

A new species of the microhylid frog genus *Oreophryne* from the Mamberamo Basin of northern Papua Province, Indonesian New Guinea

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Received on October 12, 2009, accepted on October 30, 2009.

Published online at www.vertebrate-zoology.de on December 11, 2009.

> Abstract

A new species of the microhylid frog genus *Oreophryne* is described from lowland rainforest in the Mamberamo Basin of northern Papua Province, Indonesian New Guinea. The new species is distinguished from congeners by its small size (males 20.5–23.3 mm SUL) and advertisement call, a loud rattle lasting about two seconds. It is only the second member of the genus known to lay and then guard eggs attached to the underside of leaves in the forest.

> Kurzfassung

Auf der Basis von Materialsammlungen im Jahr 2000 im südlichen Mamberamo Becken, nördliche Papua Provinz, Indonesien, Neuguinea, wird eine neue kleinwüchsige (Männchen 20.5–23.3 mm Kopf-Rumpf-Länge) *Oreophryne*-Art beschrieben. Die Beschreibung basiert hauptsächlich auf morphologischen und bioakustischen Befunden. Es handelt sich erst um die zweite bekannte Art dieser artenreichen Gattung, bei der die Männchen Brutpflege betreiben.

> Key words

Amphibia, Anura, Microhylidae, *Oreophryne*, new species, Papua Province, Indonesia, New Guinea.

Introduction

The microhylid frog genus *Oreophryne* is one of the most speciose groups of frogs in New Guinea, and numerous new species have been collected and described from the island in the last two decades (e.g. GÜNTHER et al. 2001, GÜNTHER 2003 a, b, ZWEIFEL et al. 2003, 2005). Despite this, numerous additional undescribed species occur in collections and the total number of species in the genus is likely to at least double (RICHARDS, unpublished data).

Conservation International's Rapid Assessment Program (RAP) biodiversity surveys aim to document poorly-known biotas in tropical regions of the world, to promote conservation of these regions and to provide training for local field biologists. In September 2000 a RAP survey and training course in the Mamberamo Basin of Indonesian New Guinea documented

several undescribed frog species on the northern edge of the central cordillera (e.g. OLIVER et al. 2007). Here we describe a new species of *Oreophryne* obtained during that survey, and report the second example in the genus of egg-guarding behaviour involving straddling of eggs glued to leaves hanging above the forest floor (JOHNSTON & RICHARDS 1993).

Materials and methods

Most frogs were collected at night after locating them by their advertisement calls. Prior to collecting, recordings of advertisement calls were made whenever

possible. Photographs of some live specimens were also taken prior to collection. Frogs were anaesthetised the next day with chlorobutanol and fixed in 10% formalin. Prior to fixing liver tissue was taken from three specimens and fixed in 70% ethanol in order to allow later DNA sequencing. All specimens were preserved in 70% ethanol before depositing them in museum collections. One paratype (ZMB 74016) was cleared and double stained using a modified method from DINGERKUS & UHLER (1977).

Advertisement calls were recorded with a Sony Pro-Walkman WMD-6C Tape Recorder and Sony ECM-Z200 microphone. Calls were analysed in the laboratory with Avisoft-SAS Lab software.

Measurements of snout-urostyle length and tibia length to the nearest 0.1 mm were made with a digital calliper, all others with an ocular micrometer in a dissecting microscope:

SUL	snout-urostyle length, from tip of snout to distal tip of urostyle bone; (SUL and snout-vent length differ insignificantly, but SUL is more accurately measured)
TL	tibia length, external distance between knee and heel (calliper gently pressed)
TaL	tarsus length
L4T	length of fourth toe, from tip of toe to metatarsal tubercle
F3D	transverse diameter of third finger disc
F1D	transverse diameter of first finger disc
T4D	transverse diameter of fourth toe disc
T1D	transverse diameter of first toe disc
HL	head length, from tip of snout to posterior margin of tympanum
HW	head width, taken in the region of the tympana
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
TyD	horizontal diameter of tympanum

Abbreviations

AMNH	American Museum of Natural History, New York, USA
BMNH	The Natural History Museum (formerly British Museum of Natural History), London, UK
JCUNQ	James Cook University, Townsville, Australia
MCZ	Museum of Comparative Zoology, Harvard University, Cambridge, USA

MZB	Museum Zoologicum Bogoriense at Cibinong, Indonesia
NMW	Naturhistorisches Museum Wien, Austria
RMNH	National Museum of Natural History, Naturalis, Leiden, The Netherlands
mm	millimetre
ms	millisecond
s	second
SD	standard deviation
SAMA	South Australian Museum Adelaide, Australia
SMF	Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt/Main, Germany
ZMA	Zoologisch Museum Amsterdam, The Netherlands
ZMB	Museum für Naturkunde (formerly Zoologisches Museum) Berlin, Germany

Material compared. *Oreophryne albopunctata*, ZMA 5821, 5822, syntypes; *O. anthonyi*, BMNH 1947.2.12.34–40, cotypes; *O. asplenicola*, type series; *O. atrigularis*, type series; *O. biroi* (*Mehelyia affinis*), NMW 19826, fide Zweifel et al. (2003); *O. brevicrus*, AMNH 43694, 43697, 43700-2, paratypes; *O. brevirostris*, type series; *O. clamata*, type series; *O. crucifer*, ZMA 5819, syntype; *O. flava*, ZMA 5823, holotype, AMNH 58152-53, 58155-57; *O. frontifasciata*, RMNH 1807, lectotype; *O. geislerorum*, SMF 4197, holotype, NMW 19825: 1–4, fide Zweifel et al. (2003); *O. habbemensis*, type series; *O. idenburgensis*, RMNH 10473, AMNH A49665-6, A49668, paratypes; *O. inornata*, AMNH 56731, 56903-4, 56984, 57259, paratypes; *O. insulana*, AMNH 56732, 57265, 57266, paratypes; *O. kampeni*, BMNH 1947.2.12.14, holotype; *O. kapisa*, type series; *O. loriae*, BMNH 1947.2.12.41-42, cotypes; *O. minuta*, MZB Amp. 3877, holotype, MZB Amp. 3878, SAMA R54071-72, all paratypes; *O. moluccensis*, SMF 4203, lectotype; *O. parkeri*, MCZ 12964, holotype; *O. pseudasplenicola*, type series; *O. sibilans*, type series; *O. unicolor*, type series; *O. wapoga*, type series; *O. wolterstorffi*, ZMB 16853, holotype.

Oreophryne furu sp. nov.

Plate I, Figs. 1–7 and Table 1

Holotype. MZB Amp. 15912 (field number = FN JCUNQ 5698), adult male collected by S. RICHARDS, D. ISKANDAR and B. TJATURADI on 3 September 2000 near Furu Camp 3 km SE Dabra, Mamberamo Basin, (3°17'04"S, 138°38'10"E), 90 m elevation, Papua Province of Indonesia, Island of New Guinea. Paratypes. MZB Amp. 15913 (FN JCUNQ 5689), MZB Amp. 15914 (FN JCUNQ 5696), MZB Amp. 15915 (FN JCUNQ 5705), SAMA R64848 (FN JCUNQ 5692), SAMA R64849 (FN JCUNQ 5695), ZMB



Plate I. Holotype of *Oreophryne furu* sp. nov. (a) Dorsal view of head, (b) lateral view of head, (c) ventral view of right hand, (d) ventral view of right foot, (e) dorsal view of entire specimen, (f) ventral view of entire specimen.

74015 (FN JCUNQ 5688) and ZMB 74016 (FN JCUNQ 5690). All paratypes same data as holotype. SAMA 64849 is a female, all other types are males.

Diagnosis. A species of *Oreophryne* with a snout-urostyle length in males from 20.5–23.3 mm (one female measured 24.7 mm), ligamentous connection between



Fig. 1. Lateral view of the head of a paratype of *O. furu* sp. nov. with weakly pigmented loreal and subocular region.



Fig. 2. Lateral view of the head of a paratype of *O. furu* sp. nov. with strongly pigmented loreal and subocular region.

procoracoid and scapula, third and fifth toes approximately equal in length, fingers not webbed, webbing of toes reaching almost to distal subarticular tubercle of toe 3 and 5, finger discs somewhat broader than toe discs (mean ratio T4D/F3D 0.87), and having the following average proportions: TL/SUL 0.44, HL/HW 0.81, ED/SUL 0.136, TyD/ED 0.28, END/IND 1.04. No W-shaped mark in the scapular region and no lumbar ocelli. The advertisement calls are loud rattles of about 2 seconds, mean note duration 12.8 ms, mean inter-note length 31 ms, mean note repetition rate 23.8 notes per second.

Description of the holotype (Plate I). Adult male with a SUL of 22.4 mm. For further measurements and body ratios see Table 1. Head in the region of tympana broader than long (HL/HW 0.87). Snout truncate and with an obtusely angled tip from above (Plate Ia), and truncate, weakly protruding and with an inconspicuous elevation in profile (Plate Ib). Nostrils directed laterally and very close to tip of snout, distance between nares same as distance between eye and naris. Canthus rostralis sharply edged, scarcely bent from above, loreal region a steep, slightly concave slope. Tongue long and broad, without posterior notch, and free posteriorly. Prepharyngeal ridge with 12 denticles, long slits on both sides of the tongue are the entrances of one subgular vocal sac. Tympana small (TyD/ED 0.32) and partly (especially upper parts) covered by skin. A weak supratympanic fold does not reach beyond the tympanum posteriorly. Legs moderately long. A minute basal web between fingers 3 and 4, relative length of fingers $3 > 2 \approx 4 > 1$ (Plate Ic), all fingers with broad terminal discs, subarticular elevations low and rounded. Relative length of toes $4 > 5 \approx 3 > 2 > 1$, all with broad terminal discs, width of third finger disc is the same as that of disc of fourth toe; basal webbing extends to subarticular elevations

of fingers 3 and 5, the latter are low and rounded (Table Id). Terminal discs of all fingers and toes with deep circummarginal grooves.

In preservative dorsal surface is smooth, ventral surface of belly and throat shows a reticulate structure. Dorsal surface pale grey with diffuse dark brown markings (Plate Ie). Two narrow and very irregularly shaped dorsolateral stripes are more densely pigmented. The same applies also to the interorbital region, to a spot above the wrist joint and a small postocular stripe. Below this dark postocular stripe there is a broad whitish diagonal stripe reaching from the eye to the insertion of the foreleg. The dorsal surface of the snout shows a similar whitish colour. Conspicuous are dense dark brown pigmentations of the loreal and subocular regions including the snout tip. Chest and abdomen are largely unpigmented, plantar and palmar surfaces are densely stippled (Plate If). Colour of dorsal surfaces in life was a mixture of lighter and darker grey and brown areas and spots (similar to the colouration of the paratype on Fig. 7).

Morphological variation in the type series. Variation in body measurements and ratios are given in Table 1. Tympanum more or less covered by skin, and may be completely invisible as in MZB Amp. 15913. All preserved frogs exhibit pale grey dorsal and lateral surfaces with various dark brown pigmentations. These dark brown pigments may be arranged uniformly (as in SAMA 64849 and MZB Amp. 15915) or in more or less intensive spots and stripes. In most specimens there are two fairly irregular dorsolateral stripes and an interocular band. Generally, flanks are more densely pigmented and show some irregular spots. Loreal and subocular region is scarcely pigmented in some (Fig. 1) and strongly (black face mask, Fig 2) in others (for example in SAMA R64848). Consistent is a whitish dorsal surface of the snout and a whitish spot from eye

Tab. 1. Body measurements and proportions of the type series of *Oreophryne furu* sp. nov. MZB Amp. 15912 is the holotype, ZMB 74016 is cleaned and stained as an cartilage-bone preparation, SAMA 64849 is a female, all other paratypes are males.

Inventory number	ZMB 74015	MZB Amp. 15913	ZMB 74016	SAMA R64848	SAMA R64849	MZB Amp. 15914	MZB Amp. 15912	MZB Amp. 15915	Mean	SD
SUL	21.8	20.5	23.3	21.8	24.7	22.4	22.4	21.4		
TL	9.6	9.2	9.8	9.3	11.2	9.9	9.8	9.5		
TaL	6.5	5.8	6.5	6.4	7.1	6.6	6.7	6.1		
T4L	9.4	8.4	9.1	7.7	10.1	8.8	9.8	8.2		
T4D	1.0	1.2	1.6	1.1	1.3	1.5	1.4	1.3		
T1D	0.75	0.8	1.0	0.6	0.75	1.0	0.9	0.9		
F3D	1.4	1.4	1.7	1.5	1.4	1.6	1.4	1.5		
F1D	0.75	0.8	1.1	0.8	0.9	1.0	0.9	0.9		
HL	6.7		7.8	7.3	8.1	7.3	7.5	6.6		
HW	9.0	8.5	9.5	8.9	9.5	9.0	8.6	8.5		
END	2.2	2.0	2.2	2.1	2.5	2.1	2.1	2.1		
IND	2.1	1.9	2.2	2.1	2.2	2.0	2.1	2.0		
ED	2.8	2.7	3.2	3.1	3.0	3.1	3.1	3.0		
TyD	0.8		0.8	0.9	1.0	0.8	1.0	0.8		
TL/SUL	0.44	0.45	0.42	0.43	0.45	0.44	0.44	0.44	0.44	0.009
TaL/SUL	0.30	0.28	0.28	0.29	0.29	0.29	0.30	0.29	0.29	0.008
T4L/SUL	0.43	0.41	0.39	0.35	0.41	0.39	0.44	0.38	0.40	0.029
T4D/SUL	0.046	0.059	0.069	0.050	0.053	0.067	0.063	0.061	0.059	0.008
T4D/T1D	1.33	1.50	1.60	1.83	1.73	1.50	1.56	1.44	1.56	0.159
F3D/F1D	2.0	1.75	1.55	1.88	1.56	1.60	1.56	1.67	1.70	0.168
T4D/F3D	0.71	0.86	0.94	0.73	0.93	0.94	1.00	0.87	0.87	0.104
HL/SUL	0.31		0.33	0.33	0.33	0.33	0.33	0.31	0.32	0.009
HW/SUL	0.41	0.41	0.41	0.41	0.38	0.40	0.38	0.40	0.40	0.013
HL/HW	0.74		0.82	0.82	0.85	0.81	0.87	0.78	0.81	0.043
END/IND	1.05	1.05	1.00	1.00	1.14	1.05	1.00	1.05	1.04	0.046
ED/SUL	0.128	0.131	0.137	0.142	0.121	0.138	0.138	0.140	0.136	0.009
TyD/ED	0.29		0.25	0.29	0.33	0.26	0.32	0.27	0.28	0.035

to forelimb insertion. One specimen (SAMA R64848) exhibits a clearly defined mid-dorsal stripe, some specimens have only a fragmentary stripe and still others no mid-dorsal stripe at all. Ventral surfaces in two specimens (SAMA R64849 and MZB Amp. 15915) whitish and very sparsely stippled with small dark pigment dots. One specimen (SAMA R64848) has the dense stippling evenly distributed on the ventral surfaces and in the remaining specimens stippled areas are unevenly distributed. In most specimens extremities (especially palmar and plantar surfaces) and throat are more densely stippled than venter. Colour in life did not differ remarkable from that in preservative.

Vocalisation. Advertisement calls of *Oreophryne furu* are loud, harsh rattles (Figs. 3 and 4). Five calls had a mean duration of 1.88 s, minimum 1.71 and maximum 2.01 s. Call notes have 1–4 (mostly 3) pulse groups, the first note of a call generally consists of only one pulse and the first three notes are shorter than all the follow-

ing ones (Fig. 3, top). 179 notes from four calls were from 3–16 milliseconds (ms) long, mean note length 12.8 ms. 175 inter-note intervals were from 26–44 ms, mean 31 ms. Note repetition rate in four calls varied from 22–25, mean 23.8 notes/s. The dominant frequency band ranges from 2.5 to 3.5 kHz with its peak at 2.9 kHz. There is one harmonic band with much less energy and culminating at 8.8 kHz (Figs. 3, below and Fig. 4). Temperature during recording was 25.4 °C

Distribution. This species is currently known only from the vicinity of the type locality near Dabra in the Mamberamo Basin (Fig. 5)

Ecological remarks. Male *Oreophryne furu* called at night from leaves between 1.5 and 3 m above the ground in lowland rainforest adjacent to the Furu River, a small tributary of the Mamberamo River (Fig. 6). Males called only infrequently, and were extremely difficult to find. The female was found sitting on a leaf

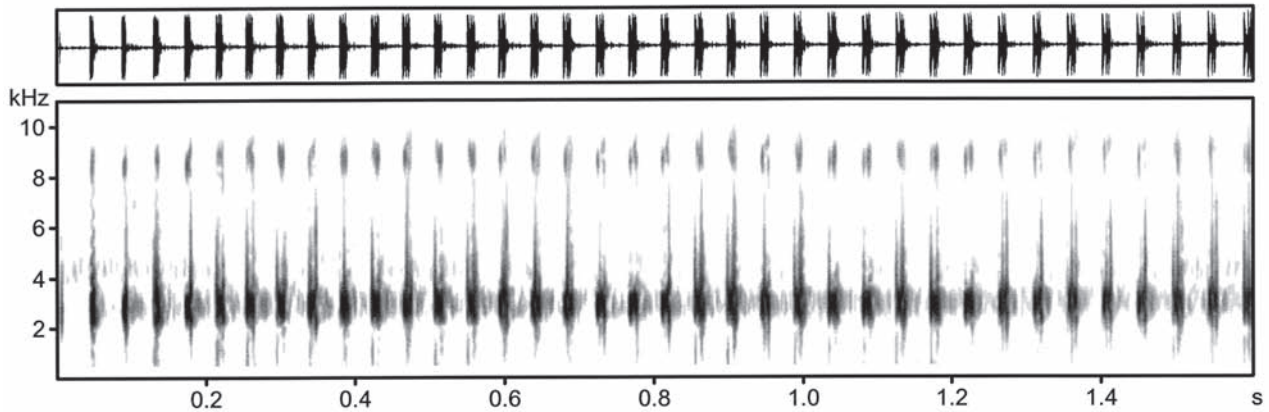


Fig. 3. Above. Wave form of an advertisement call from *Oreophryne furu* sp. nov., consisting of 37 notes. Below. Spectrogram of this call.

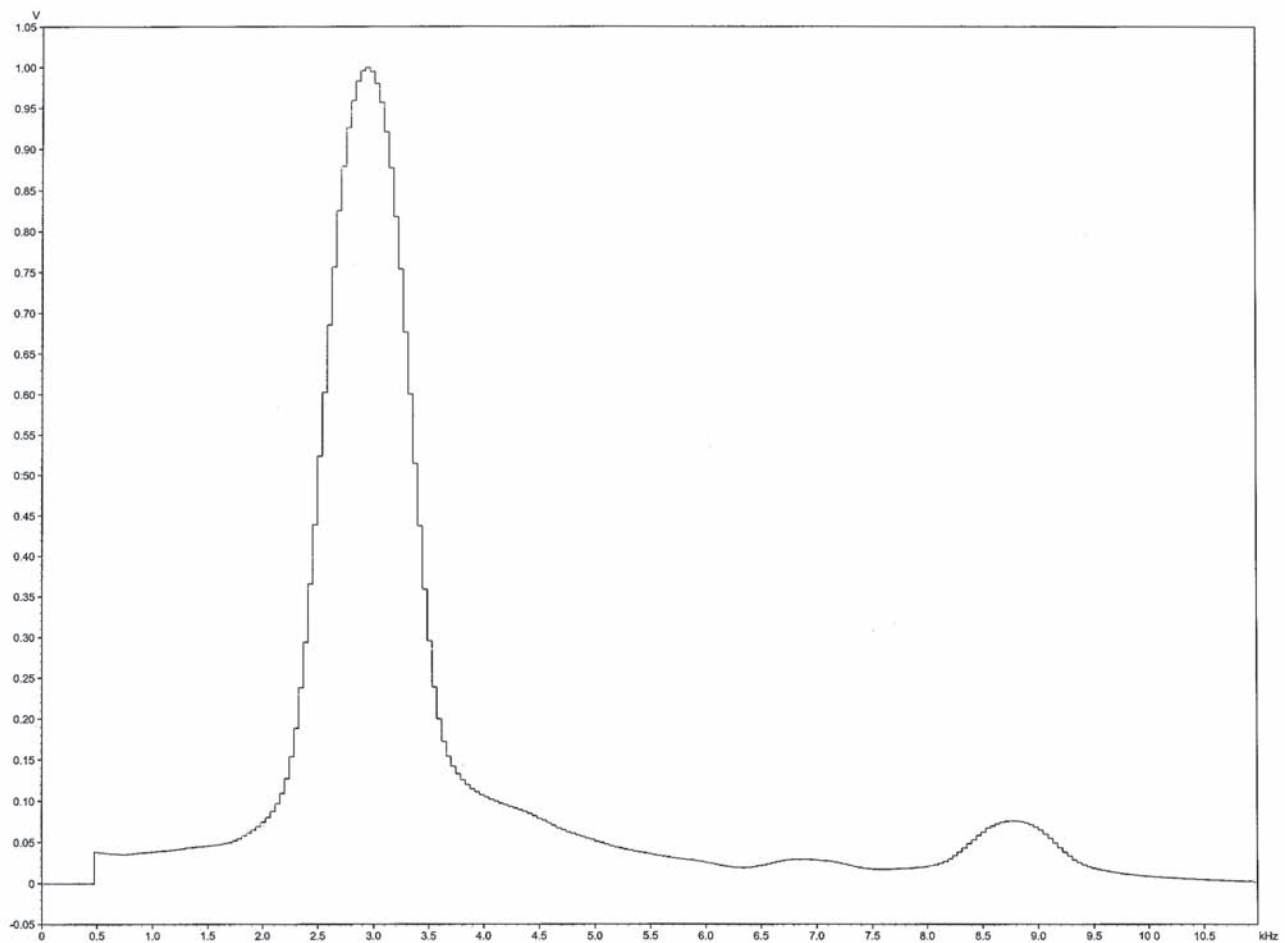


Fig. 4. Distribution of frequencies (power spectrum) of an advertisement call of *Oreophryne furu* sp. nov.

next to a trail at night and a male (MZB Amp. 15915) was found straddling a clutch of eight eggs on the under surface of a leaf 40 cm above the forest floor (Fig. 7). This behaviour is remarkably similar to that reported for an undescribed species of *Oreophryne* from southern Papua New Guinea by RICHARDS & JOHNSTON (1993) and BICKFORD (2004). BICKFORD (2004) demonstrated that in the Papua New Guinean species males reduced mortality of eggs by providing moisture to

avoid desiccation. Although that species is not conspecific with *O. furu*, differing in a number of morphological and acoustic features, it is likely that the two species' behaviour has the same function. Given the difficulty of detecting these small 'brooding' frogs hiding silently beneath leaves hanging in the forest it is entirely possible that additional species of New Guinean *Oreophryne*, and indeed other microhylid frogs, exhibit this unusual behaviour.

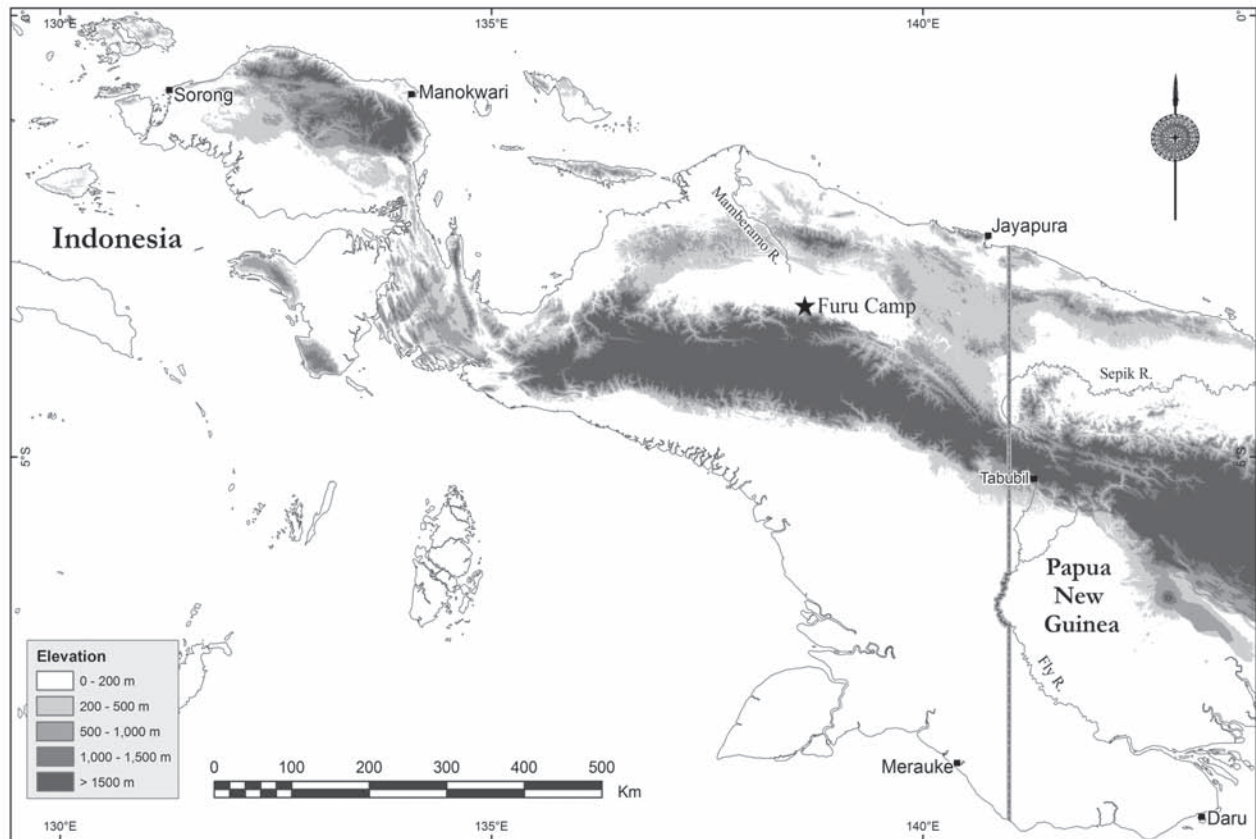


Fig. 5. Map showing type locality of *Oreophryne furu* sp. nov.

Etymology. “Furu” refers to the Furu River, a small tributary of the Mamberamo and is also the name given by local land-owners to our camp at the type locality.

Comparisons with other species. *Oreophryne atrigularis*, *O. asplenicola*, *O. clamata*, *O. crucifer*, *O. flava*, *O. idenburgensis*, *O. kampeni*, *O. lorae* (?), *O. notata*, *O. waira* and *O. wapogaensis* have a cartilaginous connection between procoracoid and scapula and differ by this character clearly from *O. furu* in which the procoracoid has a ligamentous connection of procoracoid and scapula. *O. alticola*, *O. brevicrus*, *O. brevirostris*, *O. geminus*, *O. habbemensis* and *O. terrestris* are short-legged species with small digital discs that live in exposed alpine grassy habitats at and above 2800 m while *O. furu* is an arboreal, lowland frog with large terminal discs. *O. furu* differs from *O. albopunctata* by a longer head (HL/SUL 0.31–0.33 compared with 0.25–0.26), larger eyes (ED/SUL 0.121–0.140 versus 0.106–0.107), a smaller tympanum (TyD/ED 0.25–0.33 versus 0.32–0.40), and by missing a W-shaped marking in the scapular region and lumbar ocelli. *O. furu* differs from *O. anthonyi* by, among other characters, its much smaller body size (SUL in the former is about half as long as that of the latter). *O. furu* differs from *O. biroii* by its smaller size (maximum SVL about 25 mm versus 29 mm in *O. biroii*), shorter tibiae (average TL/SUL 0.44 versus 0.47 in *O. biroii*) and adver-

tisement calls (a call of *O. biroii* lasts 3.7 s, note repetition rate is 18.1/s, dominant frequency at 2450 Hz and there is a strongly expressed harmonic at 4900 Hz). *O. furu* differs from *O. brachypus*, which is known only from the island of New Britain (Bismarck Archipelago), by a slightly greater body size, absence of webs on hands, and advertisement calls which in *O. brachypus* consists of a series of squeaks with a duration of about four seconds. *O. furu* differs from *O. geislerorum* most conspicuously in its smaller body size (largest male in *O. geislerorum* was 26.6 mm and largest female 29.4 mm) and its advertisement calls. The latter utters calls of 0.3–0.5 s with a dominant frequency of 3200–3400 Hz, note repetition rate 50–135/s. *O. furu* differs from *O. hysiops* by a broader head (average HW/SUL 0.40 in the former and 0.34 in the latter), larger eyes (ED/SUL in *O. furu* 0.121–0.142, mean 0.136, in the holotype of *O. hysiops* it is 0.113) and advertisement calls with predominantly unpulsed notes uttered at about 7–10 notes per s. *O. inornata* is larger (up to 42 mm SVL) than *O. furu* and was found up to now only on the Goodenough Island (east of mainland of New Guinea). *O. insulana*, known only from Goodenough Island in far-eastern PNG, utters rapid insect-like trills and has smaller toe discs than *O. furu* (T4D/SUL 0.032–0.042 versus 0.046–0.069). *O. kapisa* from Biak Island is a smaller species than *O. furu* (males with a SUL of 16.4–20.5 mm versus 20.5–23.3 mm)



Fig. 6. Lowland rainforest habitat of *Oreophryne furu* sp. nov. adjacent to the Furu River, Papua Province, Indonesian New Guinea.



Fig. 7. Male (MZB Amp. 15915) of *Oreophryne furu* sp. nov. guarding eggs on the underside of a leaf 40 cm above the ground in lowland rainforest.

with on average longer tibiae, shorter calls and longer internote intervals. *O. loriae* utters long notes with a harmonic structure quite unlike the loud rattles of *O. furu*. *O. minuta* is among others much smaller than *O. furu*. *O. notata* is smaller than *O. furu*, has unwebbed toes and its advertisement calls consist of peeping notes. *O. parkeri* can be distinguished from *O. furu* by its colour pattern (tiny white spots over all dorsal surfaces), internarial span (IND) conspicuously less than distance between eye and naris (END) and peeping advertisement calls. *O. sibilans* and *O. unicolor* also have advertisement calls consisting of peeping or whistling notes. *O. wapoga* has longer legs (TL/SUL 0.49–0.53 versus 0.42–0.45) and different advertisement calls. *O. wolterstorffi* differs from *O. furu* by a narrower head and more expanded webs between toes.

These comparisons between the new species and its congeners are based on our own studies of comparative material from various museums (see under materials and methods) and on the following literature: BOETTGER (1892), BOULENGER (1897), GÜNTHER (2003 a and b), GÜNTHER, RICHARDS & ISKANDAR (2001), KAMPEN (1909, 1923), LOVERIDGE (1955), MÉHELY (1897), MENZIES (2006), PARKER (1934), RICHARDS & ISKANDAR (2000), TYLER (1964, 1967), ZWEIFEL (1956, 2003), ZWEIFEL, MENZIES & PRICE (2003) and ZWEIFEL, COGGER & RICHARDS (2005).

Acknowledgements

Material reported here was collected during a RAP Biodiversity survey conducted by Conservation International in collaboration with the University of Cenderawasih (UNCEN). We are particularly grateful to SUER SURYADI, JATNA SUPRIATNA and MUHAMMAD FARID of Conservation International, and to FRANS WOSPAKRIK and SAM RENYAAN of UNCEN for their support, and to Drs SITI PRIJONO, ARIE BUDIMAN and DEDY DARNAEDI of LIPI for their approval of export permits and other courtesies. We are also extremely grateful to the local Papua CI staff who worked incredibly hard to make this survey happen, to the Mamberamo Adat Council, and particularly Mr. WEMPI BILASY for their support, and to the local community of Dabra who welcomed us to their land and assisted with this survey in numerous ways. HELLEN KURNIATI and MUMPUNI provided assistance in Cibunong and we are indebted to PAUL OLIVER, CAROLYN KOVACH and MARK HUTCHINSON at the South Australian Museum for their ongoing support. RANDAL STOREY kindly provided the map. LINDA FORD (then AMNH), COLIN MCCARTHY (BMNH), JOSÉ ROSADO (MCZ), FRANZ TIEDEMANN (then NMW), PIM ARNTZEN (RMNH), GUNTHER KÖHLER (SMF) and L. VAN TUIJL (then ZMA) kindly lent specimens deposited in collections under their care. Thanks also to FRANK TILLAK (Berlin) and NILS HOFF (ZMB) for technical support.

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