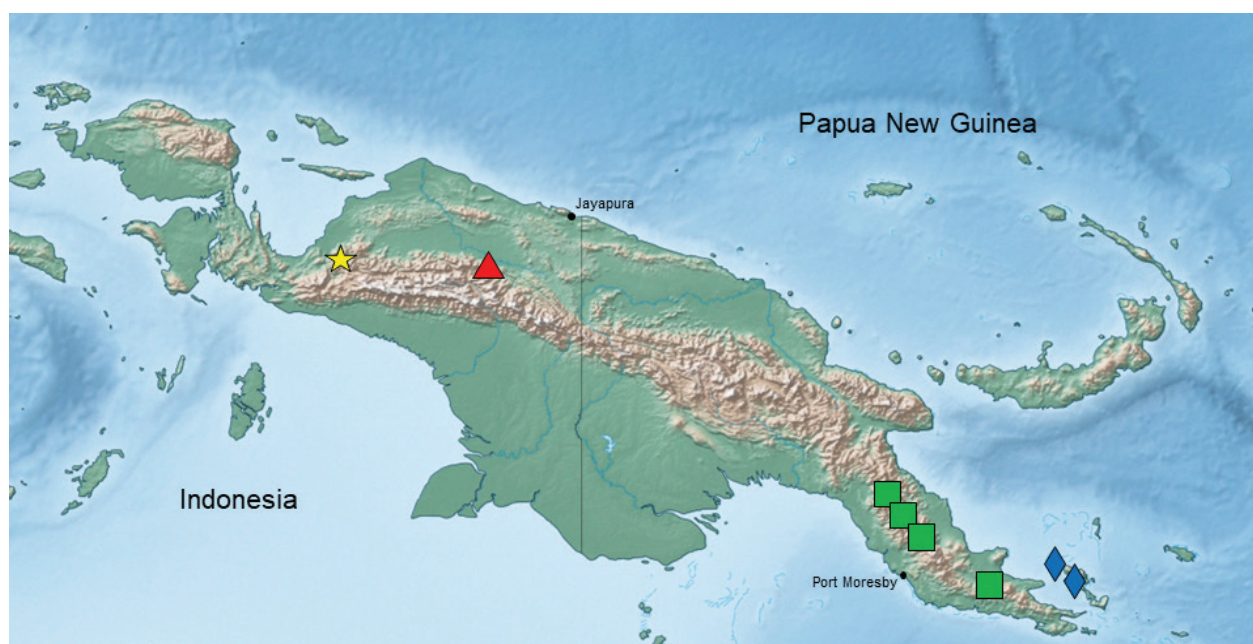


Figure 2. Distribution of four large *Oreophryne* species in the New Guinea region. **Yellow star** = *O. chlorops* **sp. nov.**, **red triangle** = *O. idenburgensis*, **green square** = *O. anthonyi* and **blue diamond** = *O. inornata*. Green squares may cover more than one known location.



Figure 3. Wet mossy forest interior at the type locality of *Oreophryne chlorops* sp. nov.

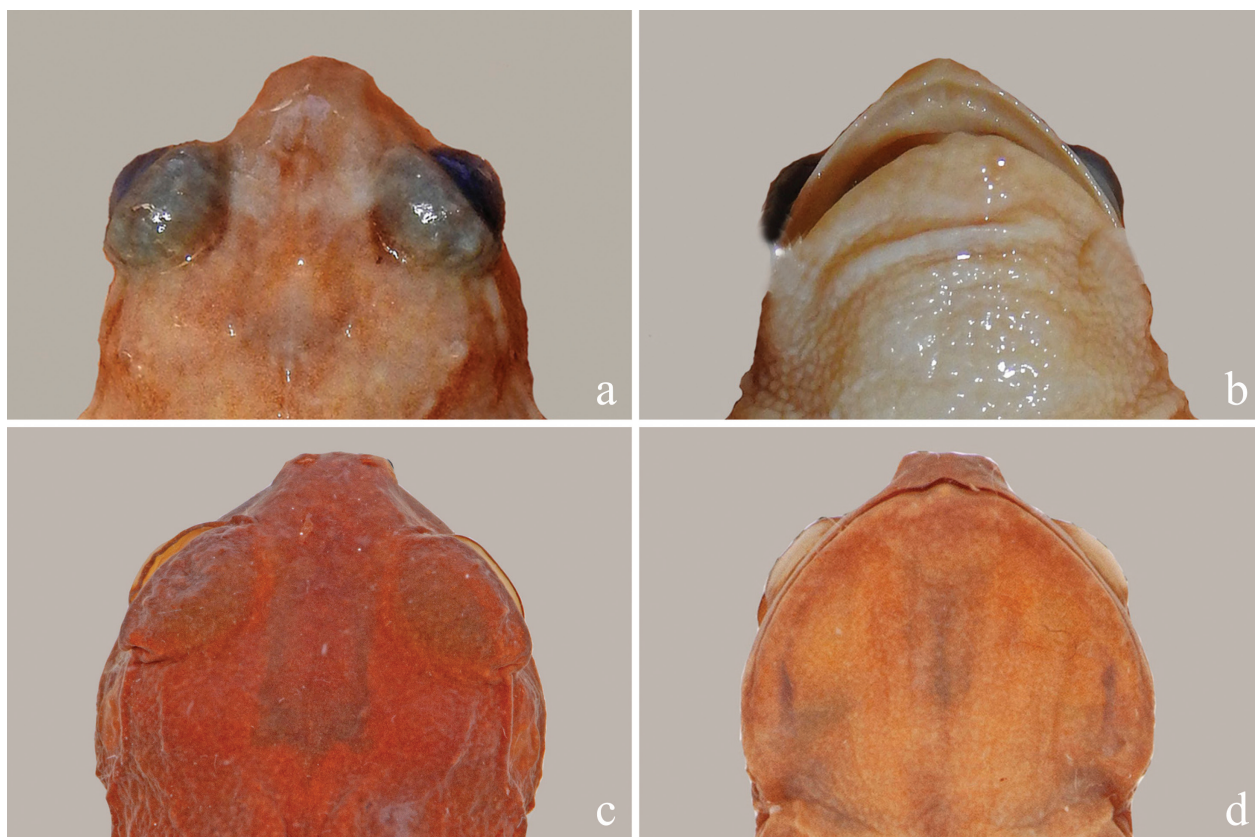


Figure 4. Snout shape in dosal and ventral views of *Oreophryne chlorops* sp. nov. (a, b) and *Oreophryne idenburgensis* (AMNH A49666) (c, d).

in nearby areas. Given the species' poorly known distribution and that threats are poorly understood, we recommend that this species should be considered as Data Deficient at this stage.

Etymology. The specific epithet is a combination of the ancient Greek adjective *chloros* meaning green, and the ancient Greek substantive *ops* meaning eye. *Chlorops* is

Table 2. Summary of morphological differences between *Oreophryne chlorops* and *O. idenburgensis*.

Feature	<i>Oreophryne chlorops</i> sp. nov.	<i>Oreophryne idenburgensis</i>
Tip of snout	Slightly pointed (Fig. 4a, b)	Truncate (Fig. 4c, d)
Head sides	Weakly convex (Fig. 4a, b)	Strongly convex (Fig. 4c, d)
Ratio HW/SUL	0.33	0.36–0.39, mean 0.38, n = 4
Lumbar ocellus	Present	Absent
W-shaped mark in scapular region	Present	Absent
Tympanum	Hidden	Visible
Ratio F3D/SUL	0.079	0.086–0.093, mean 0.090, n = 4
Ratio T4D/SUL	0.053	0.056–0.064, mean 0.061, n = 4

a compound noun in apposition meaning green-eye and refers to the blue-green iris colour of the holotype.

Comparison with other species. *Oreophryne chlorops* sp. nov. is distinguished from all congeners except *Oreophryne anthonyi*, *O. idenburgensis* and *O. inornata* by its very large size (adults exceeding 40 mm SUL). It can be distinguished from *Oreophryne anthonyi* and *O. inornata* by having a cartilaginous (vs. ligamentous) connection between the procoracoid and scapula, by its blue-green (pastel turquoise) iris in life (vs. dark brown in *O. anthonyi* and golden in *O. inornata*) and by its beige dorsum and pale cream venter in life (vs. dorsum “dark-mottled yellow-brown to dark reddish brown” and venter plain yellowish white in *O. anthonyi*; and dorsum orange-tan or yellow-tan and venter uniform lemon yellow in *O. inornata*) (Menzies 2006, Kraus 2016). *Oreophryne chlorops* is most similar to *O. idenburgensis* from which it can be distinguished by its hidden (vs. clearly detectable) tympanum, tapered (vs. truncate) snout in dorsal view (Fig. 4), broader head and smaller finger and toe discs (Tables 1, 2), and in having (vs. lacking) prominent lumbar spots and distinct W-shaped scapular folds (Fig. 1a). The major differences between these two species are summarised in Table 2.

Discussion

The description of *Oreophryne chlorops* brings to 64 the number of *Oreophryne* species known from the New Guinea region (Frost 2022). About 30 other members of the genus exhibit a cartilaginous connection between the procoracoid and scapula (Günther et al. 2018) but only one of these approaches the size of *O. chlorops* (Menzies 2006, Kraus 2016). The only *Oreophryne* of similar size that has a cartilaginous connection between the procoracoid and scapula is *O. idenburgensis*, which is also the species most proximate geographically to *O. chlorops* (Fig. 2). *Oreophryne idenburgensis* is known from a similar altitude (~2,100 m a.s.l.; Zweifel 1956) at a single location on the northern edge of New Guinea’s central cordillera, about 280 km to the west of the type locality for *O. chlorops* (Fig. 2). Given the morphological similarity of these two species they are probably closely related, but

a better understanding of the phylogenetic relationships among members of this diverse genus, including whether it represents a monophyletic assemblage, must await a detailed molecular study.

The blue-green iris of *O. chlorops* is unusual among *Oreophryne* species, being reported previously only for *O. ezra* Kraus and Allison, 2009, although the iris colour of a number of species that were described solely from preserved specimens remains undocumented. However, *O. ezra* is a small (SVL < 30 mm) species from Sudest Island in far-eastern New Guinea (Kraus and Allison 2009) and has a ligamentous connection between the procoracoid and scapula so it is unlikely to be closely related to the new species described here. Unfortunately, the iris colour of *O. idenburgensis* is unknown.

Oreophryne chlorops is currently known only from a single specimen, which was calling from 4 m high in a *Pandanus* tree on steep, rugged terrain that was difficult to traverse on foot. No other animals were heard calling, and the species has not been detected on subsequent surveys in the mountains of western New Guinea (S. Richards, unpublished data). Given the remoteness of the type locality (Mack and Alonso 2000), which was accessed by helicopter, the likelihood of returning to this location and obtaining additional material of *O. chlorops* is extremely low. Descriptions of new microhylid frogs based on limited samples, including singletons, is common (Allison and Kraus 2000, Günther et al. 2016, Günther and Richards 2021) and we believe that the unique specimen of *O. chlorops* is sufficiently distinct from all congeners to warrant formal recognition.

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